Lower Thames Crossing

7.7 Combined Modelling and Appraisal Report

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Lower Thames Crossing

7.7 Combined Modelling and Appraisal Report

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1 Executive summary

1.1.1 Within the Development Consent Order (DCO) application for the A122 Lower Thames Crossing (the Project), the transport modelling, traffic forecasts and economic appraisal of the Project are documented at three levels of detail.

1.1.2 The first is the Traffic Forecasts Non-Technical Summary (Application Document 7.8) which briefly describes the transport model of the Lower Thames area and presents maps illustrating the traffic forecasts produced using this model.

1.1.3 The second is this report, the Combined Modelling and Appraisal Report (ComMA). This summarises the transport modelling, forecasting and appraisal work undertaken for the Project. It reports on the key findings of the appraisal work on the social, environmental and economic impacts of the provision of the Project.

1.1.4 The third is the technical reports themselves, which are appendices to the ComMA as follows:

a. The Transport Data Package (Appendix A) sets out the datasets used in the building of the Lower Thames Area Model (LTAM).

b. The Transport Model Package (Appendix B) contains a technical description of the methods used to build the transport model, to calibrate it to match the real world transport system which it aims to model, and the results of the validation of the model.

c. The Transport Forecasting Package (Appendix C) presents the forecasts of the future state of the transport system in the Lower Thames area both without and with the Project.

d. The Economic Appraisal Package (Appendix D) which consists of four reports. The Economic Appraisal Report describes the methods used to assess the impacts of the Project and presents the wide range of economic, environmental and social impacts of the Project. The Distributional Impact Appraisal Report considers the extent to which the social, environmental and economic impacts occur to a different level of severity or benefit on vulnerable groups of people. The Appraisal Summary Table Report presents a ‘view on a page’ of the impacts of the Project. The Level 3 Wider Economic Impacts Report presents an examination of the economy of the Lower Thames area and the wider economic impacts of the Project.

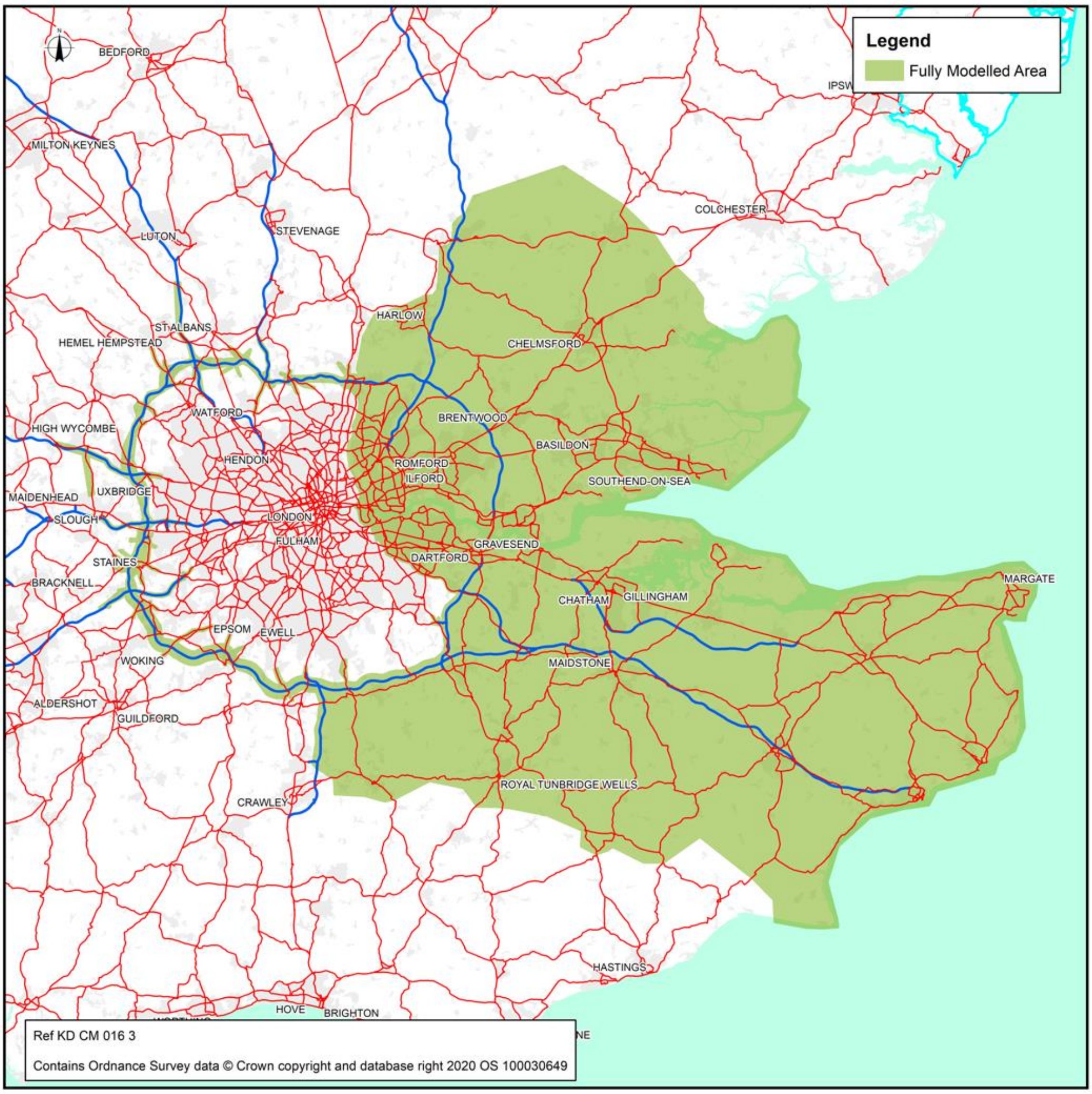
1.1.5 The forecast transport impacts of the Project are set out in the Transport Assessment (Application Document 7.9), and the Project’s proposed strategy for monitoring wider impacts on the highway network is contained within the Wider Network Impacts Management and Monitoring Plan (Application Document 7.14).

1.1.6 The Dartford Crossing is the only fixed road crossing of the River Thames east of the Blackwall Tunnel. It is heavily used by regional traffic as it provides the eastern crossing of the River Thames for users of the M25 orbital motorway around London, and by local traffic. The area around the Dartford Crossing in Kent, Thurrock and London is densely populated. Despite previous expansions of the capacity at the Dartford Crossing through the provision of, firstly, a second tunnel, then a new bridge and the removal of the toll booths, the high levels of traffic frequently lead to traffic delays and unpredictable travel times.

1.1.7 The LTAM was built using data from existing sources supplemented by bespoke data collection exercises. The existing data included mobile phone data which provides anonymised details of vehicle journeys, traffic counts and Teletrac (formerly Trafficmaster) data on the speed and location of vehicles from in-vehicle Global Positioning System (GPS) units. This data was supplemented with additional traffic counts, accident data and details on the operational performance of the Dartford Crossing.

1.1.8 The transport model was built following the principles and processes set out in the Department for Transport's (DfT's) Transport Analysis Guidance (TAG). This ensures that the model's forecasts of future traffic flows and journey times are suitable for use in the Environmental Statement (Application Document 6.1 to 6.3) and the economic appraisal for the Project. The Fully Modelled Area, shown in Plate 1.1, covers Kent, Thurrock, the M25 corridor and much of Essex and East London.

Plate 1.1 LTAM Fully Modelled Area



1.1.9 The LTAM is a variable demand model. This means that the model predicts how the travel patterns in the area would change once the Project is built and provides additional road capacity across the River Thames. These responses include changes to the frequency of making trips, the time of day at which those trips are made, the transport mode used and the destination of trips. The model then estimates the route they use, which provides information on how many vehicles are using each part of the road network and how long it takes to complete a journey.

1.1.10 The base year of the transport model represents conditions on the network in March 2016. The hours modelled are from 07:00–08:00 (the AM peak) and 17:00–18:00 (the PM peak). These were selected following an assessment to determine the busiest times of day on the main roads in the area. A typical hour in the middle of the day is also modelled (the inter-peak), reflecting the period between 09:00–15:00.

1.1.11 Forecasts of traffic conditions in the future were prepared for 2030, 2037, 2045 and 2051. The level of traffic growth for cars in the future is taken from the DfT's

National Trip End Model (NTEM). These forecasts, known as the TEMPro 7.2 forecasts, are available at the census Lower Super Output Area geography.

1.1.12 A review was undertaken of the locations of specific developments within the Lower Thames area by contacting the local authorities in the area. Where these developments were either under construction, with planning permission or had a submitted planning application (defined in TAG Unit M4 (DfT, 2019a) as 'near certain' or 'more than likely'), they were added into the model in order to provide greater spatial detail as to where the future growth is most likely to occur. The level of traffic growth nearby is then adjusted so that the overall level of future traffic in the local area matches the growth predicted in the TEMPro 7.2 forecasts (DfT, 2020a). The growth rates for goods vehicles are taken from the DfT's (2018a) Road Traffic Forecasts.

1.1.13 The forecast traffic flows and journey times on the network both with and without the Project are presented in Chapter 6 of this report. Table 1.1 shows the forecast traffic levels at the Dartford Crossing and the Project. The table uses Passenger Car Units (PCUs), which is an industry standard approach. Cars and vans are defined as 1 PCU and Heavy Goods Vehicles (HGVs) are considered to be equivalent to 2.5 PCUs, because they take up more road space.

Table 1.1 Predicted peak and inter-peak two-way hourly flows at the Dartford Crossing and the Lower Thames Crossing (PCUs)

Period	Year	Without the Project	With the Project	
		Dartford Crossing*	Dartford Crossing*	Lower Thames Crossing
AM peak hour	2016	14,430	-	
	2030	16,020	13,280	8,040
	2045	16,260	14,870	8,940
Inter-peak hour	2016	11,790	-	
	2030	14,410	10,780	6,510
	2045	15,660	12,770	7,590
PM peak hour	2016	12,830	-	
	2030	15,310	12,020	7,990
	2045	16,280	13,540	8,830

**Flows at the Dartford Crossing (northbound only) are approaching the Traffic Management Cell (TMC). Note: Flows rounded to nearest 10. Source: Lower Thames Area Model (N108 (Run 1), CM49, CS72)*

1.1.14 The Economic Appraisal Report (in Appendix D of Application Document 7.7) sets out the economic case for the Project. Where impacts can be quantified and given a monetary value, this is done for costs and benefits from now until 60 years after the Project opens. The costs and benefits are converted into 2010 prices as required by the DfT and discounted using the HM Treasury discount rates. The Present Value of Costs (PVC) is £2,700 million, based on most likely Project costs, and the Present Value of Benefits (PVB) is £3,300 million. The ratio of the PVB to the PVC produces an Adjusted Benefit Cost

Ratio (BCR) of 1.22. National Highways has also carried out two 100 year appraisals which are explained in Appendix D (Economic Appraisal Package). The more conservative of these shows a BCR of 1.66. A further scenario which provides a higher BCR based on assumptions relating to the Transport Decarbonisation Plan is presented in section 11.3.13 of the Combined Modelling and Appraisal Report - Appendix D - Economic Appraisal Package: Economic Appraisal Report (Application Document 7.7).

1.1.15 Of the benefits that can be spatially disaggregated

a. 48% are gained by users starting or ending their journeys in the Lower Thames area (Thurrock, Brentwood, Havering, Dartford, Gravesham and Medway).

b. 31% are gained by users starting or ending their journeys in other South East Local Enterprise Partnership Local Authorities.

c. 21% are gained by users starting or ending their journeys in other local authorities in Great Britain.

1.1.16 This report also covers other environmental, social and economic impacts that are not given a monetary value but are taken into consideration when assessing the overall worth of the Project.

1.1.17 A Value for Money assessment has been carried out. This has taken account of Project costs, revenues, monetised impacts and benefits, and the qualitative appraisal of other impacts and benefits. Based on the categories in the DfT's (2015) value for money framework, the Project has been assessed as providing 'Low' value for money. National Highways has also carried out two 100 year appraisals which are explained in Appendix D (Economic Appraisal Package). The more conservative shows a BCR of 1.66. A further scenario which provides a higher BCR based on assumptions relating to the Transport Decarbonisation Plan is presented in section 11.3.13 of the Economic Appraisal Report.

2 Introduction

2.1 Report purpose

2.1.1 National Highways (the Applicant) has submitted an application under section 37 of the Planning Act 2008 for an order to grant development consent for the A122 Lower Thames Crossing (the Project).

2.1.2 The purpose of this report is to set out details of the transport modelling and economic appraisal that has been carried out to support the design of the A122 Lower Thames Crossing (the Project) and to assess the social, environmental and economic impacts of the Project. This work is documented at three levels of detail.

2.1.3 The first is the Traffic Forecasts Non-Technical Summary (Application Document 7.8) which briefly describes the transport model of the Lower Thames area and presents maps illustrating the traffic forecasts produced using this model. Earlier editions of this document were produced for the Statutory Consultation in 2018 (Highways England, 2018) and the Supplementary Consultation in 2020 (Highways England, 2020a). An updated edition has been written to support the Development Consent Order (DCO) application.

2.1.4 The second is the main text of this report, which is the Combined Modelling and Appraisal Report (ComMA). This summarises the transport modelling, forecasting and appraisal work undertaken for the Project. It reports on the key findings of the appraisal work on the social, environmental and economic impacts of the provision of the Project.

2.1.5 The third is the technical reports themselves, which are appendices to this report. These consist of the following:

a. The Transport Data Package (Appendix A). This report, often referred to as a Data Collection Report, sets out the datasets used in the building of the Lower Thames Area Model (LTAM).

b. The Transport Model Package (Appendix B). This is a report often referred to as a Local Model Validation Report. It contains a technical description of the methods used to build the transport model, to calibrate it to match the real world transport system which it aims to model, and the results of the validation of the model.

c. The Transport Forecasting Package (Appendix C). This report is often known as a Traffic Forecasting Report and presents the forecasts of the future state of the transport system in the Lower Thames area both without and with the Project.

d. The Economic Appraisal Package (Appendix D). This consists of four reports. The first is the Economic Appraisal Report which describes the methods used to assess the impacts of the Project and presents the wide range of economic, environmental and social impacts of the Project. These include impacts that have been expressed in monetary terms, as well as those impacts that have been appraised qualitatively. The second is the Distributional Impact Appraisal Report which considers the extent to which the social, environmental and economic impacts occur at a different level of severity or benefit on vulnerable groups of people. The third is the Appraisal Summary Table Report which presents a 'view on a page' of the impacts of the Project. The fourth report, the Level 3 Wider Economic Impacts Report, presents an examination of the economy of the Lower Thames area and the anticipated wider economic impacts of the Project.

2.1.6 The forecast transport impacts of the Project are set out in the Transport Assessment (Application Document 7.9), and the Project's proposed strategy for monitoring wider impacts on the highway network is contained within the Wider Network Impacts Management and Monitoring Plan (Application Document 7.14).

2.1.7 The DCO application has been developed on the basis of a 2030 opening year. This assumes consent is granted in 2024. Following the DCO Grant there would be preparatory works, referred to in the draft DCO as preliminary works taking place in 2024. The main construction period for the Lower Thames Crossing would start in early 2025, with the road being open for traffic in late 2030. Construction may take approximately six years, but as with all large projects there is a level of uncertainty over the construction programme, which would be refined once contractors are appointed and as the detailed design is developed.

2.2 Background

Dartford Crossing

2.2.1 For over 58 years, the Dartford Crossing has provided the only significant road crossing of the River Thames to the east of London. Designed for 135,000 vehicles per day, since 2016 average daily flows have exceeded 150,000 and it regularly carries over 180,000 vehicles on the busiest days of the year (Highways England , 2019a). Traffic flows this far above the design capacity of the road result in frequent congestion and poor journey time reliability, making the Dartford Crossing one of the least reliable sections of the strategic road network (SRN).

2.2.2 The Dartford Crossing is a critical part of the country's road network. It connects communities and businesses and provides a vital link for the nearby major ports, which play a critically important role in the distribution of goods across the UK, including the Midlands and North of England. Reliable river crossings are essential for the provision of services and goods, enabling local businesses to operate effectively and for residents to access housing, jobs, leisure and retail facilities on both sides of the River Thames.

Scheme Objectives

2.2.3 The Department for Transport (DfT) set out a series of objectives to guide the development and assessment of solutions to alleviate the current conditions at the Dartford Crossing.

2.2.4 These objectives are as follows:

a. To support sustainable local development and regional economic growth in the medium to long term

b. To be affordable to government and users

c. To achieve value for money

d. To minimise adverse impacts on health and the environment

e. To relieve the congested Dartford Crossing and approach roads, and improve their performance by providing free flowing, north-south capacity

f. To improve resilience of the Thames crossings and the major road network

g. To improve safety

2.3 Previous analysis

2.3.1 A series of studies and consultation events have marked key stages in the development of the current proposals for the Project.

2.3.2 In 2009, the DfT published the results of a study to consider whether there were capacity constraints at the Dartford Crossing, to establish whether there was a need for additional crossing capacity and, if so, what form this might take (DfT, 2009). It concluded that the capacity of the Dartford Crossing was insufficient. It proposed some short- and medium-term measures to make best use of the existing infrastructure, such as changes to the methods of collecting the charge. It considered the potential to address the issues by investing in the light and heavy rail network.

2.3.3 It also considered the options of providing additional road capacity across the River Thames adjacent to the Dartford Crossing or at the following four alternative locations, each successively further east of the Dartford Crossing:

a. Swanscombe Peninsula

b. East of Gravesend

c. Canvey Island

d. Isle of Grain, east of Southend

2.3.4 In 2013, the DfT published the Review of Lower Thames Crossing Options: Final Review Report carried out by AECOM (DfT, 2013). This report presented the relative merits of the following three locations for the provision of a new crossing:

a. Alongside the Dartford Crossing, making use of the current M25 infrastructure

b. At the Swanscombe Peninsula, running from the A2 to the east of Dartford to the A1089 near the Tilbury Docks

c. East of Gravesend with connections from the M25 in Thurrock to the M2, with possible widening of the A229 to the M20

2.3.5 In January 2016, the Pre-Consultation Scheme Assessment Report reported on further work to inform the choice between a new crossing at the site of the Dartford Crossing and an alternative location to the east of Gravesend (Highways England, 2016). The report presented detailed assessments of a variety of alternative alignments in these two areas. These various route options were presented at a pre-statutory public consultation held later in 2016.

2.3.6 In 2017, National Highways (then, Highways England) published a further assessment of the route options at the two alternative locations in the Post-Consultation Scheme Assessment Report (Highways England, 2017). The appraisal of the alternative route alignments also incorporated findings from the 2016 pre-statutory public consultation.

2.3.7 The report was published at the same time as the DfT's announcement of its preferred route in April 2017. The chosen location was east of Gravesend, using an alignment that linked to the A2 west of the village of Shorne, provided a junction with the A226 then ran through a tunnel to a junction with the A1089/A13 at Orsett Cock and then joined to the M25 between junctions 30 and 29.

2.3.8 An updated transport model for the area using more-recent traffic data was produced in 2018. This is called the Lower Thames Area Model (LTAM) and was used to test and refine the design of the Project.

2.3.9 A Statutory Consultation in 2018, a Supplementary Consultation in 2020 a Design Refinement Consultation in summer 2020, a Community Impacts Consultation in summer 2021 and a Local Refinement Consultation in Spring 2022 reported on these refinements to the preferred route (Highways England, 2018; 2020a; 2020b, National Highways 2021 and 2022). The documentation produced for each consultation provided the reasons for the proposed changes in the design of the Project.

2.3.10 Further information about the development of the Project, including historic options, is detailed within Chapter 4 of the Planning Statement(Application Document 7.2).

2.3.11 This report presents the details of the transport modelling and appraisal of the Project design submitted for the DCO. A detailed description of the Project is given in the following section.

2.4 Project description

2.4.1 The Project would provide a connection between the A2 and M2 in Kent and the M25 south of junction 29, crossing under the River Thames through a tunnel. The Project route is presented in Plate 2.1.

2.4.2 The A122 would be approximately 23km long, 4.25km of which would be in tunnel. On the south side of the River Thames, the Project route would link the tunnel to the A2 and M2. On the north side, it would link to the A13, M25 junction 29 and the M25 south of junction 29. The tunnel portals would be located to the east of the village of Chalk on the south of the River Thames and to the west of East Tilbury on the north side.

2.4.3 Junctions are proposed at the following locations:

a. New junction with the A2 to the south-east of Gravesend

b. Modified junction with the A13/A1089 in Thurrock

c. New junction with the M25 between junctions 29 and 30

2.4.4 To align with National Policy Statement for National Networks (DfT, 2014) policy and to help the Project meet the Scheme Objectives, it is proposed that road user charges would be levied in line with the Dartford Crossing. Vehicles would be charged for using the new tunnel.

2.4.5 The Project route would be three lanes in both directions, except for:

a. link roads

b. stretches of the carriageway through junctions

c. the southbound carriageway from the M25 to the junction with the A13/A1089, which would be two lanes

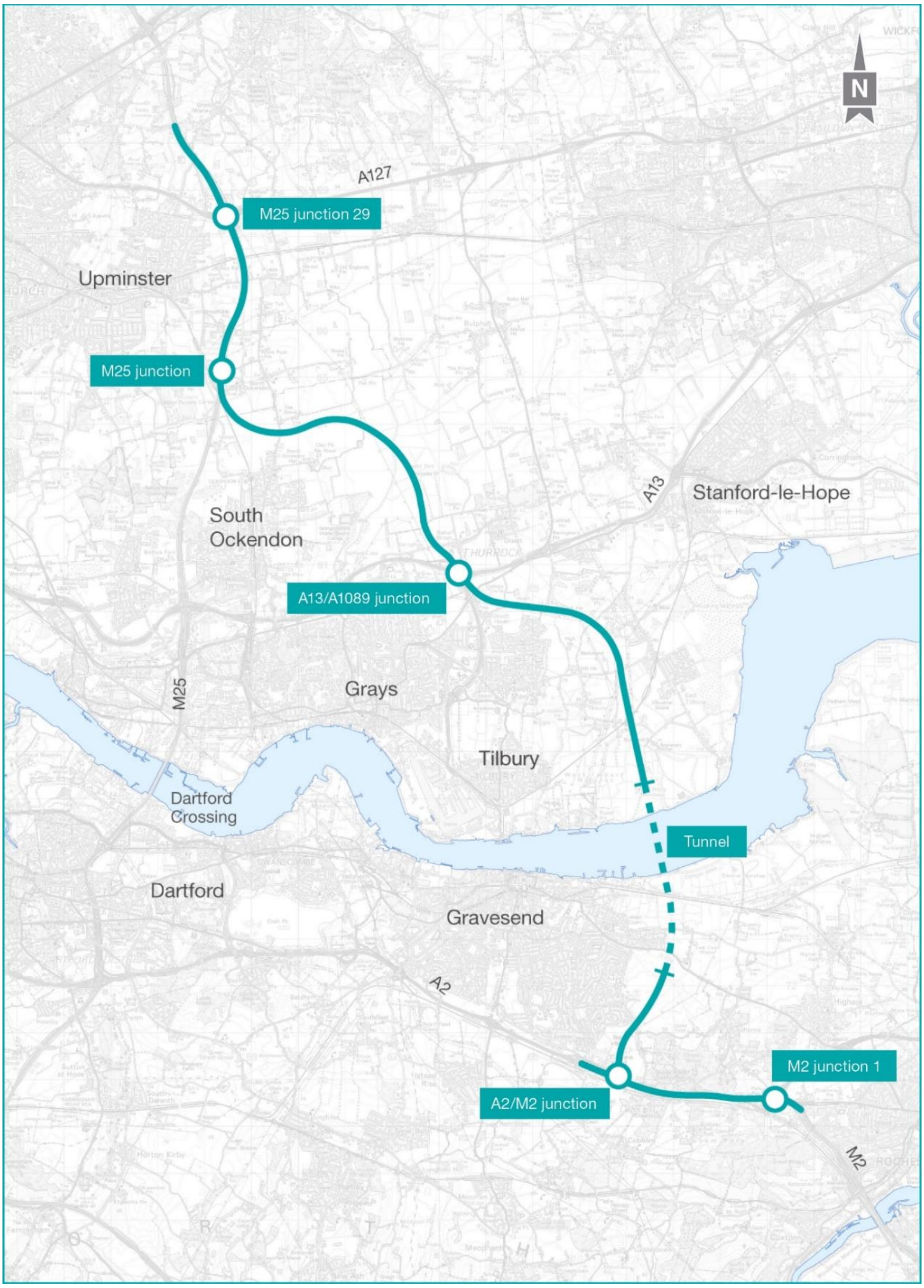
2.4.6 In common with most A-roads, the A122 would operate with no hard shoulder but would feature a 1m hard strip on either side of the carriageway. It would also feature technology including stopped vehicle and incident detection, lane control, variable speed limits and electronic signage and signalling. The A122 design outside the tunnel would include emergency areas. The tunnel would include a range of enhanced systems and response measures instead of emergency areas.

2.4.7 The A122 would be classified as an ‘all-purpose trunk road’ with green signs. For safety reasons, walkers, cyclists, horse riders and slow-moving vehicles would be prohibited from using it.

2.4.8 The Project would include adjustment to a number of local roads. There would also be changes to a number of Public Rights of Way, used by walkers, cyclists and horse riders. Construction of the Project would also require the installation and diversion of a number of utilities, including gas pipelines, overhead electricity powerlines and underground electricity cables, as well as water supplies and telecommunications assets and associated infrastructure.

2.4.9 The Project has been developed to avoid or minimise significant effects on the environment. The measures adopted include landscaping, noise mitigation, green bridges, floodplain compensation, new areas of ecological habitat and two new parks.

Plate 2.1 Lower Thames Crossing route



2.5 Report structure

2.5.1 Following this introduction, the remaining chapters of this report are as follows:

a. Chapter 3 presents details of the current transport situation.

b. Chapter 4 describes the data sources used to support the development of the transport model.

c. Chapter 5 summarises the development of the transport model and presents the model validation results.

d. Chapter 6 sets out the processes used to produce the traffic forecasts and shows the forecast future levels of traffic flows on the network.

e. Chapter 7 sets out the methods used in the economic appraisal and provides a summary of the impacts of the Project.

f. Chapter 8 presents a concluding summary.

3 Current transport situation

3.1 Introduction

3.1.1 This chapter describes the current performance of the transport network at the Dartford Crossing and the consequences of the high levels of traffic congestion.

3.1.2 The Dartford Crossing provides four lanes for traffic in each direction. The four lanes northbound are provided in two tunnels, each having two lanes. The four lanes southbound are provided over a bridge.

3.1.3 The first crossing at Dartford was a single two-lane tunnel with one lane operating in each direction. This tunnel was opened in 1963. A second tunnel was opened in 1980, which meant that the western tunnel provided two lanes northbound and the new tunnel provided two lanes southbound.

3.1.4 The Queen Elizabeth II Bridge was opened in 1991. It provides four lanes for southbound traffic and both tunnels are now used solely for northbound traffic. This means that the Dartford Crossing now has four lanes in each direction.

3.1.5 There is a charge for using the Dartford Crossing. This used to be paid at toll booths but is now collected remotely.

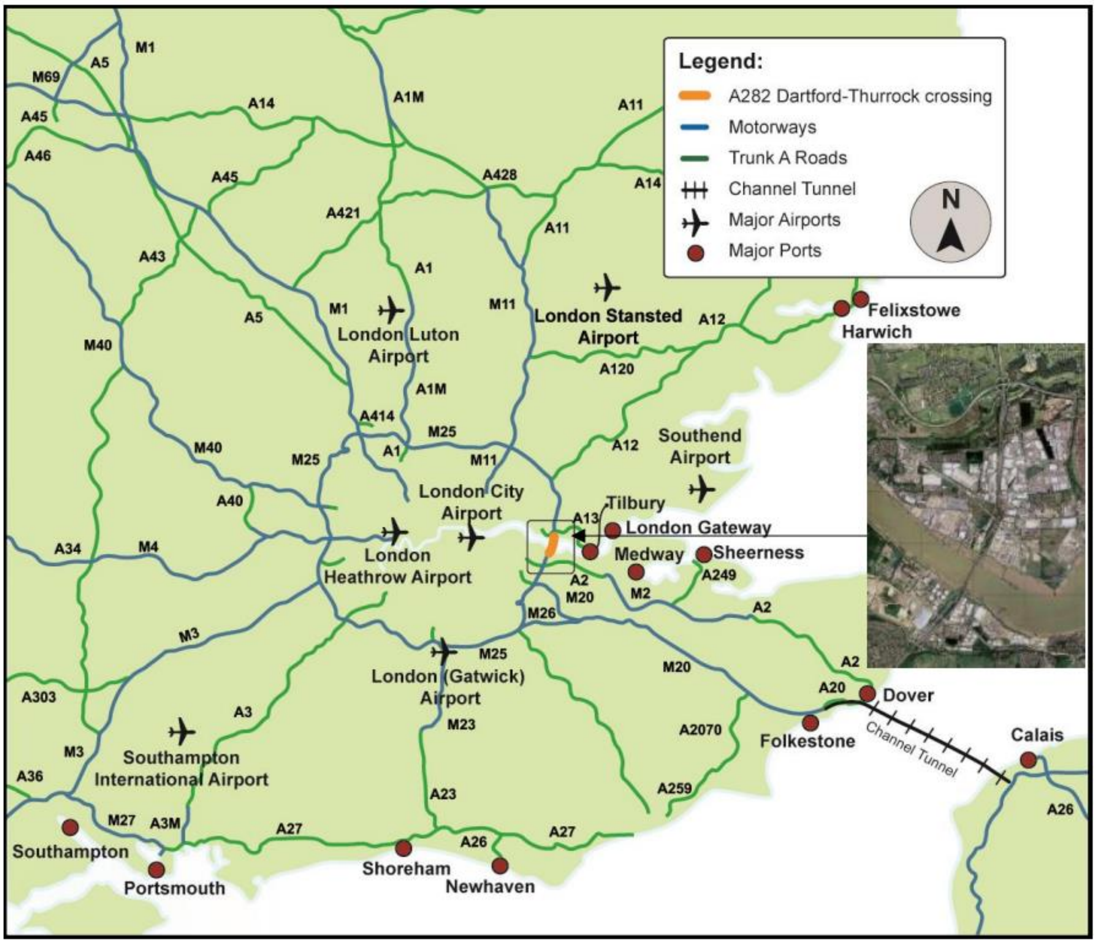
3.2 Transport network

Role in the regional highway network

3.2.1 The Dartford Crossing is part of the A282 and is the only non-motorway section of the M25 orbital motorway that runs around London. The M25 links many of the main motorways in England and lies at the heart of a hub and spoke arrangement, with much of the SRN focused on routes that run towards London and intersect with the M25.

3.2.2 The A282 provides the only crossing of the River Thames on the eastern section of the M25. The Dartford Crossing is used as the main route from the Port of Dover to the Midlands and the North of England. The location of the Dartford Crossing is shown in Plate 3.1. It shows the position of the Dartford Crossing in the SRN and the connectivity it provides between the airports and seaports in the area.

Plate 3.1 Location of the Dartford Crossing



Role in the local highway network

3.2.3 The Dartford Crossing is the only fixed road crossing of the River Thames east of the Blackwall Tunnel, which lies 15 miles to its west in inner London. The Silvertown Tunnel currently under construction will lie adjacent to the Blackwall Tunnel.

3.2.4 Usually, people travel in all directions from their homes to a variety of destinations. In north Kent, the River Thames forms a barrier to local trips going north and likewise from Thurrock and south Essex for trips going south. The Dartford Crossing provides the only road for local traffic to cross the natural barrier to movement created by the river.

Public transport network in the Lower Thames area

3.2.5 The development of the public transport network in the Lower Thames area was heavily influenced by the barrier effect caused by the river. The main rail corridors run east–west into London. The only rail crossing of the river is provided by High Speed 1 (HS1) services which call at Ebbsfleet near Dartford and Stratford in east London. There is no HS1 station in Thurrock.

3.2.6 The bus network has developed separately on each side of the river. The X80 service runs to/from Chafford Hundred Station in Thurrock across the Dartford Crossing to the Bluewater shopping centre to the south of the river in Kent.

3.3 Capacity at Dartford Crossing

3.3.1 The capacity provided at the Dartford Crossing has risen since the first tunnel was opened, first by the provision of the second tunnel and then by the construction of the Queen Elizabeth II Bridge. The introduction of remote payment of the charge for the Dartford Crossing in 2014 also increased the effective capacity by removing the need for vehicles to stop at the toll booths.

3.3.2 The capacity of the A282 as it approaches the Dartford Crossing is reduced by the close proximity of the junctions, with traffic merging and crossing lanes before and after the junctions.

3.3.3 The capacity northbound through the tunnels is lower than the capacity southbound over the bridge, even though they both have four lanes. This is primarily due to some limitations caused by the design of the tunnels.

3.3.4 The Dartford Crossing tunnels are not suitable for use by unaccompanied Dangerous Goods Vehicles. The vehicles have to wait in a designated area by the western tunnel. The general flow of traffic is stopped for a short time while these vehicles are escorted through the western tunnel. This happens around every 15 minutes.

3.3.5 The general flow of traffic is also held back sometimes if an over-height vehicle approaches the western tunnel, which has a lower height and width limit than the eastern tunnel. Occasionally, a vehicle arrives which is too large for either tunnel and again general traffic is held up while this vehicle is extracted from the road.

3.3.6 In times of high traffic flow and/or congestion on the M25 in Thurrock, vehicles are held back to avoid the build-up of queues of stationary traffic in the tunnels.

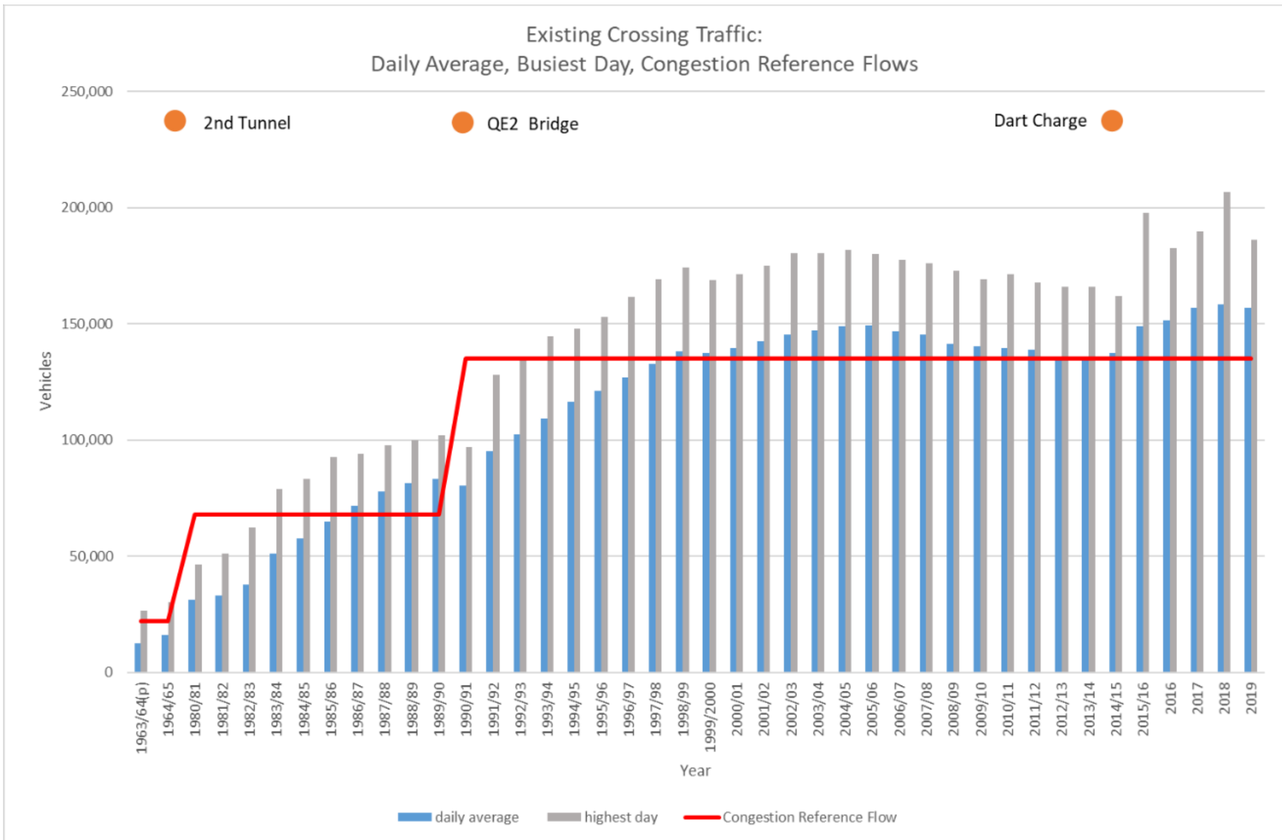
3.4 Levels of demand at Dartford Crossing

3.4.1 The number of vehicles using the Dartford Crossing has risen considerably since the first tunnel opened. This is due to a number of factors, such as the growth in population, the increased levels of car ownership and usage over the years, and the completion of the M25 orbital motorway.

3.4.2 Plate 3.2 shows the average daily flow for each year to 2019, and the highest daily flow since the Dartford Crossing opened. It also shows the capacity of the Dartford Crossing. This is known as the congestion reference flow which is the daily number of vehicles using a road, above which congestion would be expected in at least the peak hours.

3.4.3 The number of vehicles using the Dartford Crossing has exceeded its capacity for many years and this causes congestion. The DfT’s analysis of congestion levels on the road network for 2018/19 measures congestion by calculating the average delay in seconds per vehicle per mile. This is published as part of the Road Congestion Statistics as table CGN0402b (DfT, 2020b). On this measure, the A282 northbound between A296/A225 (junction 1b) and A206 (junction 1a) was the most congested link, between junctions, on the SRN in 2018/19, with an average delay of 82 seconds per vehicle per mile. This was a 12% increase over the average delay on this link in 2017.

Plate 3.2 Timeline of average daily flows compared to capacity increases



(Source: Dart Charge and Design Manual for Roads and Bridges TA 46/97 (Highways Agency, 1997))

3.5 Impact on journey times

3.5.1 The high number of vehicles wishing to use the Dartford Crossing compared to the available capacity leads to a reduction in traffic speeds. The average speeds on the network can be examined by using the Teletrac dataset used by the DfT in calculating the road congestion statistics. This data is collected from specialist Global Positioning System (GPS) units installed in over 100,000 vehicles in the UK.

3.5.2 The speed of cars and Light Goods Vehicles (LGVs) reported for 15-minute time intervals for each day of the year are presented in Plate 3.4 to Plate 3.11. The heatmaps show the average speed of vehicles on the A282/M25 approaches to the Dartford Crossing and on the Dartford Crossing itself, northbound and then southbound, for an average weekday, Saturdays and Sundays between April 2018 and June 2019.

3.5.3 The data covers vehicles on the mainline between the M25 junction 2 and M25 junction 29. This is shown in Plate 3.3.

Plate 3.3 Travel speeds analysis area, M25 junction 2 to M25 junction 29

3.5.4 In Plate 3.4 to Plate 3.11, the average speed is shown for each 15-minute interval between 06:00 and 20:00. Where the average speed is below 30mph, the cell is highlighted in red. Light orange is used to indicate speeds between 30 and 40mph, and yellow denotes speeds between 40 and 50mph. Speeds between 50 and 60mph are shown in light green, and speeds above 60mph are shown in green.

3.5.5 These plates show that the traffic speeds are lower travelling northbound than southbound. The average speed through the western tunnel is lower than through the eastern tunnel. There is a 50mph speed limit in the tunnels and on the Queen Elizabeth II Bridge.

3.5.6 On a weekday, the biggest impact on speeds northbound is in the evening peak, although speeds are low (i.e. below 30mph) on the approach to the tunnels from 09:00 onwards.

3.5.7 At the weekends, the speeds are lowest from around 09:00 to 14:00 and then rise towards the end of the day. On Sundays, the low speeds continue until around 18:00 before they start to rise again.

3.5.8 On Bank Holidays, the lowest speeds are in the morning, but the chart shows that the low speeds continue right back to junction 2 and possibly further.

