Department for Transport

**Environment**
**Transportation**

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# Review of Lower Thames Crossing Options: Final Review Report Appendices

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# Appendix A: Detailed Appraisal Assessments

## Detailed Appraisal Assessments

### 1.1 Appraisal: Economy Impacts

1.1.1 The appraisal of economy impacts is specified in WebTAG 3.5; the appraised sub-impacts are as follows:

- business users and transport providers;
- reliability impact on business users;
- wider impacts; and
- regeneration.

1.1.2 The potential economic impacts on business users and transport providers, and wider impacts are particularly significant, and therefore these impacts have been monetised.

1.1.3 Other economic impacts are assessed qualitatively.

**Economy: Business Users & Transport Providers**

1.1.4 The economic appraisal of the scheme impact on transport users has been carried out using the DfT's TUBA software using outputs from the Lower Thames Crossing Model (LTCM). The methodology is discussed in detail in Appendix B.

1.1.5 At this stage it has been assumed that provision of a new crossing would be funded as a conventional public sector project and therefore the scheme costs and revenue generated accrue to the public sector. No benefits to private transport providers are therefore estimated. However, within the commercial and financial cases (chapters 5 and 6 of the review report) comparable privately financed solutions are considered. The contractual arrangements that might be considered for providing a new crossing are also discussed further in the commercial case.

1.1.6 Substantial user benefits are forecast to accrue to business travellers. These are summarised in the tables below, and include estimated delays during construction of the schemes (which of course are negative as they are disbenefits).

1.1.7 Non-Fuel Operating Costs include vehicle maintenance, oil, tyre replacement and mileage-related depreciation.

**Table A1.1: Business User Benefits, Option A, PV 60 years, £m, 2010 market prices and values**

| Benefit Type | Car | LGV | HGV | Totals |
|---|---|---|---|---|
| Time | 540 | 64 | 102 | 705 |
| Toll | -21 | -15 | -27 | -64 |
| Fuel Costs | 2 | -0 | 23 | 25 |
| Non-Fuel Operating Costs | 7 | 2 | 15 | 25 |
| Construction Delay | -15 | -4 | -2 | -21 |
| **Total Benefit** | **513** | **47** | **111** | **671** |

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

**Table A1.2: Business User Benefits, Option B, PV 60 years, £m, 2010 market prices and values**

| Benefit Type | Car | LGV | HGV | Totals |
|---|---|---|---|---|
| Time | 911 | 58 | 130 | 1,100 |
| Toll | -21 | -15 | -35 | -72 |
| Fuel Costs | 19 | 6 | 56 | 81 |
| Non-Fuel Operating Costs | 34 | 11 | 28 | 74 |
| Construction Delay | -8 | -2 | -1 | -10 |
| **Total Benefit** | **935** | **59** | **178** | **1,172** |

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

**Table A1.3: Business User Benefits, Option C, PV 60 years, £m, 2010 market prices and values**

| Benefit Type | Car | LGV | HGV | Totals |
|---|---|---|---|---|
| Time | 1,385 | 204 | 279 | 1,867 |
| Toll | -39 | -26 | -52 | -117 |
| Fuel Costs | 55 | 37 | 250 | 343 |
| Non-Fuel Operating Costs | 57 | 26 | 81 | 165 |
| Construction Delay | -63 | -14 | -6 | -83 |
| **Total Benefit** | **1,395** | **226** | **553** | **2,175** |

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

**Table A1.4: Business User Benefits, Option $C_{variant}$, PV 60 years, £m, 2010 market prices and values**

| Benefit Type | Car | LGV | HGV | Totals |
|---|---|---|---|---|
| Time | 1,898 | 321 | 332 | 2,551 |
| Toll | -45 | -27 | -53 | -125 |
| Fuel Costs | 66 | 39 | 273 | 378 |
| Non-Fuel Operating Costs | 72 | 32 | 92 | 197 |
| Construction Delay | -69 | -15 | -6 | -91 |
| **Total Benefit** | **1,922** | **350** | **638** | **2,911** |

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

1.1.8 The direct user benefits for business travellers are large comprising predominantly of time benefits. Some significant vehicle operating cost benefits also accrue to heavy goods vehicles. A relatively small toll disbenefit accrues to new users of a new crossing at location Options A, B or C who might previously have used the Blackwall Tunnel or the west side of the M25, and thus now pay an additional toll, but these users will of course benefit overall or they would not choose to re-route.

1.1.9 No benefits accrue to transport providers, due to the public-sector funding assumption. The impacts upon operators of the scheme are thus discussed under Appraisal: Public Accounts Impacts (Section 1.4.2).

### Wider Economic Impacts Assessment

1.1.10 A new crossing at any of the location options under consideration would change levels of congestion and network geometry in ways that have significant implications for patterns of journey times. Changing patterns of connectivity and relationships between businesses and their employees, customers and suppliers could in turn have significant impacts on the economy, land use and regeneration.

