

Lower Thames Crossing

Design, construction and operations

Lower Thames Crossing

Approach to Design, Construction and Operation

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1 INTRODUCTION

1.1 Background

- 1.1.1 The Lower Thames Crossing (the 'Project') is a proposed new motorway connecting Kent, Thurrock and Essex through a tunnel beneath the River Thames. The Project will provide over 90% additional road capacity across the River Thames east of London.
- 1.1.2 The Project is classified as a Nationally Significant Infrastructure Project (NSIP), as defined by the Planning Act 2008 and was identified by HM Treasury as one of the top 40 priority investments in its National Infrastructure Plan 2013.
- 1.1.3 The Lower Thames Crossing Project is being developed as part of the Government's £15 billion Road Investment Strategy over the period 2015-2020.

1.2 The Project

- 1.2.1 The Lower Thames Crossing will comprise:
- approximately 14.5 miles (23km) of new motorway connecting to the existing road network from the A2/M2 to the M25
 - two 2.5-mile (4km) tunnels, one southbound and one northbound
 - three lanes in both directions with a maximum speed limit of 70mph
 - improvements to the M25, A2 and A13, where the Lower Thames Crossing connects to the road network
 - new structures and changes to existing ones (including bridges, buildings, tunnel entrances, viaducts, and utilities such as electricity pylons) along the length of the new road
 - a free-flow charging system, using remote payment, similar to that at the Dartford Crossing

1.3 Consultation

- 1.3.1 This report forms part of a suite of documents that we have published as part of the statutory consultation we are carrying out to support the DCO application process.
- 1.3.2 Statutory consultation is the stage where we present our proposals and listen to your feedback to help us develop the Project. The next stage is applying for a DCO.

1.4 Development consent

- 1.4.1 As the Lower Thames Crossing is an NSIP, we are required to make an application for a DCO to build, operate and maintain the Project. A DCO is similar to planning permission but is designed for NSIPs to make the process

clearer, faster and fairer. It does this by allowing many of the consents and permissions needed for the Project to be considered at the same time.

- 1.4.2 An Examining Authority, appointed by the Planning Inspectorate on behalf of the Secretary of State for Transport, has six months to examine the DCO application. During this process, local authorities, regulatory agencies, local communities and the public are invited to comment on the application.
- 1.4.3 After the examination is complete, the Examining Authority has three months to prepare and publish a report on the application to the Secretary of State for Transport with its recommendation.
- 1.4.4 The Secretary of State for Transport then has a further three months to decide whether to grant or refuse development consent. The Government has published a National Policy Statement for National Networks (NPSNN), which provides the framework within which the Examining Authority makes this recommendation, as required by the Planning Act 2008.
- 1.4.5 Once the decision has been made, there is a six-week period in which the decision may be challenged by judicial review.
- 1.4.6 If the development consent is granted, the DCO will be made by the Secretary of State and we would start construction in 2021. Contractors will be appointed to carry out the work as set out in the DCO and the road will be open for traffic in 2027.
- 1.4.7 We will seek appropriate consents and comply with relevant legislation for Project-related activity that does not fall within the DCO scope.

1.5 Highways England

- 1.5.1 Highways England is responsible for the delivery of the Lower Thames Crossing.
- 1.5.2 We are a government-owned company who work with the Department for Transport (DfT). We operate, maintain and improve England's motorways and major A-roads, also known as the strategic road network (SRN). Our aim is to ensure that road users have safer and more reliable journeys and that businesses have the effective road links they need to prosper.

1.6 Glossary

- 1.6.1 You can find explanations of terms and abbreviations used here in the glossary at the back of this document.

1.7 Structure of this document

- 1.7.1 The document is structured as follows:
 - a. Sections 2 to 8 (**Design approach**) describe our approach to the design of the Project, based upon the design principles set out in section 2.1. These sections also describe the constraints that we have considered in our development of the design.
 - b. Section 9 (**Route selection history overview**) outlines the process that we have followed to identify potential options for the Project. This includes

options considered in studies from 2009 up to the selection of the preferred route announced by the Secretary of State in April 2017. We also present a summary of re-appraisals that we have carried out since the preferred route announcement to validate the preferred route.

- c. Sections 10 to 15 (**Design development since preferred route**) set out how we have developed the preliminary design presented at statutory consultation from the design that we presented as the preferred route.
- d. Sections 16 to 19 (**Construction**) outline how we propose to construct the Project.
- e. Sections 20 to 23 (**Operations**) summarise how we plan to operate and maintain the completed Project.

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2 DESIGN APPROACH

2.1 Introduction

2.1.1 Our Project design philosophy recognises that it is a once in a generation opportunity to significantly improve connections between Kent, Thurrock and Essex and acknowledges the responsibility to create a Project of which our and future generations can be proud.

Design philosophy

2.1.2 Our design philosophy is developed within the following context supporting our Project ambition and Highways England *Strategic Business Plan 2015-2020* (www.highwaysengland.co.uk):

- a. To preserve and enhance – we seek to provide long-term protection and enhancement of the landscape that is affected by the Project.
- b. Promote legacy and development of the local environment to have a positive impact in our design – work closely with stakeholders to identify opportunities to create public spaces for present and future generations to enjoy.

Design principles

2.1.3 Building from our philosophy we have established a set of design principles that discipline us to meet this ambition throughout design development, construction planning, implementation and operation of the Project.

2.1.4 Our design principles are aligned with the 10 design principles set out in Highways England's *The road to good design* (www.highwaysengland.co.uk):

- a. Makes roads safe and useful
- b. Is inclusive
- c. Makes roads understandable
- d. Fits in context
- e. Is restrained
- f. Is environmentally sustainable
- g. Is thorough
- h. Is innovative
- i. Is collaborative
- j. Is long lasting

2.2 Design approach overview

2.2.1 Our design approach in developing the preliminary design for the Project presented at statutory consultation is as follows:

Identifying the need

- a. Compliance with DfT scheme objectives (see section 3.2)
- b. Designing for future traffic growth
- c. Increasing connectivity

Considering the existing conditions

- a. Minimising environmental impact including minimising impacts on communities, land and property
- b. Understanding and taking account of highly variable existing ground conditions
- c. Minimising impacts on physical constraints including utilities, the local road network, railways and rivers

Applying design standards

- a. Designing for safety
- b. Designing for operation and maintenance
- c. Setting architectural principles

Considering the future

- a. Taking a holistic approach to sustainable design at every stage
- b. Creating a positive legacy

2.3 Identifying the need

2.3.1 The first stage in designing the Project was to understand the issues on the strategic road network (SRN) and local roads in the area, both now and in the future. By undertaking this appraisal, we set out an overall strategy for the road capacity and connectivity that need to be provided by the Project.

Compliance with scheme objectives

2.3.2 The Client Scheme Requirements (see section 3) formally establish the need for the Project. In collaboration with DfT we have developed a set of scheme objectives to respond to this need. These are set out in more detail in section 3.

Designing for future traffic growth

2.3.3 We have developed an updated version of the traffic model used to inform our traffic assessments prior to the selection of the preferred route in April 2017. We

have used this updated model, the Lower Thames Area Model (LTAM), to predict the traffic flows on the Project route and the surrounding road network. We have forecast traffic flows for an assumed opening year of 2026 (which covers a range between 2025 and 2027) and a design year of 2041. Our approach to the design of the Project route, its junctions and the immediately affected sections of the strategic and local road networks is to accommodate the predicted traffic in 2041, as far as reasonably possible. This is to comply with the scheme objectives, particularly the transport related scheme objectives (refer to section 3). More details of the traffic modelling undertaken and predicted flows are provided in the *Traffic Forecasts Non-Technical Summary*.

Increasing connectivity

- 2.3.4 To increase connectivity, we have developed a junction strategy for the Project to provide free-flow junctions at the connections with the SRN (the M2/A2, A13 and M25) and grade-separated junctions at other locations where junctions have been considered or are to be provided.

2.4 Considering the existing conditions

- 2.4.1 To develop a design, it is essential to consider the existing conditions in the area. This includes both environmental conditions and the existing infrastructure.

Minimising environmental impact including minimising impacts on communities, land and property

- 2.4.2 The Project passes through an area which contains several environmentally sensitive and designated areas. We have identified these, and considered them through the development of our design, to seek to minimise the overall impact of the Project.

Existing ground conditions

- 2.4.3 The existing geotechnical conditions are an important factor in the design of the Project. They determine the type of structure and the form of their foundations. In addition, they determine the design and construction method for the tunnel. They also determine the design of the earthworks (cutting and embankments) including the angles of their slopes. We have obtained historic and geological information from external stakeholders including local councils, the Environment Agency (EA), British Geological Survey and landfill operators. We have also obtained information from site investigations carried out for other projects in the area such as High Speed 1. We are carrying out further ground investigations along the route to better understand the geology and inform the future development of the design.

Physical constraints including utilities and the local road network

- 2.4.4 The lower Thames area contains both locally and nationally significant infrastructure, including the existing road network, railway lines, and multiple utility assets. We have considered our interaction with these assets as we have

developed the design, seeking to minimise impacts and make connections with the road network where necessary.

2.5 Applying design standards

2.5.1 Our approach to design has been guided by standards and best practice (see section 5), which seek to ensure that the Project is safe to construct and operate, sustainable and creates a positive legacy for future generations.

Designing for safety

2.5.2 One of the scheme objectives is to improve safety (see section 3). This includes the safety of road users and road workers both during construction and future operation and maintenance of the Project. It also includes the safety of other people who could be affected by the construction and operation of the Project such as people living close to the route.

2.5.3 Our target is that, by 2041, no one should be killed or seriously injured when travelling or working on the Project. We will aim to achieve this through a progressive reduction in casualties by following these two core strategies:

- a. Implementation of operational safety, engineering and technology interventions for the Project road.
- b. Addressing secondary causes of collisions through involvement at national level with bodies including behavioural specialists, legal bodies, modal shift specialists, car manufacturers – vehicle technology and logistic companies. These bodies could influence those areas which fall beyond the area affected by the Project route.

Designing for operation and maintenance

2.5.4 We will design the Project so that it can be operated and maintained safely and efficiently in accordance with the operational strategy summarised in sections 20 to 23 including the asset management strategy set out in section 20.5.

Setting architectural principles

2.5.5 We will be designing our architecture to be in context with the local setting thus meeting one of our design principles, to be long lasting and to be environmentally sustainable. Our approach to achieving these aims is provided in section 6.

2.6 Considering the future

Taking a holistic approach to sustainable design

2.6.1 We have incorporated the Highways England sustainability strategy into the design approach. More information on the sustainability strategy is provided in section 7.

Providing a positive legacy

- 2.6.2 We are determined that the Project will create a powerful positive legacy for this and future generations. More information on our plans to deliver a positive legacy is provided in section 8.

3 Scheme objectives

3.1 Introduction

3.1.1 The scheme objectives for the Project were agreed between DfT and Highways England. These are recorded in the Client Scheme Requirements (CSR, Version 2.8). The CSR are the formal means by which DfT instructs Highways England to develop a project.

3.2 Scheme objectives

3.2.1 The CSR were used to develop a single set of scheme objectives for the Project, which are shown in Table 3.1.

Table 3.1 Scheme objectives

| Scheme objectives | |
|-------------------------|--|
| Economic | <ol style="list-style-type: none"> 1. To support sustainable local development and regional economic growth in the medium to long term 2. To be affordable to government and users 3. To achieve value for money |
| Community & environment | <ol style="list-style-type: none"> 4. To minimise adverse impacts on health and the environment |
| Transport | <ol style="list-style-type: none"> 5. To relieve the congested Dartford Crossing and approach roads and improve their performance by providing free-flowing north-south capacity 6. To improve the resilience of the Thames crossings and the major road network 7. To improve safety |

3.2.2 We appraised all options developed during the options appraisal carried out before the preferred route announcement (PRA) in April 2017 against these scheme objectives. We have carried out all subsequent development of the preliminary design presented at public consultation to ensure that the Project continues to meet these objectives.

4 Existing conditions

4.1 Introduction

4.1.1 Our approach to the design of the Project has included taking account of the existing conditions set out in this section. In taking account of these conditions, we have sought to avoid or minimise adverse impacts as far as possible.

4.2 Environmental conditions

4.2.1 Existing environmental conditions and constraints that we have considered are described in the *Preliminary Environmental Information Report (PEIR)*. The topics covered in the *PEIR* are:

- a. air quality
- b. cultural heritage
- c. landscape
- d. marine biodiversity
- e. terrestrial biodiversity
- f. geology and soils
- g. materials
- h. noise and vibration
- i. people and communities (including existing businesses, properties and public rights of way)
- j. road drainage and the water environment
- k. climate

4.2.2 Environmental considerations inform our approach to the evolution of the design. As a result, we are incorporating environmental design measures within highways design. This is to mitigate impacts arising from highways development and address effects on different environmental receptors. Examples of these measures are detailed in the *PEIR*. They are also shown in the Outline Environmental Masterplan.

4.2.3 Our landscape design has been developed to integrate the Project with the local character of the surrounding area and soften the visual impact. Our proposed landscaping aims to maintain local vegetation patterns and landform while ensuring that any biodiversity benefits have also been maximised.

4.2.4 We are considering environmental barriers in the form of earth mounding or green walls to provide screening from increased noise levels during the Project's operational phase. As part of our proposed landscaping, where

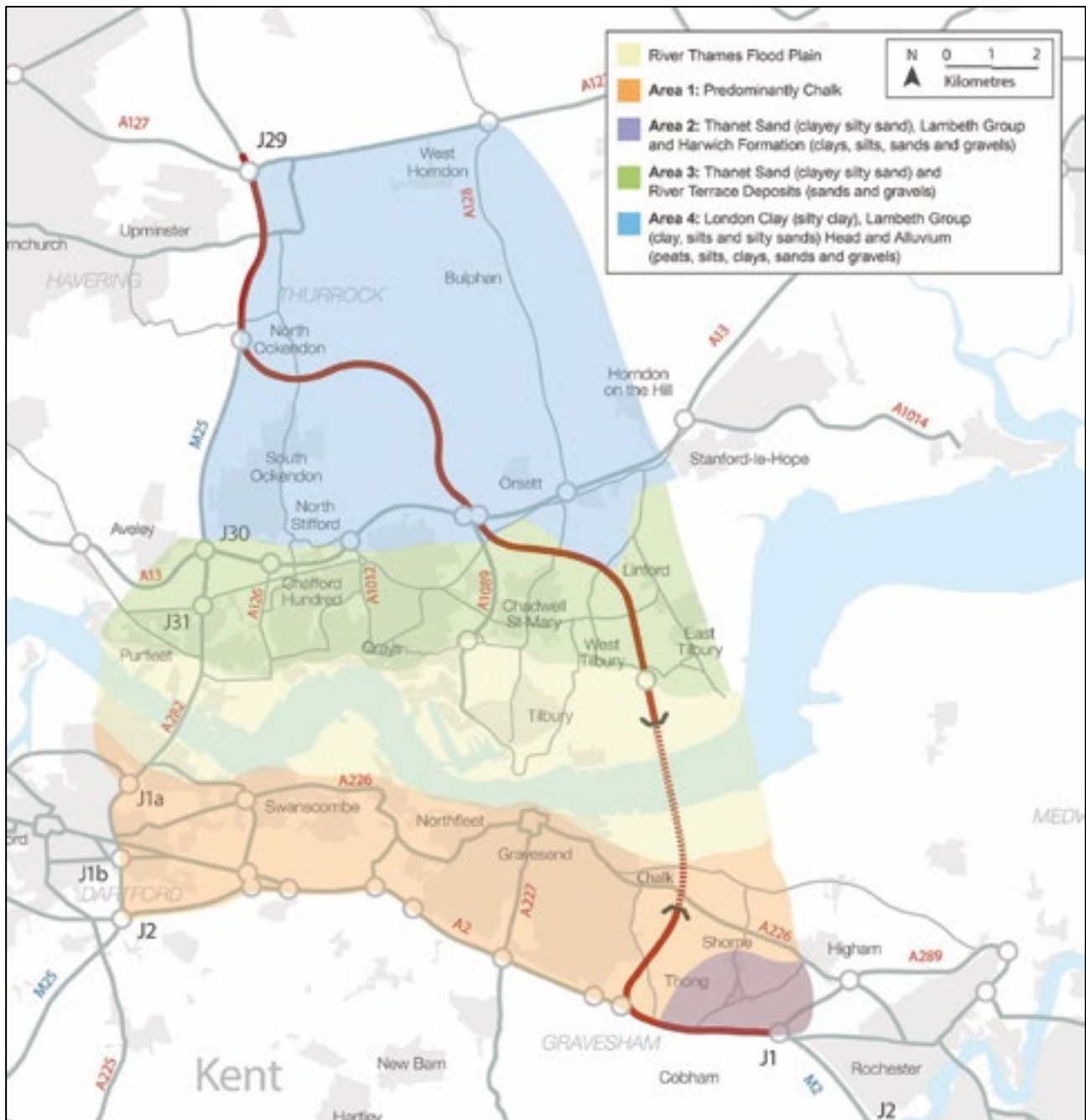
appropriate, any earthworks are also to be planted to minimise visual impacts on the landscape.

- 4.2.5 Our design for the Project has also considered biodiversity and we are exploring opportunities to identify the most suitable areas for potential habitat creation where significant effects on designated areas and protected species have been identified. This has informed our design process so that linkages between habitats and new wildlife corridors are incorporated within Project design. For example, the proposed green structures on the A2 corridor and Project route aim to connect new and existing habitats north-south and east-west.
- 4.2.6 To mitigate potential impacts on the water environment associated with the construction and operational phases of the Project, our proposed design includes measures to control water pollution and methods to drain surface water from the site effectively. This includes surface water outfalls, soakaways and the creation of balancing ponds.

4.3 Existing ground conditions

- 4.3.1 The existing geotechnical conditions are an important factor in the design of the Project. They determine the form of the foundations of structures and the design and construction method for the tunnel. They also determine the design of the earthworks (cutting and embankments) including the angles of their slopes.
- 4.3.2 The anticipated strata within the area of the Project comprise bedrock strata which include Chalk, Lambeth Group, Thanet Sand Formation, Harwich Formation and London Clay Formation, and superficial deposits which include River Terrace Deposits, Alluvium and Head Deposits. This is illustrated in Figure 4.1.

Figure 4.1 Primary geological areas



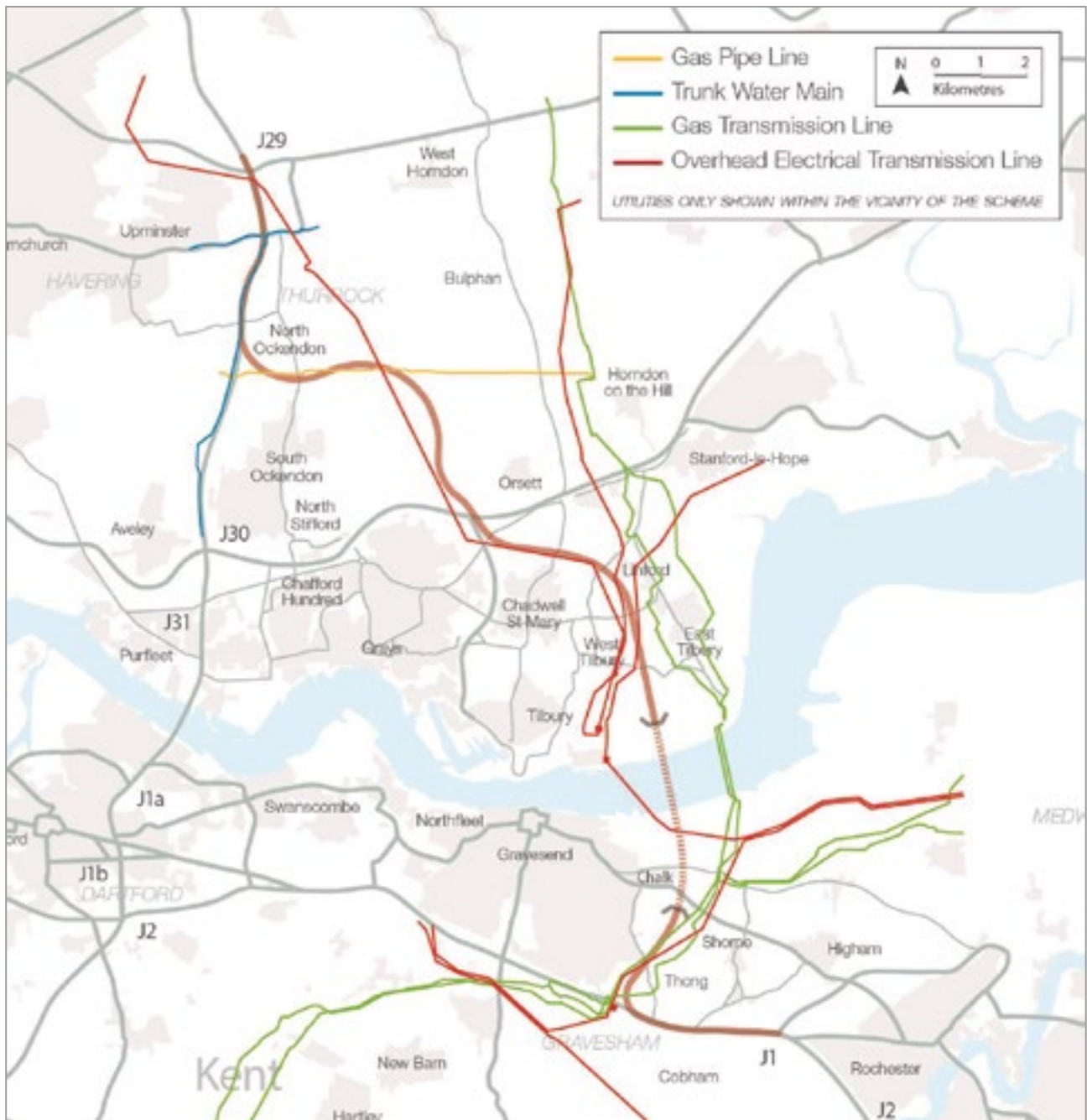
- 4.3.3 Made Ground materials are also present, in particular around the north portal and the former airfield in the south.
- 4.3.4 Potential contamination sources exist along and close to the route. Particular land uses of relevance include land raise and landfills located around the north portal and temporary construction areas along the north bank of the Thames. Other landfills are known to occur at various locations along the route as well as historic quarries (possibly infilled), tanks (current and historic) and industrial land uses (current and historic).
- 4.3.5 The area of the Project is situated on the southern limb of the London Basin syncline, which includes the strata up to the Thames Group. The strata dips very gently to the north-west at generally less than 2 degrees. Unconformably

overlying the Upper Chalk in the central part of the London Basin are Palaeogene deposits, which are mainly comprised of the Thanet Sand Formation and Lambeth Group. These are dominated by sands and clays. The Thames Group (mainly the London Clay Formation) is also present, although mainly in the area north of the A13.

- 4.3.6 The Palaeogene and Late Cretaceous deposits are overlain in places by Quaternary deposits mainly of Alluvium (with peat lenses and beds), River Terrace and Head Deposits. The Alluvium Deposits are most evident along the River Thames channel and subsidiary river channels, such as the Mardyke and the River Darent. The River Terrace Deposits are also present in places below the Alluvium to varying thicknesses. River Terrace Deposits dominate the hilltops and higher ground, especially to the north and to the south of the River Thames valley.
- 4.3.7 In the north, generally north of the Mardyke channel, around Ockendon but also continuing eastwards to Orsett, the London Clay Formation is present below the River Terrace and Head Deposits. It is shown in outcrop in many places where there have been old quarries and pits. However, most of these areas are shown on the geological maps as Worked Ground (described as mainly chalk, sand and gravel pits with little or no fill), and as Worked Ground and Made Ground (described as wholly or partly backfilled pits). The natural London Clay outcrops begin to appear intermittently around North Ockendon and become more regular in the far north of the study area near Little Warley along the A127 and to the east of the A128.
- 4.3.8 South of the Mardyke valley and north of the West Thurrock and Tilbury Marshes, the higher ground and hilltops consist of River Terrace Deposits overlying the Lambeth Group and Thanet Sand Formation; these in turn unconformably overlie the Upper Chalk Formation. In the West Thurrock area, where the land slopes gently towards the West Thurrock Marshes, the Upper Chalk is shown in outcrop. Although most of the area is shown as Worked Ground, which is described as mainly chalk, sand and gravel pits with little or no fill on the geological maps and Worked Ground and Made Ground, which is described as wholly or partly backfilled pits.
- 4.3.9 Similarly, on the south side of the River Thames Valley the Upper Chalk outcrops on the lower sides of the hills, although in the western area from Swanscombe to Dartford it is shown with hatching identifying Worked Ground and Worked Ground and Made Ground.

4.4 Utilities

- 4.4.1 We have obtained details of existing utilities within the area of the Project from utility companies. The principal utilities are high voltage electricity transmission lines and high-pressure gas transmission mains, both of which run beneath the River Thames at different points. There are also electricity and gas distribution networks and trunk water mains.
- 4.4.2 The major utilities are shown in Figure 4.2.

Figure 4.2 Major utilities in the Project area

- 4.4.3 On the south side of the River Thames are two parallel overhead electricity transmission lines which run from a substation south of the A2 near Cobham services, over the A2 with their large supporting pylons located either side of the dual carriageway, to approximately 1km east of Chalk. Following a similar corridor are a pair of major gas transmission pipelines.
- 4.4.4 There are overhead transmission lines from the east which run parallel with the Thames and Medway Canal, these end at a pylon on the south bank of the River Thames to the east of the Metropolitan Police Specialist Training Centre. At this point the lines go into a cable tunnel below the river running in a north-westerly direction towards Tilbury power station.

- 4.4.5 The gas transmission pipelines also cross the river via a tunnel towards Coalhouse Fort.
- 4.4.6 On the north side of the river there are a large number of overhead transmission and distribution lines that run north from a substation at Tilbury. These run north and then east. There are overhead distribution lines running parallel to and south of the Tilbury loop railway from a substation at Fort Road towards East Tilbury. There is also a network of overhead lines and buried cables between the substations at Tilbury and Fort Road.
- 4.4.7 The gas transmission pipelines from south of the river run between West Tilbury and East Tilbury and then north, eventually crossing the A127 to the east of the A127/A128 grade separated junction.
- 4.4.8 To the north of South Ockendon there is a gas pipeline transmitting gas to Barking power station. This runs east to west close to the proposed Project route.
- 4.4.9 A trunk water main runs north to south on the west side of the M25 at Ockendon.
- 4.4.10 There is a significant amount of other utility infrastructure throughout the area including low voltage electricity lines and buried cables, gas and water distribution mains, sewers, and fibre optic and copper telecoms cables. These are largely concentrated along the existing road corridors.

4.5 Strategic road network

- 4.5.1 Figure 4.3 shows the existing road network, including strategic roads and local roads, in the area of the Project. Our approach to the design of the Project has been to connect to the SRN at appropriate locations to meet the scheme objectives.

Figure 4.3 Existing road network near the Project and in the surrounding area



A2 and M2

4.5.2 The A2 is a 4-lane dual carriageway from the A282/M25 junction 2 to M2 junction 1 with 6 grade separated interchanges along this length at Bean (B255), Ebbsfleet (B259), Northfleet (B262) and 3 junctions for Gravesend with the middle junction connecting with the A227. The M2 then continues south-east with 4 lanes in each direction, except through junctions (reduction to 3

lanes), to its junction with the A229 (junction 3). The M2 then continues south-east towards Canterbury, becoming the A2 again before Dover.

A13 and A1089

- 4.5.3 North of the River Thames there are three main A-roads, the A13, A1089 and A127. These roads form strategic commercial connections from the M25 to Tilbury Port and London Gateway Port (DP World) and connections to towns including Basildon, Tilbury, Grays, Corringham, Southend-on-Sea and Canvey Island.
- 4.5.4 East of the M25 the A13 runs west to east with 5 grade separated interchanges along this length at the A126, A1012, A1089, A128 and A1014. The carriageway is predominantly dual-3 lanes between the M25 junction 30 and the A128 junction. The section between the A128 and the A1014 is currently a 2-lane dual carriageway, but Thurrock Council have recently started work to widen this section to dual-3 lanes. The A13 also runs west from M25 junction 30 to London. An improvement scheme on the A13 at M25 junction 30 was completed in early 2017.
- 4.5.5 The A1089 is a link between the A13 and Tilbury Port. The majority is 2-lane dual carriageway with the southern end a single carriageway.

M25

- 4.5.6 At the point that the Project's route is proposed to join the M25 it is a dual 4-lane carriageway having been widened from dual-3 lanes in a scheme that widened between junctions 27 and 30 and was completed in 2012. Most of this section has hard shoulders but there are some discontinuities at structures. Through junction 29 there is a reduction to dual-3 lanes with hard shoulders. This section has gantries with lane signalling but is not operated as a controlled motorway with variable mandatory speed limits.

4.6 Local road network

- 4.6.1 The key local roads are shown in Figure 4.3. Our approach to the design of the Project has been to maintain existing connections as far as possible. We have also sought to avoid adverse effects and provide improvements where possible.

South of the river

- 4.6.2 The A289 is a dual carriageway which connects junction 1 on the M2 through to London Thamesport and Grain power station.
- 4.6.3 The A229 is a dual carriageway connecting junction 6 of the M20 to junction 3 of the M2. It is generally a dual 2-lane carriageway but has an additional southbound climbing lane approaching M2 junction 3. Other roads connecting the M20 and M2 include the A249, a dual carriageway connecting M20 junction 7 to M2 junction 5, and the A228, a single carriageway connecting M20 junction 4 to M2 junction 2.
- 4.6.4 To the south of the River Thames there are several single carriageway roads including Lower Higham Road, the A226 and Thong Lane. These roads provide a connection between Gravesend and the A2/M2 and smaller villages including Shorne and Higham.

- 4.6.5 There are also a number of local roads that connect to or cross the A2 to the east of Gravesend. These include Hever Court Road, Henhurst Road, Valley Drive and Brewers Road.

North of the river

- 4.6.6 To the north of the River Thames there are several single carriageway roads including the A128, Fort Road, Brentwood Road, Orsett Road, Muckingford Road and the A1013 Stanford Road which runs roughly parallel to the A13 between Grays and Stanford-le-Hope. These roads provide connections between Tilbury and the surrounding urban areas, East Tilbury, Orsett and north to the A127.
- 4.6.7 The A127 which is an Essex County Council and Southend-on-Sea Council road is located towards the northern limit of the area. It is a dual 2-lane carriageway linking London to Southend-on-Sea. The A127 runs west and east from M25 junction 29.

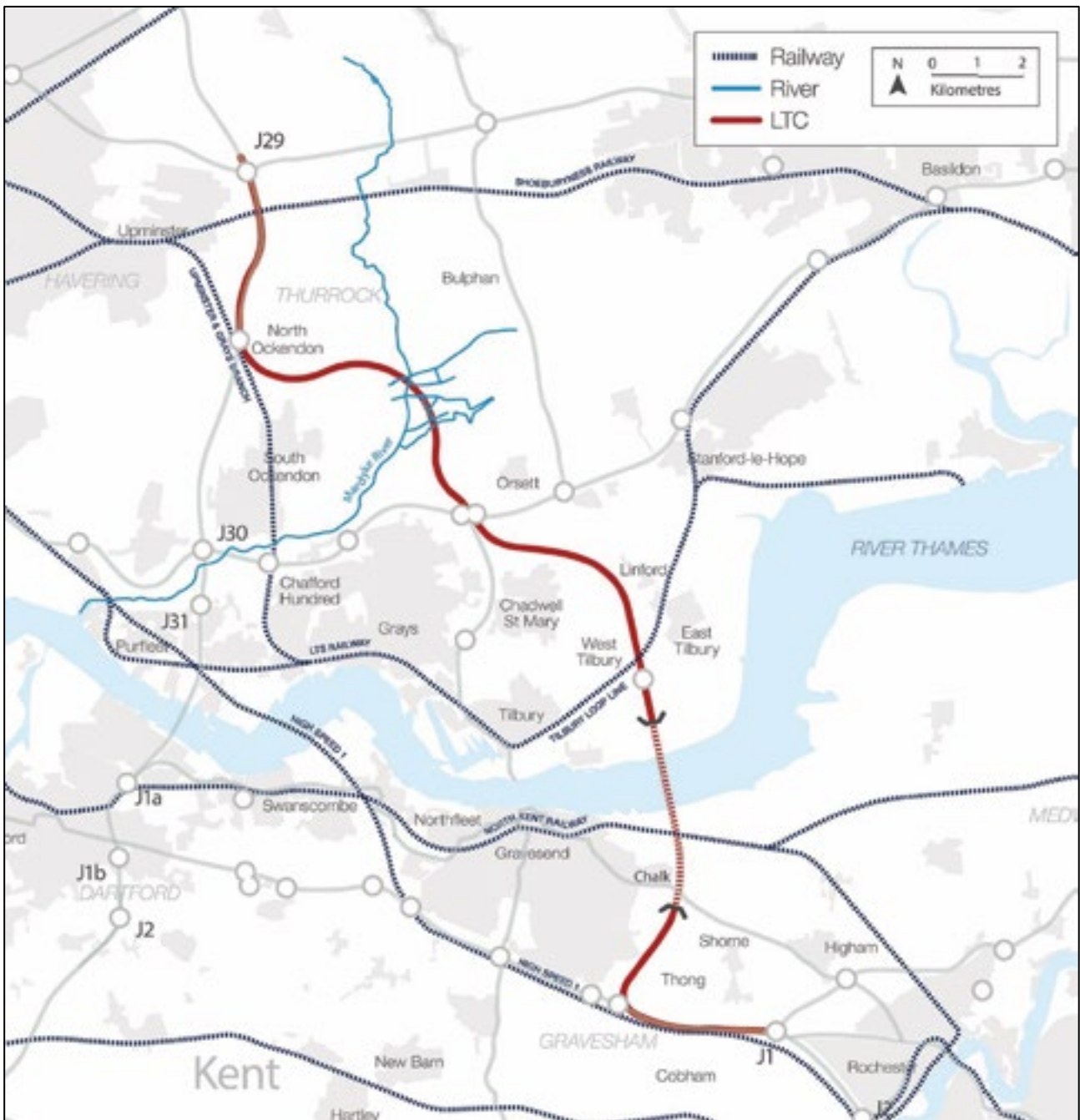
Walkers, cyclists, horse-riders

- 4.6.8 Several Public Rights of Way and bridleways are near to the Project. These are identified within the *PEIR*. Our approach to the design of the Project has been to maintain these routes by providing crossings or diversions where necessary.

4.7 Railways

- 4.7.1 The Project crosses or is close to 5 railway lines which are shown on Figure 4.4. These are:
- High Speed 1, the high-speed railway connecting London St Pancras International and the Channel Tunnel which runs parallel to and south of the A2 at the southern end of the Project.
 - The North Kent railway which connects London to the Medway towns and the rest of Kent further to the east via Dartford and Gravesend. It crosses the line of the proposed tunnel at ground level about 500m south of the river.
 - The Tilbury loop line which connects London Fenchurch Street to Shoeburyness via Grays and Tilbury. It crosses the Project route at ground level about 2km north of the river.
 - The Upminster and Grays branch line which connects the Tilbury loop line to the Shoeburyness railway and crosses under the M25 in cutting north of Ockendon close to the proposed Project/M25 junction.
 - The Shoeburyness railway which connects London (Liverpool Street and Fenchurch Street) to Shoeburyness via Upminster and Basildon. It crosses under the M25 about 1km south of junction 29.

Figure 4.4 Railways and rivers in the Project area



4.7.2 Our approach to the design of the Project has been to seek to minimise disruption during construction and future operations for all these railways.

4.8 Rivers

4.8.1 The rivers near to the Project are shown in Figure 4.4.

4.8.2 At the site of the proposed crossing the River Thames is about 1.3km wide. At this location the navigation channel is 300m wide with a river bed level of about minus 13m Above Ordnance Datum (AOD). The mean high water spring level is 3.47m AOD and the mean low water spring level is minus 2.51m AOD. There is

a flood protection embankment on the south bank of the river and a flood protection wall on the north bank.

- 4.8.3 The other significant river affected by the Project is the Mardyke which flows roughly north-east to south-west between Orsett and Ockendon and joins the Thames at Purfleet to the west of the existing Dartford Crossing. This is classified by the EA as a main river. Other smaller rivers, some of which are classified as main rivers, and ditches join the Mardyke in the area that it is crossed by the Project's route.
- 4.8.4 Other smaller unnamed rivers classified as main rivers are crossed near the north tunnel portal and Tilbury loop railway.
- 4.8.5 Our approach to the design of the Project has been to maintain these rivers and comply with the requirements of the EA or other relevant authorities such as the Port of London Authority (PLA) in order to mitigate any potential adverse impacts.

5 Design standards

5.1 Design for safety

5.1.1 Our approach to designing for safety is explained in section 21 of the Operations section of this document.

5.2 Design standards summary

5.2.1 Our approach to the design of the Project is to comply with the design standards in the *Design Manual for Roads and Bridges (DMRB)*. It is noted that the *DMRB* is currently undergoing a significant review and update. Our design will continue to be developed using the most up-to-date version of the standards.

5.2.2 The standards we have used define the horizontal and vertical alignment of the road and its cross-sections, junction layouts and road type (including the number of lanes). The standards determine the design of highway structures including the tunnel and geotechnics and earthworks. They also define the requirements for drainage, lighting, road signs and markings, traffic control technology and provision for non-motorised users such as pedestrians, cyclists and horse riders.

5.2.3 The main standards we have used are:

- a. TD 9/93 Highway Link Design for horizontal and vertical alignment design
- b. TD 27/05 Cross-Sections and Headrooms for highway cross-sections
- c. TD 22/06 Layout of Grade Separated Junctions for new grade-separated junctions including slip roads
- d. BD 78/99 Design of Road Tunnels for the design of the main crossing of the river and any tunnels at junctions
- e. BD 100/16 The Use of Eurocodes for the Design of Highway Structures for the design of new highway structures

5.2.4 The standards define design parameters. Our aim when developing the preliminary design for the Project has been to achieve, wherever possible, the required parameters while complying with the approach and constraints set out in this document.

5.2.5 The standards include a 3-stage process for situations where the required design parameters cannot be achieved. The first 2 stages are relaxations which can be used at the discretion of the designer. The final stage is a departure which must be submitted to Highways England's design specialists and approved before inclusion in the design to ensure the safety of the Project.

5.2.6 Our preliminary design for the Project includes several proposed departures from the standards. We are in the process of agreeing these departures in principle with the design specialists.

- 5.2.7 We have supplemented these standards, where appropriate and necessary, using other documents and good practice guidance including the *Manual of Contract Documents for Highways Works, British and European (Eurocodes) Standards*.

Design speed

- 5.2.8 A key parameter for the design of a highway is the design speed. This determines the geometry and layout of the road and junctions.
- 5.2.9 The design speed for the Project's main road and the improved sections of M2/A2 and M25 is 120kph (70mph speed limit).
- 5.2.10 In accordance with the requirements of the junction standard the design speeds of connector roads (a collective term for interchange links, slip roads and link roads) are:
- a. interchange links (free-flow links within an interchange), 85kph
 - b. slip roads, 70kph
 - c. link roads (one-way connector roads adjacent to but separate from the main road), 120kph or 100kph

Notwithstanding the different design speeds, the signed speed limit within the grade separated junctions will be 70mph.

6 Architectural and landscape requirements

6.1 Introduction

6.1.1 Using Highways England's 10 Principles of Good Design (see section 2.1) as a basis, the Project has set itself some challenging ambitions. These recognise that it is a once in a generation opportunity to significantly improve connections between Kent, Thurrock and Essex and acknowledge the responsibility to create a Project of which our and future generations can be proud.

6.2 Architectural and landscape considerations

6.2.1 Our architecture and landscape design approach will be based on a detailed understanding of the context along the Project route. The Project will pass through a remarkably diverse range of landscapes within a relatively short distance, including:

- a. the high ground of the North Downs
- b. flat, open marshland close to the River Thames
- c. urban fringe farmland south of the A13
- d. the fen landscape north of Orsett
- e. undulating farmland alongside the M25

6.2.2 Enabling road users to experience this range of landscapes will enhance their journey. Our design response to these landscapes will seek to enhance the different landscape character of these areas and enable users of the Project to experience them. It will also seek to minimise impacts on local communities, wildlife and other environmental assets.

6.2.3 To enable more detailed consideration of context, the Project route has been divided into 8 sectors (see section 6.4 below).

6.2.4 The design of the Project within each sector will be influenced by five overarching considerations, which also inform the construction strategy:

- a. Environmental constraints: there are many and varied environmental constraints along the route; from the North Downs Area of Outstanding Natural Beauty (AONB) in the south, through multiple important habitats, areas of flooding and important scheduled monuments to the north. We will minimise and/or mitigate impacts on these environmental assets wherever practicable.
- b. Stakeholder and community concerns: we recognise that the Project will have a significant impact on local communities. We will seek to minimise adverse effects and deliver a positive legacy for local communities and the environment.