Plate 3.4 Heatmap of average speeds (mph), weekday, northbound

Plate 3.5 Heatmap of average speeds (mph), weekday, southbound

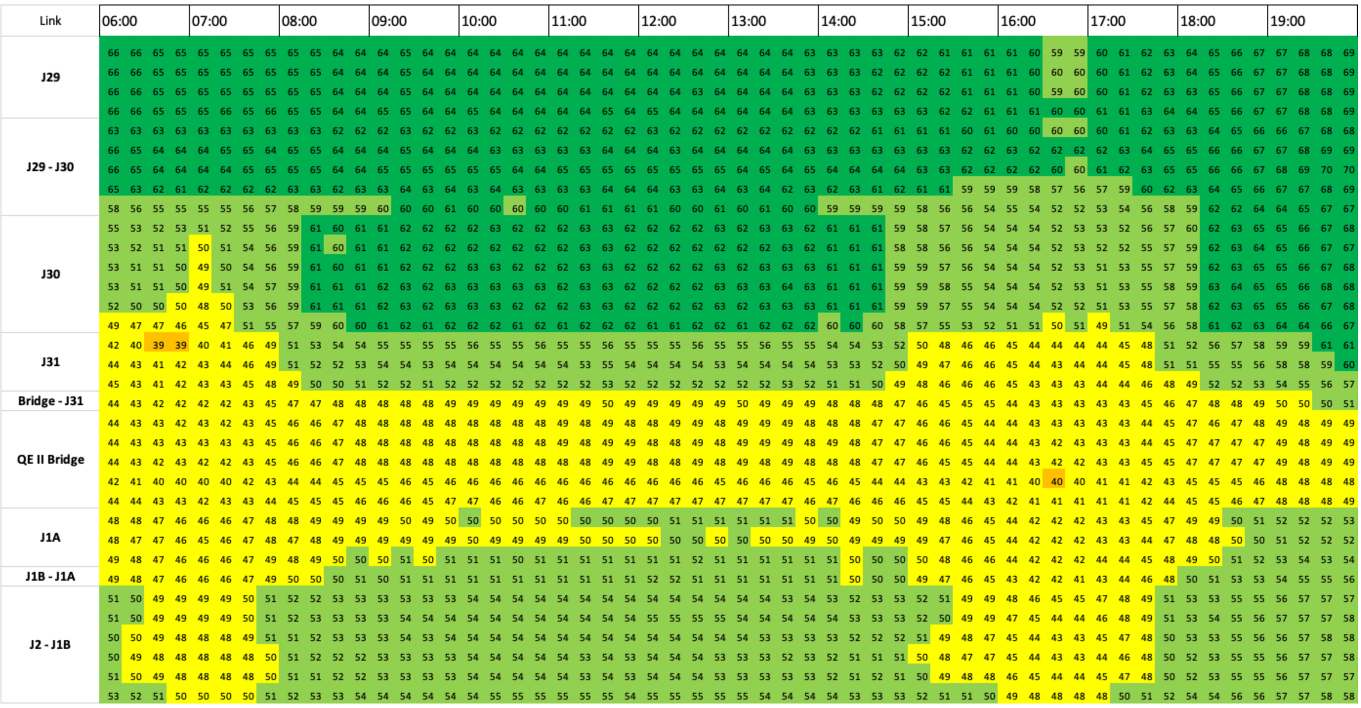


Plate 3.6 Heatmap of average speeds (mph), Saturdays, northbound

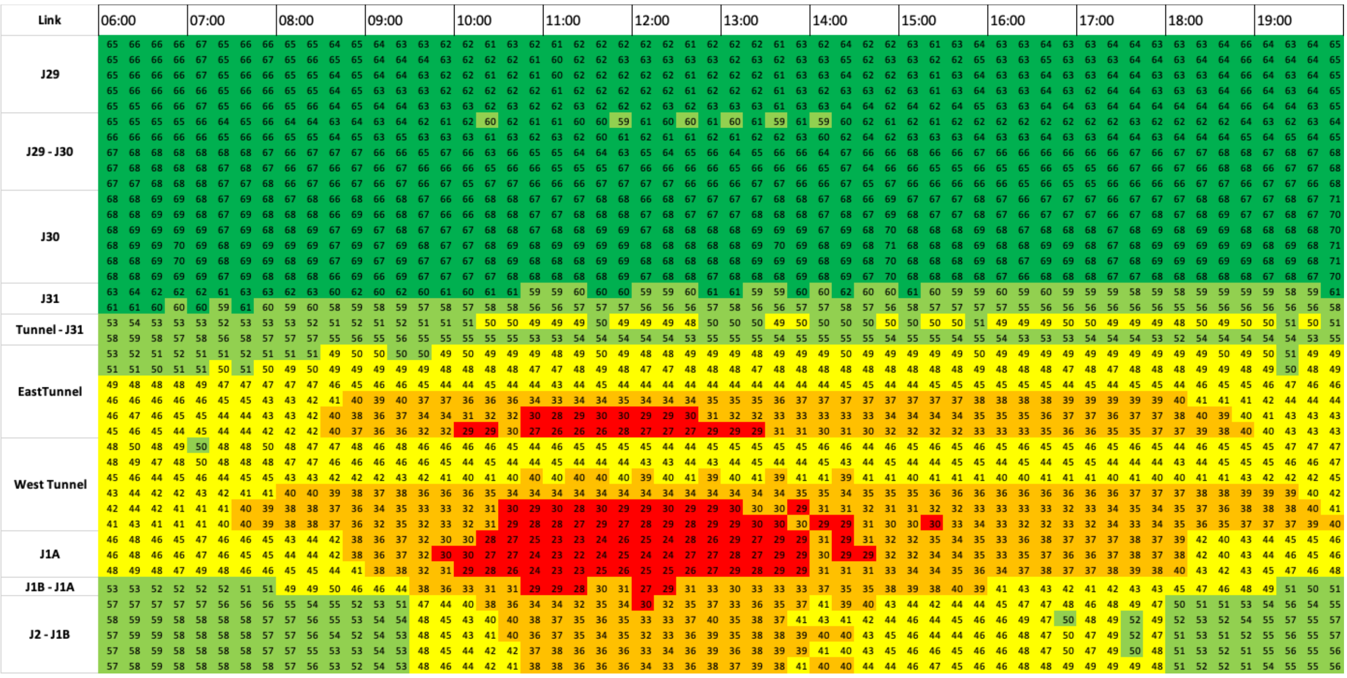


Plate 3.7 Heatmap of average speeds (mph), Saturdays, southbound

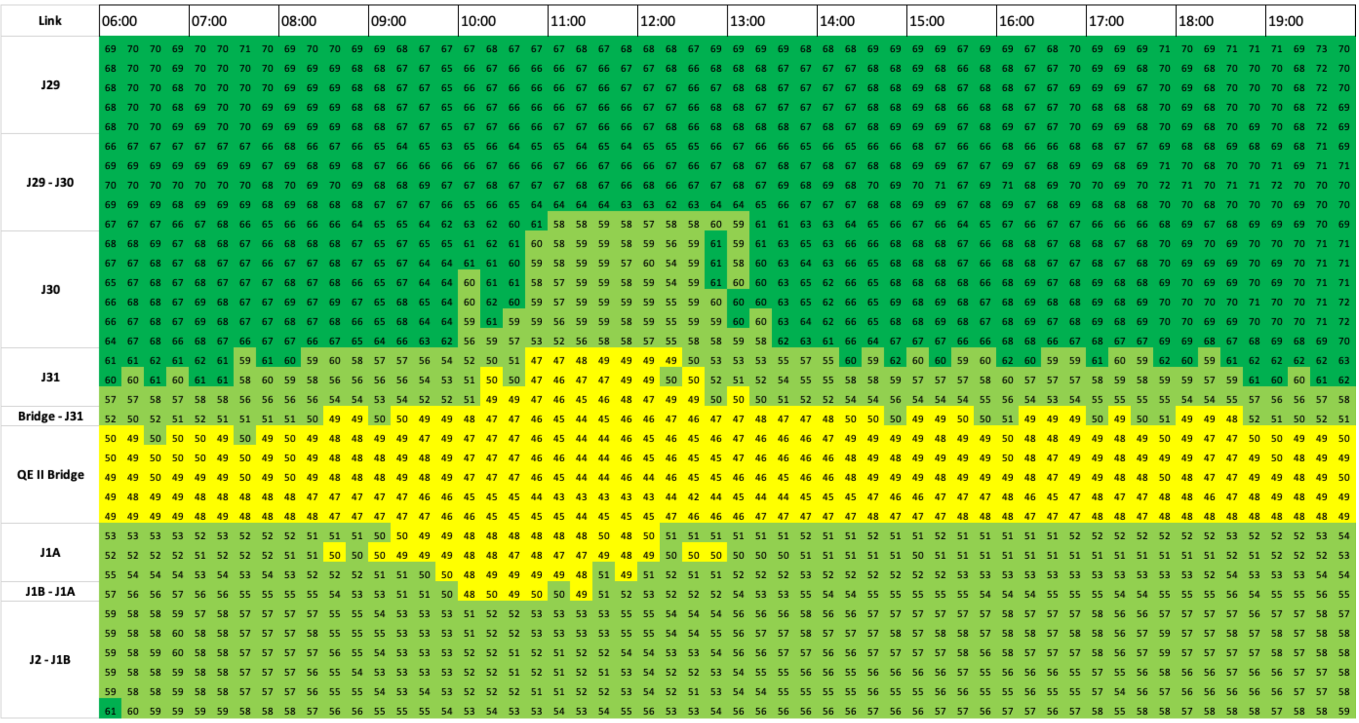


Plate 3.8 Heatmap of average speeds (mph), Sundays, northbound

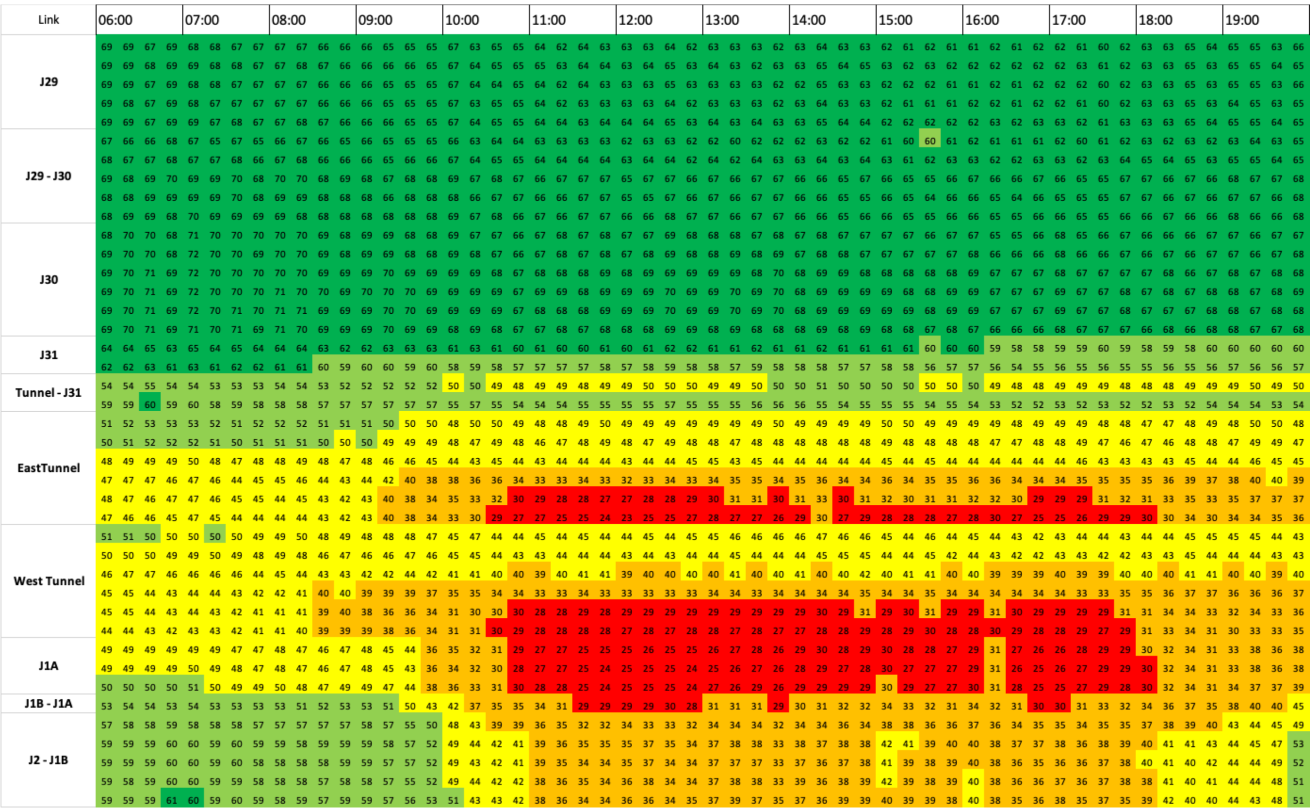


Plate 3.9 Heatmap of average speeds (mph), Sundays, southbound

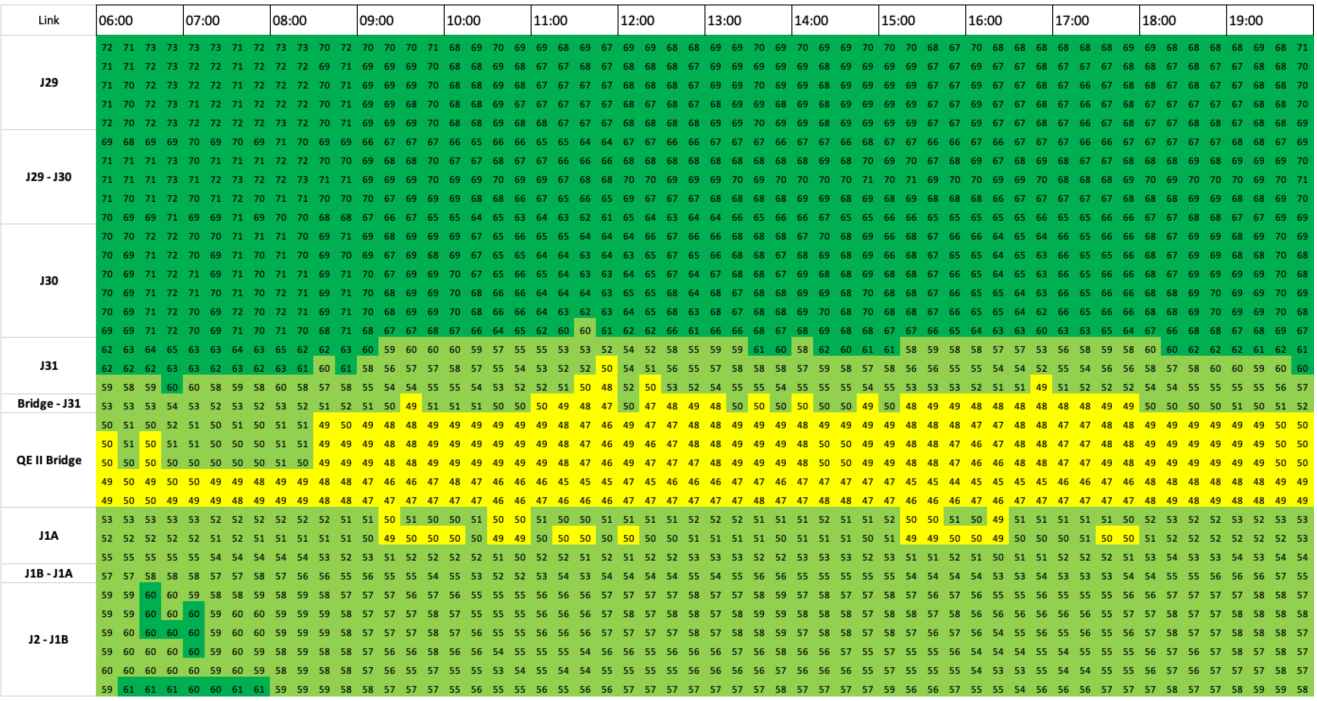


Plate 3.10 Heatmap of average speeds (mph), Bank Holidays, northbound

Link	06:00:00				07:00:00				08:00:00				09:00:00				10:00:00				11:00:00				12:00:00				13:00:00				14:00:00				15:00:00				16:00:00				17:00:00				18:00:00				19:00:00			
J29	68	68	70	68	69	69	66	64	68	61	69	65	67	64	69	66	67	64	62	63	65	64	66	65	65	60	62	66	64	66	63	61	66	63	64	66	63	62	63	68	62	66	66	69	61	62	68	67	66	66	68	65	66	61	70	69
	68	68	70	69	70	69	66	65	68	63	69	65	66	64	68	66	66	64	63	63	64	65	65	64	65	61	64	67	65	65	63	62	66	63	64	65	63	63	64	69	62	66	66	68	61	62	67	68	67	68	68	66	67	63	70	68
	68	69	70	68	70	69	66	64	68	61	69	64	67	63	68	66	67	64	62	64	64	64	66	63	65	60	63	67	64	65	63	62	66	63	64	65	63	62	63	68	62	66	66	68	61	62	67	67	66	67	68	66	66	62	69	68
	67	69	70	68	69	69	65	64	68	61	68	65	67	65	69	66	67	64	63	64	64	65	66	64	65	60	63	66	64	66	64	62	66	63	64	65	64	62	63	68	62	66	66	68	61	62	67	67	67	67	69	65	65	62	69	69
	68	69	71	67	70	69	65	65	68	62	68	65	67	66	71	67	67	65	63	64	66	65	67	65	65	60	64	65	66	66	65	64	65	63	65	66	64	62	62	67	63	66	66	68	62	63	67	68	68	68	70	65	66	63	69	70
J29 - J30	68	71	69	68	64	64	66	64	69	61	69	66	64	64	69	63	66	63	62	63	65	63	66	61	63	61	64	64	66	67	64	63	66	63	63	66	62	61	60	63	60	65	64	65	64	63	65	66	67	65	73	65	67	61	68	67
	68	71	70	69	67	66	67	65	69	63	70	64	64	68	67	64	67	64	62	64	64	64	67	63	63	62	65	64	67	66	66	64	62	63	63	66	65	60	58	64	57	65	65	66	65	65	65	66	68	69	73	67	65	65	71	67
	69	73	70	70	68	72	68	66	70	66	71	64	66	69	73	67	70	65	65	66	67	69	68	67	66	66	68	65	70	68	69	67	64	63	67	67	67	63	60	63	63	66	68	67	66	68	69	68	71	71	74	69	69	68	74	72
	68	72	68	70	67	72	65	67	70	64	68	65	65	68	71	67	69	66	64	66	70	69	66	68	67	66	68	65	68	67	68	66	67	65	66	67	63	64	65	60	62	59	67	65	67	67	68	67	71	70	71	69	69	68	72	70
	60	71	73	67	69	70	64	66	71	65	70	65	69	70	70	68	72	67	65	66	68	69	67	67	66	65	67	68	68	68	71	68	67	68	65	68	66	65	70	67	66	65	70	68	66	66	68	67	71	68	69	65	70	69	72	66
J30	69	71	73	70	70	73	66	68	71	65	70	62	69	73	70	68	68	69	67	68	67	69	66	66	66	69	69	72	67	70	68	69	69	71	71	70	67	65	72	68	70	68	70	68	66	68	67	66	70	69	70	69	68	72	71	67
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	71	71	73	69	70	74	67	69	73	66	71	65	70	75	70	70	69	68	68	69	70	70	69	69	68	68	69	70	68	71	70	71	71	71	70	69	66	68	73	69	73	71	72	69	67	70	70	65	71	71	70	67	70	73	71	69
	71	72	73	69	70	74	67	68	72	66	71	65	70	73	70	69	68	68	69	70	70	70	70	69	68	68	69	70	68	71	71	71	72	71	69	69	67	68	74	69	72	71	72	69	67	70	70	65	70	70	70	67	72	73	71	69
	69	72	72	68	69	73	66	69	72	67	71	65	70	72	69	69	68	69	69	70	68	66	70	71	68	69	67	69	67	70	72	70	70	71	72	69	66	66	72	68	68	69	71	68	67	69	70	64	70	73	67	67	72	72	71	68
J31	65	66	64	66	64	65	62	63	64	64	64	61	62	63	61	66	63	61	58	62	59	59	62	64	63	64	60	60	60	63	60	63	62	64	63	61	60	59	61	61	60	62	59	58	60	61	63	60	64	60	61	60	63	64	62	59
	64	63	62	65	61	64	60	58	60	62	62	58	60	59	59	63	59	58	55	58	57	54	56	60	58	61	57	57	58	58	58	60	59	59	61	57	56	55	57	56	58	58	56	56	58	58	59	57	61	59	59	57	60	61	59	58
Tunnel - J31	55	54	55	55	55	56	49	52	55	52	53	53	49	51	52	53	53	50	51	51	49	51	47	49	50	51	50	50	49	51	48	52	50	50	52	49	49	50	51	50	51	51	52	48	51	53	51	51	53	52	51	51	51	52	52	51
	62	61	58	61	59	61	55	56	59	59	61	56	56	56	57	57	58	55	52	56	55	52	51	56	55	57	55	55	55	57	55	57	56	57	58	56	53	53	53	53	55	55	55	54	55	57	56	55	57	57	56	54	56	58	56	54
EastTunnel	51	51	53	49	53	55	48	52	52	51	51	52	48	51	50	51	52	51	48	48	48	48	47	48	47	49	47	48	50	50	49	51	50	50	50	51	50	49	52	50	50	51	50	46	49	50	46	49	49	52	52	47	52	47	53	50
	51	49	54	47	52	52	48	52	52	50	50	51	49	49	49	50	51	49	48	48	47	49	47	48	47	48	46	48	49	50	48	50	49	49	50	47	50	49	51	49	51	50	50	46	48	50	46	47	49	50	51	47	52	47	52	48
	50	47	50	46	51	48	47	49	48	48	48	48	46	45	45	46	46	44	44	45	43	43	44	44	43	44	43	44	43	47	43	44	45	44	47	39	45	43	47	46	47	48	46	43	43	43	44	45	47	47	47	47	49	45	48	44
	47	45	48	45	48	45	43	44	43	43	41	41	39	37	41	38	34	32	34	34	36	34	34	35	32	29	33	34	34	35	32	32	34	38	39	35	39	36	39	39	41	40	39	37	37	34	37	41	42	45	41	42	45	43	46	41
	47	46	47	47	47	44	46	44	44	41	40	37	35	33	38	36	28	28	29	31	30	31	25	30	27	22	26	27	30	32	25	25	29	36	36	32	37	33	38	39	38	38	38	35	34	30	36	40	41	44	41	40	44	42	46	40
	45	45	45	45	46	44	45	43	44	42	37	34	33	31	38	32	24	24	29	30	26	27	23	25	24	15	23	24	25	30	21	19	24	35	36	28	36	32	36	39	37	36	35	34	33	31	37	38	40	43	38	36	44	41	46	40
West Tunnel	51	51	51	55	49	48	46	48	49	47	51	44	47	47	49	49	48	48	48	47	43	49	45	45	46	45	46	45	45	46	44	50	45	47	45	43	47	47	44	47	45	47	47	47	45	47	47	44	45	47	48	51	45	51	45	46
	51	49	50	57	50	48	44	47	50	47	48	42	47	46	47	46	47	47	45	47	43	47	44	45	45	43	47	44	42	44	43	47	45	46	43	43	45	44	43	44	47	47	46	47	43	46	48	44	45	47	48	49	43	51	45	46
	49	43	46	55	47	45	44	42	46	43	44	37	45	42	44	42	41	41	41	45	40	41	40	38	39	39	42	39	39	39	41	41	42	40	40	41	41	40	41	38	45	43	41	42	41	43	45	41	41	43	46	45	39	46	42	38
	47	42	45	51	44	44	41	39	42	41	40	34	35	37	36	36	34	36	35	37	35	34	33	34	29	30	33	32	32	33	32	33	34	33	35	36	34	33	36	35	39	38	35	36	36	36	38	32	37	38	37	42	36	41	35	42
	44	43	45	45	42	45	43	39	41	41	40	33	29	34	32	31	32	30	29	32	32	28	29	29	23	24	27	30	27	28	25	28	29	28	29	32	30	31	33	33	36	34	31	31	31	32	37	27	36	35	32	39	34	38	34	30
	43	40	45	45	41	45	39	42	39	39	38	33	25	37	35	31	31	29	25	30	26	25	26	22	25	19	22	21	22	26	22	29	28	28	29	31	30	33	35	31	36	32	28	29	32	32	37	24	36	37	30	41	34	36	37	29
J1A	48	51	52	50	47	47	48	48	50	50	42	36	35	40	39	32	24	27	29	27	23	22	16	24	23	21	20	18	18	20	21	26	28	34	30	31	31	36	38	37	43	35	40	32	34	33	40	35	42	42	44	42	45	37	43	35
	48	51	51	50	48	47	48	48	49	50	41	36	36	40	40	33	24	26	29	28	21	22	16	25	22	20	19	19	18	20	21	27	29	33	30	31	32	35	38	39	43	36	41	32	35	31	40	35	41	42	45	42	45	38	43	36
	50	51	51	52	50	50	49	50	51	50	42	39	36	43	43	34	26	23	24	27	19	19	16	18	22	20	19	18	18	20	21	27	33	35	28	29	31	37	43	45	46	37	42	37	35	28	46	39	44	43	50	46	41	40	43	38
J1B - J1A	53	54	52	56	55	56	51	53	56	54	50	41	45	41	47	38	33	26	28	26	23	22	20	22	24	20	19	17	22	26	31	33	42	39	34	34	37	48	46	52	50	42	47	44	37	39	48	49	49	46	54	47	51	48	54	40
J2 - J1B	57	59	56	58	59	60	56	57	60	59	56	53	49	44	53	41	38	32	33	28	21	22	20	26	23	20	20	20	22	32	39	35	48	43	41	39	43	55	52	56	54	48	53	56	43	46	54	55	54	52	58	53	56	53	59	42
	59	62	57	58	60	60	59	59	61	60	57	55	49	47	53	44	42	30	33	33	27	25	18	27	24	20	20	19	29	37	40	36	53	49	43	45	42	58	54	57	55	48	58	57	48	52	55	55	55	51	59	51	56	56	59	44
	62	61	58	58	59	61	59	59	62	60	57	55	49	50	53	45	40	34	31	32	31	23	18	25	23	18	20	18	26	35	42	36	52	47	45	42	46	55	55	52	52	52	59	56	48	53	49	54	55	51	53	59	53	56	59	45
	62	62	58	60	59	60	59	58	63	61	55	55	51	47	53	46	36	37	35	32	34	22	21	29	23	19	21	22	30	37	42	39	53	46	45	47	46	54	56	52	51	51	57	55	50	52	49	52	53	49	53	60	53	55	60	45
	62	63	59	62	60	60	59	60	63	60	56	56	54	54	47	47	35	32	37	32	32	26	22	23	25	22	25	26	39	40	40	37	49	44	45	48	47	56	58	52	52	53	56	54	52	51	54	53	50	49	59	59	52	54	54	45

Plate 3.11 Heatmap of average speeds (mph), Bank Holidays, southbound

Link	06:00				07:00				08:00				09:00				10:00				11:00				12:00				13:00				14:00				15:00				16:00				17:00				18:00				19:00			
J29	70	71	70	73	70	71	73	74	74	70	72	71	73	69	71	68	68	67	70	66	72	66	69	70	69	67	71	73	68	67	68	68	70	71	69	69	68	73	70	70	71	70	65	70	70	72	72	74	72	70	74	71	71	71	70	75
	69	70	70	73	69	71	73	73	75	68	71	71	72	68	71	67	68	68	69	67	69	69	67	69	69	66	71	72	66	66	68	68	67	71	68	68	67	72	71	68	70	66	63	69	70	71	70	73	71	68	73	70	70	71	70	73
	69	70	70	73	70	71	72	73	75	68	72	72	73	68	71	67	68	68	69	69	67	69	67	68	69	67	70	72	67	66	68	68	67	71	67	69	67	70	75	68	70	65	62	70	69	73	70	73	71	68	73	70	70	72	70	73
	69	70	70	73	69	71	72	73	75	68	72	72	72	68	70	67	68	67	68	68	67	69	67	69	69	67	71	72	67	66	69	68	67	71	67	68	66	70	75	68	70	66	62	69	70	73	70	72	70	68	74	70	70	72	70	73
	70	70	70	73	69	72	70	73	72	68	72	72	73	69	70	67	68	67	68	68	67	69	67	68	70	67	70	71	67	67	69	68	68	71	68	69	67	72	76	68	69	67	63	70	71	72	71	73	70	68	74	71	70	73	70	74
J29 - J30	65	65	69	71	65	71	70	74	67	64	67	71	69	67	64	65	67	63	66	68	65	63	64	66	69	68	67	69	64	65	68	66	65	67	71	67	67	71	68	67	67	68	62	70	69	72	70	72	68	66	71	72	69	68	69	68
	68	71	69	71	67	71	70	73	70	68	68	72	70	70	64	67	69	66	69	68	66	66	67	69	70	69	67	69	66	67	69	69	67	70	72	69	68	73	72	69	69	67	65	71	68	72	73	73	71	71	73	71	71	72	69	71
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	71	70	71	71	68	71	72	73	68	74	69	70	69	68	71	67	65	69	63	63	61	63	58	60	61	62	61	68	62	68	66	70	68	72	68	70	66	72	72	69	70	62	67	70	71	73	71	74	69	71	71	71	70	72	69	72
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J30	69	71	71	74	70	69	73	74	71	68	70	69	67	68	70	70	65	61	61	72	65	63	59	61	60	58	46	47	55	56	65	66	70	71	68	66	64	67	74	68	73	67	67	68	71	72	70	72	76	65	75	75	75	72	69	74
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J31	63	63	65	67	65	63	61	66	62	60	62	58	58	62	60	59	52	56	50	54	53	49	46	49	54	51	46	44	46	47	57	56	61	64	66	61	65	62	63	64	63	60	61	66	61	60	64	62	64	60	68	66	66	66	64	65
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	59	57	61	63	59	59	59	60	58	55	59	53	54	56	55	52	53	55	47	51	51	50	47	51	52	52	47	42	48	48	53	57	56	58	59	58	58	57	56	58	56	54	56	59	55	59	56	58	57	54	64	59	63	58	60	58
Bridge - J31	52	53	56	56	51	52	54	52	52	50	53	52	50	50	52	48	48	49	48	48	50	49	49	48	51	49	49	47	46	49	50	52	52	52	53	53	53	52	52	51	51	51	51	51	51	53	52	51	51	50	54	52	56	53	53	51
QE II Bridge	52	51	51	51	50	50	54	51	51	50	51	49	49	48	49	45	46	44	46	47	47	47	50	49	50	48	47	50	42	49	51	51	50	51	51	51	50	51	50	50	51	49	50	49	50	51	51	47	50	50	51	50	52	51	50	49
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	51	51	51	50	50	50	53	51	52	49	51	50	49	49	49	48	46	47	45	47	47	47	51	48	48	47	44	49	44	50	51	50	50	51	51	51	50	50	50	49	51	49	50	50	49	50	52	48	49	49	49	48	51	50	47	50
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	49	50	51	48	50	49	49	48	49	49	49	47	48	48	48	46	46	47	46	47	48	48	47	48	46	47	48	48	46	47	48	48	48	49	48	49	50	49	49	47	49	47	48	47	48	49	49	48	47	49	51	50	50	49	50	51
J1A	54	53	54	50	54	51	52	53	53	52	53	50	50	51	48	49	49	50	50	51	50	52	50	51	51	51	50	52	51	49	51	50	53	53	51	53	53	52	55	51	52	52	52	50	53	55	55	53	52	54	57	55	55	53	56	53
	53	52	53	49	52	50	52	51	51	51	52	50	50	50	48	49	48	50	49	50	49	52	50	50	51	49	50	51	50	49	50	50	52	52	51	52	53	51	54	50	51	52	52	50	52	54	54	52	50	53	56	54	54	52	55	52
	55	55	56	53	56	53	55	57	53	54	55	52	52	51	48	51	51	51	51	51	51	53	51	52	52	51	52	52	52	49	53	51	54	54	52	55	56	54	56	53	54	52	53	51	53	57	57	55	54	56	60	57	58	54	58	54
J1B - J1A	58	58	58	56	59	58	56	60	56	58	57	57	54	54	52	52	52	55	57	50	55	54	52	51	55	54	55	55	55	52	55	55	56	55	55	57	59	56	58	56	56	55	54	54	51	58	60	58	57	57	61	60	59	57	59	59
J2 - J1B	60	59	60	58	62	59	57	60	58	60	59	59	56	56	52	56	55	59	58	53	57	57	57	57	53	58	57	58	57	54	57	58	57	56	58	59	61	57	60	57	59	57	56	56	57	55	62	63	59	58	63	62	62	57	60	60
	59	60	61	58	64	58	58	60	59	59	59	59	57	56	52	57	56	58	59	53	58	58	57	57	54	58	59	60	59	55	60	58	57	59	59	59	61	58	60	61	58	56	57	57	57	55	61	63	60	60	62	64	63	58	61	60
	59	60	61	59	64	58	59	60	60	59	58	59	57	56	53	58	55	58	56	52	56	56	56	55	54	57	58	59	58	54	59	58	56	60	59	60	60	59	60	60	57	57	57	56	57	53	60	63	59	60	62	65	62	57	62	60
	60	61	59	58	64	58	58	59	59	58	57	59	57	54	53	56	52	56	54	50	55	55	55	55	54	56	58	59	57	53	58	56	55	59	58	60	59	59	59	61	56	55	58	55	56	55	60	64	59	59	60	64	61	55	63	60
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	62	61	59	59	66	59	59	59	60	58	59	58	58	55	53	57	53	59	56	54	56	57	55	57	53	56	57	62	57	55	58	60	56	60	58	61	59	58	59	65	57	56	59	58	57	57	61	62	61	59	60	63	61	56	63	59

3.6 Impact on journey reliability

Variability in average speeds

3.6.1 One impact of the high traffic levels relative to the available road capacity is the variation in traffic speeds. The 2018/19 Teletrac dataset was used to calculate the average speed for vehicles for each hour of the day on weekdays, Saturdays and Sundays. The speeds were calculated from M25 junction 2 through to M25 junction 29. These are presented in Plate 3.12 to Plate 3.17.

3.6.2 The plates show the great variation in traffic speeds which leads to uncertainty for users when planning their journeys. For example, on an average weekday travelling northbound between 17:00 and 18:00, the median speed is 40.6mph but on 25% of days the speed is below 33.5mph, and on 25% of days the average speed is above 51.2mph.

3.6.3 The extents of the lines show the minimum and maximum speeds for each hour. The box on each line represents the first to the third quartiles of these speeds. The horizontal line inside each box represents the median speed.

3.6.4 The analysis also shows that there is greater variability in traffic speeds travelling north rather than south. There is also a large variation in traffic speeds at the weekend, particularly from around 10:00 to 18:00.

Plate 3.12 Variation in average speeds, weekdays, northbound

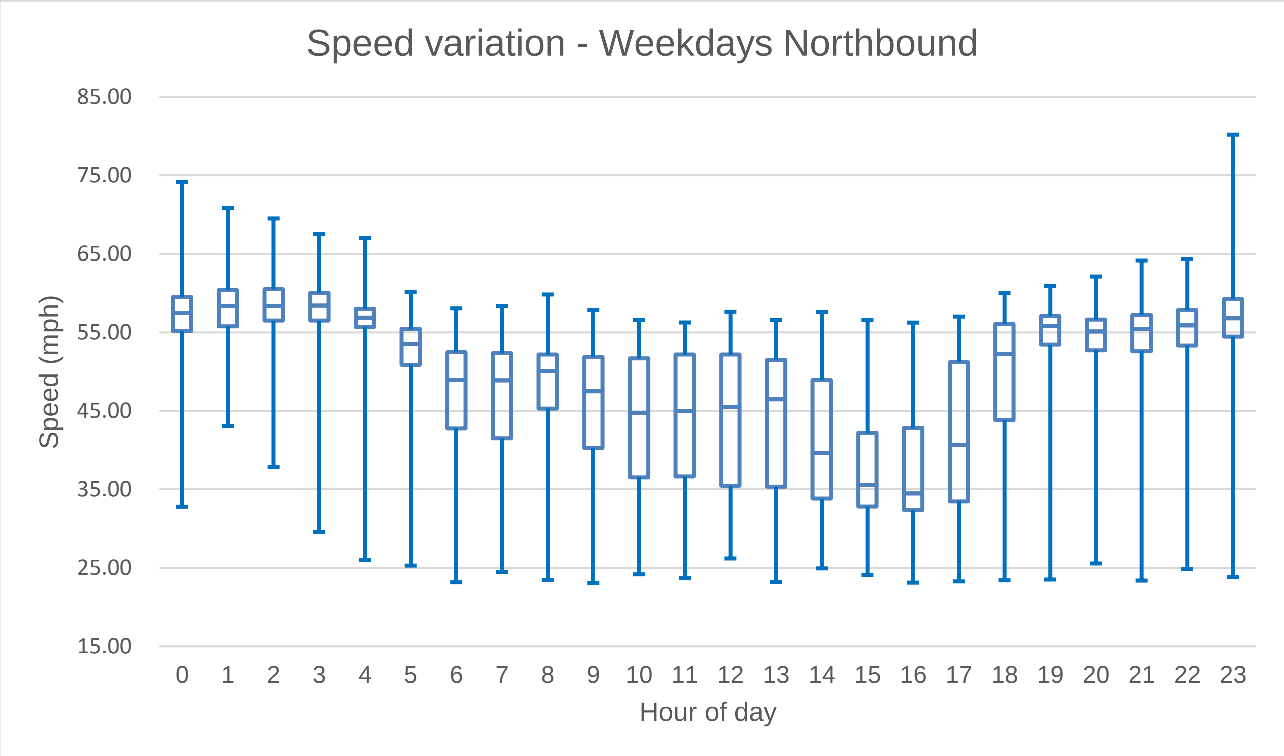


Plate 3.13 Variation in average speeds, weekdays, southbound

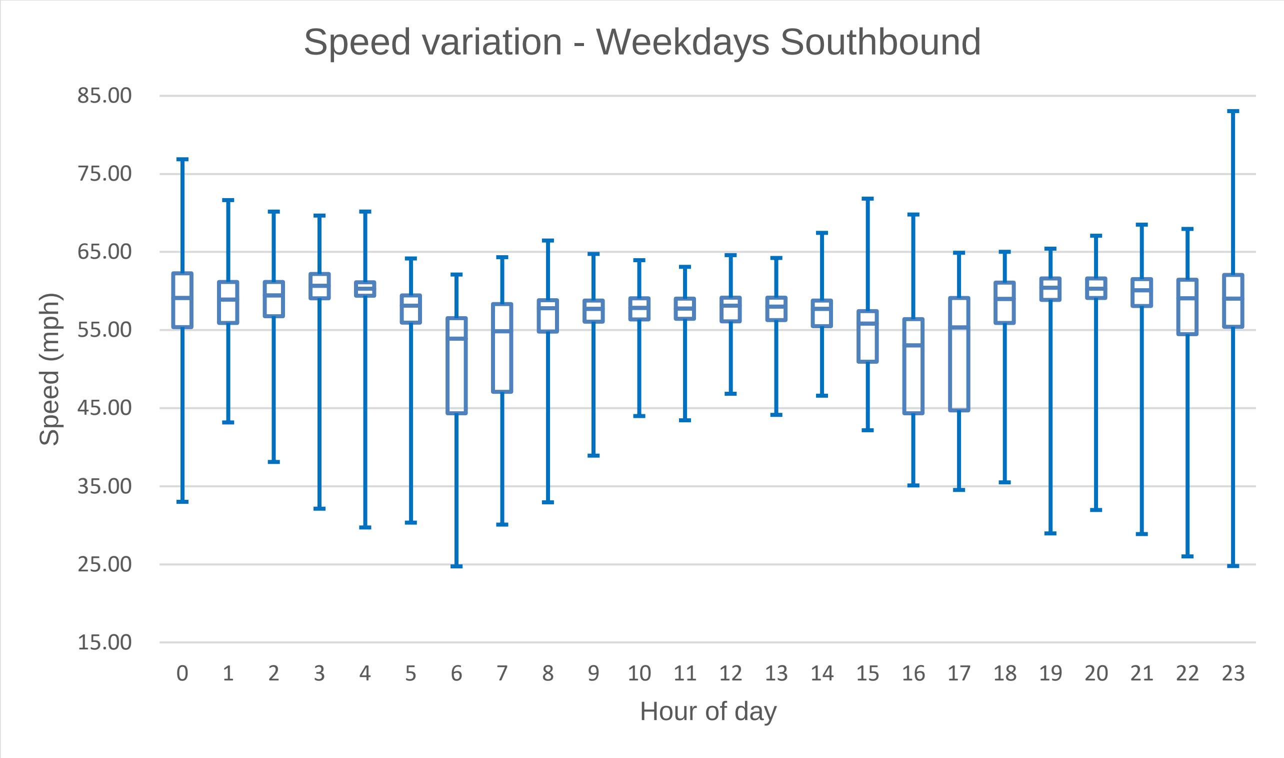


Plate 3.14 Variation in average speed, Saturdays, northbound

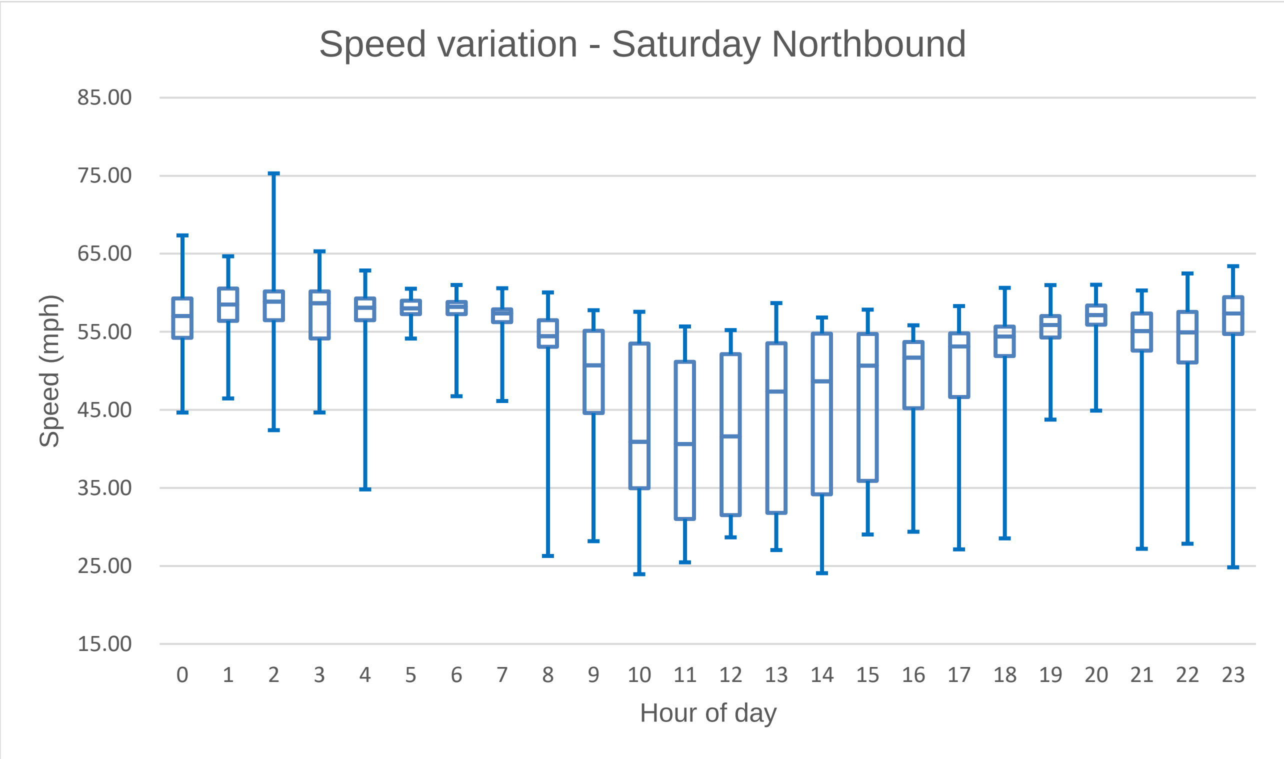


Plate 3.15 Variation in average speed, Saturdays, southbound

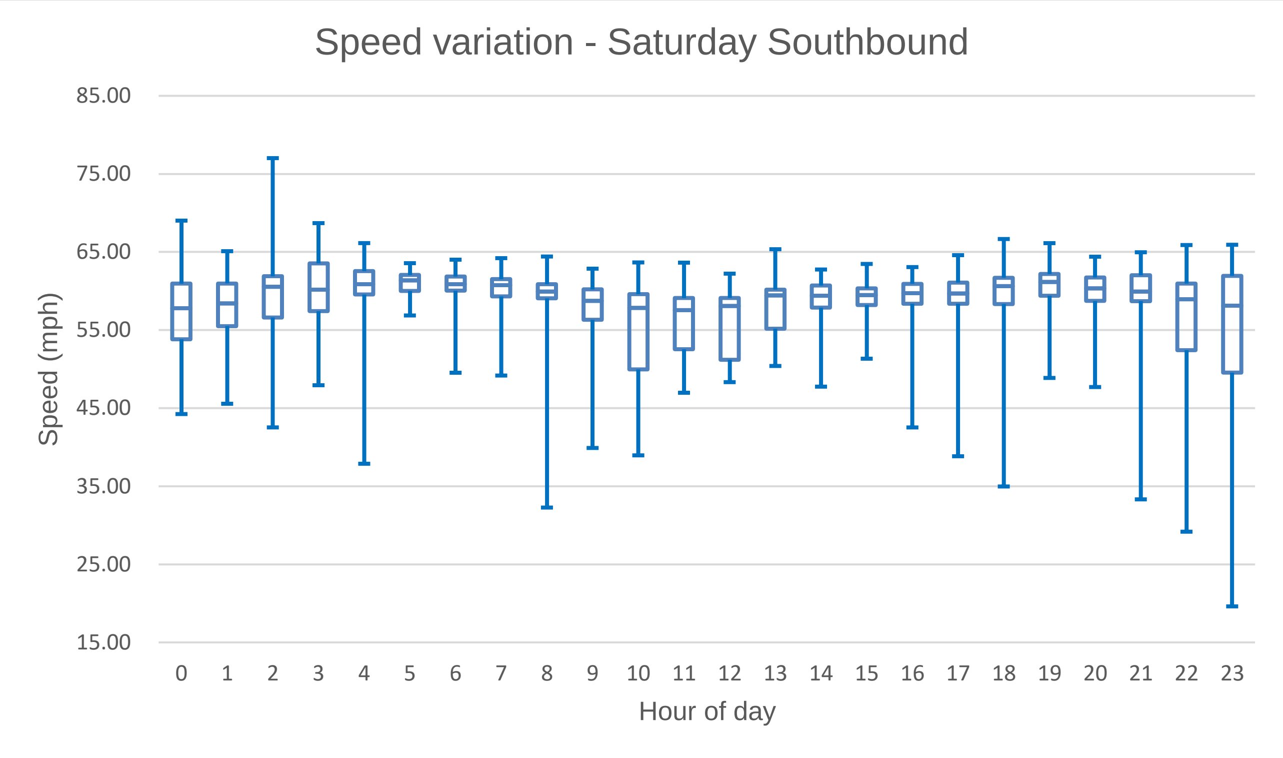


Plate 3.16 Variation in average speed, Sundays, northbound

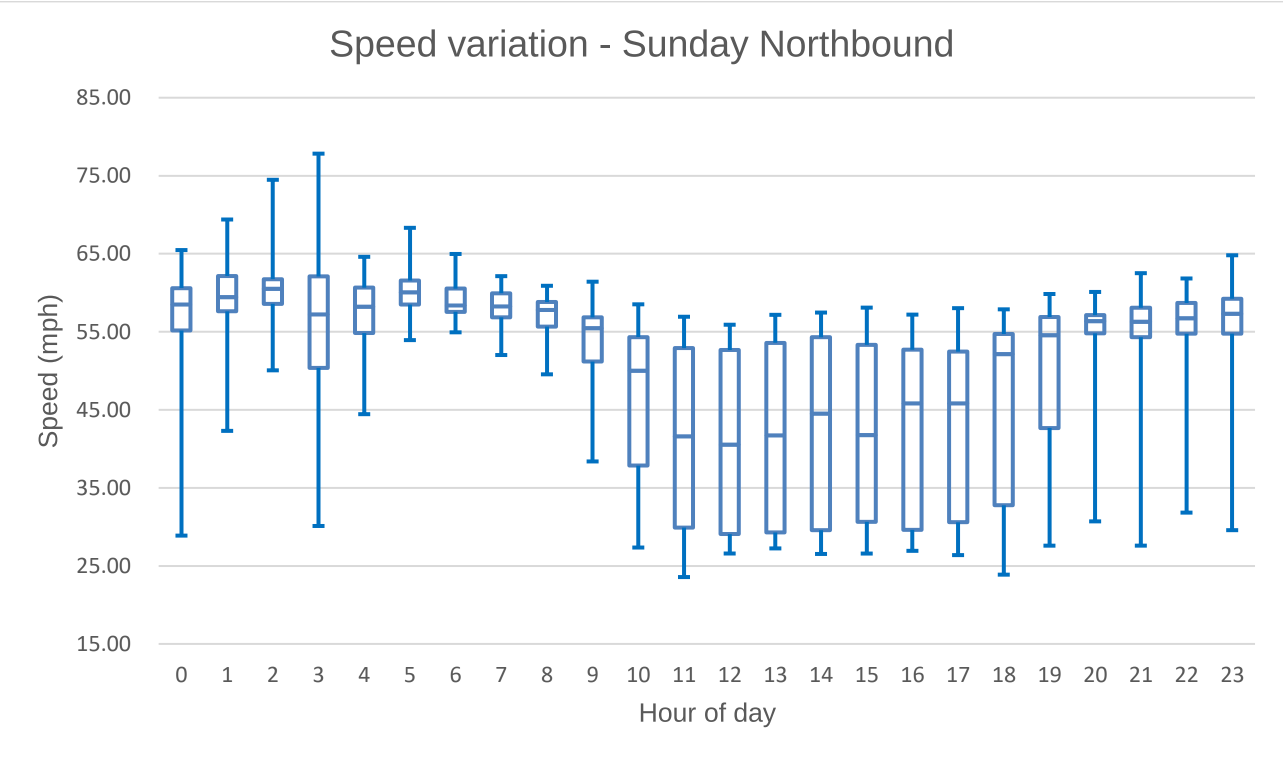
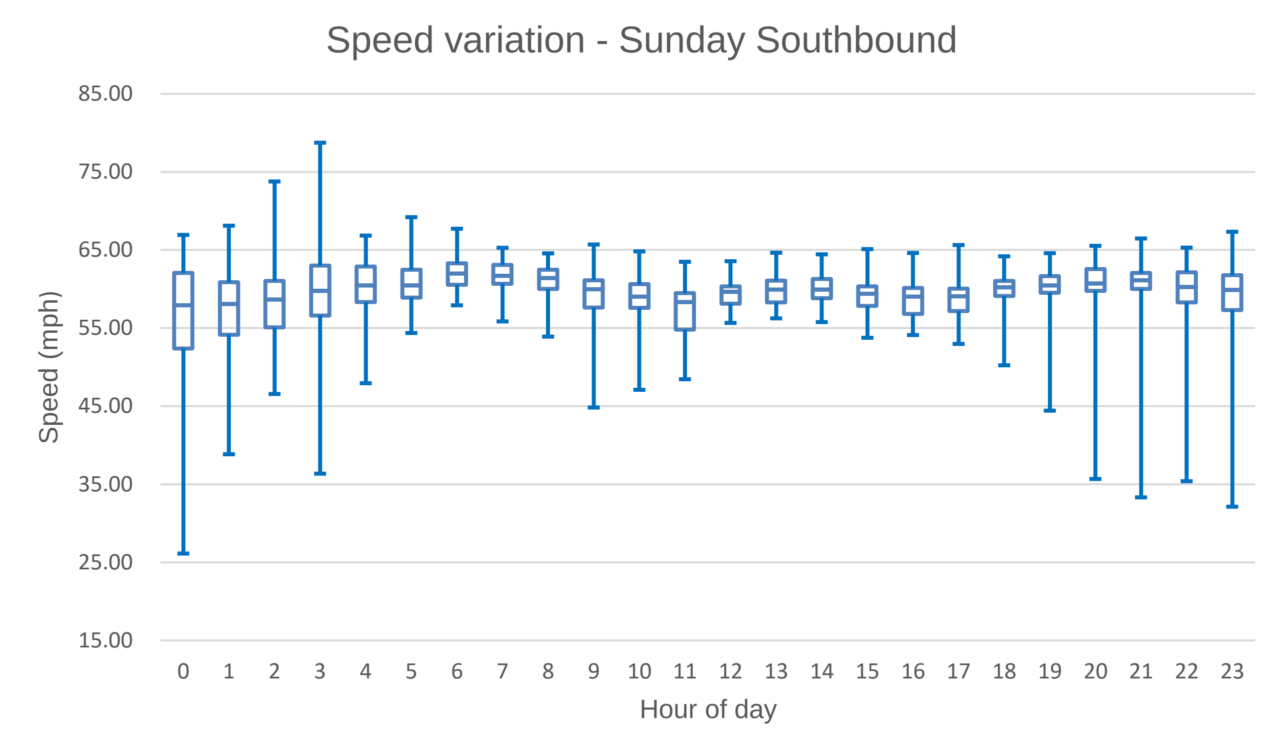


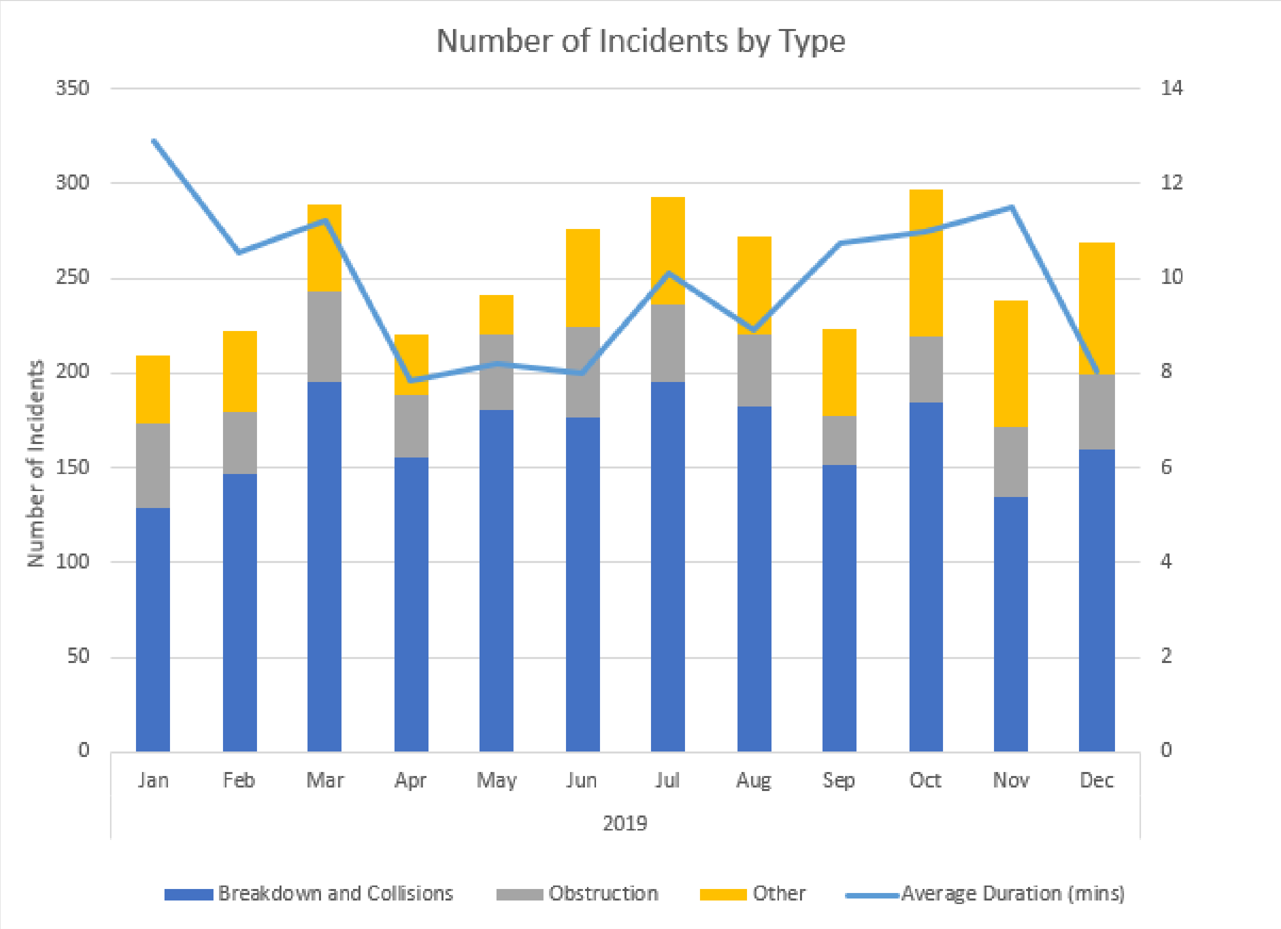
Plate 3.17 Variation in average speed, Sundays, southbound



Incidents at Dartford

3.6.5 A review of the incidents on the A282 has identified that the majority of incidents are caused by vehicle breakdowns and collisions (Highways England, 2019). The number and type of incidents is shown in Plate 3.18. Even though most incidents are cleared within 10 minutes, they contribute to the variability in journey speeds described above.

Plate 3.18 2019 Closure incident durations by incident type



Impact of incidents on the wider network

3.6.6 When more serious incidents occur, journeys are severely disrupted and slow-moving traffic typically extends back as far as junction 4 (over nine miles) in the case of a northbound incident, and back to junction 29 (over seven miles) for a southbound incident. It can take up until the late evening for journey times across the Dartford Crossing to return to normal.

3.6.7 An illustration of the impact of an incident on the wider network is provided in Plate 3.19 and Plate 3.20. The two plates compare the median speeds on links on 27 January 2016 with the following day, 28 January, when there was a fuel spill at the Dartford Crossing.

Plate 3.19 Average speeds, 27 January 2016, 17:00-18:00, without incident

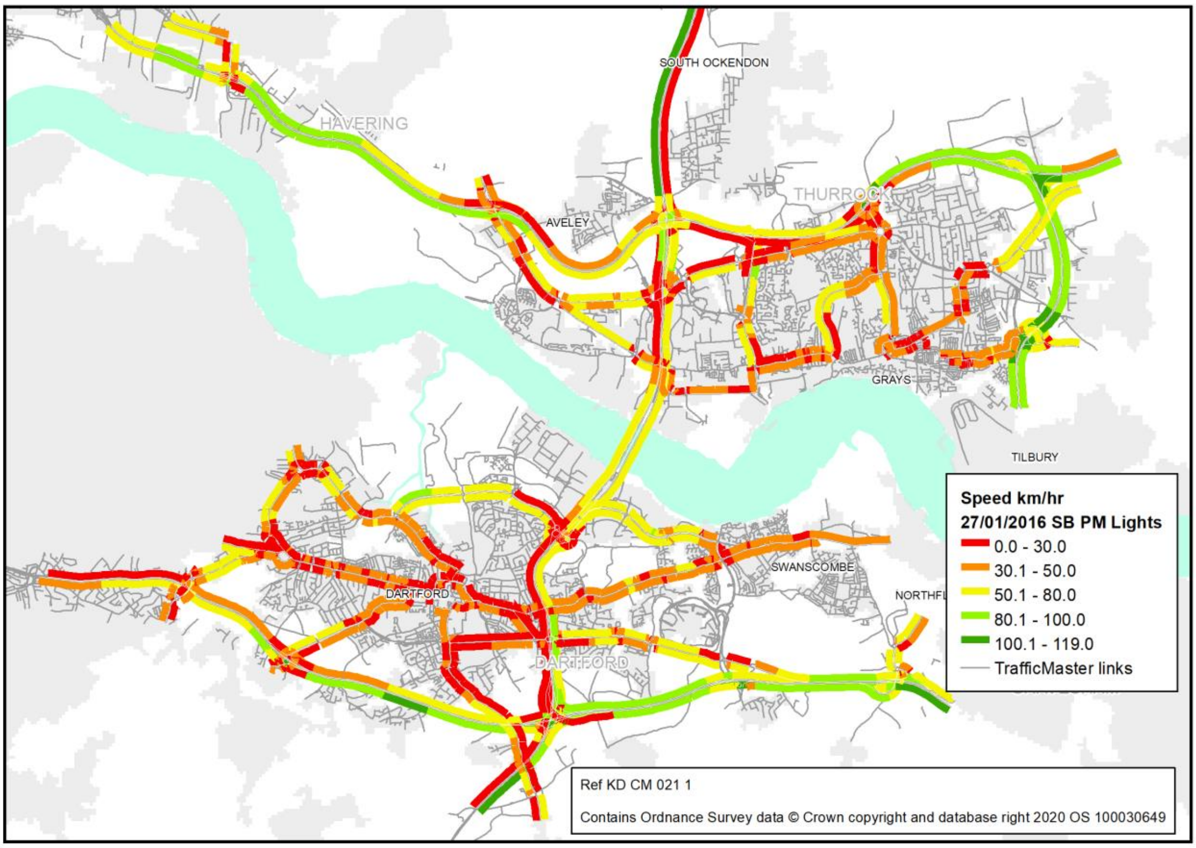
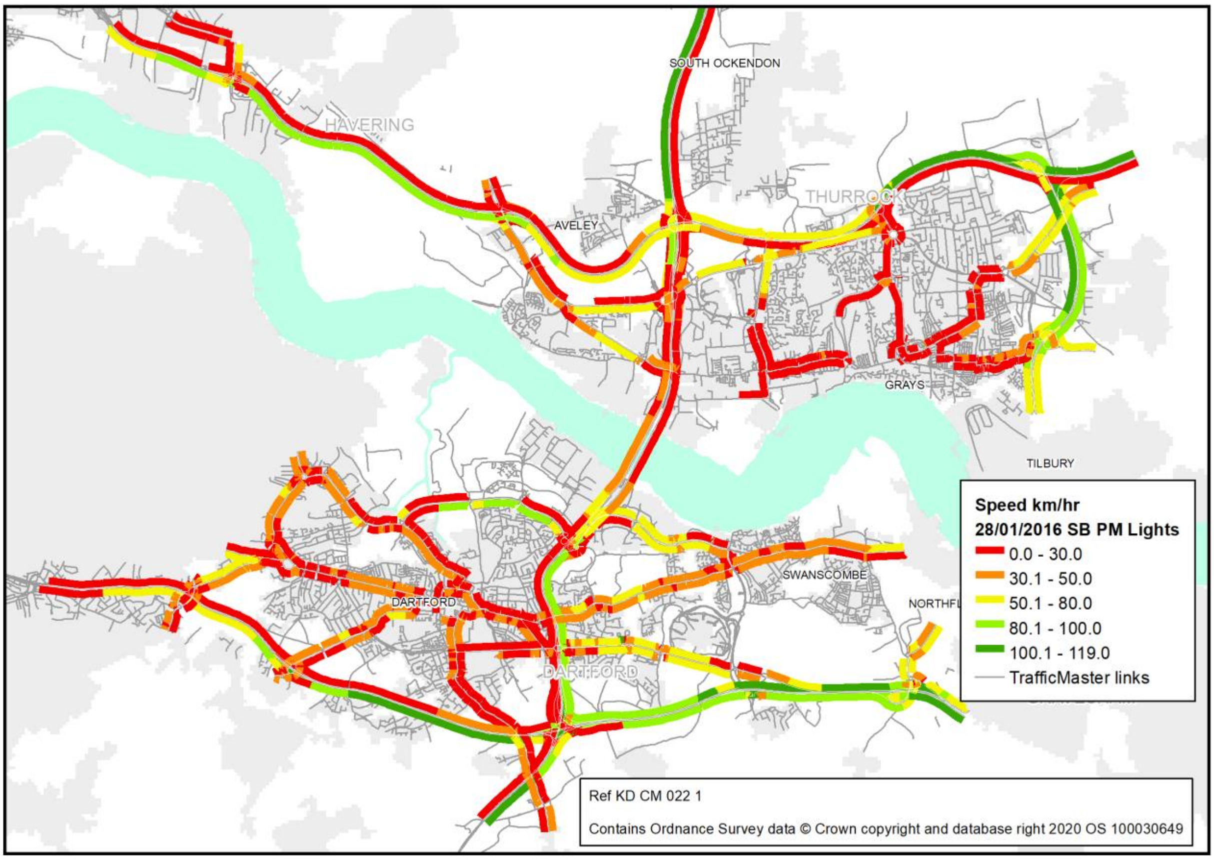


Plate 3.20 Average speeds, 28 January 2016, 17:00-18:00, with incident southbound



3.7 Impact on people

3.7.1 A major impact on the people using the Dartford Crossing is that the high traffic levels at the Dartford Crossing mean that their journeys take longer than they would otherwise expect. This is a loss of their time. The value of this lost time is the main component of the economic appraisal.

3.7.2 In addition, there is stress caused by the uncertainty over the actual length of delay that would be experienced on any particular trip.

3.7.3 For people living or working around the Dartford Crossing in Dartford and Thurrock, there is the nuisance value of their journeys being affected when there is an incident at the Dartford Crossing.

3.7.4 The high levels of traffic, combined with the close proximity of junctions and the movement of vehicles into their preferred lane when approaching the tunnels, contribute to a higher than average accident rate at the tunnels. Table 3.1 compares the number of Fatalities and Weighted Injuries (FWI) per billion vehicle miles to the national average for the Strategic Road Network (SRN) for the links approaching the tunnels and through the tunnels. The analysis is based on National Highways data for the five years from 2015 to 2019.

Table 3.1 Link safety in proximity to the Dartford Crossing

Section of M25/A282	FWI rate compared to SRN average
Junction 2 – junction 3	77% higher
Junction 1b – junction 2	305% higher
Junction 1a – junction 1b	230% higher
Junction 1a – junction 31 (Dartford Crossing)	62% higher
Junction 31 – junction 30	47% higher
Junction 30 – junction 29	40% lower

3.7.5 There is evidence that people choose not to work or seek employment on the other side of the Thames from their home. The 2011 census shows that the river causes a barrier to employment and people choose to work on the same side of the river. This limits their choice of jobs as effectively their search area for employment is reduced by the barrier created by the river.

3.7.6 The barrier effect of the river also extends to choices that people make about destinations for their non-work related trips.

3.8 Impact on the environment

3.8.1 The high levels of traffic and stop-start traffic on the approach to the tunnels contribute to the poor air quality in the area. There are four Air Quality Management Areas within Dartford, all of which are south of the Dartford crossing.

3.8.2 The congestion also means that the vehicles are burning more fuel than necessary which leads to the excess emission of greenhouse gases and wasteful use of carbon.

3.9 Impact on the economy

3.9.1 Businesses suffer as a result of the congestion at the Dartford Crossing in a number of ways. They are affected by the time wasted in slow-moving traffic at the Dartford Crossing. The variability in journey times leads to wasted time on occasions when travellers add in an allowance, to guard against being late for appointments, that is not required. For the logistics industry, the uncertainty over travel times hinders the efficiency of their just-in-time operations.

3.9.2 There is good evidence that businesses are more productive when they are clustered together and located close to similar businesses. This is known as agglomeration benefits. The congestion at the Dartford Crossing effectively separates businesses on each side of the river and reduces their productivity.

3.9.3 Business surveys have reported that the river reduces the size of the market available to businesses, with a reluctance to serve the opposite side of the river. Some companies have offices and depots on both sides of the river for this reason, which leads to inefficiencies and excess costs. These surveys are discussed in the Level 3 Wider Economics Impact Report, as part of Appendix D: Economic Appraisal Package (Application Document 7.7).

3.9.4 Owing to the reluctance of people to seek employment on the other side of the River Thames, businesses have a reduced number of potential candidates for their available jobs and so may not be recruiting the best suited staff to their vacant posts. This would lead to reduced productivity levels for businesses.

4 Data sources

4.1 Datasets

4.1.1 The transport model built to support the DCO application is called the Lower Thames Area Model (LTAM). The model covers the whole of England, Scotland and Wales in order to represent the full length of trips which might wish to use the Project or the Dartford Crossing.

4.1.2 The Lower Thames area is modelled in the greatest amount of detail. This is called the 'Fully Modelled Area' in the model. For this area, all vehicle trips are included, the junctions are coded, and each driver's journey time and route chosen depends on the number of other vehicles on the network.

4.1.3 This chapter sets out the data sources used in the production of LTAM and additional data collected for use in more local area analysis. Full details of the datasets are presented in Appendix A: Transport Data Package (Application Document 7.7).

4.1.4 The main datasets are as follows:

a. Traffic counts, used to calibrate the model and then in the model validation

b. Journey times from the Teletrac GPS system, again used in the model calibration and validation

c. Information on traffic flows at the Dartford Crossing from the Dart Charge system

d. Information on the start and finish locations of trips from anonymised mobile phone data, Teletrac GPS units in vans and from the Great Britain Freight Model for HGVs

e. Automatic Number Plate Recognition (ANPR) data in some local areas to look at routing of traffic

f. Video surveys to record queue lengths at some junctions

4.1.5 Other datasets collected for use in the transport modelling and appraisal were as follows:

a. Traffic signal data

b. Ordnance Survey Integrated Transport Network (ITN) network data

c. Accident data

d. Planning data

4.2 Traffic counts from existing sources

4.2.1 The information on the number of vehicles using the road network in 2016 (the base year of the transport model) was sourced from existing publicly available counts held by National Highways and DfT, counts provided by local authorities, counts carried out for other National Highways studies and new counts commissioned by National Highways for use in support of the Project.

4.2.2 Two different types of traffic counts have been used. Automatic Traffic Counts (ATCs) come from tubes laid down on the road surface or permanently laid into the road surface. They provide continuous counts but are poor at distinguishing the type of vehicle crossing the counter. When an ATC is set out on a temporary basis the counter is usually kept on the road for two weeks so that it can provide data on the daily variation in traffic levels. Permanent counters provide information on variation over the whole year and between years.