1.1.11 Wider Impacts for the proposed interventions have been calculated in accordance with WebTAG Unit 3.5.14 using bespoke spreadsheet software. The central case results described here follow WebTAG and are based on the latest wider impacts dataset available from the Department for Transport, published in July 2012. A basic land use model has also been developed to examine potential impacts on the distribution and level of employment. The land use model results have been used in sensitivity tests to examine how changes in land use may change the modelled wider impacts; these are provided in Appendix D. The land use model is separate from the traffic model and takes inputs from it. Where they are used for sensitivity testing, modelled land use changes therefore do not feed back into traffic forecasting but only alter the Wider Impact calculations due to changes in employment location.

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

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

1.1.13 A fuller discussion can be found in the Wider Impacts Methodology Report in Appendix D. A wide range of sensitivity tests can also be found within this document explaining how the results vary in response to different assumptions. The methodology appendix also contains further details of the data sources and model geography.

1.1.14 The assessed options affect journey times in a part of the country which is heavily populated both with people and businesses and could significantly affect the metropolitan area of Greater London. It has therefore been considered appropriate to calculate the impacts of the interventions on agglomeration. Potentially significant journey time changes and changes in network geography suggest that a new River Thames crossing could also have significant impacts on land use. It is therefore also appropriate to consider how land use change could affect GP3 (the move to more/less productive jobs) and WI1 (agglomeration) within sensitivity testing. Land use change sensitivities are described in Appendix D.

1.1.15 New crossing capacity at Option A is forecast to reduce journey times for traffic using the existing Dartford-Thurrock Crossing. The largest times savings are expected on routes from Maldon and Chelmsford to the Medway Towns and Tunbridge Wells where average journey times are forecast to fall by up to 2.5 minutes in 2025.

1.1.16 There is some asymmetry in forecast journey time changes so in the economic analysis and the tables below journey times are presented as a 24 hour average for commuting and business trips only, averaged across outbound and return directions. This reflects the fact that most commuters and business travellers must make return trips. A summary of the pattern of forecast changes in weighted highway generalised costs[1] brought about by Option A and averaged across the two

[1] 'Generalised cost' is a measure that combines all of the features of a journey that are burdensome into a single measure that represents how an overall journey is perceived by a traveller. It includes both the time taken and financial costs associated with the trip such as fares, vehicle operating costs, etc.

directions is shown in Table A1.5 below. The forecast journey time changes in the table reflect the ones used to estimate economic impacts.

**Table A1.5: Percentage change in weighted average highway generalised costs, Option A, 2025**

| Destination / Origin | London | Kent | Essex | Other |
|---|---|---|---|---|
| London | Less than 0.1% | Less than 0.1% | Less than 0.1% | Less than 0.1% |
| Kent | Less than 0.1% | Less than 0.1% | -1.3% | -0.1% |
| Essex | Less than 0.1% | -1.3% | 0.1% | Less than 0.1% |
| Other | Less than 0.1% | -0.1% | Less than 0.1% | Less than 0.1% |

Costs are weighted across all hours of the day and include commuting and business trips averaged across outbound and return directions.

1.1.17 A new crossing at Option A is expected to reduce the average cost of travel by road between Kent and Essex for business travellers and commuters by 1.3% in 2025. Other small journey time improvements are seen between Kent and Essex and other areas. Some small increases in journey times are forecast within Essex as a result of changes in traffic patterns.