- c. User experience: the Thames Estuary is a significant historic and landscape feature and a key threshold in north-south journeys past London. The Project should allow road users to experience the range of landscapes through which the route passes.
- d. Smarter design: our designers will strive for the best approach to design. This means designing elements of the highway, landscape, buildings and mitigation measures to achieve multiple objectives wherever possible.
- e. Technical and operational requirements: to serve its strategic transport objectives, the Project must be designed and built to the appropriate standards, many of which relate to the safety of road users, workers and those affected by the construction and operation of the Project. It must also respond to site specific constraints and characteristics such as geology. In addition, it must seek to minimise adverse health and environmental impacts and achieve value for money.

6.3 Technical design standards

- 6.3.1 The principal design and technical standards with which the Project will comply are:
- a. The Road to Good Design (10 Principles of good road design)
 - b. *DMRB*
 - c. DfT Circular 02/2013: The Strategic Road Network and the Delivery of Sustainable Development
 - d. Module Maintenance Depot Design Brief
 - e. The Building Regulations (as applicable)
 - f. BS8300: Design of an accessible and inclusive built environment. Buildings. Code of practice
 - g. Relevant Planning Policy Statements and Supplementary Planning Guidance

6.4 Existing conditions: context analysis

- 6.4.1 To facilitate design solutions that are responsive to context we have divided the route into 8 sectors as listed below. These are derived from variations in landscape character along the course of the route. They also reflect key elements of the Project such as junctions, the tunnel and portals.
- 6.4.2 The sectors are (from south to north):
- a. **Shorne Woodlands** – This area contains the heavily wooded high ground of the North Downs and the A2 dual carriageway, with which the Project will have its junction. The A2 will be widened within this section.

- b. **Chalk Sloping Farmland** – This area, mainly arable farmland, slopes from the A2 down to the marshes on the south bank of the Thames between the village of Thong and the edges of Gravesend. It contains the slip roads north of the A2, the cutting leading down to the south portal and the portal itself.
- c. **Shorne Marshes and Thames** – This area comprises the River Thames and the marshland area along its south bank which is protected by national and international biodiversity designations. The Project will be tunnelled beneath this entire sector.
- d. **Tilbury Marshes** – This area comprises the low lying, flat landscape of drained marshlands on the north bank of the Thames. It contains the north portal and, at its north edge, a junction giving access to a potential rest and service area (RaSA), maintenance depot and DVSA (Drivers and Vehicles Standards Agency) site.
- e. **Thurrock Urban Fringe** – This is an area of gently undulating farmland wrapping around the edge of Chadwell St Mary and Grays. It includes the junction between the Project and the A13.
- f. **Orsett Fen** – This is an area of flat, open arable fenland north-west of Orsett. The principal watercourse is Mardyke, which flows south-west to join the Thames at Purfleet. As the Project crosses the Fen, it will be raised above flood levels.
- g. **Ockendon Farmland** – An area mainly of farmland slightly elevated above Orsett Fen, which lies to its east, and close to both North and South Ockendon. The Project junction with the M25 is within this area.
- h. **Thames Chase Forest** – This area is an undulating rural landscape heavily affected by the M25. The Project includes widening the M25 through this sector and the provision of a parallel northbound link road between the Project junction and M25 junction 29.

7 Sustainability

7.1 Introduction

7.1.1 We will take a sustainable approach to design at every stage of the Project to take account of economic, environmental and social needs. Sustainability is about achieving a balance between the environment, the economy and society while understanding the constraints and pressures that impact on decisions about the Project. These include community needs and financial, legal and technological constraints. We are committed to embedding safe and sustainable practices in our design by planning effectively to achieve goals through measured impact analysis and life cycle assessments.

7.2 Approach

7.2.1 Our approach to sustainability on the Project takes account of National Policy Statement requirements, the Client Scheme Requirements, Highways England's *Sustainable Development Strategy* and supporting strategies. Our aim is to incorporate sustainable principles into the design development and ensure that we achieve a sustainable solution that not only meets the primary need for the Project and achieves value for money, but also meets rigorous safety, environmental and resilience requirements.

7.2.2 During the design, construction and operation of this project we intend to:

- a. Design a scheme that is adaptable and takes account of future maintenance and operational needs using the advantages of new technologies and innovations.
- b. Deliver a robust and collaborative supply-chain procurement process that demonstrates value and efficiency.
- c. Demonstrate our commitment to mitigating environmental impacts, and considering how the Project's fits into the landscape by designing environmentally sensitive solutions to construction and maintenance challenges.
- d. Create a working environment that encourages creative talent, skills development and a stable, safe and healthy workforce.
- e. Engage with communities affected by the Project, so we respond effectively to community concerns and needs.

7.2.3 This approach outlines the priorities for the inclusion of sustainable development into Project. As the Project develops, we will demonstrate how these priorities have been incorporated to deliver long-term sustainable benefits.

8 Legacy

8.1 Introduction

- 8.1.1 Good design and thinking about any solution in terms of long-term impact is at the heart of providing a positive legacy. Through our design we will enable sustainable growth, improve local and regional accessibility and be sensitive to the local landscape.
- 8.1.2 At a project level we will incorporate best practice and learning from other major projects. We will work with stakeholders, communities and our supply chain to understand the impacts of the Project and the opportunities it creates for wider benefits to be realised.
- 8.1.3 We will identify where our objectives are shared and explore opportunities to work together. This could deliver additional benefits to people and communities, our customers, the environment and the economic growth across the region.

8.2 Education and employment

- 8.2.1 The Project will create opportunities for businesses to grow and create more jobs, apprenticeships and training.
- 8.2.2 There is currently a national shortage of people with a good knowledge of science, technology, engineering and mathematics (STEM) subjects. We will establish a programme for local schools and educational bodies to develop these skills.
- 8.2.3 We also want to make more job opportunities available to local people, regardless of their background or level of education or training. By joining the Project's workforce, they will continue to use and build on these skills long after construction is complete.
- 8.2.4 Working with organisations such as the Local Enterprise Partnership, local businesses and local authorities, we will better understand the long-term aspirations of the region. We will use this knowledge to shape the training we offer our workforce. This will mean that local people have the skills needed to support continued development in the area long after construction of this route has finished.
- 8.2.5 We will also work with our supply chain to develop a long-term apprenticeship programme with focus on ensuring that these apprentices can transfer into long term employment.

8.3 Future-proofing

- 8.3.1 Transport is going through huge changes, spurred on by new technologies such as electric and driverless vehicles. The design of the road must consider the impact of these changes, both in terms of the infrastructure we build, and how this will affect drivers' behaviour. For example, the way people use electric vehicles may be different to how they use petrol or diesel vehicles, particularly in terms of refuelling or recharging. As a result, we are making sure there will be sufficient electric charging points at the RaSAs based on anticipated future demand. By designing for the future now, we will seek to minimise the potential

need for upgrades to the roads or tunnel in the future, avoiding unnecessary costs and disruption to road users.

8.4 Road users

- 8.4.1 We will create a positive driving experience by carefully considering the design of every element of the roads and tunnel. This extends beyond the tunnel and tunnel portals, to how we will approach the landscape and the design of bridges that cross the route.
- 8.4.2 Engaging with road users to understand their needs is central to our plans. Our aim is to set a new benchmark in customer satisfaction during and after construction that reflects a commitment to being accessible to listen, engage and improve.

8.5 Engagement

- 8.5.1 For infrastructure to best serve the needs of society it must be fully understood and widely accepted.
- 8.5.2 The Project offers an exceptional opportunity to bring local and national benefits, unlocking access to economic growth and other social, cultural and environmental benefits.
- 8.5.3 Through engagement, the Project can be tailored to best serve the local communities. We will ensure their needs and concerns are heard and acted upon. This demands excellent design combined with positive communication, using a language that is accessible and inclusive to build trust and respect. This will include continuing engagement with the contractors that we employ to construct the Project.

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9 ROUTE SELECTION HISTORY OVERVIEW

9.1 Introduction

- 9.1.1 This section outlines the process that we have followed to identify and assess potential options for the Project up to the selection of the preferred route.
- 9.1.2 A structured approach has been followed by DfT, and then by Highways England, to identify and assess potential options for the Project. At key stages in the Project development, options were identified and then assessed for their technical feasibility, environmental acceptability and performance against the scheme objectives. Selected options were taken forward for development in further detail and then re-appraised. At two key stages in the process, options were presented in a non-statutory public consultation. The key stages that led to the selection of the preferred route in 2017 were as follows:
- a. DfT carried out a study in 2009 that reviewed six potential crossing locations, identified as A, B, C, D1, D2 and E (Figure 9.1). The locations included a link between the M2 and M20 at Bluebell Hill which was considered as a variation of location C with the potential to enhance the benefits from the Project and therefore was known as C variant (CV). Further work was carried out by DfT in 2013 to consider three of the potential crossing locations in more detail, A, B and C, and, following public consultation, two crossing locations, A and C, as well as CV, were taken forward for further consideration.
 - b. We then carried out a detailed option identification and route selection process at crossing locations A and C. This commenced in 2014, and included a non-statutory public consultation in 2016 which included three route options at location C. These were identified as routes 2, 3 and 4 north of the River Thames, and western southern/eastern southern links south of the River Thames (Figure 9.10). Route 1, at location A, was assessed and found not to meet the scheme objectives, and consequently was not identified as a proposed route in the 2016 public consultation. A further appraisal was undertaken, considering the findings of the public consultation, and this resulted in the selection of the preferred route announced in April 2017. The preferred route was route 3 north of the River Thames, all with a bored tunnel crossing of the River Thames east of Gravesend and Tilbury and a new road south of the river which will join the A2 east of Gravesend (the Western Southern Link (Figure 9.11).
 - c. We have carried out a further re-appraisal of the historic options to re-appraise the PRA in advance of our statutory consultation.

9.2 Department for Transport option identification and selection

- 9.2.1 DfT identified a series of potential route corridors that could serve as future new routes for improvements in cross-Thames capacity (*Dartford River Crossing Study – Final Report, 2009*). Each option was assessed against DfT's goals, as defined in *Delivering a Sustainable Transport System (DaSTS, November 2008)*.
- 9.2.2 DfT study was reported in two reports:
- Dartford River Crossing Study Final Report, 2009, DfT*
 - Options for a New Lower Thames Crossing, 2013, DfT*
- 9.2.3 The 2009 study described in paragraph 9.1.2 (a) concluded that three locations (A, B and C) offered the greatest benefits in terms of relieving congestion at the existing crossing and should be assessed further. Locations D and E were discounted for the following reasons:
- Location D – The location would not meet the traffic objective to relieve congestion at the existing Dartford Crossing and provide free flowing north-south capacity. It would have poor to low value for money, limited safety benefits, and have significant environmental impacts including on Sites of Special Scientific Interest (SSSI). It would also require substantial areas of flood compensation.
 - Location E – The location would provide very limited relief to the existing Dartford Crossing and would have poor to low value for money. There would be potential direct and indirect effects on many international and nationally important nature conservation sites including: Medway Estuary and Marshes Ramsar site and SSSI, Swale Ramsar site and SSSI, Foulness (Mid-Essex Coast Phase 5) Ramsar site and Special Protection Area (SPA) and the Foulness SSSI and the Essex Estuary Special Area of Conservation.
- 9.2.4 In 2012, a further study was undertaken by DfT to investigate the three remaining locations (A, B and C). These locations were developed and taken to a non-statutory public consultation in 2013.
- 9.2.5 Following the public consultation, the Secretary of State announced in December 2013 that location B had the weakest case of the three and that the location should be discarded. Location B would jeopardise major redevelopment of the Swanscombe Peninsula and this option received limited support in the 2013 public consultation. In addition, there were considered to be likely problems with connections to adjacent junctions and impacts on local roads, particularly the connection with the A2. The A2 in this area is likely to be heavily congested due to the existing and planned developments in the area
- 9.2.6 In 2014, the Government published its response to the 2013 consultation, confirming the need for an additional crossing between Kent and Essex. The response acknowledged that there was no preference at that stage on location,

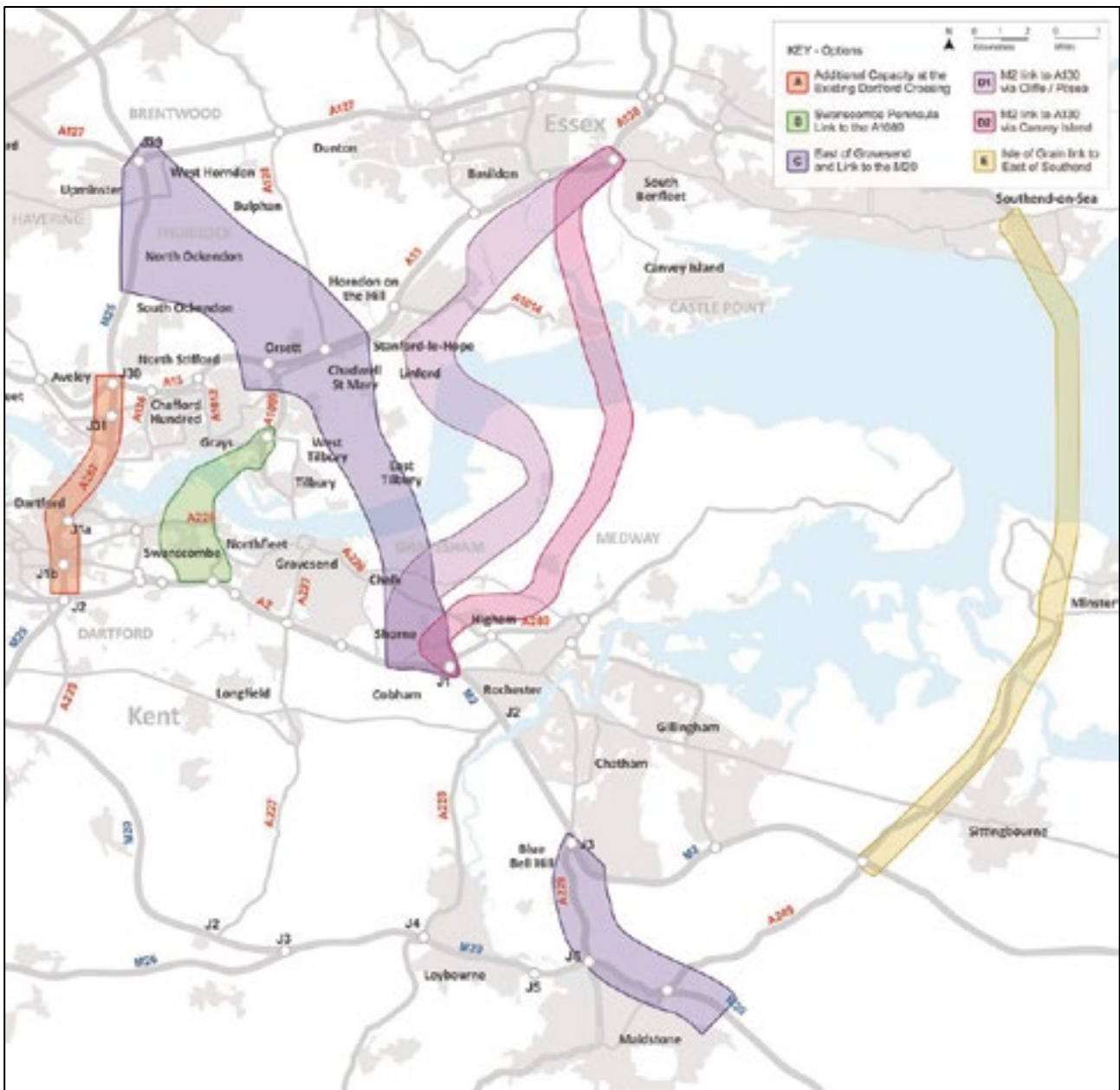
and that further work would be carried out to develop and appraise a more detailed set of options within the areas defined by location A and location C, with or without C variant.

9.2.7 A summary of the study undertaken by DfT is presented in Table 9.1.

Table 9.1 Summary of the Department for Transport study

| Location | Status |
|---|--|
| A – Additional capacity at the existing Dartford Crossing | 2009 – Identified in the study carried out on behalf of DfT |
| B – Swanscombe Peninsula Link to the A1089 | 2013 – Appraised and presented for public consultation by DfT |
| C – East of Gravesend and Link to the M20 | 2013 – Recommended for further assessment |
| D1 – M2 Link to A130 via Cliffe/Pitsea | 2009 – Identified in the study carried out on behalf of DfT. The two alternative location D options were not taken forward following the first stage of location identification and appraisal. The location D options were found to be located too far to the east and modelling showed that they failed to provide the necessary relief to the congested Dartford Crossing as they did not support the key traffic movements across the River Thames. |
| D2 – M2 to A130 via Canvey Island | |
| E – Isle of Grain Link to East of Southend | 2009 – Identified in the study carried out on behalf of DfT. As with the two alternative location D options, location E was not taken forward following the first stage of location identification and appraisal. |

Figure 9.1 Six locations investigated in the 2009 DfT study



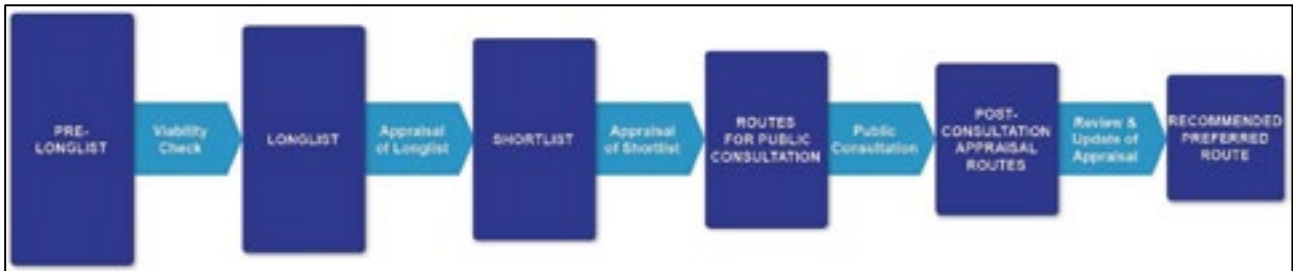
| Key | |
|-----|---|
| A | Additional capacity at the existing Dartford Crossing |
| B | Swanscombe Peninsula Link to the A1089 |
| C | East of Gravesend and Link to the M20 |
| D1 | M2 Link to A130 via Cliffe/Pitsea |
| D2 | M2 Link to A130 via Canvey Island |
| E | Isle of Grain Link to East of Southend |

9.2.8 The DfT study also reviewed the current operation of the rail infrastructure for both passengers and freight and considered the need for further improvements. The study found that the inclusion of rail infrastructure within the Project was not considered to have a reasonable business case.

9.3 Highways England option identification and selection

9.3.1 Highways England agreed a set of scheme objectives with DfT, as described in section 3, and continued development of the Project. We developed a series of route options at potential crossing locations A and C, and then followed a staged approach to the appraisal process as shown in Figure 9.2 below.

Figure 9.2 Overview of options, identification and selection process



9.3.2 The key stages in the appraisal are set out below.

- a. **Viability check.** An initial list of route options at locations A and C was developed. Route options which performed poorly against the scheme objectives (see section 3 for details of the scheme objectives) or were considered unviable (for example, 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 in two phases. During the first phase we considered the options on the grounds of:
 - i. value for money (cost against economic benefit)
 - ii. significant environmental impact
 - iii. other significant impacts (eg, congestion, network resilience, impact on planned or existing developments)

In the second stage longlist appraisal, we used a comprehensive set of criteria that was aligned to the scheme objectives. Through this longlist appraisal we identified options that failed to deliver against the scheme objectives, and these options were not taken forward for further assessment. The result of this appraisal was a shortlist of routes for more detailed assessment.

- c. **Appraisal of shortlist.** We undertook a detailed appraisal of each of the shortlisted options. The shortlisted routes and resultant appraisal are summarised below:
 - i. Route 1 at location A, with either a bridge or a bored tunnel was appraised and found not to meet the scheme objectives. It failed to relieve the congestion on the approaches to the Dartford Crossing as it

did not provide a suitable alternative route for traffic travelling along the A2 and A13.

- ii. Routes 2, 3 and 4 north of the River Thames, and western southern/eastern southern links south of the River Thames (Figure 9.10), connected by a bored tunnel, bridge or an immersed tube tunnel at location C, east of Gravesend and Tilbury, were appraised. On each route, it was determined that the bored tunnel would have lesser effects on the Thames Estuary and Marshes SPA and Ramsar site, compared to the bridge and immersed tube tunnel solutions. Consequently, the immersed tube tunnel and bridge solutions were not considered further.
- d. **Public consultation** on options and a proposed solution. Through the shortlist appraisal, we identified routes 2, 3 and 4 north of the River Thames, the western southern/eastern southern links south of the River Thames and the bored tunnel crossing at location C, performed satisfactorily against the scheme objectives and were considered viable solutions. These routes, including a proposed solution, were presented at the non-statutory public consultation, which was held between January and March 2016. The consultation also included information on those routes that were not considered viable and the reasons for those conclusions.
- e. **Review and update of appraisal of Post-Consultation Appraisal Routes and Recommended Preferred Route.** Following public consultation, we identified a series of routes for further consideration. The routes selected included the two routes presented at statutory consultation that were most strongly supported (routes 3 and 4), as well as further appraisal of Route 1 at location A. Route 1 had been discounted in the previous appraisal process but, having regard to consultation responses received, it was concluded that Route 1 should be appraised in more detail. These routes, comprising Routes 1, 3 and 4, were reviewed and updated taking account of the feedback from the consultation and using new or revised information where appropriate. This review resulted in the development of the recommended preferred route.

- 9.3.3 A detailed review of each of the identified options and the assessment process was provided in a report published at the announcement of the preferred route (*Post-Consultation Scheme Assessment Report*, March 2017).

Viability check

- 9.3.4 In 2014 we commenced a further, more detailed assessment of locations A and C. This study resulted in the identification of a series of potential options, all following the general routes defined by location A and location C, while not encroaching upon locations that had been eliminated in previous DfT studies, ie, locations B, D and E.

9.3.5 The pre-longlist developed included 14 potential options within the location A route, and one further modification that could be made on junction 30 of the M25 that could enhance the performance of the other potential options (Figure 9.3). The options included a selection of bored tunnel, immersed tunnel and bridge solutions, with associated infrastructure to connect into the SRN. A total of six potential options were identified within the location C route (Figure 9.4), again including a selection of bored tunnel, immersed tunnel and bridge solutions, and a further four potential options were identified within the C variant option (Figure 9.5).

Figure 9.3 All route options within the location A route

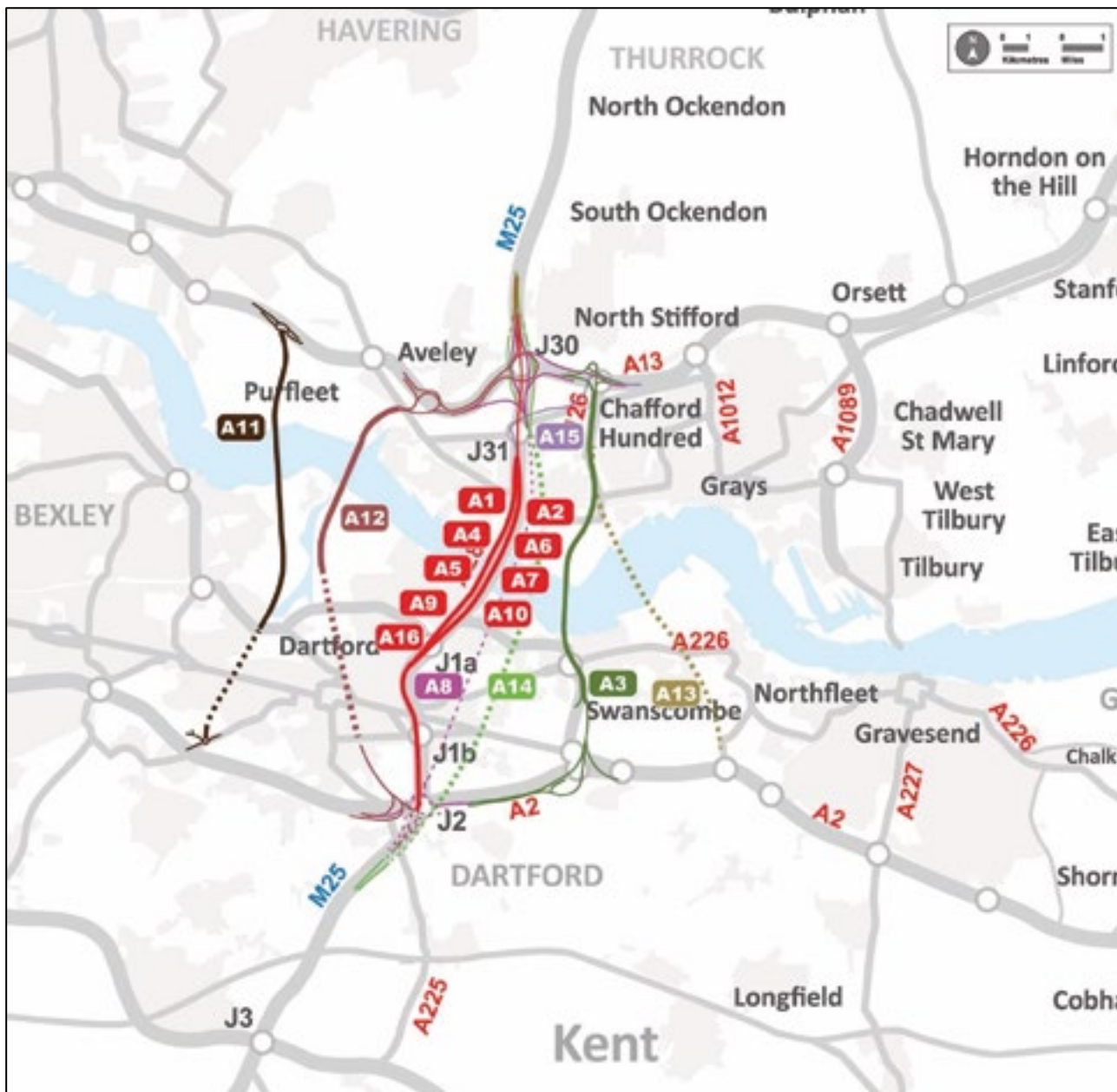


Figure 9.4 All main route options within the location C route

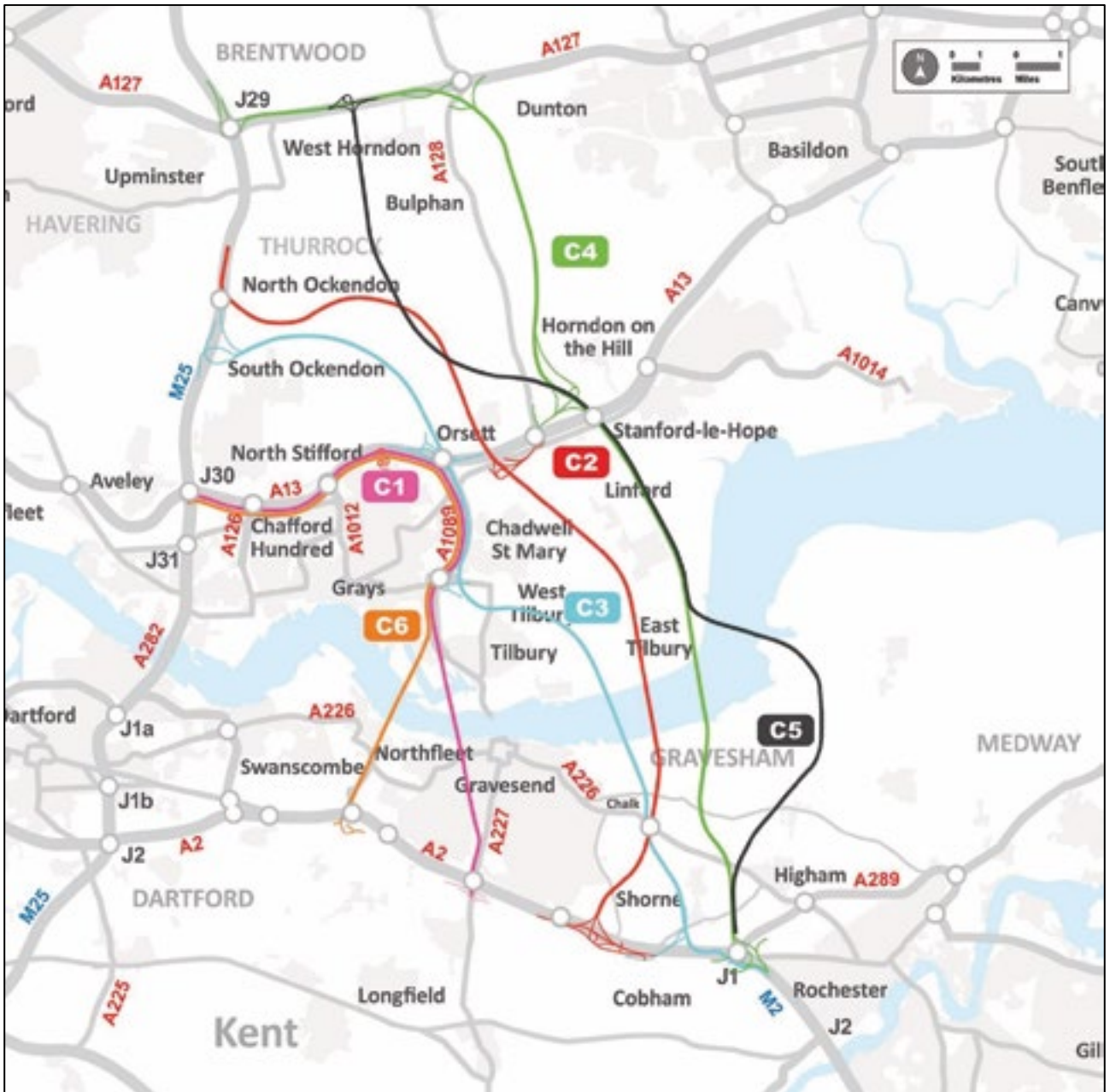


Figure 9.5 All route options within the C variant option route



9.3.6 We decided not to take forward 11 potential options through the pre-longlist appraisal. We considered two options, A5 and C6 to not be technically viable. The remaining options that we decided not to take forward, A3, A6, A7, A10, A11, A13, C5, CV3 and CV4 failed to achieve one or more of the scheme objectives. The key reasons for the decisions to not select these options for the longlist are set out in Table 9.2.

Table 9.2 Pre-longlist viability check – options not forwarded to longlist appraisal

| Route option | Key reason for decision |
|--------------|---|
| A3 | High cost and complexity of construction directly impacting access to Bluewater and Lakeside shopping centres, and impact on new Eastern Quarry housing development |

| Route option | Key reason for decision |
|--------------|--|
| A5 | Technical non-viability; insufficient space to create effective connections to existing roads |
| A6 | Significant impact on existing development north and south of the river east of existing crossing |
| A7 | Significant impact on existing development north and south of the river east of existing crossing |
| A10 | Significant impact on existing development north and south of the river east of existing crossing |
| A11 | Doesn't solve strategic traffic problem, too far from Dartford and too close to proposed Transport for London Belvedere crossing |
| A13 | Impact on new development (London Resort Company Holdings site and Ebbsfleet Garden City) |
| C5 | Significant environmental impacts on protected ecological sites (Ramsar, SPA) and Cliffe Pools (RSPB) |
| C6 | Technical non-viability due to insufficient space to effectively connect to A2 and impact on new development (Ebbsfleet Garden City) |
| CV3 | Impact on Blue Bell Hill village and construction impact at M2 junction 3 |
| CV4 | Significant environmental impact and high cost of tunnels |

9.3.7 The outcome of the viability check is detailed in Table 9.3.

Table 9.3 Viability check – summary of outcomes

| Location | Options not taken forward to longlist appraisal | Taken forward for further assessment |
|-----------|---|--------------------------------------|
| A | A3, A5, A6, A7, A10, A11, A13 | A1, A2, A4, A8, A9, A12, A14 |
| C | C5, C6, | C1, C2, C3, C4 |
| C variant | CV3, CV4 | CV1, CV2 |

Appraisal of longlist

9.3.8 We then appraised the longlist remaining from the previous viability check stage. In addition, we identified elements of the potential option C routes that could be combined to create a further 13 combination solutions along the option C route, C7 through to C19 (Figure 9.6, Figure 9.7, Figure 9.8, and Figure 9.9).