4.2.3 Classified link counts are carried out either in person on the day or by video which is reviewed later away from the site. Vehicles are categorised by eye into different vehicle types. A variation of this type of count is a classified junction count where the turning movement of a vehicle is recorded along with the vehicle type. These counts are usually only carried out for a single day and are often located at the site of ATCs, in order to supplement the latter with detailed information on vehicle type.

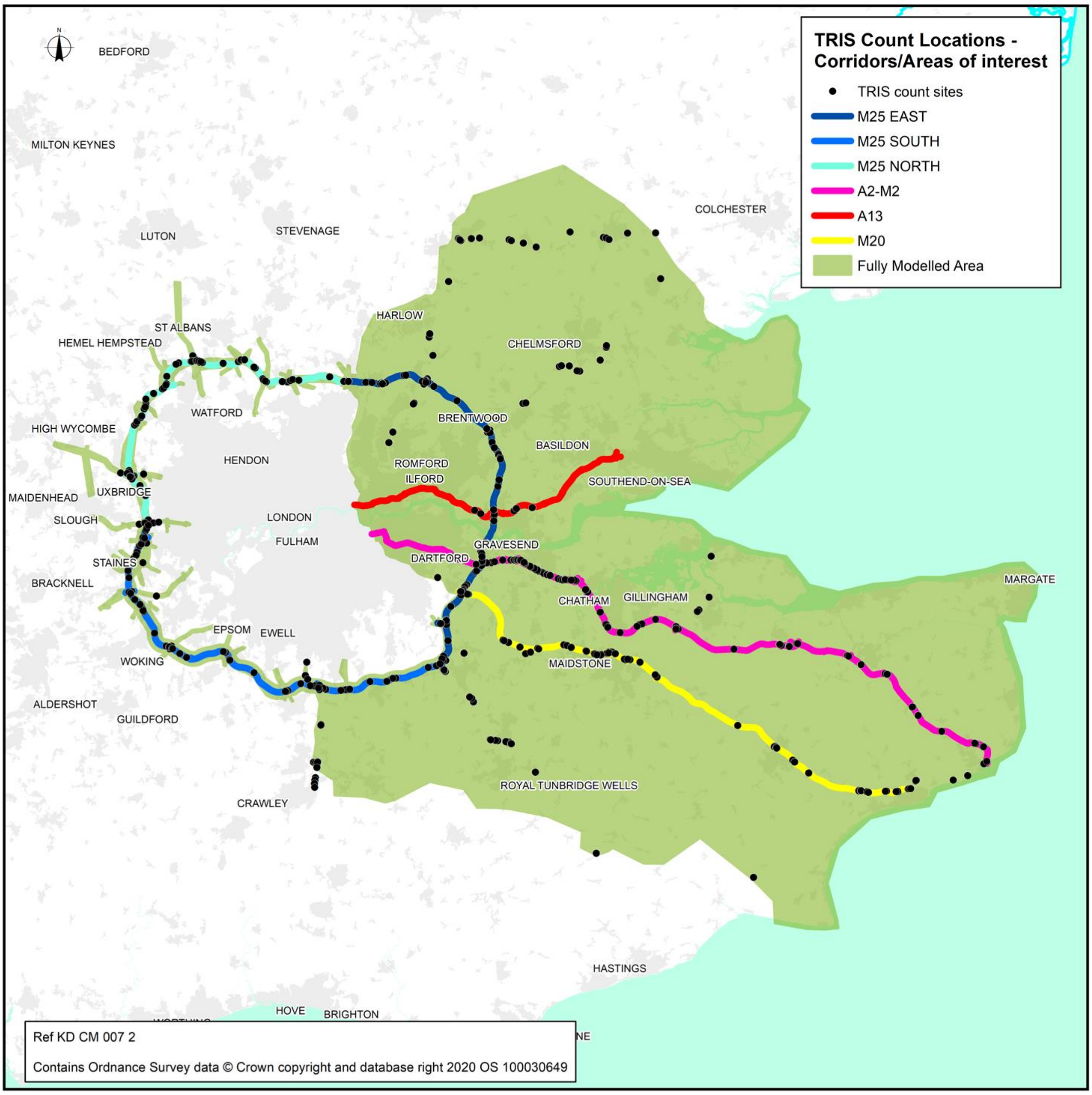
4.2.4 The source and locations of all the counts is described below. The count data from all sources used in support of the Project was cleaned, verified and stored in a counts database. More information on the methods used to check the data are provided in Appendix A: Transport Data Package (Application Document 7.7).

TRIS data

4.2.5 TRIS is a database of ATCs collected by National Highways on the SRN in England. The database records the number of vehicles at each site in 15-minute intervals. The vehicles are classified by vehicle length, with vehicles over 6.6m assumed to be HGVs.

4.2.6 The TRIS sites within the Fully Modelled Area, used in the model development, were included in the Project's count database. Plate 4.1 shows the extent of the Fully Modelled Area and the locations of the TRIS counts. More detailed information on the locations of the counts, including grid references, is given in Appendix A: Transport Data Package (Application Document 7.7).

Plate 4.1 TRIS count locations used in LTAM development



4.2.7 The main benefit of the TRIS data is that it is a continuous data set of ATCs. The development of the LTAM started in 2016, and an analysis of TRIS count data was carried out in order to select a typical month upon which to base the model. The data was used to produce factors that take account of seasonal variation in traffic levels to convert other traffic counts to the model's base month of March.

4.2.8 These seasonality factors are shown in Table 4.1. The factors were calculated for three main road corridors (A2/M2, A13 and M20), four quadrants of the M25 and for the remaining main roads in the area.

4.2.9 The appropriate adjustment factor was used to convert any counts taken in different months to a March level. Where values are over 1.00 in this table it shows that the traffic flows in that month are typically lower than in March, and where values are below 1.00 this shows that the traffic flows are higher in that month than in March.

Table 4.1 Seasonal factors compared to March

Month/Corridor	A2-M2	A13	M20	M25 east	M25 south	M25 north	M25 west	Other
January	1.05	1.00	1.10	1.07	1.08	1.06	1.07	1.07
February	1.00	1.01	1.01	1.01	1.01	0.99	1.00	1.00
March	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April	0.96	0.98	0.97	0.96	0.97	0.96	0.96	0.96
May	0.99	1.02	0.97	0.99	0.98	0.96	0.98	0.97
June	0.96	0.97	0.93	0.94	0.95	0.95	0.95	0.95
July	0.93	0.93	0.90	0.93	0.94	0.92	0.93	0.93
August	0.94	0.96	0.93	0.94	0.95	0.94	0.94	0.94
September	0.95	0.92	0.95	0.95	0.95	0.94	0.95	0.95
October	0.95	0.89	0.96	0.96	0.96	0.95	0.96	0.95
November	0.96	0.89	0.98	0.99	1.00	0.98	0.99	0.98
December	1.01	0.95	1.05	1.01	1.05	1.04	1.04	1.03

4.2.10 When developing the model, some counts, such as classified link counts, were available from previous years. These were adjusted to 2016 traffic levels using annual adjustment factors derived from the TRIS count dataset. These factors are shown in Table 4.2.

4.2.11 The factors were derived for the same areas as the seasonal adjustment factors. Again, a factor of, for example, 1.09 for the A13 in 2013 implies that traffic levels in 2016 were in general 9% higher in 2016 than in 2013. Further refinement of the counts is made in the model calibration process described in Chapter 5 of this report.

Table 4.2 Annual adjustment factors compared to 2016

Year/Corridor	A2-M2	A13	M20	M25 east	M25 south	M25 north	M25 west	Other
2013	1.10	1.09	1.06	1.11	1.03	1.12	1.08	1.09
2014	1.06	1.06	1.03	1.10	1.02	1.08	1.06	1.06
2015	0.99	1.01	1.03	1.00	1.01	1.01	1.01	1.01
2016	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

DfT traffic count database

4.2.12 DfT commissions manual classified link counts each year and publishes the data on its website (DfT, 2020f). The dataset has a traffic count for every junction-to-junction link on the A-road and motorway network in Great Britain. The data gives an hourly traffic flow from 07:00 to 19:00 for each direction on the link by vehicle type. Data collected in 2014, 2015 and 2016 was used in the development of the LTAM.

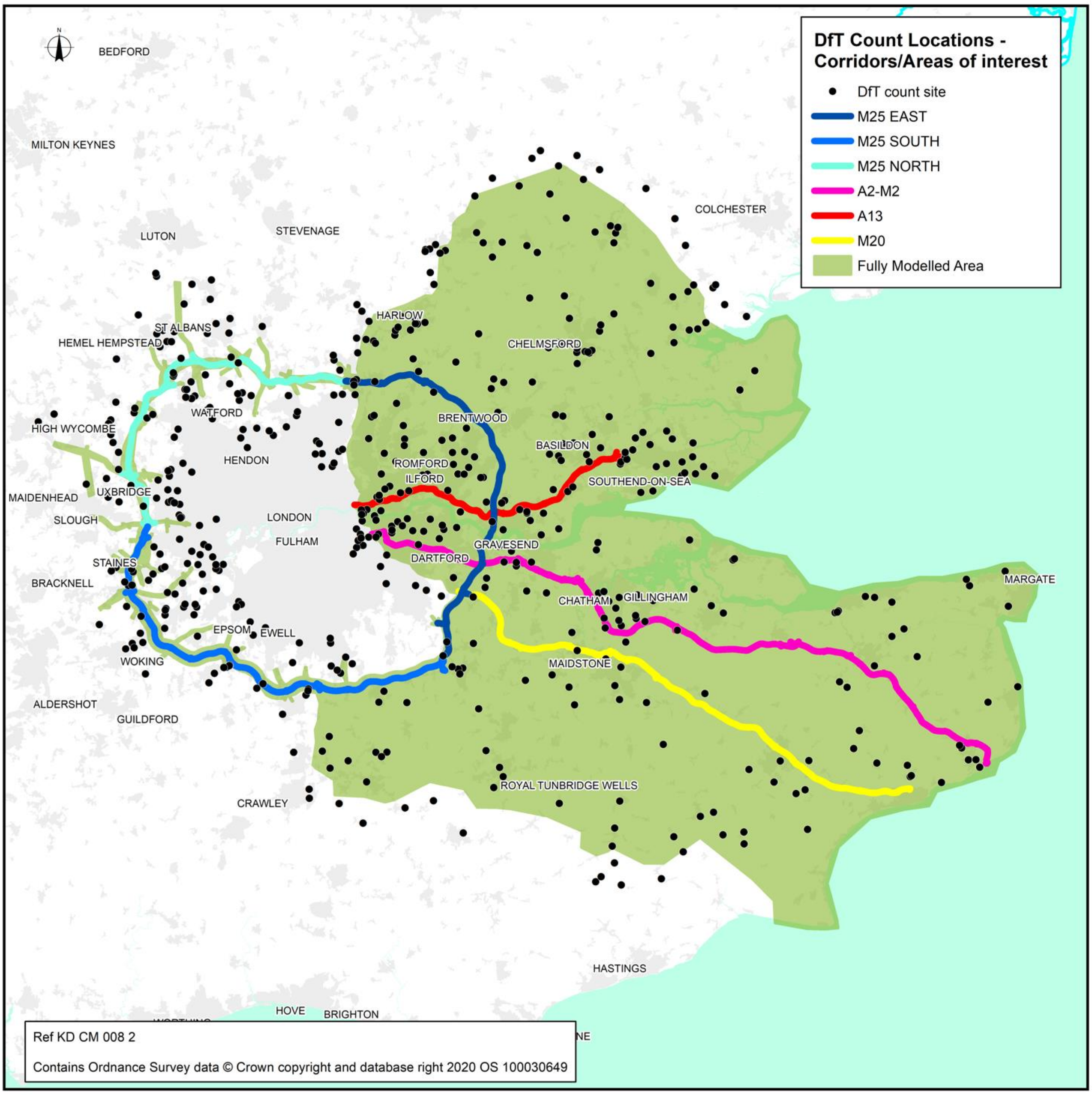
4.2.13 The benefit of this data is that the count data is provided by vehicle type, so the split of traffic between cars, LGVs and HGVs can be derived. This data was used to generate vehicle type percentages for each corridor/region/area of interest in the LTAM by road type.

4.2.14 The LTAM divides vehicles into cars, LGVs and HGVs because the drivers of these vehicles have different preferences between the time and cost of alternative routes when choosing which route to take. For example, HGVs typically prefer using main roads and shorter routes. As the transport model is used to predict which routes traffic would take in the future if the Project were built, the quality of the traffic forecasts is improved by taking account of these differences in the model.

4.2.15 The vehicle type split calculated from DfT count data is applied to the total number of vehicles collected at sites where only an ATC was available, in order to subdivide that count into the vehicle categories used in the LTAM.

4.2.16 The locations of DfT counts used in the development of the LTAM are shown in Plate 4.2.

Plate 4.2 DfT count locations used in LTAM development



4.2.17 The vehicle type percentages calculated by time period for the main corridors are presented in Table 4.3.

Table 4.3 Vehicle composition of traffic flow

Road type	Corridor/county/area of interest	AM Car	AM LGV	AM HGV	IP Car	IP LGV	IP HGV	PM Car	PM LGV	PM HGV
M	A2-M2	71%	20%	8%	68%	17%	15%	80%	15%	6%
M	M20	70%	20%	10%	67%	17%	16%	77%	15%	8%
M	M25_East	64%	21%	14%	63%	17%	20%	74%	15%	11%
M	M25_South	74%	18%	8%	71%	16%	13%	80%	14%	6%
M	M25_North	70%	18%	12%	68%	16%	15%	80%	12%	7%
M	M25	70%	19%	11%	68%	17%	15%	78%	14%	8%
M	Other	71%	19%	10%	69%	17%	15%	79%	14%	7%
A	Buckinghamshire	79%	15%	6%	75%	16%	10%	87%	10%	3%
A	East Sussex	77%	19%	4%	77%	16%	7%	86%	12%	2%
A	Essex	74%	20%	6%	73%	18%	9%	83%	14%	3%
A	Hertfordshire	77%	18%	5%	75%	17%	8%	86%	12%	2%
A	Kent	76%	19%	5%	76%	17%	8%	84%	13%	3%
A	Medway	79%	17%	4%	79%	15%	5%	86%	12%	2%
A	Southend-on-Sea	77%	18%	5%	76%	18%	7%	86%	13%	2%
A	Surrey	79%	17%	4%	78%	16%	6%	88%	11%	2%
A	Thurrock	71%	20%	10%	67%	18%	15%	79%	16%	5%
A	West Sussex	78%	17%	5%	76%	17%	7%	86%	12%	2%
A	Greater London (East)	71%	21%	8%	70%	19%	12%	82%	14%	4%
A	Greater London (South)	78%	18%	5%	75%	18%	7%	85%	12%	3%
A	Greater London (North)	68%	22%	10%	68%	19%	13%	78%	14%	8%
A	Greater London	72%	20%	8%	70%	18%	11%	82%	14%	4%

Road type	Corridor/county/area of interest	AM Car	AM LGV	AM HGV	IP Car	IP LGV	IP HGV	PM Car	PM LGV	PM HGV
B	Buckinghamshire	83%	14%	3%	83%	13%	3%	91%	8%	1%
B	East Sussex	75%	21%	4%	80%	16%	4%	87%	11%	2%
B	Essex	79%	18%	3%	80%	15%	5%	86%	13%	1%
B	Hertfordshire	77%	18%	5%	77%	15%	8%	84%	13%	3%
B	Kent	80%	17%	3%	82%	14%	4%	87%	11%	2%
B	Medway	84%	14%	2%	81%	15%	5%	88%	10%	1%
B	Southend-on-Sea	82%	16%	2%	83%	15%	2%	90%	10%	0%
B	Surrey	83%	14%	2%	81%	15%	4%	89%	10%	1%
B	Thurrock	75%	19%	6%	86%	10%	4%	90%	8%	2%
B	West Sussex	76%	21%	3%	76%	20%	4%	89%	10%	1%
B	Greater London (East)	79%	14%	6%	81%	13%	6%	87%	10%	3%
B	Greater London (South)	82%	16%	2%	81%	16%	3%	90%	9%	1%
B	Greater London (North)	84%	13%	3%	82%	13%	5%	90%	8%	1%
B	Greater London	82%	14%	4%	81%	14%	5%	89%	9%	2%
Minor	Buckinghamshire	86%	12%	2%	85%	13%	3%	89%	10%	1%
Minor	East Sussex	77%	21%	2%	80%	17%	3%	85%	14%	1%
Minor	Essex	81%	16%	3%	81%	15%	4%	87%	12%	1%
Minor	Hertfordshire	83%	15%	2%	82%	14%	3%	89%	10%	1%
Minor	Kent	81%	16%	2%	82%	15%	3%	87%	12%	1%
Minor	Medway	83%	14%	3%	85%	13%	3%	88%	10%	1%
Minor	Southend-on-Sea	83%	15%	1%	86%	12%	1%	90%	10%	0%
Minor	Surrey	82%	15%	3%	83%	14%	3%	90%	9%	1%

Road type	Corridor/county/area of interest	AM Car	AM LGV	AM HGV	IP Car	IP LGV	IP HGV	PM Car	PM LGV	PM HGV
Minor	Thurrock	74%	17%	9%	71%	16%	13%	81%	11%	8%
Minor	West Sussex	86%	13%	1%	87%	12%	1%	91%	9%	0%
Minor	Greater London (East)	81%	14%	4%	81%	13%	6%	88%	10%	2%
Minor	Greater London (South)	77%	13%	10%	67%	18%	14%	77%	13%	10%
Minor	Greater London (North)	84%	13%	2%	81%	15%	4%	88%	10%	2%
Minor	Greater London	81%	14%	5%	78%	15%	7%	86%	11%	4%

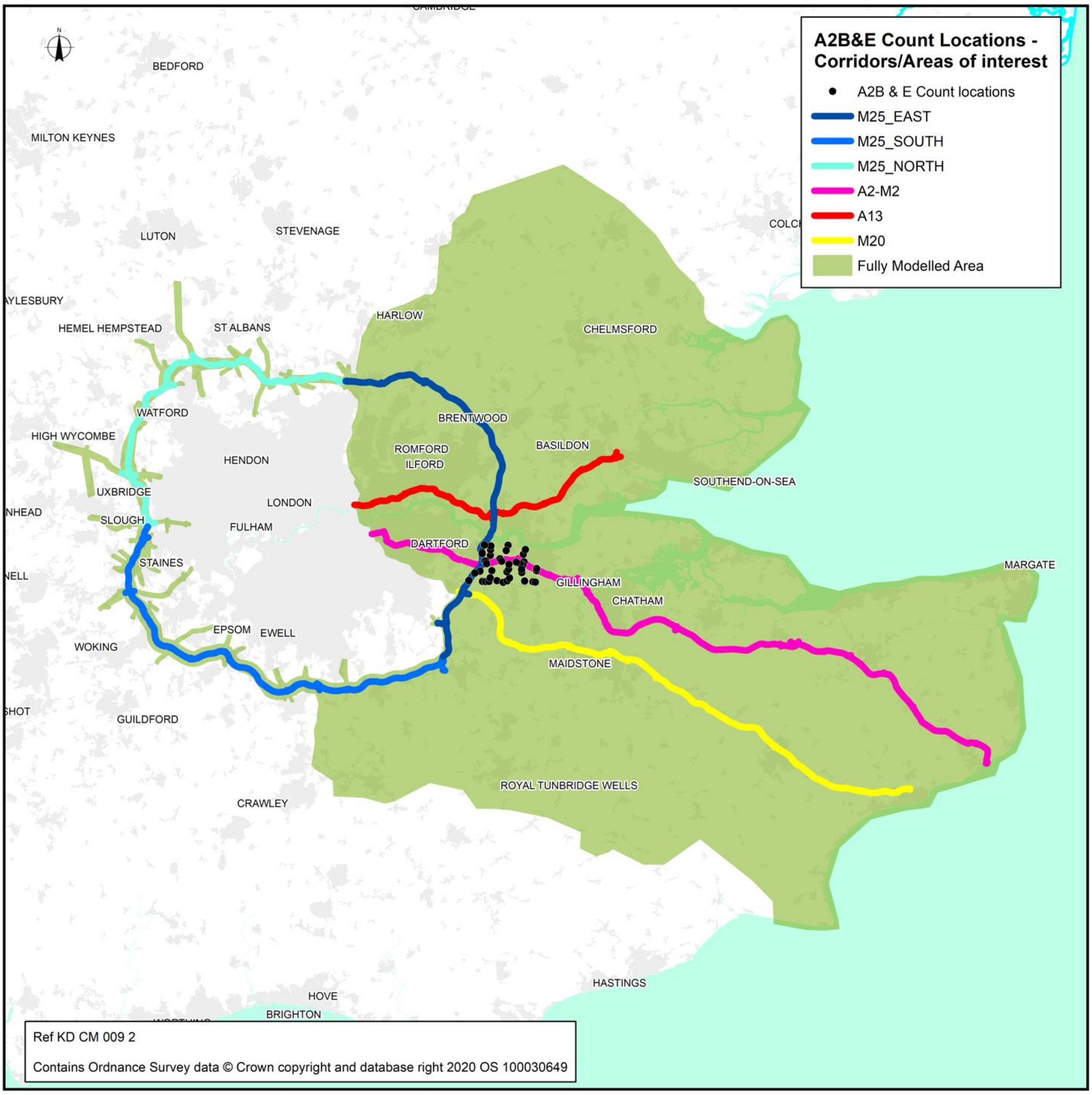
Counts from other National Highways studies

4.2.18 National Highways had some recent traffic counts available in the area which had been collected for other studies. These were also used in the development of the LTAM.

A2 Bean/Ebbsfleet study

4.2.19 National Highways has plans, now approved, for changes to the A2 Bean and Ebbsfleet junctions. As part of the design work at these junctions, traffic count data was collected from automatic traffic counters for two weeks in June 2014 in the local area near the A2 Bean and Ebbsfleet junctions together with some manual one-day classified link and junction counts. The locations of these counts are shown in Plate 4.3.

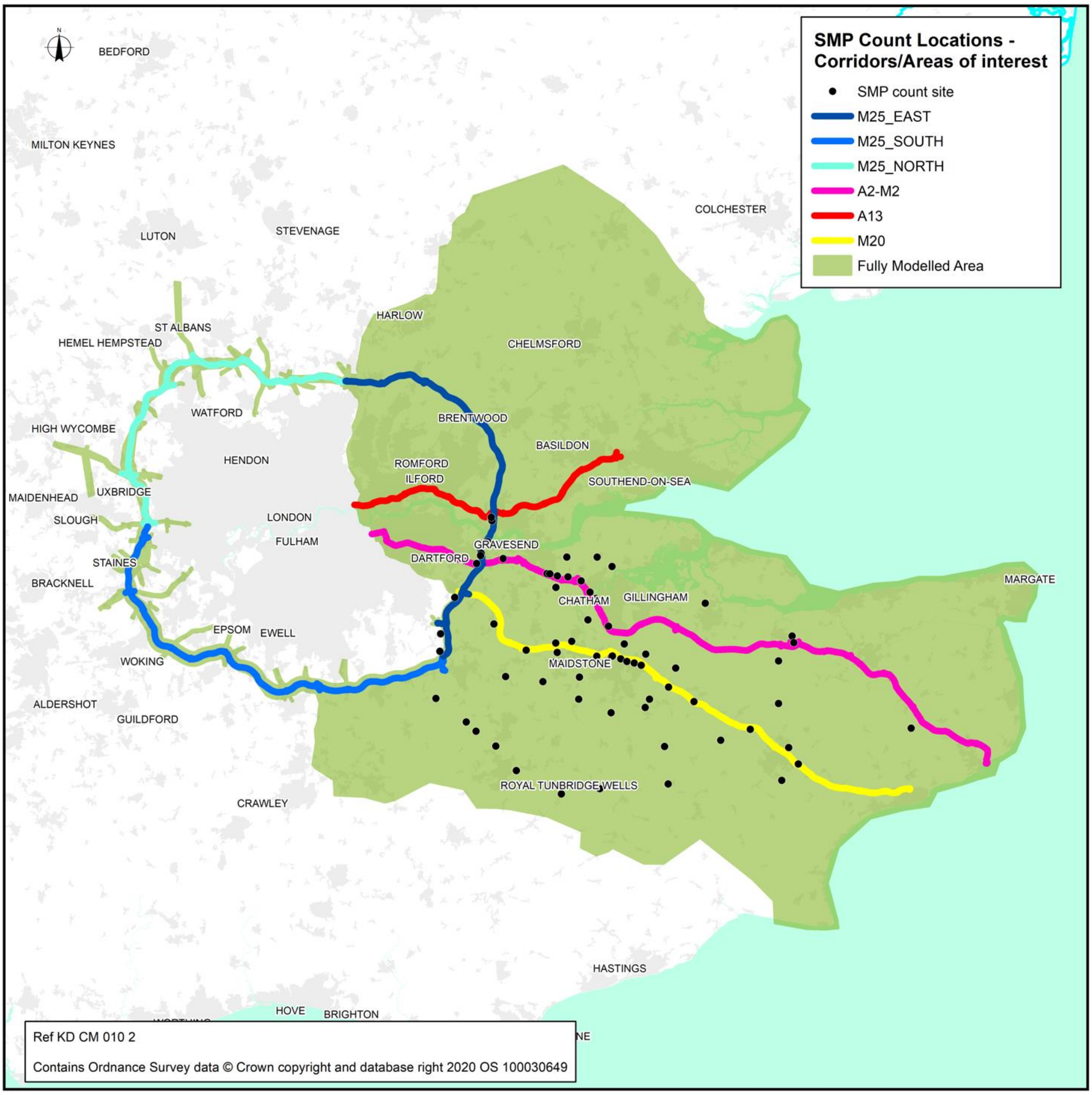
Plate 4.3 A2 Bean/Ebbsfleet count locations used in LTAM development



M20 Smart Motorways Programme

4.2.20 A series of ATCs and classified link counts were also carried out in May/June 2015 for use in a National Highways study for a Smart Motorway on the M20 between junctions 3 and 5. Plate 4.4 shows the locations of these sites. Again, full details of these sites, including their precise locations, are included in Appendix A of this report.

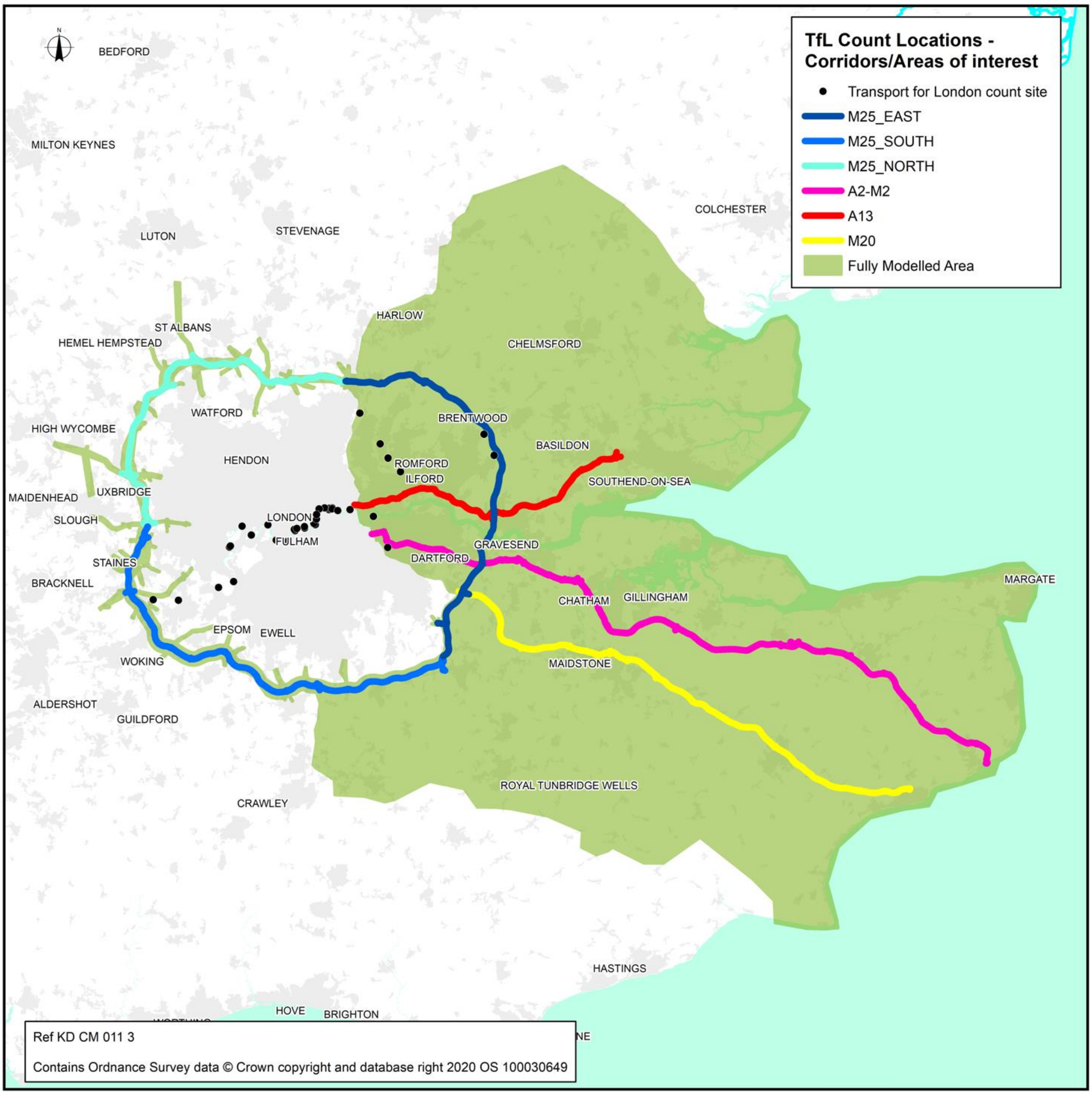
Plate 4.4 M20 count locations used in LTAM development



Transport for London (TfL) count database

4.2.21 TfL maintains a large database of traffic counts collected throughout London and provided access to these counts for use in the development of the LTAM. Plate 4.5 shows the locations of the TfL counts used in the development of the LTAM.

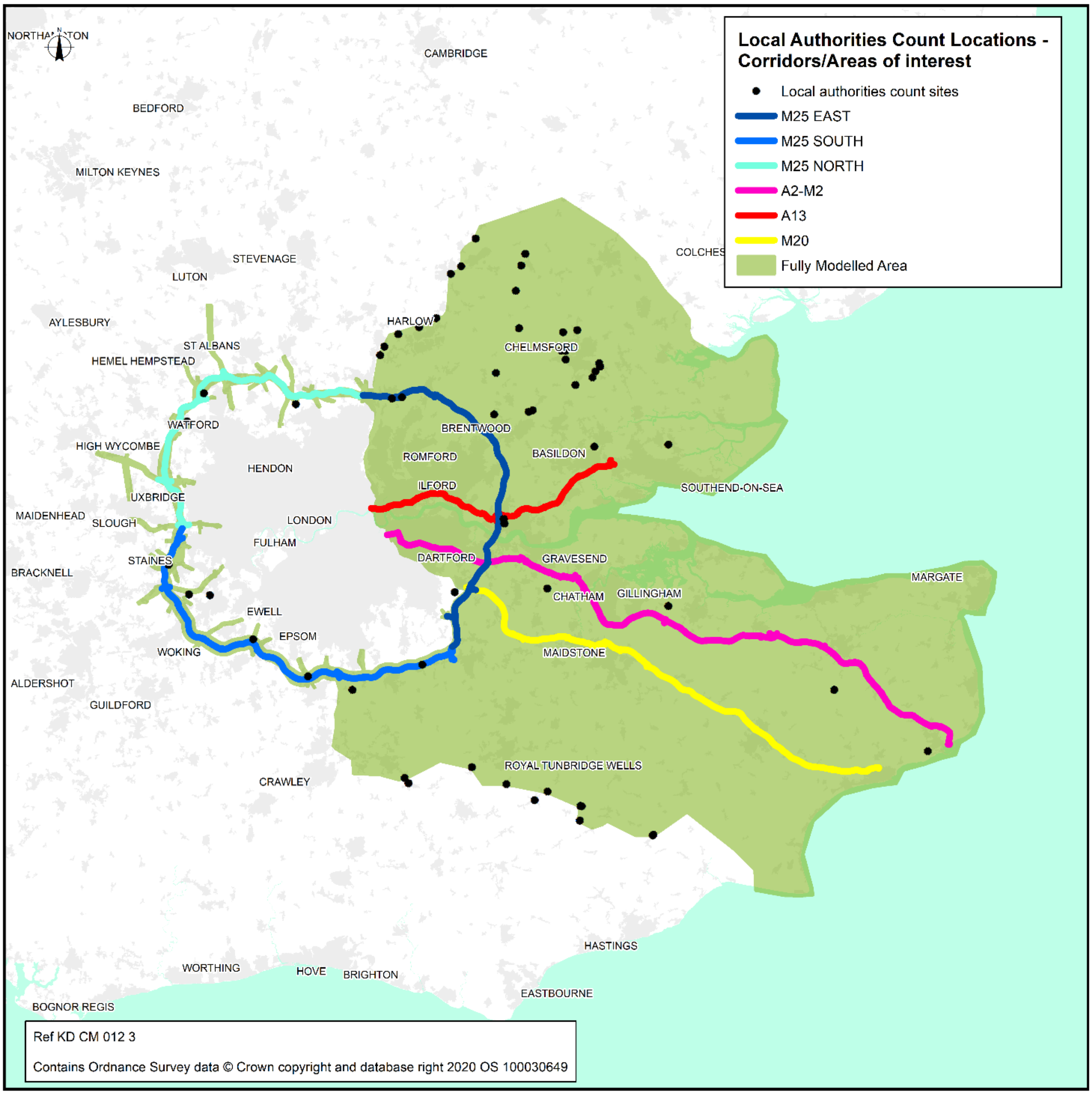
Plate 4.5 TfL count locations used in LTAM development



Local highway authority count data

4.2.22 Local authorities collect traffic count data in their areas, and they were contacted in order to identify any relevant data that they might hold. Traffic count data was provided by local highway authorities in the area. The locations of these counts used in the development of the LTAM are shown in Plate 4.6.

Plate 4.6 Local authority count locations used in LTAM development

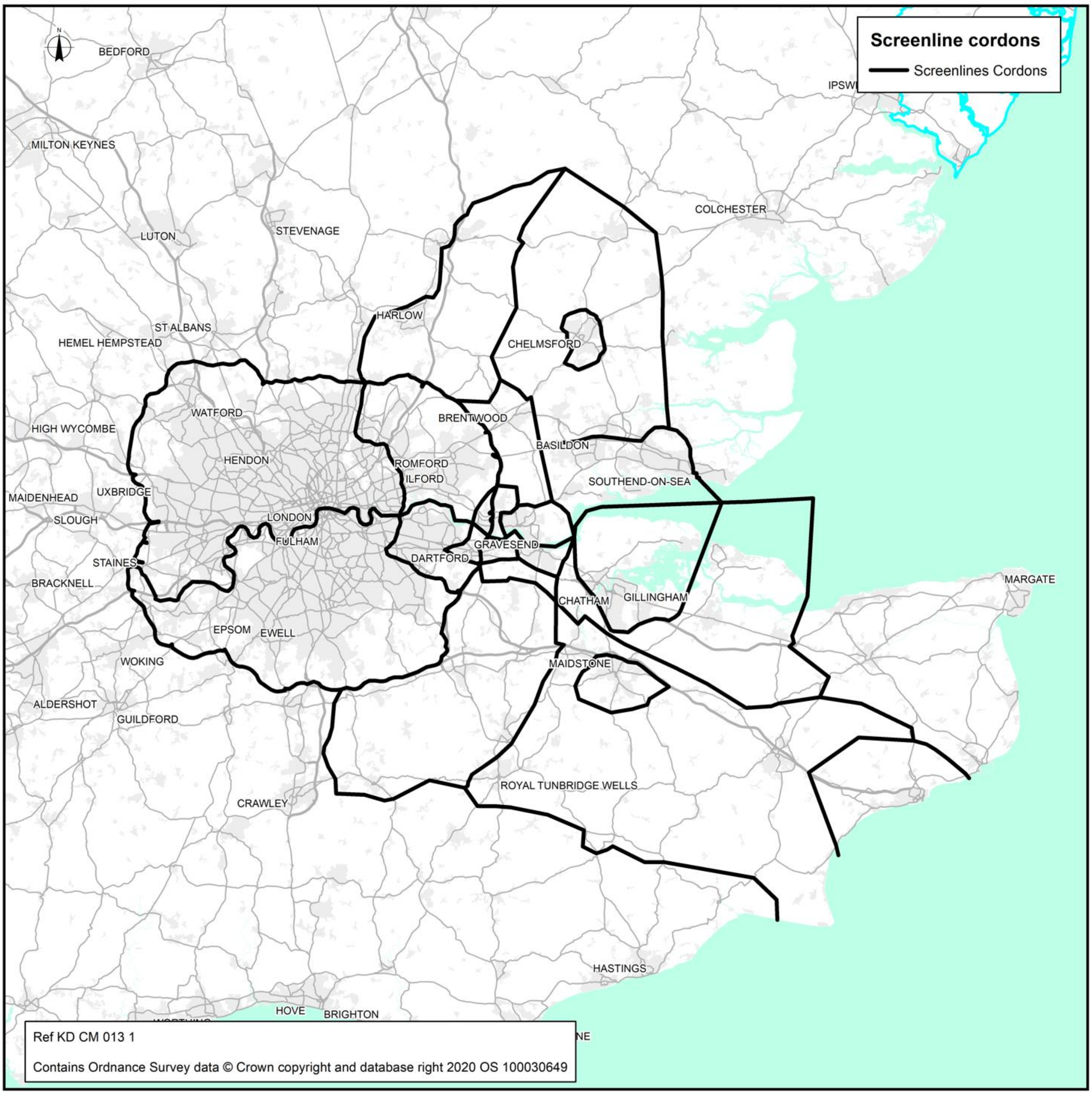


Traffic counts commissioned by the Project in 2016

4.2.23 During the calibration of the transport model, the number of trips is scaled to match the observed number of trips recorded in the traffic counts. Particular care was taken to match the total number of trips crossing over screenlines and entering/leaving a cordon. The locations of the screenlines and cordons used in the LTAM are shown in Plate 4.7.

4.2.24 In order for the comparison of modelled and observed counts to be useful, counts are needed on all the main links crossing a screenline or cordon. Additional counts were commissioned to supplement the data already available, in order to ensure that a complete set of counts for the screenlines and cordons was available for the model development.

Plate 4.7 LTAM screenlines and cordons



4.2.25 In total, ATCs were collected at an additional 175 locations and classified link counts at 33 locations. These sites are shown in Plate 4.8 and Plate 4.9.

4.2.26 The traffic surveys were undertaken in October and November 2016, avoiding the school holidays. The ATC data was collected for at least seven days, but for most sites data was successfully collected for 14 days. The vehicle counts were recorded in 15-minute intervals.

4.2.27 The classified link data was collected by video camera for a 14-hour period on a midweek day (a Tuesday, Wednesday or Thursday) during the ATC data collection period.

Plate 4.8 LTAM ATC data collection points, 2016

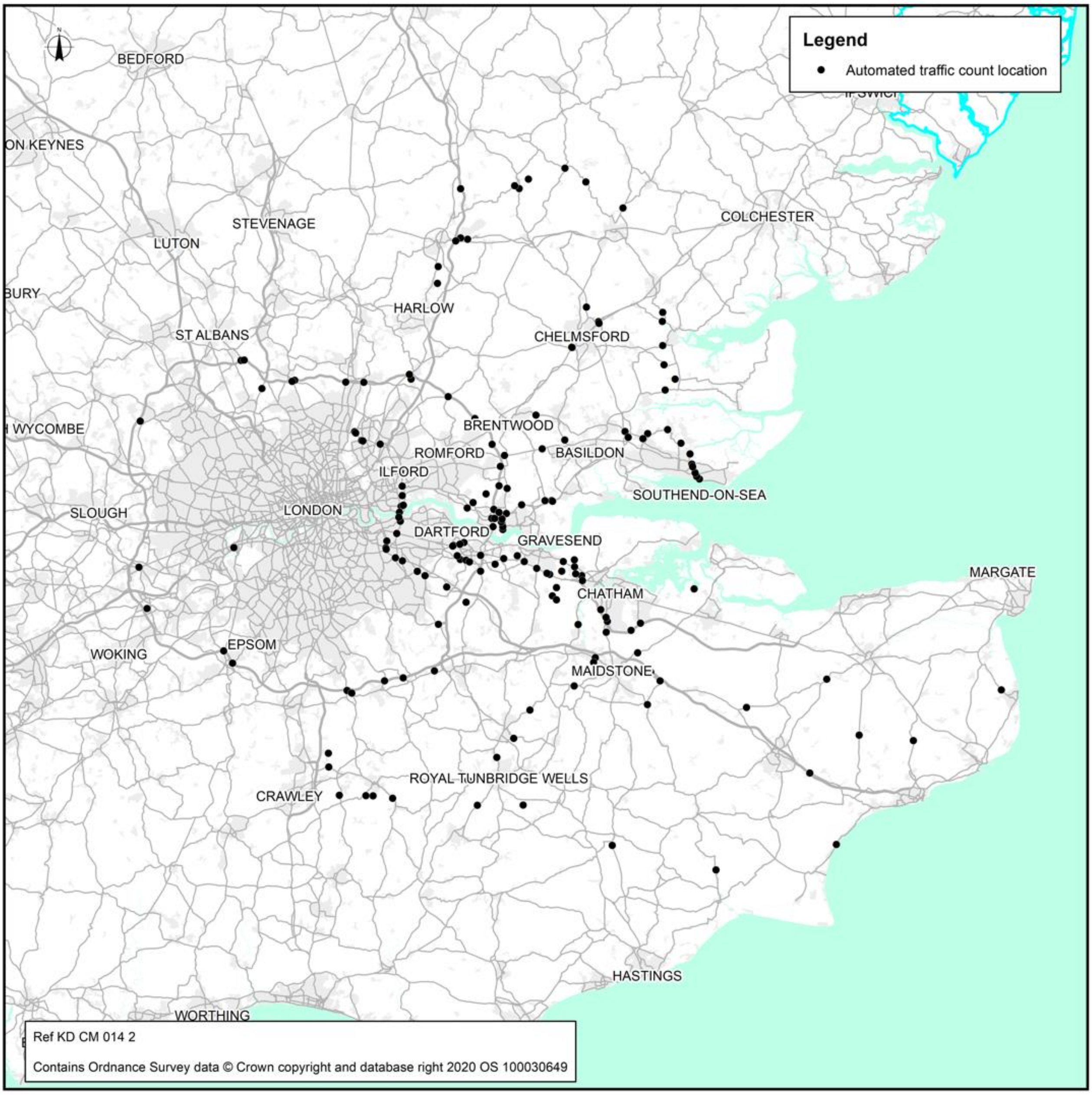
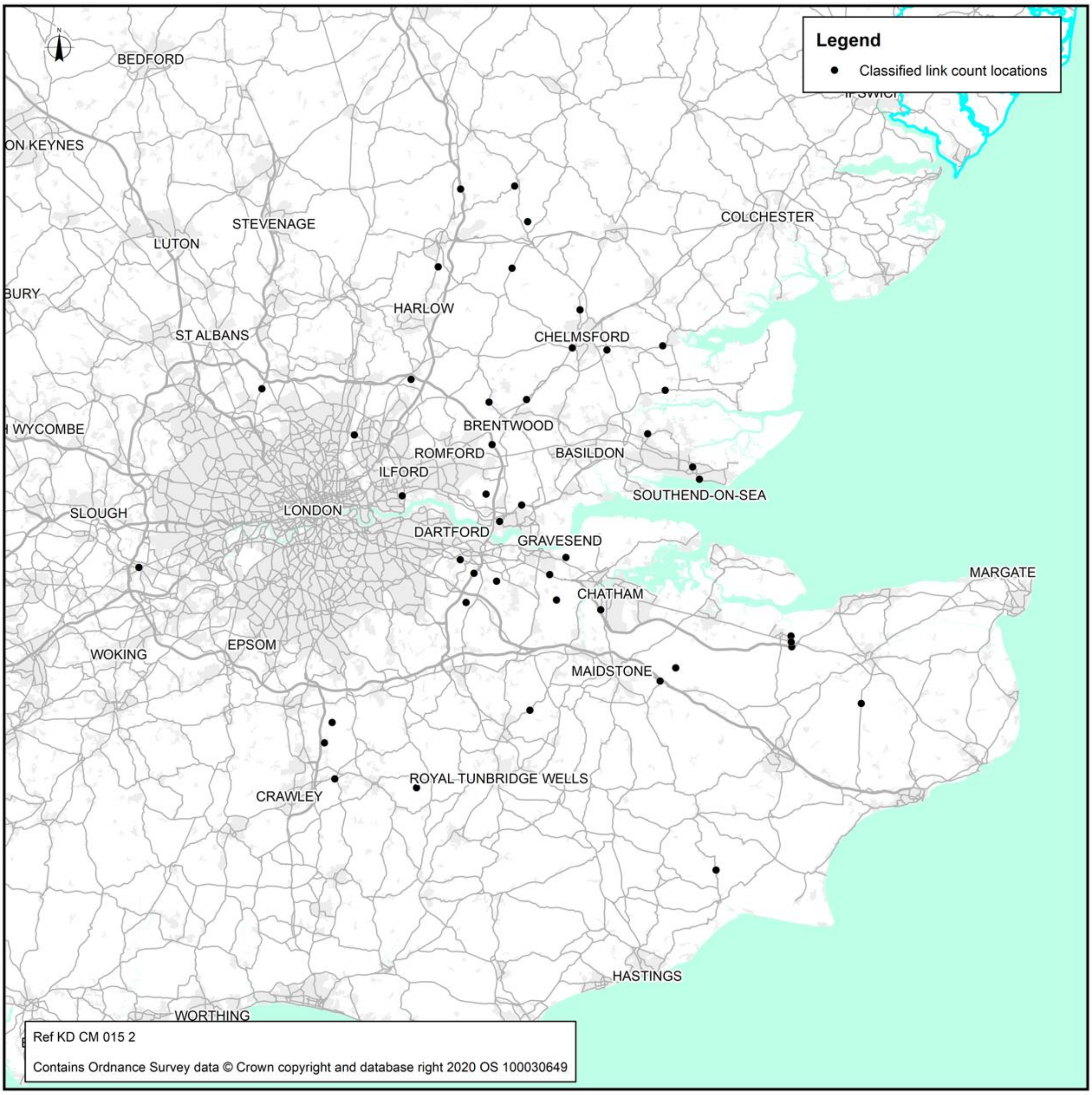


Plate 4.9 LTAM classified link count data collection points, 2016

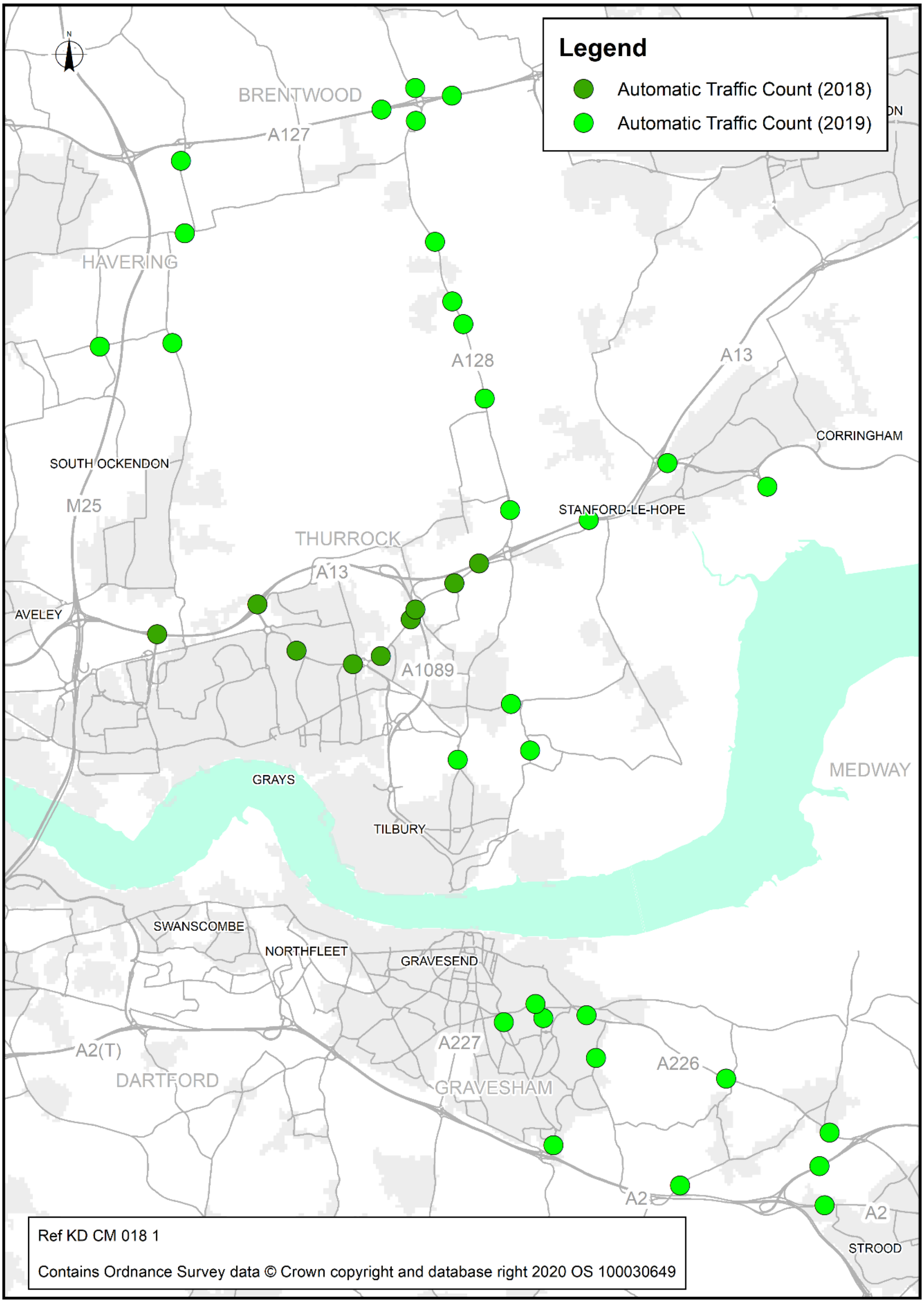


Counts commissioned by the Project in 2018 and 2019

4.2.28 During the design process for the Project and the investigation of possible routes for construction traffic, a series of additional traffic counts were carried out in October 2018 and May/June 2019. These counts were not included in the LTAM, as it was built to represent the network and traffic patterns as it was in March 2016. For more information, see the Appendix A: Transport Data Package (Application Document 7.7).

4.2.29 Plate 4.10 shows the locations of ATCs collected in 2018 and 2019.

Plate 4.10 Locations of ATC sites, 2018 and 2019

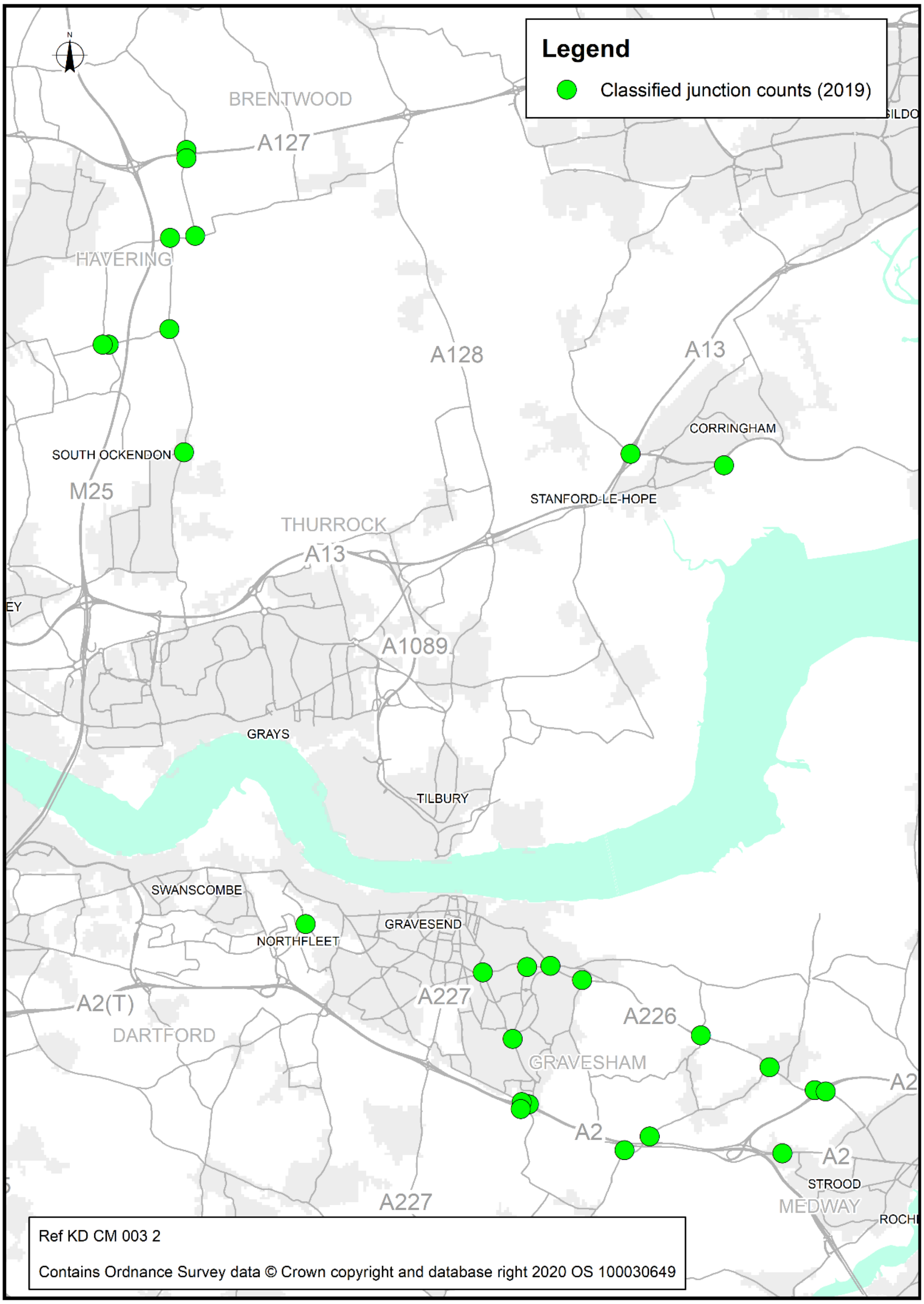


4.2.30 Classified link counts were also collected in October 2018. The locations of these counts are shown in Plate 4.11.

4.2.31 Classified junction counts were carried out in May/June 2019. The locations of these counts are shown in Plate 4.12.