1.1.18 Table A1.6 summarises the forecast Wider Impacts associated with these journey improvements.

**Table A1.6: Wider Impacts, Option A, £m, 2025-2084**

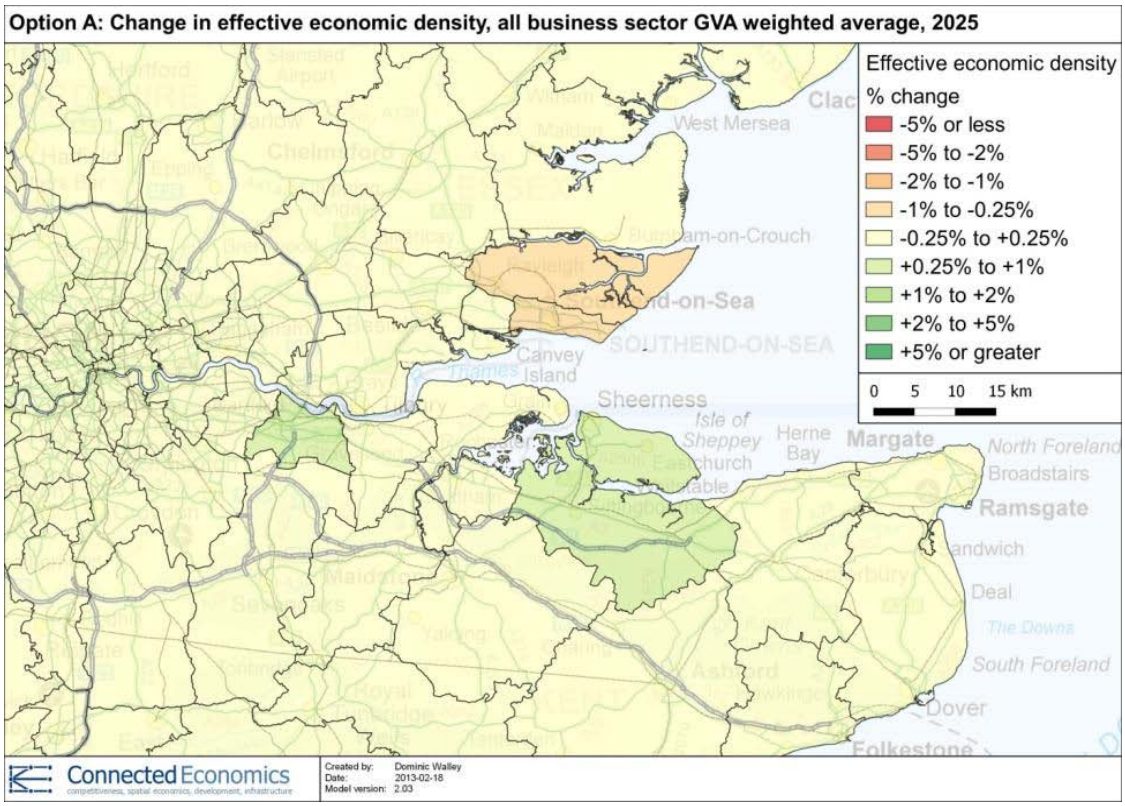
| | Description | 2025 | 2041 | NPV |
|---|---|---|---|---|
| WI1 | Agglomeration | 12.6 | 9.4 | 195 |
| WI3 | Change in output in imperfectly competitive markets | 2.1 | 3.0 | 56 |
| WI4 | Tax wedge on labour market impacts GP1 and GP3 | 0.0 | 0.0 | 0 |
| **Total** | **Total welfare impact** | **14.7** | **12.4** | **251** |

GP2 (people choosing to work longer hours) and WI2 (impact of increased competition) are assumed to be zero in line with WebTAG guidance. GP3 (move to more productive jobs) is zero in the central case where land use is assumed to be fixed.

1.1.19 The largest wider economic impact is expected to be support for the agglomeration of business activity (WI1). The value of these agglomeration benefits is estimated at £12.6m in 2025, falling to £9.4m by 2041. The benefit arises as businesses are effectively brought closer together and can benefit from spill-over benefits such as improved labour market matching and improved diffusion of best practice. Agglomeration effects arise where businesses become better connected to each other. This connectivity is known as ‘effective economic density’ and it improves in Option A where the pattern of journey time benefits is forceats to bring businesses closer to each other.

1.1.20 Figure A1.1 shows how the pattern of effective economic density is affected by forecast journey time changes that arise as a result of a new crossing at Option A in 2025. The analysis is undertaken for four business sectors and the map shows the average across all sectors weighted by their contribution to economic output (GVA). The largest percentage changes in effective economic density are seen in Dartford and Swale where effective economic density is forecast to rise by 0.3%. Some reductions are also seen in effective density due to some negative impacts on journey times, for example in Rochford and Southend.

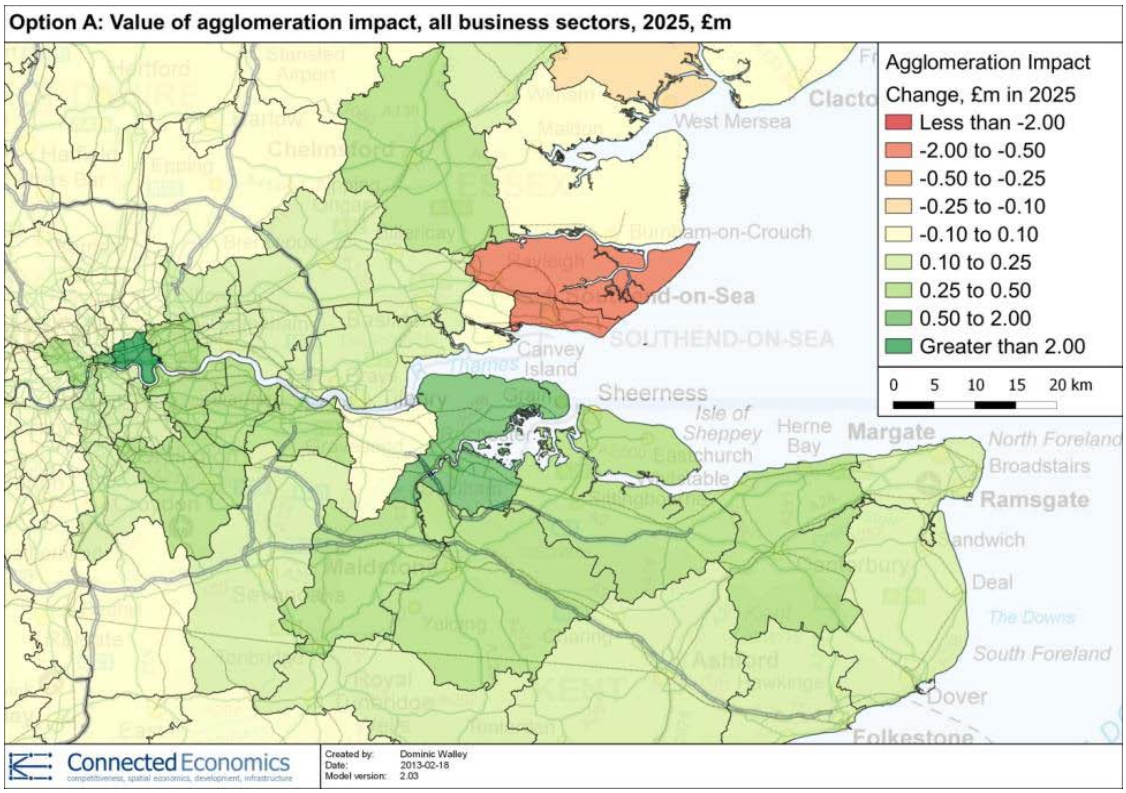
**Figure A1.1: Option A: % change in effective economic density, all business sector GVA weighted average, 2025**