Figure 9.6 Combination option C7

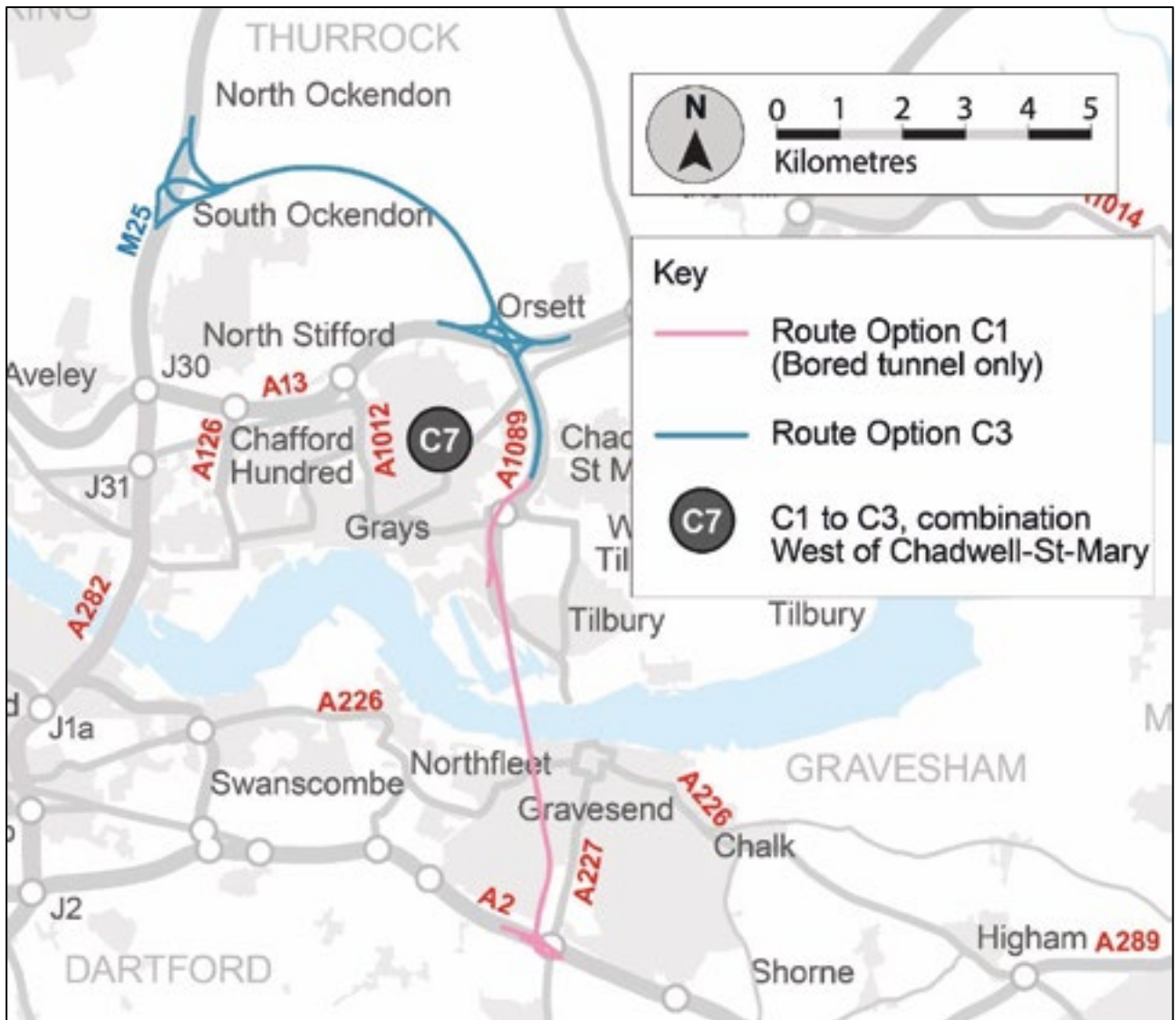


Figure 9.7 Combination options C8, C9 and C10

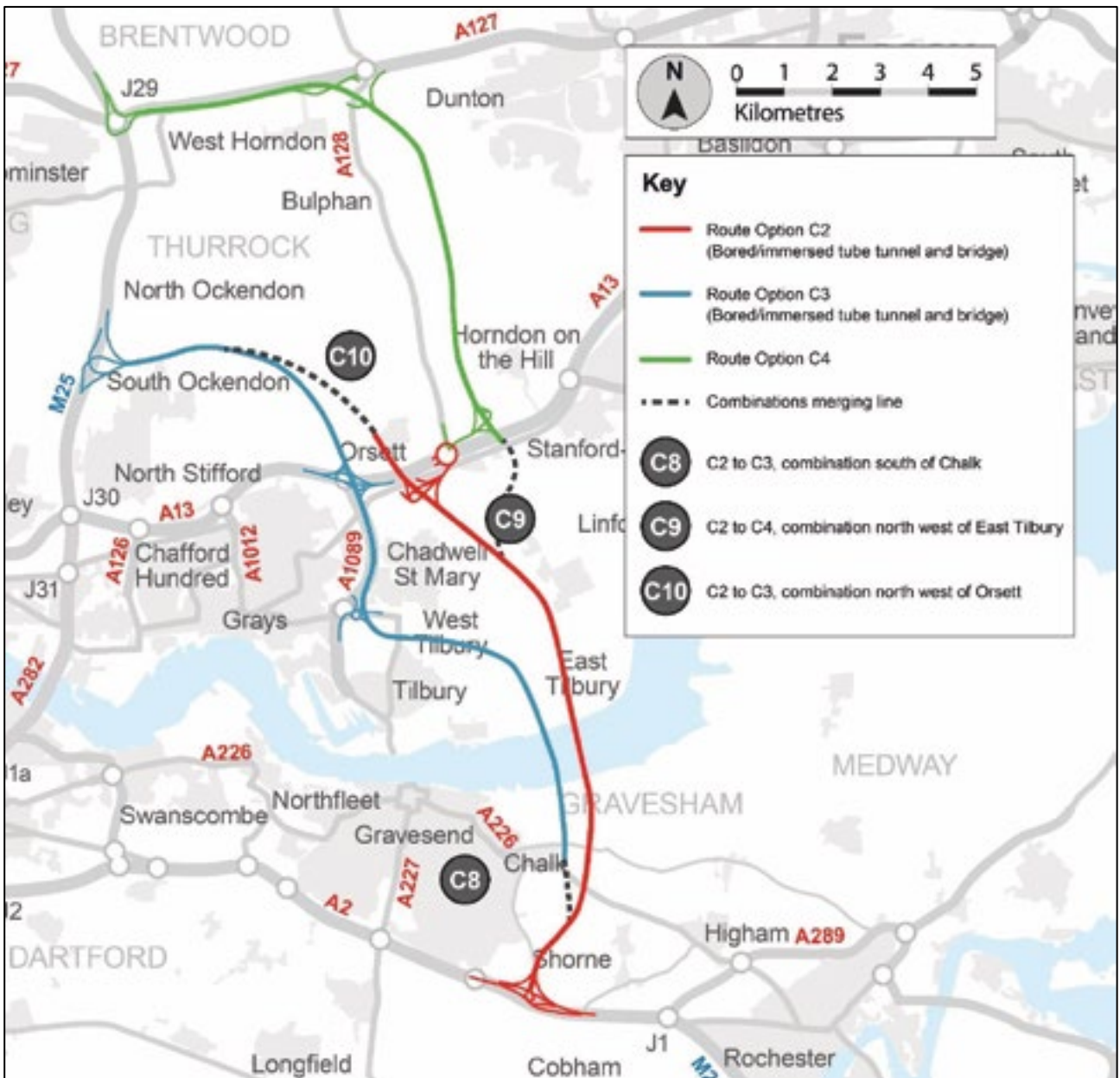


Figure 9.8 Combination options C11, C12, C13 and C14

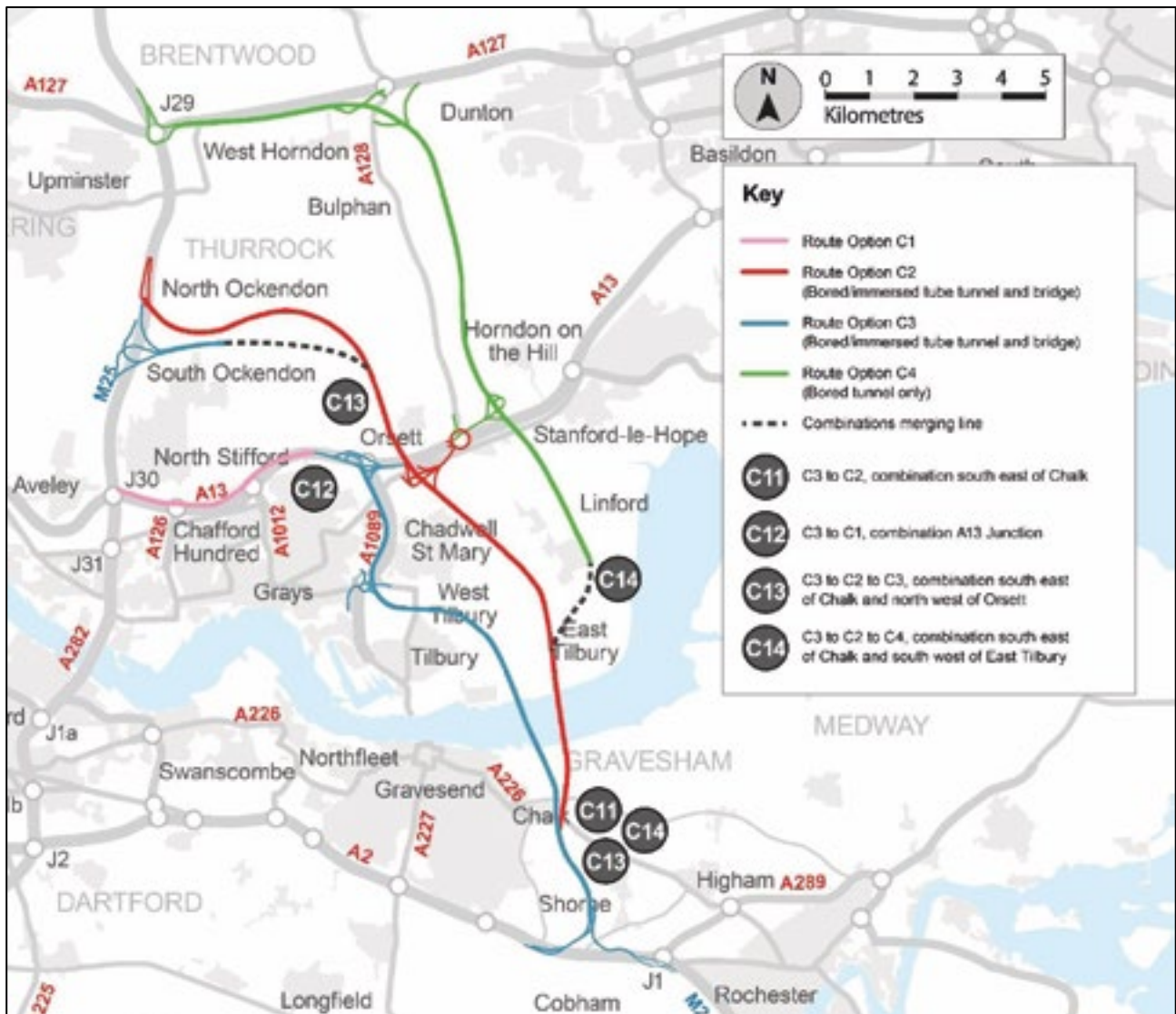
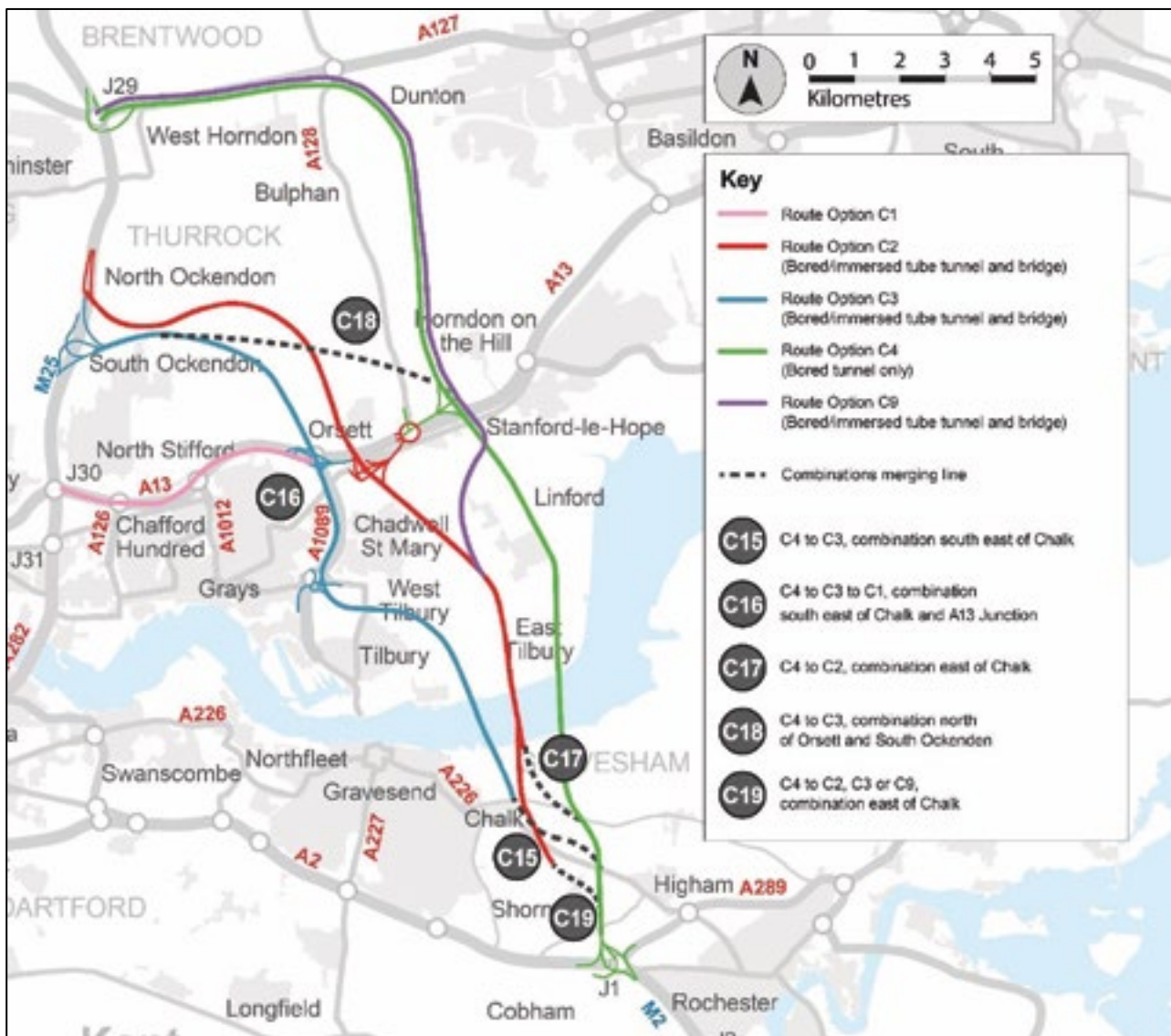


Figure 9.9 Combination options C15, C16, C17, C18 and C19



9.3.9 The key reasons for our decision during the first stage of the longlist appraisal to not select options for further assessment are set out in Table 9.4.

Table 9.4 Stage 1 appraisal of longlist – options not taken forward to further appraisal

| Route option | Key reason for decision |
|--------------|--|
| A8 | Cost approximately more than twice A1. Very complex junctions required to connect A2 and A13 traffic with significant impact on existing property. |
| A12 | Cost approximately three times A1. Poor economic benefits, significant impact on planned development at Purfleet. Potential impact on an SSSI. |
| A14 | Cost approximately more than twice A1. Poor level of economic benefit due to limited attraction of traffic. |

| Route option | Key reason for decision |
|--------------|---|
| C3 | Environmental impact on Shorne Wood Country Park, affecting AONB, SSSI and ancient woodland. Reasonably practicable alternative available (southern section of C2). |

- 9.3.10 Combination options which were contingent upon the route of options that were discarded at this stage were also not taken forward past this stage.
- 9.3.11 Combination options C11, C12, C13 and C14 contained elements that included the section of option C3 that runs through Shorne Wood Country Park.
- 9.3.12 At the second stage longlist appraisal, we took the decision not to take forward potential options A2, A9, A15, A16, C1, C4 and the remaining C variant options to the shortlist stage. The key reasons for the decisions to not select these options for the shortlist are set out in Table 9.5.

Table 9.5 Appraisal of longlist – options not taken forward to shortlist appraisal

| Route option | Key reason for decision |
|-------------------------------|--|
| A2 | Low value for money (limited benefits from travel time savings or congestion relief compared to capital cost). Significant impact on commercial property north and south of the river east of existing crossing (impact on current/planned infrastructure). Impact on SSSI (biodiversity). |
| A9 | High technical risks, significantly more difficult to construct than other options (practical feasibility). Impact on river/jetty operations unlikely to be acceptable to owners/operators or PLA (impact on current/ planned infrastructure and construction disruption). |
| A15 | Significant impact on commercial property around junction 31 (impact on current/planned infrastructure). Major high voltage overhead cable diversions required (construction disruption and implementation timetable). |
| A16 | Reduces value for money compared to the C option on its own. High cost solution with limited additional economic benefits (high capital cost and limited benefits from travel time savings or congestion relief). |
| C1 | Low value for money (high capital cost, low benefits from travel time savings). Poor resilience due to use of A13 (resilience). Potential impacts on Tilbury Docks from tunnelling under existing structures (impact on current/ planned infrastructure). |
| C4 | High cost (capital cost). Impact on scheduled monuments (historic environment). There are better, lower cost options available. |
| C variant options CV1 and CV2 | C variant has negligible effect in transferring M20 traffic from existing Dartford Crossing onto a new crossing at location C. Significant impact on AONB (biodiversity and landscape). High capital cost (capital cost). Does not bring traffic and economic benefits that materially add value to the Project. |

- 9.3.13 As previously, combination options which were contingent upon the route of options that were discarded at this stage were also not taken forward past this stage:
- a. Combination option C7 was not selected as it included the section under the Tilbury Docks that was significant in the decision not to take forward option C1
 - b. Combination option C15 was not selected as it had a similar route south of the river to combination option C19 which was selected for the shortlist. It was considered that the combination option C19 was preferable as it was further from Shorne Woods Country Park
 - c. Combination option C16 was not selected as it included a section of option C1 that included the A13, and therefore failed to meet the scheme objective of relieving the congested Dartford Crossing
 - d. Combination options C17 and C18 were not selected as they included sections of option C4 that impacted on Coalhouse Fort
- 9.3.14 Combination option C10 comprised a modification to C2 amending the route between the A13 and the M25. This option was considered insufficiently different to option C2, and therefore we did not carry this option forward as this could be considered later as design development if C2 was selected to be the preferred route.
- 9.3.15 The following combination options were used to modify other options enabling them to be carried forward into the shortlist appraisal:
- a. Combination option C8 comprised a modification to option C3 south of the River Thames, avoiding Shorne Woods Country Park by moving the route to the west, corresponding with the C2 route. This option was adopted as a modification to option C3, allowing that option to be carried through into the shortlist phase.
 - b. Combination option C19 comprised a modification to option C2, C3 or C8 south of the River Thames to avoid Shore Woods Country Park by moving the route to the east, corresponding to the C4 route. This option was adopted as a modification to options C2 and C3, enabling those options to be carried through into the shortlist phase.
 - c. Combination option C9 comprised the southern section of C2 connecting to C4 north-west of East Tilbury. This combination option was carried forward into the shortlist phase.
- 9.3.16 Following the longlist appraisal stage, several options were identified and were carried forward into the shortlist stage. The outcome of the longlist appraisal is detailed in Table 9.6.

Table 9.6 Appraisal of longlist – summary of outcomes

| Location | Eliminated at first stage appraisal | Eliminated at second stage appraisal | Taken forward for further assessment |
|-----------|-------------------------------------|--------------------------------------|---|
| A | A8, A12, A14 | A2, A9, A15, A16 | A1, A4 |
| C | C3, C11, C12, C13, C14 | C1, C4, C7, C15, C16, C17, C18 | C2, C9 C3 (modified by C8) C19 was taken forward as a modification to C2, C3 and C9 |
| C variant | None | CV1, CV2 | None |

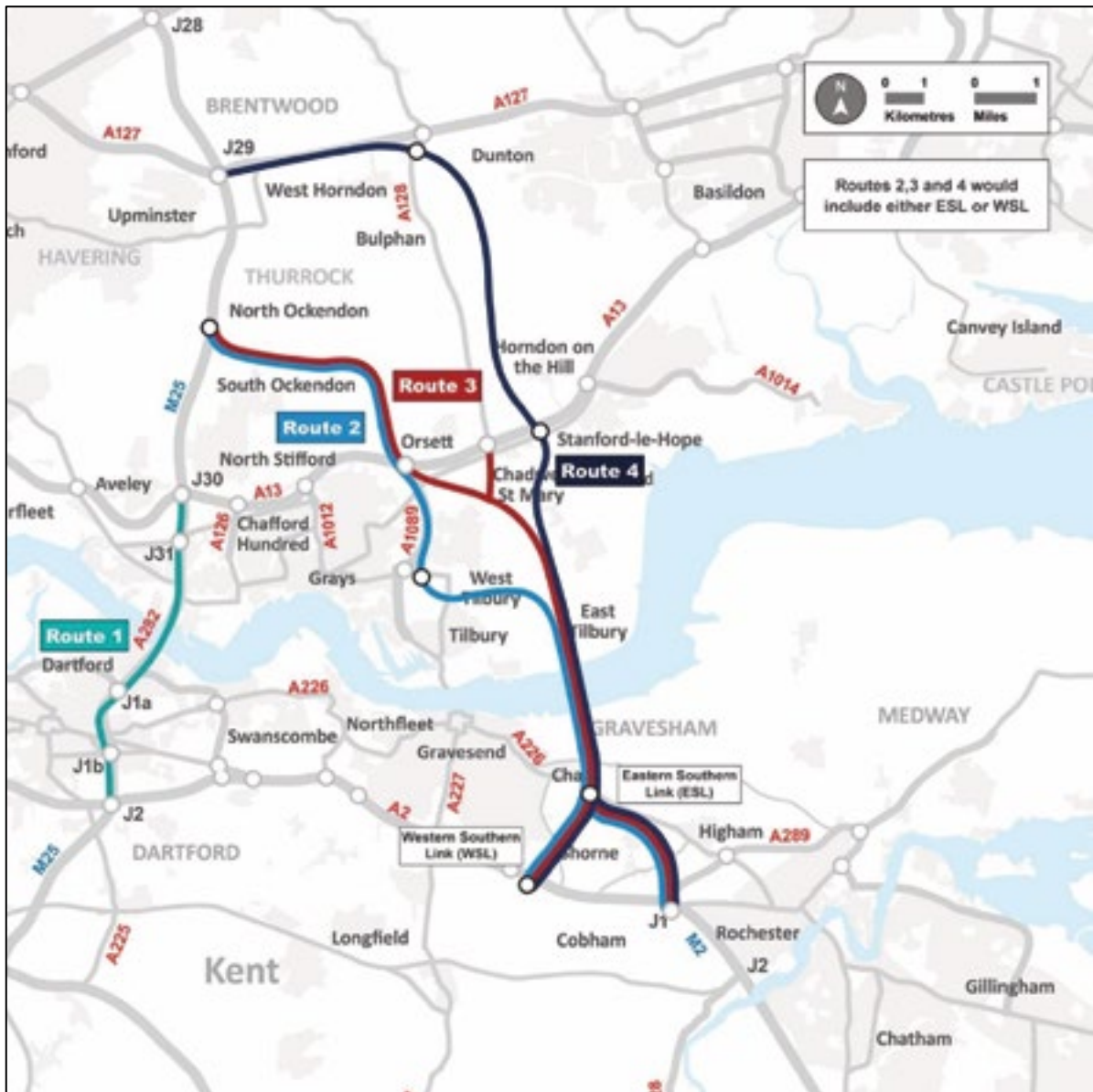
9.3.17 We renamed these options for clarity, as detailed in Table 9.7 and Figure 9.10. We simplified the options by defining a single route for the tunnel for Routes 2, 3 and 4, and defining two specific routes south of the River Thames, Eastern Southern Link and Western Southern Link. For each of Routes 2, 3 and 4 we considered the three options of a bridge, a bored tunnel and an immersed tunnel. Route 1 was also considered with a single route, and for a bridge and a bored tunnel.

Table 9.7 Options selected for appraisal of shortlist

| Shortlist route | Previous reference |
|--|---------------------------|
| Route 1 with bridge | A1 |
| Route 1 with bored tunnel | A4 |
| Route 2 with Western Southern Link and bridge | C3 modified by C8 |
| Route 2 with Western Southern Link and bored tunnel | C3 modified by C8 |
| Route 2 with Western Southern Link and immersed tunnel | C3 modified by C8 |
| Route 2 with Eastern Southern Link and bridge | C3 modified by C8 and C19 |
| Route 2 with Eastern Southern Link and bored tunnel | C3 modified by C8 and C19 |
| Route 2 with Eastern Southern Link and immersed tunnel | C3 modified by C8 and C19 |
| Route 3 with Western Southern Link and bridge | C2 |
| Route 3 with Western Southern Link and bored tunnel | C2 |
| Route 3 with Western Southern Link and immersed tunnel | C2 |
| Route 3 with Eastern Southern Link and bridge | C2 modified by C19 |
| Route 3 with Eastern Southern Link and bored tunnel | C2 modified by C19 |
| Route 3 with Eastern Southern Link and immersed tunnel | C2 modified by C19 |
| Route 4 with Western Southern Link and bridge | C9 |
| Route 4 with Western Southern Link and bored tunnel | C9 |

| Shortlist route | Previous reference |
|--|--------------------|
| Route 4 with Western Southern Link and immersed tunnel | C9 |
| Route 4 with Eastern Southern Link and bridge | C9 modified by C19 |
| Route 4 with Eastern Southern Link and bored tunnel | C9 modified by C19 |
| Route 4 with Eastern Southern Link and immersed tunnel | C9 modified by C19 |

Figure 9.10 Shortlisted routes



Appraisal of shortlist

- 9.3.18 We undertook a detailed appraisal of the shortlist options to determine which met the scheme objectives and should be taken forward to public consultation.
- 9.3.19 The detailed appraisal identified that on each of Routes 2, 3 and 4 with both bridge and immersed tube solutions there would be a risk of significant effects

to the Thames Estuary and Marshes, a statutory designated site protected under the Ramsar convention. The bored tunnel was therefore considered the only viable crossing option on Routes 2, 3 and 4 as it met the scheme objectives and would have lesser effects on the designated site compared to the other crossing options. As a result, on Routes 2, 3 and 4 only the bored tunnel solution was taken forward to public consultation.

- 9.3.20 The detailed appraisal identified that Route 1 performed poorly against the traffic related scheme objectives, as it did not provide an alternative route, the completed scheme would still be subject to a 50mph speed limit and it performed poorly when appraised for the safety, noise and air quality impacts. In addition, Route 1 would take at least six years to construct with significant delay and disruption to the existing crossing. It also offered lower value for money than location C options. As a result, we concluded that Route 1 was not viable and should not be presented as a potential option in public consultation.
- 9.3.21 The outcome of the shortlist appraisal is detailed in Table 9.8.

Table 9.8 Appraisal of shortlist – summary of outcomes

| Location | Options not taken forward to public consultation | Taken forward for public consultation |
|-----------|--|--|
| A | Route 1 with a bridge Route 1 with a bored tunnel | None |
| C | All solutions with a bridge or an immersed tube tunnel | Routes 2, 3 and 4 north of the River Thames. Eastern Southern Link and Western Southern Link south of the River Thames. |
| C variant | Not included in shortlist | |

Public consultation

- 9.3.22 Routes 2, 3 and 4 were presented for non-statutory public consultation in 2016. Highways England stated that its preferred scheme was Route 3 with the Eastern Southern Link and a bored tunnel and invited comment on this scheme and the other routes.

Review and update of appraisal of post-consultation appraisal routes and recommended preferred route.

- 9.3.23 Following the public consultation, a detailed appraisal was undertaken of Routes 3 and 4, as well as of Route 1, to take account of the responses received during the consultation.
- 9.3.24 Route 2 was not appraised further beyond statutory consultation for several reasons. It was not supported at consultation by the public, or by key statutory bodies due to the potential impacts on the environment and on local communities. In addition, there were safety issues with the section of the route that followed the existing A1089 alignment.

- 9.3.25 Route 1 was assessed as not meeting the scheme objectives, re-validating the assessments carried out prior to the public consultation, and the conclusions that it should not be taken forward.
- 9.3.26 Route 3 and Route 4 were appraised against the scheme objectives, and Highways England determined that overall Route 3 best meets the transport objectives of providing free-flowing north-south capacity, improving network resilience and improving road user safety. While the economic benefits generated by both Route 3 and Route 4 are similar, Route 3 has the lowest capital cost and the highest benefit-cost ratio. It would also have the lowest overall environmental impact of the two options.
- 9.3.27 From the consultation responses, Route 3 had greater support from members of the public and groups and organisations than Route 4.
- 9.3.28 Based on the consultation responses and the detailed appraisal, it was also concluded that the Western Southern Link would best meet the scheme objectives. The Western Southern Link would achieve the transport objectives, offer high value for money and would fully support wider regeneration and economic objectives, while having a materially lower impact than the Eastern Southern Link on the environment and local communities.
- 9.3.29 Before the 2016 public consultation, the assessments had demonstrated that the Eastern Southern Link performed better against the economic and transport scheme objectives. However, having regard to concerns raised during the consultation and following further assessment, it was concluded that given the significance of the environmental effects of the Eastern Southern Link, the Western Southern Link provided the best overall performance against the scheme objectives.
- 9.3.30 The Secretary of State announced in April 2017 that Route 3 with Western Southern Link and bored tunnel comprised the preferred route (Figure 9.11).

Figure 9.11 The preferred route announced in April 2017

- 9.3.31 The preferred route was Route 3 north of the River Thames, a future-proofed twin bored tunnel crossing of the river large enough to accommodate a dual three lane carriageway and the Western Southern Link south of the River Thames.

Additional information

- 9.3.32 Following the announcement of the preferred route in April 2017, we have gathered new information that we have used to further develop the Project's designs. Information that we have gathered following the preferred route announcement includes:
- stakeholder and community engagement that have helped us develop the Project
 - new local plans published by Gravesham Borough Council and Dartford Borough Council. The London Borough of Havering has consulted on a new draft Local Plan, while Gravesham Borough Council has recently consulted on planned further updates to their Local Plan.

- c. a new traffic model – the LTAM – based on updated traffic data gathered in 2016 and using newly published DfT national traffic forecasts. This work has improved understanding of current and projected traffic flows (see *Traffic Forecasts Non-Technical Summary*).
- d. environmental and geotechnical surveys carried out by Highways England along the preferred route

9.3.33 We have used the information that we have gathered to improve the Project's route, making changes to junctions, link roads and carriageway routes. The key changes we have made to the Project are described in sections 12 to 15 of this report.

9.4 Option re-appraisal

9.4.1 As we have gathered more information, we wanted to ensure that the previous work that we had undertaken to identify the preferred route, and to discount other routes, was still valid. We therefore carried out a review of all the options for the Project that had been presented, starting with the six options first presented by DfT in 2009 and concluding with the announcement of the preferred route. We undertook this appraisal in three phases:

- a. **Viability check:** a review of the presented options to determine whether they were technically viable. Options that were considered unviable (eg, due to not being technically viable or having unacceptable environmental impacts) were not considered further.
- b. **Review of assumptions:** we then reviewed the technically viable options to determine whether the key assumptions that resulted in the decision not to take them forward remained valid. If the assumptions remained valid (for example the new traffic baseline indicated that the option would still fail to meet the scheme objectives) the option was not considered further.
- c. **Detailed assessment:** where we identified that new information, or the development of the Project merited a more detailed assessment of whether the selection process of the preferred route remained valid, a more comprehensive appraisal was conducted. This assessment considered the performance of the option against the scheme objectives, particularly focusing on the scheme objectives relevant to the reason that the option had been previously discarded.

Location A option re-appraisal

9.4.2 The findings of the re-appraisal of the location A options are shown in Table 9.9.

Table 9.9 Location A option re-appraisal

| Check or review | Outcome |
|-----------------------|---|
| Viability check | <p>A5, A6 - the technical design challenges that resulted in options A5 and A6 not being taken forward due to non-viability had not changed and consequently the decision to not take these options forward remains valid.</p> <p>A9 - option A9 was not taken forward due to the concerns of the PLA. We have therefore determined that this decision not to take this solution forward remains valid.</p> |
| Review of assumptions | <p>We reviewed the assumptions for the technically viable options A2, A3, A6, A7, A10, A13, A15 and A16. These options were not taken forward as they failed to meet the scheme objectives, including for their impact on the sustainable local development and regional economic growth. The updated Local Plans for Gravesham and Dartford, along with the existing Local Plan for Thurrock, reconfirm the scale of the impact these options would have on local development in the area, and consequently the decision to not take these options forward continues to be valid.</p> <p>We had not taken option A11 forward as it did not solve the strategic traffic problem. As the potential option did not provide a free flow connection with the A2, it failed to meet the scheme objectives, and the decision not to take this option forward is considered to remain valid.</p> <p>We had decided not to take forward potential option A12 because of high construction costs while delivering poor economic benefits, as well as impacts on local development and potential impacts on an SSSI. We reviewed the new Local Plan for Dartford, and as there was no change to the assumptions leading to this decision, the decision to not take this option forward remains valid.</p> <p>Option A14 was not taken forward because it did not provide connectivity with the A2 or the A13, and as a result it only attracted limited volumes of traffic. It would, therefore, not meet the scheme objective of relieving the congested Dartford Crossing. Following comments we received during the non-statutory consultation, this option was re-appraised prior to the selection of the preferred route, validating the decision not to take this option forward to the shortlist stage. We re-appraised the performance of this option following the development of the 2016 traffic baseline. The lack of connectivity with the A2 and A13 continues to limit the relief this solution would provide for the congested Dartford Crossing. As such, the decision not to take this option forward remains valid.</p> <p>Option A8 was an attempt to provide a similar solution to option A14, while including the important connectivity with the A2 and the A13. Making these connections would require significant remodelling of the existing road network. At the A2, existing developments and road layout would prevent the provision of a connection with the A2 westbound, one of the most important connections to achieve the scheme objective of relieving the congested Dartford Crossing. Following comments we received during the non-statutory consultation, this option was also re-appraised prior to the selection of the preferred route, validating the decision not to take this option forward to shortlist stage. We reviewed the performance of this option following the development of the 2016 traffic baseline. The lack of connectivity with the A2 westbound continues to limit the relief this solution would provide for the congested Dartford Crossing. As such, the decision not to take this option forward remains valid.</p> |

9.4.3 To support the detailed assessment of route 1, we have re-modelled the route’s performance using LTAM. The model indicates that there would be an increase in traffic between M25 junction 1a and junction 3, when compared to the model used to support the PRA. An assessment of how this impacts the previously conducted appraisal on route 1 is set out below in Table 9.10. It demonstrates that route 1 remains unviable as a solution, because it would not meet the scheme objectives.

Table 9.10 Summary assessment of route 1

| Scheme objective | | Route 1 |
|------------------|---|--|
| Transport | Relieve the congested Dartford Crossing and approach roads and improve their performance by providing free flowing north-south capacity | <p>The 2017 appraisal, reported in the <i>Post Consultation Scheme Assessment Report (2017, Highways England)</i> identified that route 1 was an online improvement which did not increase the existing speed limit from the current 50mph, because of the constraints caused by the existing infrastructure. Closely spaced junctions would remain, with increased weaving moves due to higher traffic flows. Free-flowing north-south capacity could not be achieved with route 1 and the new crossing would not change the overall experience for road users.</p> <p>The appraisal also determined that attracting more traffic into the existing corridor would increase congestion on key east-west approach roads to the crossing, such as the A2 and A13.</p> <p>We modelled route 1 using LTAM, this confirmed the findings at the options selection stage, particularly the issue of increasing congestion on the approach roads to the Dartford Corridor. The modelling work showed that the journey time savings from route 1 were less than a quarter of those delivered by the preferred route. It remains the case that route 1 would not meet this objective.</p> |
| | Improve resilience of the Thames crossings and major road network | <p>The 2017 appraisal identified that while route 1 would provide additional crossing resilience, it would not improve the resilience of the wider road network and so would fail to meet this objective. Traffic would still be funnelled through the existing M25/A282 corridor between junction 2 and junction 30.</p> <p>The new traffic modelling information does not change this conclusion.</p> |
| | Improve safety | <p>The 2017 appraisal identified that there would be a small increase in the overall accident rate if route 1 were pursued. The existing M25/A282 corridor has a poor safety record, and with the significant increase in traffic on the route, it is likely to continue to perform poorly compared with national average rates.</p> <p>There would be a more complex driving environment at the crossing with substantial weaving movements, because of the split of traffic between the two bridges and two tunnels, combined with the proximity of junctions 1a and 31.</p> <p>The increased traffic flows demonstrated by the revised traffic model indicate that these adverse impacts would likely increase.</p> |

| Scheme objective | | Route 1 |
|------------------|--|---|
| Economic | Support sustainable local development, regional economic growth in medium to long term | <p>The 2017 appraisal identified that direct benefits generated by route 1 are estimated to be £1.0bn, which are made up principally of journey time savings. The appraisal also identified that route 1 provided limited 'Wider Impact' benefits as it would not connect new communities or areas of business growth to the road network.</p> <p>The increased traffic flows demonstrated by the revised traffic model result in a reduction of the direct benefits generated by route 1. These direct benefits are less than a quarter of the journey time benefits delivered by the Project.</p> |
| | Be affordable to government and users | Route 1 remains a lower-cost option than the Project but does not address the problem of congestion along the Dartford Crossing corridor. |
| | Value for money | The 2017 appraisal identified that route 1 represented low value for money. The reduction in the generated direct benefits would reduce the performance and this route option would deliver poor value for money. |
| Environment | Minimise adverse impacts on health and the environment | <p>The full adverse environmental and health effects were appraised in 2017 and reported in the <i>Post Consultation Scheme Assessment Report, 2017</i>, Highways England.</p> <p>Many of the existing and future predicted (opening year without the Project) exceedances of Air Quality Strategy (AQS) objectives in the study area are around the existing M25/A282 route corridor in Dartford. In the previous options appraisal, the air quality modelling for route 1 concluded that air quality would get worse in this area because more traffic would be attracted to the existing road corridor along the M25/A282. It was predicted that this would have led to increases in pollution where there are exceedances of AQS objectives for NO₂. The revised traffic data from the updated LTAM has confirmed that traffic flows would increase along the existing M252/A282 corridor because of route 1, and therefore the findings of the options appraisal air quality modelling remain valid. In contrast, the preferred route, through reducing traffic and congestion in this area, is currently expected to improve air quality in this area. It is also not expected to lead to significant adverse air quality effects elsewhere (for example, by creating new exceedances of AQS objectives or leading to poorer air quality where the objectives are exceeded).</p> |

Location B option re-appraisal

9.4.4 The findings of the re-appraisal of the location B option are presented in Table 9.11.

Table 9.11 Location B option re-appraisal

| Check or review | Outcome |
|-----------------------|---|
| Viability check | There was insufficient information to determine the technical viability of location B as the option was not developed further following the consultation in 2013. |
| Review of assumptions | Location B was re-appraised, considering changes in the Local Plans. In 2014 the Gravesham Local Plan was adopted and in 2017 the Dartford Local Plan was adopted. In 2015 the Ebbsfleet Development Corporation became the planning authority for Ebbsfleet Garden City, the area of redevelopment of the Swanscombe Peninsula. These updated Local Plans reinforce the strategic nature of this site, and so the decision not to take forward location B remains valid. |
| Detailed appraisal | Not required |

Location C option re-appraisal

9.4.5 The findings of the re-appraisal of the location C options is presented in Table 9.12.

Table 9.12 Location C option re-appraisal

| Check or review | Outcome |
|-----------------------|--|
| Viability check | All the options at location C that included a bridge or an immersed tube tunnel were considered to be non-viable. As an alternative solution exists that would have a lesser impact on the Ramsar site, constituting a bored tunnel, these alternative solutions were considered to be impermissible having regard to the Conservation of Habitats and Species Regulations 2017. Option C5 was located further to the east than the other options, and therefore had a more significant impact on the Ramsar site. Again, as alternatives that would have a lesser impact on the Ramsar site exist, this solution was considered to be impermissible having regard to the Conservation of Habitats and Species Regulations 2017. |
| Review of assumptions | We re-appraised potential options C1, C7, C6, C12 and C16 as they failed to meet the scheme objectives due to the impacts on local commercial developments and infrastructure resulting from their construction, and for delivering low value to the government. We re-appraised these options against the relevant updated Local Plans, and the situation has not changed, so consequently the decision not to take this solution forward was validated. |

| Check or review | Outcome |
|--------------------|--|
| | <p>To the north of the River Thames, route 4, which was derived from options C4, C9, C14, C17 and C18, was not taken forward due to the environmental impacts on ancient woodland along the route and on Coalhouse Fort. We have considered the design developments that have occurred across the Project since the PRA in April 2017. The increased carriageway width arising from the dual-3 configuration would have increased the relative difference in the environmental impacts, affecting several ancient woodlands along route 4.</p> <p>Route 2, developed from option C3, was not supported at consultation by the public, or by key statutory bodies due to the potential impacts on the environment and on local communities. In addition, there were safety issues with the section of the route that followed the existing A1089 route. The increased carriageway width arising from the dual-3 configuration, as well as the increased traffic flows measured in the revised traffic baseline, indicate that these impacts would increase. Consequently, the decision not to take this route option forward remains valid.</p> |
| Detailed appraisal | A detailed assessment of the Eastern Southern Link is provided below |

- 9.4.6 To support the detailed assessment of the Eastern Southern Link, we have reassessed its performance against the scheme objectives, considering the changes to the Project that have arisen since PRA. An assessment of how this impacts the previously conducted appraisal on the Eastern Southern Link is set out below in Table 9.13.

Table 9.13 Summary assessment of Eastern Southern Link

| Scheme objective | | Eastern Southern Link |
|------------------|---|--|
| Transport | Relieve the congested Dartford Crossing and approach roads and improve their performance by providing free flowing north-south capacity | The 2017 appraisal, reported in the <i>Post Consultation Scheme Assessment Report</i> (2017, Highways England) identified that both the Western Southern Link and Eastern Southern Link (as part of a route at location C) would have a similar positive impact on reducing congestion at Dartford crossing. |
| | Improve resilience of the Thames crossings and major road network | The 2017 appraisal identified that both the Western Southern Link and Eastern Southern Link provide improved network resilience as part of a new and completely alternative route to the existing crossing. |
| | Improve safety | The 2017 appraisal identified that both the Western Southern Link and Eastern Southern Link would provide a new high-quality route with a high standard of safety for road users. |
| Economic | Support sustainable local development, regional economic growth in medium to long term | The 2017 appraisal identified that the Eastern Southern Link provided higher benefits than the Western Southern Link. These differences were considered during the 2017 appraisal. |

| Scheme objective | | Eastern Southern Link |
|------------------|--|--|
| | Be affordable to government and users | <p>The 2017 appraisal found that although the Western Southern Link had a lower cost the Eastern Southern Link provided better value for money.</p> <p>The decision to select the Western Southern Link was driven by the requirement within the NPSNN to minimise the environmental impacts on the AONB.</p> |
| | Value for money | |
| Environment | Minimise adverse impacts on health and the environment | <p>The full adverse environmental and health effects were appraised in 2017 and reported in the <i>Post Consultation Scheme Assessment Report, 2017</i>, Highways England.</p> <p>Landscape/Townscape The 2017 appraisal indicated that the Western Southern Link would result in minor intrusion into the Kent Downs AONB, with impacts on the setting of the AONB. The Eastern Southern Link was assessed as having greater intrusion than the Western Southern Link and having a greater impact on its setting at the A2/M2 junction.</p> <p>Biodiversity The Eastern Southern Link was determined to result in direct loss of habitat from, and fragmentation of, the woodland within the Great Crabbles Wood SSSI. Direct loss of two areas of ancient woodland and Court Wood local wildlife site, The Western Southern Link was assessed as resulting in direct habitat loss from Claylane Wood ancient woodland and Shorne and Ashenbank Woods SSSI.</p> <p>Assessment of the scheme changes Following the PRA, the design has developed to include widening of the A2, through the Kent Downs AONB, and the section of the route between the A2 and the southern portal has increased to dual-3 lanes. This has increased the intrusion into the AONB and on the setting. A more detailed appraisal of these impacts is set out in Chapter 8 of the <i>PEIR</i>.</p> <p>The widening of the A2 may also result in direct loss of ancient woodland, and direct loss of habitat from the woodland within Shorne and Ashenbank Woods SSSI.</p> <p>Despite the increase in the impacts on landscape arising from the design changes, the overall impacts of the Western Southern Link on the AONB remain lower than the Eastern Southern Link, as the Project is widening an existing corridor. Development of the Eastern Southern Link would require creation of a new corridor, directly impacting on the AONB and the setting along the eastern boundary. While the Project as now proposed will increase the existing impacts on the AONB that arise from the A2, the Eastern Southern Link would extend the impacts to encroach on a wider area of the AONB and its setting.</p> <p>The impacts on ancient woodland and SSSI arising from the design changes may result in a similar impact as the Eastern Southern Link. However, further development of the Eastern Southern Link to accommodate the increased traffic would likely result in a further increase to the impacts of the option.</p> |

C variant options re-appraisal

9.4.7 The findings of the re-appraisal of the location C variant options is presented in Table 9.14.

Table 9.14 Location C variant option re-appraisal

| Check or review | Outcome |
|-----------------------|--|
| Viability check | The C variant options were all considered to be technically viable. |
| Review of assumptions | Options CV3 and CV4 were not taken forward due to the significant adverse impacts on the environment. As there is no change to the impacts associated with these options, we have determined that the previous decision not to take these options forward remains valid. |
| Detailed appraisal | <p>A more detailed appraisal was undertaken of route 1 and for the C variant options CV1 and CV2, which had not been taken forward to consultation because the traffic model showed that they failed to meet the scheme objectives by failing to relieve the congested Dartford Crossing. The new LTAM was used to re-appraise the performance of these options. The model demonstrated that:</p> <ul style="list-style-type: none"> the revised traffic figures still support the decision not to consult on these proposed options the CV1 and CV2 options still result in traffic wishing to cross the river concentrating at Dartford and the lack of sufficient capacity on the roads leading to the crossing meant that performance gains over the river crossing itself are offset by congestion delays to reach the crossing <p>Consequently, it was concluded that the decision not to take these options to consultation remained valid.</p> |

Location D option re-appraisal

9.4.8 The findings of the re-appraisal of the location D options are presented in Table 9.15.

Table 9.15 Location D option re-appraisal

| Check or review | Outcome |
|-----------------------|--|
| Viability check | There was insufficient information to determine the technical viability of location D as the option was not developed further following the initial DfT study in 2009. |
| Review of assumptions | We have appraised both locations D1 and D2 against the scheme objectives considering the new traffic information available from the 2016 traffic baseline. Neither of these options would meet the objective of relieving the congested Dartford Crossing. In consequence, we consider that the decision not to take forward locations D1 and D2 remained valid. |
| Detailed appraisal | Not required |

Location E option re-appraisal

9.4.9 The findings of the re-appraisal of the location E option are presented in Table 9.16.

Table 9.16 Location E option re-appraisal

| Check or review | Outcome |
|-----------------------|---|
| Viability check | There was insufficient information to determine the technical viability of location E as the option was not developed further following the initial DfT study in 2009. |
| Review of assumptions | We appraised Location E against the scheme objectives considering the new traffic information available from the 2016 traffic baseline. This option would not meet the objective of relieving the congested Dartford Crossing. In consequence, we consider that the decision not to take forward location E remained valid. |
| Detailed appraisal | Not required |

Summary

9.4.10 In summary, we have reviewed the option identification and selection process that led to the development of the PRA. We reconsidered each of the decisions that was made, accounting for changes to local development plans, new understandings of traffic movements, and the design changes as we have developed the Project. We have determined that the findings of the option identification and selection process remain valid. Route options at locations A, B, D and E would not meet the scheme objectives and are not viable. Of the route options at location C the route presented in this consultation remains the best solution for the Project.