Plate 4.11 Classified link count sites 2018

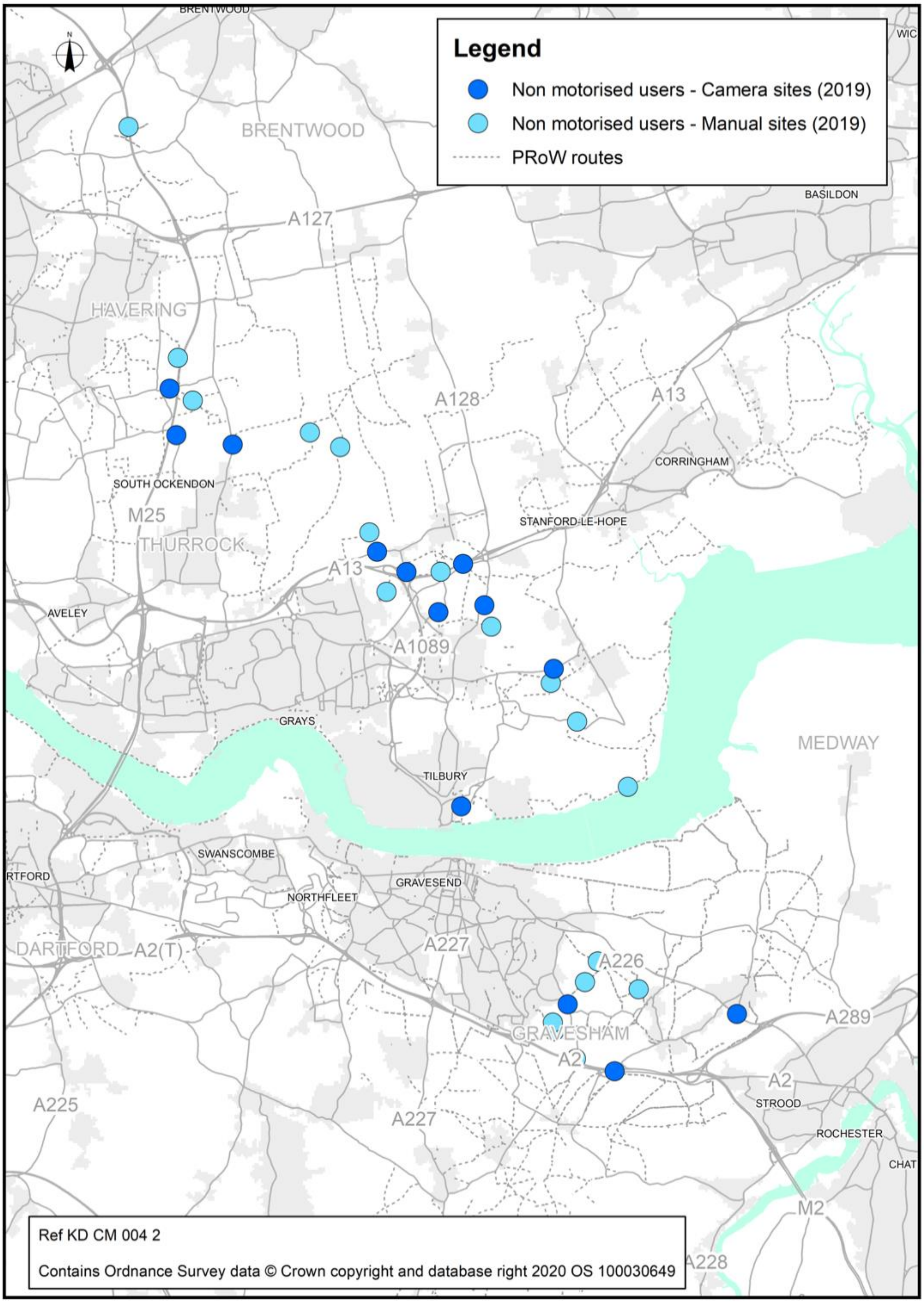
Plate 4.12 Classified junction count sites 2019



Pedestrian and cycle counts

4.2.32 Counts were taken at a selection of footpaths and bridleways in 2019. The locations of these counts are shown in Plate 4.13.

Plate 4.13 Locations of pedestrian and cycle counts



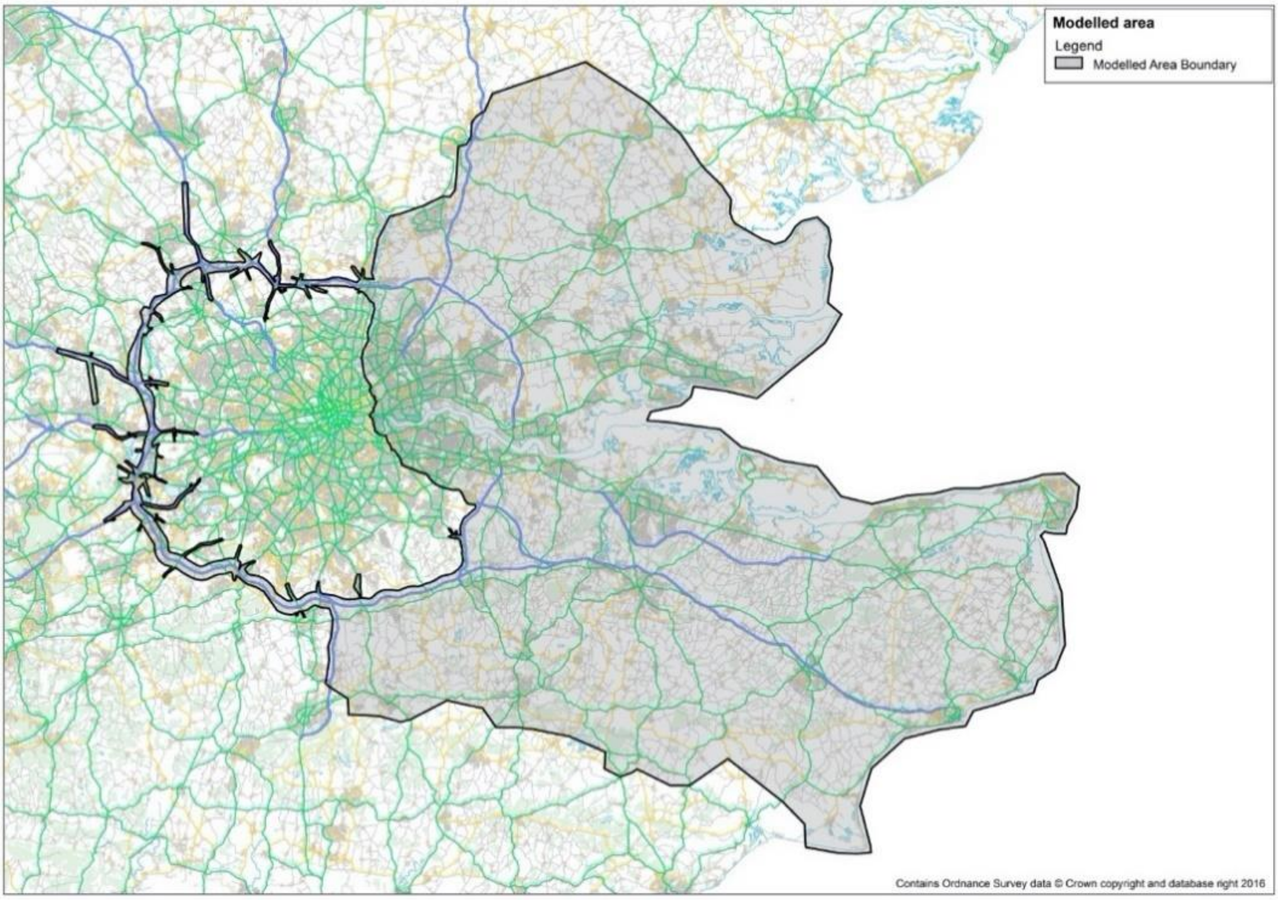
4.3 Journey time data

Teletrac journey time database

4.3.1 Journey time data from vehicles equipped with precision Teletrac GPS units supplied by Teletrac is now widely used when developing transport models. The data is collected via GPS devices installed in vehicles that record the time taken for the vehicle to travel along individual roads and matched to individual links in the digital Ordnance Survey ITN. The Teletrac units are fitted to approximately 100,000 vehicles in the UK. The data is used by DfT in the production of their congestion statistics and is made available to consultants working on government-funded projects.

4.3.2 For use in developing the LTAM, Teletrac GPS data for March 2016 was used for the area shown in Plate 4.14.

Plate 4.14 Teletrac data area used in LTAM



4.3.3 In the Teletrac data, vehicle times are recorded in time periods of 15-minute intervals. The data provides the average journey time, for each link, within each 15-minute interval, by vehicle type. The ITN network contains the exact length of each link, so when matched with the GPS observed times it is possible to calculate observed vehicle speeds.

4.3.4 The Teletrac data was used to derive the journey times along a set of routes. These routes are shown in Plate 4.15. During the model calibration the modelled times along these routes were compared to the observed times from the Teletrac data.

4.3.5 The median journey times along each of the component links were summed to provide the total journey time, by direction, along each route. The times were compiled for each of the three model time periods and for car/light vehicles and HGVs separately.

4.3.6 More information on these journey times is provided in Appendix B: Transport Model Package (Application Document 7.7), but the journey times for the morning peak hour, between 07:00 and 08:00, are presented in Table 4.4 to illustrate the data available. The dataset clearly shows how travel times are longer for HGVs than cars and that trips towards central London have a lower average speed than trips leaving London in the morning peak.

Plate 4.15 LTAM journey time routes

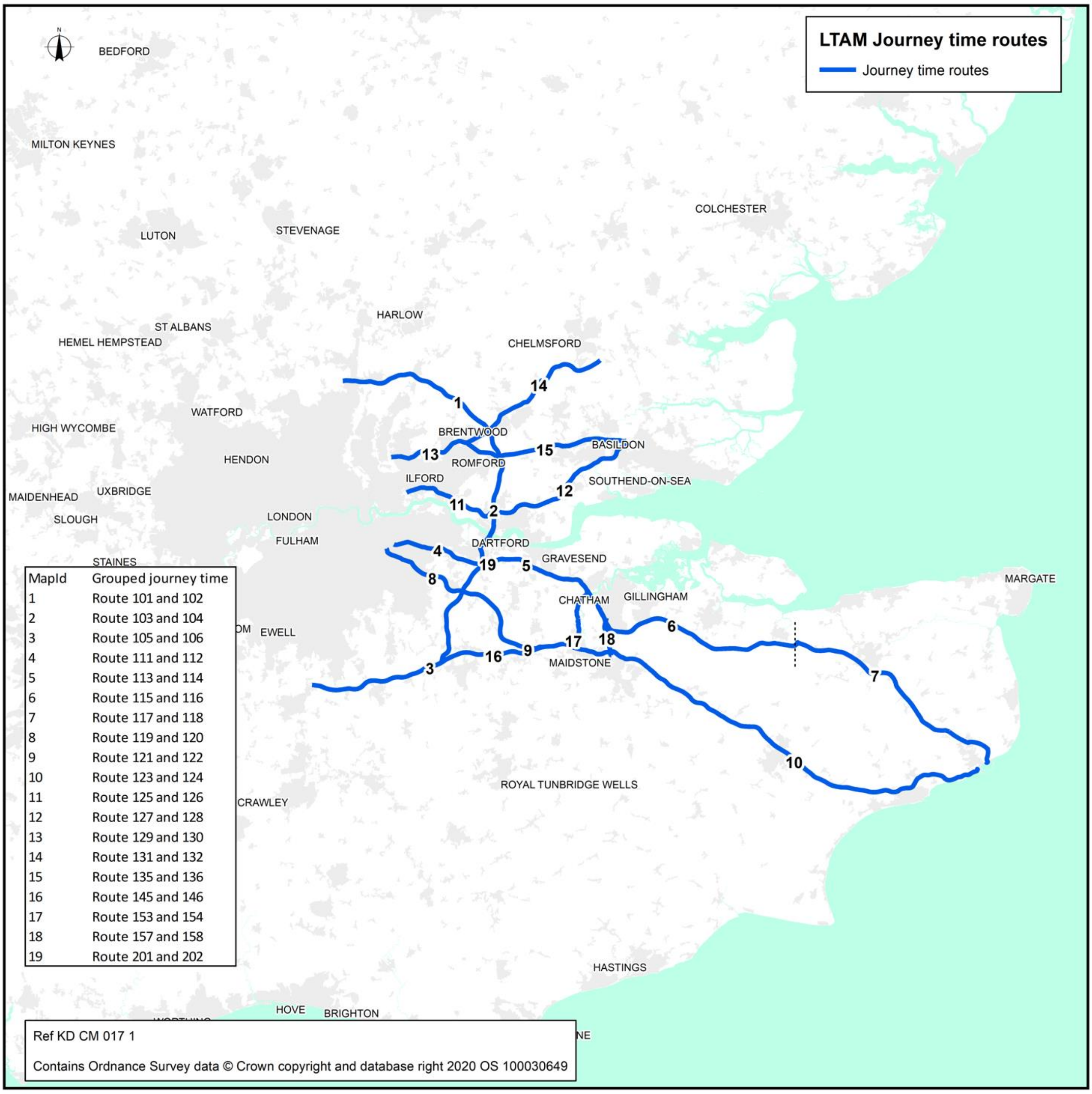


Table 4.4 Median journey time route statistics by vehicle class (AM peak)

Route number	Route description	AM			
		Light		Heavy	
		Median time (mins)	Speed (km/h)	Median time (mins)	Speed (km/h)
Route 101	M25 junction 25 - junction 30 CW	22.55	102.57	26.56	87.07
Route 102	M25 junction 30 - junction 25 ACW	26.37	87.44	29.79	77.41
Route 103	M25 junction 30 - junction 2 CW (A282)	7.26	78.63	7.75	73.59
Route 104	M25 junction 2 - junction 30 ACW (A282)	8.47	67.18	8.91	63.83
Route 105	M25 junction 2 - junction 7 CW	32.42	70.09	36.44	62.36
Route 106	M25 junction 7 - junction 2 ACW	21.26	107.48	26.24	87.08
Route 111	A2 South Circular - M25 junction EB	9.95	83.70	10.98	75.85
Route 112	A2 M25 junction - South Circular WB	15.11	55.01	15.51	53.59
Route 113	A2 M25 junction - M2 junction 1 EB	8.62	105.18	10.49	86.47
Route 114	A2 M2 junction 1 - M25 junction WB	15.50	57.52	17.25	51.69
Route 115	M2 junction 1 - junction 7 EB	22.85	106.95	28.05	87.12
Route 116	M2 junction 7 - junction 1 WB	24.16	101.82	28.39	86.66
Route 117	A2 M2 junction - Dover EB	25.02	92.23	31.08	74.26
Route 118	A2 Dover - M2 junction WB	24.01	95.71	30.26	75.93
Route 119	A20 South Circular - M25 junction EB	12.07	69.48	14.85	56.48
Route 120	A20 M25 junction - South Circular WB	19.37	42.78	22.06	37.56
Route 121	M20 junction 1 - junction 7 EB	16.87	109.83	21.56	85.93
Route 122	M20 junction 7 - junction 1 WB	25.15	74.43	30.06	62.28
Route 123	M20/A20 junction 7 - Dover EB	39.58	97.59	49.11	78.65
Route 124	M20/A20 Dover - junction 7 WB	37.19	103.66	47.74	80.75
Route 125	A13 North Circular - M25 junction EB	11.01	80.00	11.43	77.09
Route 126	A13 M25 junction - North Circular WB	25.21	35.29	26.75	33.27
Route 127	A13 M25 junction - Basildon EB	17.21	89.19	19.85	77.32
Route 128	A13 Basildon - M25 junction WB	28.68	53.26	31.89	47.90
Route 129	A12 North Circular - M25 junction EB	20.89	46.19	23.11	41.75
Route 130	A12 M25 junction - North Circular WB	37.41	25.87	46.96	20.61
Route 131	A12 M25 junction - Chelmsford EB	13.31	102.54	15.18	89.90
Route 132	A12 Chelmsford - M25 junction WB	18.66	72.89	22.39	60.76
Route 135	A127 Gallows Corner - Basildon EB	24.41	62.47	26.03	58.59
Route 136	A127 Basildon - Gallows Corner WB	30.57	49.93	35.08	43.51
Route 145	M26 M25 junction - M20 junction EB	8.39	114.11	10.66	89.81

Route number	Route description	AM			
		Light		Heavy	
		Median time (mins)	Speed (km/h)	Median time (mins)	Speed (km/h)
Route 146	M26 M20 junction - M25 junction WB	9.01	106.68	10.97	87.61
Route 153	A228 M20 junction - M2 junction NB	9.31	62.65	10.62	54.93
Route 154	A228 M2 junction - M20 junction SB	11.41	51.21	12.92	45.23
Route 157	A229 M20 junction - M2 junction NB	4.23	85.31	5.07	71.06
Route 158	A229 M2 junction - M20 junction SB	4.55	77.83	4.92	71.88
Route 201	M25 junction 30 – M2 junction 1	15.27	92.27	17.45	80.73
Route 202	M2 junction 1 – M25 junction 30	23.67	60.22	25.86	55.13

TRIS journey time database

4.3.7 National Highways has a database of average journey time and speed information for 15-minute periods on all the motorways and A-roads that form the SRN in England, with data available from April 2015.

4.3.8 Journey times and speeds are estimated using a combination of sources, including ANPR cameras, in-vehicle GPS and inductive loops built into the road surface.

4.3.9 This dataset was used to supplement and verify the Teletrac journey time data.

Dartford Crossing Bluetooth data

4.3.10 In late 2014, a system of electronic payment (the Dart Charge) was introduced at the Dartford Crossing. Before the new system was opened, a set of Bluetooth monitors were installed to collect travel time and speed data for traffic using the Dartford Crossing. The data was used to monitor the impact of removing the toll booths and switching to Dart Charge.

4.3.11 This vehicle speed data was made available for the period July 2014 to August 2017. It contained many more observations than the Teletrac dataset and was used to verify the Teletrac data.

4.4 Trip data

Mobile phone data

4.4.1 The main source of data on the origin and destination of trips comes from mobile phone data collected in March 2015. The data was used to build the trip matrices for the South East Regional Traffic Model (SERTM). These matrices were then enhanced and factored to 2016 during the development of the LTAM. Further information on this is provided in Chapter 5 of this report and in Appendix B (Application Document 7.7).

4.4.2 The mobile phone data was divided into highway and rail passenger trips and the following journey purpose specifications:

a. Home to work trips

b. Work to home trips

c. Trips from home for other purposes

d. Trips to home for other purposes

e. Non-home-based trips

South East Regional Traffic Model (SERTM) matrices

4.4.3 The SERTM trip matrices were developed from the mobile phone data for the following time periods:

a. An average morning peak hour between 07:00 and 10:00

b. An average inter-peak hour between 10:00 and 16:00

c. An average evening peak hour between 16:00 and 19:00

4.4.4 In addition, separate matrices were developed for car, LGVs and HGVs. Data from other sources such as roadside interviews, the national census and the National Travel Survey (NTS) were used to allocate car trips to a relevant journey purpose, distinguishing between commuting trips, those made on employers' business and trips made for other purposes (DfT, 2019b).

Census journey to work

4.4.5 A national census of the population takes place every 10 years. The most recent census was held in March 2021. However, data from the 2011 census has been used in this analysis. The census population and employment statistics were used to provide zonal correspondence between the SERTM and the LTAM.

National Travel Survey (NTS)

4.4.6 The NTS data is a household survey commissioned by the DfT (2019b). It is based on a household travel diary for a week and is designed to monitor long-term trends in personal travel. The survey collects information on how, why, when and where people travel as well as factors affecting travel (e.g. car availability). The NTS covers travel by people of all age groups, including children. Approximately 16,000 individuals, in 7,000 households in England, participate in the NTS each year. The survey results from the years 2002 to 2014 were used in the development of the LTAM.

Teletrac origin destination data

4.4.7 The Teletrac dataset owned by DfT, which provides journey times from in-vehicle GPS units, also contains the exact origin and destination of trips made in these vehicles.

4.4.8 This information was supplied at Census Lower Super Output Areas for use by the Project. The data was used to verify the trip length of LGV trips for the LTAM.

Dartford Crossing user survey

4.4.9 A survey for users of the Dartford Crossing to ask about the origin and destination of their trips and the journey purpose was developed.

4.4.10 The survey was conducted online by National Highways' Digital Team who sent out the survey to all registered holders of a Dart Charge account.

4.4.11 The responses were analysed, and the data used to check the trip matrices developed for LTAM from the mobile phone data. This check showed a high level of correlation between the two datasets and gave confidence that the origin and destination of trips using the Dartford Crossing predicted in 2016 by the LTAM matches the observed trips as reported in this survey.

4.5 Other data

Dart Charge transaction data

4.5.1 Transaction data collected by the Dart Charge system was used to identify the traffic flow profiles and types of vehicles using the Dartford Crossing.

4.5.2 In March 2016, the TRIS sites located at the Dartford Crossing in both directions were out of order. The transaction data collected by the Dart Charge automatic payment system was used to estimate the number of vehicles using the Dartford Crossing.

Automatic Number Plate Recognition (ANPR)

4.5.3 ANPR surveys are video surveys of vehicles passing the camera sites that record the registration numbers of vehicles and the time at which they passed in front of the camera. The data can be used to check routings that vehicles use, as the passage of a vehicle through the network can be traced by using its unique registration plate number.

4.5.4 The data also supplies journey time data which is taken by comparing the time stamps on the camera observations of a single vehicle at the different camera sites passed.

4.5.5 The data is also used to verify the types of vehicles using a road. The registration plate numbers are supplied to the Driver and Vehicle Licensing Agency who provide details of the road tax class of the vehicle and the euro rating of the engine. This data is useful for environmental assessment of air quality.

4.5.6 A large ANPR survey was carried out in five areas in October/November 2016 for a single weekday between 05:30 and 20:30. The surveyed areas were:

a. the A127 between the M25/A127 junction and the A127/A128 junction

b. the A13 between the M25/A13 junction and the A13/B1007 junction

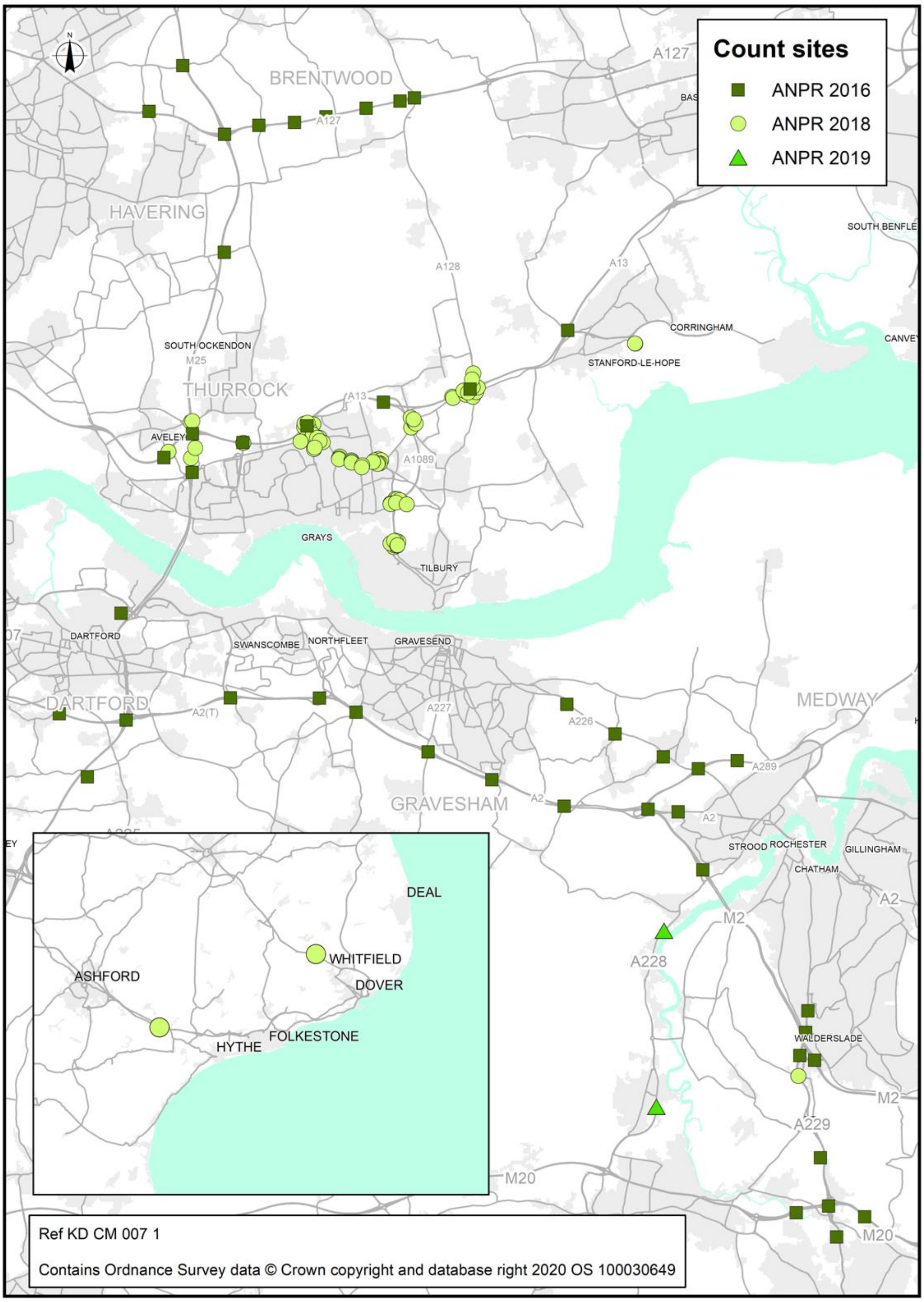
c. the A2 between the M25/A2 junction and the M2/A229 junction

d. the A226 between the A226/A289 junction and the A226/Chalk Road junction

e. the A229 between the M2/A229 junction and the M20/A229 junction

4.5.7 The locations of the ANPR surveys are shown in Plate 4.16. This map also shows the locations of additional ANPR surveys carried out in 2018 and 2019.

Plate 4.16 Locations of ANPR surveys



Queue length surveys

4.5.8 Video recordings from cameras can also be used to estimate the length of traffic queues along links and at junctions. A set of queue length surveys were carried out on Tuesday 11 October 2016 between 06:00 and 20:00 at the following locations:

a. The A127 between the M25/A127 junction and the A127/A128 junction

b. The A13 between the M25/A13 junction and the A13/B1007 junction

c. The A2 between the M25/A2 junction and the M2/A229 junction

d. The A226 between the A226/A289 junction and the A226/Chalk Road junction

e. The A229 between the M2/A229 junction and the M20/A229 junction

Traffic signal timings

4.5.9 At each signalised junction surveyed in the queue length surveys in 2016, the survey company was asked to ensure that the traffic signal head was clearly visible. This enabled the green times and cycle times to be recorded. At some locations, additional cameras were required to ensure this information was captured fully.

GIS data (ITN)

4.5.10 The Ordnance Survey ITN data provides an accurate digital description of the road network. The Teletrac journey time data is matched to the highway links in the ITN data. A correspondence file was created between the links in the LTAM and the ITN network. This enabled the journey times in the Teletrac database to be matched to the ITN network and to the LTAM, which allowed observed and modelled journey times to be compared.

4.5.11 This dataset was also used for reference when coding the highway network in the transport model.

4.5.12 The link flows, capacities and speeds from the model are displayed using geometry from the ITN network when data is used in the environmental and social appraisal of the Project. The maps of the forecast future year flows shown in Chapter 6 of this report and in the Traffic Forecasts Non-Technical Summary (Application Document 7.8) are based on the ITN shapefile.

Accident data

4.5.13 DfT publish detailed STATS19 data, which provides road safety data about the circumstances of personal injury road accidents in Great Britain and is now available under an open data licence. The data contains details of the location of each accident, the types of vehicles involved, the number of casualties and the severity of the injuries. Accidents are only reported if there is a casualty. The details of the accidents and injuries are provided by the police using the STATS19 accident reporting form.

4.5.14 The accident data was used to calculate local accident rates that are used in DfT's COsts and Benefits Appraisal - Light Touch (COBALT) software to predict the change in the number of accidents on the network in the future as a result of the Project.

Incident data

4.5.15 National Highways provided data logs for the M25 and A2 which showed when incidents occurred on these roads. Incidents are defined as all events which impact upon the operation of the network, including breakdowns, shed loads/spillages, weather restrictions, over-height vehicles and accidents. The data logs were used to analyse the frequency and duration of incidents on these roads.

4.5.16 The operators of the Traffic Management Cell (TMC) at the Dartford Crossing provide data to National Highways on the operation of the traffic management system at the Dartford Crossing. This data was used when analysing the impact of the TMC on the available capacity at the Dartford Crossing.

4.5.17 The TMC is a traffic safety system for the Dartford Tunnels with advance detection of queues and the active management of the use of the tunnels by restricted vehicles. It is controlled by the TMC Control System that provides a strategic operational control facility for the operational staff that manage the crossing 24 hours per day

New developments

4.5.18 Local authorities were contacted for information regarding the status and degree of certainty regarding new developments planned for their area. This information is stored in the Uncertainty Log. Following guidance in Transport Analysis Guidance (TAG) Unit M4 (DfT, 2019a), developments were included if the likelihood of them going ahead is near certain or more than likely. The spatial location of these developments and the number of trips expected to enter and leave the site were used in the development of future year traffic forecasts. More information on this is provided in Chapter 6 of this report and in Appendix C: Transport Forecasting Package (Application Document 7.7).

New highway schemes

4.5.19 Local highway authorities in the region and National Highways were also contacted for information regarding the status and degree of certainty regarding planned changes to the highway network. This information was used when coding up the future year highway networks in the LTAM.

4.6 Data store

4.6.1 A data store has been set up which contains data used in building the LTAM and the appraisal of the Project.

4.6.2 A counts database is available (in Excel format) which contains the following details for each count:

a. Survey location information (including a unique site ID, Easting and Northing, corresponding A Node and B Node in the LTAM network coding, site direction and corresponding LTAM screenline/cordon)

b. Survey information (including survey dates, the count sources and the original ID)

c. ATC and Classified Link Count data for each survey location

d. Processed flows for each survey location in the AM, inter-peak and PM peak periods, split by cars, LGVs and HGVs

4.6.3 A spreadsheet is also kept in the data store showing for each survey location the following:

a. Count information

b. Confidence interval test results

c. Raw data

d. Data formatted to a standardised template

e. Data analysis, including flow profiles

f. Factors for vehicle composition

4.6.4 The data used to develop the trip matrices used in the model is stored in a variety of formats as shown in Table 4.5.

Table 4.5 Origin and destination data

Data source	Data format
SERTM Demand Matrices	SATURN Binary Matrix Format (.UFM)
Provisional Mobile Phone Data	Comma Separated Variable File (.CSV)
Census Journey to Work	MS Excel Spreadsheet Tables (.XLSX)
Teletrac OD	Comma Separated Variable (.TXT)
National Travel Survey	Space Delimited Text File (.TAB)

Journey times

4.6.5 The journey time data used for the validation of the LTAM comes from the Teletrac dataset which is stored as csv files. The ITN is an ESRI shapefile.

Transport model

4.6.6 The transport model itself consists of text files containing the coded networks and a series of binary files in the structure determined by the modelling software. The trip matrices are stored as SATURN UFM files. The link flows are transferred into a csv file and attached to an ESRI shapefile for presentation using GIS software. The link flows presented in the Traffic Forecasts Non-Technical Summary (Application Document 7.8) were produced using this method and are preserved in the Projects' datastore.

5 Transport model

5.1 Introduction

5.1.1 This chapter summarises the key features of the transport modelling used to produce the traffic forecasts that informed the design of the Project and are used in the appraisal of the Project. A full description of the development of the transport model is presented in Appendix B: Transport Model Package (Application Document 7.7).

5.2 Previous transport models

5.2.1 The first study into the traffic issues at the Dartford Crossing in 2009 by Parsons Brinckerhoff (DfT, 2009) used existing transport models. The Highways Agency's East of England model was used to look at strategic traffic, the South Essex Transport and Land Use Model to look at local traffic and the Great Britain Freight Model for HGVs.

5.2.2 The AECOM study in 2013 (DfT, 2013) developed a single transport model for the analysis work starting with the Highways Agency's M25 model, adding more detail into the representation of the highway network and updating the 2001 data on trip patterns in the area with 2009 traffic counts. This model informed the selection of the long list of options for further appraisal.

5.2.3 The transport model was then further enhanced with additional network detail, particularly in London, for use in the analysis of the short list of options and selection of the preferred route.

5.2.4 Following the Preferred Route Announcement (PRA) in 2017, a bespoke transport model for the Lower Thames area was built to inform the detailed design of the Project. This model was able to use the trip matrices developed by National Highways for the SERTM, which were based on 2015 mobile phone data. An extensive data collection exercise was also undertaken in 2016 as reported in the previous chapter in this report.

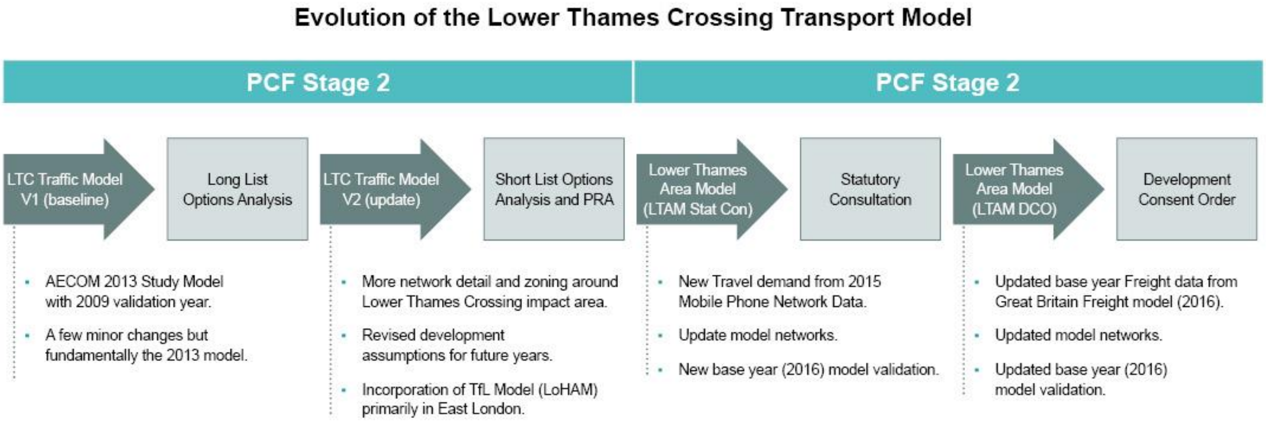
5.2.5 This new model was developed specifically for the development and appraisal of the Project. This model was known as the LTAM. Traffic forecasts from this model were published for the Statutory Consultation held in late 2018 in the Traffic Forecasts Non-Technical Summary (Highways England, 2018). A Local Model Validation Report, which described the development of the model, and a Traffic Forecasting Report were also published at this time (Highways England, 2018).

5.2.6 It was acknowledged in the LTAM Local Model Validation Report published in 2018 that the information used in the model for the origin and destination of trips made by HGVs came from the 2006 DfT Base Year Freight Matrices and could be updated.

5.2.7 The DfT commissioned MDS TransModal to produce a set of goods vehicle matrices for 2016 from their Great Britain Freight Model. This work was completed after the Statutory Consultation for the Project. The matrices were made available to National Highways and the LTAM was updated in summer 2019 to include this more recent freight data.

5.2.8 This version of the transport model is known as the 'LTAM (DCO)'. The series of transport models used since 2013 is shown in Plate 5.1. Those within Project Control Framework (PCF) Stage 2 formed part of the option selection stage, while PCF Stage 3 is the preliminary design stage.

Plate 5.1 Evolution of the Project transport model



5.2.9 The details of the LTAM (DCO) transport model are presented in the remainder of this chapter.

5.3 Model purpose

5.3.1 The transport model is used to support and inform the design of the Project. The forecasts for traffic flows using the Project 15 years after opening are used by the engineers to inform decisions on the number of lanes required and the layout of the junctions.

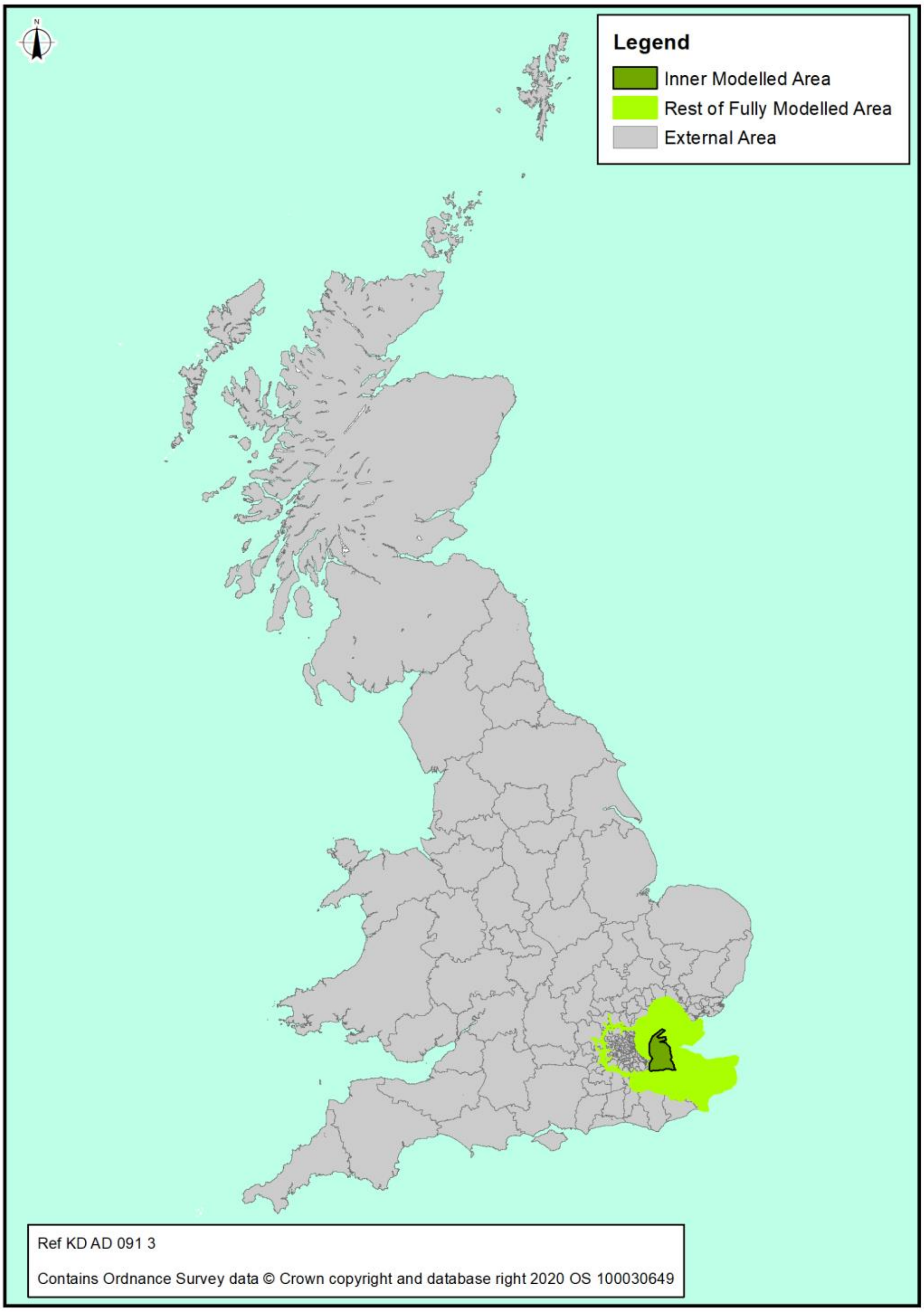
5.3.2 The outputs from the transport model are also used to understand the impacts of building the new crossing. The forecast change in traffic flows on other roads in the area when the Project opens, as well as those on the Project itself, are used in the appraisal of the environmental, social and economic impacts of the Project.

5.3.3 The transport modelling is carried out in accordance with all the principles and processes set out in the DfT's TAG. This ensures that the model's forecasts of future traffic flows and journey times are suitable for use in the Environmental Statement and the economic appraisal for the Project.

5.4 Study area

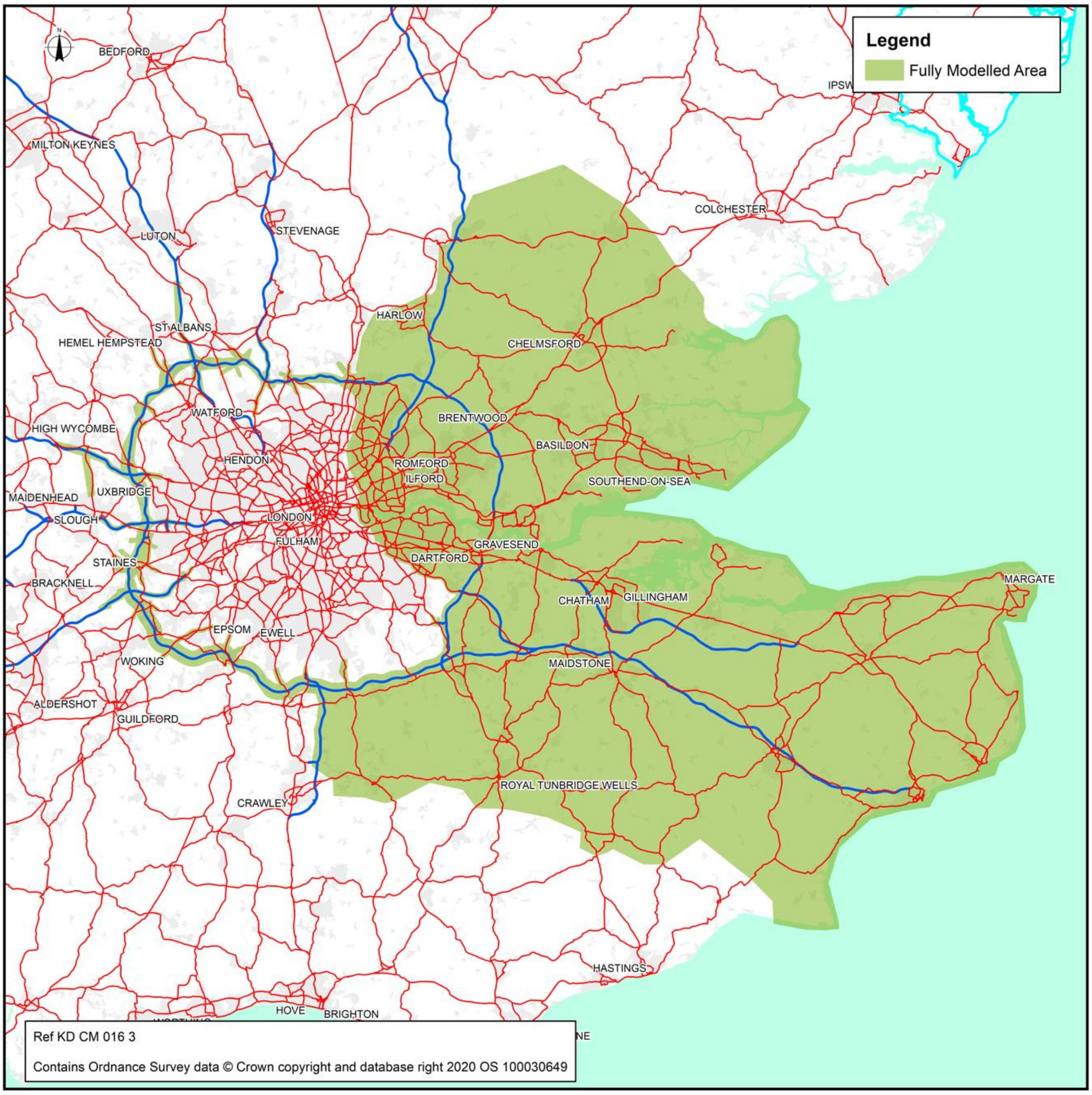
5.4.1 The LTAM covers the whole of England, Wales and Scotland in order to record the start (origin) and end (destination) points of all trips on the mainland. The model contains a description of the main road network and is used to predict the routes that each vehicle would take, the length of the trip and the time taken. More geographically precise detail on the origin and destination of trips is provided closer to the main area of interest, which is the Lower Thames area. The main ports and airports in the south-east are also included in the model. The extent of the model area is shown in Plate 5.2.

Plate 5.2 Extent of the LTAM zoning system



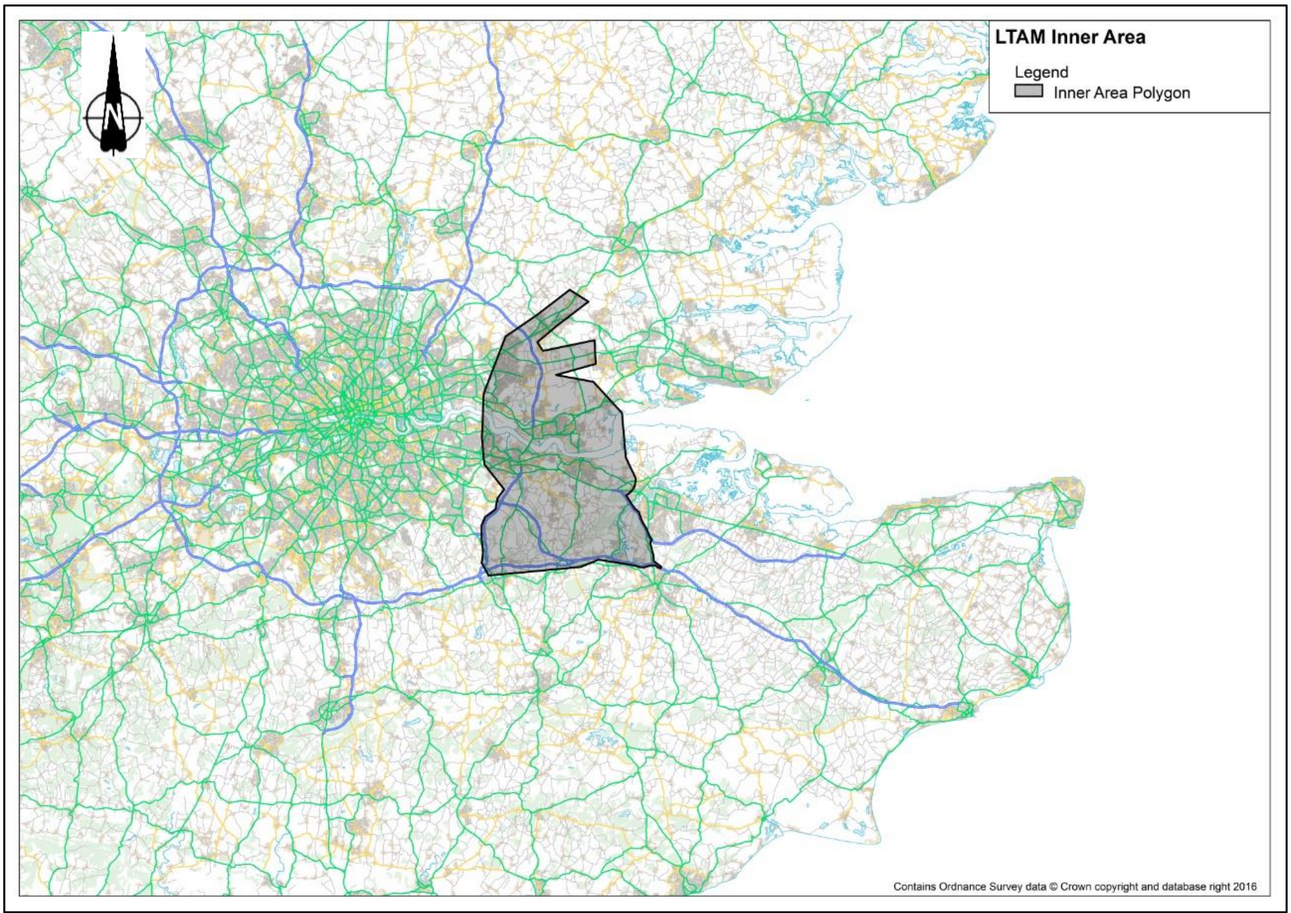
5.4.2 The area within the south-east that needed to be covered in more detail was determined by looking at the findings of the model used to support the PRA. This identified the area where there is a significant change in traffic flows and/or speeds as a result of the opening of the Project. In this area the description of the network is more detailed. This area is referred to in this report as the 'Fully Modelled Area' which is the term used in DfT TAG. Vehicles going from Dover to the Midlands can, for example, travel either clockwise or anticlockwise around the M25, so the Fully Modelled Area includes the whole of the M25 as well as all of Kent, Medway, Thurrock and Essex. The extent of the Fully Modelled Area is shown in Plate 5.3.

Plate 5.3 The LTAM Fully Modelled Area



5.4.3 For the purposes of model validation, the area of most interest is the Lower Thames area itself and particularly the roads leading to the Dartford Crossing and the site of the A122 Lower Thames Crossing. The model validation was reported for both the Fully Modelled Area and for this more local area, known as the Inner Modelled Area. The extent of the Inner Modelled Area is shown in Plate 5.4.

Plate 5.4 The LTAM Inner Modelled Area



5.5 Model structure

5.5.1 The LTAM is a variable demand model with a feedback loop. This allows the model to take into account the impact that the introduction of the Lower Thames Crossing would have on the highway network and journey times which leads to changes in the number of trips made, the mode of transport used, the time period during which the trip takes place and the destination of the trip. The latter, together with the re-routing of trips, is forecast to be the most significant of these impacts.

5.5.2 The model consists of three main components:

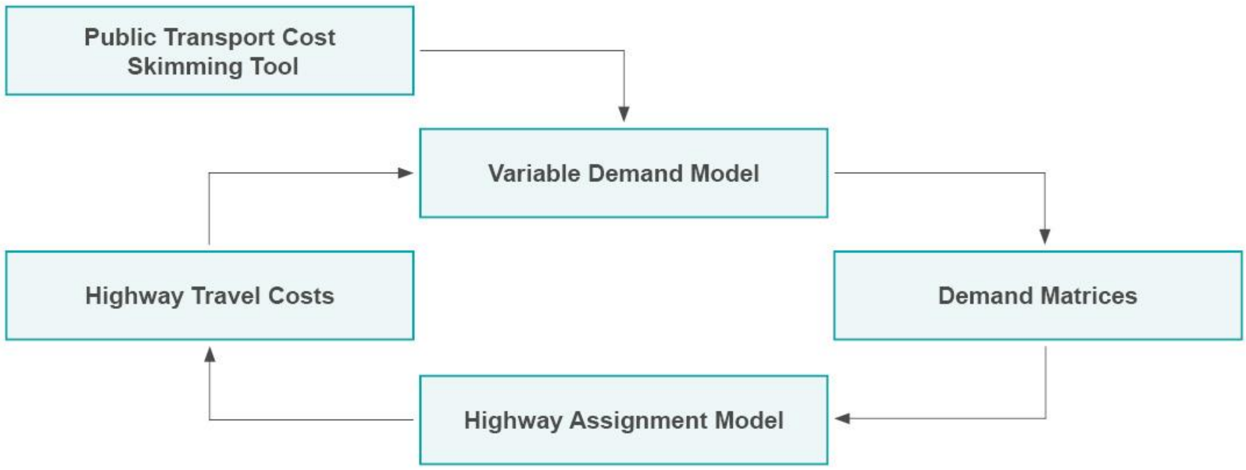
a. A public transport cost skimming model that includes the rail network and services

b. A highway assignment model

c. A variable demand model

5.5.3 The way these components are combined in the LTAM is shown in Plate 5.5.

Plate 5.5 The LTAM overall model structure



5.5.4 The public transport cost skimming model uses PTV VISUM Version 17 software. It is adapted from the national rail model developed by Stantec for the National Highways Regional Traffic Models. The model was used to calculate the time and cost of travel by public transport between the zones in the transport model.

5.5.5 The highway assignment model uses Simulation and Assignment of Traffic to Urban Road Networks (SATURN) software version 11.4.07H. SATURN was jointly developed by the University of Leeds and Atkins. It selects the best route for each vehicle to take, given the other vehicles on the network and the driver's trade-off between time and cost when choosing between alternative routes. It calculates the time and cost of travel between each zone in the transport model for the different types of vehicles and the purpose of people's journeys covered in the model.

5.5.6 The variable demand model is implemented using the DfT's DIADEM (Dynamic Integrated Assignment and Demand Model) software. DIADEM Software Version 6.3.4 is used for this model.

5.5.7 The variable demand model is used to predict how the number of trips people make, the time at which they travel, the transport mode they use and the choice of the destination of their trip varies when there is a substantial change in the transport network as a result of the provision of the Project. The demand model is applied as an incremental model and is calibrated to the range of expected elasticities set out in TAG.

5.5.8 As shown in Plate 5.5, the model runs for many iterations. As the variable demand model changes the forecast of the number of trips and the trip patterns, this leads to variations in the route some of the drivers take and the time and cost of travelling. These revised costs are fed back into the variable demand model. The model continues to run until there is very little change in the demand matrices and the time/cost of travel between zones. This is known as convergence and the model meets the TAG guidance on the degree of convergence required for a transport model.

5.6 Model zoning system

5.6.1 The zoning system covers the whole of the study area, with the zones being smaller in the Fully Modelled Area. The zones are based on the zoning system used in the National Highways SERTM, with some amalgamation of these zones further away from the Lower Thames area and disaggregation closer to the proposed site of the new crossing. The zones are designed to follow UK census boundaries, such as those used for Lower Super Output Areas and Output Areas.

5.6.2 The major ports and airports in the south-east are each represented by their own zone. Sixty spare zones were included to represent specific major development sites when the model is used for forecasting.