1.1.21 Changes in effective economic density drive the proportionate change in productivity that is associated with the transport investment. The overall agglomeration impact brings together this proportionate change in productivity with the existing level of economic output in the areas affected. The largest impacts are therefore forecast to occur in areas which have both significant decreases in journey times and a large existing business base.

1.1.22 Figure A1.2 shows the overall modelled agglomeration impact forecast across all sectors in 2025 due to a new crossing at Option A. The largest changes in agglomeration in 2025 are forecast in Central London, while significant benefits are also expected across East London, much of Northern Kent and along the A12 corridor in Essex. However, there are also some negative impacts, particularly in southeast Essex influenced by changes in traffic patterns on the A13 and A127.

**Figure A1.2: Option A: Value of modelled agglomeration impact in 2025, £m, all business sectors**




1.1.23 A new crossing at Option A is forecast to generate significant business user benefits which, by reducing business costs, are estimated to increase output in imperfectly competitive markets by a present value of £56m. Impacts on the labour supply are expected to be negligible. The total net present value of Wider Impacts is estimated to be £251m.

1.1.24 A new crossing at Option B, between the Swanscombe Peninsula and the A1089, is forecast to provide the largest generalised cost savings on routes between the Medway Towns, Swale, Gravesham and Dover to the south and Maldon, Castle Point and Chelmsford to the north. Average generalised costs are expected to fall by around 10 to 12 minutes on many of these routes in 2025, although journey time benefits are eroded slightly by 2041. A summary of the pattern of changes in weighted highway generalised costs brought about by Option B, averaged across outbound and return directions, is shown in Table A1.7 below.

**Table A1.7: Percentage change in weighted average highway generalised costs, Option B, 2025**

| Destination / Origin | London | Kent | Essex | Other |
|---|---|---|---|---|
| **London** | Less than 0.1% | -0.2% | -0.2% | Less than 0.1% |
| **Kent** | -0.2% | 0.1% | -4.5% | -0.1% |
| **Essex** | -0.2% | -4.5% | 0.2% | -0.1% |
| **Other** | Less than 0.1% | -0.1% | -0.1% | Less than 0.1% |

Costs are weighted across all hours of the day and include commuting and business trips.

1.1.25 Option B is expected to reduce the average cost of travel by road between Kent and Essex for business travellers and commuters by 4.5% in 2025. Smaller changes are forecast to occur across a wider area. Most of these are reductions in journey time, although highway journeys

within Essex see a small deterioration and in Kent see a very small deterioration due to changes in local traffic patterns.

1.1.26 Table A1.8 summarises the forecast Wider Impacts of these journey improvements.

**Table A1.8: Wider Impacts in the Policy Area, Option B, £m, 2025-2084**

| | Description | 2025 | 2041 | NPV |
|---|---|---|---|---|
| WI1 | Agglomeration | 22.1 | 27.4 | 507 |
| WI3 | Change in output in imperfectly competitive markets | 3.6 | 5.3 | 99 |
| WI4 | Tax wedge on labour market impacts GP1 and GP3 | 0.0 | 0.0 | 0 |
| **Total** | **Total welfare impact** | **25.7** | **32.7** | **606** |