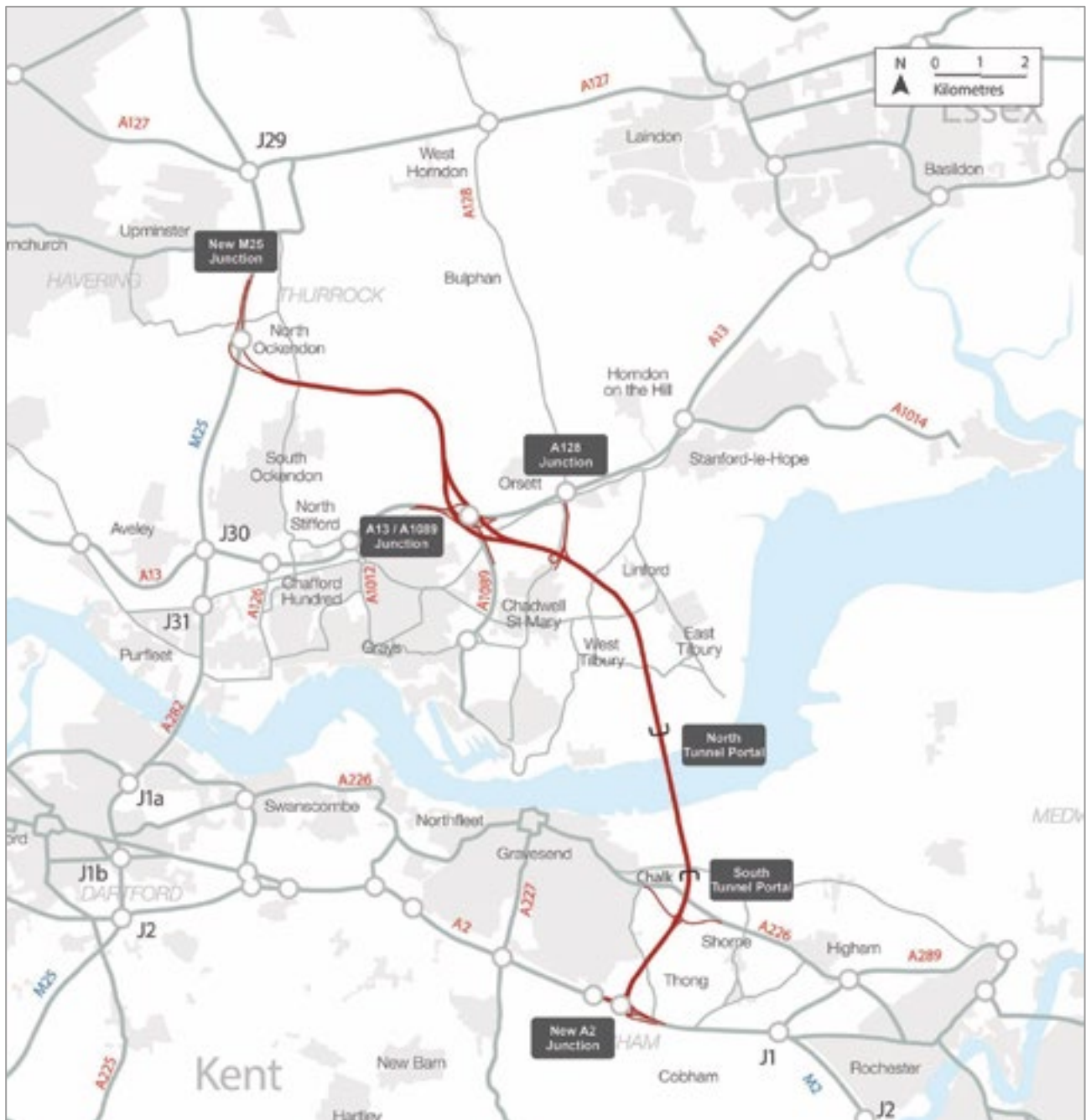
10 DESIGN DEVELOPMENT SINCE PREFERRED ROUTE

10.1 Preferred route

- 10.1.1 We published the *Post-Consultation Scheme Assessment Report (SAR)* at the time of the PRA in April 2017. This reported on the appraisal of route options and Highways England's recommended preferred route which was Route 3 with the Western Southern Link and a twin-bored tunnel river crossing large enough to accommodate a dual-3 lane carriageway while being initially constructed with a dual-2 lane carriageway. Route 3 was one of 3 alternative routes north of the river at location C, the others being routes 2 and 4. The Western Southern Link was one of 2 alternative routes south of the river, the other being the Eastern Southern Link. A summary of our appraisal of these routes and route 1 at location A is set out in section 9 above.
- 10.1.2 Further details of the appraisal of route options and the identification of the recommended preferred route are provided in the *Pre-Consultation SAR* and the *Post-Consultation SAR* which can be found on the Highways England Lower Thames Crossing consultation Citizen Space website¹. These appraisals are summarised in section 9 of this report. The strategic reasons for the selection of the recommended preferred route are:
- a. of the 2 locations considered, only a new crossing at location C (east of Gravesend) satisfies the scheme objectives. Options at location A (adjacent to the existing Dartford Crossing) did not meet the objectives.
 - b. a new crossing at location C opens up new opportunities for development and would strongly support the regional economic growth objectives.
 - c. a bored tunnel provides the best opportunity to mitigate adverse impacts on the Thames Estuary and Marshes Ramsar and SPA sites, which are international and European designations.
 - d. route 3 provides the most direct route with the lowest environmental and community impacts north of the river.
 - e. the Western Southern Link south of the river would achieve the transport and economic objectives and provide a high-quality solution, while having a materially lower impact than the Eastern Southern Link on the environment and local communities.
- 10.1.3 On 12 April 2017, the PRA by the Secretary of State for Transport stated that the recommended preferred route was the preferred route.

¹ www.highwaysengland.citizenspace.com/cip/lower-thames-crossing-consultation

Figure 10.1 Preferred route



- 10.1.4 The preferred route provided a new 70mph route (design speed 120kph) between the A2 in Kent and the M25 in Essex. It included the following junctions:
- A2 – a compact free-flow junction to the east of Gravesend providing for all movements between the A2 and the Project's route.
 - A226 – a local grade-separated roundabout junction to the east of Gravesend.
 - A128 Brentwood Road – a one-way free-flow junction allowing northbound Project route traffic to reach the A13 eastbound via the existing Orsett Cock

junction and A13 westbound traffic from the Orsett Cock junction to join the Project route southbound (these movements were not provided at the A13 junction).

- d. A13/A1089 – a free-flow junction providing connections for most movements between the Project route, the A13 and A1089 (see also A128 Brentwood Road above).
- e. M25 – a one-way free-flow junction between junctions 29 and 30 providing connections between the Project route northbound and M25 northbound and M25 southbound and the Project route southbound.

10.1.5 We said in the *Post-Consultation SAR* that further work would be undertaken during the next stage of Project development to determine whether the A226 junction should be included.

10.1.6 The A2 junction in the preferred route was provided as a compact junction to avoid impacts on the adjacent HS1 and minimise impacts on the nearby ancient woodland and Kent Downs AONB. It also minimised impacts on the existing adjacent A2 junctions. However, as part of the further appraisal work to support the preferred route we carried out further, more detailed, appraisal work on the design of this junction. We concluded that it was possible to provide a higher speed junction similar to the one proposed for the Eastern Southern Link at M2 junction 1 without significantly increasing the environmental impacts (see *Post-Consultation SAR* volume 7, section 6.3).

10.1.7 During the options stage we assumed that the Project's main route would be an all-purpose trunk road (APTR), while in the *Post-Consultation SAR* we considered the possibility of an expressway standard.

10.1.8 The *Post-Consultation SAR* describes the recommended preferred route (which became the preferred route) in more detail and sets out its performance against the scheme objectives.

10.2 SAR commitments and other changes considered

10.2.1 We committed to carrying out further detailed consideration of several aspects of the preferred route in developing the preliminary design (see *Post-Consultation SAR*, volume 7, section 7.4). These considered feedback from the public consultation and the further appraisal work carried out to support the preferred route and included:

- a. whether a dual-3 lane solution should be provided for all or part of the route
- b. whether new local junctions should be provided with the A226 south of the river and at Tilbury north of the river
- c. whether tunnelling should continue further south of the river to mitigate the impacts of the Project
- d. development of the junction arrangements with the A2, A13 and M25 to reduce their impacts on the community and the environment

- e. alternatives for the route where it passed through the landfill site north of South Ockendon
- f. further assessment of the impacts of the preferred route on the wider road network

10.2.2 In developing the design for statutory consultation, we have also considered other changes. Most of these aspects were not considered before the PRA as they were not differentiators in route selection. The traffic flows predicted by the updated traffic model were an important consideration in these developments. These changes include:

- a. the road type to be used (APTR, expressway, or motorway)
- c. whether any of the strategic roads directly connecting with the Project (A2, A13 and M25) require additional lane provision
- d. whether part or all of the Project should be either a high or heavy load route
- e. whether a rest or service area should be provided and if so where
- f. the location of any maintenance facilities and accesses
- g. the position of the north tunnel portal
- h. changes to the vertical route and depth of the tunnel
- i. development of junction designs, not only to reduce impacts on the community and the environment but also to accommodate predicted flows from the updated traffic model
- j. lowering of the level of the route north of the river following receipt of more detailed information from the EA about flood zones
- k. refinement of the route to reduce the impact on utilities, particularly overhead powerlines, following more detailed liaison with utility companies

10.2.3 In addition to the above changes, we have carried out other development of the design to improve the Project's safety, sustainability, construction schedule and environmental impact. These developments also took account of more detailed information as it became available.

10.3 Further design development

10.3.1 We are continuing to carry out surveys and studies of the site area, to improve our understanding of the ground conditions and environmental conditions along the route. We will continue to develop our designs to incorporate our improved understanding and where feasible to mitigate any adverse effects.

10.3.2 Part of the purpose of the statutory consultation which we are now undertaking is to receive your views on the way in which the Project has developed.

Following the consultation, we will undertake further design development having regard to the responses we receive.

- 10.3.3 Our design, as further developed following this consultation, will be presented in our DCO application. Should the Secretary of State decide to grant consent for the application, the final detailed design will be carried out by contractors appointed to construct the Project. This design will include any changes required following the DCO process.

11 Assessment methodology

11.1 Summary of methodology

- 11.1.1 For each of the proposed changes from the preferred route design set out in section 10.2 we developed alternative options which are summarised in the discussion of the changes in sections 12 to 15 that follow.
- 11.1.2 We assessed the alternative options under the following criteria which align with the scheme objectives:
- a. Consultation and stakeholder feedback
 - b. Accommodating forecast traffic flows
 - c. Environmental impact
 - d. Impact on road safety
 - e. Property impacts including impacts on proposed developments
 - f. Changes to estimated construction costs
 - g. Changes to economic performance
 - h. Effect on the operation and maintenance of the Project
 - i. Impact on non-motorised users (pedestrians, cyclists and horse riders and their facilities)
 - j. Impact on existing utilities
 - k. Buildability
 - l. Enabling development opportunities
- 11.1.3 Our assessment of the alternative options also considered engineering issues including geotechnics, the highway geometry and the requirements for new, or impacts on existing, highway structures.
- 11.1.4 We carried out an initial assessment to scope out those criteria which we did not consider to be significant differentiators in making a choice between the alternative options. We then assessed the options considering the remaining criteria.
- 11.1.5 After we had assessed the alternative options using the selected criteria to choose a recommended option we reviewed the performance of the options against the scheme objectives (see section 3) and compared their performance against the preferred route. We then made a final decision on the option to be included in the preliminary design.

12 Project-wide developments

12.1 Road standard

Position at PRA

- 12.1.1 At PRA, we assumed that the Project's route would be an APTR although it was acknowledged in the Post-Consultation SAR that the Project could be designed to emerging 'expressway' standards (introduced in the Road Investment Strategy).

Alternatives considered since PRA

- 12.1.2 Following the PRA we considered three road standards, namely:

- a. APTR
- b. Expressway
- c. Conventional/smart motorway

- 12.1.3 On 13 December 2017, Highways England proposed in its *Strategic Road Network Initial Report* that 'expressways' could be classified as motorways, creating a new type of motorway standard for new motorways or upgraded A roads.

Statutory consultation design

- 12.1.4 As a result of Highways England's continuous development of modern motorway standards, and following assessment of the alternative road standards available, we concluded that the Project should be designed to this new type of motorway standard. As an official standard has not yet been issued for this, it means that the Project will be designed to conventional motorway standards but with departures from standard for the omission of the hard shoulder, the provision of emergency areas and the provision of traffic control technology like that used on smart motorways including lane signals and variable mandatory speed limits (VMSLs).

- 12.1.5 The main reasons we decided to design the Project to this new type of motorway standard are:
- a. The classes of vehicles permitted to use the Project should be restricted for road safety and tunnel operational reasons. An APTR is therefore not appropriate without the application of restrictions on vehicle classes. This new motorway standard makes sure that the right traffic will be on the right roads.
 - b. This new type of motorway standard would produce a high-standard free-flowing route for road users, with the highest standards of safety and operational performance on the network. The cost of this new type of motorway standard solution would be £200–300 million less than a

conventional motorway solution This new type of standard would therefore provide better value for money.

- c. The lack of hard shoulder compared to a motorway designed to conventional standards may have some operational disadvantages but these would be mitigated by the provision of emergency areas and controlled motorway traffic control technology including lane signals and VMSL (in much the same way as a smart motorway solution). We consider this to be a more appropriate solution than an APTR.
- d. This new standard would have lower environmental impacts than a motorway designed to conventional standards due to the lesser land take.
- e. With the design solution we propose for the M2/A2 corridor (see section 13.1) the Project will be effectively providing a motorway-to-motorway connection between the M2 and the M25.

12.2 Number of lanes

Position at PRA

- 12.2.1 At PRA the Project was a dual-2 lane carriageway throughout. The bored tunnel river crossing was large enough to accommodate a dual-3 lane carriageway while being initially constructed with a dual-2 lane carriageway.
- 12.2.2 At PRA we decided not to widen the connecting highways beyond the Project's main road.

Alternatives considered since PRA

- 12.2.3 We reassessed the capacity of the route and connecting strategic roads following the PRA and the development of the updated traffic model.
- 12.2.4 The alternatives we have considered were to change the Project to a dual-3 lane carriageway either between the M2/A2 and the A13 or throughout from the M2/A2 to the M25.
- 12.2.5 We have considered the provision of additional lanes on the connecting strategic roads intersected by the Project at the following locations:
 - a. The A2 between M2 junction 1 and the Gravesend east junction.
 - b. The A13 between the A1012 Stifford junction and the A128 Orsett Cock junction.
 - c. The M25 from the Project's route to north of junction 29 including through junction 29.

Statutory consultation design

- 12.2.6 In the Project statutory consultation design, we include the following lane provision:
 - a. Project main road dual-3 lanes throughout.

- b. The A2 between M2 junction 1 and the Project is maintained as dual-4 lanes but the overall lane provision within the corridor is increased to 6 in each direction by the provision of 2-lane parallel connector roads in each direction (see sections 13.1 and 13.2).
- c. The A13 is widened to 4 lanes eastbound between the Project and the A128 Orsett Cock junction (see section 15.4).
- d. Six lanes northbound in the M25 corridor between the Project's route and junction 29 by maintaining the M25 as 4 lanes and adding a 2-lane connector road from the Project's route to junction 29 (see sections 15.7 and 15.8).
- e. Five lanes southbound on the M25 from junction 29 to the Project's route (see sections 15.7 and 15.8).
- f. Dual-4 lanes on the M25 through junction 29 (see sections 15.6 and 15.7).

12.2.7 Initially we considered that dual-3 lanes were only needed between the M2/A2 and A13 junctions but following refinement of the modelling we concluded that dual-3 lanes were needed throughout.

12.2.8 The key reasons for our conclusion that dual-3 lanes are needed throughout on the main road of the Project are:

- a. Between the M2/A2 and A13 junctions our analysis showed that with dual-2 lanes the link was likely to become congested in peak periods soon after opening with speeds predicted to drop as low as 45mph by 2041. By comparison with dual-3 lanes the crossing is forecast to operate at speeds greater than 60mph for most of the time and therefore better meet the transport-related scheme objectives.
- b. Between the A13 and M25 junctions our analysis following the refinement of the modelling showed that dual-3 lanes were also required on this link to accommodate actual peak hour flows and revised (higher) freight traffic forecasts (up to 40% heavy good vehicles (HGVs) are predicted on this link between the peak periods).
- c. The provision of a third lane provides additional capacity to give reliable and safe journeys on the Project's main road beyond 2041. This capacity also supports the network when there are incidents at the existing Dartford Crossing.
- d. The additional capacity allows the implementation of policy interventions to reduce demand at Dartford.
- e. The additional lane supports future developments in the area by providing extra capacity.

- f. Even though the extra lane would increase the estimated cost of the Project, our analysis shows that it would lead to improved journey times.
- g. There are slight environmental disbenefits due to the greater land take and additional traffic, which can be mitigated.
- h. An extra lane adds safety and operational benefits.

12.2.9 We have increased the lane provision on the A2, A13 and M25:

- a. to accommodate the design year traffic flows predicted by the updated traffic model
- b. because of the results of our more detailed assessment of the performance of the Project's junctions and connecting roads

12.2.10 As well as providing for predicted traffic flows, the reasons for providing additional lanes on the A2, A13 and M25 include:

- a. allowing joining and leaving traffic to safely change lanes between relatively closely spaced adjacent junctions as required by design standards
- b. providing the layouts for joining and leaving traffic required by design standards. These include the provision of additional lanes or the loss of lanes at junctions

12.3 High and heavy load routes

Position at PRA

12.3.1 At PRA we had not assessed whether any part of the Project's route should be either high or heavy load.

Alternatives considered since PRA

12.3.2 To develop the design in more detail we have carried out a study reviewing the need for the Project to cater for over-height or abnormal weight vehicles for part or all its length.

12.3.3 In carrying out this study we obtained and assessed information about existing high and heavy load routes. In addition, we sent a questionnaire to the operating agents listed below to assess the current high and heavy load movements in the area and their understanding of future demands:

- a. Connect Plus (operating the M25)
- b. Kent County Council (operating the road network in Gravesham)
- c. Thurrock Council (operating the local road network north of the river)
- d. Transport for London (operating the road network in London Borough of Havering)
- e. A-One+ Integrated Highway Services (operating the SRN south of the river)

12.3.4 The following figures (Figure 12.1 and Figure 12.2) and tables (Table 12.1 and Table 12.2) show high and heavy load routes on the Highways England network and the Project’s impact on these routes.

Figure 12.1 High load routes on Highways England’s network

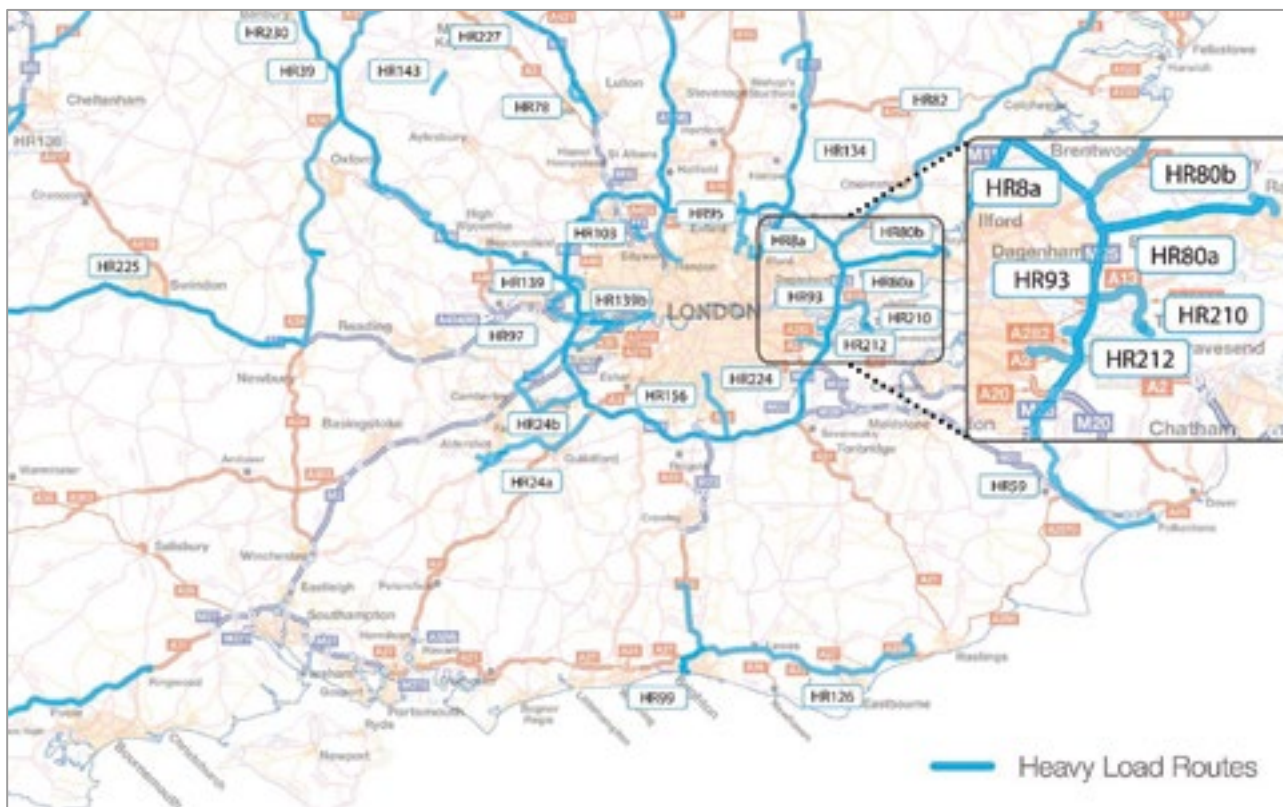


(Highways England, 2012) – Extract of ‘Highways England High and Heavy Load Grids Map for Abnormal Loads’ – High Load Routes

Table 12.1 Local authority high load routes affected by the Project

| Local authority | Route | Maintained headroom |
|---------------------|--|---------------------|
| Kent County Council | Dartford to Higham (along the A226 between Chalk and the A289) | 5.5m |
| Thurrock Council | M25 junction 30 to London Gateway Port via the A13 and A1014 | |
| | M25 junction 30 to Tilbury docks via the A13 and A1089 | |

Figure 12.2 Heavy load routes on Highways England’s network



(Highways England, 2012) – Extract of ‘Highways England High and Heavy Load Grids Map for Abnormal Loads’ – Heavy Load Routes

Table 12.2 Local authority heavy load routes affected by the Project

| Local authority | Route | Abnormal load class |
|------------------|--|-------------------------|
| Thurrock Council | M25 junction 30 to London Gateway Port via the A13 and A1014 | Class 1, 2 and 3 (STGO) |
| | South of Ockendon to M25 via B186 Fen Lane, A128 and A127 | |
| | M25 junction 30 to Basildon via the A13 | |

Statutory consultation design

12.3.5 Our study of high load routes showed:

- a. There are existing high load routes in the area that cater for the passage of high loads.
- b. The existing local authority routes set out in Table 12.1 that are crossed by the Project’s route should be maintained.
- c. There were no plans to expand the existing high load network, as confirmed by the relevant authorities responsible for maintaining the road network (as listed in paragraph 12.3.3) whom we contacted.

- d. Creating a high load route on the main road would require a substantial increase in the tunnel diameter as well as upgrades of existing adjacent infrastructure to be effective. The cost of this would be high and not justified.

12.3.6 Our study of heavy load routes showed:

- a. There are existing routes for the passage of Road Vehicles (Authorisation of Special Types) (General) Order 2003 (STGO) and Special-Order vehicles but these are not affected by the Project's route.
- b. There are no obvious heavy load routes that carry Special Order vehicles that can be connected by the Project's route.
- c. There were no plans to expand the existing heavy load network, as confirmed by the relevant authorities responsible for maintaining the road network (as listed in paragraph 12.3.3) whom we contacted.
- d. The design standards cater for some loads that would be classified as heavy loads by the Highways England Abnormal Loads Team, for example STGO vehicles.
- e. While it might be possible, providing a full duplication of the M25 capacity may also require an upgrade to the A2. The cost of this would be high and not justified.

12.3.7 From our assessment of this information we concluded that:

- a. Creation of a dedicated high load route or a route which caters for heavy loads greater than those covered by current design standards would not be economically justifiable and therefore would not meet the Project's scheme objectives.
- b. The Project's route should ensure that the existing high load routes which it crosses remain in place.

12.3.8 In the statutory consultation design for the Project we therefore propose not to make any specific provision for high or heavy load routes other than ensuring that existing routes crossed or affected are maintained.

12.4 Rest and service area

Position at PRA

12.4.1 At PRA we had not assessed whether an RaSA should be provided as part of the Project.

Alternatives considered since PRA

- 12.4.2 During the development of the statutory consultation design we assessed the need for an RaSA as part of the Project, where it could be located and what form it might take.
- 12.4.3 We considered potential locations along the length of the route, including:
- a. Upgrading the existing facilities on the A2. We discounted this because the distance to the next services (South Mimms) was appreciably further than the distance to the services on A2. Also, there were no obvious sites available on the A2 near the Project that avoid the ancient woodland and SSSIs.
 - b. Locating the RaSA near Ockenden. We discounted this because the Project is on a viaduct at this location and it would be difficult and expensive to provide an access roundabout.
 - c. Locating the RaSA adjacent to the Tilbury junction.
- 12.4.4 Within the vicinity of the Tilbury junction, we assessed locations to the south west, south east and north east. We chose the north-eastern site because it is outside the flood zone, avoids the historic landfills and other poor ground conditions and ground water protection zones which would be affected by the other two sites. The site is also the furthest away from the scheduled monuments of Tilbury and Coalhouse Forts.

Statutory consultation design

- 12.4.5 In the statutory consultation design for the Project we have included potential provision for a rest area in the form of an RaSA accessed from the Tilbury junction south of the Tilbury loop railway near East Tilbury. The proposed RaSA, if built, would be to the north-east of the Tilbury junction and would be combined with a maintenance depot.
- 12.4.6 The strategic need and reasoning for providing an RaSA are:
- a. Motorway service areas perform an important road safety function by providing opportunities for the travelling public to stop and take a break during their journey.
 - b. Government advice is that motorists should stop and take a break of at least 15 minutes every 2 hours. Drivers of many commercial and public service vehicles are subject to a regime of statutory breaks and other working time restrictions and these facilities assist in complying with such requirements. The RaSA would have facilities that allow customers to rest and relax before continuing their journey.
 - c. The ability to refuel or recharge vehicles is also an important element of an RaSA. By have refuelling and recharging facilities, it is hoped that the number of vehicles running out of fuel on the road network will be

minimised, creating a safer road and reducing occurrences of lane closures due to broken down vehicles.

- d. Refreshments are an important part of any rest break when undertaking a journey. The RaSA would include facilities for hot and cold refreshments, which would allow customers to obtain food and drinks. This would provide important nutrition, reducing fatigue for drivers when continuing their journey.
- e. The nearest sites are at Medway on the M2, Maidstone on the M20, Clacket Lane, Thurrock and South Mimms on the M25 and Birchanger on the M11 as shown on Figure 12.3.
- f. A fuelling station on the A2 (Cobham) will be removed as part of the Project and cannot be replaced due to lack of available land and unsuitable access.
- g. Hence the absence of an RaSA for journeys along the Project's route would mean exceeding the advised journey times between sites.
- h. There is a government commitment to provide frequent electrical charging points due to the increasing use of electric and hybrid vehicles.
- i. We were already considering providing a junction near East Tilbury. There are advantages for the operation of the tunnel from providing a junction in this location. and having a maintenance depot at the same place. This is therefore also a suitable location for the RaSA as there is land available around the proposed junction.

Figure 12.3 Existing service and rest areas



13 South of river developments

13.1 M2/A2 corridor

Position at PRA

- 13.1.1 At PRA we did not propose any works in the M2/A2 corridor either to the east or west of the Project's junction.

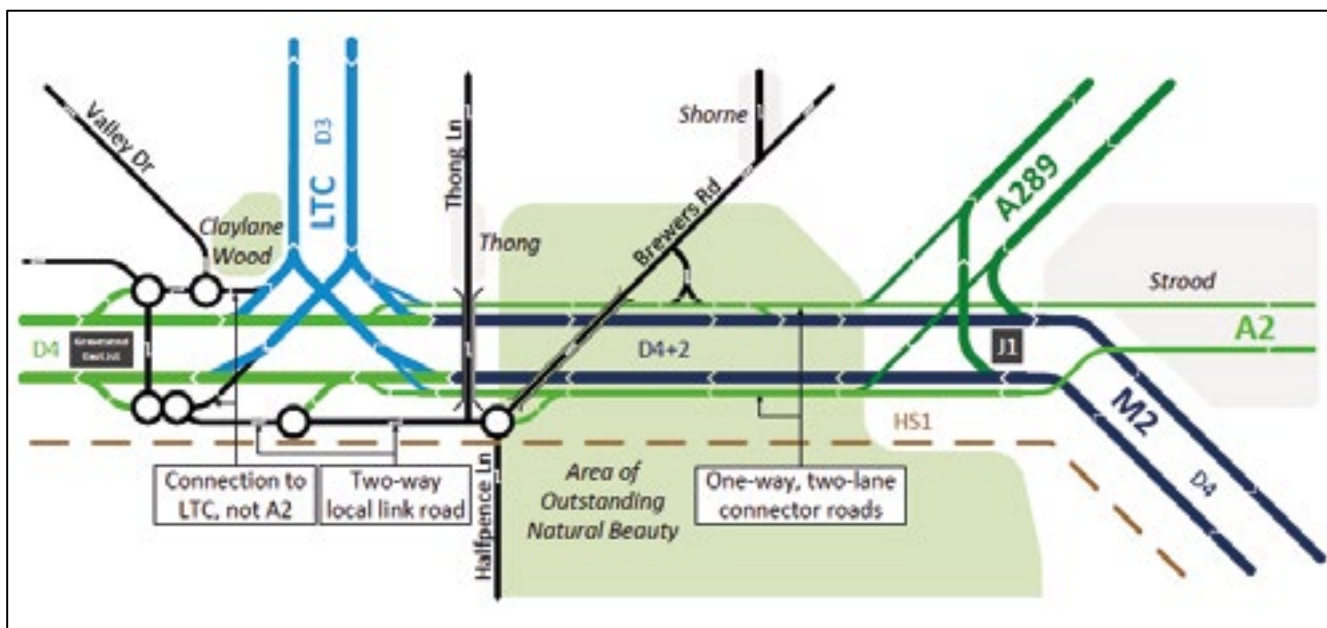
Alternatives considered since PRA

- 13.1.2 We considered works in the A2/M2 corridor east and west of the Project's junction because of the increased and changed pattern of traffic flows predicted by the updated traffic model. Works were also necessary due to the increase of the Project's main road from dual-2 to dual-3 lanes. The increased traffic flows would result in increased congestion on the A2 and M2, reduced air quality and reduced levels of safety. The SRN in this location would, therefore, not meet Highways England's performance requirements. Alternatives we have considered include:
- a. Keeping the A2 as it is
 - b. Widening the A2 between M2 junction 1 and the Project's junction from dual-4 lanes to dual-5 lanes by adding an extra lane and keeping the hard shoulder.
 - c. Widening the A2 between M2 junction 1 and the Project's junction from dual-4 lanes to dual-5 lanes by conversion of the existing hard shoulder to a running lane.
 - d. Keeping the A2 as dual-4 lanes and providing 2-lane one-way connector roads in each direction parallel to the A2 between M2 junction 1 and the Project's junction. These connector roads connect to the A289 Wainscott bypass and the old A2 into Strood and Rochester.
- 13.1.3 We considered alternatives including combinations of alterations to the local junctions at and between M2 junction 1 and the Gravesend east junction including slip road closures.
- 13.1.4 The option of maintaining the A2 as it is was assessed in detail as it passes through the AONB. However, vehicles travelling along the M2 and the A2 towards the Project route would cross with traffic using the A2 to travel to and from the Medway towns. This would result in high levels of weaving traffic, which would not comply with highway design standards or the Project's objective to improve safety.
- 13.1.5 We considered options that avoided the direct effects within the AONB during the development of the preferred route. The reasons for selecting the proposed route rather than the alternatives are summarised in section 9 (Route selection history overview). Section 9 also summarises our reassessment of the previously considered options.

Statutory consultation design

13.1.6 The statutory consultation design is illustrated in Figure 13.1.

Figure 13.1 Proposed M2/A2 corridor layout



13.1.7 In this layout we are proposing to keep the A2 as dual-4 lanes with hard shoulders. We also propose 2-lane one-way connector roads in each direction parallel to the A2 between M2 junction 1 and the Project's junction. Our proposals include widening the M2 from dual-3 lanes to dual-4 lanes through M2 junction 1. The connector roads connect with the A289 and old A2 and we propose link roads in both directions between the connector roads and both the Project's route and the A2 towards London.

13.1.8 We are also proposing to close the east-facing slip roads connecting to the A2 at the Gravesend east junction and to replace them with connections to and from the Project's route. We also propose a 2-way single carriageway local link road south of the A2 between the Brewers Road junction and the Gravesend east junction. Access is proposed at Brewers Road both on and off the northern, eastbound connector road but on the south side we only propose access off the westbound connector road.

13.1.9 The main reasons we are proposing this layout now are to:

- a. accommodate the design year traffic flows predicted by the updated traffic model
- b. avoid the high levels of weaving that would need to take place in the relatively short distance between M2 junction 1 and the Project's junction (about 2km) if this section was widened to dual-5 lanes. Our assessments show that this weaving would not take place safely and would result in congestion and poor traffic performance

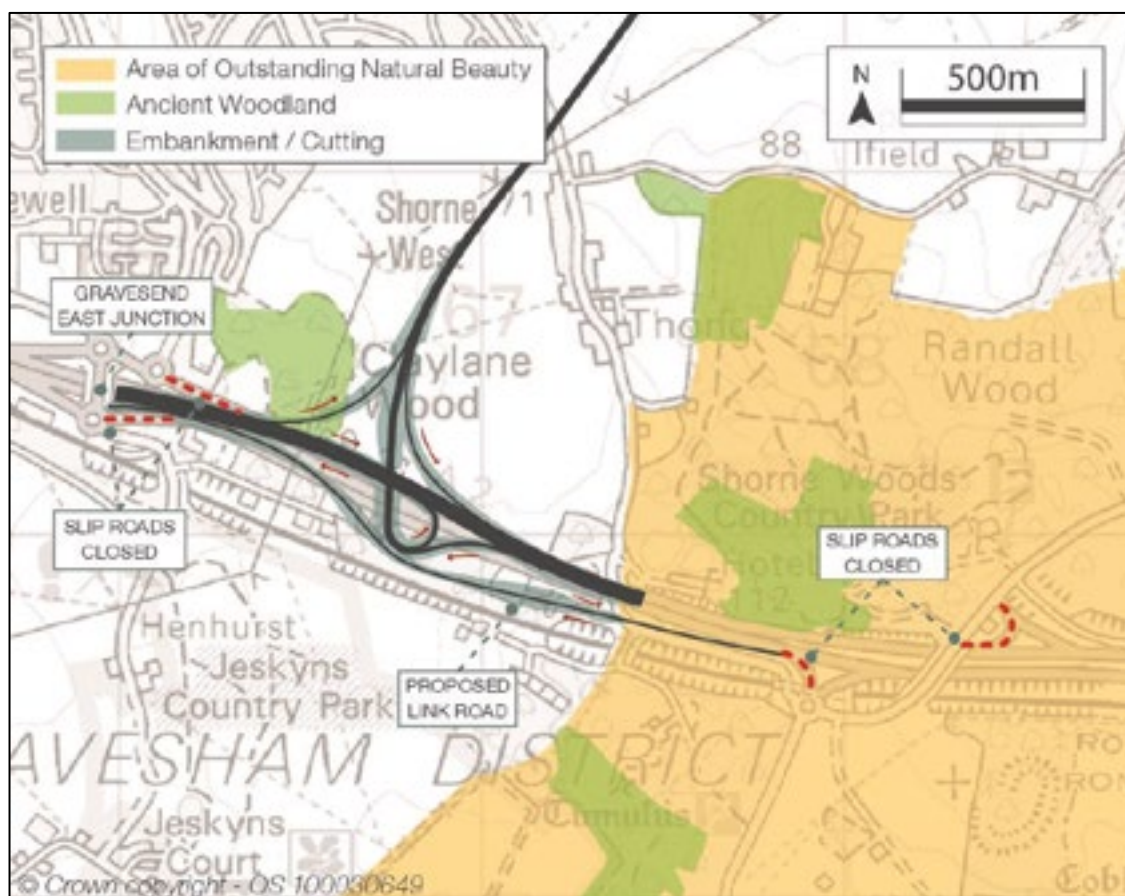
- c. provide connections between all the main roads (M2, A2, A289) and the Project's route while maintaining as many local traffic movements as possible
- d. effectively provide a motorway-to-motorway connection between the M2 and Project's route
- e. cater for local traffic between the A2 and M2 junction 1

- 13.1.10 Our proposed works in the A2/M2 corridor east of the Project's junction are within the AONB and close to areas of ancient woodland but would be kept within the existing highway boundary as far as possible. We have reviewed the impact of the developed design in this area against the Eastern Southern Link assessed before the selection of the preferred route. We have concluded that the developed design would still have less impact. See paragraph 9.4.6 and Table 9.13 in the Route selection overview section of this document for details of this assessment.
- 13.1.11 Due to the impact of the Project in this area, we are developing a series of mitigation works, including the provision of green bridges. These mitigation works are discussed within the *PEIR* and presented in the Environmental Master Plan.

13.2 A2 junction

Position at PRA

- 13.2.1 The Project/A2 junction included at PRA is a compact junction, see Figure 13.2.
- 13.2.2 To provide a junction in this location without impacting on HS1, which is adjacent to the highway boundary to the south, we proposed that the existing A2 would be realigned north over an approximate length of 2.5km.
- 13.2.3 This proposal required the east-facing slip roads at the Gravesend east junction to be closed due to the connections from the Project being too close to allow weaving to take place safely. In addition, the existing merge on the westbound A2 and diverge on the eastbound A2 from the Brewers Road junction were closed. This was again due to there being insufficient weaving length.
- 13.2.4 Because of closing these slip roads, we proposed a new link road between Henhurst Road roundabout and Brewers Road roundabout on the south side of the A2.
- 13.2.5 Due to the constraints in this area we used design speeds as low as 50kph for the slip roads.
- 13.2.6 We carried out work as part of the assessments leading up to the selection of the preferred route (see paragraph 10.1.6) as to whether this compact junction could be improved to provide a higher speed junction similar to the one that had been proposed at M2 junction 1 for the Eastern Southern Link (see *Post-Consultation SAR* volume 7, section 6.3).
- 13.2.7 Our conclusion from this work was that it was possible to provide a higher speed junction without significantly increasing the environmental impacts.

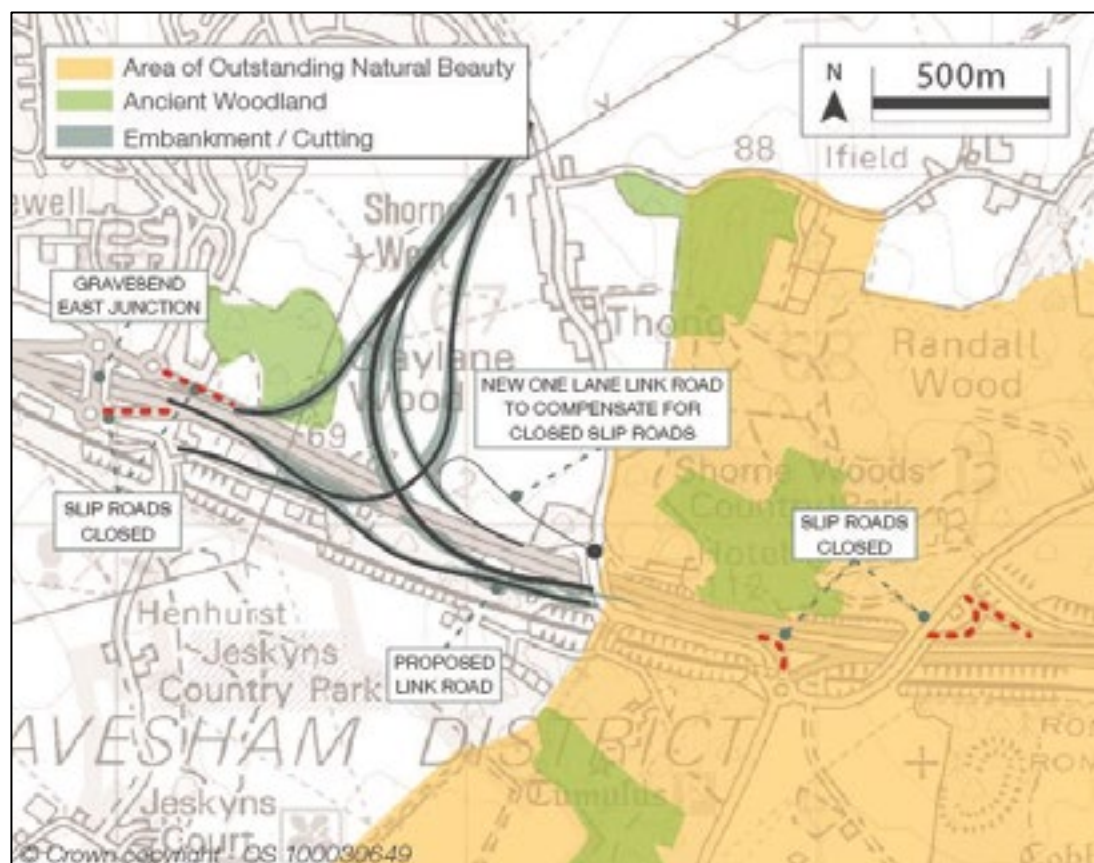
Figure 13.2 Project/A2 preferred route compact junction layout

Alternatives considered since PRA

- 13.2.8 The higher speed junction (see paragraph 13.2.7), for which the design speed for all 4 free-flow links between the Project's route and the A2 was 85kph, was our starting point for the development of the junction for the statutory consultation design. This layout is shown in Figure 13.3.
- 13.2.9 Factors and features that we have considered and assessed in developing the statutory consultation design from the layout shown in Figure 13.3 included:
- a. Providing dual-5 lanes on the A2 between M2 junction 1 and the Project's route to accommodate increased traffic flows predicted when the Project's main road was increased to dual-3 lanes (see section 12.2).
 - b. Reconfiguring the A2 corridor between M2 junction 1 and the Project's route to maintain dual-4 lanes on the A2. Also provide 2-lane one-way parallel connector roads to accommodate further increased traffic and weaving flows predicted by the updated traffic model (see section 13.1).
 - c. Closure of east-facing slips at Brewers Road and provision of slip roads from Thong Lane onto the Project's southbound to A2 eastbound connector road and from the A2 westbound to the Project's northbound link onto the 2-way local link road to maintain local connectivity.