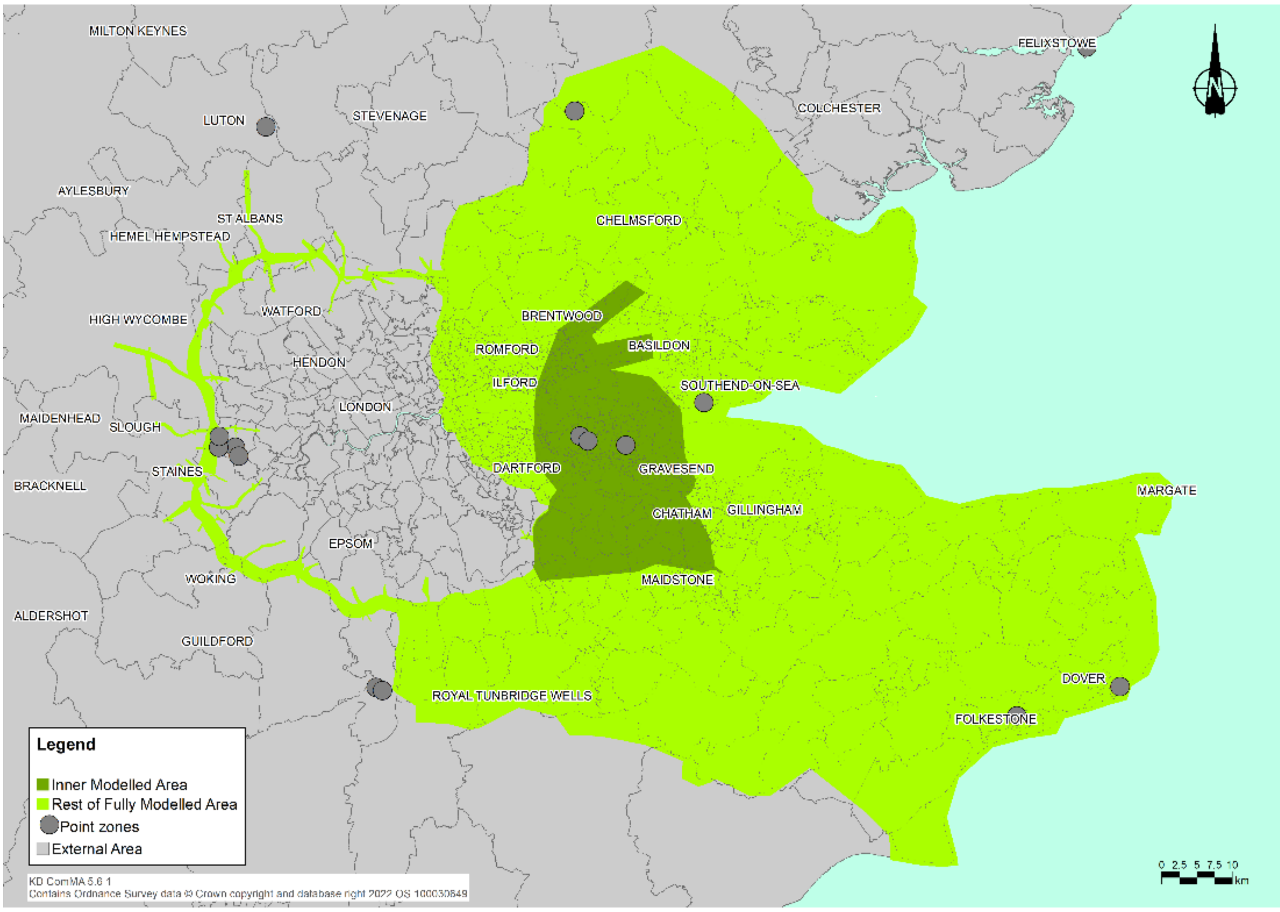
5.6.3 The total number of zones in the LTAM is shown in Table 5.1.

Table 5.1 The LTAM zones

Model area	Number of zones
Inner Modelled Area	270
Rest of Fully Modelled Area	408
External Area	259
Airport and Seaport Zones (Point Zones)	16
Development Zones (Point Zones)	60
Total	1,013

5.6.4 The zoning system in the Fully Modelled Area is shown in Plate 5.6.

Plate 5.6 Zoning structure within the Fully Modelled Area



5.7 Model details

Base year and month

5.7.1 The base year for the LTAM is 2016 and many of the traffic counts were collected for this year. The model base month is March as this was the month for which the mobile phone data was available. An analysis of traffic flows at the Dartford Crossing showed that traffic flows in March were similar to the neutral months in the year.

5.7.2 The model is for an average weekday, including Mondays and Fridays, because again an analysis of the counts in the TRIS database and for the Dartford Crossing showed that the level of traffic overall is similar across the weekdays on the SRN in the Lower Thames area.

Time periods

5.7.3 The model time periods used in the variable demand model were based on an examination of traffic flows on the SRN in the Lower Thames area. The traffic count data used was the number of vehicles using the Dartford Crossing (from the Dart Charge dataset) and on the SRN in the Lower Thames area (from the TRIS dataset). The following main time periods were identified:

a. Morning peak period (06:00–09:00)

b. Inter-peak period (09:00–15:00)

c. Evening peak period (15:00–18:00)

d. Off-peak period (18:00–06:00)

5.7.4 The highway assignment model covers a single hour. Each of the peak hours are modelled, as the model provides the future year design flows for the Project and the new crossing is designed to be able to accommodate peak hour flows 15 years after opening. The selection of the peak hour in the morning and evening were also assessed using the Dart Charge and TRIS datasets. An average inter-peak hour is modelled, which is all the trips that occur between 09:00 and 15:00 divided by six to provide a representative average hour. The model time periods in the highway assignment model are as follows:

a. Morning peak hour, 07:00–08:00

b. Average inter-peak hour between 09:00 and 15:00

c. Evening peak hour, 17:00–18:00

User classes

5.7.5 For the variable demand model, the highway trips that are made in the area are first divided into those trips which, according to DfT TAG guidance, are ‘in scope’ for the variable demand model. The remaining trips have a fixed demand, that is the trips made do not change in response to the provision of the Project. The only change they might make is to the route they use, and this is captured in the highway assignment model. The fixed demand trips in the LTAM are the LGVs and HGVs.

5.7.6 The remaining car trips are categorised according to their journey purpose (employer’s business, commuting or other trips) and household income (low, medium and high). Car trips to and from ports and airports are also excluded from the variable demand model as future trip numbers for these sites are taken from other sources.

5.7.7 The demand segments in the variable demand model are as follows:

a. Home-based employer’s business

b. Home-based commute low income

c. Home-based commute medium income

d. Home-based commute high income

e. Home-based other low income

f. Home-based other medium income

g. Home-based other high income

h. Non-home-based employer's business

i. Non-home-based other low income

j. Non-home-based other medium income

k. Non-home-based other high income

l. LGVs

m. HGVs

n. Port trips (sea and air) employer's business

o. Port trips (sea and air) other low income

p. Port trips (sea and air) other medium income

q. Port trips (sea and air) other high income

5.7.8 The trips are segmented in the highway assignment model according to the values placed by drivers on their value of time and the cost of motoring. National Highways publishes values for pence per minute and pence per kilometre based on DfT published values of time and vehicle operating costs. These are available for trips differentiated by journey purpose: employer's business, commuting and other. The DfT supplied additional values of time so that the latter two categories could also be divided by household income (low, medium and high income) in the route assignment and the variable demand model. HGVs associated with the ports were separated in order to match the coding of appropriate bans on large HGVs in Thurrock.

5.7.9 The user classes in the highway assignment model are as follows:

a. Cars – Employer's business

b. Cars – Commute low income

c. Cars – Commute medium income

d. Cars – Commute high income

e. Cars – Other low income

f. Cars – Other medium income

g. Cars – Other high income

h. LGVs

i. HGVs – Non-port

j. HGVs – Port

User charges

5.7.10 The London congestion charge and the charge for users of the Blackwall Tunnel and the Dartford Crossing are coded into the model based on the average charge paid by each user class. The average charge paid by each user class at Dartford in the model's base year was calculated by examining the Dart Charge data to determine the percentage of vehicles in each class paying a lower charge due to receiving a discount for pre-payment or use of a resident's discount.

5.8 Networks

5.8.1 The LTAM is a strategic transport model that covers a large geographical area. The network links for the model include all the motorways and A roads managed by National Highways, other key A and B roads that play a significant role in allowing traffic to access the SRN and any local roads that are required in order to capture local traffic routing in the Lower Thames area realistically.

Buffer network

5.8.2 In the highway assignment model, the network is coded at two levels of detail. Buffer coding is used for the External Area and simulation coding in the Fully Modelled Area. For the links in the buffer area, the length, road type and speed of traffic on each link is coded. These speeds are shown in Plate 5.7.

5.8.3 Traffic speeds in London were taken from information in TfL traffic models. These link speeds are shown in Plate 5.8.

Plate 5.7 Traffic speeds on the buffer network

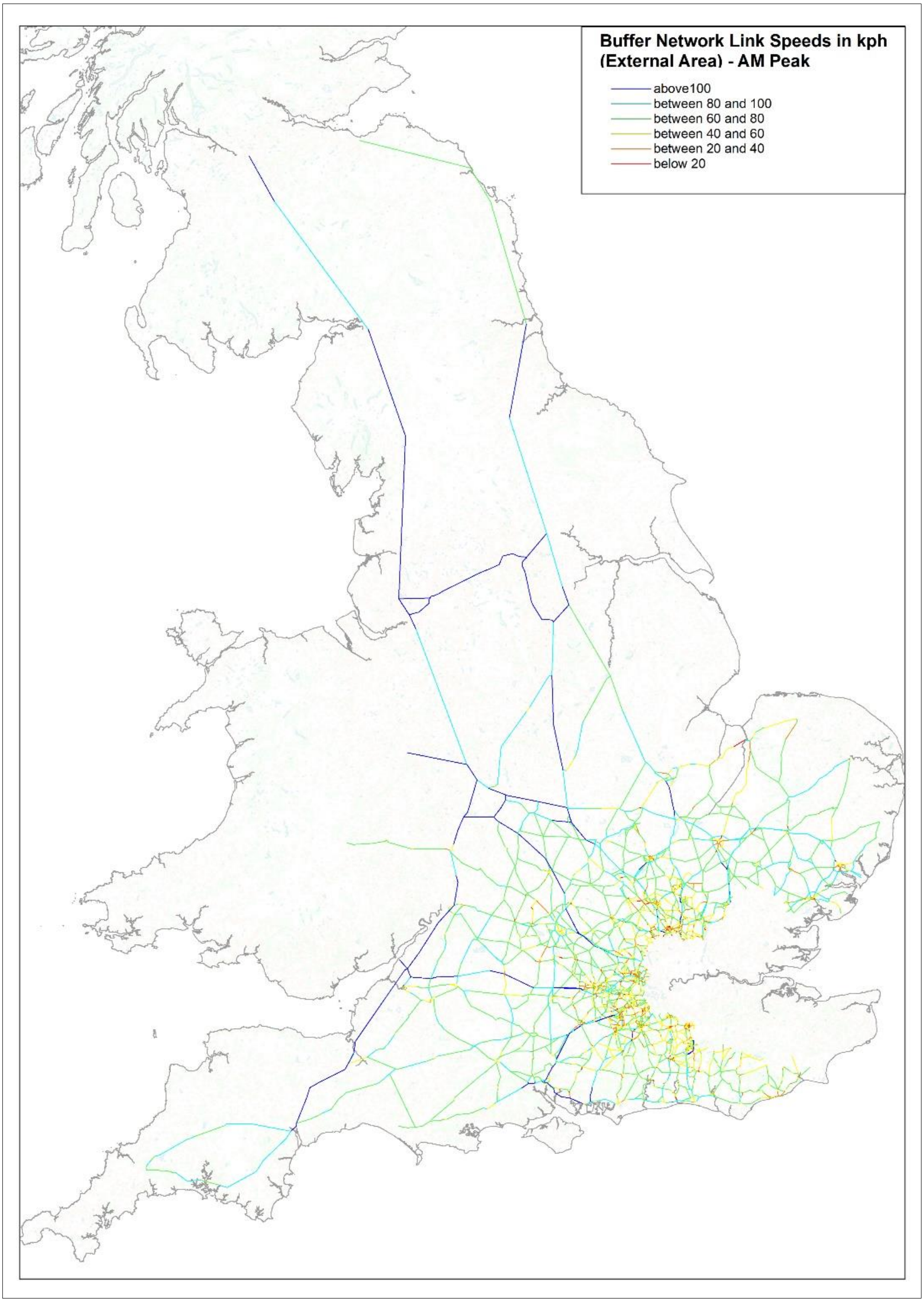
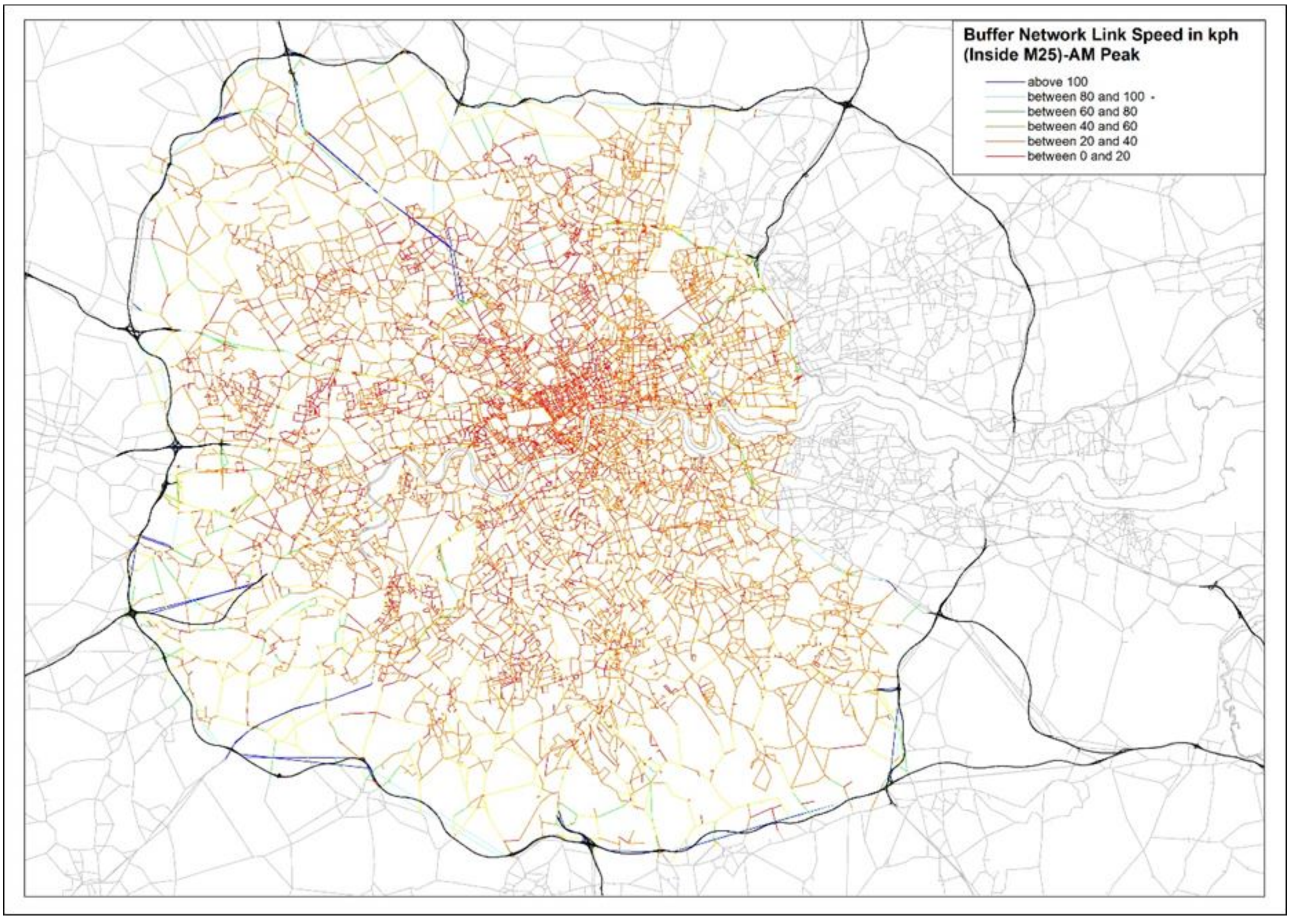


Plate 5.8 Traffic speeds on the buffer network within London

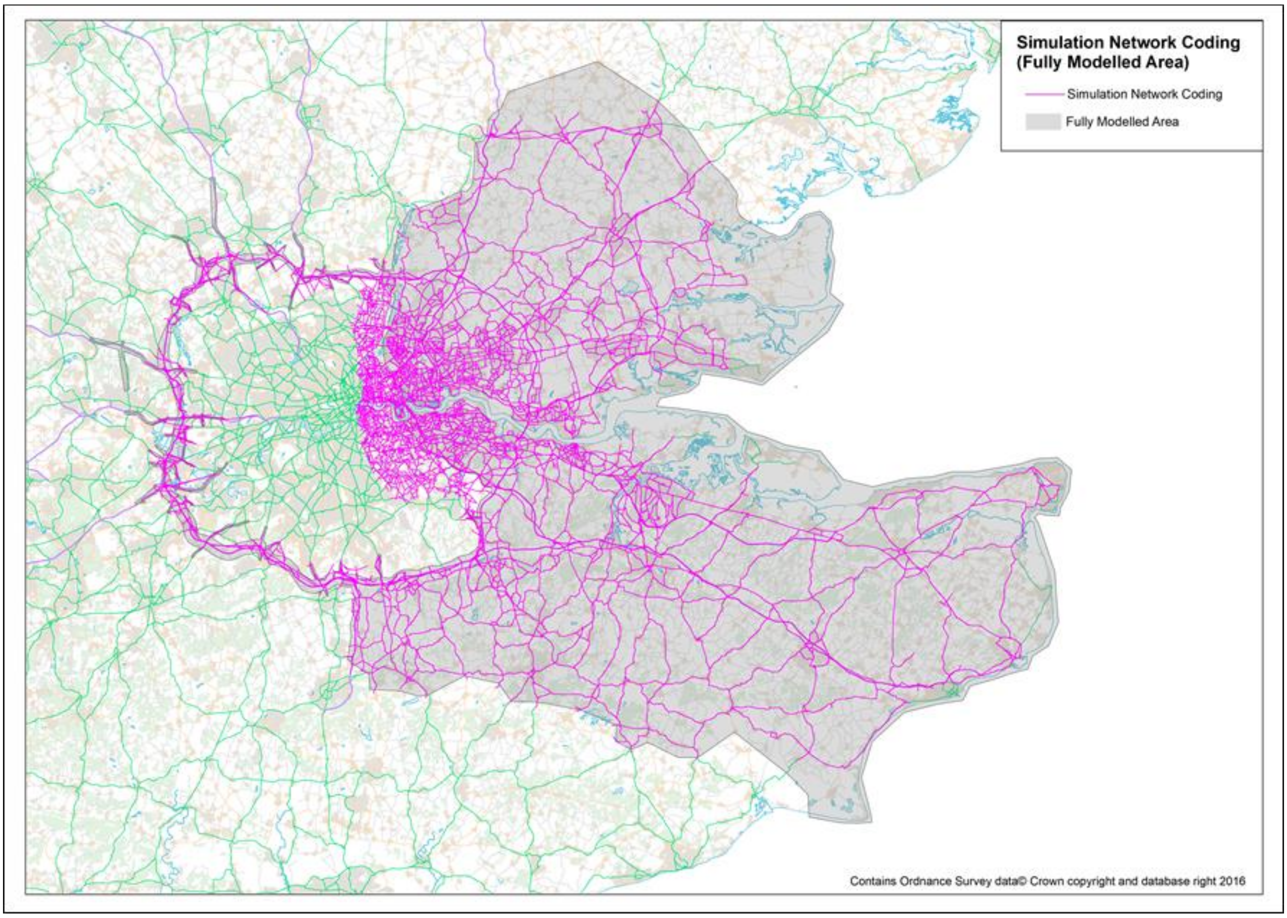


Simulation network

5.8.4 For coding within the simulation area, additional data is provided for each of the junctions so that the delay experienced by each vehicle using the junction can be calculated. This data includes, for example, the timing of traffic signals, the number of circulating lanes at a roundabout and which movement has priority at a 'give-way' junction.

5.8.5 The extent of the simulation network is shown in Plate 5.9. In this area, all major and many minor junctions are coded as simulation nodes which allows for the modelling of blocking back and flow metering.

Plate 5.9 LTAM simulation network



5.8.6 The coding for the network was taken, wherever possible, from existing coded SATURN networks from well-used models. The donor networks are set out in Table 5.2. They were the previous Lower Thames Crossing model used for the route selection (LTC V2.1), TfL's River Crossing Model (RXHAM), National Highways' SERTM and National Highways' M20 Smart Motorways Model (M20STM). Fresh coding was produced where required, such as in the immediate area around the Project, to provide additional detailed network information.

Table 5.2 Use of selected available model network data

Data	Most appropriate model
Primary source of highway network data outside the M25	LTC V2.1
Primary source of highway network data inside the M25	RXHAM
Supplementary model highway network on SRN corridors	SERTM
Supplementary model highway network in Kent	M20STM
Primary source of public transport network data	SERTM

Capacity at the Dartford Crossing

5.8.7 The effective capacity of the Dartford Crossing through the tunnels is reduced by the operation of the TMC which frequently holds back the traffic for safety reasons. The three main reasons why the TMC is activated are to temporarily stop traffic to allow for the escort of Dangerous Goods Vehicles through the tunnel, to prevent traffic queuing in the tunnel and to allow for vehicles that have approached the tunnels in the wrong lane to cross over to the correct lane. These are:

a. Escorts: Dangerous Goods Vehicles, such as the petrol tankers going to/from the oil refinery in Purfleet, have to wait at the queuing station adjacent to the western tunnel. They are escorted through the western tunnel in a convoy at regular intervals, usually every 15 minutes.

b. Flow metering: When there is significant queuing on the north side of the river with the queues reaching back to near the tunnel exits, then traffic is held back on the southern side of the river to regulate the flow through the tunnel to avoid queues in the tunnel itself.

c. Extractions: This occurs when a vehicle approaches a tunnel that it is not allowed to use and all traffic approaching both tunnels is stopped to allow the vehicle to cross lanes over to the correct tunnel. Vehicles over 4.8m high cannot use the western tunnel. Dangerous Goods Vehicles should not approach in the lanes that lead to the eastern tunnel as they must first go to the queuing station to the west of the western tunnel.

5.8.8 The effective capacity of the tunnels is reduced by these temporary closures. These closures were implemented in the LTAM by considering how often there is a red light at the traffic signals for the tunnels. The capacity of the tunnels for a whole hour is reduced to account for the number of minutes when, on average, traffic is held at a red light.

5.8.9 The maximum capacity of the western tunnel is 3,650 Passenger Car Units (PCUs) an hour and for the eastern tunnel 3,850 PCUs. In the model, the capacity of each part of the road network is given as the number of PCUs that can use each road link each hour, which is an industry standard approach. Cars and vans are defined as 1 PCU, while HGVs are considered to be equivalent to 2.5 PCUs because they take up more road space.

5.8.10 The effective capacity available of the tunnels in March 2016, as coded in the SATURN model, is shown in Table 5.3. For comparison purposes, the observed flow in 2016 is also shown along with the Volume/Capacity (V/C) ratio.

5.8.11 The V/C ratio shows the number of vehicles forecast to use a road as a ratio of the number of vehicles that could use the road. As the V/C rises towards 1.0, then the road is approaching capacity; the speed at which the vehicles can travel will start to fall due to the sheer volume of traffic on the link and journey times will become more unreliable. For example, there will be more episodes of delay when a car in the flow of traffic brakes and there is a ripple effect back along the link. There are also less opportunities to overtake a slow-moving vehicle. A V/C ratio of above 0.85 indicates the likelihood of frequent occurrences of slow-moving traffic and above 0.95 indicates a network under pressure.

Table 5.3 Dartford Crossing capacity (northbound) for March 2016

Time period	Tunnel	Maximum capacity (PCUs/h)	Effective capacity (PCUs/h)	Base year observed flow (PCUs/h)	Base year V/C ratio
AM	Western	3,650	3,194	3,108	0.97
	Eastern	3,850	3,754	3,652	0.97
	Total	7,500	6,948	6,760	0.97
IP	Western	3,650	3,125	2,773	0.89
	Eastern	3,850	3,754	3,330	0.89
	Total	7,500	6,879	6,103	0.89
PM	Western	3,650	2,814	2,874	1.02
	Eastern	3,850	3,305	3,376	1.02
	Total	7,500	6,118	6,250	1.02

5.8.12 For the southbound traffic over the Queen Elizabeth II Bridge, the capacity is 8,500 PCUs/hour. The observed flows and V/C ratios are shown in Table 5.4.

Table 5.4 Dartford Crossing capacity (southbound) for March 2016

Time period	Maximum capacity (PCUs/h)	Effective capacity (PCUs/h)	Base year observed flow (PCUs/h)	Base year V/C ratio
AM	8,500	8,500	7,633	0.90
IP	8,500	8,500	5,531	0.65
PM	8,500	8,500	6,777	0.80

Public transport network

5.8.13 The coding of the public transport model came originally from the network developed for the National Highways Regional Traffic Models. The model includes all rail, light rail and tram services. It also covers the London Underground network. The model was updated to match the zoning system in the LTAM.

5.8.14 The fares in the LTAM public transport model are based on the distance travelled. In the variable demand model, the public transport model provides the time and cost of travelling by rail between each of the model zones.

5.9 Matrix development

5.9.1 The primary source of data for developing the LTAM demand matrices was the SERTM prior matrices. The SERTM matrices were converted to the LTAM zoning system and then factored to the LTAM model time periods. The overall level of trips in different areas were adjusted to reflect the general level of trips observed from traffic counts.

5.9.2 Further adjustments were made to the level of demand from ports and airports. The pattern of trips for HGVs was taken from the Great Britain Freight Model.

5.9.3 These matrices were developed separately for each time period, vehicle type and journey purpose in the LTAM. The matrices were then scaled to match the 2016 traffic counts using the matrix estimation algorithm in the SATURN software.

5.9.4 The total number of trips in each of the models' matrices is shown in Table 5.5.

Table 5.5 The LTAM matrix totals (PCUs)

User class	AM	IP	PM
Car employer's business	446,238	388,822	535,264
Car commute low income	416,937	189,525	476,874
Car commute medium income	844,010	291,124	915,198
Car commute high income	717,359	207,507	740,837
Car other low income	650,296	1,156,146	1,127,337
Car other medium income	693,521	923,590	1,135,034
Car other high income	554,821	620,234	860,322
Car Total	4,323,182	3,776,948	5,790,865
LGV	730,141	630,596	527,223
HGV (Port and non-port combined)	129,666	145,529	83,900

5.10 Highway model validation

Validation criteria

5.10.1 TAG guidance sets out checks that should be carried out to examine whether a model is a fair representation of the world it represents. These checks were carried out and are reported in full in Appendix B: Transport Model Package (Application Document 7.7). TAG sets out validation criteria which assess how closely the modelled traffic flows in the base year model match observed traffic counts and how well the journey times in the model reflect reality.

5.10.2 It is important to note here that these are provided in TAG as guidelines and should not be seen as a series of pass/fail criteria. A model that meets the standards may not be fit for purpose whereas a model that fails to meet some degree of the standards may be usable for certain applications.

5.10.3 These validation checks for the highway assignment model cover the following:

a. Assigned flows and counts totalled for each screenline or cordon as a check on the quality of the trip matrices

b. Assigned flows and counts on individual links and turning movements at junctions as a check on the quality of the assignment

c. Modelled and observed journey times along routes as a check on the quality of the network and the assignment

5.10.4 The criteria for screenline flow validation are set out in Table 5.6, for link flows in Table 5.7 and for journey times in Table 5.8. The GEH statistic mentioned in Table 5.7 is a bespoke statistic used in traffic modelling which measures how close two values are to each other, taking into account the absolute values as well as the percentage difference between them.

Table 5.6 Screenline flow validation criterion and acceptability guideline

Criterion	Acceptability guideline
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines (i.e. 95%)

Table 5.7 Individual link flow validation criteria and acceptability guidelines

Criteria	Description of criteria	Acceptability guideline
1	Individual flows within 100 veh/hr of counts for flows less than 700 veh/hr	> 85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/hr	> 85% of cases
	Individual flows within 400 veh/hr of counts for flows more than 2,700 veh/hr	> 85% of cases
2	GEH < 5 for individual flows	> 85% of cases

Table 5.8 Journey time validation criterion and acceptability guideline

Criterion	Acceptability guideline
Modelled times along routes should be within 15% of surveyed times (or 1 minute if higher than 15%)	> 85% of routes

Traffic flows at calibration sites

5.10.5 During the model calibration, modelled flows were compared with observed counts. Where there were differences, the matrices and networks were checked, and adjustments made to the traffic signal settings, for example, so that the model more closely reflected reality. Details of all the calibration checks are provided in Appendix B: Transport Model Package (Application Document 7.7). Table 5.9 to Table 5.14 summarise the match at individual count sites in the model calibration for cars, and then for all vehicles, for each of the three modelled time periods.

Table 5.9 Modelled vs. observed individual count comparison, calibration sites, AM peak: cars

	No. Sites	Cars			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	475	405	423	426	90%
Non-Screenline	371	327	340	341	92%
Total	846	732	763	767	91%
Inner Modelled Area	309	286	291	293	95%

Table 5.10 Modelled vs. observed individual count comparison, calibration sites, AM peak: all vehicles

	No. Sites	All vehicles			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	475	401	414	416	88%
Non-Screenline	371	327	332	335	90%
Total	846	728	746	751	89%
Inner Modelled Area	309	284	290	290	94%

Table 5.11 Modelled vs. observed individual count comparison, calibration sites, inter-peak: cars

	No. Sites	Cars			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	475	425	445	446	94%
Non-Screenline	371	341	349	350	94%
Total	846	766	794	796	94%
Inner Modelled Area	309	291	297	297	96%

Table 5.12 Modelled vs. observed individual count comparison, calibration sites, inter-peak: all vehicles

	No. Sites	All vehicles			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	475	420	437	439	92%
Non-Screenline	371	335	347	347	94%
Total	846	755	784	786	93%
Inner Modelled Area	309	286	296	296	96%

Table 5.13 Modelled vs. observed individual count comparison, calibration sites, PM peak: cars

	No. Sites	Cars			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	475	410	422	422	89%
Non-Screenline	371	323	330	333	90%
Total	846	733	752	755	89%
Inner Modelled Area	309	280	282	283	92%

Table 5.14 Modelled vs. observed individual count comparison, calibration sites, PM peak: all vehicles

	No. Sites	All Vehicles			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	475	408	419	422	89%
Non-Screenline	371	322	328	329	89%
Total	846	730	747	751	89%
Inner Modelled Area	309	280	281	282	91%

5.10.6 These tables show that, overall, the LTAM is able to effectively predict the levels of flow by cars and all vehicles combined. In particular, the comparison in the Inner Modelled Area is very close with between 91% and 96% of sites passing the TAG guidance.

Traffic flows at validation sites

5.10.7 Some of the available traffic counts were selected at random to be set aside and not used in the model calibration. These are known as validation sites and once the model was complete, a comparison was made between the modelled and observed flows at these sites. Table 5.15 to Table 5.20 provide a summary of the observed and modelled flows at the validation sites. Again, the match was better for cars than for all vehicles and better at the inter-peak. Over 84% of the validation sites met the TAG criteria in the Inner Modelled Area in the morning peak hour, 86% in the inter-peak hour and 72% in the evening peak hour for all vehicles. This is considered a good match for a model that covers such a large area as the LTAM.

Table 5.15 Modelled vs. observed individual count comparison, validation sites, AM peak: cars

	No. sites	Cars			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	60	25	34	35	58%
Non-Screenline	130	83	89	93	72%
Total	190	108	123	128	67%
Inner Modelled Area	43	32	35	36	84%

Table 5.16 Modelled vs. observed individual count comparison, validation sites, AM peak: all vehicles

	No. sites	All vehicles			
		No. Sites GEH<5	No. Sites DMRB Pass	No. Sites Overall Pass	% Sites Overall Pass
Screenline	60	17	29	29	48%
Non-Screenline	130	84	83	86	66%
Total	190	101	112	115	61%
Inner Modelled Area	43	35	36	36	84%

Table 5.17 Modelled vs. observed individual count comparison, validation sites, inter-peak: cars

	No. Sites	Cars			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	60	22	30	32	53%
Non-Screenline	130	95	100	102	78%
Total	190	117	130	134	71%
Inner Modelled Area	43	40	39	40	93%

Table 5.18 Modelled vs. observed individual count comparison, validation sites, inter-peak: all vehicles

	No. sites	All vehicles			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	60	19	26	26	43%
Non-Screenline	130	87	93	94	72%
Total	190	106	119	120	63%
Inner Modelled Area	43	36	37	37	86%

Table 5.19 Modelled vs. observed individual count comparison, validation sites, PM peak: cars

	No. sites	Cars			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	60	23	28	28	47%
Non-Screenline	130	80	86	87	67%
Total	190	103	114	115	61%
Inner Modelled Area	43	32	34	34	79%

Table 5.20 Modelled vs. observed individual count comparison, validation sites, PM peak: all vehicles

	No. sites	All vehicles			
		No. sites GEH<5	No. sites DMRB pass	No. sites overall pass	% sites overall pass
Screenline	60	24	26	27	45%
Non-Screenline	130	81	84	85	65%
Total	190	105	110	112	59%
Inner Modelled Area	43	31	31	31	72%

Journey times

5.10.8 The predicted journey times from the model along the routes illustrated in Plate 4.15 were compared with the observed times from the Teletrac data for March 2016. The results are reported in Table 5.21 to Table 5.23; the times for cars and LGVs have been differentiated from the times for HGVs.

Table 5.21 Modelled vs. observed journey time summary statistics, AM peak

Difference	Light		Heavy	
	No pass	% pass	No. pass	% pass
<15% or less than 1 min difference	35	90%	35	90%
<30%	4	10%	4	10%
>30%	0	0%	0	0%
Total	39		39	

Table 5.22 Modelled vs. observed journey time summary statistics, inter-peak

Difference	Light		Heavy	
	No pass	% pass	No pass	% pass
<15% or less than 1 min difference	39	100%	39	100%
<30%	0	0%	0	0%
>30%	0	0%	0	0%
Total	39		39	

Table 5.23 Modelled vs. observed journey time summary statistics, PM peak

	Light		Heavy	
Difference	No pass	% pass	No pass	% pass
<15% or less than 1 min difference	37	95%	35	90%
<30%	2	5%	4	10%
>30%	0	0%	0	0%
Total	39		39	

5.10.9 These tables show that, overall, the LTAM is able to effectively predict journey times on key routes. This is the case for both light and heavy vehicles where the TAG guidance of 85% of routes is achieved for all time periods.

Statement of convergence

5.10.10 The challenge for the highway assignment model is that the time/cost of the routes available to each driver vary as the number of other vehicles using the links and junctions on the alternative routes for each trip also varies. The software iterates between assigning the 'best' route, recalculating the link and junction turn times and then re-assigning the trips. This carries on until convergence is reached, that is until there is very little difference in the resulting traffic flows and travel times/costs between iterations. It is important that the model converges, otherwise changes that are predicted by the model when the network is changed might not be due to the network changes but to the model 'stopping' at a different point. If the model had been stopped sooner or run for longer, it is possible that different traffic flows would have been predicted.

5.10.11 TAG guidance sets the acceptable base year convergence standards. These are shown in Table 5.24.

Table 5.24 TAG Summary of convergence measures and base model acceptable values

Measure of convergence	Base model acceptable values
Delta and % GAP	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P)<1%	Four consecutive iterations greater than 98%
Percentage of links with cost change (P2)<1%	Four consecutive iterations greater than 98%

5.10.12 The convergence of the highway assignment model is shown in Table 5.25 to Table 5.27 for each time period. The tables show that the model has met the DfT convergence criteria.

Table 5.25 Highway assignment model convergence statistics, AM peak

Iteration	Delta (%)	% GAP	% flows	% delays
48	0.0028	0.0052	98.9	99.5
49	0.0042	0.0046	98.7	99.5
50	0.0027	0.0034	98.8	99.6
51	0.0030	0.0046	99.0	99.6

Table 5.26 Highway assignment model convergence statistics, inter-peak

Iteration	Delta (%)	% GAP	% flows	% delays
47	0.0017	0.0024	98.7	99.7
48	0.0017	0.0019	98.8	99.7
49	0.0014	0.0024	99.0	99.7
50	0.0013	0.0024	98.7	99.7

Table 5.27 Highway assignment model convergence statistics, PM peak

Iteration	Delta (%)	% GAP	% flows	% delays
68	0.0020	0.0027	98.5	99.5
69	0.0019	0.0027	98.6	99.5
70	0.0018	0.0025	98.7	99.5
71	0.0022	0.0023	98.7	99.6

5.10.13 The highway assignment models converge well for all time periods and to a significantly tighter level of convergence than stipulated in guidance.

5.10.14 The LTAM highway assignment model predicts traffic flows and journey times for the base year across strategic routes to an acceptable level. The model is therefore considered to be appropriate for use in forecasting the potential impacts of the Project on the performance of the highway network.

5.11 Variable demand model

5.11.1 A variable demand model was considered to be an essential part of the LTAM because a high number of trips are likely to change their route and use the Project instead of the Dartford Crossing. This could cause significant change in traffic volumes and times on the network over a large area. The Dartford Crossing is already at capacity in the base year with high levels of congestion, so the introduction of the Project could have a significant impact on the journey time for trips using the Dartford Crossing.

5.11.2 The opening of a new river crossing is likely to result in a change in travel behaviour and an increase in the number of trips made across the River Thames. A variable demand model allows the LTAM to be used to predict these effects.

5.11.3 The variable demand model was created using the parameters set in TAG Unit M2.1 (DfT, 2020c). All the distribution and mode choice parameters are the 'median' values in Table 5.28 and Table 5.29 of TAG Unit M2.1.

5.11.4 Following section 5.6.17 of TAG Unit M2.1, time period choice has been set so that all variable demand segments have the same sensitivity to cost as mode choice.

5.11.5 As TAG does not contain any recommended values for the frequency response, the values used in the LTAM were taken from the Design Freeze 2 version of SERTM.

5.11.6 The distribution, mode and frequency response parameters used in the LTAM are set out in Table 5.28. The value of θ for the time period response was set to 1 for all user classes.

Table 5.28 The LTAM variable demand model parameters

Segment	Distribution		Other responses (mode-independent)	
	Car	PT	Mode	Frequency
HBEB	-0.067	-0.036	0.45	-
HBW	-0.065	-0.033	0.68	-
HBO	-0.090	-0.036	0.53	0.087
NHBEB	-0.081	-0.042	0.73	-
NHBO	-0.077	-0.033	0.81	0.066

5.11.7 The strength of the variable demand responses was tested by running the realism tests as set out in TAG Unit M2.1 (DfT, 2020c). These tests check how the model responds to changes in the cost of fuel for highway trips, in public transport fares and in journey times. Full details of these tests are provided in Appendix B: Transport Model Package (Application Document 7.7).

5.11.8 Running the tests allows the computation of the elasticity of demand in respect of changes in journey cost and times. For example, the elasticities with respect to the change in vehicle kilometres driven from a 10% increase in the fuel price is shown in Table 5.29.

Table 5.29 Final matrix-based fuel price elasticities of PCU kilometres

Internal zones to all destinations (OD, matrix calculation)				
Car elasticity	**Business**	**Commuting**	**Car other**	**Total**
AM	-0.09	-0.14	-0.38	-0.24
IP	-0.12	-0.19	-0.38	-0.31
PM	-0.09	-0.15	-0.32	-0.23
OP	-0.17	-0.20	-0.43	-0.34
All Day	-0.12	-0.16	-0.38	-0.29
Excl OP	-0.10	-0.16	-0.36	-0.27

5.11.9 The variable demand model meets the realism tests set out in TAG Unit M2.1. The LTAM also meets the convergence statistics both for the highway assignment model and for the iterations between the variable demand model and the highway assignment model.

5.11.10 The model has been assured by National Highways and is considered suitable for forecasting the future traffic flows and speeds on the Lower Thames Crossing and the wider transport network.

6 Traffic forecasts

6.1 Forecast years

6.1.1 The LTAM is used to predict the traffic flows, speeds and journey times on the road network in the Lower Thames area in the future. The model is first used to predict what is called the 'Do Minimum' scenario, which is where the Project is not built but where any changes to the road network and planned development that are forecast to go ahead (whether the new crossing is built or not) are included. When the Project is added to the model, this is known as the 'Do Something' scenario.

6.1.2 The forecast years are:

a. 2030 – the Project's proposed opening year

b. 2037 – an interim year used in the economic appraisal

c. 2045 – the Project's design year being 15 years after opening

d. 2051 – the final forecast year. This is the furthest into the future for which the DfT publishes traffic growth forecasts in NTEM v7.2.

6.1.3 The DCO application has been developed on the basis of a 2030 opening year. This assumes consent is granted in 2024. Following the DCO Grant, there would be preparatory works, referred to in the draft DCO as preliminary works taking place in 2024. The main construction period for the Lower Thames Crossing would start in early 2025, with the road being open for traffic in late 2030. Construction may take approximately six years, but as with all large projects, there is a level of uncertainty over the construction programme, which would be refined once contractors are appointed and as the detailed design is developed.

6.2 Future year networks

Highway networks

6.2.1 The highway networks for future years were produced by including any highway schemes that have a high degree of certainty to be constructed in the future. National Highways, TfL and the local authorities in the area were contacted about their future investment plans, and their schemes included if funding had been allocated and a final route chosen (in the case of National Highways schemes, a Preferred Route Announcement). The schemes are shown in Plate 6.1 to Plate 6.3.

Plate 6.1 Transport schemes in core scenario (south)

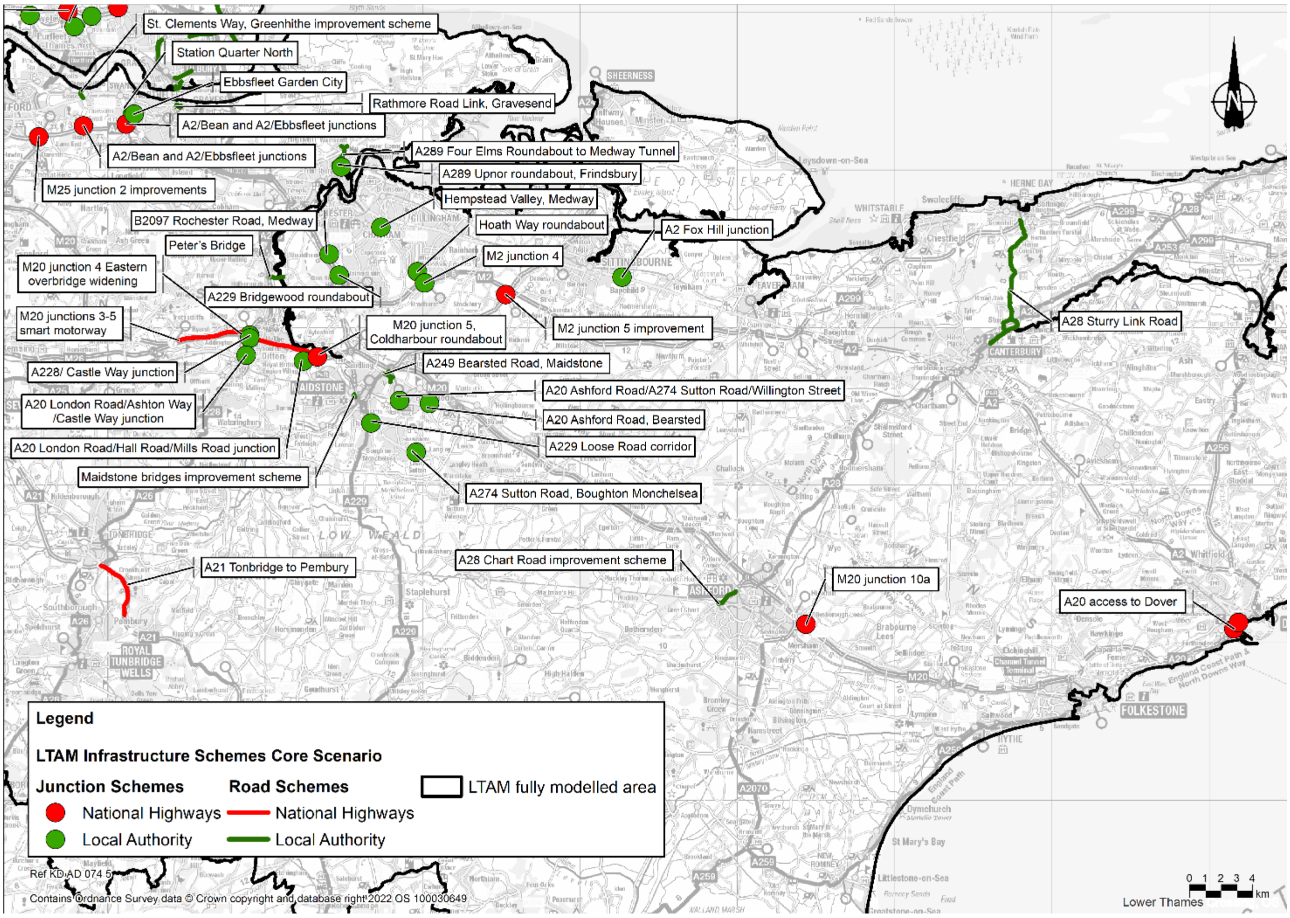


Plate 6.2 Transport schemes in core scenario (west)

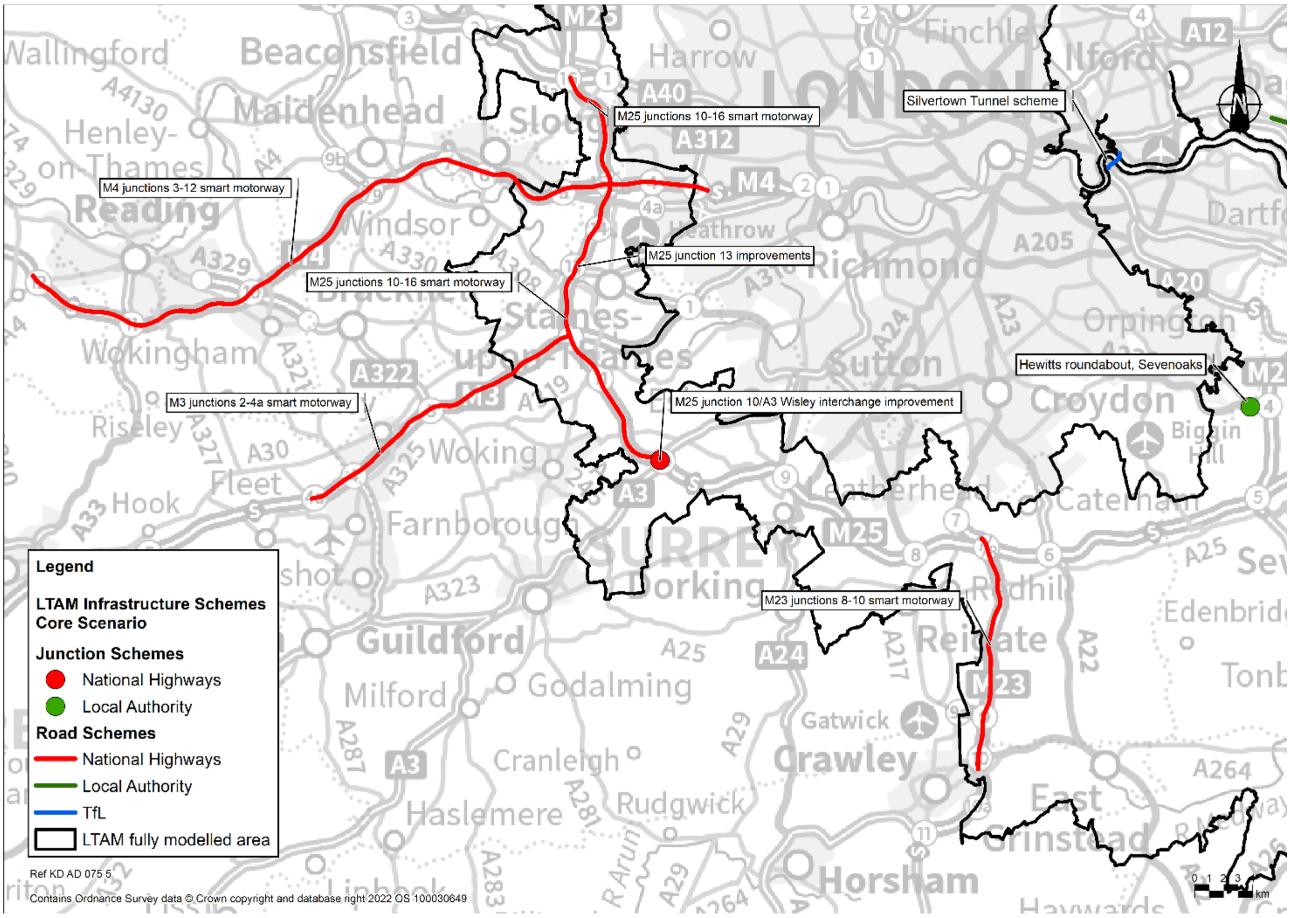
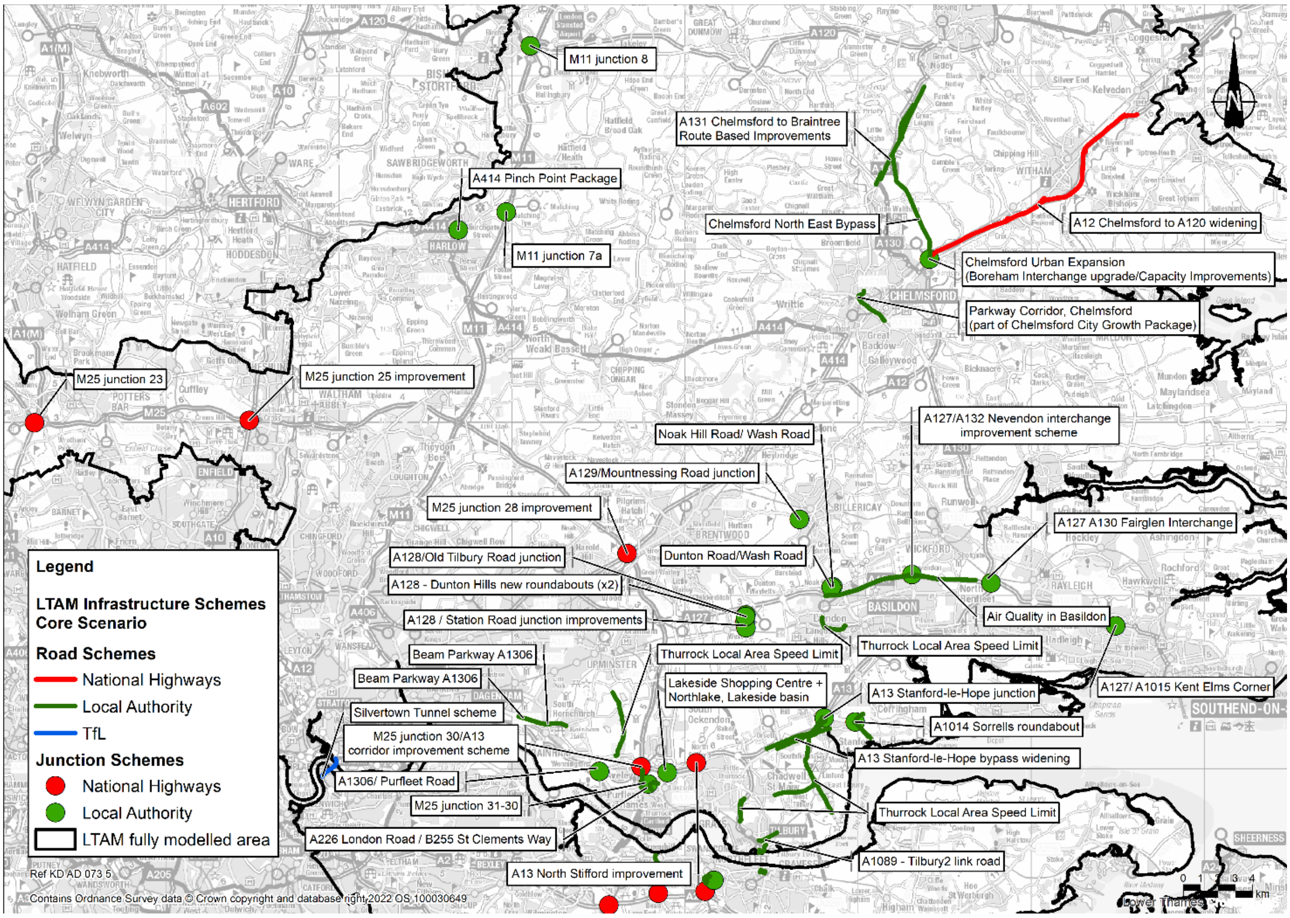


Plate 6.3 Transport schemes in core scenario (north)



Public transport networks

6.2.2 Public transport networks for future years were produced with current service levels but updated to include the Elizabeth Line (Crossrail) and High Speed 2.

Charges in the model

6.2.3 In the model, the charge at the Project is the same as at the Dartford Crossing. The charges at Dartford and the Lower Thames Crossing have been assumed to rise in line with the Retail Price Index, with the full increase being in place in each of the forecast years. All other assumptions relating to charges remain as in the base model, with the exception of the Gravesham and Thurrock area where residents who use the Project would receive a discount.

6.2.4 A charge is applied in the model at the new Silvertown Tunnel and the Blackwall Tunnel in accordance with TfL's plans for charging at both crossings when the Silvertown Tunnel opens. The London Congestion Charge is also incorporated into the model.

6.3 Future year travel demand

DfT traffic growth forecasts

6.3.1 The future year trip matrices are produced by starting with the validated base year matrices and applying traffic growth factors by area within the model. These factors come from the DfT's National Trip End Model (NTEM). Further spatial information on the locations of this growth is provided by explicitly adding the trips associated with new developments into the future year matrices, with the overall total increase in the number of trips matching the total increase in the wider area forecast by the NTEM.

6.3.2 This is the method set out in TAG guidance. It is designed to ensure that all new road schemes in the country are assessed on a level playing field, with the forecast of the amount of traffic growth in different parts of the country coming from a single national traffic model. This approach means that scheme promoters cannot over-exaggerate the number of people using their schemes by using an exceptionally high forecast for the increase in the number of trips in their area.

6.3.3 The traffic forecasts produced by the DfT's NTEM are freely available through software known as the Trip End Model Presentation program (TEMPro) (DfT, 2020a). The version of traffic forecasts used for the expected growth in car trips is the TEMPro 7.2 set of growth factors.

6.3.4 The DfT website provides links to information about the NTEM and a copy of the zoning system. NTEM supplies the growth factors for the 7,201 Middle Layer Super Output Areas (MSOAs) in England and Wales drawn up by the Office for National Statistics.

6.3.5 The forecasts for traffic growth for each area are based on projections of population (from the Office for National Statistics), employment and housing numbers for each area, and forecast changes in car ownership rates. The model also uses information on the number of trips made per person derived from the NTS.

New developments

6.3.6 More detailed information on the spatial locations of this traffic growth is obtained by examining the locations of new developments that have been constructed since the model's base year of 2016 and those that have been given planning permission. Information on these developments was obtained by contacting the local authorities in the area and viewing their online planning portals for details of planning applications.

6.3.7 The developments explicitly included in the future year trip matrices are listed in the Uncertainty Log which is provided in Appendix C: Transport Forecasting Package (Application Document 7.7). The Uncertainty Log was finalised in September 2021 and reflects knowledge of future developments available at that time.

6.3.8 The Uncertainty Log also gives the assumed size of each development, such as the number of houses and the trip rate for each development, and the number of car trips per 100 houses into and out the site by time of day.

6.3.9 A map showing the new development sites in 2045 is presented in Plate 6.4. A more detailed map for Dartford, Gravesham and Thurrock is provided in Plate 6.5 and for Maidstone, Medway, Tonbridge and Malling in Plate 6.6.