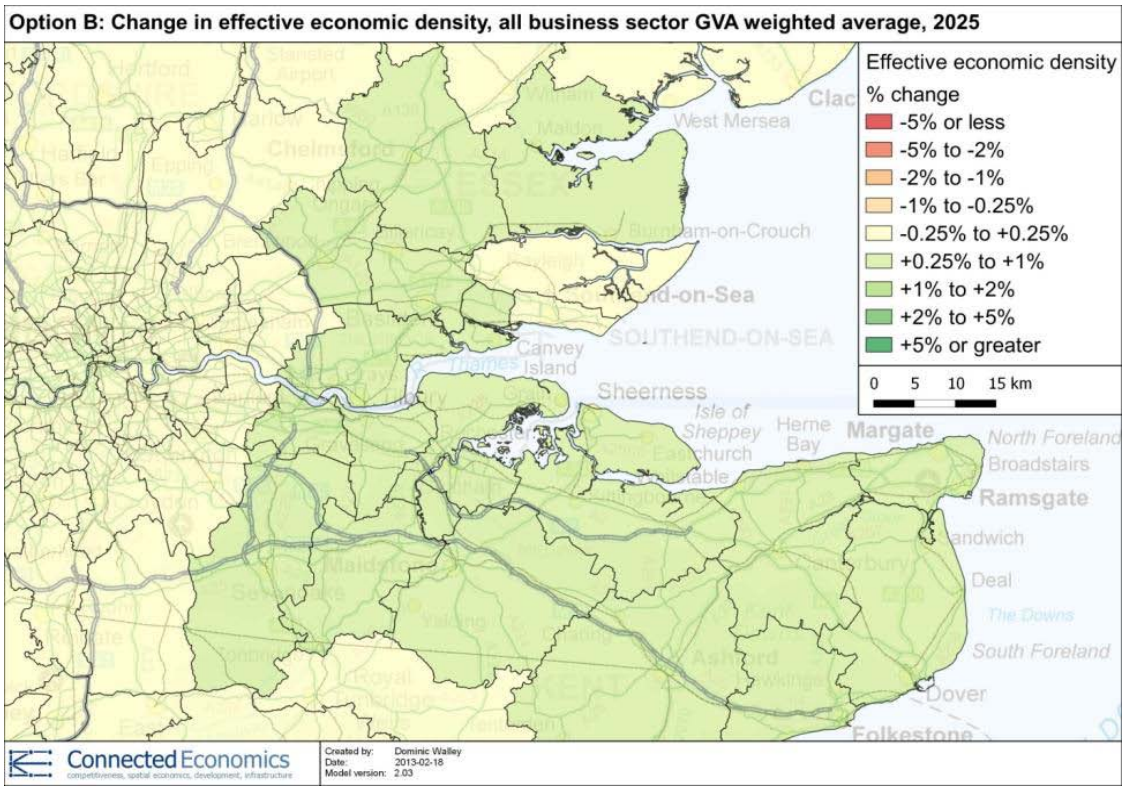
GP2 (people choosing to work longer hours) and WI2 (impact of increased competition) are assumed to be zero in line with WebTAG guidance. GP3 (move to more productive jobs) is zero in the central case where land use is assumed to be fixed.

1.1.27 The wider economic impacts associated with a new crossing at Option B are dominated by support for the agglomeration of business activity (WI1). In 2025 the value of these agglomeration benefits is estimated at £22.1m in 2025 and £27.4m in 2041.

1.1.28 These agglomeration benefits arise as journey time improvements provide improved connectivity to businesses in north Kent and south Essex as shown Figure A1.3. For ease of comparison, the scale in Figure A1.3 is the same as the scale in Figure A1.1 which describes the same impacts in Option A. The wider spread of significant impact on effective economic density in Option B can be seen by comparing the two figures. The largest percentage improvements in effective economic density in Option B are found in Castle Point, Swale and Thurrock which all see a 0.6% increase.