- d. Provision of further grade-separated links between the M2, A2, A289, connector roads and the Project's route in the section between M2 junction 1 and the Project's route in various locations.
- e. Refinement of links and connections to allow more of the local connections at Brewers Road to be maintained.
- f. Assessment of the number of lanes required on each of the slip, link and connector roads.
- g. Moving the A2 carriageway to the north to take it off-line between Clay Lane woods and Thong Lane to aid buildability and reduce the impact on the HS1 substation.
- h. Considering whether along the Project's southbound route the eastbound link should diverge from the westbound link or vice-versa.
- i. Adjustments to horizontal alignment and road levels to reduce impacts on ancient woodland, AONB and HS1 while maintaining the 85kph design speed for all links.
- j. Whether it would be possible to retain the Cobham Services on the south side of the A2.

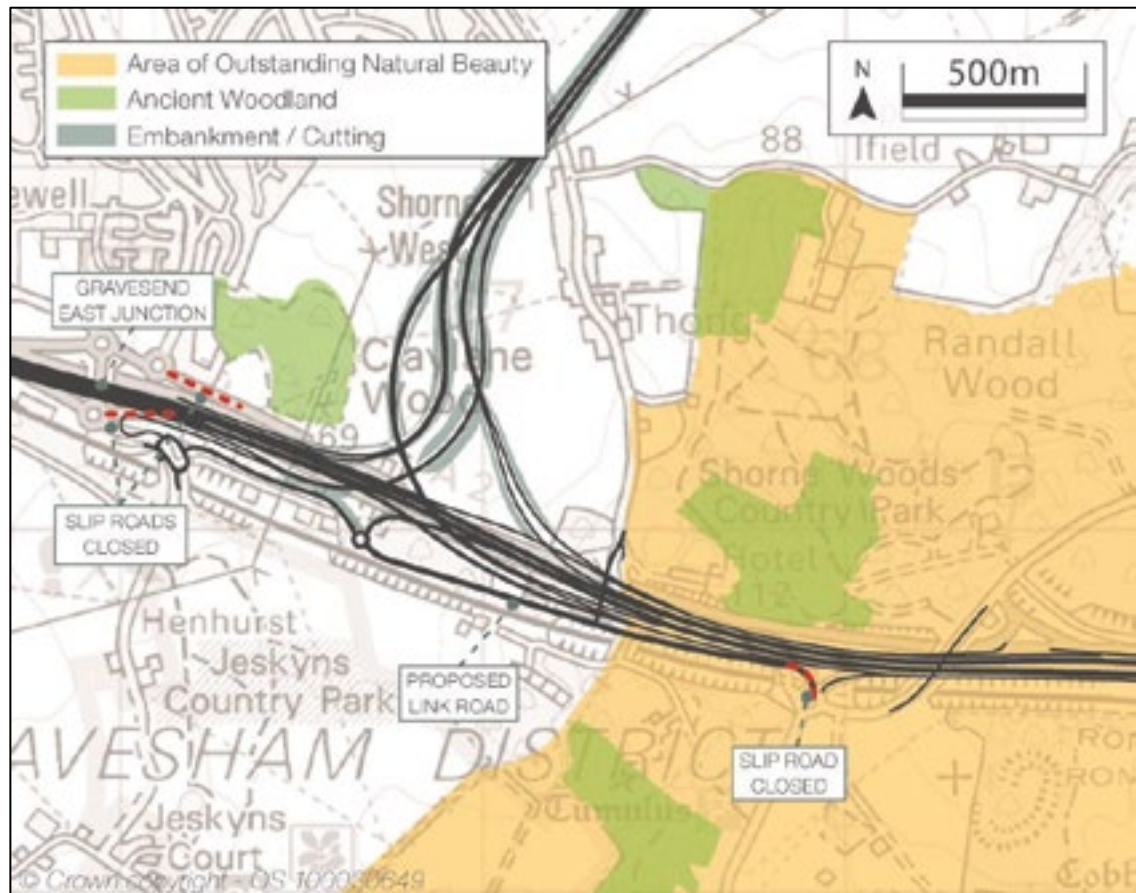
Figure 13.3 Project/A2 junction layout for development of statutory consultation design



Statutory consultation design

13.2.10 Our proposed statutory consultation design is shown in Figure 13.4.

Figure 13.4 Project/A2 junction proposed statutory consultation design



13.2.11 Features of our proposed design:

- a. The Gravesend east junction (Valley Drive) east-facing slip roads are disconnected from the A2 and connected to the Project's route instead.
- b. The A2 is reduced from 4 lanes to 3 lanes eastbound between the point at which the connector road leaves and the point at which the Project's route joins.
- c. The A2 is reduced from 4 lanes to 3 lanes westbound between the point at which the Project's route northbound leaves and the point at which the Project's route southbound joins.
- d. Access is provided both onto and off the eastbound connector road from Brewers Road.
- e. Access is provided from the westbound connector road to Brewers Road but not from Brewers Road to the westbound connector road.
- f. A 2-way local link road is provided from Valley Drive to the Brewers Road roundabout parallel to the A2 on the south side.

- g. The link from A2 eastbound to the Project's route northbound crosses over the link from A2 westbound to the Project's route northbound twice before joining it on the nearside.
- h. The link from the Project's route southbound to A2 westbound leaves from the nearside of the Project's route southbound before crossing over the link from the Project's route southbound to A2 eastbound, the link from M2 westbound to the Project's route northbound and the A2 mainline.
- i. The link from M2 westbound to the Project's route northbound passes under the A2 mainline, the link from the Project's route southbound to A2 westbound and link from A2 eastbound to the Project's route northbound (twice).
- j. An M2 westbound to local link road slip road is provided and passes over the link from M2 westbound to the Project's route northbound and the link from the westbound connector road to A2 westbound.
- k. The link from the Project's route southbound to A2 eastbound passes over the link from A2 eastbound to the eastbound connector road.
- l. We have decided to move the A2 further south than had been considered during the development of the design to avoid impacts on the ancient woodland to the north. This has resulted in a potential encroachment into HS1 land to the south.
- m. It was not possible to retain the Cobham Services.

13.2.12 We are recommending this layout because it:

- a. Maintains the 85kph design speed on the free-flow links between the A2 and the Project's route.
- b. Provides the number of lanes and merge (joining) and diverge (leaving) layouts required for the design year traffic flows predicted by the updated traffic model.
- c. Provides motorway-to-motorway connectivity between the Project's route and the M2.
- d. Caters for local traffic movements between the A2 and M2 junction 1 (Strood and Rochester).
- e. Avoids the ancient woodland located along the northern boundary of the A2 corridor although this results in encroachment into the HS1 corridor.
- f. Retains connectivity for local traffic at Brewers Road.

- g. Aligns the local link road away from the HS1 substation and associated HS1 land.
- h. Takes account of buildability considerations.

13.2.13 Our proposed works are adjacent to the AONB boundary and close to areas of ancient woodland. We have designed the junction to minimise the impacts where reasonably possible while complying with the design standards. We are developing a series of mitigation works to address the impacts. These mitigation works are discussed within the *PEIR* and presented in the environmental master plan.

13.3 A226 junction

Position at PRA

- 13.3.1 We first included a local junction with the A226 in the Project following early engagement with key stakeholders as the connectivity created would potentially unlock economic development opportunities providing benefit to the surrounding community and local businesses.
- 13.3.2 To establish the level of support for a local junction with the A226, we included a junction with east and west arms (see Figure 13.5 below), as part of the route options taken to public consultation in early 2016. We included this junction in the preferred route but, as noted in paragraph 10.2.1, we also included a commitment that further consideration would be given in the development phase to decide if the junction should remain part of the Project.

Figure 13.5 A226 junction at public consultation and PRA

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Alternatives considered since PRA

- 13.3.3 The alternatives we considered were the Project both with and without an A226 junction.
- 13.3.4 As part of these considerations we developed a further junction arrangement that removed the eastern connection to the A226 as shown in Figure 13.6. This was aimed at addressing concerns about the impact of additional traffic volumes through Higham village.

Figure 13.6 A226 junction with no eastern connection

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Statutory consultation design

- 13.3.5 Following further appraisal of the Project's route with and without an A226 junction we have concluded that the A226 junction should not be included in the statutory consultation design of the Project. The main reasons for this conclusion are:
- a. The removal of the A226 junction was supported by the majority of key stakeholders associated with the Project
 - b. Including a local junction with the A226 provides very few benefits to the Project. Although a junction does contribute positively to the overall benefit-cost ratio for the Project, most of this benefit is for local traffic, much of which does not use the new crossing or the Project's main road as part of a strategic journey.
 - c. Providing a junction also has a negligible effect on traffic levels at the existing Dartford Crossing. Furthermore, it will result in significant increases

in traffic flows on unsuitable local routes, particularly the A226 to the east and west of the Project's route.

- d. There are no environmental reasons to support the retention of an A226 junction in the Project.
- e. An A226 junction is not needed for maintenance or operational reasons and will have a negative influence on road safety and travel patterns on the local road network. This is due to additional joining and leaving traffic on the Project's route and additional traffic on minor local roads.
- f. Providing an A226 junction is not compatible with moving the southern tunnel portal southwards (see section 14.1).

14 Main crossing developments

14.1 South tunnel portal

Position at PRA

- 14.1.1 At PRA the south tunnel portal was located just to the south of Lower Higham Road and therefore outside the Thames Estuary and Marshes Ramsar site, Special Area of Conservation, Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI).
- 14.1.2 The total tunnel length (that is the length of enclosed road) with the portal locations at PRA was 3.33km.
- 14.1.3 To the south of the south tunnel portal the route was in a 25m deep water retaining trough structure, under the groundwater table in highly permeable chalk. This crossed under the A226 and between the village of Chalk and the Grade II* listed St. Mary the Virgin church. South of the A226 the road was above the groundwater table and the water retaining trough structure was replaced by an open cutting with free-standing slopes in the chalk.

Alternatives considered since PRA

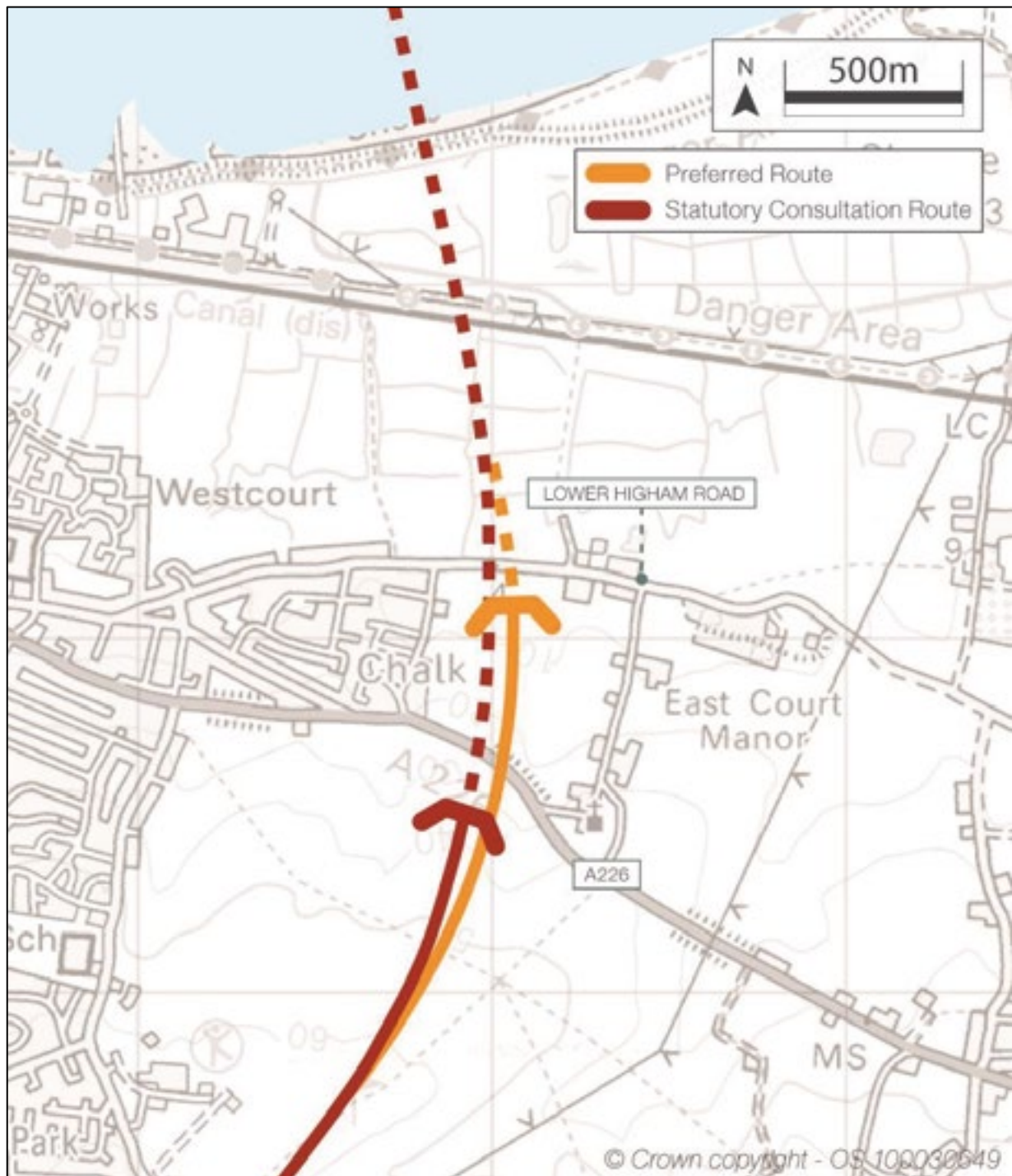
- 14.1.4 We considered that the risk associated with the construction of a deep excavation under groundwater table close to the Ramsar site could be mitigated by an extension of the bored tunnel drive, in similar type of ground conditions.
- 14.1.5 In addition to the risk during construction, due to the road being a physical barrier between the village of Chalk and St. Mary the Virgin church, we considered that it would be beneficial to the Project to consider an alternative with the south tunnel portal moved further to the south. This also took into account comments that we received during the 2016 public consultation.
- 14.1.6 We have considered the following alternative portal locations to the south of the PRA location:
- a. Just south of the A226 with an additional tunnel length of 600m giving a total tunnel length of 3.9km.
 - b. 200m further south of the A226 with an additional tunnel length of 800m giving a total tunnel length of 4.1km.
 - c. In the Southern Valley Golf Course with an additional length of 1.2km giving a total tunnel length of 4.5km.

Statutory consultation design

- 14.1.7 In the statutory consultation design, we have moved the southern tunnel portal to the south by about 600m compared to its location at PRA (that is option a. above). The proposed location is now about 100m south of the A226. We have also adjusted the route horizontally for about 2.2km to make it straighter to allow the drainage cross falls in both tunnel bores to be directed away from the centre. At the new southern portal location, the route has moved about 50m

west from its previous position. Figure 14.1 shows both the PRA portal location and the location proposed in the statutory consultation design.

Figure 14.1 South tunnel portal locations



- 14.1.8 The main reasons we are proposing to extend the tunnel by this amount are:
- The assessed difference in whole life cost compared to the PRA solution was marginal compared to the benefits of the extended length.
 - It reduces the risk of impacting the adjacent Ramsar site and therefore gives environmental benefits.

- c. It addresses the concerns about the severance between the village of Chalk and St. Mary the Virgin church, expressed in the 2016 public consultation.
- d. Both the 800m and 1.2km extensions would mean that there is not enough distance between the tunnel portal and the start of the diverge for the A2 junction to accommodate the required signs and signals. This would therefore require a departure from standards that, following discussions with Highways England safety specialists, is unlikely to be agreed. With the 600m extension the required signs and signals can be accommodated without a departure from standards.
- e. The construction cost of the 1.2km extension is significantly more than the PRA or recommended solution. The costs of the 800m extension are also higher. These costs are higher than any increased benefits.

14.2 Other tunnel design changes

Position at PRA

14.2.1 Our tunnel design at PRA assumed the following:

- a. A minimum cover under the river of 1.5 times the outer diameter of the tunnel.
- b. A minimum cover for the onshore section of the tunnel equal to the outer diameter of the tunnel.
- c. A maximum road gradient both north and south of the river of 4%.
- d. 100m of cut and cover tunnel and retained ramp structure at the south portal.
- e. 320m of cut and cover tunnel and retained ramp structure at the north portal.
- f. Ballast concrete placed as support under the roadway with some of the mechanical and electrical equipment placed within the concrete ballast.

Alternatives considered since PRA

14.2.2 We have considered the following options and changes to these proposals as part of our development of the statutory consultation design:

- a. Reducing the cover to the tunnel for both the river and onshore sections.
- b. Reducing the maximum road gradient to 3% both north and south of the river.
- c. Changing the lengths of cut and cover tunnel and retained ramp structure at both portals.

- d. Replacing the ballast concrete under the roadway with an under-deck gallery beneath the roadway. Also placing parts of the mechanical and electrical equipment within this gallery.

Statutory consultation design

14.2.3 Following assessment of the options we made the following changes to our proposals for the statutory consultation design:

- a. We reduced the minimum cover to the tunnel under the river to 1.0 times the outer diameter of the tunnel and the minimum cover for the onshore section to 0.8 times the outer diameter of the tunnel. These changes have been made because our assessment of the unit weight of relevant soils and the risk of tunnel uplift allowed the cover to be reduced without exceeding the limits for a safe design. This reduces the cost of construction.
- b. The maximum road gradient on the north side of the river has been reduced to 3%. We have made this change because the change from APTR to a new type of motorway standard (see section 12.1) means that the desirable maximum gradient reduces from 4% to 3%. This change will also bring benefits in reduced vehicle emissions. On the north side of the river our assessment has shown that it is possible to accommodate this change without a change to the portal location.
- c. On the south side of the river we have kept the maximum road gradient at 4%. This is because our assessment has shown that the ground level along the route is about 4%. Therefore, we cannot reduce the gradient to 3% without significantly further extending the tunnel length (see section 14.1) and increasing the depth and width of the approach cutting. This would have a potentially greater impact on properties around Thong Lane.
- d. We have changed the lengths of cut and cover tunnel and retained ramp structure to 60m at the south portal and 950m at the north portal. These changes have been made to reflect the changed location of the south portal and our greater knowledge and understanding of the ground conditions at both portals.
- e. We have adopted the change from ballast concrete to an under-deck gallery beneath the roadway. We have made this change to provide safe access to the mechanical and electrical equipment for maintenance during normal operation.

15 North of river developments

15.1 Vertical alignment – flood zones

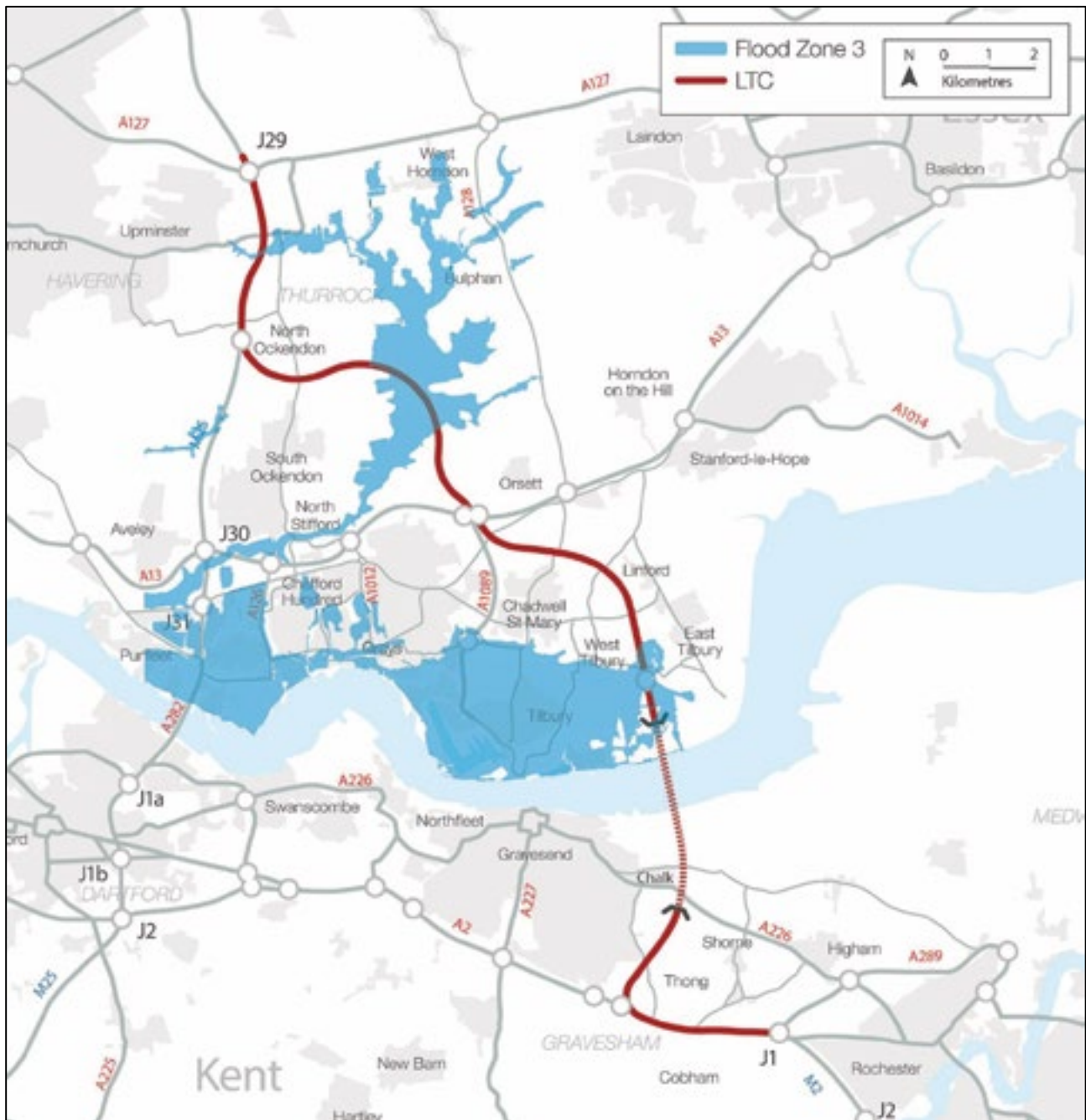
Position at PRA

- 15.1.1 At PRA we adopted a minimum road level of 6m above ordnance datum (AOD) for the main route north of the river. This was based on work carried out at the start of the options appraisal in reviewing flood maps (rivers and sea). A flood zone 3 is located north of the river with a flood height of 5.5m. Allowing for a 0.5m freeboard on top of this to account for wave action and any other mechanism, the flood extent would be approximately 6m AOD. In the absence of more detailed information we adopted this level throughout resulting in most of the route being on embankment.

Alternatives considered since PRA

- 15.1.2 Since PRA we have received more detailed information through engagement with the EA.
- 15.1.3 This information has shown that the flood zone 3 only affects two specific areas (see Figure 15.1). The first is East Tilbury Marsh between the north bank of the river and about 350m north of the Tilbury loop railway with a flood level of 6m AOD. The second is the floodplain of the Mardyke (Orsett Fen) starting about 2km north of the A13 and extending to the east side of the Ockendon landfill site. This has a flood level of 5.5m AOD. As for the preferred route we have assumed a minimum road level 0.5m above the flood level in each of these areas.

Figure 15.1 Flood zone 3 north of River Thames



- 15.1.4 We have developed alternative vertical alignments north of the river taking account of this new information.

Statutory consultation design

- 15.1.5 Where possible outside the two flood zones we have lowered the level of the route close to ground level removing much of the embankment needed for the Project's route. Because of the reduction in the road level most of the existing side roads are now proposed to go over the Project's route instead of under it. Exceptions are Station Road and Coal Road (East Tilbury), which go under the elevated section at the Tilbury loop railway.

- 15.1.6 The overall reduction in the level of the Project's main route has environmental benefits in reducing the visual impact.

15.2 Tilbury junction and link road

Position at PRA

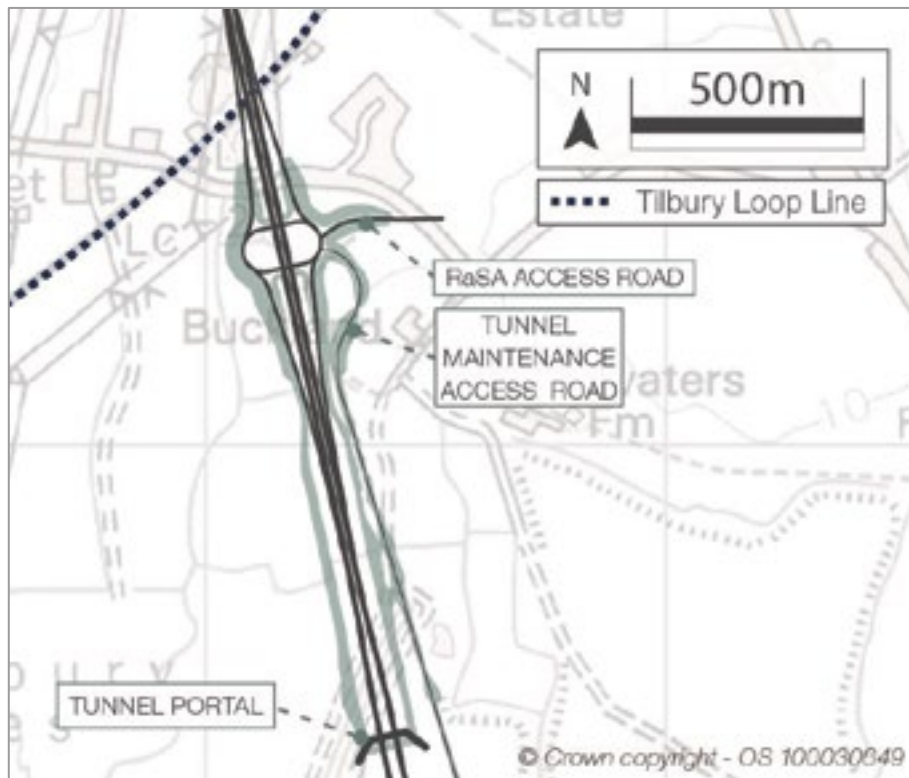
- 15.2.1 At PRA we did not include a junction or connecting link road at Tilbury.

Alternatives considered since PRA

- 15.2.2 As noted in the *Post-Consultation SAR* (see paragraph 10.2.1 above), we said that we would consider the addition of a local junction near Tilbury to provide direct access to the Port of Tilbury and other developments in the area.
- 15.2.3 Following PRA, we considered the inclusion of a junction near Tilbury both as a stand-alone feature and in combination with changes to the A13 junction (see section 15.4). This included a link road to the west of the Project's route connecting to the proposed Tilbury2 port development and Tilbury to the west.
- 15.2.4 We considered junctions to the west of East Tilbury located both north and south of the Tilbury loop railway. These were roundabout junctions either above or below the level of the Project's route with both north and south-facing slip roads.

Statutory consultation design

- 15.2.5 For the statutory consultation design, we propose to include a junction south of the Tilbury loop railway. This junction will give access to the potential provision of an RaSA and maintenance depot (see section 12.4). We have not included a link road to the west towards Tilbury. The proposed junction is shown on Figure 15.2.

Figure 15.2 Proposed Tilbury junction

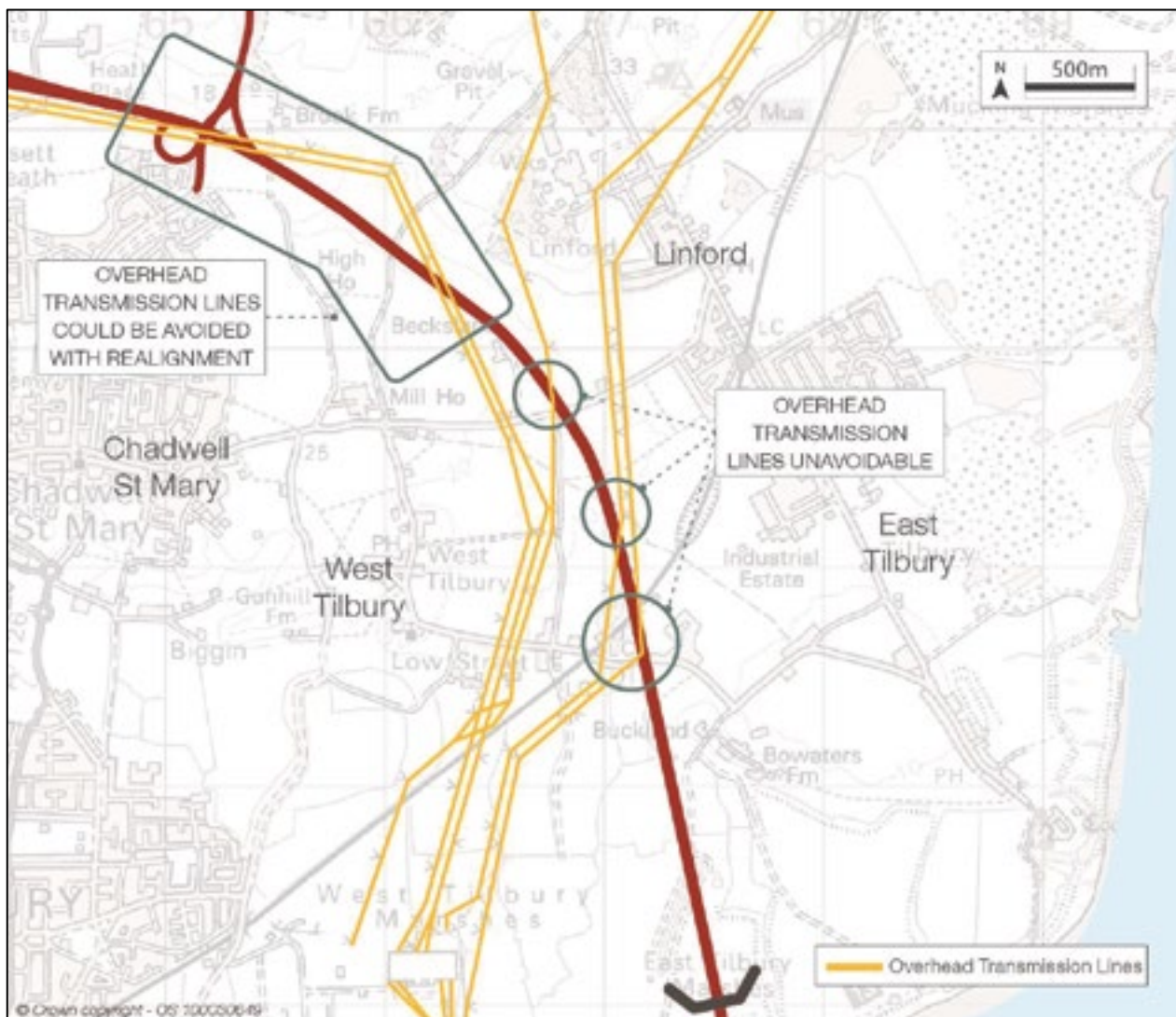
- 15.2.6 The main reasons we made this decision are:
- Although a link road to Tilbury2 and Tilbury has some benefits in providing additional connectivity, it also has significant environmental impacts, including impacts on ecological sites and heritage sites, particularly Tilbury Fort.
 - Traffic modelling highlighted several drawbacks with the link road design including unnecessary delays to HGV journeys and significant impacts on the local road network.
 - We consider this is the most suitable location for an RaSA (see section 12.5).
 - The link road would be located entirely in the flood zone and would require the provision of a significant additional flood storage compensation volume.
 - The link road would not be compatible with the Tilbury2 DCO application which envisages road traffic from the port using the existing A1089. We consider that it is more appropriate to maintain the existing strategic free-flow connections between the A1089 and A13 rather than providing an alternative access. (See section 15.4).

15.3 Horizontal alignment – electricity pylons between Tilbury and A13

Position at PRA

- 15.3.1 The preferred route passed under five overhead transmission line routes (see Figure 15.3).

Figure 15.3 Overhead transmission line routes between Tilbury and A13 adjacent to the preferred route



- 15.3.2 The preferred route passed about 820m from the nearest residential properties in West Tilbury, 470m from the nearest residential properties in East Tilbury, 500m from the nearest residential properties in Linford and 140m from the nearest residential properties in Chadwell St Mary (see Table 15.1). It bisected six fields and did not require the demolition of any properties.
- 15.3.3 Three of the transmission line routes that pass between Tilbury and Linford are affected by the Project's route through this area and diversion of these is unavoidable. However, two transmission line routes which run from Tilbury and

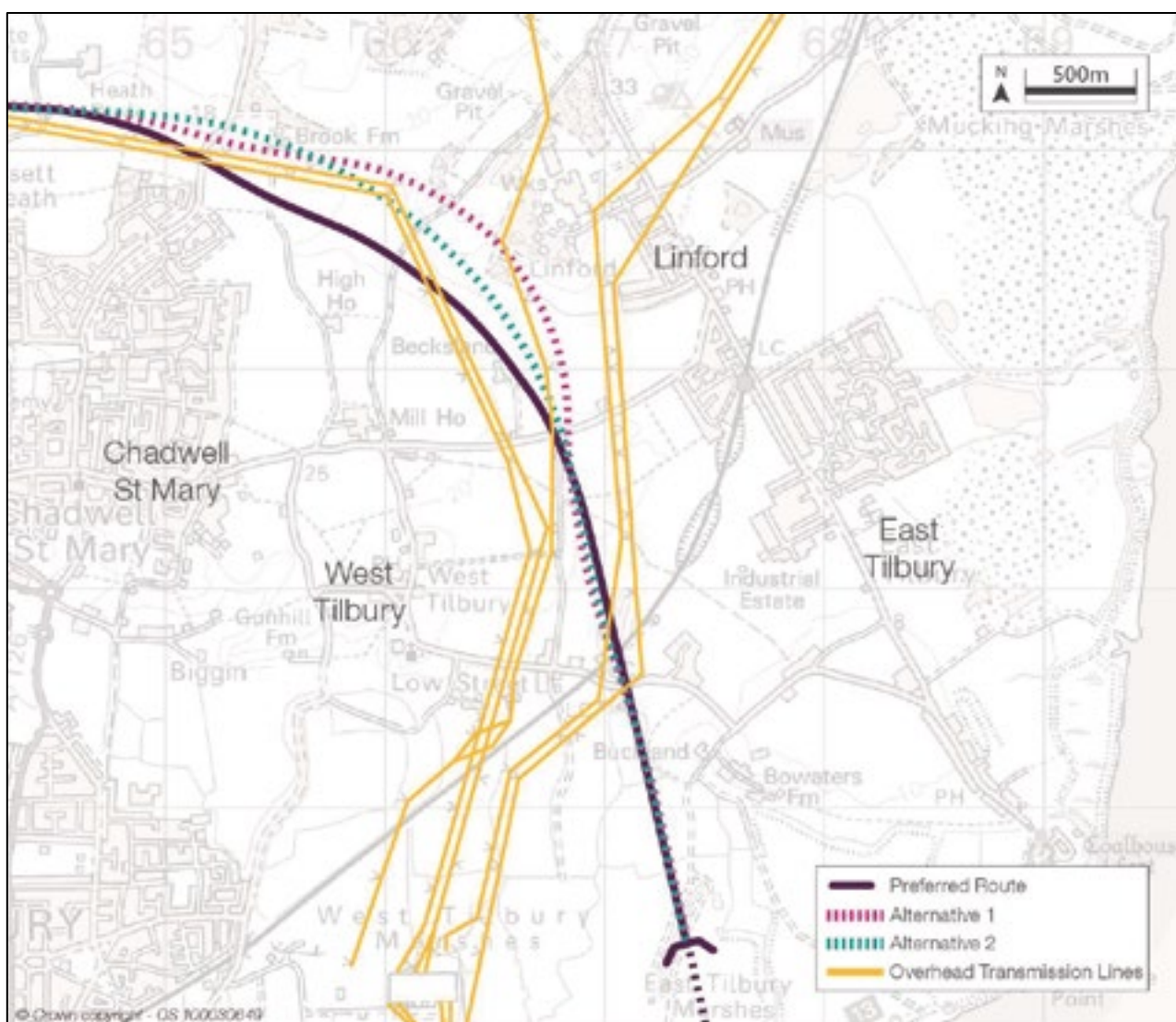
around Chadwell St Mary can be avoided if the route is realigned. This reduces the length of transmission lines to be diverted.

- 15.3.4 Diverting the transmission lines also makes their future maintenance easier. The overhead transmission lines run in parallel to each other as 275kv and 400kv lines. If the preferred route is kept the two overhead cable routes would need to be diverted for 1.5km affecting 10 pylons. The diversion would move the cables to within 70m of residential properties in Chadwell St Mary. National Grid have expressed concern about this diversion being permitted.

Alternatives considered since PRA

- 15.3.5 We considered two alternative horizontal routes to reduce the impact on the overhead cable routes. These are shown in Figure 15.4.

Figure 15.4 Alternative routes between Tilbury and A13



- 15.3.6 The first alternative route we considered did not have any impact on either of the overhead transmission line routes or pylons. It reduced the minimum horizontal radius to move the line of the route. This route moved slightly closer to West Tilbury, was the same distance from East Tilbury, 200m closer to

Linford and 80m further away from Chadwell St Mary (see Table 15.1). It bisected two additional fields and had an impact on the access to 2 properties.

- 15.3.7 The second alternative route we considered reduced, but did not eliminate, the impact on the overhead transmission line routes. It affected the pylons where the transmission line routes change direction. This required the removal of two pylons, modification of four pylons and a diversion length of 600m. This alignment had the same horizontal radius as the preferred route but was realigned to the south to achieve the required shift. Compared to the preferred route, this route also moved slightly closer to West Tilbury, was slightly further away from East Tilbury, slightly closer to Linford (by 60m) and was 140m further away from Chadwell St Mary (see Table 15.1). It bisected the same number of fields as the preferred route but required the demolition of two isolated residential properties.