Plate 6.4 Overall development locations in the LTAM study area

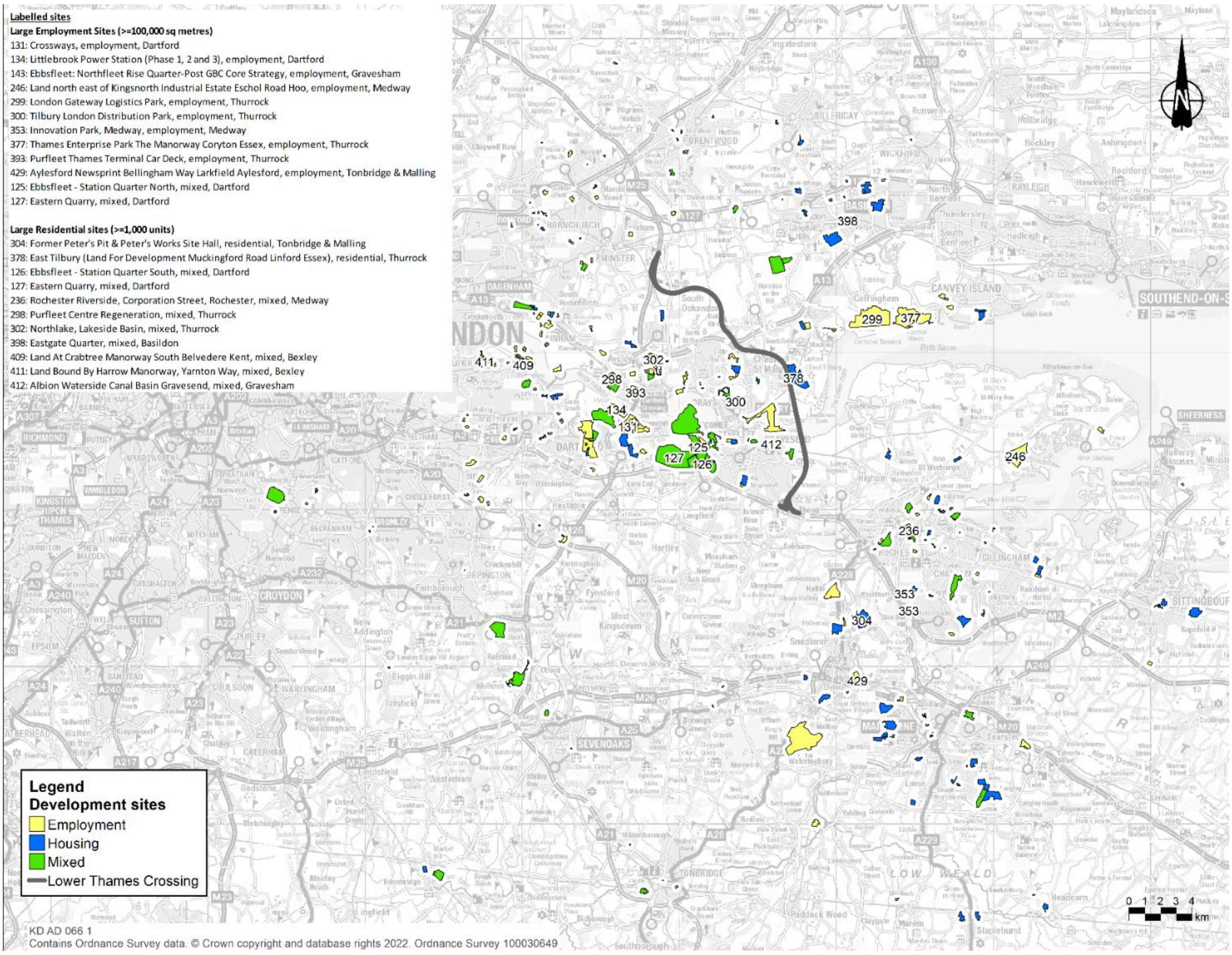


Plate 6.5 Development locations in Dartford, Gravesham and Thurrock

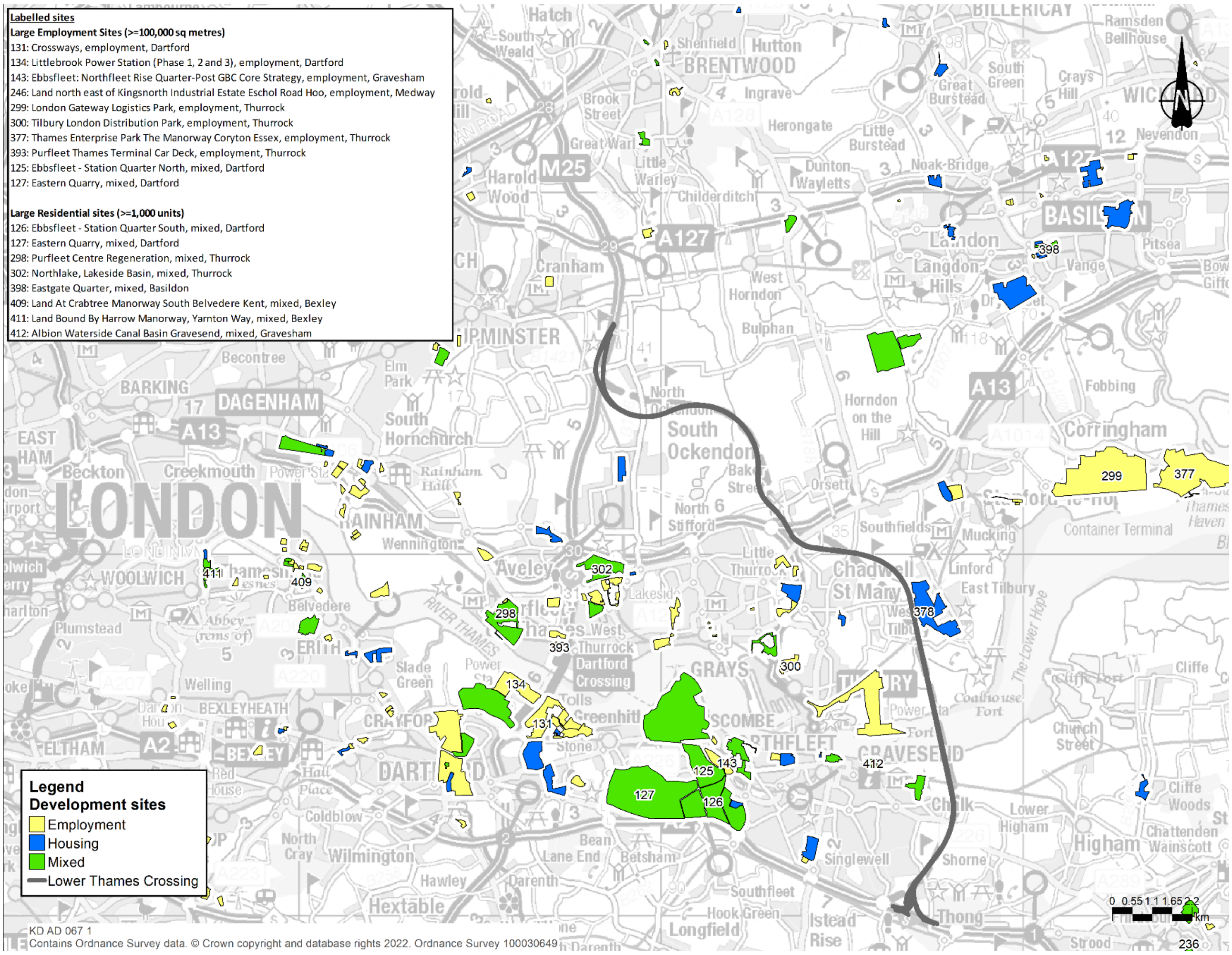
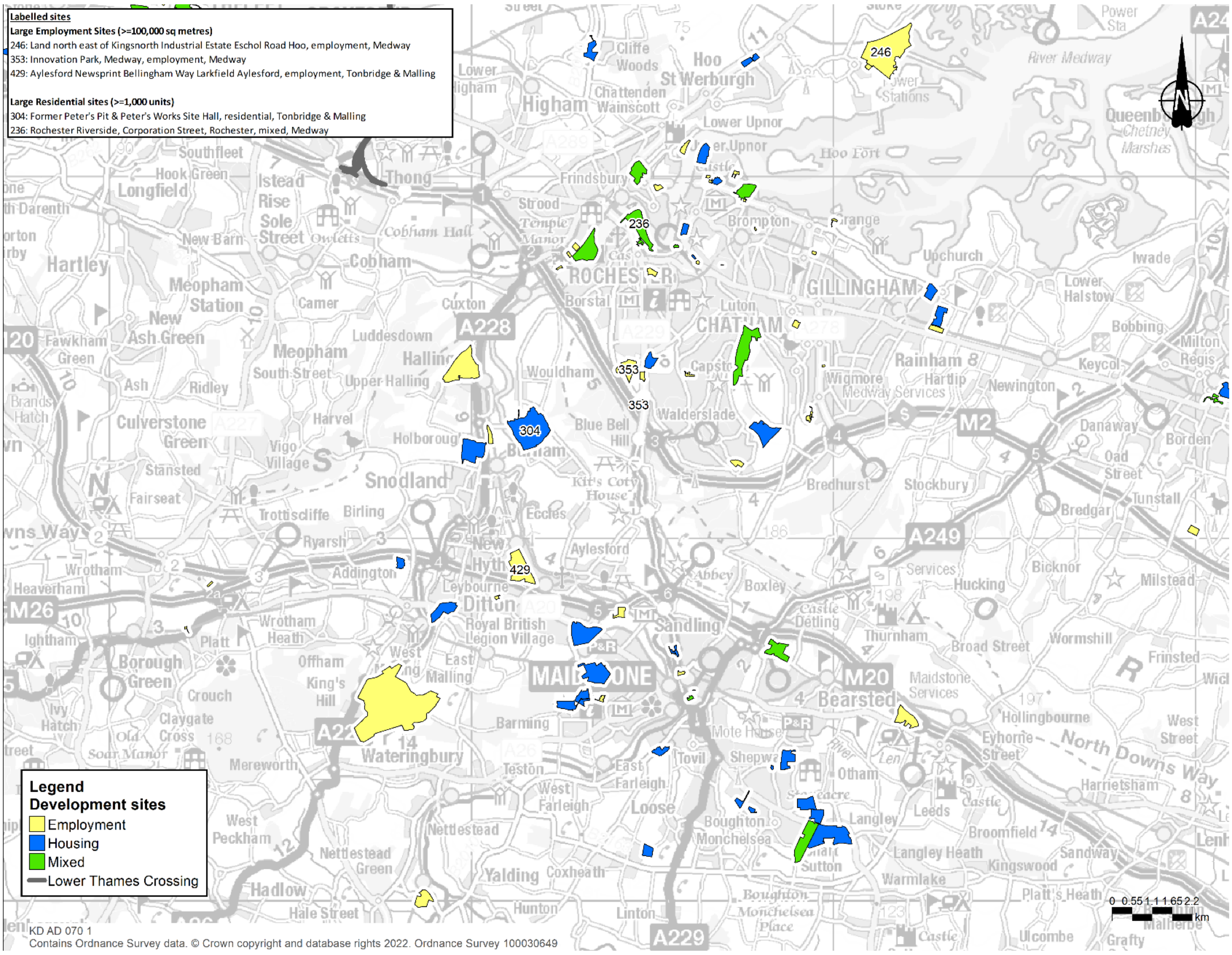


Plate 6.6 Development locations in Maidstone, Medway, Tonbridge and Malling



Light and Heavy Goods Vehicles

6.3.10 The forecasts for growth in LGVs and HGVs come from the DfT's National Transport Model, published in the Road Traffic Forecasts 2018. Documentation on methods used to produce these forecasts and the forecasts themselves can be downloaded from the DfT (2018a).

6.3.11 The DfT (2018b) also provides a useful visualisation tool for the forecasts and key input data.

6.3.12 The forecasts for the reference case, Scenario 1, are used in the LTAM as these are consistent with the traffic growth forecasts for car trips provided by TEMPro. Scenario 1 assumes central fuel prices, central Gross Domestic Product (GDP) growth forecasts and central Office for National Statistics population projections.

6.3.13 The growth forecasts for the number of LGVs is based on the growth in LGV trips for the previous two years, the forecast change in GDP per capita and average fuel costs, which take into account fuel prices, fuel efficiency and the proportions of different fuel types used by the LGV fleet.

6.3.14 The growth forecasts for HGVs come from the Great Britain Freight Model. These forecasts are based on the forecasts for the level of manufacturing output by industry sub-sector produced by the Department for Business, Energy and Industrial Strategy and forecasts for average HGV fuel costs.

6.3.15 The trip matrices produced by applying growth factors to the base year matrices are called the reference case matrices. These are then used as inputs into the LTAM, which applies the variable demand model to forecast how the matrices themselves may change as a result of traffic conditions on the network in the future.

6.4 Variable demand modelling

6.4.1 The future year matrices are run in the LTAM using the appropriate network, either the Do Minimum networks or the Do Something networks which include the Project. The forecast results in this report are for the 2045 future year, but details of all the model forecast years are available in Appendix C: Transport Forecasting Package (Application Document 7.7).

6.4.2 The variable demand modelling shows how the trip matrices themselves change in response to the changed journey times and costs in the future. Table 6.1 shows the change in the total number of trips in the matrices as a result of the variable demand modelling (VDM), with negative values shown in red. The results are for trips in the Fully Modelled Area and show a very small change in the total number of car trips made. There is no change in the number of LGV and HGV trips as these matrices are fixed and so are not included in the variable demand model.

Table 6.1 The LTAM SATURN matrix total comparison – Before and After VDM 2045 Reference, Do Minimum and Do Something hourly flows (PCUs)

User class	Time period	Reference case	VDM output matrix			VDM output matrix		
			(Core 2045 DM)			(Core 2045 DS)		
		Matrix total	Matrix total	Diff to Reference	Diff %	Matrix total	Diff to Reference	Diff %
Car Employers Business	AM	45,708	45,586	-122	-0.27%	45,696	-12	-0.03%
	IP	31,688	31,672	-16	-0.05%	31,693	4	0.01%
	PM	46,320	45,284	-1,036	-2.24%	45,363	-957	-2.07%
	OP	12,665	13,636	971	7.67%	13,616	951	7.51%
Car Commute Low Income	AM	36,797	37,106	309	0.84%	37,066	270	0.73%
	IP	20,847	21,258	411	1.97%	21,281	434	2.08%
	PM	38,657	39,020	363	0.94%	39,038	382	0.99%
	OP	7,697	8,019	321	4.17%	8,018	321	4.17%
Car Commute Medium Income	AM	77,415	77,093	-322	-0.42%	77,192	-223	-0.29%
	IP	31,994	32,206	213	0.66%	32,205	211	0.66%
	PM	76,604	76,150	-453	-0.59%	76,204	-400	-0.52%

User class	Time period	Reference case	VDM output matrix			VDM output matrix		
			(Core 2045 DM)			(Core 2045 DS)		
		Matrix total	Matrix total	Diff to Reference	Diff %	Matrix total	Diff to Reference	Diff %
	OP	11,796	12,142	346	2.94%	12,129	333	2.82%
Car Commute High Income	AM	74,051	72,915	-1,136	-1.53%	72,846	-1,205	-1.63%
	IP	27,194	27,044	-149	-0.55%	27,057	-136	-0.50%
	PM	75,081	73,389	-1,691	-2.25%	73,593	-1,488	-1.98%
	OP	10,170	10,341	171	1.68%	10,334	164	1.62%
Car Other Low Income	AM	90,661	92,119	1,458	1.61%	92,417	1,756	1.94%
	IP	125,942	129,767	3,825	3.04%	129,825	3,883	3.08%
	PM	135,210	134,698	-512	-0.38%	135,012	-198	-0.15%
	OP	40,427	44,691	4,264	10.55%	44,640	4,214	10.42%
Car Other Medium Income	AM	100,334	98,803	-1,531	-1.53%	98,997	-1,337	-1.33%
	IP	117,089	118,036	947	0.81%	118,195	1,106	0.94%
	PM	150,564	146,687	-3,878	-2.58%	146,887	-3,677	-2.44%
	OP	40,852	43,785	2,934	7.18%	43,735	2,883	7.06%
Car Other High Income	AM	95,274	92,011	-3,263	-3.43%	92,149	-3,125	-3.28%
	IP	95,677	95,006	-671	-0.70%	95,086	-591	-0.62%
	PM	135,177	129,479	-5,698	-4.21%	129,897	-5,280	-3.91%
	OP	35,713	37,792	2,079	5.82%	37,742	2,029	5.68%
Car Total	AM	520,240	515,633	-4,607	-0.89%	516,363	-3,877	-0.75%
	IP	450,431	454,991	4,560	1.01%	455,342	4,912	1.09%
	PM	657,612	644,707	-12,905	-1.96%	645,994	-11,618	-1.77%
	OP	159,320	170,406	11,086	6.96%	170,215	10,895	6.84%
LGV	AM	130,781	130,781	0	0.00%	130,781	0	0.00%
	IP	98,780	98,780	0	0.00%	98,780	0	0.00%
	PM	100,821	100,821	0	0.00%	100,821	0	0.00%
	OP	39,237	39,237	0	0.00%	39,237	0	0.00%
HGV	AM	58,542	58,542	0	0.00%	58,542	0	0.00%
	IP	64,351	64,351	0	0.00%	64,351	0	0.00%
	PM	36,953	36,953	0	0.00%	36,953	0	0.00%
	OP	25,221	25,221	0	0.00%	25,221	0	0.00%

Note: red text indicates negative values.

6.4.3 The difference in flows on the network for the morning peak hour, when these matrices are assigned, is shown in Plate 6.7 for the Do Minimum and Plate 6.8 for the Do Something. The flows for the other time periods present a similar pattern, details of which can be found in Appendix C: Transport Forecasting Package (Application Document 7.7).

6.4.4 Within Plate 6.7 to Plate 6.12, increases in flow are shown in green, and decreases in flow are shown in blue, and the thicker the line the greater the forecast change.

Plate 6.7 Assigned flow differences – Reference matrix vs. VDM output matrix (Core 2045 Reference vs. 2045 Do Minimum, AM peak)

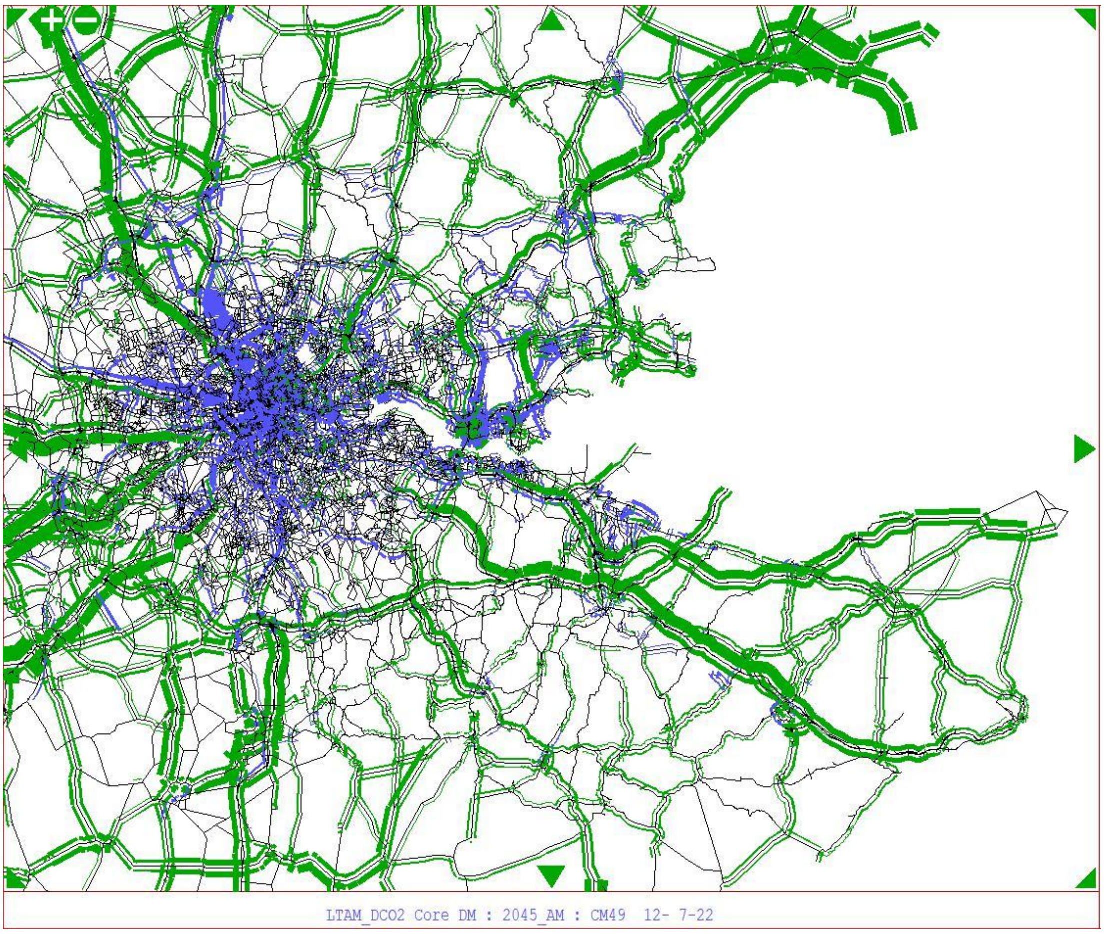
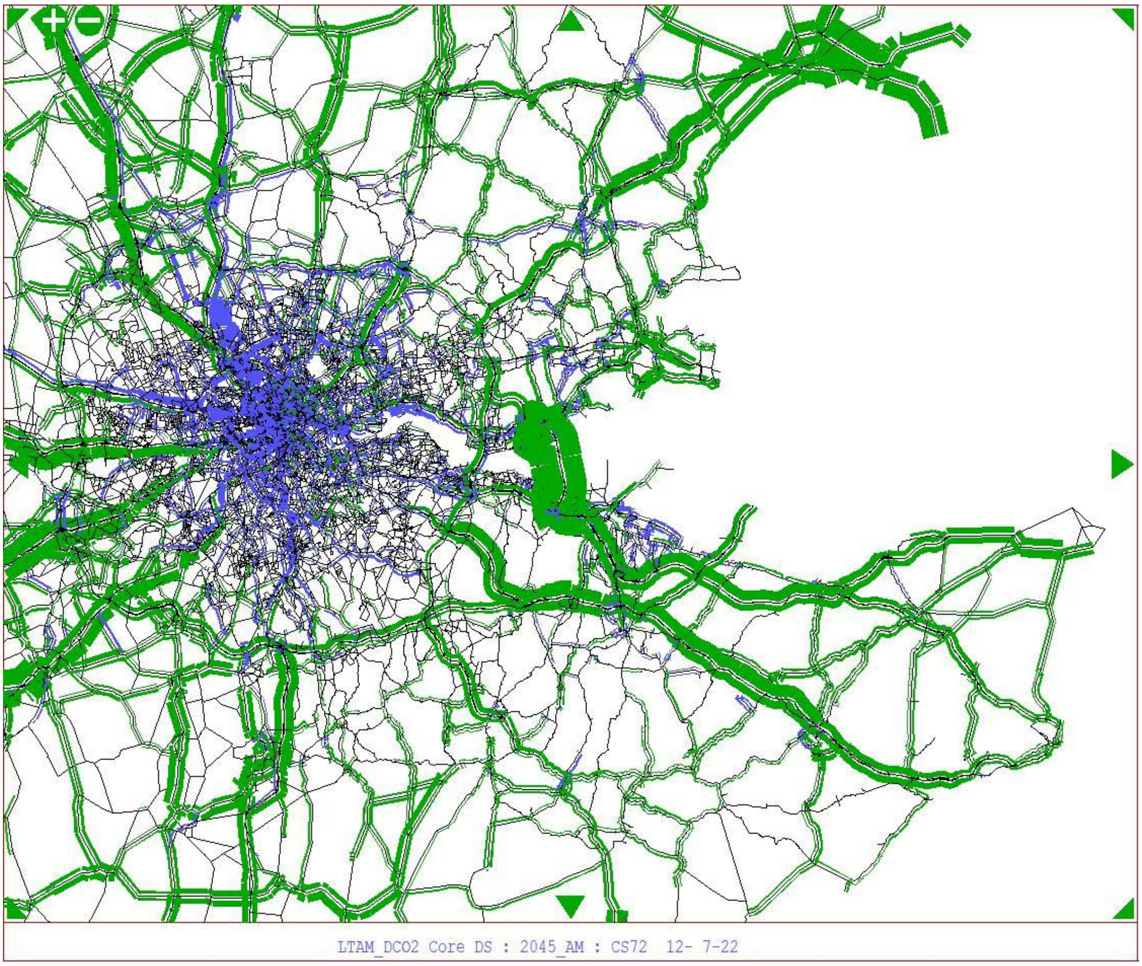


Plate 6.8 Assigned flow differences – Reference matrix vs. VDM output matrix (Core 2045 Reference vs. 2045 Do Something, AM peak)



6.4.5 In Plate 6.7 and Plate 6.8, the links in blue show where there is a reduction in flows on the network as a result of the VDM and the links in green show where there is an increase in trips. It should be noted that this change is caused by the VDM; it is not a change from the current year but rather shows the variation in flows in 2045 between keeping the matrices as they are (by applying the TEMPro growth factors) and allowing the matrices to change with behavioural responses to the changed costs and travel times on the network.

6.4.6 The results of the VDM show that in the future, as a result of changes in conditions on the network, there would be fewer trips on the roads in central London and other urban areas but more trips on the SRN.

6.4.7 Table 6.2 compares the network statistics for the assignment of the reference matrices to the networks with the assignments of the Do Minimum and Do Something matrices for the Fully Modelled Area.

6.4.8 Without using the variable demand model, the total distance driven in the Fully Modelled Area in 2045 in the morning peak hour is forecast to fall by -0.33% if the Project is built. This is the difference in total PCU kilometres, when assigning the reference matrices to the Do Minimum network, compared to assigning the reference matrices to the Do Something network without applying the VDM module within the LTAM. The introduction of the Lower Thames Crossing would lead to a reduction in distance driven of 48,733 PCU kilometres.

6.4.9 With the variable demand model, the total distance driven increases by 1.06% in the morning peak hour, 0.82% in the average inter-peak hour and 1.22% in the evening peak hour. This is mainly as a result of road users responding to the new capacity across the river and changing the destination of their trips. Some of these new trips are longer than the trips that would have been made without the Project. The appraisal of the Project uses the results from the VDM component of the LTAM.

Table 6.2 Key network statistics – Reference matrix vs. VDM output matrix (Core 2045) (Simulation Area Only)

Metric	Time period	Reference matrix (Core 2045)				VDM output matrix (Core 2045)			
		DM*	DS**	Diff	Diff%	DM***	DS****	Diff	Diff%
Time (PCU hours)	AM	324,949	318,673	-6,275	-1.97%	317,150	317,455	305	0.10%
	IP	229,890	226,802	-3,088	-1.36%	235,957	235,603	-354	-0.15%
	PM	343,709	337,002	-6,707	-1.99%	325,983	326,625	642	0.20%
	OP	74,066	73,883	-183	-0.25%	83,679	83,693	14	0.02%
Distance (PCU km)	AM	14,908,631	14,859,898	-48,733	-0.33%	15,059,440	15,220,741	161,301	1.06%
	IP	12,179,062	12,147,779	-31,283	-0.26%	12,667,716	12,772,716	105,000	0.82%
	PM	15,079,764	15,040,844	-38,920	-0.26%	15,109,576	15,296,170	186,594	1.22%
	OP	4,858,232	4,847,421	-10,811	-0.22%	5,595,459	5,609,832	14,374	0.26%
Average Speed (km/h)	AM	45.88	46.63	0.75	1.61%	47.48	47.95	0.46	0.96%
	IP	52.98	53.56	0.58	1.09%	53.69	54.21	0.53	0.97%
	PM	43.87	44.63	0.76	1.70%	46.35	46.83	0.48	1.03%
	OP	65.59	65.61	0.02	0.03%	66.87	67.03	0.16	0.24%

** These statistics are generated by assigning the reference matrix to the DM network.*

*** These statistics are generated by assigning the reference matrix to the DS network.*

**** These statistics are generated from the final VDM loop for the DM.*

***** These statistics are generated from the final VDM loop for the DS.*

Negative numbers are shown in red.

6.5 Future year traffic flows

Cross river traffic flows

6.5.1 The number of vehicles using the Dartford Crossing is forecast to be lower with the Lower Thames Crossing than without it. The total number of trips on both crossings would be higher than if only the Dartford Crossing were available. This is because, with the Project, more people in the catchment area of the new crossing would choose to cross the river than would do so without the new crossing. Thus, the number of trips using the Project would be higher than the number of trips that would otherwise have used the Dartford Crossing.

6.5.2 In addition, local residents in the surrounding catchment area would be more likely to use the Dartford Crossing once the Project was available as congestion at the Dartford Crossing would fall and travelling to the other side of the river would become a more attractive option. Table 6.3 shows the forecast traffic flows at the two crossings.

Table 6.3 Forecast peak and inter-peak two-way hourly flows at the Dartford Crossing and the Lower Thames Crossing (PCUs)

Period	Year	Without the Project	With the Project	
		Dartford Crossing*	Dartford Crossing*	Lower Thames Crossing
AM peak hour	2016	14,430	-	
	2030	16,020	13,280	8,040
	2045	16,260	14,870	8,940
Inter-peak hour	2016	11,790	-	
	2030	14,410	10,780	6,510
	2045	15,660	12,770	7,590
PM peak hour	2016	12,830	-	
	2030	15,310	12,020	7,990
	2045	16,280	13,540	8,830

**Flows at the Dartford Crossing (northbound only) are approaching the TMC. Note: Flows rounded to nearest 10. Source: Lower Thames Area Model (N90 (Run 1), CM49, CS72)*

6.5.3 The model predicts that even with these additional journeys:

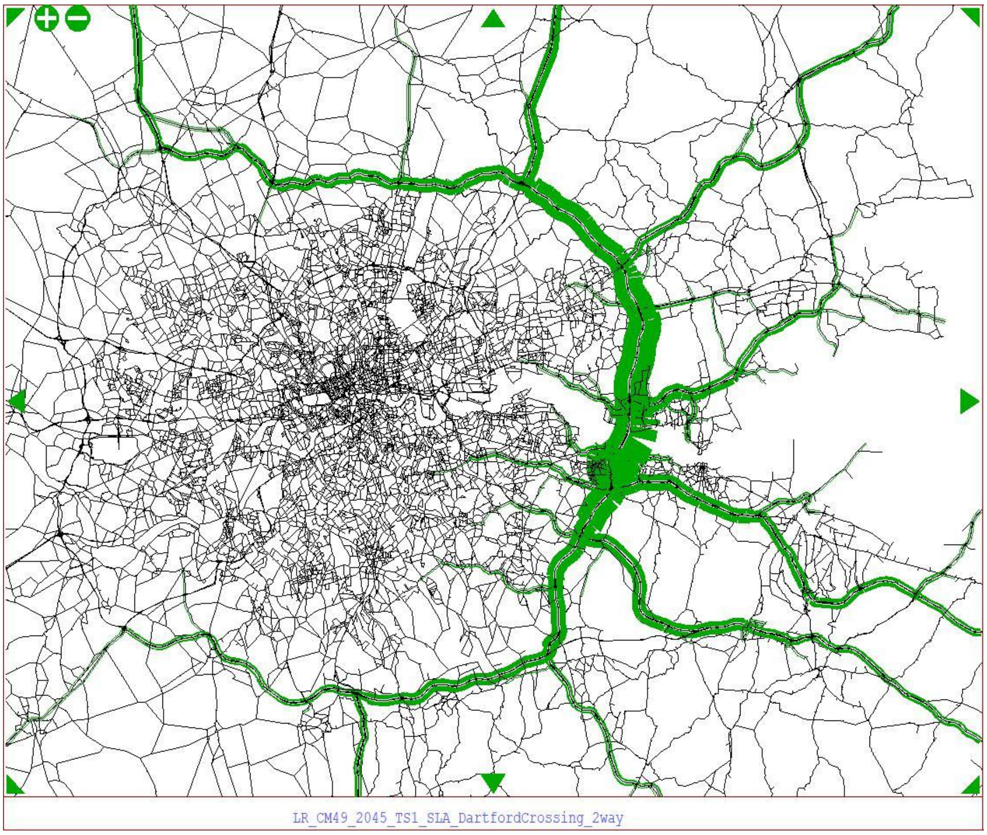
a. the overall level of traffic using the Dartford Crossing would fall in the peak hours by up to 21% in 2030 and up to 17% in 2045, when compared to the scenario without the Project.

b. average speeds on that part of the network would rise and journey times would become more reliable.

Trips using the Dartford Crossing and Lower Thames Crossing

6.5.4 The traffic forecasts for 2045 were examined to identify the trips that would use the Dartford Crossing without the Project. These trips across the Dartford Crossing in 2045 for the morning peak hour are shown in Plate 6.9.

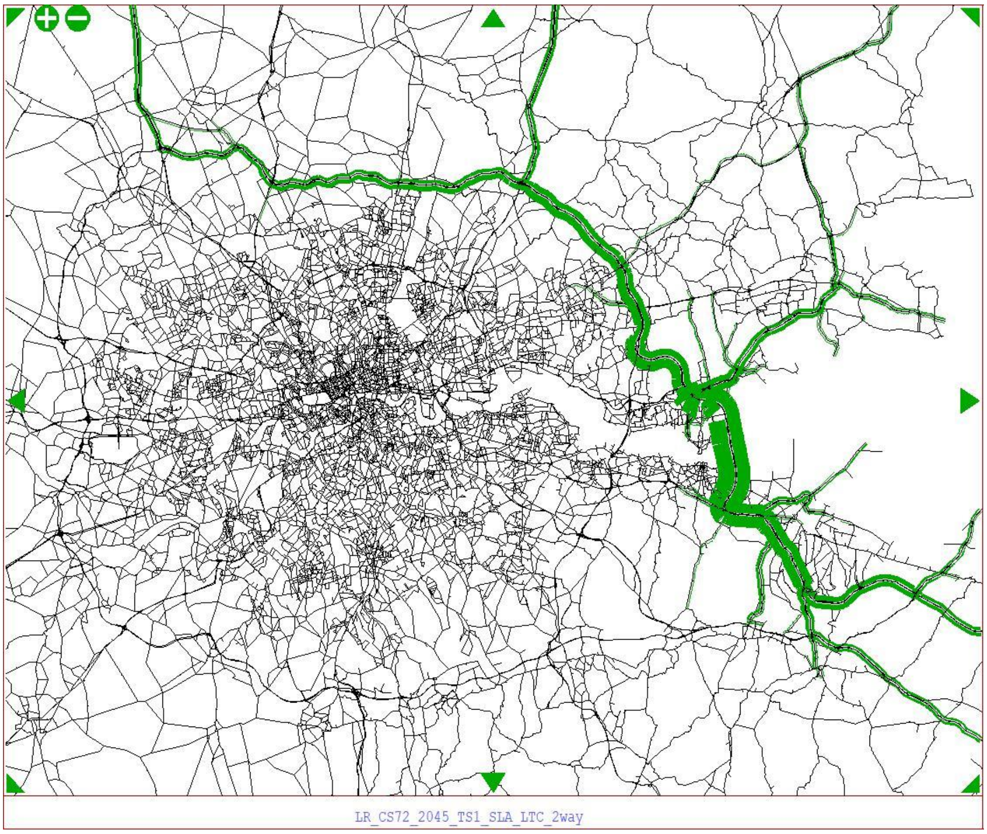
Plate 6.9 Flows across the Dartford Crossing without the Project, 2045, AM peak hour



6.5.5 Plate 6.9 and Plate 6.10 show the traffic flows across the Dartford Crossing and the Lower Thames Crossing, respectively, for 2045 in the morning peak hour. Appendix C: Transport Forecasting Package (Application Document 7.7) provides comparable plots for the other model years and time periods. The findings are similar in all scenarios, with traffic to/from much of Kent diverting to the new Crossing.

Plate 6.10 Flows across the Dartford Crossing with the Project, 2045, AM peak hour

Plate 6.11 Flows across the Lower Thames Crossing with the Project, 2045, AM peak hour



6.5.6 The origin and destination of trips by sector is shown in Table 6.4 and Table 6.5 for the two crossings (which are highlighted in orange). It is based on an analysis of trips using the tunnels northbound after the TMC at the Dartford Crossing and southbound on the Queen Elizabeth II Bridge. Table 6.4 shows that the proportion of trips using the Dartford Crossing to/from the A2 and M2 in Kent and the A13 to/from Essex would fall if the Project were available for use and that the proportion of longer distance traffic at the Dartford Crossing would rise.

Table 6.4 Primary corridors of movement for trips using the Dartford Crossing, 2045, AM peak two-way flow

Movement	Corridor	Do Minimum		Do Something	
		Flow (PCUs)	% of link flow	Flow (PCUs)	% of link flow
South of River	Local (inside M25)	2,576	17%	3,671	25%
	Local (outside M25)	2,029	13%	2,006	13%
	M25 south (junctions 2-3)	7,543	49%	7,864	53%
	A2/M2 to/from Kent	3,333	22%	1,327	9%
Total Flow	Dartford Crossing	**15,481**	**100%**	**14,868**	**100%**
North of River	London north	2,179	14%	2,984	20%
	Local traffic	1,538	10%	1,715	12%
	M25 north (junctions 30-29)	8,744	56%	7,635	51%
	A13 to/from Essex	3,020	20%	2,533	17%

6.5.7 Table 6.5 shows that the main catchment area for the Project south of the River Thames is to the east of the Lower Thames Crossing in Kent, accounting for 83% of trips. This matches the pattern shown in Plate 6.9 North of the river, the trips are mainly split between trips going to the north along the M25 (49%) and trips going east along the A13 (40%).

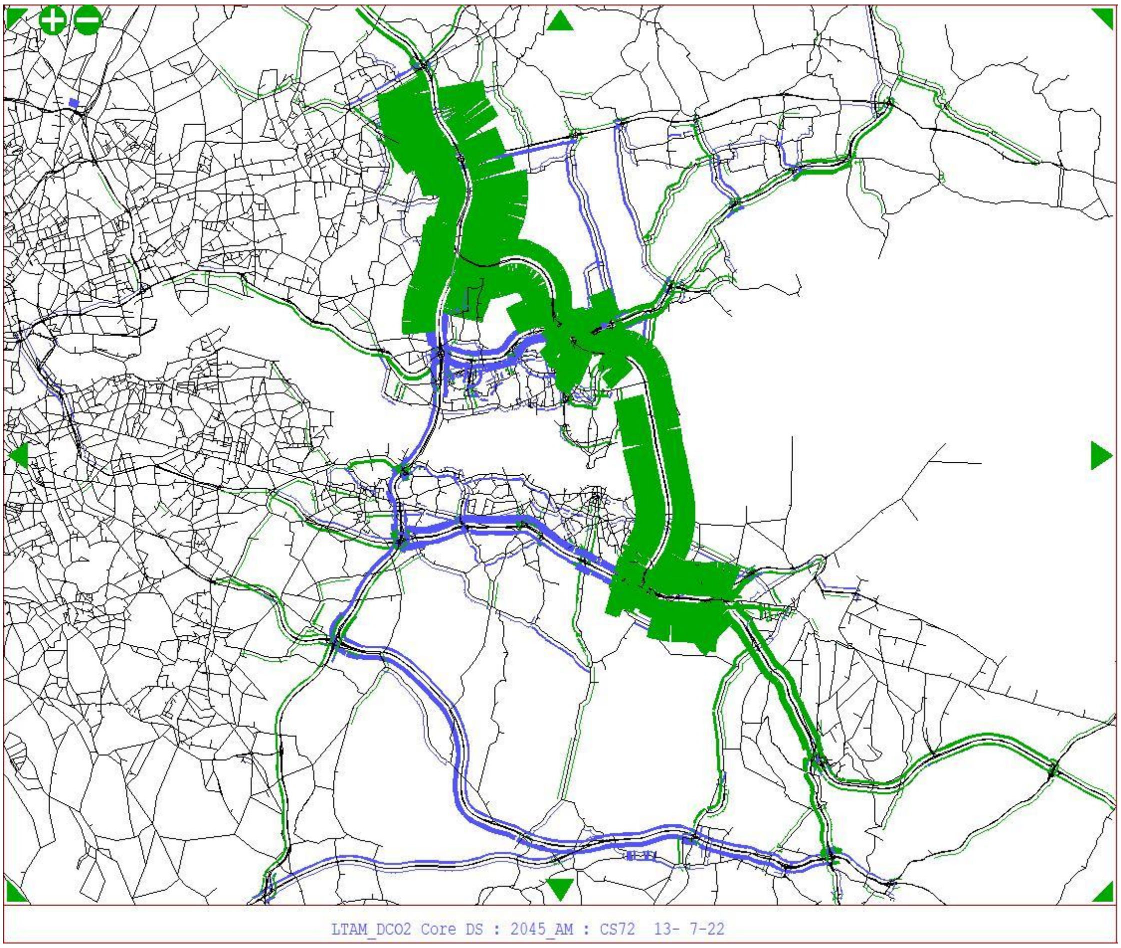
Table 6.5 Primary corridors of movement for trips using the Lower Thames Crossing, 2045, AM peak two-way flow

Movement	Corridor	Flow (PCUs)	% of link flow
South of River	Local Traffic	880	10%
	A2 west of the A122	625	7%
	A2 east of the A122	7,439	83%
Total Flow	Lower Thames Crossing	**8,944**	**100%**
North of River	A1089	833	9%
	A13 west of the A122	91	1%
	A13 east of the A122	3,602	40%
	M25 north of the A122	4,417	49%
	M25 south of the A122	0	0%

6.5.8 Plate 6.12 compares the cross-river flows in the Lower Thames area with and without the Project for the morning peak hour in 2045. Where the links are coloured blue, there is a reduction in flow and where the links are green, there is an increase in flow. The width of the link is proportional to the size of the change in flow. Links with less than a 100 PCUs change in flow are not coloured in the plot.

6.5.9 Plate 6.12 shows that the number of trips using the Project is greater than the number of trips that divert from the Dartford Crossing to the Project. It also shows that many of the trips using the Project start or finish in Kent or Medway.

Plate 6.12 Difference in traffic flow with and without the Project, 2045, AM peak hour



Changes in traffic flows across the Lower Thames area

6.5.10 The change in traffic flows on the network in 2045 between the Do Minimum and the Do Something, that is solely as a result of the Project, are shown in Plate 6.13 to Plate 6.15.

6.5.11 Roads are shown in varying shades of blue if traffic levels are forecast to decrease, and in yellow to red if they are forecast to increase; the darker the colour, the greater the change. The Project is shown in red as it is not present in the Do Minimum scenario.

6.5.12 Overall, the impact on traffic as a result of the Project is similar during the morning, evening and inter-peak periods, with more pronounced changes covering a wider area during the morning and evening peaks.

6.5.13 On many roads to the west of the Project, such as the A2, the A13, the Dartford Crossing and the M25 in Thurrock, the number of vehicles would fall if the Project opened. However, some roads on the approach to the Project, including the M2, A228 and A229, as well as roads to the east of the Project, such as the A13, the A2 and some sections of the M25, would experience an increase in traffic levels as travel across the River Thames became easier and more reliable.

Plate 6.13 Change in flows with the Project: AM peak (07:00–08:00), 2045

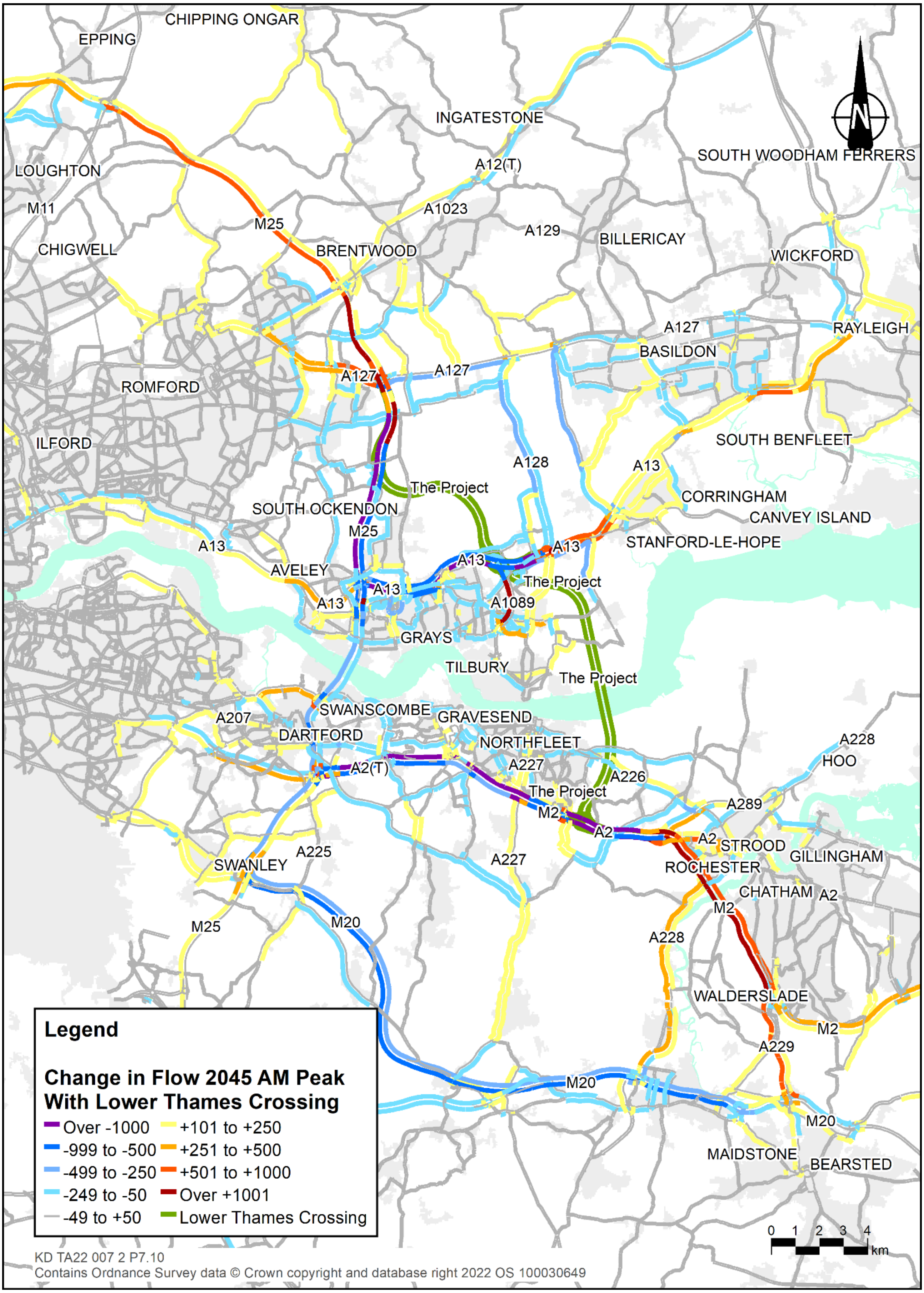


Plate 6.14 Change in flows with the Project: Inter-peak, 2045

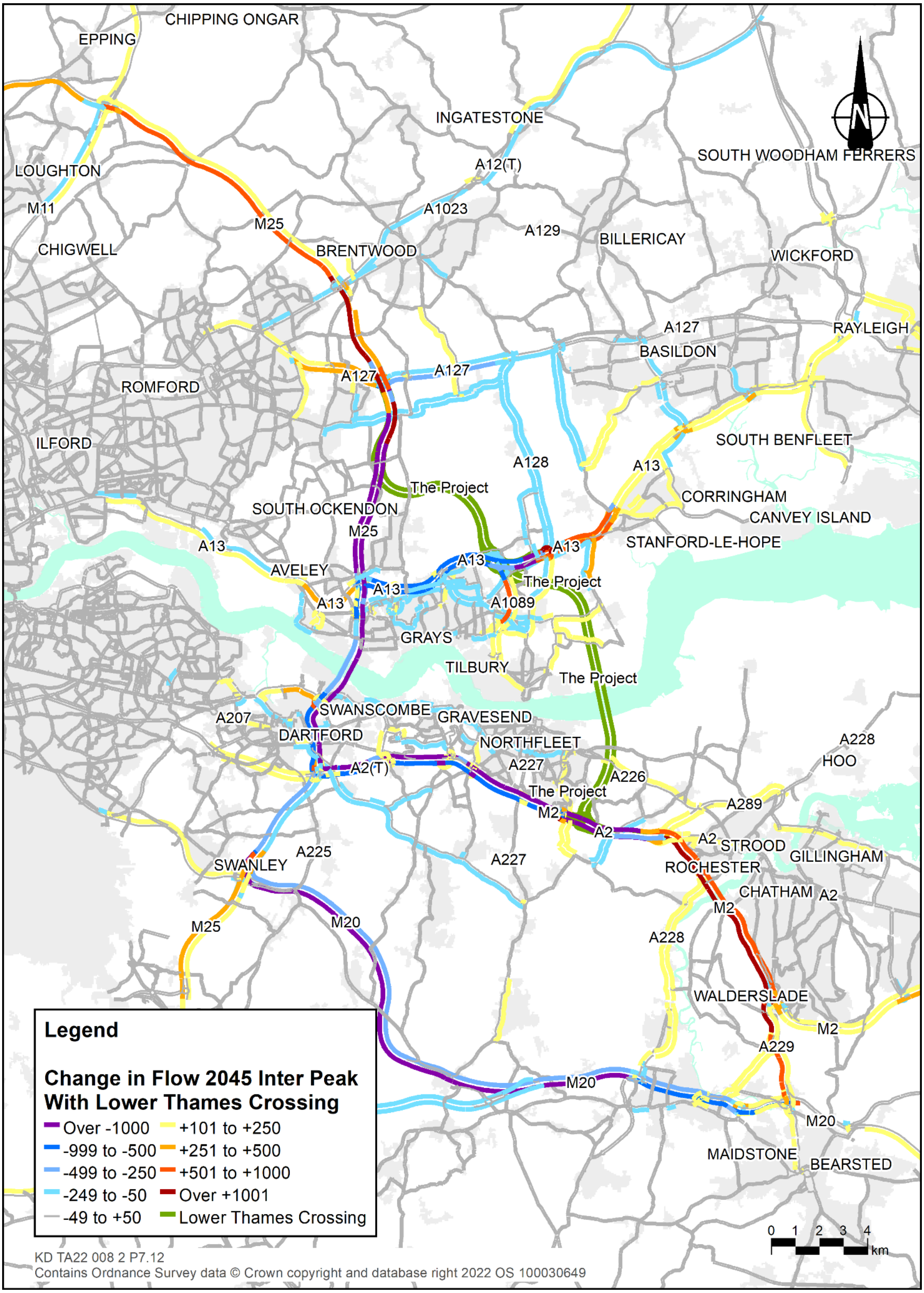
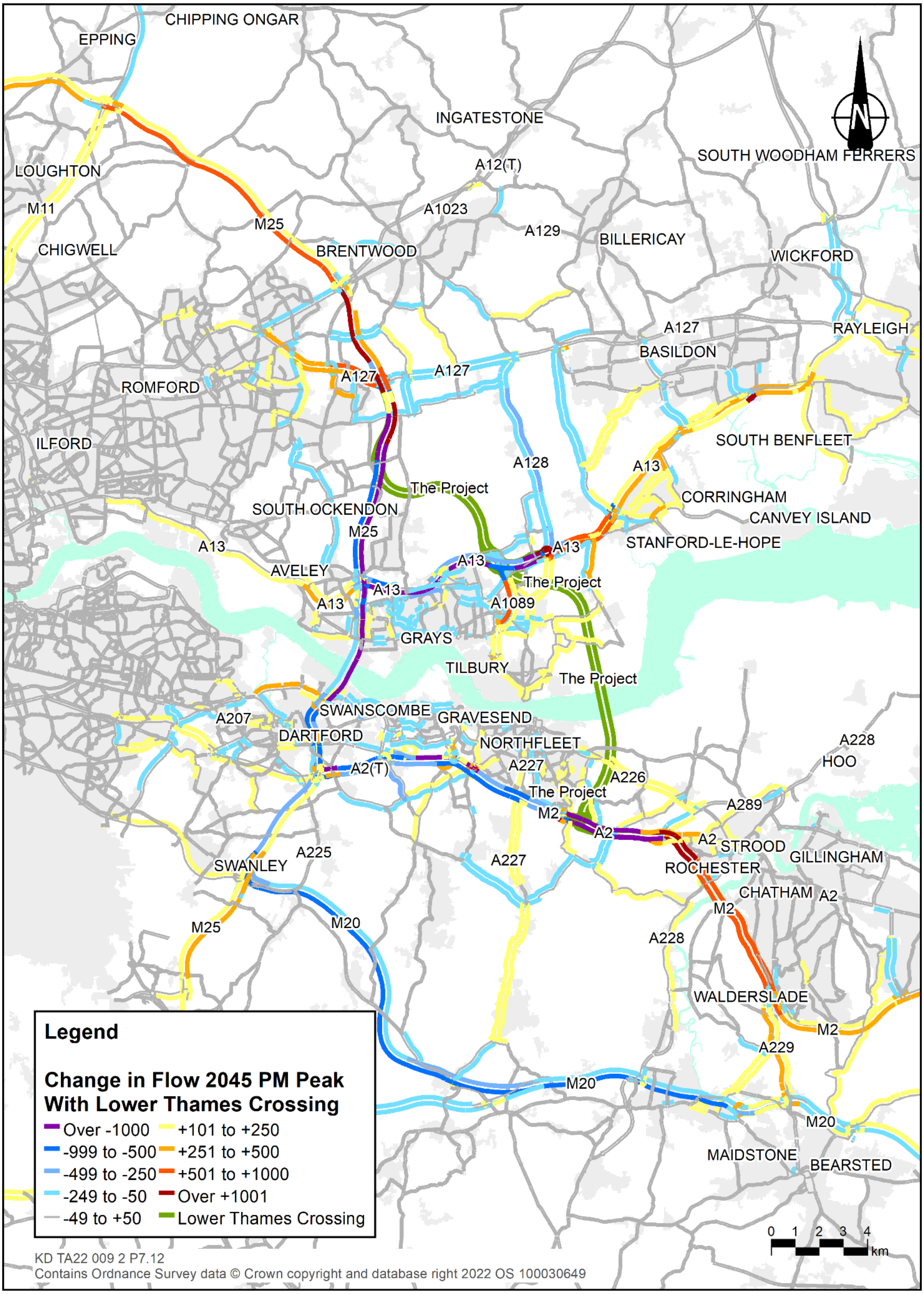


Plate 6.15 Change in flows with the Project: PM peak (17:00–18:00), 2045



6.5.14 The traffic flows on key roads in the area, both with and without the Project, and comparisons with the capacity on the road network are provided in Table 6.6 for each modelled time period in 2045. Plate 6.16 shows the locations of the key corridors that are referenced in Table 6.6.

6.5.15 Table 6.6 highlights in green links where the V/C ratio is below 0.85. Links in orange have a V/C ratio of between 0.85 and 0.95 and links in red have a V/C ratio of above 0.95. Negative values are shown in red text.