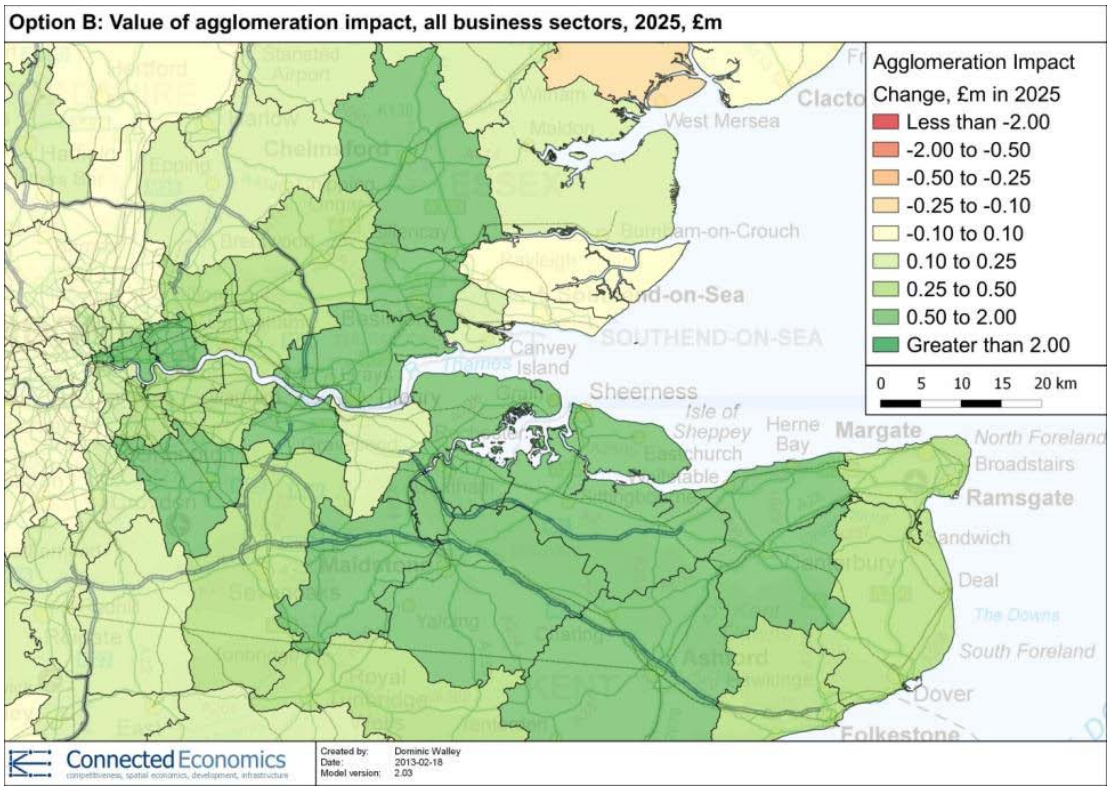
1.1.29 Through its impact on business productivity, this increase in effective economic density is expected to support an increase in economic activity.

**Figure A1.3: Option B: % change in effective economic density, all business sector GVA weighted average, 2025**




1.1.30 Figure A1.4 shows the forecast impact of this in 2025 across all business sectors. Benefits are forecast to be concentrated in north-eastern Kent and in Thurrock, Basildon and Chelmsford in Essex due to the combination of changes in effective economic density and the size of existing business activity. In London, forecast benefits are clustered in the Tower Hamlets and Newham where smaller journey time benefits are forecast to produce significant impacts because of their large economic output. The scale in Figure A1.4 is the same as in Figure A1.2 for ease of comparison.

**Figure A1.4: Option B: Value of modelled agglomeration impact in 2025, £m, all business sectors**




1.1.31 A new crossing at Option B is forecast to generate business user benefits of £36m in 2025. If markets are perfectly competitive, the welfare benefit would be completely measured by the change in user benefits. However, markets are not perfectly competitive so a transport intervention that leads to an increase in output will deliver an additional welfare gain, as consumers of the goods and services will value any increases in production by more than the cost of the additional units of production. This is referred to as the "increased outputs in imperfectly competitive markets" impact. It is calculated by uplifting business user benefits by 10%, which for option B corresponds to £3.6m in 2025, and to a total of £99m over the appraisal period.

1.1.32 Option C and $C_{variant}$, new crossing scenarios east of Gravesend and Tilbury are forecast to offer substantial reductions in travel time and cost across a wide area, with particularly large benefits for areas in the far east of Essex and Kent.

1.1.33 Reductions in the average cost of travelling between districts are forecast to be up to around 19 minutes between the Medway Towns and Rochford (Essex), representing an improvement of almost 20% for these movements. On average, the cost of car travel between Essex and Kent for commuters and business trip makers is expected to fall by around 5.2% in 2025, and 4.9% in the opposite direction. A summary of the forecast pattern of changes in weighted highway generalised costs brought about by Options C and $C_{variant}$ averaged across outbound and return directions, are shown in Table A1.9 below.

**Table A1.9: % change in weighted average highway generalised costs, Option C and $C_{Variant}$, 2025**

| Destination Origin | London | Kent | Essex | Other |
|---|---|---|---|---|
| **Option C** | | | | |
| London | Less than 0.1% | -0.4% | -0.3% | Less than 0.1% |
| Kent | -0.4% | - | -5.2% | -0.5% |
| Essex | -0.3% | -5.2% | 0.1% | -0.1% |
| Other | Less than 0.1% | -0.5% | -0.1% | Less than 0.1% |
| **Option $C_{variant}$** | | | | |
| London | Less than 0.1% | -0.5% | -0.2% | Less than 0.1% |
| Kent | -0.5% | -0.2% | -5.5% | -0.6% |
| Essex | -0.2% | -5.5% | 0.1% | -0.1% |
| Other | Less than 0.1% | -0.6% | -0.1% | Less than 0.1% |

Costs are weighted across all hours of the day and include commuting and business trips.