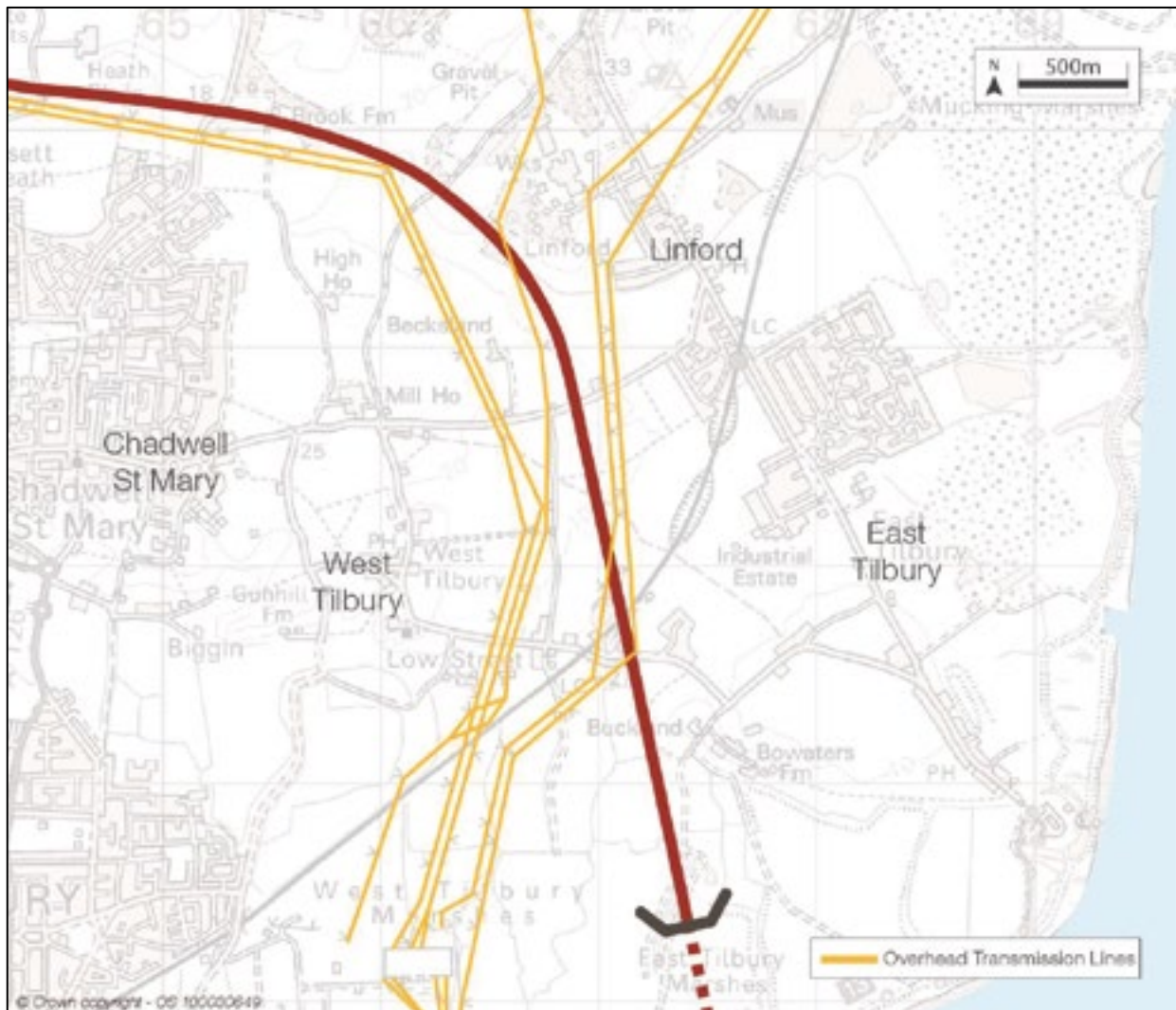
Statutory consultation design

- 15.3.8 The route we propose in the statutory consultation design (see Figure 15.12) is a compromise between the two alternative routes considered. It has the same impact on the two overhead cable routes as the second alternative route requiring the removal of two pylons, the modification of four pylons and diversion of 600m of cables. We have decreased the minimum horizontal radius but not as much as for the first alternative considered. This route is about the same distance from West Tilbury and East Tilbury as the preferred route. It is closer to Linford than the preferred route and the second alternative route but not as close as the first alternative route. It is about the same distance from Chadwell St Mary as the first alternative route (see Table 15.1). It avoids the requirement to demolish the two isolated residential properties. The distance of the preferred route, alternatives 1 and 2 and the statutory consultation route from the nearest residential properties in West Tilbury, East Tilbury, Linford and Chadwell St Mary are set out in Table 15.1.

Table 15.1 Distances to nearest residential properties from different routes

| Location | PR | Alt 1 | Alt 2 | Stat Con |
|------------------|-----|-------|-------|----------|
| West Tilbury | 820 | 740 | 770 | 820 |
| East Tilbury | 470 | 470 | 530 | 470 |
| Linford | 500 | 300 | 440 | 340 |
| Chadwell St Mary | 140 | 220 | 280 | 220 |

Note: All distances are in metres

Figure 15.5 Revised route between Tilbury and A13

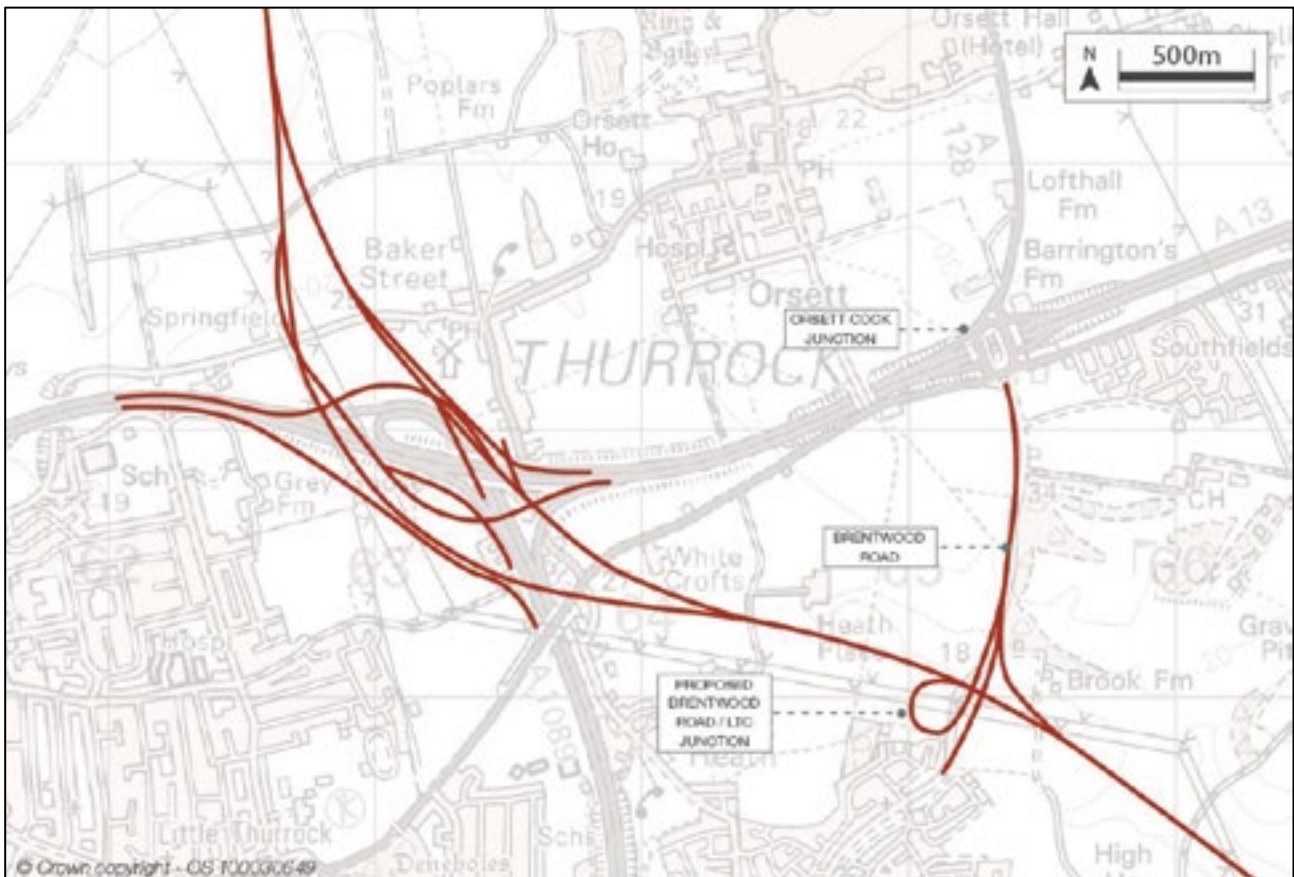
- 15.3.9 The main reasons we have adopted this route are:
- It significantly reduces the impact on the overhead transmission line routes while not moving the diverted cables closer to residential areas. This addresses the main concern expressed by National Grid.
 - It makes the future maintenance of the overhead transmission lines easier.
 - It maintains a distance of at least 200m between the route and residential properties. While the route moves nearer to some properties than the preferred route this is offset by the benefit of not moving the transmission lines closer to residential properties in Chadwell St Mary.
 - It does not require the demolition of any properties.
 - It minimises the severance of agricultural land.
 - It results in a cost saving through not relocating as many pylons.

15.4 A13 junction

Position at PRA

15.4.1 The preferred route layout of the A13 junction is shown in Figure 15.6.

Figure 15.6 Preferred route A13 junction layout



- 15.4.2 The junction was located at the site of the existing A13/A1089 junction. All movements between the A13 and A1089 were retained with some layout changes and movements between the Project's route and A13 and A1089 added. To achieve this, the Project's northbound and southbound main roads were split through the junction as shown in Figure 15.6.
- 15.4.3 It was not possible to accommodate all the movements between the Project's route and A13 at the A13/A1089 junction. Therefore, the Project's route northbound to A13 eastbound and A13 westbound to the Project's route southbound were provided through the existing Orsett Cock junction. This required the provision of a one-way junction between the Project's route and A128 Brentwood Road and the widening of the A128 from the new junction to Orsett Cock to a dual-2-lane carriageway. The Project's route southbound to A13 westbound and A13 eastbound to the Project's route northbound movements were not provided due to predicted low traffic demand.
- 15.4.4 In the 2016 public consultation several issues were raised about the junction layout including:
- a. The layout's impact on properties.

- b. The impact on the existing Orsett Cock junction.
- c. The size and complexity of the junction layout and its consequent impact on local residents.
- d. Impact on agricultural land and segregating farms.

15.4.5 The preferred route junction layout required the demolition of 38 properties: the whole of a travellers' site to the west of the A1089 (22); 7 along the A1089; 7 on Baker Street; and 2 on Stifford Clays Road.

Alternatives considered since PRA

15.4.6 Shortly after PRA we prepared a refined version of the junction layout addressing some of the most immediate concerns with the preferred route.

15.4.7 To address more of the issues and concerns with the preferred route we subsequently developed 10 alternative options.

15.4.8 We carried out a 2-stage appraisal of the 10 options. Stage 1 was a high-level engineering and traffic appraisal of all the options. Stage 2 was a more detailed appraisal of the remaining options considering safety, buildability and environmental effects.

15.4.9 During the stage 1 appraisal we discounted 8 of the options as they either did not provide sufficient traffic turning movements or there was an engineering issue identified.

15.4.10 We considered the remaining 2 viable alternative options to the preferred route and we carried out the more detailed stage 2 appraisal on them.

15.4.11 Our appraisal of these junction options showed that while there were some improvements on the preferred route neither addressed all the issues and there were still several concerns, in particular, over the complexity of the junction and the impacts at the Orsett Cock junction. In the case of the latter, even with additional improvements our more detailed traffic assessments of the junction's performance indicated that there could still be congestion.

15.4.12 To address these concerns, we developed 2 further options. These were:

- a. Further Option 1 – preferred route with an enhanced Orsett Cock junction.
- b. Further Option 2 – alternative simplified A13 junction together with a Tilbury junction. This option avoided the requirement for the A128 spur and improvements at A13 Orsett Cock junction. The Tilbury junction provided for direct access to the Project's route for Port of Tilbury traffic.

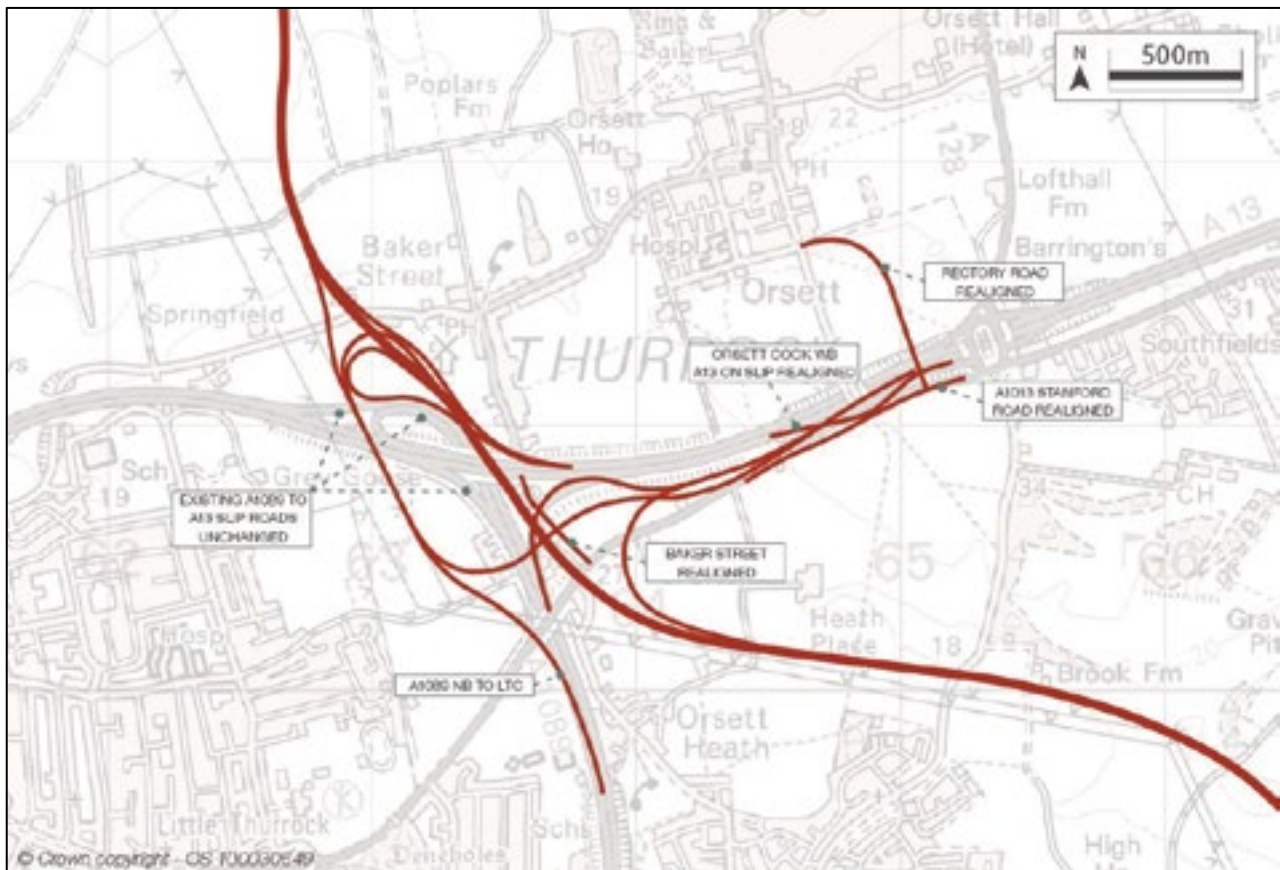
15.4.13 For the Tilbury junction we carried out work in response to the *Post-Consultation SAR* commitment to consider the provision of a local junction at Tilbury. This developed and appraised several junction options to the west of East Tilbury located both south and north of the Tilbury loop railway line (see section 15.2). We concluded that the most appropriate solution was a grade-separated roundabout junction south of the railway line with a single carriageway link road to the west connecting to the proposed new link road for the Tilbury2 development. If the Tilbury2 development does not go ahead the

link road would be extended further west to connect to the A1089. This is the Tilbury junction that we included as part of Further Option 2.

- 15.4.14 We initially considered that Further Option 2 was the most appropriate solution and should be included in the statutory consultation design. However, after we had carried out more detailed assessment of this design several issues were identified including:
- a. The environmental impact of the Tilbury link road (see section 15.2).
 - b. The incompatibility of the Tilbury link road with the most recent version of the Tilbury2 DCO application (see section 15.2).
 - c. The complexity of the A13/A1089 junction which included long viaduct structures on links carrying relatively little traffic.
 - d. The need to widen the A13 between the A1012 Stifford junction and the Project's route.
 - e. The need to demolish and replace the A1089 bridge under the A13 leading to significant buildability concerns.
 - f. Without the Tilbury link road the connections between the A1089 and A13 need to be retained. The addition of an at-grade roundabout with the A1013 would not be appropriate due to the delays that it would introduce.

Statutory consultation design

- 15.4.15 To address the above issues, we developed a simplified A13 junction maintaining the connections between the A1089 and A13, providing the key strategic connections between A13 east and the Project's route. We also propose connections between A1089 northbound and the Project's route northbound and southbound for traffic from the Port of Tilbury. This is the A13 junction that we have included in the statutory consultation design (see Figure 15.7).

Figure 15.7 A13 junction for statutory consultation design

15.4.16 Our main reasons for adopting this design are that it:

- a. maintains all the existing connections between the A13 and A1089, providing free-flow access for traffic from the Port of Tilbury
- b. maintains the port's connections to the Project's route, reduces traffic flows on the A13 and protects local roads in Tilbury
- c. provides the key strategic connections between the Project's route and the A13 to the east while not providing connections between the Project's route and the A13 to the west. These are predicted to carry relatively little traffic partly because the forecast improved performance at Dartford means that users west of the Project's route are likely to continue to cross at Dartford
- d. retains the existing A1089 bridge under the A13 and provides a new separate underbridge for the Project's route. This addresses some of the most significant build concerns with the previous layout
- e. simplifies the junction layout overall to improve connections to Tilbury port enabling us to remove the proposed Tilbury link road, which would have had a negative impact on the local road network
- f. reduces changes on the A13

15.5 Mardyke crossing

Position at PRA

- 15.5.1 At PRA the route between the A13 and M25 crossed the Mardyke Valley on a low embankment about 4m high. It also crossed the Mardyke river and the nearby main rivers (Orsett Fen Sewer and Golden Bridge Sewer) on short individual single span structures which were slightly wider than the rivers.

Alternatives considered since PRA

- 15.5.2 Following engagement with the EA after PRA we agreed criteria for crossing these three rivers as:
- minimum headroom over river 4.0m
 - minimum clearance either side of river 8.0m
- 15.5.3 Our more detailed consideration of geotechnical information has indicated that construction of embankments in this area would require ground improvements.
- 15.5.4 Embankments in the flood zone also need to be compensated by an equivalent volume of excavation contiguous with the flood zone to maintain the current flood volume.
- 15.5.5 We considered three options to address the issues raised by the new information. These were:
- Option 1 – similar to preferred route with embankment and three separate short span structures crossing the rivers. The embankment would be higher to provide the required clearance over the rivers and the spans of the structures would be increased. This increases the volume of flood compensation required.
 - Option 2 – a long viaduct (about 1,500m) spanning all three rivers with typical spans of 40 to 50m. This minimises the volume of flood compensation required.
 - Option 3 – a hybrid option with a shorter viaduct (about 450m) over the Mardyke river and Golden Bridge Sewer and embankment (about 980m total length) across the rest of the area with a single span (about 50m) over Orsett Fen Sewer.

Statutory consultation design

- 15.5.6 Following comparison of the three options we concluded that option 3, the hybrid option, should be the basis of the statutory consultation design.
- 15.5.7 Our main reasons for recommending this option are:
- Including a viaduct gives a more open aspect reducing the visual impact in this open area.

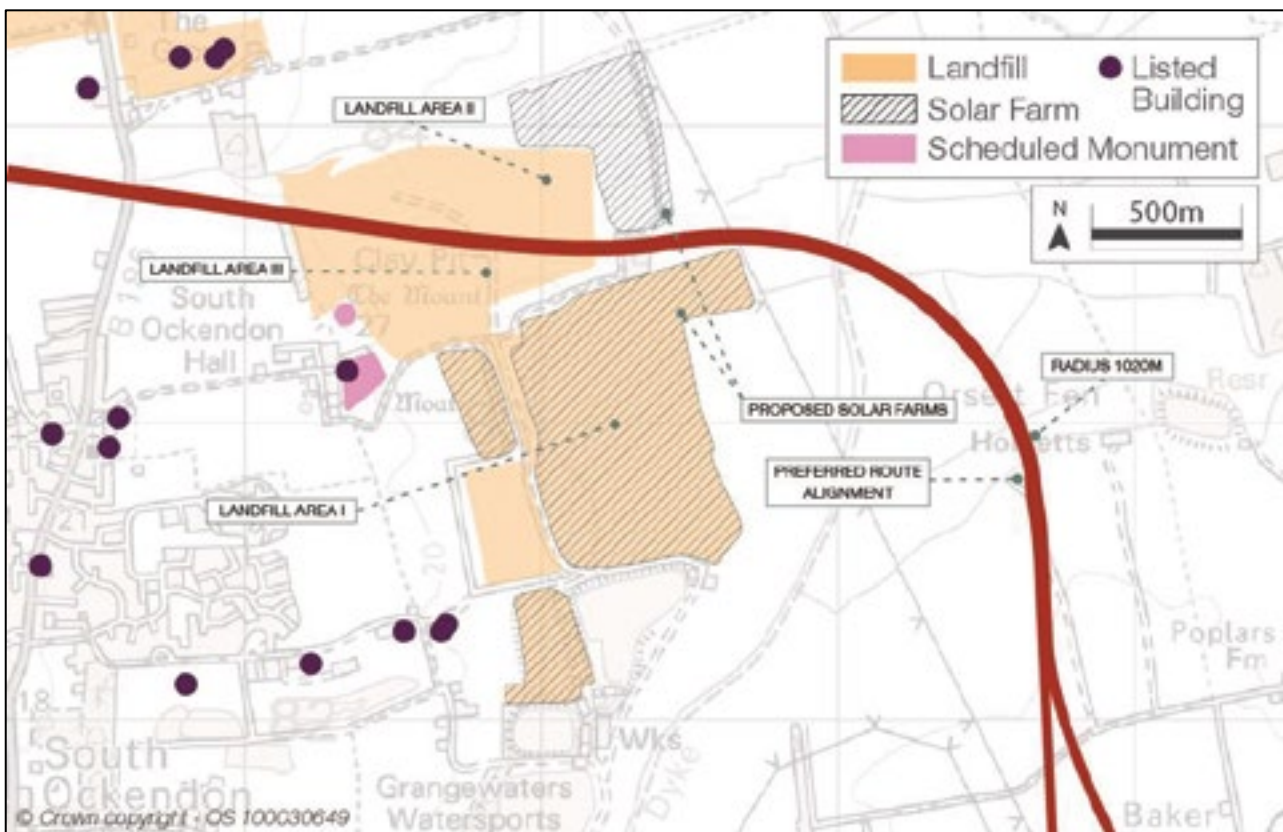
- b. A combination of viaduct and embankment is a more cost-effective solution than a viaduct over the whole of the valley.
- c. A shorter viaduct will be less of a long-term maintenance issue than the longer viaduct while it will still present an opportunity for architectural treatment that minimises visual impact.
- d. Reducing the length of embankment reduces the volume of flood compensation and consequently the amount of land compared to the preferred route and option 1 making it easier to find suitable land.

15.6 Horizontal alignment – Ockendon landfill site

Position at PRA

- 15.6.1 At PRA the route passed through a closed landfill site north of South Ockendon (see Figure 15.8).

Figure 15.8 Ockendon landfill site and preferred route



- 15.6.2 The preferred route had a design speed of 120kph and was a dual-2 lane carriageway between the A13/A1089 and M25 junctions. The route was mainly constructed on embankment with a minimum horizontal radius of 1,020m.
- 15.6.3 We used this radius to mitigate the impact on a planned solar farm development, allowing the route to pass through a small corridor between the two landfill areas (see Figure 15.12). This route also provided an appropriate connection with the M25 junction.

Alternatives considered since PRA

- 15.6.4 As noted in the *Post-Consultation SAR* (see paragraph 10.2.1 above), we said that we would consider alternative route alignments to avoid the landfill site.
- 15.6.5 We developed and assessed three alternative routes avoiding the landfill site. The three alternative routes and the preferred route had significant constraints (see Figure 15.9).

Figure 15.9 Alternative routes at Ockendon Landfill



Alternative 1

- 15.6.6 This route runs north of the landfill site close to its northern boundary passing through a proposed solar farm to the east of the landfill site. This route creates a triangle of land between the landfill and the route. This could be used to compensate for the solar farm area that would be lost. The route also crosses a gas pipeline in two places. It has an improved horizontal alignment to the east of the landfill site as it has a radius of 1,700m compared with 1,020m.

Alternative 2

- 15.6.7 This route also runs north of the landfill site but further from the northern boundary of the site avoiding the proposed solar farm. This route crosses two gas pipelines each in two places. It has the same radius as the preferred route to the east of the landfill site, 1,020m. This is followed by a curve of radius 1,400m. This is the most northerly route, avoiding both the landfill sites and solar farm developments. This creates a longer route than the preferred route and will therefore require more land and have slightly longer journey times.

Alternative 3

- 15.6.8 This route runs south of the landfill site through a historic landfill area which is also the site of a second proposed solar farm. This route does not cross either of the gas pipelines. It has the same radius as the current route to the east of the landfill site with two 1,020m radii to the south of the landfill site. The route is compatible with the proposed M25 junction design. A narrow corridor to the west of South Ockendon Hall is used to connect this southern route to the M25 junction. Using this corridor would place the route closer to a listed building and several ancient monuments. This route is also closer to residential areas in South Ockendon than the preferred route and the other two alternatives.

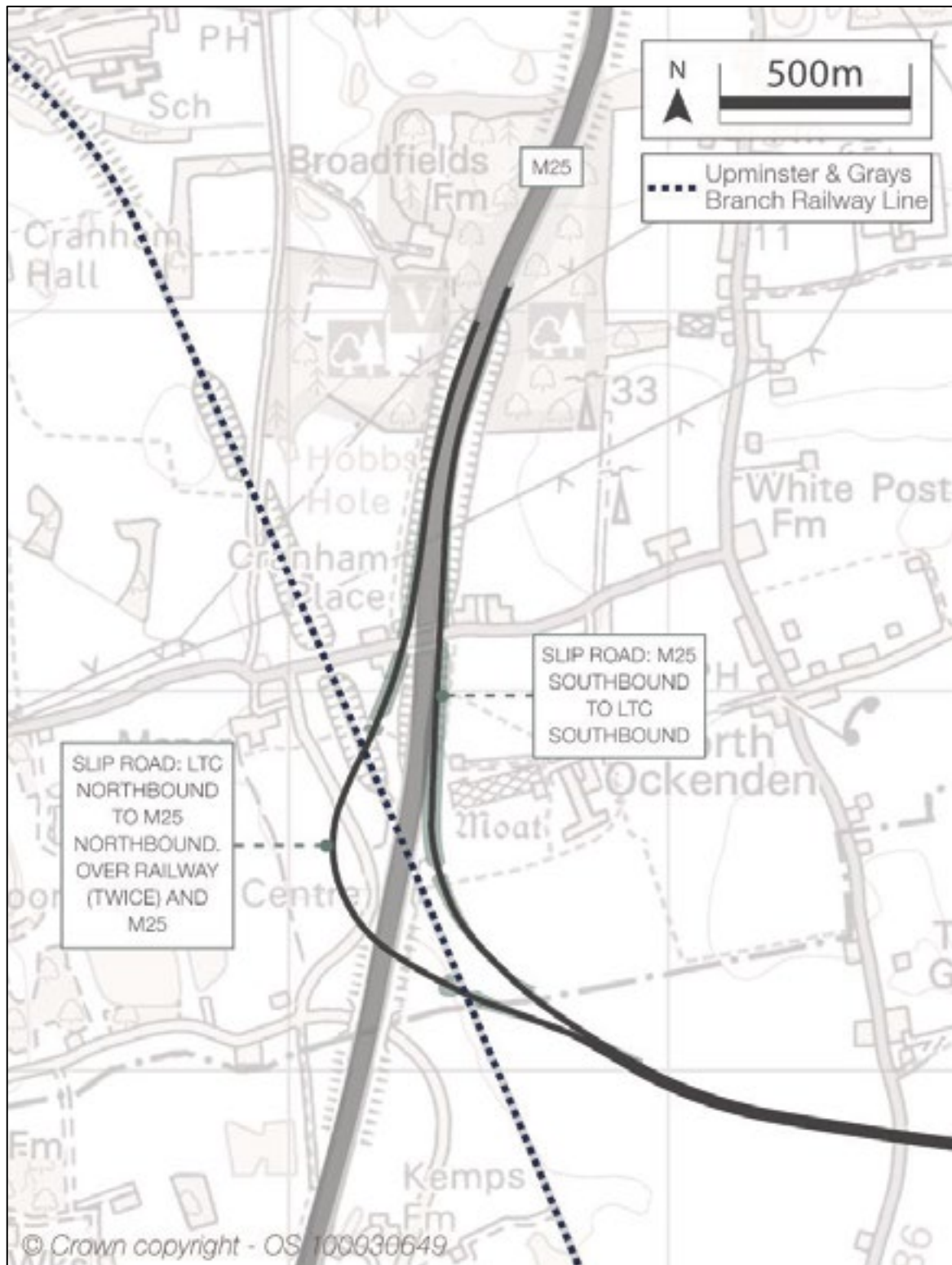
Statutory consultation design

- 15.6.9 Following the assessment of the preferred route and the three alternative routes we decided to change the route to alternative 1. The main reasons for this decision are:
- a. It avoids the high geotechnical and geo-environmental remedial costs of taking the route through the landfill site.
 - b. It has lower construction risk as it avoids:
 - i. the handling of landfill materials
 - ii. potential settlement issues from construction of an embankment over landfill material
 - iii. modifications to the existing landfill leachate and gas management systems
 - iv. possible creation of preferential contaminant pathways
 - c. It avoids operation and maintenance risks and liabilities which would apply with a route through the landfill.
- 15.6.10 The alternative route has greater impacts on the proposed solar farm and gas pipeline, but we consider that these can be mitigated and that these disadvantages are outweighed by the advantages noted above.

15.7 M25 junction

Position at PRA

- 15.7.1 The preferred route layout for the M25 junction is shown in Figure 15.10.

Figure 15.10 Preferred route M25 junction layout

15.7.2 Our preferred route for the M25 junction connected the Project's route to the M25 approximately 3.4km south of junction 29 and 5km north of junction 30 around Ockendon Road. The junction was a free-flow interchange which provided the following movements:

- a. The Project's route northbound to M25 northbound

b. M25 southbound to the Project's route southbound

- 15.7.3 This proposal involved the construction of high embankments, two railway crossings and a viaduct structure over the M25. In terms of horizontal alignment, this junction layout included several relaxations from standard due to site constraints and proximity to junction 29 which imposed a weaving length constraint. Because this layout did not involve any works to the M25 north of the junctions there were departures from standards for the proposed layouts for joining and leaving the M25.
- 15.7.4 This option would require the demolition of two properties at Ockendon Road.
- 15.7.5 In the 2016 public consultation several issues were raised about the junction layout including:
- a. The impact on the M25 during construction and in operation.
 - b. The impact on Ockendon Road and adjacent properties.
 - c. Visual impact due to the high embankments and viaduct structures.
 - d. Route going over a live railway twice and over the M25 on a long, skewed structure.

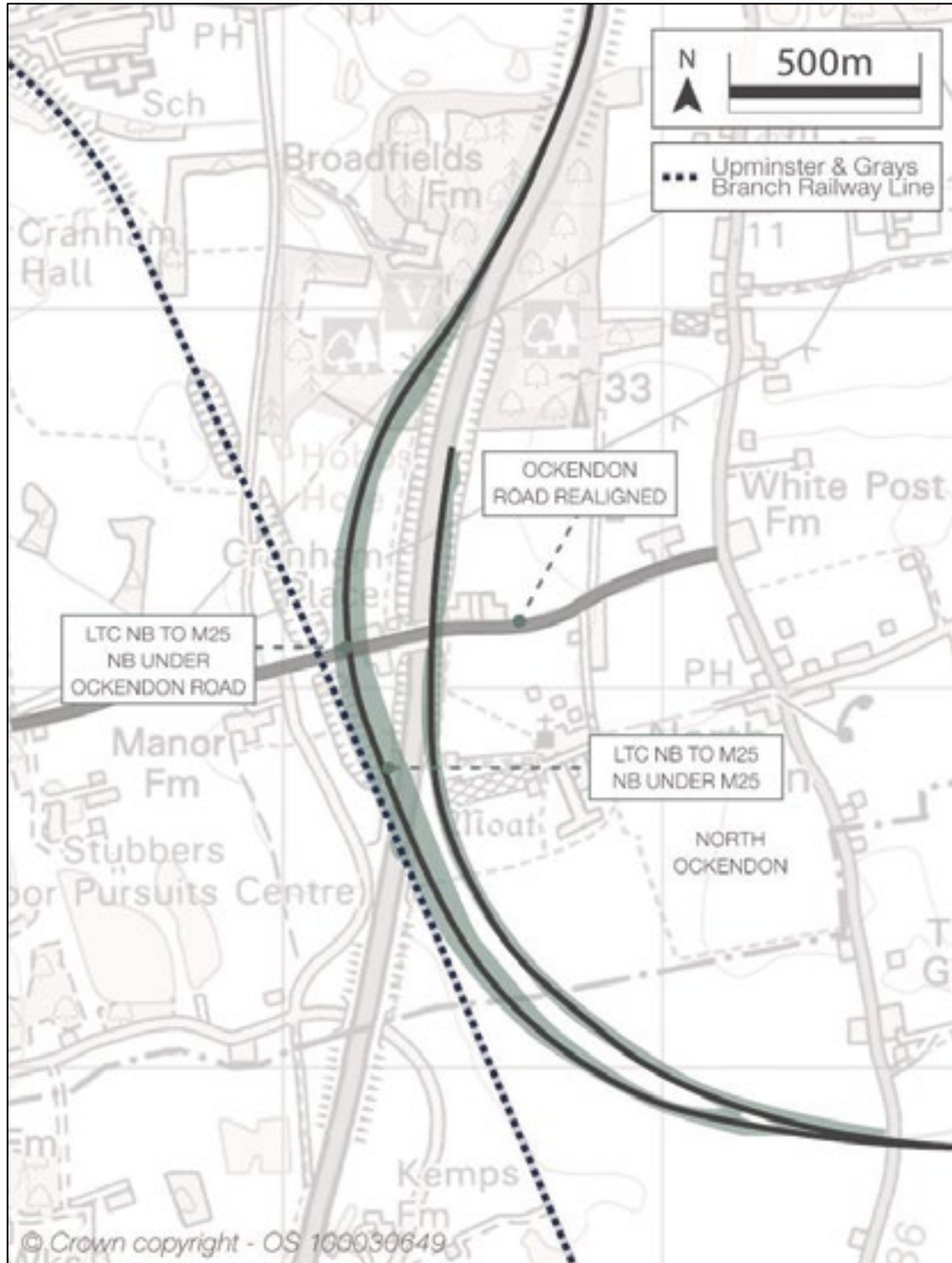
Alternatives considered since PRA

- 15.7.6 Shortly after PRA we prepared a refined version of the junction layout addressing some of the most immediate concerns with the preferred route.
- 15.7.7 This refined version addressed the issues on the southbound carriageway, but still had issues in terms of the merge and diverge layouts and the northbound carriageway viaduct and high embankments. We developed seven options to try and address four key issues. These were:
- a. Reduce the number of structures.
 - b. Mitigate the impact over Ockendon Road overbridge.
 - c. Address merge and diverge layouts and weaving departures (see section 15.8).
 - d. Address the impact on the M25 in terms of cross-section between the Project's route and junction 29 (see section 15.8).
- 15.7.8 We carried out a two-stage appraisal of the seven options. Stage 1 was a high-level engineering and traffic appraisal of all the options. Stage 2 was a more detailed appraisal of the remaining options considering safety, buildability and environmental effects.
- 15.7.9 During the stage 1 appraisal we discounted three of the options as they either did not address the traffic requirements or there was an engineering issue identified.
- 15.7.10 We considered the remaining four options viable alternatives to the preferred route and carried out the more detailed stage 2 appraisal.

Statutory consultation design

- 15.7.11 Following the stage 2 appraisal we concluded which was the most appropriate revised option for the Project's route/M25 junction to be included in the statutory consultation design (see Figure 15.11).

Figure 15.11 M25 junction statutory consultation design



- 15.7.12 The changes compared to the preferred route are:
- The northbound link does not cross the railway.

- b. The northbound link goes under instead of over the M25 and Ockendon Road.
- c. We have also lowered the southbound link which goes under instead of over Ockendon Road. This change means that the Ockendon Road overbridge needs to be demolished and replaced.
- d. We have changed the layouts for joining and leaving the M25 and included works on the M25 north of the Project's route junction, at junction 29 and north of junction 29 (see section 15.8).

15.7.13 Our main reasons for adopting this option are:

- a. It has a significantly lower impact on the landscape and visual amenity compared to the preferred route, which was on significant embankment and viaduct structure where it crossed over the existing railway, M25 and Ockendon Road.
- b. It avoids two railway crossings, which could have programme and future operational implications. However, it is noted that it does require the construction of a skewed crossing under the M25 close to the railway line.
- c. Although the estimated construction cost of this layout is more than the preferred route it will generate additional economic benefits, in combination with the works north of the junction (see section 15.8) due to the journey time savings relating to reduced congestion and improved free-flow capacity.

15.8 M25 corridor and M25 junction 29

Position at PRA

15.8.1 At PRA we did not propose any works on the M25 north of the connection of the Project's route or at junction 29.

Alternatives considered since PRA

15.8.2 We considered works on the M25 north of the Project junction and at junction 29 because of the increased traffic flows predicted by the updated traffic model. This was also necessary due to the increase of the Project's main road from dual-2 to dual-3 lanes. Alternatives we have considered include:

- a. Widening the M25 between the Project's route and junction 29 from dual-4 lanes to dual-5 lanes with and without a hard shoulder.
- b. Keeping the M25 as dual-4 lanes and providing 2-lane one-way parallel connector roads linking the Project's route and the junction 29 roundabout while also providing connections between the Project's route and M25 and between the M25 and the connector roads. We considered this option for

both the northbound and southbound carriageways and for the northbound direction only.

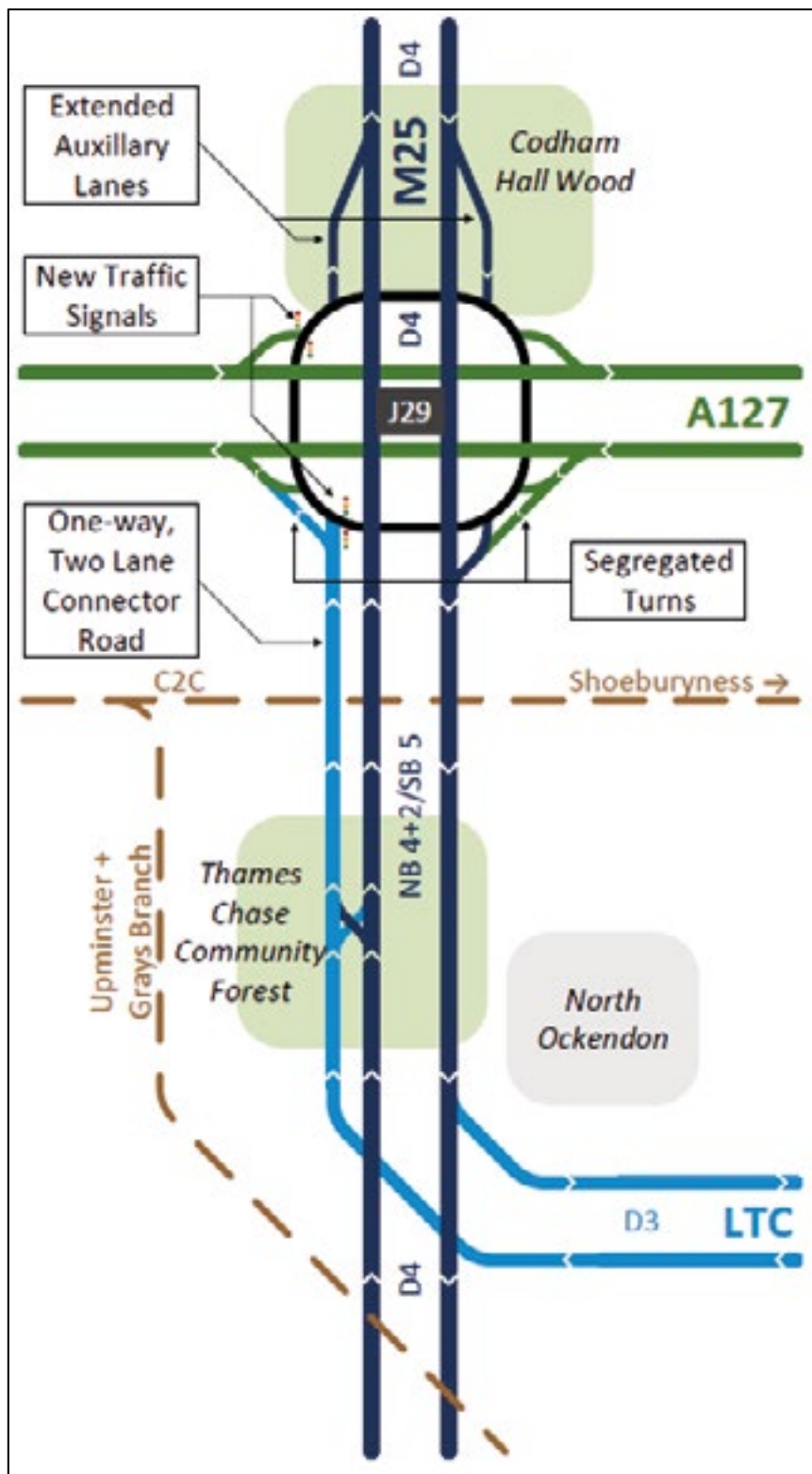
- c. Reducing the M25 to dual-3 lanes through the Project's route junction in association with the connector road layouts.
- d. Keeping the M25 through junction 29 as dual-3 lanes with a hard shoulder or widening to dual-4 lanes with or without a hard shoulder.
- e. Widening the M25 through junction 29 to 4 lanes northbound but keeping it as 3 lanes southbound.
- f. Changing the layouts for joining and leaving traffic north of junction 29 from a lane gain and a lane drop to a ghost island merge and taper diverge both with extended auxiliary lanes.

15.8.3 We have also considered improvements to the junction 29 roundabout including full signalisation in place of the existing partial signalisation of the eastern arms and the provision of free-flow left turn lanes.