Plate 6.16 Identification of key corridor locations

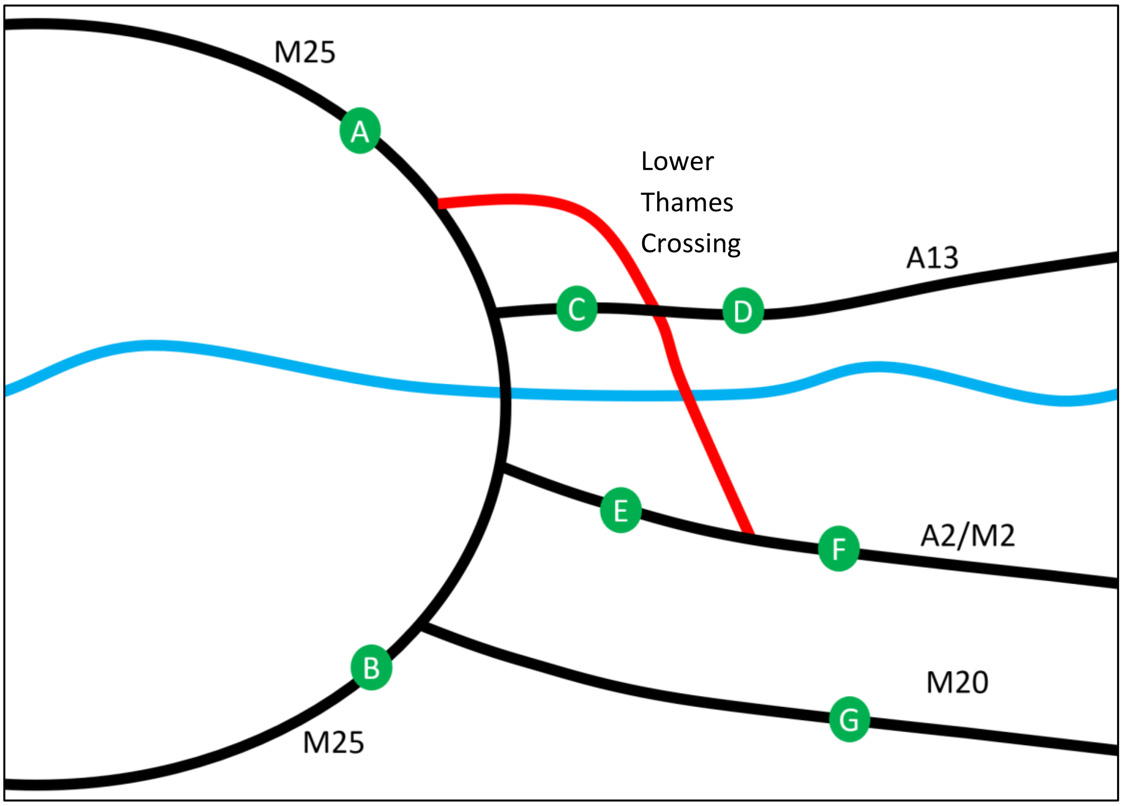


Table 6.6 Key corridor traffic flows, 2045 (PCUs)

Location	Location description	Time period	DM			DS			Flow differences	
			Flow	Effective capacity	V/C	Flow	Effective capacity	V/C	Diff	Diff %
A	M25 junction 29 to M25 junction 28 (NB)	AM	**7,814**	**9,180**	**0.85**	**9,124**	**9,180**	**0.99**	**1,310**	**17%**
		IP	7,098	9,180	0.77	8,273	9,180	0.90	1,176	17%
		PM	7,165	9,180	0.78	8,278	9,180	0.90	1,112	16%
	M25 junction 28 to M25 junction 29 (SB)	AM	7,930	9,115	0.87	8,115	9,180	0.88	184	2%
		IP	7,767	9,115	0.85	8,151	9,180	0.89	385	5%
		PM	8,040	9,115	0.88	8,485	9,180	0.92	445	6%

Location	Location description	Time period	DM			DS			Flow differences	
			Flow	Effective capacity	V/C	Flow	Effective capacity	V/C	Diff	Diff %
B	M25 junction 4 to M25 junction 3 (NB)	AM	5,747	6,850	0.84	5,940	6,850	0.87	193	3%
		IP	5,853	6,850	0.85	6,166	6,850	0.90	313	5%
		PM	6,431	6,850	0.94	6,582	6,850	0.96	151	2%
	M25 junction 3 to M25 junction 4 (SB)	AM	6,843	6,850	1.00	6,844	6,850	1.00	1	0%
		IP	5,723	6,850	0.84	5,872	6,850	0.86	149	3%
		PM	6,008	6,850	0.88	6,317	6,850	0.92	309	5%
C	A13 A126 to A1012 (EB)	AM	5,226	6,310	0.83	4,386	6,295	0.70	-840	-16%
		IP	5,283	6,299	0.84	4,575	6,280	0.73	-708	-13%
		PM	5,752	6,268	0.92	5,719	6,236	0.92	-33	-1%
	A13 A1012 to A126 (WB)	AM	6,155	6,360	0.97	5,469	6,360	0.86	-686	-11%
		IP	5,685	6,360	0.89	4,791	6,360	0.75	-894	-16%
		PM	6,015	6,360	0.95	4,971	6,360	0.78	-1,044	-17%
D	A13 Orsett Cock to Manor Way (EB)	AM	5,099	6,370	0.80	5,669	6,370	0.89	571	11%
		IP	4,404	6,370	0.69	5,207	6,370	0.82	803	18%
		PM	5,069	6,370	0.80	5,950	6,370	0.93	880	17%
	A13 Manor Way to Orsett Cock (WB)	AM	5,261	6,220	0.85	5,870	6,220	0.94	609	12%
		IP	4,570	6,220	0.73	5,300	6,220	0.85	730	16%
		PM	4,968	6,220	0.80	5,865	6,220	0.94	897	18%
E	A2 A227 to Gravesend East (EB)	AM	6,528	9,231	0.71	5,549	9,226	0.60	-979	-15%
		IP	6,862	9,189	0.75	5,758	9,181	0.63	-1,104	-16%
		PM	9,071	9,187	0.99	8,751	9,168	0.95	-321	-4%
	A2 Gravesend East to A227 (WB)	AM	7,258	7,296	0.99	6,542	7,002	0.93	-716	-10%
		IP	6,156	7,051	0.87	5,354	6,890	0.78	-802	-13%
		PM	6,260	6,824	0.92	5,796	6,701	0.87	-464	-7%
F	M2 junction 1 to M2 junction 2 (EB)	AM	5,829	8,561	0.68	6,699	8,420	0.80	871	15%
		IP	5,117	8,700	0.59	5,910	8,630	0.68	793	15%
		PM	6,651	8,619	0.77	7,858	8,441	0.93	1,206	18%
	M2 junction 2 to M2 junction 1 (WB)	AM	6,391	8,811	0.73	7,736	8,584	0.90	1,345	21%
		IP	4,478	8,860	0.51	6,279	8,707	0.72	1,801	40%
		PM	5,643	8,936	0.63	6,678	8,761	0.76	1,035	18%

Location	Location description	Time period	DM			DS			Flow differences	
			Flow	Effective capacity	V/C	Flow	Effective capacity	V/C	Diff	Diff %
G	M20 junction 3 to M20 junction 4 (EB)	AM	6,469	9,115	0.71	6,077	9,115	0.67	-392	-6%
		IP	6,435	9,115	0.71	5,974	9,115	0.66	-461	-7%
		PM	8,823	9,115	0.97	8,576	9,115	0.94	-247	-3%
	M20 junction 4 to M20 junction 3 (WB)	AM	8,853	9,115	0.97	8,203	9,115	0.90	-650	-7%
		IP	6,316	9,115	0.69	5,131	9,115	0.56	-1,185	-19%
		PM	6,287	9,115	0.69	5,504	9,115	0.60	-783	-12%

Journey times

6.5.16 The impact on individual journey times depends on the time of day that the journey is undertaken and differs depending on the origin and destination of the trip. All the changes in journey time, both positive and negative, for trips with any part of their journey in the Fully Modelled Area are considered in the economic appraisal in Chapter 7 of this report. Appendix C: Transport Forecasting Package (Application Document 7.7) reports the changes in journey times for a representative sample of journeys. Some key insights from this analysis are presented here.

6.5.17 At the Dartford Crossing, journey times would be shorter in the future with the Project than without it. The predicted average journey time in the morning peak hour in 2030 between the M25 junction 2 (with the A2) south of the River Thames and the M25 junction 31 (for Lakeside Shopping Centre) north of the River Thames is forecast to fall from 13 minutes to seven minutes if the Project is built. By 2045, the journey time would be almost halved from around 16 minutes without the Project to just under eight minutes with the Project.

6.5.18 If the Project is not built, it is expected that the high levels of traffic using the Dartford Crossing could lead to a higher number of incidents and more days where traffic conditions are worse than typically experienced.

6.5.19 If the Project is built, some trips would become quicker either because road users would now have a shorter journey due to using the Lower Thames Crossing or because much of their journey would be on parts of the network which would now have a reduced traffic flow and the journey times would thus be reduced.

6.5.20 If the Project is built, some trips would become longer if much of the journey was on links where the traffic flow had increased as a result of people changing the destination of their trips. However, the overall assessment of the impact of the Project on journey times, which is used in the economic appraisal, shows a reduction in total travel time on the network. This means that the total saving in time for the journeys that would have a reduction in travel time is greater than the total increase in journey time for trips that would become longer.

6.5.21 The change in travel times on a selection of links on the network are shown in Table 6.7 to Table 6.9 for the morning peak hour (with reductions shown in red text), the average inter-peak hour and the evening peak hour in 2045. Plate 6.17 identifies the locations referred to in the tables.

Plate 6.17 Link based journey times

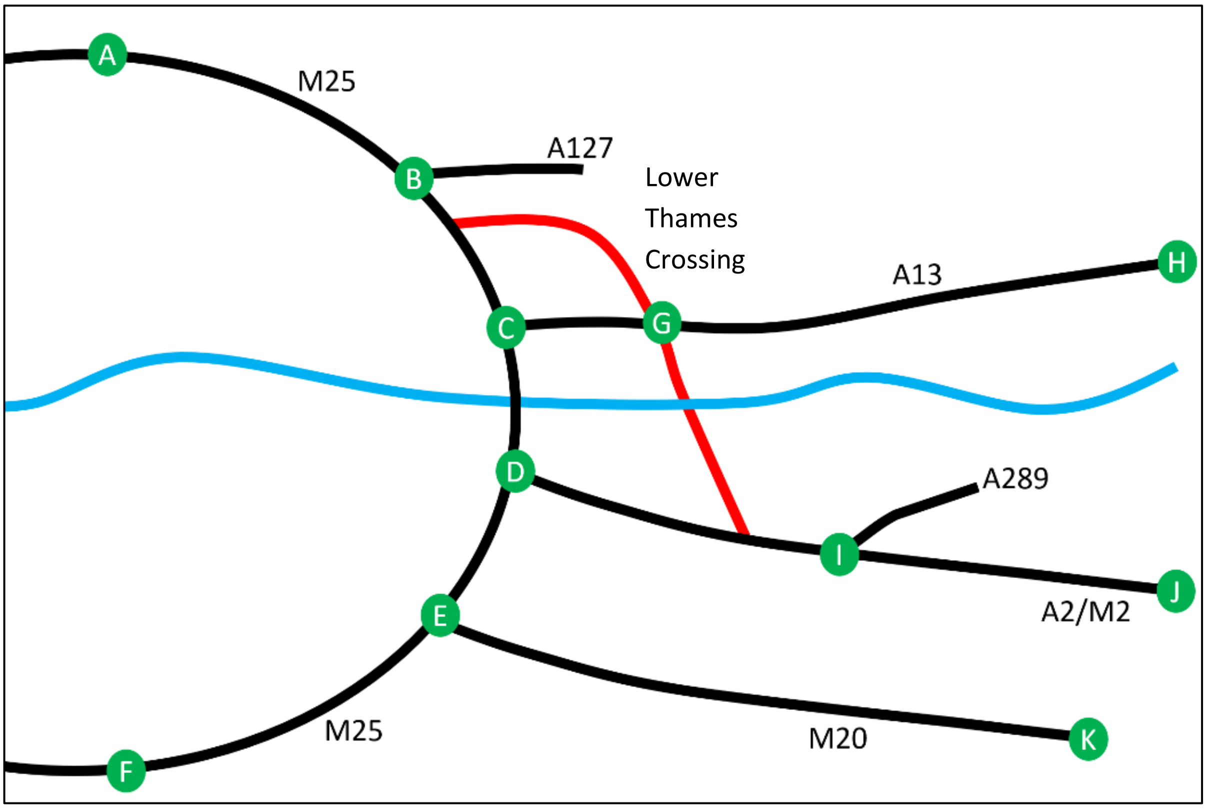


Table 6.7 Link based journey time comparison 2045, AM peak hour

Road	Movement	From	To	Difference							
				Time (mins)	Av. speed (km/h)	Time (mins)	Av. speed (km/h)	Time (mins)	Av. speed (km/h)	Time	Av. speed
M25 clockwise	A to B	M25 J26	M25 J29	17.5	80.7	18.2	77.7	0.7	-3.0	3.8%	-3.8%
	B to D	M25 J29	M25 J2	21.9	51.6	16.4	68.9	-5.4	17.2	-24.8%	33.3%
	D to F	M25 J2	M25 J7	32.0	70.8	34.1	66.4	2.1	-4.4	6.6%	-6.2%
M25 anti-clockwise	F to D	M25 J7	M25 J2	26.9	84.9	27.2	83.9	0.3	-0.9	1.1%	-1.1%
	D to B	M25 J2	M25 J29	21.5	52.2	14.7	76.8	-6.8	24.6	-31.6%	47.1%
	B to A	M25 J29	M25 J26	17.8	78.1	21.4	64.9	3.6	-13.2	19.9%	-16.8%
A13 EB	C to G	M25 J30	A1089	5.4	57.9	4.3	73.3	-1.1	15.5	-20.4%	26.7%
	G to H	A1089	A130	13.4	70.6	14.4	65.2	1.0	-5.3	7.7%	-7.5%
A13 WB	H to G	A130	A1089	15.2	60.4	17.4	52.2	2.3	-8.2	14.8%	-13.5%
	G to C	A1089	M25 J30	9.2	35.7	6.0	55.9	-3.3	20.3	-35.2%	56.8%
A2/M2 EB	D to I	M25 J2	M2 J1	9.5	96.1	9.1	101.5	-0.5	5.4	-4.9%	5.7%
	I to J	M2 J1	M2 J4	8.7	101.8	9.2	96.1	0.5	-5.7	6.0%	-5.6%
A2/M2 WB	J to I	M2 J4	M2 J1	9.4	96.5	10.6	85.6	1.1	-10.9	12.0%	-11.3%
	I to D	M2 J1	M25 J2	20.0	44.3	13.8	64.4	-6.2	20.1	-30.8%	45.4%
M20 EB	E to K	M25 J3	M20 J8	20.8	101.7	20.6	103.0	-0.3	1.3	-1.3%	1.3%
M20 WB	K to E	M20 J8	M25 J3	26.6	79.7	24.4	86.9	-2.2	7.2	-8.3%	9.0%

Table 6.8 Link based journey time comparison 2045, inter-peak hour

Road	Movement	From	To	Do Minimum		Do Something			Difference			Difference (%)		
				Time (mins)	Av. speed (km/h)	Distance (km)	Time (mins)	Av. speed (km/h)	Distance (km)	Time (mins)	Av. speed (km/h)	Distance	Time	Av. speed
M25 clockwise	A to B	M25 J26	M25 J29	17.2	82.3		17.8	79.4		0.6	-2.9		3.5%	-3.5%
	B to D	M25 J29	M25 J2	15.0	75.3		12.9	87.9		-2.1	12.6		-14.1%	16.8%
	D to F	M25 J2	M25 J7	26.4	85.9		26.6	85.3		0.2	-0.6		0.8%	-0.8%
M25 anti-clockwise	F to D	M25 J7	M25 J2	27.0	84.4		28.0	81.4		1.0	-3.0		3.7%	-3.6%
	D to B	M25 J2	M25 J29	21.3	52.7		13.9	81.0		-7.4	28.3		-34.5%	53.7%
	B to A	M25 J29	M25 J26	15.1	92.0		17.0	81.5		1.9	-10.5		12.6%	-11.4%
A13 EB	C to G	M25 J30	A1089	5.6	55.5		4.6	69.3		-1.1	13.8		-19.2%	25.0%
	G to H	A1089	A130	11.8	79.9		13.1	71.9		1.3	-8.0		10.7%	-10.0%
A13 WB	H to G	A130	A1089	11.9	76.9		13.4	67.8		1.5	-9.2		12.7%	-11.9%
	G to C	A1089	M25 J30	6.7	48.9		5.0	67.4		-1.8	18.5		-26.2%	37.7%
A2/M2 EB	D to I	M25 J2	M2 J1	9.8	93.6		9.1	101.7		-0.7	8.1		-7.5%	8.6%
	I to J	M2 J1	M2 J4	8.5	104.0		8.7	101.6		0.2	-2.4		2.4%	-2.3%
A2/M2 WB	J to I	M2 J4	M2 J1	8.6	106.1		8.9	101.4		0.3	-4.7		3.9%	-4.4%
	I to D	M2 J1	M25 J2	12.2	72.8		9.5	94.1		-2.7	21.3		-22.2%	29.3%
M20 EB	E to K	M25 J3	M20 J8	20.5	103.2		20.3	104.4		-0.2	1.2		-1.1%	1.1%
M20 WB	K to E	M20 J8	M25 J3	20.7	102.5		20.2	105.2		-0.5	2.6		-2.5%	2.6%

Table 6.9 Link based journey time comparison 2045, PM peak hour

Road	Movement	From	To	Do Minimum		Do Something		Difference		Difference (%)	
				Time (mins)	Av. speed (km/h)	Time (mins)	Av. speed (km/h)	Time (mins)	Av. speed (km/h)	Time	Av. speed
M25 clockwise	A to B	M25 J26	M25 J29	19.1	74.1	20.1	70.0	1.1	-4.1	5.7%	-5.5%
	B to D	M25 J29	M25 J2	17.7	63.8	13.8	82.3	-4.0	18.5	-22.3%	29.1%
	D to F	M25 J2	M25 J7	25.2	90.0	26.0	87.2	0.8	-2.8	3.2%	-3.1%
M25 anti-clockwise	F to D	M25 J7	M25 J2	32.1	71.0	32.8	69.5	0.7	-1.5	2.2%	-2.1%
	D to B	M25 J2	M25 J29	20.3	55.4	14.5	77.6	-5.7	22.3	-28.2%	40.2%
	B to A	M25 J29	M25 J26	14.9	93.6	16.5	84.4	1.6	-9.3	10.7%	-9.9%
A13 EB	C to G	M25 J30	A1089	8.9	35.2	5.8	54.1	-3.0	18.8	-34.2%	53.4%
	G to H	A1089	A130	13.3	71.1	15.0	62.8	1.7	-8.3	12.8%	-11.7%
A13 WB	H to G	A130	A1089	12.7	72.0	15.0	60.6	2.3	-11.4	18.1%	-15.9%
	G to C	A1089	M25 J30	8.0	41.4	5.3	63.3	-2.7	21.9	-33.5%	52.9%
A2/M2 EB	D to I	M25 J2	M2 J1	15.3	59.8	11.6	79.7	-3.8	19.9	-24.6%	33.3%
	I to J	M2 J1	M2 J4	9.9	89.4	12.7	69.5	2.8	-19.9	28.6%	-22.2%
A2/M2 WB	J to I	M2 J4	M2 J1	9.0	101.3	9.3	97.6	0.3	-3.8	3.2%	-3.7%
	I to D	M2 J1	M25 J2	15.7	56.3	11.5	77.4	-4.2	21.0	-26.7%	37.3%
M20 EB	E to K	M25 J3	M20 J8	27.0	78.6	25.6	82.7	-1.3	4.1	-4.9%	5.2%
M20 WB	K to E	M20 J8	M25 J3	20.9	101.3	20.5	103.5	-0.4	2.1	-2.1%	2.1%

6.6 National uncertainty

6.6.1 The forecasts presented in this report are for Scenario 1 from the National Transport Model. The current methodology in TAG guidance for modelling uncertainty at the national level regarding future changes in traffic levels is to model a low growth scenario and a high growth scenario.

6.6.2 The low and high growth trip matrices are produced by applying a global adjustment factor to the core (Scenario 1) traffic growth matrices. This factor is derived for highway trips using TAG Unit M4 (DfT, 2019a). For highway trips, this can be represented using the formula:

$$2.5\% \times \sqrt{(Forecast\ Year - Base\ Year)}$$

6.6.3 For the low growth scenario, this adjustment is applied to reduce the number of trips in the matrices. For the high growth scenario, this adjustment is applied to increase the number of trips in the matrices.

6.6.4 The national uncertainty factors relate to global input assumptions in the National Transport Model, such as future rates of GDP growth and changes in fuel prices. The range in the number of trips produced by applying this adjustment factor covers most of the outcome scenarios explicitly modelled in the National Transport Model.

6.6.5 The forecast traffic flows at the Dartford Crossing and Project are shown in Table 6.10 for the low growth scenario and in Table 6.11 for the high growth scenario. These tables are directly comparable to Table 6.3 which shows the forecast cross-river flows for the core scenario.

6.6.6 The economic appraisal is carried out for the low and high growth scenarios, as well as for the core scenario.

Table 6.10 Forecast peak and inter-peak two-way hourly flows at the Dartford Crossing and the Lower Thames Crossing (PCUs), low growth scenario

Period	Year	Without the Project	With the Project	
		Dartford Crossing*	Dartford Crossing*	Lower Thames Crossing
AM peak hour	2016	14,430		
	2030	15,880	12,720	7,710
	2045	16,160	14,340	8,640
Inter-peak hour	2016	11,790		
	2030	13,780	10,080	6,120
	2045	15,090	11,900	7,070
PM peak hour	2016	12,830		
	2030	14,970	11,470	7,710
	2045	15,940	13,080	8,580

**Flows at the Dartford Crossing (northbound only) are approaching the TMC. Note: Flows rounded to nearest 10. Source: Lower Thames Area Model (N108 (Run 1), LM49, LS72)*

Table 6.11 Forecast peak and inter-peak two-way hourly flows at the Dartford Crossing and the Lower Thames Crossing (PCUs), high growth scenario

Period	Year	Without the Project	With the Project	
		Dartford Crossing*	Dartford Crossing*	Lower Thames Crossing
AM peak hour	2016	14,430		
	2030	16,150	13,850	8,210
	2045	16,320	15,140	9,170
Inter-peak hour	2016	11,790		
	2030	14,880	11,450	6,860
	2045	16,060	13,410	8,040
PM peak hour	2016	12,830		
	2030	15,610	12,510	8,170
	2045	16,330	13,800	9,030

**Flows at the Dartford Crossing (northbound only) are approaching the TMC. Note: Flows rounded to nearest 10. Source: Lower Thames Area Model (N108 (Run 1), HM49, HS72)*

6.7 Conclusions

6.7.1 The Project is forecast to have a significant impact on the operation of the highway network in the Lower Thames area. There would be a substantial reduction in the amount of traffic to/from Kent using the Dartford Crossing as these trips would switch to the Project. Some of the released capacity at the Dartford Crossing would be absorbed by an increase in shorter distance trips in the Dartford area and from within London as road users would switch to destinations on the other side of the river to make use of the newly available capacity. These movements are suppressed in the Do Minimum scenario by the congestion at the Dartford Crossing.

6.7.2 The Lower Thames Crossing tunnel has been designed with three lanes in both directions as the forecast 2045 level of traffic through the tunnels is greater than could be accommodated with only two lanes in the peak periods. The tunnel is also designed to allow all HGVs to use the tunnel without the need for escorts. The design of the tunnel and link roads to the SRN combined allow for the free flow of traffic across the River Thames at the A122 Lower Thames Crossing and would improve the performance at the Dartford Crossing.

6.7.3 The traffic forecasts produced using the LTAM were also used in the appraisal of the Project, which considers the social, environmental and economic impacts of the Project. These are reported in the following chapter of this report.

7 Economic appraisal

7.1 Introduction

7.1.1 This chapter sets out the economic appraisal of the Project. It summarises the information presented in Appendix D: Economic Appraisal Package (Application Document 7.7). In accordance with DfT guidance, the economic appraisal also presents the expected environmental and social impacts of the Project. The appendix contains four reports: Economic Appraisal Report, Appraisal Summary Table Report, Distributional Impact Appraisal Report and Level 3 Wider Economic Impacts Report.

7.1.2 The appraisal of the Lower Thames Crossing considers the impacts that are solely attributable to the Project. In terms of traffic forecasts, the appraisal considers the difference between what is termed the Do Minimum and the Do Something future conditions. The Do Minimum is the future scenario if the new crossing is not built, but where changes to the road network and planned developments that are forecast to go ahead (whether the new crossing is built or not) are included.

7.1.3 The Do Something is identical to the Do Minimum in all respects except that the highway network includes the Project. The land uses in the area are identical in the Do Minimum and Do Something.

7.1.4 The Economic Appraisal Report describes the impacts as the differences between the 'Without Scheme' and 'With Scheme' scenarios.

7.1.5 DfT sets out in its guidance well established methods for quantifying many of the impacts of the Project and giving them a monetary value. The combined monetary values of these benefits up to 60 years after the opening of the Project are all converted into 2010 prices and discounted back to 2010 values, referred to as 2010 prices and values. The DfT has set 2010 as the common base year to be used in transport appraisals.

7.1.6 The discount rates used are set by HM Treasury (2022) and for the central case appraisal are the following:

a. 3.5% for the first 30 years from the 2022 appraisal year and 3.0% thereafter for all impacts except human health impacts

b. 1.5% for the first 30 years from the 2022 appraisal year and 1.29% thereafter for human health impacts

7.1.7 All the monetary costs incurred in building, operating, maintaining and renewing the Project are treated in this way and then compared to the value of the benefits to produce the Benefit Cost Ratio (BCR) for the Project.

7.1.8 There are other impacts which can be quantified but for which the monetary values are less certain and some impacts that are best described in a qualitative manner. Some impacts are seen as positive and these are called 'benefits'. Other impacts are negative and these are called 'disbenefits' in the appraisal process.

7.1.9 A value for money assessment is made based on the BCR and on all benefits or disbenefits, which cover the anticipated social, environmental and economic impacts of the Project. These impacts are summarised in the Appraisal Summary Table (AST) for the Project. The AST is provided in the Combined Modelling and Appraisal Report - Appendix D - Economic Appraisal Package: Appraisal Summary Table Report (Application Document 7.7).

7.1.10 This summary of the appraisal first presents background information and key assumptions. Benefits which are given monetary values and used in the calculation of the BCR are described, followed by the costs of the Project. The other non-monetised impacts included in the transport appraisal are described. The BCR of the Project for the core scenario and sensitivity tests are then presented.

7.2 Background information

7.2.1 The Project appraisal is based on the following:

a. The methods used are those set out in the DfT's TAG.

b. The monetary values used, discount rates and forecasts of GDP growth are those set out in the DfT's (May 2022) TAG data book.

c. All benefits, revenues and costs are based on the Project design.

d. Benefits are calculated for seven days a week and 24 hours of each day.

e. The Project is open to traffic in 2030.

f. All monetised impacts are modelled and appraised for the standard appraisal period of up to 60 years after Project opening.

g. The charges for users of the Lower Thames Crossing are set at the same level as for the Dartford Crossing.

h. The charges at the Dartford Crossing and Lower Thames Crossing are assumed to increase in line with the Retail Price Index.

i. The costs of the Project reflect the government's commitment to fully fund the Project.

Software

7.2.2 The following software was used in the appraisal:

a. DfT's Transport Users Benefit Appraisal (TUBA) v1.9.17 software and installer with the TUBA Economics file v1.9.18, which is consistent with the DfT (May 2022) TAG databook v1.18 (May 2022), to estimate transport user and provider impacts

b. Costs and Benefits Appraisal - Light Touch (COBALT) version 2.3 to estimate accident impacts

c. Motorway Reliability Incidents and Delays (MyRIAD) version 2021 to estimate journey time reliability impacts

d. Wider Impacts Transport Appraisal (WITA) version 2.2 to estimate wider economic impacts

e. QUeues And Delays at ROadworks (QUADRO) 2019 version 4 release 17.0.1 to estimate transport user delays during maintenance periods

f. DfT's Active Mode Appraisal Toolkit (May 2022) to value the benefit of changes to footpaths, cycleways and bridleways

g. National Highways Carbon Valuation Toolkit version 1.4.2 to provide a monetary value for the greenhouse gas emissions from road users over the 60 years after the road opening and the Project's embodied carbon.

Annualisation

7.2.3 The LTAM transport model produces traffic flows, travel times and distances for each of the three modelled time periods:

a. The morning peak hour between 07:00 and 08:00

b. An average inter-peak hour between 09:00 and 15:00

c. The evening peak hour between 17:00 and 18:00

7.2.4 For the non-modelled hours, the most appropriate set of trip matrices was selected from the three modelled time periods based on the expected pattern of trips in the non-modelled hour.

7.2.5 The matrices were then scaled to the overall level of flow expected in that hour and assigned to the most appropriate network.

7.2.6 This assignment was then skimmed to produce the travel time, distance and charge matrices used in TUBA.

7.2.7 Seven time periods were treated in this manner; when combined with the original modelled time periods, this resulted in the creation of inputs that covered seven days a week and 24 hours of the day. Table 7.1 shows the 10 time periods used in the appraisal.

Table 7.1 Time periods used for appraisal

Time period	Classification	Hours
AM shoulder	AM	06:00–07:00
AM peak	AM	07:00–09:00
Inter-peak	IP	09:00–15:00
PM shoulder	PM	15:00–16:00 18:00–19:00
PM peak	PM	16:00–18:00
Weekday off-peak charge	OP	19:00–22:00
Weekday off-peak non-charge	OP	22:00–06:00

Time period	Classification	Hours
Weekend peak	WE	09:00–19:00
Weekend off-peak charge	WE	06:00–09:00 19:00–22:00
Weekend off-peak non-charge	WE	22:00–06:00

7.2.8 TAG default purpose splits were applied to the non-modelled hours, with the exception of the evening shoulder peak hours, which use the modelled evening peak hour journey purposes as they provided a more consistent profile for the journey purposes of trips.

7.3 Project benefits

Transport users

7.3.1 As a result of the Project, users of the transport system could experience changes to their:

a. journey times

b. journey distances, which affect vehicle operating costs

c. charges paid at river crossings or for entering the London congestion zone

7.3.2 Some travellers would experience a change in their journey time/cost because they would take a different route to reach the same destination. Others would experience a change because they would go to a different place, for example, they might now decide to cross to the other side of the river. Others might take the same route to the same place as they would have done before the Project, but the number of other vehicles on the roads they use would have changed and so their journey time would be different.

7.3.3 Road user journeys in the appraisal are divided into the following categories:

a. Car commuting trips

b. Car trips on employers' business

c. Other car trips

d. LGV trips

e. HGV trips

7.3.4 The impact on the journey times and distances of road users during the construction of the Project was forecast using LTAM and valued using the DfT's TUBA software. The impact of delays during planned maintenance were forecast using QUADRO and values using the DfT's TUBA software.

7.3.5 Table 7.2 shows the 60-year discounted value of the changes in travel time, vehicle operating costs and user charge impacts. The main impact is the change in travel time.

Table 7.2 Transport user benefits (£million, 2010 prices and values)

	Low growth	Core growth	High growth
Travel time	1,871.0	2,088.2	2,343.6
Vehicle operating costs	-64.2	-49.6	-24.3
User charge impacts	-57.0	-66.6	-79.2
Construction and maintenance delays	-140.8	-140.8	-140.8
Total	**1,608.9**	**1,831.2**	**2,099.3**

7.3.6 Table 7.3 shows the disaggregation of total user benefits (excluding construction and maintenance delays) by vehicle type for the low, core and high traffic growth scenarios.

7.3.7 Table 7.4 shows the disaggregation of total user benefits (excluding construction and maintenance delays) by journey purpose for the low, core and high traffic growth scenarios.

Table 7.3 Transport user benefits by vehicle type (£million, 2010 prices and values)

	Vehicle type	Low growth	Core growth	High growth
Benefits	Car	968.0	1,057.0	1,175.5
	LGV	322.4	374.6	437.9
	HGV	459.3	540.3	626.6
	Total	**1,749.7**	**1,971.9**	**2,240.1**
Share of total %	Car	55	54	52
	LGV	18	19	20
	HGV	26	27	28
	Total	**100**	**100**	**100**

Table 7.4 Transport user benefits by journey purpose (£million, 2010 prices and values)

		Low growth	Core growth	High growth
Benefits	Commuters	347.8	389.2	440.0
	Other users	423.8	459.4	507.0
	Business users	978.1	1,123.3	1,293.1
	Total	**1,749.7**	**1,971.9**	**2,240.1**
Share of total %	Commuters	20	20	20
	Other users	24	23	23
	Business users	56	57	58
	Total	**100**	**100**	**100**

Delays during construction and maintenance

7.3.8 Transport users would experience delays during the construction of the Project. A total disbenefit value of £130.8m (2010 prices and values) for construction delays has been calculated using TUBA.

7.3.9 The values of user benefits are split between commuters (£-25.8m), other users (£-30.5m) and business users (£-74.5m). These figures are included in the low, core and high traffic growth appraisal scenarios.

7.3.10 The delays to transport users for maintenance work on the Project were calculated using QUADRO software and estimated at -£10.0 million. This figure is included in the low, core and high traffic growth appraisal scenarios.

7.3.11 The delays during construction and maintenance are shown in Table 7.5.

Table 7.5 Construction and Maintenance Impacts on users (£million, 2010 prices and values)

	Commuters	Other users	Business users	All users
Construction Delays	-25.8	-30.5	-74.5	-130.8
Maintenance Delays	-1.8	-2.3	-5.9	-10.0
Total	-27.6	-32.8	-80.4	-140.8

Indirect tax benefits

7.3.12 As a result of the provision of the Project, the transport model predicts that more people would cross the River Thames and that overall the number of vehicle kilometres driven would increase. This would lead to an overall increase in use of fuel and government receipts from fuel duty and VAT. This would result in an increase in tax revenues of £43.5 million, discounted over 60 years from the Project opening date for the core growth scenario. This is set out in Table 7.6 together with the values for the low and high growth appraisal scenarios.

Table 7.6 Estimates of indirect tax revenues (£million, 2010 prices and values)

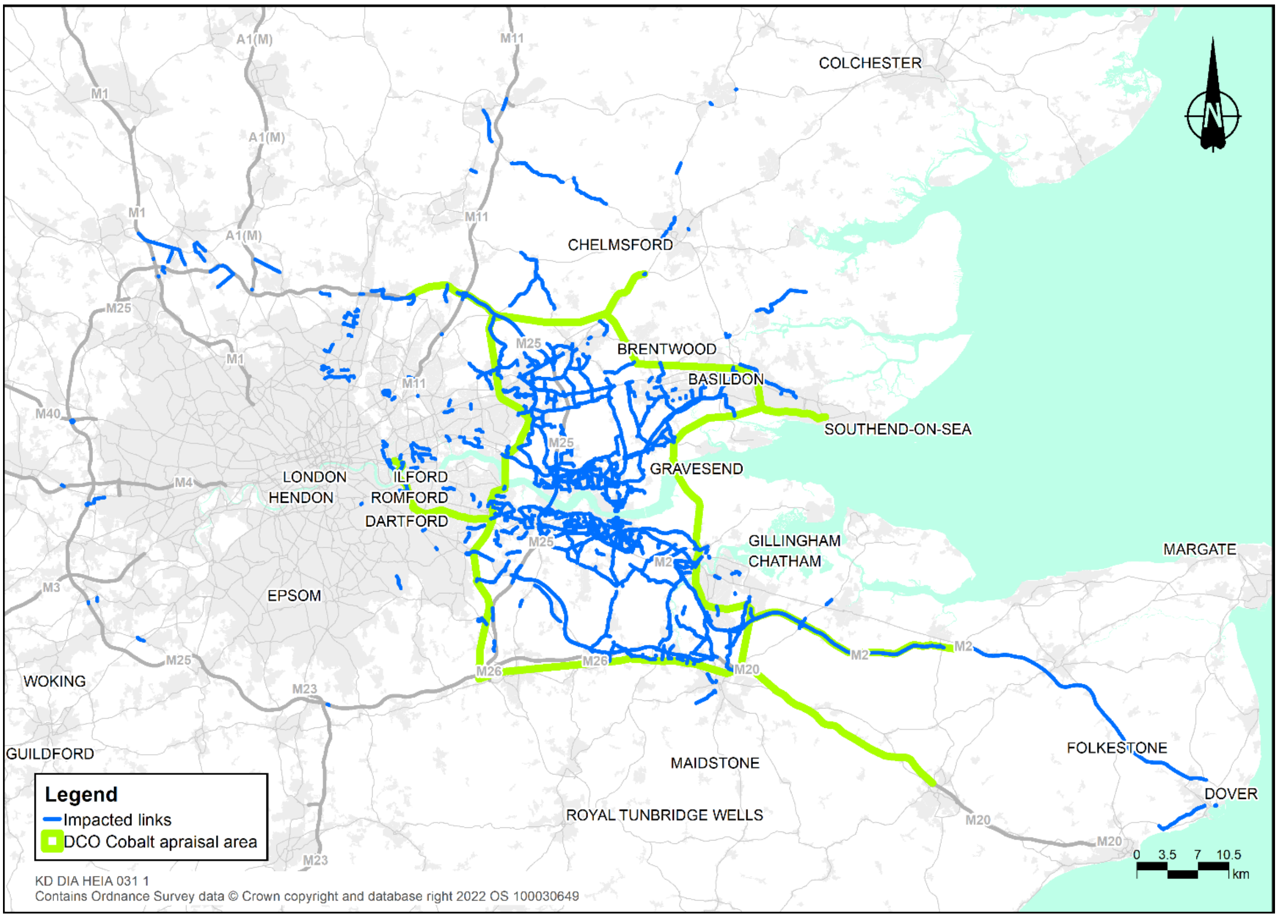
	Low growth	Core growth	High growth
Indirect tax revenues	50.1	43.5	34.2

Accidents

7.3.13 The number and severity of accidents is forecast by applying the relevant accident rate per million vehicle kilometres driven to the forecast number of kilometres driven on each road over the 60-year appraisal period. DfT's COBALT software applies accident rates by road type to the forecast traffic flows. For the appraisal, the main roads where there would be a significant change in traffic flow if the Project opens were each allocated the appropriate road type, and the change in the number and severity of accidents calculated. Each accident/casualty has a value which enables the value of the change in accidents to be calculated.

7.3.14 Plate 7.1 shows the roads included in the accident appraisal. The appraisal area is demarcated by a green boundary line and all impacted links, including additional main roads outside the appraisal area where there would be a significant change in traffic flow, are marked in blue.

Plate 7.1 Accident appraisal area



7.3.15 Table 7.7 shows the change in the number of casualties by severity type over the 60 years from the Project opening for the core traffic growth scenario.

Table 7.7 Change in the number of casualties, core traffic growth

Without Scheme				With Scheme				Change			
Fatal	**Serious**	**Slight**	**Rate/km**	**Fatal**	**Serious**	**Slight**	**Rate/km**	**Fatal**	**Serious**	**Slight**	**Rate/km**
1,441	14,559	146,987	40.65	1,467	14,741	149,451	40.08	26	182	2,464	-0.57

7.3.16 Table 7.8 shows the value of accident disbenefits of -£67.5m calculated using COBALT in the appraisal.

Table 7.8 Value of COBALT accident benefits, core traffic growth (£million, 2010 prices and values)

Benefit	Without Scheme	With Scheme	Change
Accidents	-£4,679.1m	-£4,746.6m	-£67.5m

7.3.17 The maintenance delay appraisal includes a monetary value for accidents of -£0.3m. This is added to the monetary value of -£67.5m produced by COBALT to produce a total value for accident disbenefits of -£67.8m. This figure is included in the low and high traffic growth appraisal scenarios.

7.3.18 It is worth noting that the absolute increase in accidents is due to the increased number of kilometres driven. Table 7.9 shows that the provision of the Project would reduce the overall accident rate per million vehicle kilometres driven.

Table 7.9 Accident cost per vehicle kilometre

	Without the Project	With the Project	Change
Number of accidents over 60-year appraisal period	116,899	118,566	1,667
Accident cost over 60-year appraisal period (£million)*	-4,679.1	-4,746.6	-67.5
Total network length appraised (km)	2,876	2,958	82
Accident rate per million vehicle km in 2030	0.117	0.113	-0.004
Accident rate per million vehicle km in 2045	0.105	0.101	-0.004
Number of accidents per km over 60-year appraisal period	40.65	40.08	-0.57
Accident cost per km over 60-year appraisal period (£million)	1.627	1.605	-0.022

**Excludes -£0.3million from planned maintenance*

Physical activity benefits

7.3.19 The Project's provision for walkers, cyclists and horse riders is set out in the Project Design Report Part E (Application Document 7.4). It includes improvements to existing footways, cycle paths and bridleways and new footways, cycle paths and bridleways, dedicated bridges and new signalised crossings.

7.3.20 The monetary value of benefits from the Project's provision of new and improved walking and cycling facilities was calculated using the May 2022 version of DfT's Active Mode Appraisal Toolkit (AMAT) (DfT, 2022a). The toolkit implements the guidance set out in TAG Unit A5.1 (DfT, 2020b).

7.3.21 The physical activity benefits of the Project are estimated for the number of new walkers and cyclists. These benefits include the following:

a. health benefits for people using the new and improved facilities and a decrease in their absenteeism from work

b. benefits from users' perceptions of the improved quality of the facilities provided

c. benefits from having fewer vehicles on the road as some of the users of the new facilities would have used a car or taxi for their journey

7.3.22 The total value of the benefits of the scheme, as calculated using the AMAT, are £21.2m (2010 prices and values).

Journey time reliability

7.3.23 Journey time reliability impacts cover the unexpected changes to the time a journey takes due to:

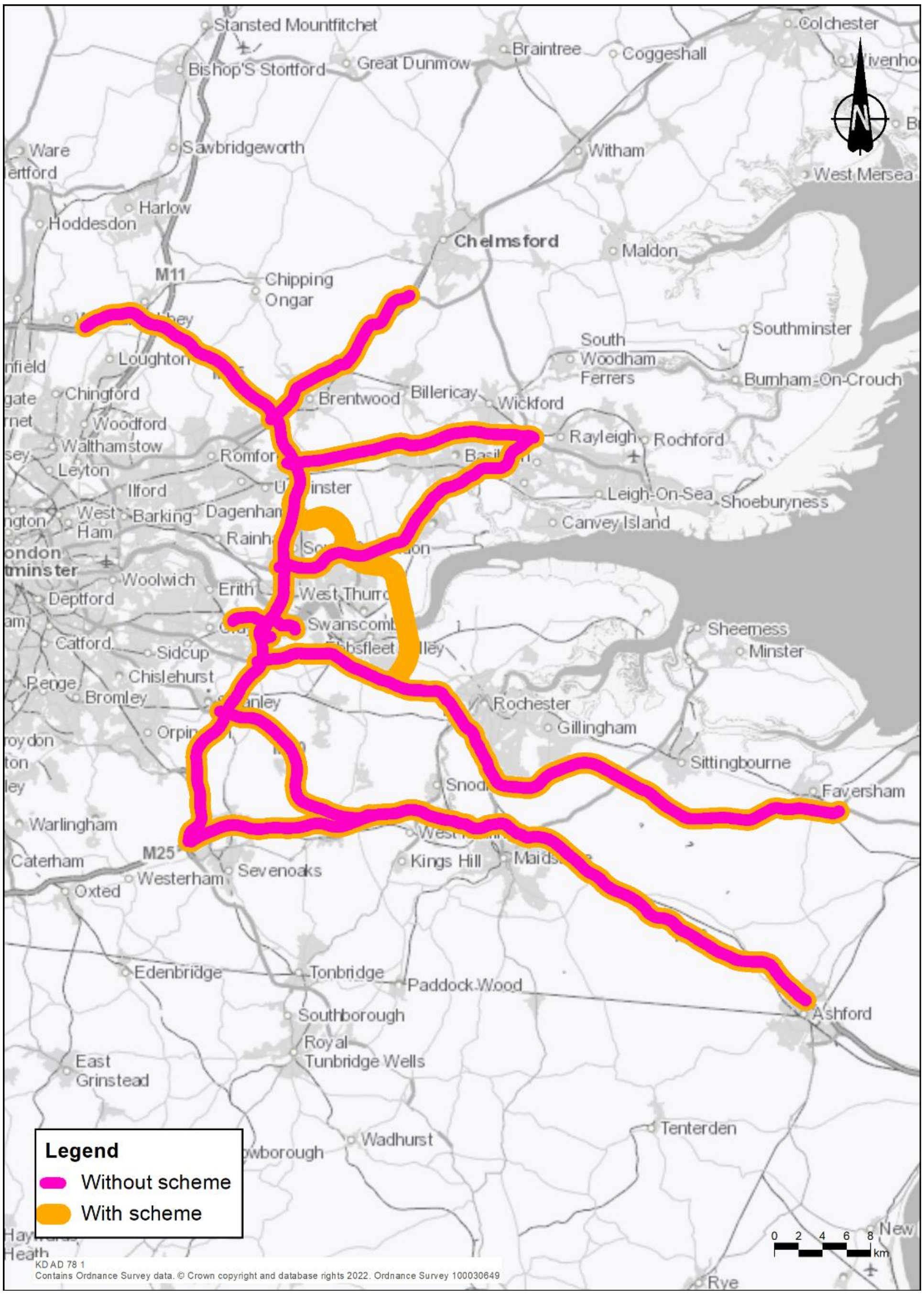
a. direct impacts of incidents on users of the SRN (incident delays)

b. additional impacts of incidents due to some users of the road with the incident diverting to other routes (diversion impacts)

c. changes in travel time variability for journeys on the SRN within the study area, both for non-incident related variability and variability specifically related to incidents.

7.3.24 The roads included in the assessment are shown in Plate 7.2.

Plate 7.2 Journey time reliability study area network



7.3.25 The value of these impacts was calculated using National Highways' MyRIAD 2021 software for the core growth scenario. The disaggregation between business users, commuters and other users was based on that observed in the split in the Do Minimum scenario. MyRIAD provides the value of the impact as a discounted cost over the 60-year appraisal period.

7.3.26 The Project is expected to generate benefits of £265.4 million from reduced incident delays, £68.8 million from reduced diversion impacts and £152.9 million from reduced travel time variability.

7.3.27 These benefits, which total £487.1m, are presented in Table 7.10 by journey purpose. This figure is included in the low, core and high traffic growth appraisal scenarios.

Table 7.10 Journey time reliability benefits by journey purpose, core growth scenario (£million, 2010 prices and values)

Benefit	Business	Commuters & others	Total
Incidents	114.6	150.8	265.4
Local diversions	31.6	37.3	68.8
Travel Time Variability	64.8	88.1	152.9
Total	**210.9**	**276.2**	**487.1**

Noise, greenhouse gases and air quality

7.3.28 The environmental impacts of the Project which are quantified and monetised are:

a. noise – changes in noise levels on sensitive receptors (for example, residential properties)

b. air quality – changes in the exposure of people to air pollutants

c. greenhouse gases – the overall change in emissions of greenhouse gases including carbon dioxide

7.3.29 For noise, a monetary value was calculated using the TAG noise workbook and the method set out in TAG Unit A3 (DfT, 2019c). The monetary value for noise impacts includes the effects on amenity, sleep disturbance, acute myocardial infarction, stroke and dementia.

7.3.30 The total value of noise impacts for the core growth scenario is an overall benefit of £3.4 million. This figure is also included in the low and high traffic growth appraisal scenarios.

7.3.31 For air quality, the appraisal estimates the monetary value of NO_2 and $PM_{2.5}$ air quality impacts using the TAG air quality workbook and the methods set out in TAG Unit A3.

7.3.32 The total value of the air quality impacts for the core growth scenario is a disbenefit of -£7.8 million. This figure is also included in the low and high traffic growth appraisal scenarios.

7.3.33 For greenhouse gas emissions, the appraisal includes estimates of road user tailpipe and embodied greenhouse gas emissions (GHG). More details about these emissions are set out in the Carbon and Energy Management Plan (Application Document 7.19).

7.3.34 Based on the traffic outputs from the LTAM, estimates of GHG for the 60-year appraisal period have been generated to calculate the additional tonnes of untraded and traded CO_2 equivalent (CO_2e) emissions that road users would generate over 60 years from the Project opening as tailpipe emissions as a result of the Project. An annual profile of these emissions was produced using the TAG greenhouse gas emissions workbook and the monetary value of these emissions was generated using National Highways Carbon Valuation Toolkit v1.4.2.

7.3.35 The Project is based on a low carbon construction design and construction emissions have been modelled to reflect the Project's construction programme and use of the low carbon materials during construction. During the construction period, the Project is predicted to generate 1.078 million tonnes of traded and 0.685 million tonnes of non-traded carbon – a total of 1.763 million tonnes.

7.3.36 The Project's combined operational, maintenance and renewals carbon emissions total 2,008 tonnes of traded carbon and 28,605 tonnes of non-traded emissions.

7.3.37 The total greenhouse gas carbon emissions from the Project are 6.6 million tonnes and reflect the difference between the Without Scheme and With Scheme scenarios.

7.3.38 The monetary values of traded and untraded tailpipe and embodied emissions, based on the latest central prices of carbon in TAG data book v1.18, are £101.3m and £424.7m, totalling £526.1m. There is also a small additional disbenefit of £1.7m for additional carbon emissions from maintenance delays.

7.3.39 The monetary values of the monetised environmental impacts are shown in Table 7.11.

Table 7.11 Monetised environmental benefits (£million, 2010 prices and values)

Benefit	Core growth
Noise	3.4
Air quality	-7.8
Greenhouse gases	-527.8
Total	-532.2

Landscape impacts

7.3.40 A monetary valuation of the impact of the Project on landscape was undertaken. The DfT has concerns over the robustness of the methodology for valuing landscape impacts, so following TAG guidance, the valuation was not included in the BCR or the AST, but was taken into account in the value for money assessment of the Project. The appraisal was based on DfT's Value for Money Supplementary Guidance on Landscape (Department for Transport, 2021a). The valuation of the landscape impacted by the Project, based on the appraisal parameters in TAG data book v1.18. results in a disbenefit of £93.35 million.

Wider economic impacts

7.3.41 TAG unit A2.1 (DfT, 2019d) sets out some additional impacts on the economy that are relevant for a project such as the Lower Thames Crossing Project which would make a significant change in the operation of the transport network and to the local, regional and national economy, These are agglomeration benefits, increased tax revenues arising from changes in the labour supply, and economic output changes in imperfectly competitive markets.

7.3.42 Agglomeration benefits arise when firms are closer to each other and there is an increase in the concentration of activities. Improved journey times across the River Thames would bring the two economies on either side of the river closer together and the productivity of existing firms would be expected to improve through knowledge spill-over, for example, and the growth of specialist support firms.

7.3.43 Labour supply changes arise when more people decide to join the labour force or work longer hours as a result of reduced commuting time and costs. The change in tax revenue received by the government is included as a benefit in the appraisal.

7.3.44 The values of these two benefits were calculated using DfT software WITA version 2.2, which implements the TAG methods for estimating the value of these benefits.

7.3.45 When there is a reduction in transport costs, businesses are able to operate more efficiently and increase their output. In line with TAG guidance, the value of this benefit in an imperfectly competitive market is valued at 10% of the monetised user benefits to businesses, as reported in Table 7.4 and 10% of the journey time reliability benefits for business users.

7.3.46 The values of the wider economic impacts used in the appraisal are shown in Table 7.12.

Table 7.12 Wider economic impacts (£million, 2010 prices and values)

Benefit	Low growth	Core growth	High growth
Agglomeration	1,343.3	1,374.8	1,370.5
Labour supply impacts	8.0	8.4	8.8
Change in output in imperfectly competitive markets	118.9	133.4	150.4
Total	**1,470.2**	**1,516.6**	**1,529.7**
Wider economic impacts as % of total monetised benefits	48%	46%	43%

Total benefits

7.3.47 The total monetised benefits of the project for the three traffic growth scenarios (low, core and high) are shown in Table 7.13.

Table 7.13 Total monetised benefits (£million, 2010 prices and values)

Benefit	Low growth	Core growth	High growth
Transport user benefits	1,749.7	1,971.9	2,240.1
Construction and maintenance delays	-140.8	-140.8	-140.8
Indirect tax revenues	50.1	43.5	34.2
Accidents	-67.8	-67.8	-67.8
Environmental impacts	-532.1	-532.1	-532.1
Physical activity	21.2	21.2	21.2
Sub-total	**1,080.2**	**1,295.9**	**1,554.8**
Wider economic impacts	1,470.2	1,516.6	1,529.7
Journey time reliability	487.1	487.1	487.1
Total	**3,037.4**	**3,299.5**	**3,571.5**

7.3.48 Of the benefits that can be spatially disaggregated

a. 48% are gained by users starting or ending their journeys in the Lower Thames area (Thurrock, Brentwood, Havering, Dartford, Gravesham and Medway).

b. 31% are gained by users starting or ending their journeys in other South East Local Enterprise Partnership Local Authorities.

c. 21% are gained by users starting or ending their journeys in other local authorities in Great Britain.

7.4 Project costs

7.4.1 Project costs are built up from the base costs with the addition of risk and uncertainty allowances. The base costs of the Project, which include capital expenditure (CAPEX) and operating, maintenance and renewals (OMR) costs, were prepared in real terms and allow for variations in the rates of inflation for highway construction and OMR costs compared to the general rate of inflation for the economy.

7.4.2 The costs of the Project are differentiated between those that would be incurred during its planning and construction phase, known as the capital costs (CAPEX), and those incurred once the Project is in use; these would be the Project's ongoing OMR costs.

7.4.3 The costs have been estimated on the basis of the government's commitment to publicly fund the Project.

7.4.4 The revenues include user charge receipts collected at the Project, as well as the change in receipts at the Dartford Crossing, for the London Congestion Charge and those collected at the Silvertown and Blackwall tunnels. These revenues are subtracted from the costs of the Project in the appraisal.

7.4.5 The costs reported here are the most likely CAPEX costs, the central estimate of OMR costs and the revenues based on core traffic growth forecasts produced by the LTAM.

7.4.6 The costs were estimated at 2019 Q1 prices in line with National Highways guidance. They were then inflated to outturn prices, which represent the money required to construct, operate, maintain and renew the Project at the point at which those funds are required.

CAPEX costs

7.4.7 The CAPEX costs were estimated and profiled for the Project's planning and construction period. The costs are based on an opening date in 2031.

7.4.8 Benefits have been modelled and appraised based on a 2030 open for traffic date. The opening year used for the appraisal of capital expenditure (CAPEX) costs is different from the rest of the application assumptions, whereby the costs assume a completion of construction in 2031. The application as a whole is based on the opening year of 2030. The project construction schedule supports this opening date, with a reasonable allowance for construction time risk, and National Highways are confident that this can be achieved. Nevertheless, for the purposes of the cost assessment it is appropriate to allow for a reasonable level of time risk for both the duration of the DCO statutory process and for construction. The estimate of CAPEX costs was prepared in accordance with National Highways' capital cost estimating process for major projects. It was assured by National Highways' Commercial Services Division team.