1.1.34 Journey time benefits are widespread. For example, journeys from Kent to London are forecast to improve by 0.4% on average. However, small journey time disbenefits again arise in Essex. Journey time benefits between Essex and Kent improve slightly in the $C_{variant}$ scenario. In both cases, the benefits are expected to persist through to 2041 at a similar level.

1.1.35 Table A1.10 and Table A1.11 summarise the modelled Wider Impacts of these journey improvements for Options C and $C_{variant}$.

**Table A1.10: Wider Impacts in the Policy Area, Option C, £m, 2025-2084**

| | Description | 2025 | 2041 | NPV |
|---|---|---|---|---|
| WI1 | Agglomeration | 39.1 | 55.3 | 999 |
| WI3 | Change in output in imperfectly competitive markets | 7.2 | 8.8 | 162 |
| WI4 | Tax wedge on labour market impacts GP1 and GP3 | 0.1 | 0.1 | 1 |
| **Total** | **Total welfare impact** | **46.4** | **64.2** | **1162** |

GP2 (people choosing to work longer hours) and WI2 (impact of increased competition) are assumed to be zero in line with WebTAG guidance. GP3 (move to more productive jobs) is zero in the central case where land use is assumed to be fixed.

**Table A1.11: Option $C_{variant}$ Wider Impacts in the Policy Area, £m, 2025-2084**

| | Description | 2025 | 2041 | NPV |
|---|---|---|---|---|
| WI1 | Agglomeration | 49.0 | 70.9 | 1,275 |
| WI3 | Change in output in imperfectly competitive markets | 8.6 | 12.6 | 227 |
| WI4 | Tax wedge on labour market impacts GP1 and GP3 | 0.1 | 0.1 | 2 |
| **Total** | **Total welfare impact** | **57.7** | **83.6** | **1,504** |

GP2 (people choosing to work longer hours) and WI2 (impact of increased competition) are assumed to be zero in line with WebTAG guidance. GP3 (move to more productive jobs) is zero in the central case where land use is assumed to be fixed.

1.1.36 The largest wider economic impact is again forecast to be support for the agglomeration of business activity (WI1). The value of these agglomeration benefits is estimated at £39.1m in 2025 and £55.3m in 2041 in Option C. Widening the A229 between the M2 and M20 improves these to £49.0m and £70.9m respectively.

1.1.37 The pattern of changes in effective economic density can be seen in Figure A1.5 for Option C and Figure A1.7 for Option $C_{variant}$. The map scales are the same as in Figure A1.1 and Figure A1.3 for ease of comparison. In Option C in 2025, effective economic density is forecast to increases across northern and eastern Kent by between 1% and 2% with smaller increases expected in Essex, southeast London and western Kent. In Option $C_{variant}$ these are bolstered by a further forecast increase in effective economic density along the A229 between the M2 and M20. In Option $C_{variant}$ in 2025 effective economic density in Maidstone is forecast to increase by 2.3%, in the Medway Towns by 1.9% and in Ashford by 1.7%.

1.1.38 Significant agglomeration benefits are expected to arise across a wide area of Kent and Essex in relation to a new crossing at both location Option C and $C_{variant}$ with benefits particularly prevalent around the Medway area where significant increases in effective economic density are forecast to arise in areas where there is a large existing business base. Although Option $C_{variant}$ is forecast to have similar overall agglomeration benefits to Option C, these benefits are larger and increase by 2041 in Medway and the M20/M2 corridor. Agglomeration impacts associated with Option C and $C_{variant}$ are shown in Figures A1.6 and A1.8. The map scales are the same as in Figure A1.2 and Figure A1.4 for ease for comparison.