Statutory consultation design

15.8.4 The provision we have included in the statutory consultation design (see Figure 15.12) includes:

- a. M25 northbound between the Project route's junction and junction 29 kept as 4 lanes with hard shoulder. Also, the addition of a parallel 2-lane one-way connector road (with hard shoulder) from the Project's route to the junction 29 roundabout with connections from the Project's route to M25 and from M25 to the connector road. This also includes reducing the M25 to 3 lanes between the diverge to the connector road and the merge from the Project's route.
- b. M25 southbound widened to 5 lanes with hard shoulder between junction 29 and the Project route junction.
- c. M25 through junction 29 widened to dual-4 lanes with hard shoulder including widening of the viaduct over the junction.
- d. Changing the layouts for joining and leaving traffic north of junction 29 from a lane gain and a lane drop to a ghost island merge and taper diverge both with extended auxiliary lanes.
- e. Making improvements to the junction 29 roundabout including full signalisation and the addition of free-flow left turn lanes on the 2 southern arms.

Figure 15.12 M25 corridor statutory consultation design

15.8.5 Our main reasons for making these proposals are:

- a. To provide a better solution than the preferred route layout in meeting the traffic objectives of relieving congestion and providing free-flowing capacity by removing the pinch-point at junction 29.

- b. To accommodate the design year traffic flows predicted by the updated traffic model including the predicted increased traffic through junction 29.
- c. To avoid weaving on the northbound carriageway in the short length between the Project's route junction and junction 29 (about 1.3km). In the southbound direction the weaving length is more than 2km and therefore the provision of 5 lanes is sufficient for the predicted weaving traffic.
- d. The auxiliary lanes north of junction 29 are provided to compensate for the loss of the lane gain and lane drop.
- e. The improvements to the junction 29 roundabout are included to maintain the performance of the junction and reduce queueing on slip roads blocking back onto the Project's main road.
- f. Hard shoulders are provided for safety reasons and to maintain operational flexibility.

15.8.6 Our proposals for the northbound connector road between the Project's route and junction 29 require land to be taken from the Thames Chase Community Forest. Alternative land will need to be provided as compensation and we are investigating suitable available land.

15.8.7 There are areas of ancient woodland around junction 29 and our proposals have been designed to avoid direct impacts on these.

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16 CONSTRUCTION

16.1 Construction works

- 16.1.1 We anticipate that construction of the Project will last for approximately seven years, including an enabling works period at the start and testing and commissioning towards the end. The following construction activities will be needed to deliver the Project scope:
- Enabling and advance works
 - New junctions on the A2/M2, A13 and M25
 - New carriageway in cuttings, on embankments and viaducts
 - Multiple crossings of roads, rail lines and watercourses
 - Large tunnel approach structures
 - Twin-bored tunnel river crossing
- 16.1.2 To set out how we will manage the construction of the Project we will develop a Code of Construction Practice (CoCP). The CoCP will include provisions aimed at minimising disruption to local communities and mitigating impacts on the wider environment.
- 16.1.3 The provisions of the CoCP will be based on the findings of the environmental impact assessment carried out for the Project as documented in our Environmental Statement (ES). We will prepare a draft CoCP, which will be submitted to accompany our DCO application.
- 16.1.4 Contractors on the Project will need to prepare and submit for approval their own Construction Environmental Management Plan (CEMP). The CEMP will need to be drafted substantially in accordance with the CoCP and incorporate the appropriate mitigation measures identified in the ES.

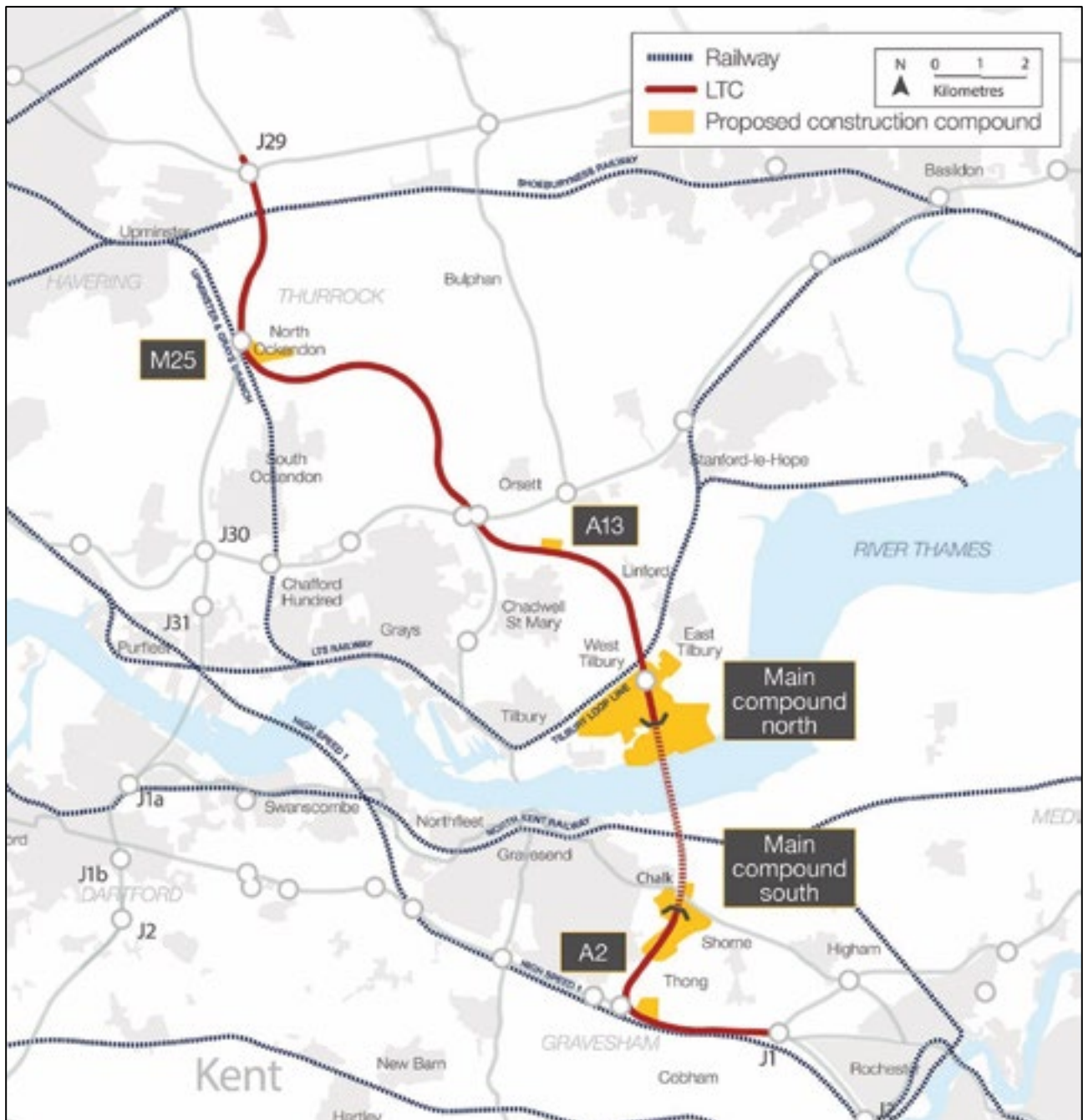
16.2 Construction compounds

- 16.2.1 To promote efficiency on site we plan to create several construction compounds along the Project route. In some areas these site compounds will be geared towards specialist activities, such as the tunnel construction compound at the north portal site. In other areas the construction compounds will service wider Project functions. Overall there are likely to be five main compounds, with several smaller satellite compounds along the Project route.
- 16.2.2 Compounds will be located to mitigate disturbance to the local communities and wider environmental receptors wherever practicable. The main compounds will vary in size according to the local construction requirements, but will typically incorporate offices, equipment storage and maintenance, materials storage, staff accommodation, vehicle parking and welfare facilities among others. Where significant earthworks are required, for example at the tunnel portals, soil and spoil storage areas will also be incorporated in these site compounds. The

satellite compounds will typically comprise welfare facilities and accommodation.

- 16.2.3 Proposed construction compound locations are shown in Figure 16.1. The main functions at each of these compounds would be:
- a. M25: Highways and junction structures
 - b. A13: Highways and junction structures
 - c. Main compound north: Tunnel, highways, spoil handling and segment manufacture
 - d. Main compound south: Tunnel and highways
 - e. A2: Highways and junction structures

Figure 16.1 Site compound locations



16.3 Site access

- 16.3.1 Accessing our construction compounds and sites will initially lead to additional pressure on the SRN and local roads, resulting from the movement of construction personnel and materials. We will identify and create dedicated access routes to our sites, which all construction traffic will need to adhere to. Where no roads are currently available we will create access routes within, or in proximity to, the footprint of the final road alignment. These will be prepared to minimise the impact on local roads, providing direct connections to main roads wherever possible.

- 16.3.2 For sites north of the river we will seek to create main access points from the A1089, A13 and junction 29 of the M25. In the south we will initially access our sites from the A226, Thong Lane and the A2 but will create a main access point from the A2 as the works progress.

Road construction

- 16.3.3 The roads constructed for the Project will be in accordance with Highways England's standards of construction, including sections built on engineered embankments (or fill), at ground level (at grade) and below ground level (in cut) at varying depths. The design complies with road standards in the *DMRB*.
- 16.3.4 The new 31km road, with approximately 3.9km of this in tunnel, will connect the M2/A2 in Kent with the M25 south of junction 29 in Essex, crossing the A13 north of Chadwell St Mary. To effectively connect the Project with these existing roads, as well as the A1089, we will construct junctions and will have to carry out some work on these roads as well. These include improvements such as road widening for the M2/A2 and M25. The following table indicates the scope of these proposed improvements.

Table 16.1 Improvements to existing strategic road network

| Road number | Improvements |
|-------------|---|
| A2 | Construction of one-way 2-lane parallel link roads either side of the existing A2 between M2 junction 1 and the Project |
| M2 | Widening from 3 to 4 lanes through junction 1 |
| M25 | Widening from 4 to 5 lanes southbound between junction 29 and the Project Construction of a northbound 2-lane parallel link road between the Project and junction 29 |

- 16.3.5 The Project's route crosses a number of existing roads. We plan to construct new bridges and underpasses, which will need temporary and/or permanent changes to the horizontal alignment of these roads. Where sufficient space is available these will be constructed offline of their existing alignment, which will enable traffic to continue using the existing roads during construction. Details of the effects on the side roads are included in the *PEIR* scheme description.

16.4 Tunnel

- 16.4.1 It is proposed that the tunnel crossing will be constructed starting from the north of the River Thames and driving south. Before tunnel construction begins, essential site facilities will be established adjacent to the north portal. In addition to the regular site compound components this site will include a precast facility for tunnel lining production and storage, separation plant for processing excavated material, a water treatment plant, hyperbaric facilities and other plant to support tunnel construction. We will need to construct a temporary substation to provide power from the grid for the tunnel boring machines (TBMs) constructing the tunnels and all the necessary support functions described above.

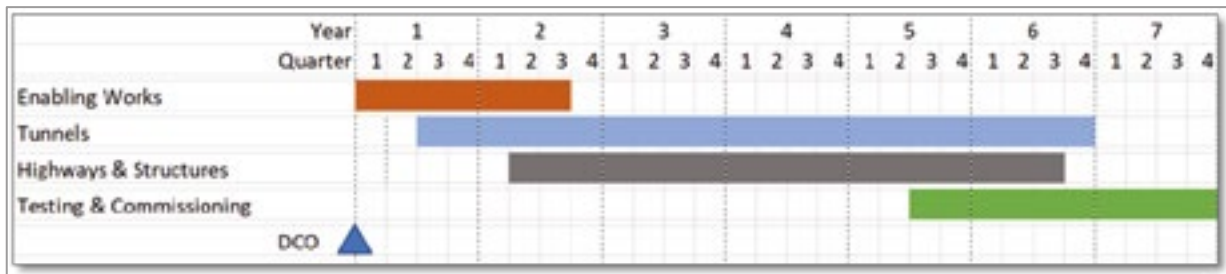
- 16.4.2 Launch structures will be constructed at the north portal site for launching and servicing the TBMs for their respective tunnel drives. Each tunnel will be excavated by a single TBM and lined with precast concrete segments erected behind it.
- 16.4.3 Where possible, excavated material from tunnels and portals will be deposited on site. A proportion may be reused for fill elsewhere on the Project and a proportion may be removed from site to designated areas.
- 16.4.4 Potential reuse and soil conditioning is being explored, as well as potential options for excavated material disposal. Methods of transport of the excavated material for disposal are still under consideration but may be by road or river. River transport will require the use of existing or the provision of new infrastructure in the River Thames such as a jetty. Transportation by rail has been considered but was found unsuitable for this Project due to the lack of available capacity.
- 16.4.5 Some ground movement around the tunnel is inevitable due to the excavation process. We will use established methods to assess the potential impact and identification of appropriate prevention and mitigation measures. We will carry out pre-condition surveys and monitoring of any assets considered to be at risk before the start of construction to establish a baseline. These will continue during construction to ensure the mitigation proposed is effective.

17 Phasing

17.1 Outline

- 17.1.1 To reduce the impacts from road construction on our neighbours and the environment we will develop a time and geographically phased construction programme. This programme distributes activity across multiple project areas, allowing efficiencies across the entire construction period.
- 17.1.2 Site activity will commence with site preparation or enabling works. These enabling works comprise activities such as the implementation of environmental mitigation measures, construction of access routes and any necessary utility works. If required, this phase will also incorporate demolition and soil remediation works, as well as further surveys and monitoring.
- 17.1.3 Once these activities have progressed sufficiently we will proceed with earthworks to prepare individual sites for the construction of the permanent works, such as the tunnel, underpasses, overbridges and ramps. The more complex construction areas, such as the tunnels and the A2 and M25 junctions, are likely to be among the first active construction sites. The A13 junction and main road construction will follow once these complex elements have made sufficient progress. The bulk of the construction activity for the road and junctions is anticipated to take about five years, with the tunnels taking around six years.
- 17.1.4 The diagram below provides an indication of the overall construction programme.

Figure 17.1 Plan of construction programme



18 Enabling works

18.1 General

18.1.1 To commence the construction of the Project there are several activities that will need to be carried out in advance to prepare the construction site. These enabling works include activities such as the diversion of public rights of way and utilities, creation of habitats and flood compensation areas, removal of existing vegetation, remediation of any contaminated sites, and undertaking surveys. The following paragraphs address some of these in more detail.

18.2 Public rights of way

18.2.1 During the construction of linear projects such as the Project public rights of way will be affected during the construction phase. We have identified the routes that are most likely to be affected and will prepare a detailed programme of mitigation measures to minimise disruption along these routes.

18.2.2 Disruption to routes will take different forms, ranging from restricted access due to lane closures or diversions to temporary closures. We aim to limit the occurrences and impacts of full route closures as much as possible. We will provide clearly signed and suitable diversions wherever available.

18.3 Habitat and flood compensation areas

18.3.1 The Project is partially located in flood zones, while it also affects protected habitats and species. We are developing a comprehensive mitigation programme in this respect, including the provision of flood compensation areas and replacement habitat. The implementation of these areas will form part of the early construction programme.

18.3.2 It is also expected that any development authorised will be subject to a requirement to comply with a programme of mitigation, which we are now developing. We will also be working with Natural England to agree upon the nature of any protected species licences that may be required

18.3.3 We have identified potential habitat replacement areas. Work in these areas may be phased. To avoid undue stress to species we will prepare multiple replacement habitat areas, including an area for translocation of species affected by early construction activity. This approach removes the need for multiple translocations of individuals. It also has the added benefit that significant areas of replacement habitat will have more time to develop.

18.3.4 We propose a staged approach to flood compensation, with areas progressively growing as the need for flood compensation capacity develops. Throughout this process we will ensure that flood risk will not increase for land and home owners in the area. The creation of these areas will involve significant amounts of earthworks to provide the required capacity.

18.3.5 Some of this work will be among the first site activity the public will notice as we prepare for the start of the first construction phases as described in section 2.

18.4 Utilities general

- 18.4.1 The alignment of the Project's route requires some permanent diversions to existing power, gas and mains water lines. To limit the duration of the major works we will start the utility works early. These utilities will be realigned to their new permanent routes in advance of road and tunnel construction activities.
- 18.4.2 The construction of these diversions, and particularly their subsequent connection to the various networks may result in brief disruptions to these services in selected locations. We aim to minimise the impact of these disruptions through careful planning and working closely with the relevant network operators to achieve this. More details of our proposals for the diversion of National Grid infrastructure (high voltage electricity overhead lines and gas pipelines) are summarised in section 18.5 below.
- 18.4.3 Tunnel construction will need its own temporary substation with a connection to the power network. Planning for the design and construction of this vital piece of equipment has already started to ensure that tunnel construction may begin as early as possible to avoid delay to the overall Project completion.

18.5 Utilities – National Grid Assets

Introduction

- 18.5.1 As part of the Lower Thames Crossing, we are proposing to divert existing high voltage electricity overhead lines, including pylons, and high-pressure gas transmission pipelines at several locations along the Project route. This is to allow the physical construction of the road, achieve operational safety clearances and allow room for future maintenance.
- 18.5.2 The diversions to these overhead lines, pylons and gas pipelines would be carried out by National Grid as the statutory undertaker who own and operate the transmission networks. National Grid has carried out feasibility studies and options appraisal for each of its locations affected by the new road.
- 18.5.3 The following principles have been followed in identifying potential options and selecting a preferred option at each location:
- a. Technically feasible and meet the relevant technical specifications
 - b. Avoid or minimise impacts on ecological, historic, landscape and visual and socio-economic constraints
 - c. Sufficient separation between the electricity infrastructure (pylons and overhead lines), gas pipelines and the Project during construction, operation and maintenance
 - d. Minimise impact on existing transmission networks including security and continuity of supply
 - e. Perpendicular overhead line crossings over the road to ensure safe and cost-effective maintenance
 - f. Ensuring adequate protection for diverted gas pipeline

g. Minimise changes to the existing overhead lines, pylons and gas pipelines

18.5.4 As well as the overhead line, pylons and gas mains temporary construction areas will be required including access routes, culverts, working areas, welfare facilities, material storage and laydown areas. It will often also be necessary to replace conductors between adjacent pylons that are not being moved as the conductors are in specific sections. This will require temporary works at each tower location and scaffold protection above roads and properties in-between. There is also a requirement to ensure access is maintained at all times to the networks for future operations and maintenance.

Overhead lines and pylons

18.5.5 To appraise the required changes, National Grid reviewed its current infrastructure records and carried out an onsite inspection. They also considered other infrastructure including gas and communications assets to gain a better understanding of current infrastructure at each location and whether any diversions would be required.

18.5.6 As a result of this appraisal a number of changes to the overhead lines are proposed, including removing and installing pylons, in some cases making pylons higher, stringing conductors in-between and building temporary pylons while the permanent electricity lines are installed. The new pylon positions have been identified based on National Grid's standard methodology for routing overhead lines including considerations such as siting them as far away from local communities as possible and to make sure that the visual impact of the pylons is minimised.

18.5.7 The locations where diversions are proposed are listed below:

- a. A2/M2 junction
- b. Westwood farm near Thong and Riverview Park
- c. West of Low Street (East Tilbury)
- d. Muckingford Road
- e. A13 junction
- f. South of Fen Lane and west of the Mardyke
- g. M25 junction 29

18.5.8 The sections below describe the indicative temporary and permanent diversions proposed based on the statutory consultation design. These will be reviewed following further studies, surveys and consultation feedback.

A2/M2 junction

18.5.9 A new taller pylon would replace the current two pylons. The route of the overhead lines would stay the same through Claylane Wood.

18.5.10 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheets 3 and 5 and for further information see the *PEIR*.

Westwood farm near Thong and Riverview Park

- 18.5.11 Three new pylons would be built and two would be removed as one pylon is currently in the proposed route of the Project. The new towers would be shorter than the current towers although they would be nearer to Riverview Park. The length of new overhead line would be about 1,045 metres.
- 18.5.12 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheet 5 and for further information see the *PEIR*.

West of Low Street (East Tilbury)

- 18.5.13 New pylons would be parallel to two existing 400kV pylon routes. Five pylons would be removed and five new 400kV pylons would be installed, so there would be no net increase in the number of pylons and the new length of overhead line would be 1,315 metres.
- 18.5.14 The existing 132kV distribution network line on the new alignment would be put underground prior to new line being built.
- 18.5.15 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheets 8a, 9, 10 and 10a and for further information see the *PEIR*.

Muckingford Road

- 18.5.16 We are proposing to replace a pylon at Muckingford Road as it would not be practical to make the existing pylons higher to accommodate Muckingford Road passing over the proposed Project route. There are also 132kV distribution network pylons that would need to be moved or routed underground.
- 18.5.17 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheet 10 and for further information see the *PEIR*.

A13 junction

- 18.5.18 West of the proposed A13 junction with the Project, two largely parallel pylon routes running closely are proposed to be diverted. We are considering a number of options for the best route for the two realigned overhead lines.
- 18.5.19 The two pylon routes affected are:
- a. 275kV route: six new towers would be installed, and 12 pylons would be taken down. There would be a new section of overhead lines 4.6km long, of which 2.5km would be on existing pylons. No new towers would be made inaccessible by the Project route.
 - b. 400kV route: 13 new towers would be installed, and 6 towers would be taken down. The new section length would be 5km long.
- 18.5.20 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheets 10, 11, 12 and 14 and for further information see the *PEIR*.

South of Fen Lane and west of the Mardyke

- 18.5.21 One existing pylon would be removed and one would be installed. The new pylon would be further from the proposed Project route and therefore would need to be 6m higher. There would be no change in overall line length.

- 18.5.22 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheet 16 and for further information see the *PEIR*.

M25 (junction 29)

- 18.5.23 At M25 junction 29, we are proposing to remove three pylons and build three new ones. There would be approximately 625m of new line. The new alignment would avoid impact on ancient woodland and the towers would be more than 200m from the existing tower location.
- 18.5.24 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheet 20 and for further information see the *PEIR*.

Gas pipelines

- 18.5.25 To appraise the required changes for the existing gas pipeline infrastructure, National Grid carried out onsite inspections and a topographical survey to mark the precise routes of the two existing gas pipelines. It also considered other infrastructure including electricity and communications assets to gain a better understanding of current infrastructure at each location and whether any diversions would be required. The appraisal included preliminary ecological and arboricultural surveys and established the available depth of soil cover over the two existing gas pipeline routes.
- 18.5.26 A number of options were then developed based on the appraisal information and two proposed locations of the Project's construction compounds. At the time of consultation, these options are still under consideration.
- 18.5.27 National Grid has identified two locations where gas pipelines would need to be diverted. These are at the A2 and Claylane Wood.

A2

- 18.5.28 A main gas pipeline would need to be diverted at the A2.
- 18.5.29 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheet 3, 5 and 5a and for further information see the *PEIR*.

Claylane Wood

- 18.5.30 A main gas pipeline would need to be diverted in Claylane Wood.
- 18.5.31 The indicative diversion is shown in our statutory consultation *Map Book 1* Sheet 3, 5 and 5a and for further information see the *PEIR*.

18.6 Land remediation and demolition

- 18.6.1 There are approximately 80 residential and business properties within the Development Boundary, with the majority of these located north of the River Thames. Not all of these properties will need to be demolished, but some will be severely impacted by the works. However, it is too early for us to confirm which properties will be demolished.
- 18.6.2 Through desk-based studies, it has been established that our route crosses a few locations where we might encounter contaminated land. We will select appropriate foundation techniques, as well as management of excavated

materials, following the waste hierarchy to minimise the impact of contamination.

- 18.6.3 The specific engineering solution for locations where remediation is needed will depend on the nature and distribution of contaminants identified from the ground investigations and monitoring. This may include encapsulation and/or treatment of contamination in situ or the isolation of works from sources or receptors to contamination. In all cases, the remediation would be designed to meet an appropriate standard in accordance with the relevant legislation.

19 Construction management

19.1 Traffic management

- 19.1.1 Most construction materials will be transported to site by road, which will have an impact on the local and regional road network and will have some effect on regular road users. At locations where new connections to the existing strategic network will be created, we will carry out traffic management to segregate the construction sites from road vehicles.
- 19.1.2 Some local routes will be affected by construction, with some roads temporarily closed and others having temporary diversions, traffic lights and/or lane restrictions. We will provide advance warning to enable affected parties to consider alternative routes or travel arrangements. There will be mitigation for these closures through the introduction of sign-posted diversions.
- 19.1.3 The anticipated impact on local roads is set out in Table 19.1 In this table the impacts are classified as follows:
- High: road may close, with possible diversion and/or lane restrictions
 - Medium: main road remains open, with temporary diversion, traffic lights and/or lane restrictions
 - Low: minor road remains open, with temporary diversion, traffic lights and/or lane restrictions

Table 19.1 Impact of Lower Thames Crossing (LTC) construction on local roads

| Road affected | Planned construction | Possible impact |
|------------------------|---|-----------------|
| Brewers Road | Replacement of bridge carrying Brewers Road over M2 | High |
| Thong Lane | Replacement of bridge carrying Thong Lane over A2, plus new bridge carrying Thong Lane over LTC | Low |
| A2 (near LTC junction) | New bridge and tunnel at LTC junction with A2 | Medium |
| Station Road | New viaduct to carry LTC over Station Road | Low |
| Muckingford Road | New bridge to carry Muckingford Road over LTC | Low |
| Hoford Road | New bridge to carry Hoford Road over LTC | Low |
| Brentwood Road | New bridge to carry Brentwood Road over LTC | Low |
| Hornsby Road | New bridge to carry Hornsby Road over LTC | Low |
| Heath Road | Northern end of Heath Road closed due to A1013 works | Low |
| A1013 | New bridges to carry A1013 over LTC, A13 and A1089 | Medium |
| A1089 | New viaduct and bridges at LTC junction with A13 and A1089 | Medium |

| Road affected | Planned construction | Possible impact |
|-----------------------|--|-----------------|
| Baker Street | New viaduct and bridges at LTC junction with A13 and A1089 | Low |
| A13 | New bridges at LTC junction with A13 and A1089 | Medium |
| Rectory Road | Replacement of bridge carrying Rectory Road over A13 | Low |
| Stifford Clays Road | New bridges to carry Stifford Clays Road over LTC and slip roads | Low |
| Green Lane | New bridge to carry Green Lane over LTC | Low |
| B186 North Road | New bridge to carry B186 North Road over LTC | Medium |
| M25 (at LTC junction) | New structure to take LTC under M25 | High |
| Ockendon Road | New bridge to carry Ockendon Road over LTC and M25 | Medium |
| St Mary's Lane | Replacement of structure taking St Mary's Lane under M25 | Low |
| M25 junction 29 | Widening of Codham Hall Viaduct carrying M25 over A127 | High |
| A127 | Widening of Codham Hall Viaduct carrying M25 over A127 | Low |
| Folkes Lane | Replacement of footbridge carrying Folkes Lane over M25 | Low |

- 19.1.4 Due to demand for materials to construct the new route, a significant number of HGV movements will be required. This is to facilitate the transportation of material to site and the export of excess material from site. The average number of HGV journeys per month for each of the five construction areas is shown in Figure 19.1 to Figure 19.4. Each HGV journey comprises two trips: one to site and another away from site. The average number of HGV movements is indicative at this stage and likely to change as further information becomes available.
- 19.1.5 For construction vehicles to access site, they would use the strategic road network (SRN) as far as possible. In some case access to the site would be gained directly from the SRN. Where this is not possible, an appropriate local road and/or temporary haul route would be used to access the site. The overall strategy for construction traffic would be to minimise impact on the local road network as far as possible. An overall construction transport strategy will be developed and will include specific routes identified in liaison with local authorities, worker travel plans and travel time restrictions. The maps in Figure 19.1 to Figure 19.4 show the areas through which construction traffic would have to pass in order to service the five construction areas. Exact routes are still in development.

Figure 19.1 Average monthly HGV journeys: Areas A & B South

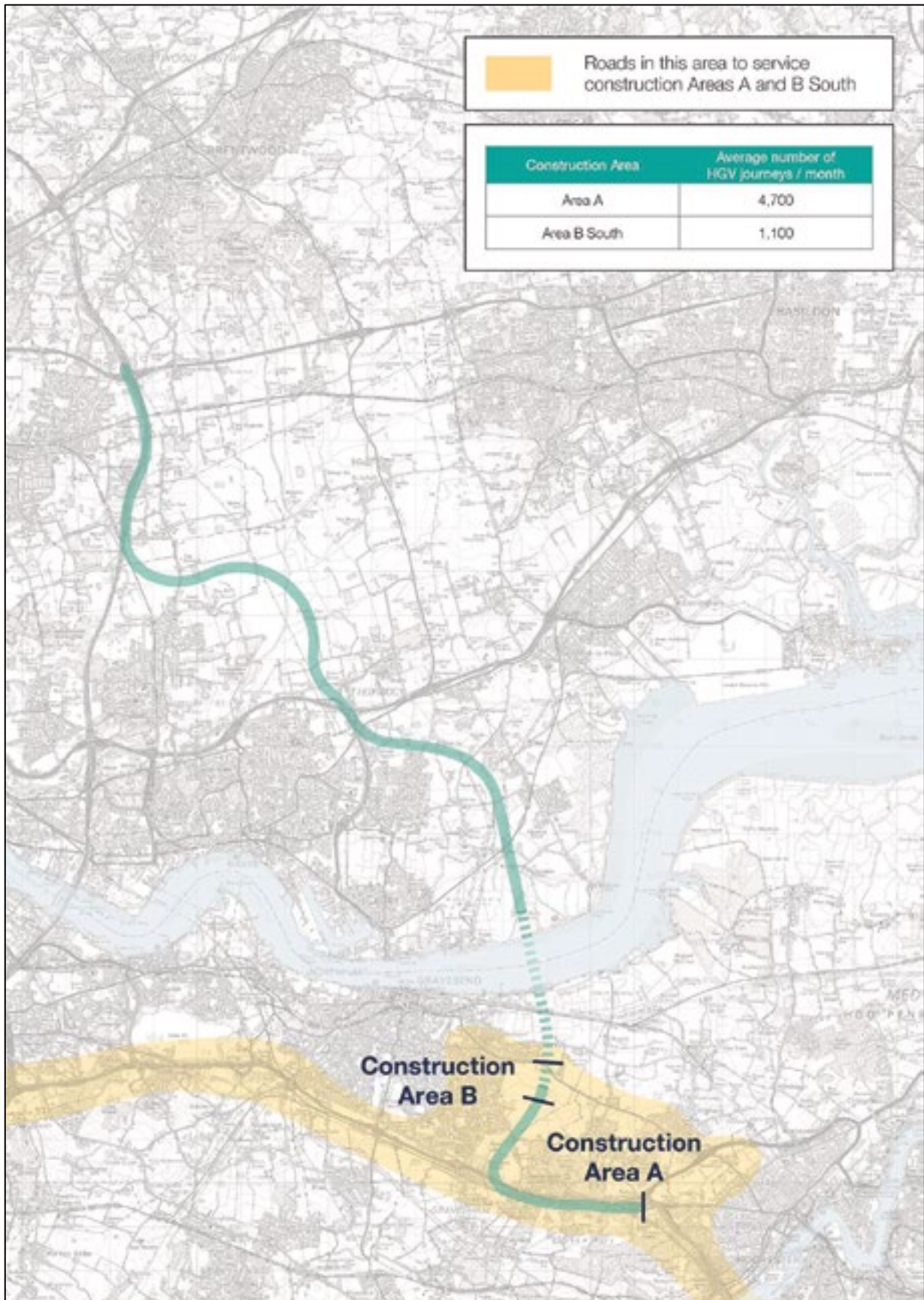


Figure 19.2 Average monthly HGV journeys: Area B North

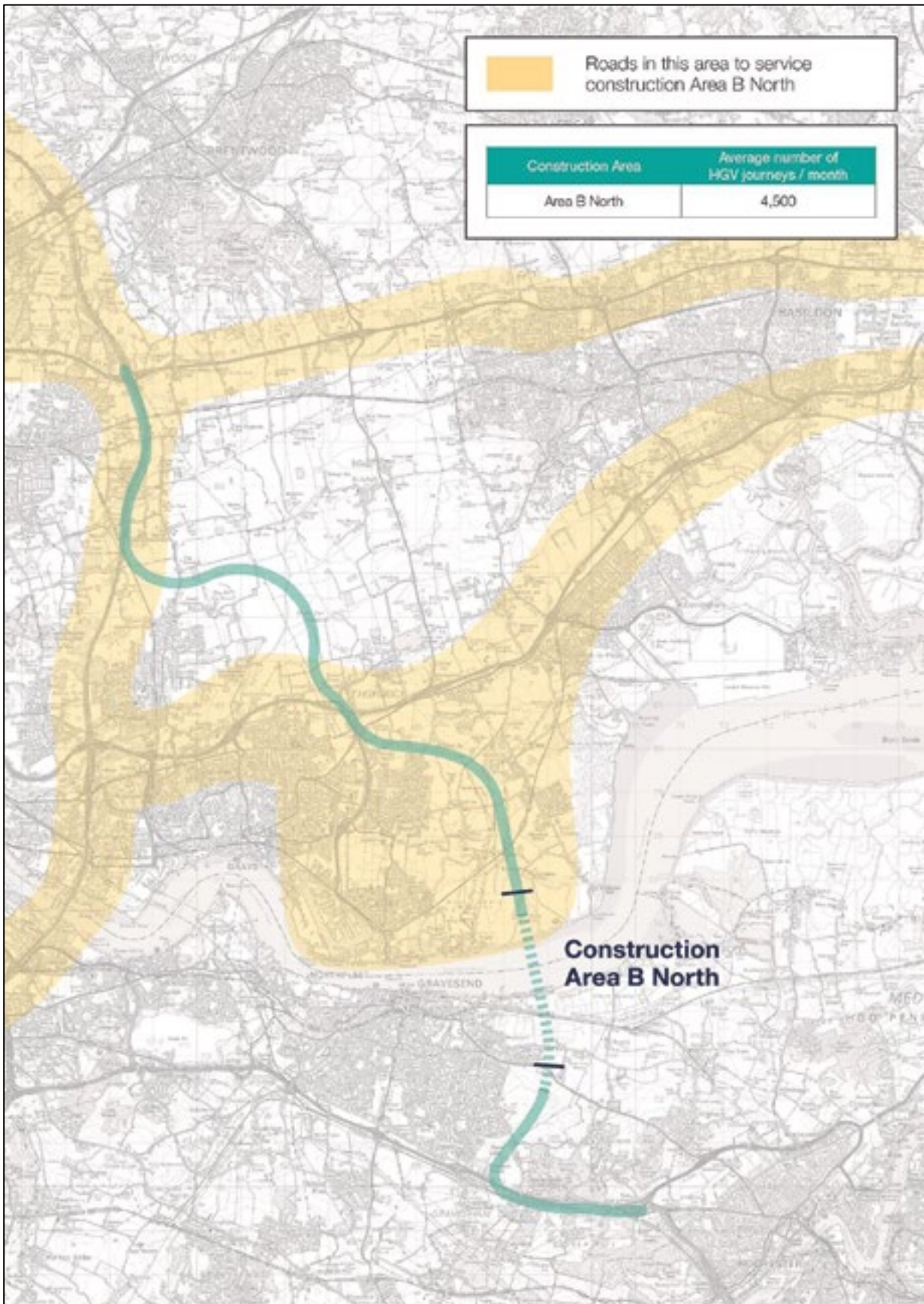


Figure 19.3 Average monthly HGV journeys: Area C

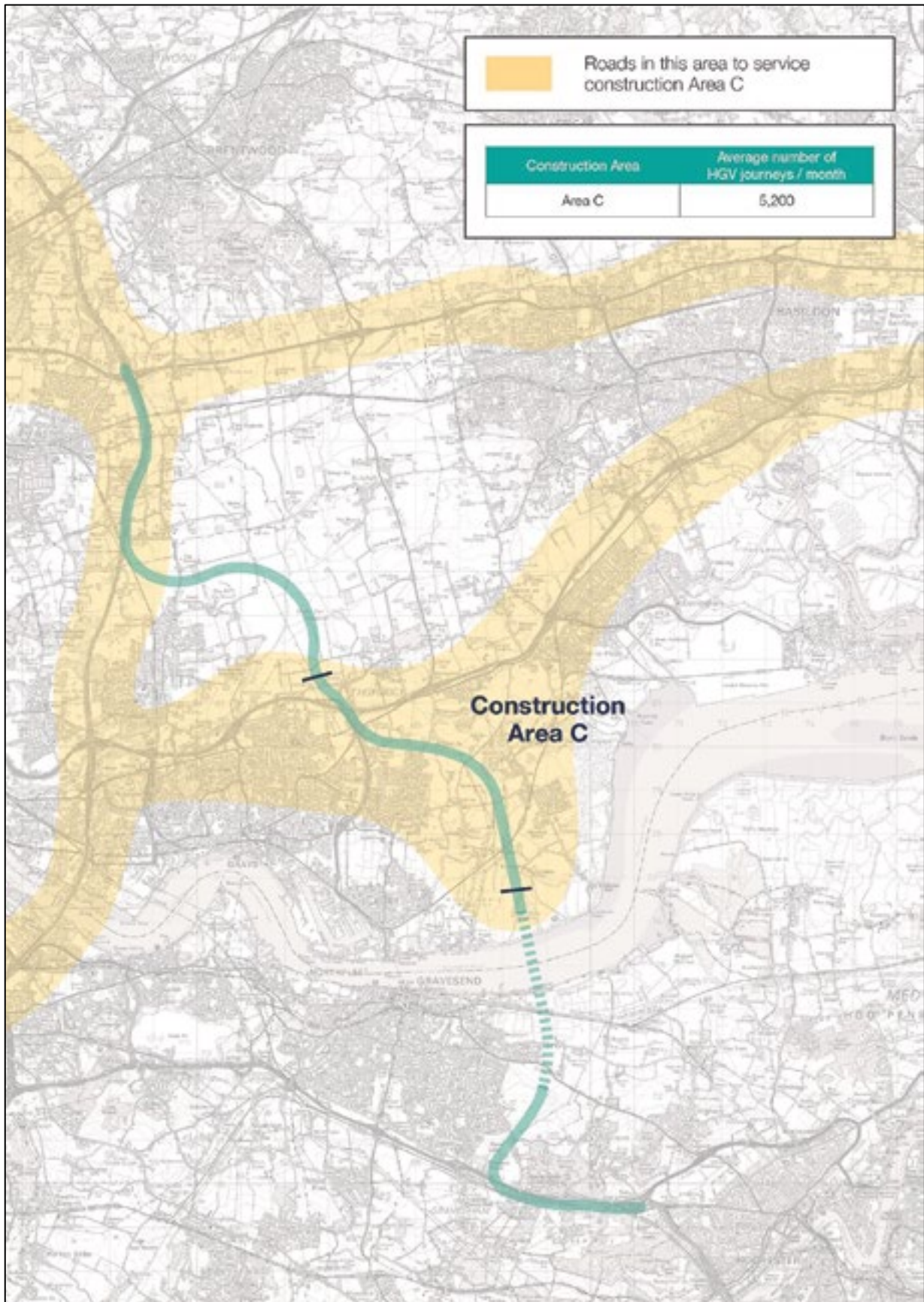
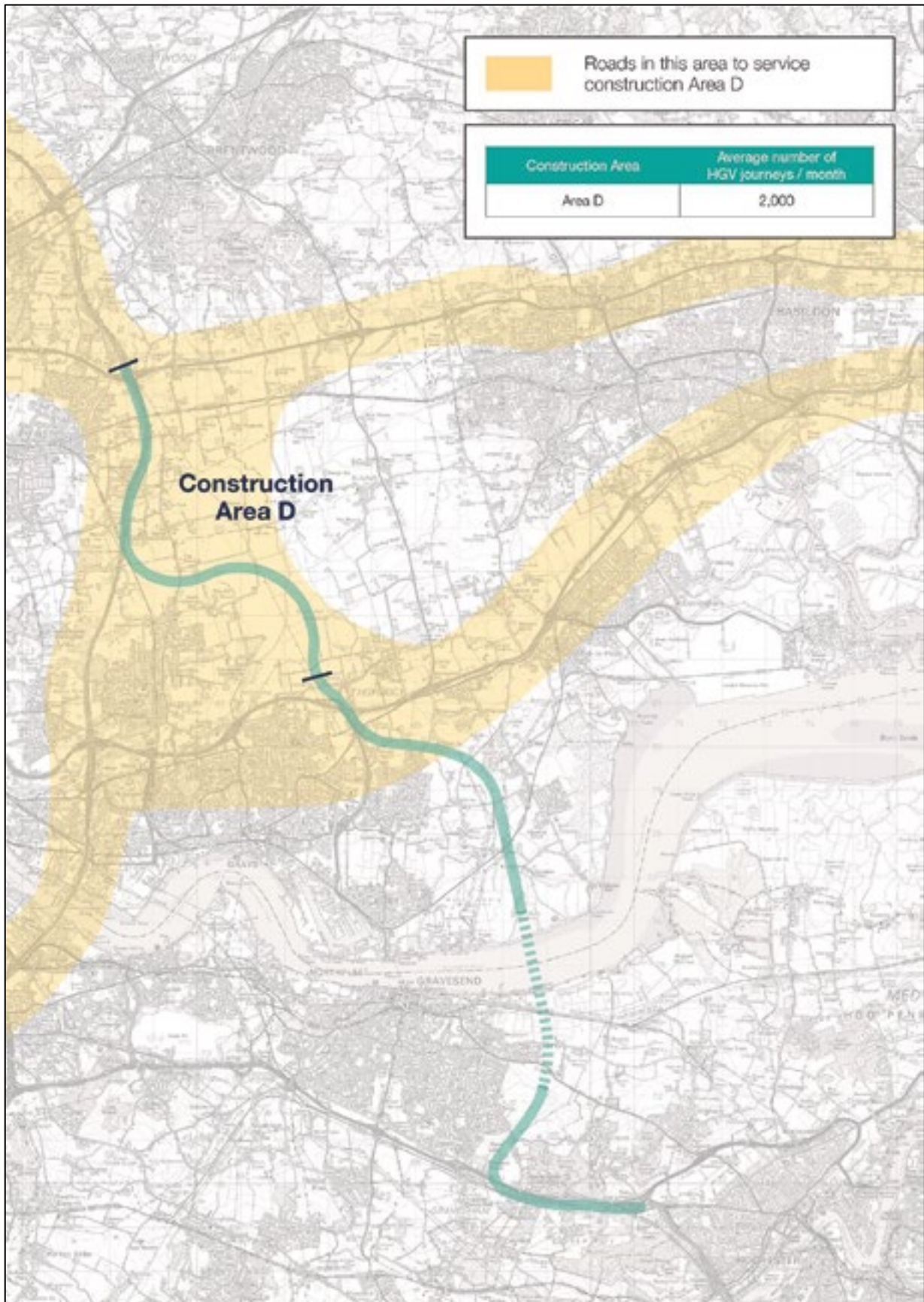


Figure 19.4 Average monthly HGV journeys: Area D



19.2 Working hours

General

- 19.2.1 The working hours at the worksites will depend on the construction activities. Table 19.2 classifies the types of working hours that will be applied. Our proposal is that the standard working hours will be 08.00 to 18.00 on weekdays and 08.00 to 16.00 on Saturdays. However, the works will be constructed over extended periods of time and there will be variations in the hours of working between sites for practicality and safety reasons. This is likely to include working on a continuous 24-hour cycle 7 days a week (24/7) basis for the tunnelling works.
- 19.2.2 The likely working hours for the various construction works inform the programme and consenting process. Flexibility needs to be retained to ensure that the works can be delivered on time, but we are committed to ensuring that the programme for construction works is sensitive to affected stakeholders. We will therefore be working closely with affected stakeholders to understand any concerns that they have and identify any reasonable mitigation that we may be able to provide.