7.4.9 The CAPEX costs consist of:

a. the base cost, which represents the costs building the Project, expressed in 2019 Q1 real terms prices

b. additional costs to allow for project risk, uncertainty, non-recoverable Value Added Tax, inflation and portfolio risk

7.4.10 The base cost estimate was converted to a probability distribution, expressed in outturn costs, by running a Monte-Carlo simulation on both the forecast schedule and cost outcomes. The most likely costs, which reflect the statistical mode of the range of costs, represent a 41% cost confidence level. A range of costs were produced and the impacts of costs at P10 and P90 confidence levels on the BCR of the Project are reported later in this chapter.

7.4.11 The total outturn CAPEX cost is £8,083.4 million as shown in Table 7.14.

Table 7.14 CAPEX costs (outturn, most likely)

Cost category	£million
Preparation	960.0
Supervision	385.0
Lands	440.5
Construction and other costs	6,298.0
Total	**8,083.4**

Note: Other costs include items such as inflation and non-recoverable VAT.

7.4.12 When expressed in 2010 prices and values, the most likely total CAPEX cost is £3,119.6 million. This excludes historic sunk costs and non-recoverable Value Added Tax.

Operating, maintenance and renewal costs

7.4.13 A central estimate of the OMR costs was estimated for a 60-year operational period from 2031 to 2090.

7.4.14 The estimate of OMR costs was prepared by the project team in accordance with National Highways' OMR cost estimating process for Major Projects (Highways England, 2018).

7.4.15 The estimate has been assured by National Highways' Commercial Service Division and Operations Directorate.

7.4.16 The OMR costs cover four main elements:

a. The roads

b. The tunnels

c. Other costs

d. The cost of implementing road user charging on the Project

7.4.17 Highways OMR costs include expenditure on routine operation, maintenance and renewals of highways assets, structures and technology, as well as expenditure required to deal with severe weather events and non-operational costs.

7.4.18 Tunnels OMR costs include maintenance expenditure on tunnel structures, electrical and mechanical systems and operational costs.

7.4.19 Other OMR costs include those incurred from renewing highway technology assets, responding to incidents, dealing with severe weather events, the management of maintenance and renewals contractors, National Highways management and systems, risk and uncertainty.

7.4.20 The road user charging system costs include the charging system's fixed, variable and renewals costs.

7.4.21 Table 7.15 shows the most likely OMR costs in 2019 Q1 prices and in outturn prices.

Table 7.15 OMR costs (central costs)

Cost category	2019 Q1 £million	Outturn £million
Highways	583.7	1,731.7
Tunnels	609.6	1,776.9
Other costs	241.8	712.3
Road user charging system costs	180.4	470.3
Total	**1,615.4**	**4,691.3**

7.4.22 The discounted value of these costs expressed in 2010 prices and values is £327.4 million.

Revenues

7.4.23 The revenues reflect the change in user charging revenues, over 60 years from Project opening, at the Dartford Crossing, Lower Thames Crossing, the Silvertown and Blackwall tunnels and in the London Congestion Charge area. The revenue estimate assumes that user charges at the Lower Thames Crossing would be the same as the charges at the Dartford Crossing and that the charges at both crossings would rise in line with the Retail Price Index.

7.4.24 The revenues are estimated using TUBA. They represent the change in revenues for the core traffic growth scenario between the Do Minimum transport model run and the Do Something transport model run. When expressed in 2010 prices and values, the revenues for the core traffic growth scenario are £748.5 million.

7.4.25 There is also a small reduction in user charge revenues of £1.7m (2010 prices and values) due to a small reduction in the number of vehicles crossing the river as a result of the construction of the Project.

7.4.26 The total value of user charge revenues of £746.8m (2010 prices and values) is included in the PVC for the central case appraisal.

Present Value Costs

7.4.27 The Present Value of Costs (PVC) is obtained by adding together the CAPEX and OMR costs, expressed in 2010 prices and values, and then subtracting the user charge revenues, also expressed in 2010 prices and values. The user charge revenue varies with traffic growth, which changes the PVC. Table 7.16 shows the PVC of the Project for the three traffic growth scenarios (low, core and high). The PVC for the central case appraisal, based on core traffic growth, is £2,700.2 million.

Table 7.16 Present Value of Costs (£million, 2010 prices and values, most likely CAPEX, central OMR costs)

Cost item	Low growth	Core growth	High growth
CAPEX	3,119.6	3,119.6	3,119.6
OMR	327.4	327.4	327.4
Revenues	-665.5	-746.8	-820.9
PVC	**2,781.5**	**2,700.2**	**2,626.1**

7.5 Benefit Cost Ratio and sensitivity tests

Introduction

7.5.1 The Benefit Cost Ratio (BCR) compares the Present Value of Benefits (PVB) with the Present Value of Costs (PVC). DfT guidance defines two BCRs. Both exclude the landscape valuation because the methodology behind this is not yet considered sufficiently mature for this value to be included.

7.5.2 The Initial BCR is the ratio of the PVC to the Level 1 PVB. The Level 1 PVB includes all monetised benefits with the exception of journey time reliability and wider economic impacts.

7.5.3 The Adjusted BCR is the ratio of PVC to the sum of the Level 1 PVB and Level 2 PVB. The Level 2 PVB is the value of the journey time reliability and wider economic impacts.

7.5.4 In the following section the Initial and Adjusted BCRs are presented for the central case appraisal. This uses the benefits from the core traffic growth scenario and the most likely CAPEX costs.

Central case appraisal

7.5.5 For the central case appraisal, the Initial BCR is 0.48 and the Adjusted BCR is 1.22. Table 7.17 shows the values used to derive these figures.

Table 7.17 BCRs – Central case appraisal (£million, 2010 prices and values, most likely CAPEX, core traffic growth)

	£million
Level 1 PVB	1,295.9
PVC	-2,700.2
Initial BCR	**0.48**
Journey time reliability	487.1
Wider economic impacts	1,516.6
Level 2 PVB	2,003.7
Level 1 and 2 PVB	3,299.5
PVC	-2,700.2
Adjusted BCR	**1.22**

Traffic growth sensitivity tests

7.5.6 Sensitivity tests were undertaken to assess the impact of low and high traffic growth levels on the benefits and revenues. The PVB changes with changes in the assumed level of traffic growth. The CAPEX and OMR costs do not change in these tests but, as revenues vary with the assumed level of traffic growth and these form part of the PVC, the PVC also changes as the level of traffic growth changes. The results of these tests are presented in Table 7.18.

Table 7.18 BCRs for different traffic growth scenarios (£million, 2010 prices and values, most likely CAPEX costs)

	Low growth	Core growth	High growth
Level 1 PVB	1,080.2	1,295.9	1,554.8
PVC	-2,781.5	-2,700.2	-2,626.1
Initial BCR	**0.39**	**0.48**	**0.59**
Journey time reliability	487.1	487.1	487.1
Wider economic impacts	1,470.2	1,516.6	1,529.7
Level 2 PVB	1,957.3	2,003.7	2,016.8
Level 1 and 2 PVB	3,037.5	3,299.6	3,571.6
PVC	-2,781.5	-2,700.2	-2,626.1
Adjusted BCR	**1.09**	**1.22**	**1.36**

CAPEX costs sensitivity tests

7.5.7 Sensitivity tests were undertaken to assess the impact of different CAPEX cost confidence levels. The cost levels used were P10, where there is a 10% chance that the CAPEX costs will not exceed this level, and P90, where there is a 90% chance that the CAPEX costs will not exceed this level. The core traffic growth scenario benefits and revenues were used.

7.5.8 The results of these tests are presented in Table 7.19.

Table 7.19 BCRs for different CAPEX cost confidence levels (£million, 2010 prices and values, core traffic growth)

	P10	Most likely	P90
Level 1 PVB	1,295.9	1,295.9	1,295.9
PVC	1,846.9	2,700.2	4,140.1
Initial BCR	**0.70**	**0.48**	**0.31**
Journey time reliability	487.1	487.1	487.1
Wider economic impacts	1,516.6	1,516.6	1.516.6
Level 2 PVB	2,003.7	2,003.7	2,003.7
Level 1 and 2 PVB	3,299.6	3,299.6	3,299.6
PVC	1,846.9	2,700.2	4,140.1
Adjusted BCR	**1.79**	**1.22**	**0.80**

TAG data book v1.19FC

7.5.9 In May 2022, DfT issued a Forthcoming Change version of the TAG data book v1.19FC that it expects to become definitive in November 2022. An accompanying TUBA Economics file was issued in June enabling these provisional databook parameters to be used in TUBA.

7.5.10 The new data book and Economics file include the following changes to TAG appraisal parameters:

a. updated base and forecast fleet proportions, including the introduction of values for PSV electric sub-vehicle/mode type

b. updated base and forecast fuel consumption and fuel efficiency values

7.5.11 A sensitivity test was run in TUBA on the core growth scenario to assess the impact of using the new parameters on the valuation of vehicle operating costs. However, most of the changes that result from having a higher proportion of electric vehicles are not captured in this test. Table 7.20 shows that the Forthcoming Change data book has a very small impact on the appraisal results.

Table 7.20 BCR for TAG data book v1.19FC (£million, 2010 prices and values)

	Central case	Sensitivity test v1.19FC
Level 1 PVB	1,295.9	1,309.3
PVC	2,700.2	2,700.2
Initial BCR	**0.48**	**0.48**
Journey time reliability	487.1	487.1
Wider economic impacts	1,516.6	1,516.6
Level 2 PVB	2,003.7	2,003.7
Level 1 and 2 PVB	3,299.6	3,312.9
PVC	2,700.2	2,700.2
Adjusted BCR	**1.22**	**1.23**

100 year appraisal period

7.5.12 In December 2020, DfT (2020c) undertook a public consultation about lengthening the appraisal period used to calculate benefits and costs for project appraisals beyond the standard 60-year period. The consultation was an acknowledgement that some projects are constructed to have a design life far exceeding the standard 60-year appraisal period. Following the consultation, DfT updated TAG Unit A1.1 in May 2021 by including new advice on the use of extended appraisal periods (DfT, 2021b). This states that:

a. extended appraisals should be undertaken as a sensitivity test and must not form part of a project's central case appraisal.

b. the extended appraisal period should not exceed the longest-lived asset constructed as part of a scheme.

c. in all cases, the extended appraisal period should be no more than 100 years, which is the maximum standard assumed economic asset life.

d. the extended appraisal must include robust cost estimates for all maintenance and renewals required over the period that benefits are claimed.

e. the appraisal should be supported by a strong strategic case rationale for the existence of significant impacts in the very long term.

7.5.13 The Project includes twin bored tunnels for which the civil engineering work has a 120-year design life. Other aspects of the tunnels, such as the mechanical, electrical, instrumentation, control and automation assets, have shorter design lives.

7.5.14 Extending the appraisal period to 100 years results in the following changes to the central case appraisal:

a. Time savings rise by £713million

b. Disbenefits for other Level 1 impacts, except for greenhouse gas emissions, increase by £21 million

c. OMR costs rise by £50 million

d. User charge revenues rise by £126 million

e. Level 2 impacts rise by £503 million

f. Greenhouse gas emissions disbenefits increase by £103 million

7.5.15 The Initial BCR rises from 0.48 (central case) to 0.71. The Adjusted BCR rises from 1.22 (central case) to 1.66. The 100 year appraisal results are shown in Table 7.21. National Highways has also carried out two 100 year appraisals which are explained in Appendix D (Economic Appraisal Package). The more conservative of these is presented below, showing a BCR of 1.66. A further scenario which provides a higher BCR based on assumptions relating to the Transport Decarbonisation Plan is presented in section 11.3.13 of the Combined Modelling and Appraisal Report - Appendix D - Economic Appraisal Package: Economic Appraisal Report (Application Document 7.7).

Table 7.21 100-year appraisal period results (£million, 2010 prices and values)

	Central case	100 year appraisal
Journey time savings	2,088.2	2,801.4
Vehicle operating costs and user charge impacts	-116.3	-126.5
Noise and air quality	-4.4	-7.3
Greenhouse gas emissions	-527.8	-630.4
Accidents	-67.8	-113.0
Indirect tax revenues	43.5	43.1
Construction delay impacts	-130.8	-130.8
Maintenance delay impacts	-10.0	-16.3
Physical activity	21.2	35.3
Level 1 PVB	**1,295.9**	**1,855.6**
CAPEX	-3,119.6	-3,119.6
OMR	-327.4	-377.4
User charge revenues	746.8	872.6
PVC	**-2,700.2**	**-2,624.5**
Initial BCR	**0.48**	**0.71**
Journey time reliability	487.1	603.7
Level 2 wider economic impacts	1,516.6	1,902.8
Level 2 PVB	**2,003.7**	**2,506.5**
Level 1 and 2 PVB	**3,299.5**	**4,362.1**
PVC	**-2,700.2**	**-2,624.5**
Adjusted BCR	**1.22**	**1.66**

Other impacts

7.5.16 There is an extensive range of additional impacts which are not included in the BCR.

7.5.17 These include environmental and social impacts which do not appear in the BCR because there is not yet a well-established method to either quantify these impacts and/or to give them a monetary value.

7.5.18 As well as examining the social impacts of the Project on people, consideration is also given as to whether these impacts affect certain groups of people disproportionally. This is reported in detail in the Distributional Impact Appraisal Report which forms part of Appendix D (Application Document 7.7).

7.5.19 Other issues which are considered when making a value for money assessment of the Project are resilience, the importance of journey time reliability for freight users, and wider economic impacts that may occur if it is assumed that land use is variable and could change as a result of the construction of the Project.

Non-monetised Environmental impacts

7.5.20 Only some environmental impacts are quantified and included in the BCR. These impacts are noise, air quality and greenhouse gases.

7.5.21 For other impacts, these are each described and given a score following the guidance set out in TAG Unit A3 (DfT, 2019c). These descriptions and scores are set out in the Appraisal Summary Table (AST) Report in Appendix D (Application Document 7.7). The methodologies set out in TAG differ from those that apply to the Environmental Statement, so there may be differences in the appraisals reported in the AST and the Environmental Statement (Application Documents 6.1 to 6.3).

7.5.22 The commentary from the AST on the assessed scores is presented in Table 7.22.

7.5.23 The assessed scores are:

a. Landscape - Moderate Adverse

b. Townscape - Moderate Adverse

c. Historic environment - Large Adverse

d. Biodiversity - Very Large Adverse

e. Water environment - Slight Adverse

Table 7.22 Summary of qualitative environmental appraisals

Impact	Qualitative appraisal summary	Score
Landscape	The widening of the existing M2/A2 corridor, expansion of the existing A13/A1089 junction and modifications to the existing M25 corridor, together with the new A122 Lower Thames Crossing, would adversely affect the landscape character and views within the Area of Outstanding Natural Beauty (AONB), its setting and the local landscape character and views within the Green Belt, including a large adverse effect in the Higham Arable Farmland and Thurrock Reclaimed Fen local landscape character areas, including a large adverse effect in the Higham Arable Farmland and Thurrock Reclaimed Fen local landscape character areas. However, the overall impact of the Project is Moderate Adverse due to the extensive mitigation proposals, including false cuttings, new planting, green bridges and the landscaping of new areas of open space at Chalk Park adjoining the South Portal and Tilbury Fields adjoining the North Portal.	Moderate Adverse
Townscape	The Project route is typically located within Green Belt and along existing trunk roads including widening of the A2 and M25 corridors, and new junctions with the A2, A13, and M25. This new infrastructure would adversely affect a range of defined townscape areas due to their associations with the surrounding rural landscapes. In addition, the historic townscape character of the rural settlements at Thong, south of the River Thames, and West Tilbury, Baker Street and	Moderate Adverse

Impact	Qualitative appraisal summary	Score
	North Ockendon to the north of the River, would be adversely impacted due to their proximity to the Project. These settlements are designated conservation areas where there would be a major change on physical and perceptual qualities and characteristics including their setting.	
Historic environment	To the south of the River Thames a Moderate Adverse effect is predicted on archaeological remains and historic buildings. To the north of the River Thames a Large Adverse effect on archaeological remains, historic buildings and historic landscapes is predicted. This results from the total removal of 3 high value listed buildings, which is exceptional in NPSNN terms and the almost total removal of a high value scheduled monument which would be wholly exceptional in NPSNN terms. Overall the effects of the Project are considered to be Large Adverse.	Large Adverse
Biodiversity	A score of Very Large Adverse is predicted as significant residual adverse effects remain from the direct loss and deterioration of irreplaceable habitats and Sites of Special Scientific Interest (SSSI). Although they would not affect the assessment of residual impacts, mitigation and compensation measures are proposed in accordance with the National Policy Statement for National Networks (NPSNN) to offset these adverse effects (Department for Transport, 2014). This includes the creation of over 200ha of new woodland and grassland which would increase the overall area of these habitats and strengthen resilience across the wider network of designated sites and semi-natural habitat within the wider landscape.	Very Large Adverse
Water environment	The Project has potential to degrade the quality of surface and groundwater bodies and change surface and groundwater levels and flow regimes. These effects may be induced by discharges of construction phase and operational runoff, earthworks, groundwater control and new crossings of watercourses and their floodplains. However, by following construction good practice and by embedding mitigation into the Project's design, effects on the water environment can be successfully avoided or reduced.	Slight Adverse

Non-monetised Social impacts

7.5.24 The Project would have some positive and negative impacts on people living in the Lower Thames area. A qualitative assessment of these impacts has been undertaken following the methods set out in TAG Unit A4.1 (DfT, 2020d).

7.5.25 A summary of these impacts and the score assigned to them in the AST is given in Table 7.23.

7.5.26 The assessed scores are:

a. Personal security – Neutral

b. Journey quality – Large positive

c. Affordability – Slight positive

d. Severance – Large positive

Table 7.23 Summary of qualitative social impact appraisals

Impact	Qualitative appraisal summary	Score
Personal security	The Project is expected to have an overall neutral impact on the personal security of drivers and vehicle occupants in the tunnel, along the route and at crossing points. Personal security of walkers, cyclists and horse riders at crossing points has also been assessed as neutral – while some crossings would be improved through lighting, environment and gradient, others may require underpasses which potentially have an adverse impact on personal security.	Neutral
Journey quality	The change in impact across the journey quality factors of traveller care, views and stress is, on balance, likely to be beneficial and large, affecting more than 10,000 travellers per day. Improvements in traveller stress arise through reductions in congestion at the Dartford Crossing and approach roads, resulting in improved accessibility. The effect on vehicle travellers in relation to views from the road during the operation phase is likely to be positive.	Large Positive
Affordability	Personal affordability would not be affected by the Project because the Without Scheme travel routes and operating costs would still be available. Therefore, the Project has no affordability impact for most users. Journeys by Gravesham residents to and from destinations north of the River Thames would be proportionately cheaper compared to the Without Scheme scenario because their cross-river road user charges would be reduced through a user charge discount. Around 106,900 Gravesham residents would benefit from a reduction in the cost of travel across the River Thames.	Slight Positive
Severance	All routes severed by the Project would be reinstated using bridges or underpasses except for Hornsby Lane in Thurrock. In net terms 49,020 walking trips per day within the LTAM transport model area are expected to experience a reduction in traffic-related severance.	Large Positive

Distributional impacts appraisal

7.5.27 The distributional impacts appraisal considers who is experiencing these impacts and whether the impacts disproportionally affect different groups of people, especially socially vulnerable groups, compared to the general population.

7.5.28 First, a screening exercise is carried out to see which impacts are noticeable and should form part of the distributional impacts appraisal. The population groups that are examined are set out in TAG Unit A4.2 (DfT, 2020e). They include children under 16, young people aged 16 – 25, older people over 70, people with a disability, people with a Black, Asian or Minority Ethnic origin, people from a household without access to a car and households with children.

7.5.29 The proportion of the population that fall into each of these groups of interest in the area is mapped. This is compared with the spatial distribution of the impacts and where an impact is experienced by a particular group more severely than for the population as a whole, then a negative score is recorded in the appraisal.

7.5.30 The results of the distributional impacts appraisal are summarised in Table 7.24. More information on the methods used in the appraisal and the mapping of impacts is provided in Appendix D: Distributional Impact Appraisal Report (Application Document 7.7).

7.5.31 The most significant distributional impact is changes in noise level and air quality. For noise there is a large adverse impact as the noise impacts affect a disproportionate number of people on low income and children, compared to the general population. For air quality there is large beneficial impact with a net decrease in NO_2 in areas with higher than average proportions of children under 16 and population on low incomes.

Table 7.24 Summary of the Distributional Impact Appraisal

Indicator	Assessment	Scores
User benefits	Overall, there is a net beneficial distributional impact from the Project on user benefits. There are net user benefits across all income quintiles. The distribution of user benefits is within 5% of the population for each income quintile and assessed as even.	Moderate Beneficial for each income quintile
Noise	The distributional appraisal shows a net adverse impact on residential noise levels. The distribution of noise impacts against income quintiles is assessed as uneven with adverse impacts higher than expected in the most deprived (20%) income quintile groups. There is a net increase in properties with increases in noise greater than 1dB in areas with higher than average proportions of children under 16 and people aged 70 and over compared with the regional study area and England and Wales, although the net increases are lower compared with the England and Wales proportions. There is a neutral impact of changes in noise levels on schools and care homes as the majority of schools and care homes would receive no change in noise level.	Income: Large Adverse Children aged under 16: Large Adverse People aged 70 and over: Moderate Adverse
Air quality	The distributional appraisal shows a beneficial air quality impact. The distribution of air quality impacts against income quintiles is assessed as uneven because the two most deprived income quintiles benefit more than the other income quintiles. There is a net decrease in NO_2 in areas with higher than average proportions of children under 16, compared with both the regional study area and with England and Wales. No schools would experience a change in air quality levels.	Income: Large Beneficial for NO_2 Children aged under 16: Large Beneficial for NO_2

Indicator	Assessment	Scores
Accidents	There is no distributional impact for vulnerable groups analysed which are walkers and cyclists (for A-roads), motorcyclists, under 16 year olds, 16 to 25 year old males, over 70 year olds for any location, compared with regional study area and Great Britain.	Neutral for all vulnerable groups.
Severance	A design aim for the Project is that as far as reasonably practicable all routes severed by the Project during the construction phase would be re-instated by means of bridges or underpasses as appropriate, with no additional impediment. There is therefore likely to be limited direct severance. Hornsby Lane in Thurrock would be permanently closed but there is no increase in distance for the alternative route. Overall, there is likely to be a small net decrease in traffic-related severance in a small number of locations, potentially affecting less than 1% of the population within the regional study area. The distribution of decreased traffic related severance is uneven with respect to car-ownership and there is likely to be a smaller than expected impact of traffic related severance on non-car owning households, compared with the regional study area and England and Wales. The distributions of traffic related severance on children aged under 16, people aged 70 and over and for people with a limiting long-term illness are even as they are similar to the regional study area and England and Wales.	Car ownership: Slight Beneficial Children under 16: Neutral People aged 70 and over: Neutral People with a limiting long-term illness: Neutral
Personal affordability	The distribution of personal affordability impacts is uneven across income quintiles as there is a higher proportion of Gravesham residents within the lowest income quintiles compared with the regional study area and England and Wales.	Large Beneficial for Gravesham residents

Resilience

7.5.32 The journey time reliability appraisal presented in Chapter 9 includes the impact of the Project on incidents that last up to six hours in duration.

7.5.33 However, sometimes incidents at the Dartford Crossing last longer than six hours. The ability of the road network to reduce the probability of, and manage and recover from, these long duration impacts is called resilience.

7.5.34 TAG does not provide guidance on how the resilience impacts of transport schemes should be appraised. However, a qualitative appraisal has been developed based on four different types of resilience. These are:

a. Event resilience

b. Weather resilience

c. Asset Management

d. Full closure

7.5.35 Event resilience relates to traffic accidents, breakdowns or non-vehicular encroachments which last more than six hours.

7.5.36 The impact of a transport scheme on event resilience can be divided into three elements:

a. The likelihood of an incident occurring – the Project is expected to cause traffic to redistribute resulting in fewer incidents across the Lower Thames area because:

   i. There would be fewer vehicles using the Dartford Crossing and this would provide a greater ability for the Crossing to recover from incidents.

   ii. The Project's modern design which would reduce the risk of incidents occurring.

7.5.37 The tunnel for the Project has been designed as a Category A tunnel which can be used by vehicles carrying hazardous loads. The tunnel would have dual three-lanes which would enable it to accommodate higher and wider vehicles. It has been designed as a free flow addition to the road network and does not have closely spaced junctions.

7.5.38 The Project would be more weather resilient than the Dartford Crossing where traffic restrictions are imposed on the QEII Bridge during periods of high winds. The Project would enable high-sided vehicles to be redirected from the Dartford Crossing to the Project during periods of high winds protecting trips for these vehicles and improving resilience for other road users. During weather related bridge closures, trip making across the River Thames would be eased.

7.5.39 The Project would provide increased flexibility for National Highways to optimise the Dartford Crossing's maintenance and minor renewal plans and ensure that effective use is made of the additional capacity and thereby minimise maintenance costs.

7.5.40 The Project would also result in less people being impacted by major renewal work at the Dartford Crossing. While this work would suppress traffic volumes and reduce the benefits of the Project, trip making across the Thames, east of London, would be eased while this essential work is undertaken.

7.5.41 A full closure of the Dartford Crossing for a long period of time (months or years), for whatever reason, has never occurred but remains a possibility that would result in major economic, environmental and social disbenefits, locally, regionally and nationally. If such an event occurred, traffic volumes and the expected benefits of the Project would be suppressed, but the provision of the Project would preserve some trip making across the Thames to the east of London in contrast to a scenario without the Project which would involve major traffic diversions.

7.5.42 Overall, the resilience impact has been assessed as positive.

Values of time and reliability for the freight sector

7.5.43 The Project is forecast to carry a higher percentage of freight users than is typical on the SRN. It is likely that the current estimates for values of time and reliability do not reflect the full value that freight users place on these impacts. This is because current freight values of time are primarily based on the value of the driver's time. As a result, they ignore the impacts of late delivery and underestimate the journey time impact for freight users.

7.5.44 It is likely that there is a non-linear relationship in which a small amount of unreliability is tolerable and has a relatively low valuation, whereas greater levels of unreliability have more serious impacts on a business.

7.5.45 A study from the Netherlands in 2013 sought to identify values of both freight time and freight journey time reliability. It found that the value of freight time is greater than would be implied by driver's time and operating cost (Significance *et al.*, 2013). This work suggests that the value for time for freight users is undervalued by around 20% in current DfT guidance.

Wider economic benefits with variable land use

7.5.46 TAG guidance for economic impacts is based on the assumption of fixed land use, that is land use in the area does not change solely as a result of the Project. TAG guidance for Level 1 and 2 impacts is based on the assumption of fixed land use, that is land use in the area does not change solely as a result of the Project. [SO1] There are other economic impacts, known as Level 3 impacts in TAG, which are included in the BCR but are relevant to the value for money assessment. The consideration of potential Level 3 impacts can consider the impacts of changes in land use brought about as a consequence of the Project.. Level 3 Wider Economic Impacts Report (part of Appendix D of this ComMA (Application Document 7.7) provides additional analysis on Level 3 impacts of the Project.

7.5.47 If land use changed, this would result in additional economic impacts. For example, there could be productivity benefits if businesses physically moved to be closer to each other (dynamic clustering) and if the labour moved to more productive jobs.

7.5.48 In order to understand the potential for changes in land use and the economic impacts of such changes, a review was undertaken of the impacts of other new estuarial crossings in the UK and the economic context of the Lower Thames Crossing.

Local economic geography

7.5.49 A review of other estuarial road crossings in the UK emphasised the importance of understanding an area's historical development and current socio-economic characteristics in assessing whether the potential of a new crossing to bring wider economic impacts are likely to be realised.

7.5.50 The Project is close to London and on the main trade route between the UK's industrial heartlands and Europe, which, because of the estuary, is congested at Dartford. That congestion, which is partly due to longer distance movements, is the major factor that limits the development of a single Lower Thames market for goods, services and skills, reducing competition and constraining productivity levels.

7.5.51 An analysis of the current socio-economic conditions of the six Lower Thames local authorities – Dartford, Gravesham and Medway (south of the river) and Thurrock, Havering and Brentwood (north of the river) – found that these areas have similar economic structures but have developed separately. This seems to be primarily due to the barriers imposed by the estuary and the influence of London as a common market for some businesses and the sameness of the hinterland markets.

7.5.52 Improved north-south connectivity across the River Thames provided by the Project would enable the creation of a 'single market' for the Lower Thames economy that would enhance competition, particularly given the current duplication of service sector activities.

7.5.53 As land change occurs in response to the enhanced connectivity and market access provided by the Project, firms may decide to relocate or reorganise their business operations, expand their markets and staff recruitment catchment areas and/or choose to specialise as a result of having access to a larger market.

7.5.54 The Lower Thames area has a growing population and the level of economic output is equivalent to a mid-sized European country. From the 2011 census journey to work data, less than 0.1% of residents in the area have regular employment on the other side of the river but with the Project the barrier of the river to reaching these employment opportunities would reduce,

Freight and logistics cluster

7.5.55 A review of the freight and logistics cluster found that transport businesses value:

a. good access to the ports along the River Thames and River Medway

b. their location on the key route between the UK's industrial heartlands and Europe

c. proximity to London

7.5.56 The River Thames is currently seen as a barrier and congestion at the Dartford Crossing imposes major costs by these businesses. A new crossing would provide additional capacity across the river and lead to reduced and more reliable journey times. This would make both sides of the river more attractive for investors and there are suitable brown field sites available for occupation as logistics spaces.

7.5.57 A survey by the Federation of Small Businesses (2018) found that:

a. 50% of respondents thought that the Project would provide better access to new customers

b. 39% said that it would provide better access to transport hubs

c. 29% believed it would secure better access to new markets

7.6 Conclusion

7.6.1 The main benefits of the Project are reduced journey times and agglomeration benefits, which account for total benefits £3,463 million. These are offset by £163 million of net disbenefits to produce the total benefits figure of £3,300 million.

7.6.2 There would be further additional economic benefits in the Lower Thames area as the local economy adjusts to the provision of a new crossing of the River Thames.

7.6.3 There are some beneficial environmental impacts from the new crossing, such as an improvement in air quality around Dartford, but there are also some adverse impacts such as the impact on ancient woodland. More information on these impacts, together with planned mitigation measures, are set out in the Environmental Statement (Application Documents 6.1 to 6.3) and the associated Environmental Statement Non-Technical Summary (Application Document 6.4).

7.6.4 All of the social impacts have overall neutral or positive AST scores. The Project provides a substantial investment in walking and cycling infrastructure which would encourage and support a greater use of active modes.

7.6.5 The distribution of these impacts on vulnerable people groups is generally neutral with a moderate positive impact on the distribution of user benefits. The impact of increased noise levels would be experienced disproportionally by young and old people and those on low incomes. The benefits of improvements in air quality would be experienced disproportionally by children under 16 and those on low incomes

7.6.6 The total construction, operating and maintenance costs of the Project, less user charging revenue for the core traffic growth scenario is estimated to be £2,700 million (2010 prices and values) based on most likely Project costs and core traffic growth.

7.6.7 A Value for Money assessment has been carried out based on a 60 year appraisal period for which the Adjusted BCR is 1.22. This has taken account of most likely project costs, revenues, monetised impacts and benefits and the qualitative appraisal of other impacts and benefits. Based on the categories in the DfT's (2015) value for money framework, the Project has been assessed as providing 'Low' value for money. National Highways has also carried out two 100 year appraisals which are explained in Appendix D (Economic Appraisal Package). The more conservative of these shows a BCR of 1.66. A further scenario which provides a higher BCR based on assumptions relating to the Transport Decarbonisation Plan is presented in section 11.3.13 of the Combined Modelling and Appraisal Report - Appendix D - Economic Appraisal Package: Economic Appraisal Report (Application Document 7.7).

8 Conclusions

8.1.1 The ComMA has presented a summary of the transport modelling undertaken for the Lower Thames Crossing study and the appraisal of the Project.

8.1.2 It provides a short history of the models used for the various studies into traffic conditions in the Lower Thames area that led to the recommendation to provide a new crossing between Kent, Thurrock and Essex.

8.1.3 The ComMA has set out the various data sets used in the development of the LTAM. A copy of all this data is stored in a data store, so that it is available if required for any evaluation studies, if the Project is built.

8.1.4 The methods used for building the LTAM are based on those set out in DfT's guidance. They are described in this report. The values used in the model are taken from the DfT's May 2022 TAG data book.

8.1.5 The traffic forecasts produced using the LTAM for 2045 were used by the engineering team to assess whether the design of the Project was able to accommodate predicted future levels of traffic demand.

8.1.6 The LTAM was also used to predict traffic flows and conditions on the SRN both with and without the Project. These forecasts were used in the appraisal of the social, environmental and economic impacts of the Project.

8.1.7 This report presents a summary of the traffic forecasts for 2045 and a summary of the appraisal of the impacts of the Project.

8.1.8 Further details of the data used can be found in Appendix A: Transport Data Package (Application Document 7.7).

8.1.9 The development of the transport model is described in more detail in Appendix B: Transport Model Package (Application Document 7.7). The traffic forecasts for the four future years modelled (2030, 2037, 2045 and 2051) can be found in Appendix C: Transport Forecasting Package (Application Document 7.7).

8.1.10 The economic appraisal of the Project and the social impacts are described in more detail in Appendix D: Economic Appraisal Package – Economic Appraisal Report (Application Document 7.7). Further information on the appraisal of the distributional impacts of the Project are provided in Appendix D: Economic Appraisal Package – Distributional Impact Appraisal Report (Application Document 7.7).

8.1.11 The environmental impacts of the Project are set out in full in the Environmental Statement and, those that are included in the economic appraisal, are summarised in this report and in Appendix D: Economic Appraisal Package – Appraisal Summary Table Report (Application Document 7.7).

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Glossary

Term	Abbreviation	Explanation
100 year appraisal period		A sensitivity test used to appraise benefits and costs of the Project over a 100-year appraisal period.
2010 prices and values		The price base and present value year used to present and compare monetised costs and benefits
2030 opening year		A modelled year in the Project's LTAM traffic model in which traffic flows and costs are estimated when the Project is opened
2045 design year		A modelled year in the Project's LTAM traffic model in which traffic flows and costs are estimated on which the Project design is based
A122		The new A122 trunk road to be constructed as part of the Lower Thames Crossing project, including links, as defined in Part 2, Schedule 5 (Classification of Roads) in the draft DCO (Application Document 3.1)
Active Mode Appraisal Toolkit	**AMAT**	A DfT toolkit for appraising the physical activity impacts of transport projects.
	Adjusted BCR	Adjusted Benefit Cost Ratio – The ratio of the sum of Level 1 and 2 PVBs to PVC
Agglomeration		In traffic and economics assessment, benefits which come when firms and/or people locate near one another in geographical clusters
AM peak hour		The hour between 07:00–08:00 in LTAM
AM peak period		The period between 06:00–09:00 in LTAM
Automatic Number Plate Recognition	**ANPR**	Automated Number Plate Recognition is a technology that reads vehicle registration plates to create vehicle location data.
Area of Outstanding Natural Beauty	**AONB**	Statutory designation intended to conserve and enhance the ecology, natural heritage and landscape value of an area of countryside.
Appraisal		The process of defining objectives, examining options and weighing up the relevant costs, benefits, risks and uncertainties
Appraisal period		The period of time over which benefits, costs and revenues are appraised. For a road scheme this includes benefits and costs before scheme opening and all impacts for 60 years from scheme opening.
Air quality	**AQ**	A measure of the level of various atmospheric pollutants.
Air Quality Management Area	**AQMA**	An area, declared by a local authority, where air quality monitoring does not meet Defra's national air quality objectives.
Appraisal Summary Table	**AST**	A table that appraises the performance of each option against economic, environmental, social and distributional sub-impacts and is used to directly inform the Value for Money assessment for the economic case.
Automatic Traffic Count	**ATC**	Equipment placed on a road that counts traffic.
Base Cost		A category of project costs that covers the material and labour inputs
Benefit Cost Ratio	**BCR**	The ratio of benefits to costs

Term	Abbreviation	Explanation
Department for Business, Energy and Industrial Strategy	**BEIS**	A department of the UK government, with responsibility for business, industrial strategy, and science and innovation with energy and climate change policy.
Benefit		An increase in the welfare of society from a project, programme or policy
	BYFM	Base Year Freight Matrices
	CAPEX	Capital expenditure – The cost of developing or providing non-consumable parts of the product or system.
Cost-Benefit Analysis	**CBA**	A systematic approach to estimating the strengths and weaknesses of alternatives, used to determine options that provide the best approach to achieve benefits while preserving savings.
Closed circuit television	**CCTV**	National Highways CCTV cameras are used to monitor traffic flows on the English motorway and trunk road network primarily for the purposes of traffic management.
Central case appraisal		The expected benefits and costs of the Project being submitted for development consent
	CJC	Classified Junction Count
	CLC	Classified Link Count
CM49		LTAM transport model Core traffic growth Without Scheme scenario
Carbon dioxide equivalent	**CO_2e**	A standard unit for measuring carbon footprints that describes, for a given amount of greenhouse gas emissions, the amount of CO2 that would have the same Global Warming Potential (GWP) when measured over a timescale of 100 years.
	COBALT	DfT's Costs and Benefits Appraisal - Light Touch accidents appraisal software
	ComMA	Combined Modelling and Appraisal Report
Conservation Area		An area of special environmental or historic interest or importance, of which the character or appearance is protected by law against undesirable changes (Section 69 of the Planning (Listed Buildings and Conservation Areas) Act 1990).
Core traffic growth		The central traffic growth forecast
Costs		Expenditure to build a road (CAPEX) and to operate, maintain and renew a road (OMR)
CS72		LTAM transport model Core traffic growth With Scheme scenario
	CTC	Classified Turning Count
Dart Charge		The Dartford Crossing free-flow electronic number plate recognition charging system
Decibel	**dB**	A unit in the noise level scale, based on logarithms, used in noise measurement
	dB(A)	A weighted decibels – values of sounds at low frequencies are reduced, compared with unweighted decibels

Term	Abbreviation	Explanation
Dartford Crossing	**DC**	Road crossing of the River Thames in England, carrying the A282 road between Dartford in Kent to the south with Thurrock in Essex to the north. It consists of two bored tunnels and the cable-stayed Queen Elizabeth II Bridge.
Development Consent Order	**DCO**	Means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects (NSIPs) under the Planning Act 2008.
Design Freeze	**DF**	A key project stage which references a 'snapshot' of the design process at a particular point in time. Design objectives may express the anticipated progress at, for example, Design Freeze 2 which is a nominated end point of a development stage in the programme.
Department for Transport	**DfT**	The government department responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved.
Dangerous Goods Vehicle	**DGV**	A vehicle which is transporting goods classified as dangerous by the relevant authorities.
Distributional Impact	**DI**	The variance of transport intervention impacts across different social groups. The appraisal of DIs is mandatory in the appraisal process and is a constituent of the Appraisal Summary Table (AST)
Distributional Impact Appraisal	**DIA**	An appraisal of Distributional Impacts.
Dynamic Integrated Assignment and DEmand Model	**DIADEM**	DfT software for finding equilibrium between demand and supply in a transport model.
Disbenefit		A negative benefit
Discount rate		The annual percentage rate at which the present value of future monetary values is estimated to decrease over time.
Discounting		A technique used to compare costs and benefits occurring at different points of time
Design Manual for Roads and Bridges	**DMRB**	A comprehensive manual which contains requirements, advice and other published documents relating to works on motorway and all-purpose trunk roads for which one of the Overseeing Organisations (National Highways, Transport Scotland, the Welsh Government or the Department for Regional Development (Northern Ireland)) is the highway authority. For the A122 Lower Thames Crossing, the Overseeing Organisation is National Highways.
Do Minimum	**DM**	A future year scenario in LTAM which includes changes to the road network and planned development that is forecast to go ahead, but not the Lower Thames Crossing.
Do Something	**DS**	A future year scenario in LTAM which includes changes to the road network and planned development that is forecast to go ahead, and the Lower Thames Crossing.
Dynamic clustering		Benefits come when firms and/or people locate near one another in geographical clusters by changing their spatial location
	EA	External Area

Term	Abbreviation	Explanation
Economic Appraisal Report	**EAR**	A report that presents the appraisal methods and results for a transport project
	EB	Eastbound
Economy Model		National Highways' land use transport interaction model
Environmental Impact Assessment	**EIA**	A process by which information about environmental effects of a proposed development is collected, assessed and used to inform decision making. For certain projects, EIA is a statutory requirement, reported in an Environmental Statement.
	ES	Environmental Statement
	FH	From Home
	FMA	Fully Modelled Area
Fatalities and Weighted Injuries	**FWI**	A statistical measurement of all fatal and non-fatal injuries, with non-fatal injuries added up using a weighting factor to produce a total number of ‘fatality' equivalents.
	GBFM	Great Britain Freight Model
Gross Domestic Product	**GDP**	Total value of all goods and services produced within an economy in one year.
	GEH	A formula used to compare two traffic volumes, named after its originator, Geoff E. Havers. It is similar to a chi-squared test.
Greenhouse gas	**GHG**	Gases able to absorb infrared radiation emitted from Earth's surface and reradiate it back to Earth's surface, thus contributing to the greenhouse effect. Carbon dioxide, methane, and water vapour are the most important greenhouse gases.
Geographic Information System	**GIS**	An integrated collection of computer software and data used to view and manage information about geographic places, analyse spatial relationships and model spatial processes.
	GPS	Global Positioning System
Green Book		HM Treasury’s guidance on how publicly funded projects, programmes and policies should be appraised and evaluated.
	GTFS	General Transit Feed Specification
	GVA	Gross Value Added – The measure of the value of goods and services produced in an area, industry or sector of an economy.
	HAM	Highway Assignment Model
	HBEB	Home-Based Employer’s Business
	HBO	Home-Based Other
	HBW	Home-Based Work (Commute)
	HDV	Heavy Duty Vehicle

Term	Abbreviation	Explanation
	HEIDI	National Highways Integrated Demand Interface – HEIDI is a bespoke DIADEM interface developed by National Highways.
	HGV	Heavy Goods Vehicle
	HH index	Herfindahl-Hirschman Index – a commonly accepted measure of market concentration.
High traffic growth		A scenario that reflects high traffic levels
HM49		LTAM transport model High traffic growth Without Scheme scenario
High Speed 1	**HS1**	A 109km high-speed railway between London and the UK end of the Channel Tunnel. The line carries international passenger traffic between the UK and continental Europe; it also carries domestic passenger traffic to and from stations in Kent and east London, as well as Berne gauge freight traffic.
	HS72	LTAM transport model high traffic growth With Scheme scenario
Indices of Multiple Deprivation	**IMD**	Socio-economic datasets for different components or domains used to classify relative deprivation.
Income domain		A component of the Index of Multiple Deprivation that measures the proportion of the population in an area experiencing deprivation in terms of low income.
Indirect tax revenues		Revenues from indirect taxes paid by road users
Inflation		A measure of the increase in prices within the economy
Initial BCR		The ratio of Level 1 PVB to PVC
	IO	Input Output tables
Indices of deprivation	**IoD**	A measure of the relative levels of deprivation. In England this considers 32,844 small areas or neighbourhoods, called Lower Layer Super Output Areas. The IOD 2019 is based on 39 separate indicators, organised across seven distinct domains of deprivation; these relate to income, employment, education, health, crime, living environment and barriers to housing and services.
Inter-peak	**IP**	An average hour within LTAM to represent an hour within the period 09:00–15:00.
	ITN	Integrated Transport Network
	KSI	Killed and serious injuries
Level 1 impacts		Monetised benefits estimated using established methodologies that are included in the Level 1 PVB when calculating the Initial and Adjusted BCRs.
Level 2 impacts		Monetised benefits estimated using less established methodologies that are included in the Level 2 PVB when calculating the Adjusted BCR.
Level 3 impacts		Either monetised or qualitatively appraised benefits that are not included in BCRs but which are taken into account in assessing a project's Value for Money.
	LGV	Light Goods Vehicle

Term	Abbreviation	Explanation
	LM49	LTAM transport model - Low traffic growth Without Scheme scenario
	LS72	LTAM transport model low traffic growth With Scheme scenario
Lower Layer Super Output Area	**LSOA**	A geographic hierarchy used to report statistics for small areas with an average population of 1,500 people in England and Wales.
Lower Thames Area Model	**LTAM**	Transport model designed to forecast impacts of providing additional road based capacity across the River Thames at locations at or east of the existing Dartford Crossing
	LTC	Lower Thames Crossing
	M25	M25 Motorway
	ME	Matrix Estimation
Monte-Carlo simulation		A computational algorithm based on repeated random sampling to obtain cost estimates.
Most Likely (costs)		The expected level of CAPEX costs
	MSOA	Middle Layer Super Output Area
Motorway Reliability Incidents And Delays	**MyRIAD**	Motorway Reliability Incidents And Delays appraisal software
	NAPALM	National Air Passenger Allocation Model
	NaPTAN	National Public Transport Access Nodes
	NB	Northbound
	NHBEB	Non-Home-Based Employer's Business
	NHBO	Non-Home-Based Other
Non-motorised user	**NMU**	Users of non-motorised vehicles (eg cyclists, horse riders) and pedestrians.
	NO2	Nitrogen dioxide
	NOMIS	Online service provided by ONS providing access to UK labour market statistics
	NPSNN	National Policy Statement for National Networks
	NPV	Net Present Value
Non recoverable VAT	**NR VAT**	Value added tax that has been paid but cannot be reclaimed by a business.
	NRTS	National Rail Travel Survey
	NSIP	Nationally Significant Infrastructure Project

Term	Abbreviation	Explanation
National Trip End Model	**NTEM**	A DfT model that forecasts the growth in trip origin-destinations (or productions-attractions) up to 2051 for use in transport modelling. The forecasts take into account national projections of population, employment, housing, car ownership and trip rates.
	NTS	National Travel Survey
	NVQ4	National Vocational Qualifications at Level 4 which are equivalent to a degree level education.
	OBR	Office of Budget Responsibility
	OD	Origin Destination
Other Goods Vehicle 1	**OGV1**	All rigid vehicles over 3.5 tonnes gross vehicle weight, including all large vehicles on a single frame: trucks, tow trucks, campers, motor homes, large ambulances, etc.
Other Goods Vehicle 2	**OGV2**	All articulated vehicles, including multi-unit goods-carrying vehicles with a tractor or straight truck power unit, including goods-carrying rigid trucks pulling trailers.
Operating, maintenance and renewals expenditure	**OMR**	Operating, maintenance and renewals expenditure
	ONS	Office for National Statistics
Off-peak period	**OP**	The hours between 18:00-06:00 within the Project traffic model (LTAM).
	OS	Ordnance Survey
	P10	The capital cost estimate for which there is a 10% probability that this will not be exceeded.
	P90	The capital cost estimate for which there is a 90% probability that this will not be exceeded.
	PA	Production Attraction
	PAAT	Public Accounts appraisal table
	PC	Pedal cycles
	PCF	Project Control Framework
	PCN	Penalty Charge Notice
Passenger car unit	**PCU**	A metric to allow different vehicle types within a traffic model to be assessed in a consistent manner.
	PIA	Personal Injury Accident
	PJT	Perceived Journey Time
PM peak hour		The hour between 17:00–18:00 within LTAM
PM peak period		The hours between 15:00–18:00 within LTAM
PM2.5		Particulate matter with a diameter of 2.5 micrometres
Portfolio Risk (costs)		A category of costs that reflect risks of a programme of road projects managed by National Highways

Term	Abbreviation	Explanation
PortPaxEB		Port Trips Employer's Business
PortPaxO		Port Trips Other
PostGIS		A GIS software package
PostgreSQL		A SQL database software package
	PPH	Pence per hour
	PPK	Pence per kilometre
	PPM	Pence per minute
	PRA	Preferred Route Announcement
Project		A122 Lower Thames Crossing – A proposed new crossing of the Thames Estuary linking the county of Kent with the county of Essex, at or east of the existing Dartford Crossing.
Project Risk (costs)		A category of costs that reflect risks associated with a road project
Public Rights of Way	**PRoW**	A right possessed by the public, to pass along routes over land at all times. Although the land may be owned by a private individual, the public may still gain access across that land along a specific route. The mode of transport allowed differs according to the type of public right of way which consist of footpaths, bridleways and open and restricted byways.
Public transport	**PT**	A system of vehicles such as buses and trains that operate at regular times on fixed routes and are used by the public
Public Accounts table		A TAG appraisal table that reports the impacts of the Project on the public finances
Present Value	**PV**	The result of discounting a stream of benefits or costs
Present Value of Benefits	**PVB**	The discounted value of benefits
Present Value of Costs	**PVC**	The discounted value of costs
Probability X level	**Px**	Costs for which there is a x % chance that they will not be exceeded
	Q1	Quarter 1
	QEII	Queen Elizabeth II Bridge
	QI	Quality Index
	QLS	Queue Length Surveys
Quantitative Risk Assessment	**QRA**	A formal and systematic risk analysis approach to quantifying the risks associated with the operation of an engineering process.
QUeues And Delays at ROadworks maintenance delays appraisal software	**QUADRO**	A National Highways sponsored computer program to estimate the effects of roadworks in terms of time, vehicle operating and accident costs on the users of the road.

Term	Abbreviation	Explanation
RAMSAR site		A wetland of international importance, designated under the Ramsar convention.
Reliability Ratio		A ratio used to calculate Journey Time Reliability benefits
Range Estimation Tool	**RET**	National Highways Excel workbook that contains the range of CAPEX costs for a road project
Revenue		Income from road users that are included in the PVC
	RH	Return Home
	RIS	Road Investment Strategy
	RIS2	Road Investment Strategy 2
Risk (costs)		A category of costs associated with events that may arise or may not arise due to a road project
Risk and Opportunity Register		A register used to list and manage project risks and portfolio risks associated with a road project
Retail Price Index	**RPI**	A measure of inflation published monthly by the Office for National Statistics. It measures the change in the cost of a representative sample of retail goods and services.
	RSI	Roadside Interview
	RTF	Road Traffic Forecasts
	RTM	National Highways Regional Traffic Model
	RUC	Road user charging
	RXHAM	TfL's River Crossing Highway Assignment Model
Simulation and Assignment of Traffic to Urban Road Networks	**SATURN**	Software used to build transport models
	SB	Southbound
	SCGE	Spatial Computable General Equilibrium model. An economic model used to estimate the wider economic impacts based on variable land uses
Scheme design		The design of the Project being submitted for development consent
South East Local Enterprise Partnership	**SELEP**	The business-led, public-private body established to drive economic growth across East Sussex, Essex, Kent, Medway, Southend and Thurrock.
Sensitivity test		A test carried out to investigate the dependency in the model outputs to the values input into the model. Often a single input value is changed in turn and the resulting model outputs examined.
Strategic Economic Plan	**SEP**	A document produced by a Local Enterprise Partnership setting out its plans for the future and the funding that will be required to deliver these plans.

Term	Abbreviation	Explanation
South East Regional Traffic Model	**SERTM**	National Highways South East Regional Traffic Model
Standard Industrial Classification	**SIC**	A system used to classify business establishments and other statistical units by the type of economic activity in which they are engaged.
Smart motorway		Term for a range of types of actively controlled motorway, using technology to optimise use of the carriageway including the hard shoulder.
Social cost benefit analysis		A technique used to assess and compare the costs and socio-economic benefits of different options.
Social Impact Appraisal		Social impacts cover the human experience of the transport system and its impact on social factors, not considered as part of economic or environmental impacts.
Special Protection Area	**SPA**	A designation under EU Directive 2009/147/EC on the Conservation of Wild Birds.
Strategic road network	**SRN**	The core road network in England managed by National Highways
Site of Special Scientific Interest.	**SSSI**	A conservation designation denoting an area of particular ecological or geological importance.
Static clustering		Benefits that come when firms and/or people locate near one another in geographical clusters but do not change their spatial location.
	STATS19	A database of all road traffic accidents that resulted in a personal injury and were reported to the police within 30 days of the accident. The data are collected by the police at the roadside or when the accident is reported to them by a member of the public in a police station.
	SUE	Stochastic User Equilibrium
Sunk costs		Costs that have already been incurred
Transport Analysis Guidance	**TAG**	Transport Analysis Guidance published by DfT which provides methods to model and appraise the impacts of transport projects
	TBM	Tunnel boring machine
	TCG	National Highways Technical Consistency Group
	TDCR	Traffic Data Collection Report
Transport Economic Efficiency	**TEE**	An appraisal table used to report the Level 1 benefits that measure the impact of a transport scheme on the efficiency of the transport system
Teletrac		DfT traffic dataset
Trip End Model Program	**TEMPro**	DfT software for viewing data from DfT's National Trip End Model
Transport for London	**TfL**	The integrated body responsible for London's transport system
	TFR	Traffic Forecasting Report
	TIS	National Highways Trip Information System

Term	Abbreviation	Explanation
	TLD	Trip Length Distribution
Traffic Management Cell	**TMC**	The Traffic Management Cell is a traffic safety system for the Dartford Tunnels with advance detection of queues and the active management of the use of the tunnels by restricted vehicles. It is controlled by the TMC Control System that provides a strategic operational control facility for the operational staff that manage the crossing 24 hours per day
	TPG	National Highways Transport Planning Group
Traded carbon		Carbon emissions in the traded sectors covered by the EU Emission Trading System such as the power and industrial sectors
TrafficMaster		DfT traffic dataset
	TRIS	National Highways Traffic Count Database
Travel Time Variability	**TTV**	The daily variation in travel times not due to incidents
	TUBA	Transport User Benefits Appraisal software
User Class.	**UC**	Categorisation of different transport users based on their journey purposes.
	UE	User Equilibrium
Uncertainty Costs		A category of project costs that are unpredictable
Untraded carbon		Carbon emissions in non-traded sectors not covered by the EU Emission Trading System.
User charging		Charges paid by road users for the use of a road, tunnel or bridge.
	V/C	Volume Over Capacity ratio
Value Added Tax	**VAT**	A consumption tax levied in the UK which was introduced in 1973. It is administered and collected by HM Revenue and Customs. VAT is levied on most goods and services provided by registered businesses in the UK and some goods and services imported from outside the European Union. The default VAT rate is the standard rate, 20% since 4 January 2011. Some goods and services are subject to VAT at a reduced rate of 5% (such as domestic fuel) or 0% (such as most food and children's clothing).
	VDM	Variable Demand Model
	Veh	Vehicles
Value for Money	**VfM**	Value for Money, being the optimum combination of whole-life costs and quality to meet the user requirement.
	VISSIM	Micro-simulation traffic modelling software
	VISUM	Strategic car and rail modelling software
Vehicle Operating Costs	**VOC**	Costs that vary with vehicle usage, including fuel, tyres, maintenance, repairs, and mileage-dependent depreciation costs.

Term	Abbreviation	Explanation
	VOL	Value of Statistical Life
Value of Time	**VOT**	The opportunity cost of the time that a traveller spends on their journey and would be the amount that a traveller would be willing to pay in order to save time
	VPD	Vehicles per Day
Wider economic impacts	**WEI**	Land use-related economic consequences of transport interventions, not directly related to impacts on users of the transport network, such as increased productivity. There are two Levels of Wider Economic Impacts, Level 2 and Level 3 benefits, that vary depending on whether land use is assumed to change.
	WITA2	DfT Wider Impacts Transport Appraisal Version 2
With Scheme		Appraisal scenario that includes a proposed intervention such as a project, programme or policy.
Without Scheme		Appraisal scenario that excludes a proposed intervention such as a project, programme or policy.

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