Table 19.2 Types of working hours

| Classification | Description |
|---|---|
| Standard working hours 08:00 to 18:00 Weekdays 08:00 to 16:00 Saturday (Plus up to 1 hour before and after for mobilisation) (Plus maintenance periods 08:00 to 17:00 Sundays) | Consist of: <ul style="list-style-type: none"> • standard working hours • mobilisation period • maintenance and support period All allowed activities for mobilisation and maintenance will be detailed in the CoCP. |
| Extended standard working hours 18.00 to 22.00 Weekdays | These are intermittent and are required to cover certain construction activities that require more than the standard working hours to be completed. These include, but are not limited to, major concrete pours and piling/diaphragm wall works. These works will be notified to and agreed with the Local Authorities in advance. |
| Continuous working hours 0.00 to 24.00 Monday - Sunday | For the tunnelling construction activities, the underground work will be undertaken on a 24/7 basis. Additionally, key support activities, such as site security, pumps, ventilation fans, cranes and compressors. are required for safeguarding the works and will be in operation and maintained on a 24/7 basis. |
| Non-standard working hours | These will be driven by specific circumstances or restrictions not within the Project's control. Examples include works where access to sites is restricted by third parties and require agreed possessions or works which are dependent on tidal movements. This could also include night-time working and delivery of abnormal loads. |

| Classification | Description |
|----------------------|---|
| Short Notice Working | On a major Project such as this, combined with the nature of work to be undertaken, there is a potential for works that are needed to be completed or undertaken to secure and make safe construction operations that will take place outside the standard working hours. |

Enabling works

- 19.2.3 Most of the enabling works activities will be completed within the standard working hours (see Table 19.2).
- 19.2.4 Certain activities cannot be completed within the standard working hours and will need either extended standard working hours, night-time working, lane closures working and/or out of hours/possession working as these activities will depend on the nature of the activities, location and site constraints.
- 19.2.5 Utility diversions carried out as part of the enabling works will need planned interruption of those services. These will need to be agreed with the relevant network operators to minimise impact to their networks and customers. We will normally aim to carry out utility diversion works during standard working hours, although some work may be carried out during planned outages, which are typically outside of standard working hours.

Tunnel construction sites

Site establishment

- 19.2.6 Most activities will be completed within the standard working hours. Occasionally certain activities may need 'extended standard working hours' because they will need to be completed in a single operation that may not be completed during standard working hours. These activities include major concrete pours and piling works.

Portals

- 19.2.7 Most surface activities will be completed within the standard working hours. Certain activities cannot be completed within the standard working hours and may therefore require 'extended standard working hours'. These activities include major concrete pours and piling/diaphragm wall works. Underground excavation of the portal structure and the required hoisting operations may be carried out on a 24/7 basis to ensure the safety and integrity of the works.

Main tunnel drive site

- 19.2.8 The tunnel construction will be carried out on a 24/7 basis to ensure the safety and integrity of the works. This will also reduce the construction time and therefore period of disruption to the local community.
- 19.2.9 Several of the construction sites will need to operate in connection with these tunnel drive sites and so may operate on a 24/7 basis as well.

Main tunnel reception site

- 19.2.10 Most activities will be completed within the standard working hours. Certain activities cannot be completed within the standard working hours and will need

extended standard working hours. These activities include major concrete pours and piling/diaphragm wall works. If sprayed concrete lining reception chambers are necessary these will be constructed on a 24/7 basis to ensure the safety and integrity of the works. The process of TBM reception will necessitate some work on a 24/7 basis to ensure the safety and integrity of the works.

Tunnel segment production facility

- 19.2.11 Due to the nature of producing the precast concrete sections, this facility will need to operate on a 24/7 basis. Pre-casting will take place within an enclosed facility.

Ground treatment and dewatering

- 19.2.12 The installation of groundwater treatment and dewatering facilities would be carried out during standard working hours, but the facilities will need to operate on a 24/7 basis.

Highways and structures sites

- 19.2.13 Most of the construction phases and activities will be completed within the standard working hours. However, certain activities cannot be completed within the standard working hours and will need 'extended standard working hours'. These planned activities include major concrete pours and piling/diaphragm wall works. In addition, there may be unplanned events that require extended standard working hours such as breakdowns or traffic delays.
- 19.2.14 The interface areas between the existing highways network and sections of the new alignment of the Project may require night-time working to facilitate traffic management and installation of signs and technology, and surface tie-ins. For example, most of the road surfacing on the existing network may have to be laid during night-time working hours. These working hours are dictated by network occupancy criteria.
- 19.2.15 Demolition of existing structures will also be needed. To ensure the safety of all road users and construction personnel, certain demolition related activities may need to be carried out during road closures.

Associated works

- 19.2.16 Some works are required on the existing highways network which is not in the immediate vicinity of the Project. These works will include requirements for traffic management such as diversion or temporary closure of the carriageway. It may be appropriate for these works to be carried out outside the standard working hours.

Rail possessions

- 19.2.17 Some construction activities will need to be coordinated with the railway network operators, including temporary line closures and possessions to facilitate monitoring of existing or new assets, demolition and construction of new structures. These would typically be outside of standard working hours, to minimise the disruption to the railway network and its customers and to ensure the safety of construction personnel and railway operations.

- 19.2.18 Where practicable, railway possessions will be used to install safety systems (eg, protection decks, railway protection barriers) to enable a greater number of the construction activities to be carried out during standard working hours. The offline sections of the Project are expected to be constructed during standard working hours.

Anticipated additional hours

- 19.2.19 Certain operations such as earthworks are season and weather dependent. In these instances, the main contractors may seek to extend the standard working hours for such operations to take advantage of daylight hours, with the consent of the relevant local authority.
- 19.2.20 Certain other specific construction activities will need extended standard working hours for reasons of engineering practicability. These activities include, but are not limited to; major concrete pours and piling/diaphragm wall works. Surveys, including wildlife and/or engineering surveys, may also need to be carried out outside standard working hours.
- 19.2.21 In the case of works required to respond to an emergency or which, if not completed, would be unsafe or harmful to the construction of the Project (or any parts of the Project already constructed), staff, public or local environment, the relevant local authority will be informed as soon as reasonably practicable of the reasons for, and likely duration of, those works.
- 19.2.22 Key support activities are needed for safeguarding the works and need to be in operation and maintained on a 24/7 basis as detailed in Table 19.1. This includes items such as site security, pumps, ventilation fans, cranes and compressors. Such equipment will be shielded to provide noise attenuation as appropriate.

Abnormal deliveries

- 19.2.23 Deliveries will be arranged to minimise impacts on the road system so far as reasonably practicable. Abnormal and special loads may be delivered outside standard working hours subject to the requirements and approval of the relevant local authorities and transport police. Examples may include, but are not limited to, delivery of prefabricated bridge beams, TBMs, transformers or other large or heavy plant.

Seasonal environmental constraints

- 19.2.24 The programming of construction works recognises seasonal constraints for a range of species and their habitats (eg, great crested newt breeding ponds, reptile hibernation habitat and bat breeding roosts as applicable). To prevent illegal disturbance of breeding birds or their nests, no removal of vegetation will take place within the bird breeding season (typically March to August), unless a competent ecologist has first carried out an appropriate inspection.

19.3 Noise and vibration

- 19.3.1 The CoCP will set out the criteria for managing noise and vibration levels from construction. The contractors will identify in their CEMP the appropriate mitigation they propose to meet these criteria.

- 19.3.2 We are currently carrying out detailed surveys assessing the existing noise and vibration background levels. This work is being undertaken as part of our environmental impact assessment. The findings will be used to assess the likely impacts of our construction sites on our neighbours and other environmentally sensitive receptors.
- 19.3.3 Where these assessments show that the likely impacts of our construction sites exceed acceptable thresholds we will seek to implement suitable mitigation measures to limit noise and vibration to within acceptable levels. These could include measures such as:
- a. using quieter plant and equipment
 - b. careful location of noisier activities away from sensitive receptors
 - c. providing acoustic barriers
 - d. providing appropriate housing for stationary noisy equipment
- 19.3.4 Throughout construction we will be monitoring noise and vibration levels at key locations around the Project site. These locations will be agreed with the local authorities and are likely to include sensitive receptors such as schools and residential properties. We will regularly share our monitoring data with the relevant authorities.
- 19.3.5 The CoCP (and by extension the CEMP) will identify acceptable maximum noise and vibration levels within which the contractor will need to operate. However, it is possible that there will be occasions where monitoring identifies levels exceeding these accepted thresholds. If and when this happens, the contractor will need to address the source of the noise or vibration and bring it back within acceptable levels.
- 19.3.6 There may also be activities that are anticipated to cause noise or vibration levels that exceed these thresholds. Where this is the case we aim to work with the local authority and other stakeholders in identifying a suitable approach to minimise the effects on the surrounding area.
- 19.3.7 We do not anticipate the tunnel-boring activity will cause any significant vibration at the surface. Our TBMs will not operate under any buildings (residential or otherwise) so we do not expect noise or vibration to be an issue.

19.4 Material handling

- 19.4.1 The Project will aim to minimise the volume of waste generated by applying the waste hierarchy (avoid - reduce - reuse - recycle - responsible disposal), as set out in the Waste (England and Wales) Regulations 2011. We will identify all wastes that are likely to be produced and the quantities likely to be generated. We will then set out the approach for the control and sustainable management of excavated materials and construction waste.
- 19.4.2 Tunnel construction will generate significant quantities of excavated material. We will provide on-site treatment of these materials to facilitate potential reuse or deposition on site, or transportation if they are unsuitable for these purposes. We are considering the option to transport material by river to reduce the number of construction movements by road. If this is found to be practicable we

may need to either construct a new jetty, or modify an existing jetty located on the River Thames.

- 19.4.3 Construction of the highway will require significant excavation of materials to create cuttings, especially south of the River Thames. Large amounts of material will also be required to create embankments, as well as to create noise bunds and similar structures. During the design process, the cut/fill balance will be optimised to minimise the total demand for material exports and imports. Not all materials excavated on site will be suitable for reuse and some material will need to be disposed of.
- 19.4.4 The movement of large quantities of material has the potential to generate dust. We will implement appropriate dust control measures to limit dust from our sites, as identified in the CoCP.

20 OPERATIONS

20.1 Purpose

- 20.1.1 The purpose of this section is to summarise how we envisage the Project will operate once opened to the public. The measures that we are developing are designed to promote the safe and efficient operation of the network and enhance users' experience. Our strategy has been derived from the requirements and objectives detailed in the *Case for the Project*.
- 20.1.2 The Project will:
- a. enable sustainable local development and regional growth leading to a stronger economy. It will open opportunities for investment in housing and allow businesses to grow, creating more jobs, apprenticeships and training.
 - b. provide a safe, reliable road that will improve the resilience of the wider road network, relieve the congested Dartford Crossing and approach roads, and improve journey times
 - c. strengthen and connect local communities, improving access to jobs, housing, leisure and retail facilities on both sides of the river
 - d. be part of the biggest investment in roads in a generation, building a road network fit for the 21st century

20.2 Operational strategy

- 20.2.1 The network operational strategy has been informed by several documents, including the 2040 Strategic Vision, the high-level scheme objectives and the CSR.
- 20.2.2 The Project aligns with three main objectives from the 2040 Strategic Vision in the *Road Investment Strategy* published in December 2014 as shown below.

Smoother

- a. The number of people killed or seriously injured on the strategic road network approaching zero.
- b. More users, more happy with more journeys, leading to road user satisfaction levels of 95%.
- c. Free-flow core network, with mile-a-minute speeds increasingly typical.

Smarter

- a. A network that enhances the UK's global competitiveness and is recognised as one of the top 10 global road networks by business.
- b. A step change in efficiency, with roads projects and maintenance delivered 30-50% cheaper than today.

Sustainable

- a. A better neighbour to communities, with over 90% fewer people impacted by noise from the strategic road network.
- b. Zero breaches of air quality regulations and major reductions in carbon emissions across the network.
- c. Improved environmental outcomes, including a net gain in biodiversity from the Company's activities.

20.2.3 Our operational strategy converts the scheme objectives into deliverable outcomes and performance criteria for these outcomes. These criteria will be used to measure the success of the Project throughout its life cycle and ensure that the Project can be built, operated and maintained safely while minimising the impact on the environment. We will consider the impact on all those using and/or working on the Project at every stage of its life cycle.

20.3 Operational model

- 20.3.1 The Project's main road will be designed as a motorway and designated as an 'M' road on signs and mapping:
- a. There will be 3 lanes in each direction.
 - b. The lanes will have hard strips at the edge of each carriageway, rather than hard shoulders.
 - c. Emergency areas will be provided at intervals of no more than 1,500m (except in the tunnel).
 - d. Expressways will have variable mandatory speed limits, indicated by roadside signals and gantries and enforced using digital cameras.
 - e. Variable speed limits will be used to optimise the flow and to help manage incidents.
 - f. Other features include a concrete central barrier which is best practice on high speed road networks.
 - g. Lighting will be provided where risk assessments indicate the need.
 - h. Learner drivers, slow moving vehicles and non-motorised users (pedestrians, cyclists and horse riders) will not be allowed to use the route and we are reviewing how to mitigate this restriction.
- 20.3.2 The signs and signals on approach roads and in the tunnel can be controlled from our regional operational centre to ensure that local and strategic requirements are taken into account when operating the network. There will also be the facility for local control in the tunnel portal building for resilience or in an emergency.

- 20.3.3 The tunnel mechanical and electrical systems will be controlled from the tunnel portal building located at the north portal with back-up from a tunnel portal building to the south to ensure resilience.
- 20.3.4 Our traffic officers operate on the entire Project network both within the control centre and on the road. They will work with the emergency services and maintenance contractors in the event of an incident or emergency.
- 20.3.5 We will look at ways to future-proof the design wherever possible. We are encouraging innovation both in the design and the construction of the Project. We are aware of emerging innovations such as autonomous vehicles and 'road trains' and the improved real-time travel information transmitted to cars and smart phones. We will make necessary contingencies in our design for these existing and emerging technologies where there is no adverse impact on safety.

20.4 Maintenance depot

- 20.4.1 Our proposal is that a new maintenance depot facility will be located adjacent to the RaSA, so that the two can share access from Tilbury junction. We expect that the depot will include the following facilities:
- a. A salt barn and tanks for de-icing both the road and tunnels
 - b. A compound for spare materials
 - c. Specialist maintenance vehicles such as winter gritters, other maintenance vehicles, incident support units, vehicle recovery units, and mobile elevated working platform
 - d. Office facilities
 - e. Highways England Traffic Officers facilities
 - f. Welfare facilities
- 20.4.2 Consideration will also be given for the provision of a DVSA site for enforcement purposes, within the maintenance depot.
- 20.4.3 The total space for the depot is seven acres. A further one acre would be needed with a DVSA facility.

20.5 Asset management

- 20.5.1 The Project asset management strategy will support our ambition to become an industry leading infrastructure delivery and management organisation. We will develop an approach to asset management that will ensure whole life consideration between:
- a. Client scheme requirements
 - b. Scheme objectives
 - c. Operations and maintenance requirements
 - d. Network and tunnel availability targets

e. Asset management objectives.

20.5.2 The strategy will be produced to guide the overall asset management activities. It will:

- a. define the high-level asset management principles for the Project based on the conventional life cycle phases of an asset
- b. define the asset management policy
- c. set the asset management objectives.

20.5.3 The strategy will outline the framework as to how the asset management objectives can be achieved and ensure key infrastructure interfaces are aligned. These include:

- a. Project tunnels
- b. Project approach roads
- c. Existing Highways England adjacent contracts on the SRN
- d. Tunnel maintenance phase requirements

20.5.4 We expect the Project's contractor will adopt the International Standard for Asset Management – ISO 55001, as the framework for developing, documenting and continually monitoring and improving an overall asset management system.

20.5.5 The requirements developed from the asset management strategy will also be included in the Project contract requirements. Contractor performance against the objectives will be incentivised through contractual performance mechanisms.

20.6 Network availability

20.6.1 Our expectation is that all lanes on both the approach roads and tunnels will be available for at least 97% of the time including all planned and unplanned maintenance activity and incidents. This improves upon current Highways England targets, where incidents are not included in the measure. We are now looking at further stretch targets for lane availability. Maximising lane availability will be a key performance requirement for the tunnel and approach roads contractors.

20.6.2 During construction of the Project, planned closures on the SRN (A2, A13 and M25) will be strictly limited to minimise disruption to users. There will be some closures on the local road networks to enable safe construction of the Project. These will be kept to an absolute minimum and only following agreement with the relevant highway authority.

20.6.3 Once the tunnel and road network are open to public, future closures of the tunnel and approach roads will be strictly limited. Planned maintenance works will be coordinated between the tunnel and the approach roads to maximise the works carried out during closures and minimise customer impact.

21 Safety

21.1 Road user safety

21.1.1 Our target is for zero people killed or seriously injured on our network by 2040. The Project is committed to playing a key role in achieving this target. The target will be pursued through carrying out work in three areas:

- a. **Safer roads** – engineering and design solutions that seek to reduce the number of incidents.
- b. **Safer people** – influencing driver behaviour by a means of improved communication and approach to driving.
- c. **Safer vehicles** – engagement with the wider transport and car industry to influence and improve the safety of vehicles operating on our network.

Safer roads

21.1.2 It is our aim to design and construct a road to a standard that allows us to achieve the 2040 target. To pursue our Safer Roads target at opening, we will review our design at an early stage to identify and address the most significant contributory factors to collisions. We are also assessing our design against the International Road Assessment Programme criteria. Our target is to achieve a minimum of 3 Star rating. The design will be further reviewed and refined during the design and build or subsequent design phases of the tunnel and approach road contacts following through into construction and operation.

Safer people

21.1.3 The Project will support Highways England nationally in influencing driver behaviour by means of improved education and communication, resulting in a safer approach to driving on the network. This will include working closely with DfT and our national communications team regarding effective campaigns and educational materials. Key topics for consideration are red X compliance and driving in tunnels.

Safer vehicles

21.1.4 Through Safer Vehicles, Highways England will lead and influence national road safety initiatives which engage with the wider transport and car industry, improving the safety of vehicles operating on the network.

21.2 Roadworker/operator safety

21.2.1 Our target is for zero deaths or serious injuries to anyone working on, operating or maintaining the Project network.

21.2.2 The design for the Project will consider the whole life safety implications for all:

- a. traffic officer operations both during everyday activity and while managing incidents

- b. activities of maintenance workers in relation to general maintenance, setting up safe working areas and contributing to incident management

21.2.3 These activities will be risk-assessed along with the associated risks to road users and others impacted by the activities.

21.2.4 Vehicle recovery will be provided for both the tunnel and approach roads with a standard response time on the approach roads. There will be an enhanced response time for the tunnel and approaches.

21.2.5 Rendezvous points will be provided on both the north and south sides of the tunnel. This allows the emergency services to congregate to manage any incidents in the tunnel. Emergency turnaround points for the emergency services are provided at each portal. We will be providing crossovers at each end of the tunnel to enable contraflow in either bore in the event of an emergency and/or enable traffic to be turned around. Emergency gates will be provided at the bore entry points and consideration is also being given to barriers on the entry slip roads from the A2, A13 and M25 junctions.

21.2.6 Tunnel design and emergency procedures for the tunnel are reviewed by the Tunnel Design and Safety Coordination Group. This group is comprised of the emergency services, local authorities and our technical specialists and Project team. They provide governance for the operational safety of the tunnel.

21.3 Tunnel systems and safety

21.3.1 The tunnels will be designed to the latest international design standards and follow industry best practice. The systems are being designed so that, where possible, maintenance can be carried out without the need to close the tunnel. The tunnel will incorporate the following systems to promote efficient and effective operation:

- a. CCTV
- b. Incident detection
- c. Electronic traffic management systems and static signing
- d. Longitudinal ventilation fans
- e. Tunnel drainage and pumps
- f. Electrical equipment
- g. Lighting
- h. Communications equipment
- i. Barriers
- j. Fixed fire-fighting system
- k. Regularly spaced cross passages between the tunnels

- 21.3.2 In the absence of emergency areas in the tunnel, the automatic incident detection system, lane control signs, PA system and enhanced recovery service will ensure that the tunnel is safe during operation.
- 21.3.3 In the event of an emergency the barriers will close at the portals and anyone left within the tunnel will be evacuated through the portals and/or cross passages under direction from the emergency services. These measures will ensure the safe operation of the tunnel once it is open to road users.

21.4 Emergency areas

- 21.4.1 The provision of emergency areas will follow our latest design guidance (IAN 161/15) and be sited no more than 1,500m apart on the approach roads.
- 21.4.2 In the tunnel we will not be providing emergency areas. We will be providing a hard strip and walkway which would enable any stranded vehicle to be moved away from running lanes. Incident detection systems will pick up the presence of stranded vehicles almost immediately and set signs and signals accordingly. This is very similar to the current arrangements on smart motorways without hard shoulders.

21.5 Rest and service area

- 21.5.1 We are considering providing a RaSA on the Project road in keeping with our intention to provide a higher level of customer experience.
- 21.5.2 RaSAs perform an important road safety function by allowing road users to stop and take a break during their journey. This reduces the effects of fatigue and subsequent impacts on the safety of all road users. Government advice in DfT Circular 02/2013 is that motorists should stop and take breaks every 2 hours. We would follow the guidance in this circular in assessing the need for an RaSA and the numbers of parking bays needed.
- 21.5.3 The nearest services are at Medway on the M2, Maidstone on the M20, Clacket Lane, Thurrock and South Mimms on the M25 and Birchanger on the M11 (see Figure 12.3).
- 21.5.4 The Project relieves traffic congestion at the Dartford Crossings, but in providing a north-south route across the Thames Estuary, the route of the Project bypasses the M25 Thurrock services. In doing so, customers will be required to travel significant distances between services as the distance from the Medway services to South Mimms would now be 56 miles. Therefore, following the Government advice, we are considering providing an RaSA as part of the Project.
- 21.5.5 Under our current proposals, the RaSA would be located to the north of the tunnel, with access from the junction at Tilbury. Other alternative sites have also been considered (please see section 12.4).
- 21.5.6 To minimise the impact on the green belt, we propose to use the same area of land that is to be used as the tunnel fabrication facility as the RaSA site. Any buildings provided for this area would be sympathetic to the surrounding landscape in terms of their design and appearance. We also propose that the general layout of the RaSA would provide rest and wellbeing benefits for all users. We have provided a visualisation of the RaSA for this consultation.

- 21.5.7 The RaSA would also provide other wellbeing and safety benefits such as mitigating the likelihood of drivers running out of fuel and providing refreshment facilities.
- 21.5.8 The facilities that would be provided at the RaSA would need to be substantial enough to cater for the safety of all drivers using the Project and be open 24 hours a day. The proposed facilities could include the following:
- a. Car parking (400 spaces), disabled parking, motorcycle parking
 - b. HGV (80 spaces) and coach parking (16 spaces)
 - c. Electric vehicle charging points
 - d. Toilets and washing facilities
 - e. Grassed picnic area
 - f. Fuel
 - g. Food
- 21.5.9 In line with the Government's low carbon agenda and future-proofing ambitions, rapid charging points for electric or hybrid vehicles would be provided in the parking bays area.
- 21.5.10 In keeping with Highways England policy, the RaSA would be built and operated by a private sector company. The site therefore would need to have sufficient facilities and size to be commercially viable.
- 21.5.11 We would carry out an environmental impact assessment for any RaSA to identify the need for acoustic and or visual environmental screening and other mitigations. The facility could occupy approximately 17 acres. To minimise impacts, access could be shared with a proposed maintenance depot and potentially a DVSA facility.

22 Network performance and road user charging

22.1 Reasons for charging

- 22.1.1 It is intended that the Lower Thames Crossing DCO will provide powers for Highways England to impose, operate and enforce road user charges at the Lower Thames Crossing. Charging powers are being sought to help Highways England manage demand and network performance across the existing Dartford Crossing and new Lower Thames Crossing.
- 22.1.2 Powers to impose a road user charge at the Lower Thames Crossing are needed to provide a long-term mechanism for achievement of the Project objectives. The road user charge would be used to help to ensure the continuing benefits of the additional road capacity provided by the Project by directly managing traffic demand, and indirectly managing the impacts of such traffic demand.
- 22.1.3 As the Lower Thames Crossing DCO, if consented, would be granted a number of years before the crossing opens, we plan to ask for the flexibility over the design of the Lower Thames Crossing charging scheme to help meet our objectives, including traffic management. This means that the charging scheme introduced for the Lower Thames Crossing may be different from the assessed charging case scheme (see section 22.2). More detail on charging flexibility is provided in section 22.3.

22.2 Assessed charging case

- 22.2.1 The existing Dartford Crossing is subject to road user charges as set out in Table 22.1 below. 'Dart Charge' is an established charging scheme that is familiar to many of our stakeholders and road users.

Table 22.1 Current Dart Charge charges

| Vehicle class | Type of vehicle | One-off payment | Account payment |
|---|--|-----------------|-----------------|
| Cars and motorcycles | | | |
| A | Motorcycles, mopeds and quad bikes | Free | Free |
| B | Cars (including trailers), motorhomes and any minibuses that have 9 or fewer seats (including the driver's seat) | £2.50 | £1.67 |
| Buses, coaches, vans and other goods vehicles | | | |
| C | Vehicles with 2 axles | £3.00 | £2.63 |
| D | Vehicles with more than 2 axles | £6.00 | £5.19 |

- 22.2.2 Our starting point for assessing the proposed charges for the Project is an 'assessed charging case' that assumes equal charging between the Project and Dartford, with charges rising annually in line with the retail price index. The

assessed charging case has formed the basis for the assessments presented to support our statutory consultation.

22.2.3 The assessed charging case adopts the same features as the current Dart Charge scheme, that is:

- a. charges apply from 06:00–22:00 hours
- b. crossings made outside 06:00–22:00 are free
- c. charges apply every day, including weekends and bank holidays
- d. fixed charges for all charged hours, which are varied by vehicle class.
- e. our traffic model assumes that similar levels of account discounts and similar exemptions would apply

22.2.4 Traffic modelling indicates that this scenario would result in ongoing acceptable performance across the two schemes, thereby achieving the scheme objectives of providing relief at Dartford and being affordable to Government and users. As outlined in section 22.3, a flexible charging scheme at the Lower Thames Crossing would give us the ability to optimise that performance.

22.3 Managing network performance

22.3.1 Road user charging is an effective and potentially flexible tool for managing demand and the associated congestion and environmental impacts. However, the effectiveness of any charging scheme depends on the level of the charge and how it is applied.

22.3.2 The benefits of this ongoing flexibility include the ability to optimise network performance and effectively manage traffic demand and distribution. For example, in response to changing conditions and to continue to meet our scheme objectives. It is therefore intended that the charging powers sought within the DCO will allow flexibility in the following areas:

- a. The amount of the charges (within certain limits – see 22.3.4 and 22.3.5).
- b. Charged and non-charged hours
- c. Application of peak charges
- d. Vehicle classifications (type of vehicle)
- e. Emissions-based charging
- f. Accounts, discounts and exemptions
- g. Payment requirements
- h. Payment channels

- 22.3.3 Highways England is seeking flexibility within the Lower Thames Crossing DCO to set the charging regime details nearer to the Project opening with ongoing flexibility after opening.

Raising and lowering the charge

- 22.3.4 We will seek flexibility in the DCO to influence network performance through lowering or raising the Lower Thames Crossing charge, within certain parameters, in comparison to a fixed Dart Charge. The objective would be to improve long-term road network performance at the Lower Thames Crossing and Dartford Crossing.
- 22.3.5 The range of road user charges that would be set in comparison to the existing Dart Charge will be confirmed in the DCO application. At this stage this requires further assessment in relation to achievability of the wider scheme objectives and the potential impacts on traffic and the environment. The results of this further modelling and assessment will be presented in our DCO application which will include a charging policy explaining how charges, discounts and exemptions will be set. An indicative range of charges currently being considered is 50% to 150% of the Dart Charge.

22.4 Accounts and exemptions

Accounts

- 22.4.1 Account-based road user charging systems are more cost-effective to operate and increase compliance, so it is recommended that account take-up is incentivised through the offering of discounts. In line with the Dart Charge scheme, we propose that those who use the Lower Thames Crossing will be able to apply for an account which will entitle them to a discount on the Lower Thames Crossing road user charge.
- 22.4.2 Details regarding our proposals for accounts and discounts will be further developed and presented in our DCO application. A charging policy explaining how charges, discounts and exemptions will be set to best meet the scheme objectives will also be presented. It is expected that the flexibility being sought in the DCO would allow details to be confirmed much nearer to Project opening and revised throughout the life of the Project if required.

Exemptions

- 22.4.3 The Dart Charge scheme is subject to exemptions, meaning that a number of tax-exempt and other vehicles are exempt from the charge. This includes emergency and military vehicles, local buses and vehicles used for the carriage of disabled persons.
- 22.4.4 Similar exemptions could apply at Lower Thames Crossing, based on tax class as this would ensure that eligibility is well understood and easy to apply and operate through a free-flow charging scheme. The proposed flexibility in the DCO would allow these details to be confirmed nearer to the Project opening, and to be varied after opening, if a variation is considered more appropriate to meet the scheme objectives.

22.5 Consultation forum

- 22.5.1 We intend to establish a consultation forum before opening the Lower Thames Crossing. This would include representatives from local authorities, other key stakeholders and Highways England officers. This forum's key roles are likely to include:
- a. reviewing options and proposals for setting of the initial charging scheme details (charge levels, discounts and exemptions etc) before Project opening
 - b. reviewing proposals to vary the charging scheme details after Project opening
- 22.5.2 It is proposed that Highways England would consult the forum who would make representations based on the scheme objectives and in accordance with the charging policy.
- 22.5.3 It is proposed that routine charge variations due to inflation would not be subject to consideration by the consultation forum.

22.6 How we will charge

- 22.6.1 The DCO will include ongoing powers to vary the charge as well as providing for retail price index increases. It is also intended that the DCO will include powers to waive and suspend the charges, in full or in part in emergencies or exceptional circumstances, which may include management of incidents or road closures.
- 22.6.2 The initial charges and any future changes would be published well in advance of the charges coming into effect. Proposals for the consultation forum, and associated policy detail will be developed and presented in full with our DCO application.
- 22.6.3 It is intended that the Project's charging scheme would be a barrier-free, free-flow operation with automatic number plate recognition technology to detect and identify vehicles and to charge remotely.
- 22.6.4 We expect the Project's charging scheme would be operated in the same way as the Dart Charge scheme in areas such as:
- a. payment processing
 - b. enquiry and complaint handling
 - c. account registration and management
- 22.6.5 Several channels for payment will be offered including but not limited to online payment and through a contact centre. We propose that users will be able to pay the road user charge before making their journey, or within a fixed period after using the Lower Thames Crossing. Further operational details will be presented with our DCO application.

Non-compliance

- 22.6.6 Barrier-free, free-flow charging schemes are subject to non-compliance, both unintentional and deliberate, so it is intended that the DCO includes powers to enforce charges as if they were made under the Transport Act 2000 (the legal apparatus under which the Dartford Crossing operates). This would allow us to draw on existing regulations and enforce the Lower Thames Crossing road user charge in the same way as the Dart Charge scheme. This is through issuing penalty charge notices, charge certificates and, in cases of continued non-compliance, through the appointment of enforcement agents.

23 Optimising road networks

- 23.1.1 Optimising traffic flows is imperative to the success of the Lower Thames Area Network (LTAN). The Lower Thames Crossing and Dartford Crossing will be operated together as one connected LTAN. Operational activity, maintenance and incident response will be coordinated to minimise impact on customers and to maximise efficiency. Each river crossing will provide resilience for the other.
- 23.1.2 Strategic journey and routing information will be available through signing and signalling, designed so that information is provided to allow customers to make optimal route choices.
- 23.1.3 Liaison between Highways England and local authorities will be key to optimising the interaction and traffic flow within the LTAN. We are working with the local highway authorities to understand the impacts on the local road networks.
- 23.1.4 Our strategic planning group is working with our area teams and the local enterprise partnerships to identify improvement schemes that could be included within route-based studies and future road investment strategies.
- 23.1.5 We will share our traffic modelling information with local highway authorities. We can support promotion of local road schemes as required by the Traffic Management Act 2004 which requires all highway authorities to consider the operation of the entire road network holistically.

Wider network impacts

- 23.1.6 We have developed the Project with the aid of our traffic model LTAM that forecasts the demand for the Project, together with changes in traffic flows on the surrounding road network, including the Dartford Crossing. The model also predicts the impact of these changes in traffic flows on journey times and congestion, compared with a forecast scenario without the Project. The model considers several transport schemes that are planned to be delivered by Highways England and Local Highway Authorities and likely to be built as these will also have an impact on traffic flows and delays in the Lower Thames region. This will provide a robust forecast of the Project impacts.
- 23.1.7 In addition, further schemes are being developed by the highway authorities to accommodate planned growth and address local and regional traffic and transport issues. The Project model forecasts will enable the authorities to develop and prioritise their investment plans, taking into account the impacts of the Project.
- 23.1.8 We will aim to work with the wider Highways England teams and Local Highway Authorities to understand the regional and local changes in network use as a result of the Project and also the beneficial and adverse traffic impacts that are predicted to arise. We will identify opportunities to mitigate these adverse impacts, where they are substantial and appropriate. Mitigation proposals might include physical measures, such as provision of additional lane capacity, signalisation or slip road rationalisation. They might also include demand management measures and opportunities to bring about modal shift. Where

relevant and reasonably practicable we will aim to complement existing Local Highway Authority transport plans and measures.

- 23.1.9 We will also provide information from LTAM to relevant highway authorities to inform their work in developing future transport investment programmes such as the Road Investment Strategies and Local Transport Plans.
- 23.1.10 Details of predicted impacts on the wider road network are provided in the *Traffic Forecasts Non-Technical Summary*.

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Glossary

| Term | Explanation |
|--------------------|---|
| 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. |
| AOD | Above ordnance datum: vertical datum used by an ordnance survey as the basis for placing 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. |
| APTR | All Purpose Trunk Road |
| AQS | Air Quality Strategy |
| Bluewater | Bluewater Shopping Centre, an out-of-town shopping centre in Stone, Kent. |
| CEMP | Construction Environmental Management Plan |
| CoCP | Code of Construction Practice |
| CSR | Client Scheme Requirements |
| Dart Charge | The Dartford Crossing free-flow electronic number plate recognition charging system (operates between 06:00 and 22:00). |
| DCO | Development Consent Order |
| 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. |
| DMRB | Design Manual for Roads and Bridges: a comprehensive manual (of 15 volumes) which contains requirements, advice and other published documents relating to works on motorways 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 |
| DVSA | Drivers and Vehicles Standards Agency |
| EA | Environment Agency, established under the Environment Act 1995 it is a Non-Departmental Public Body of Department for Environment, Food and Rural Affairs. The EA is the leading public body for protecting and improving the environment in England and Wales. It 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. |

| Term | Explanation |
|----------------------------------|---|
| 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 north-west towards Church Lane and Lower Higham Road. This route could connect into any of the Routes 2, 3 and 4 north of the river using all of the crossing options for these route options. |
| HGV | Heavy goods vehicle |
| HS1 | High Speed 1 rail line |
| 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. |
| Location A | The location for Project route options close to the existing Dartford crossing. |
| Location B | The location for a new crossing near the Swanscombe peninsula. It would connect the A2 to the south near Dartford to the A1089 to the north near Tilbury Docks. This route would cross the Eastern Quarry development site and the Swanscombe peninsula. |
| Location C | The location for Project 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. |
| Locations D and E | The two most easterly of five locations originally examined by the DfT for the proposed Lower Thames Crossing; both were eliminated from further consideration. |
| LRDS | Local residents discount scheme: a charging scheme for using part of the road network such as the Dartford Crossing's Dart Charge scheme where local residents pay discounted fees. |
| LTAM | The Lower Thames Area Model: a strategic highway model produced by Highways England to assess the impact of the Project on the highway network. It also provides traffic data for use in the environmental, social and economic assessment of the Project. |
| LTAN | Lower Thames Area Network |
| M25 | London's orbital motorway |
| Made Ground/Worked Ground | An artificial fill consisting of natural materials, refuse, brick, concrete etc. Alternatively, man-made deposits such as embankments and spoil heaps on the natural ground surface. Worked Ground is similar, but typically more likely to include landfill. |
| NPSNN | National Policy Statement for National Networks: 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. |

| Term | Explanation |
|----------------------|---|
| 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 |
| PRA | Preferred Route Announcement |
| Project | The Lower Thames Crossing project is a proposed tunnel, associated structures and connecting roads, which crosses the River Thames linking Kent, Thurrock and Essex. |
| Ramsar site | A wetland of international importance, designated under the Ramsar convention. |
| RaSA | Rest and service area |
| SAR | HHJV's Pre-Consultation Scheme Assessment Report on the Lower Thames Crossing project |
| Severance | Severance occurs when roads act as a barrier for people who need to cross the road to access employment, education, services and everyday activities. |
| 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 the Dartford Crossing, with significant improvements to junctions 30 and 31. Smart motorway technology is to be implemented from junctions 2 to 1b (with no widening) and junctions 1b to 1a (with widening to dual 5 lanes). |
| Route 2 | A new trunk road connecting A2 (2km 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. |
| Route 3 | A new trunk road connecting the A2 (2km 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. Includes a junction with the A13 at the existing junction of 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. |
| Route 4 | A new trunk road connecting the A2 (2km east of Gravesend) to the M25 at junction 29, using the 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. |
| SPA | Special Protection Area: a designation under the European Union Directive on the Conservation of Wild Birds. |
| 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. |
| STGO vehicles | Vehicles that are defined in the Motor Vehicles (Authorisation of Special Types) (General) Order of 2003. |
| TBM | Tunnel boring machine: a machine used to excavate tunnels with a circular cross-section. |
| Unconformably | An unconformity is a contact between two rock units in which the upper unit is usually much younger than the lower unit. Unconformities are typically buried erosional surfaces that can represent a break in the geologic record of hundreds of millions of years or more. |

| Term | Explanation |
|------------------------------|---|
| VMSL | Variable Mandatory Speed Limit |
| Western Southern Link | The Western Southern Link (WSL): 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 routes 2, 3 and 4 north of the river using all of the crossing options for these route options. |

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