**Figure A1.5: Option C: % change in effective economic density, all business sector GVA weighted average, 2025**

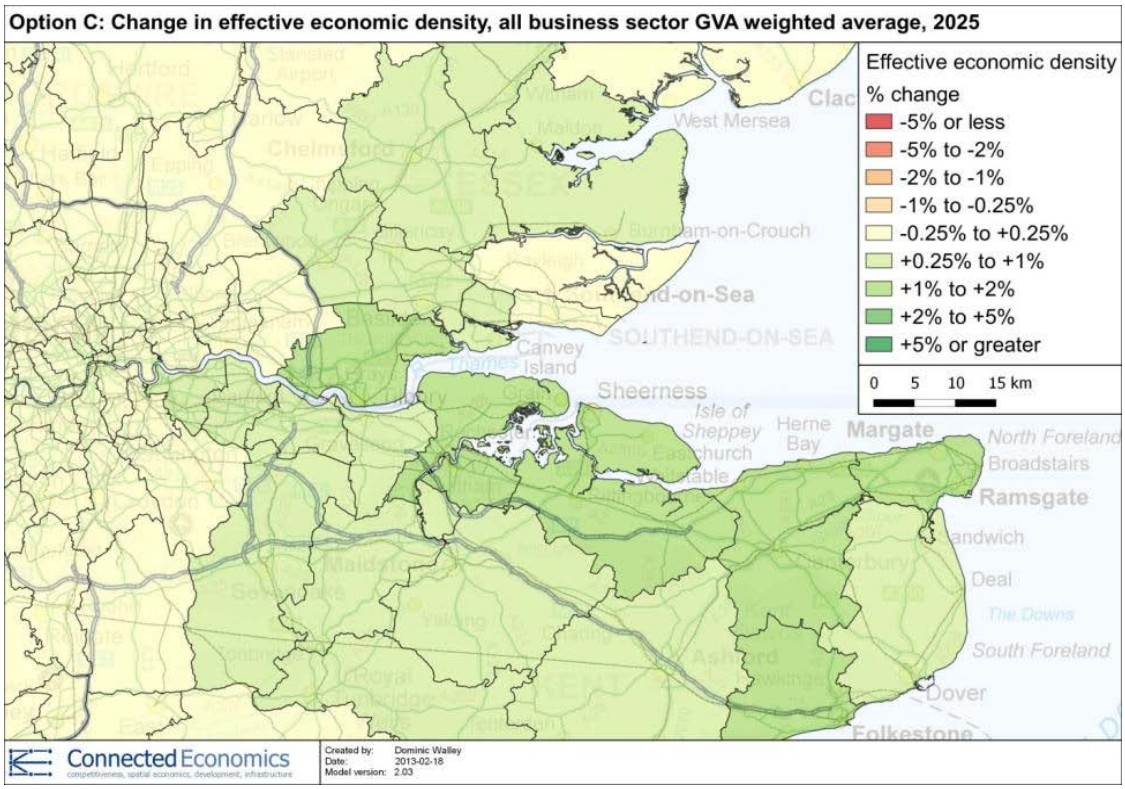


**Figure A1.6: Option C: Value of modelled agglomeration impact in 2025, £m, all business sectors**

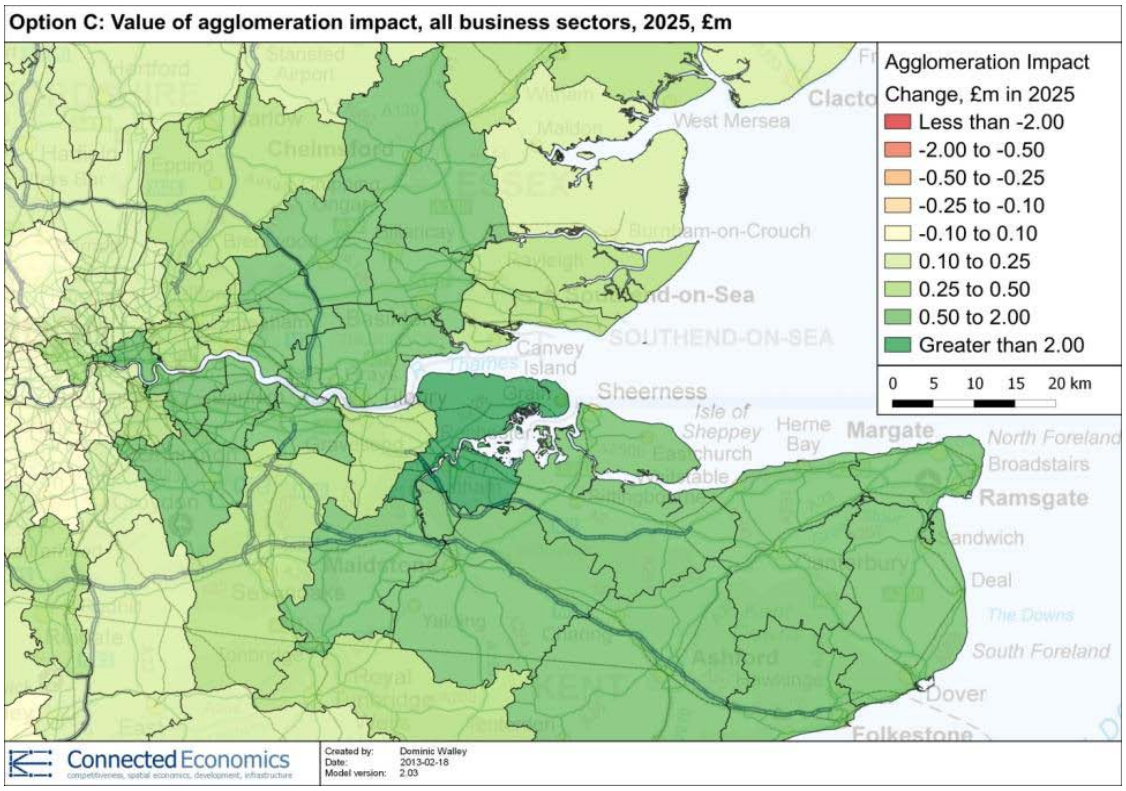



**Figure A1.7: Option $C_{variant}$: % change in effective economic density, all business sector GVA weighted average, 2025**

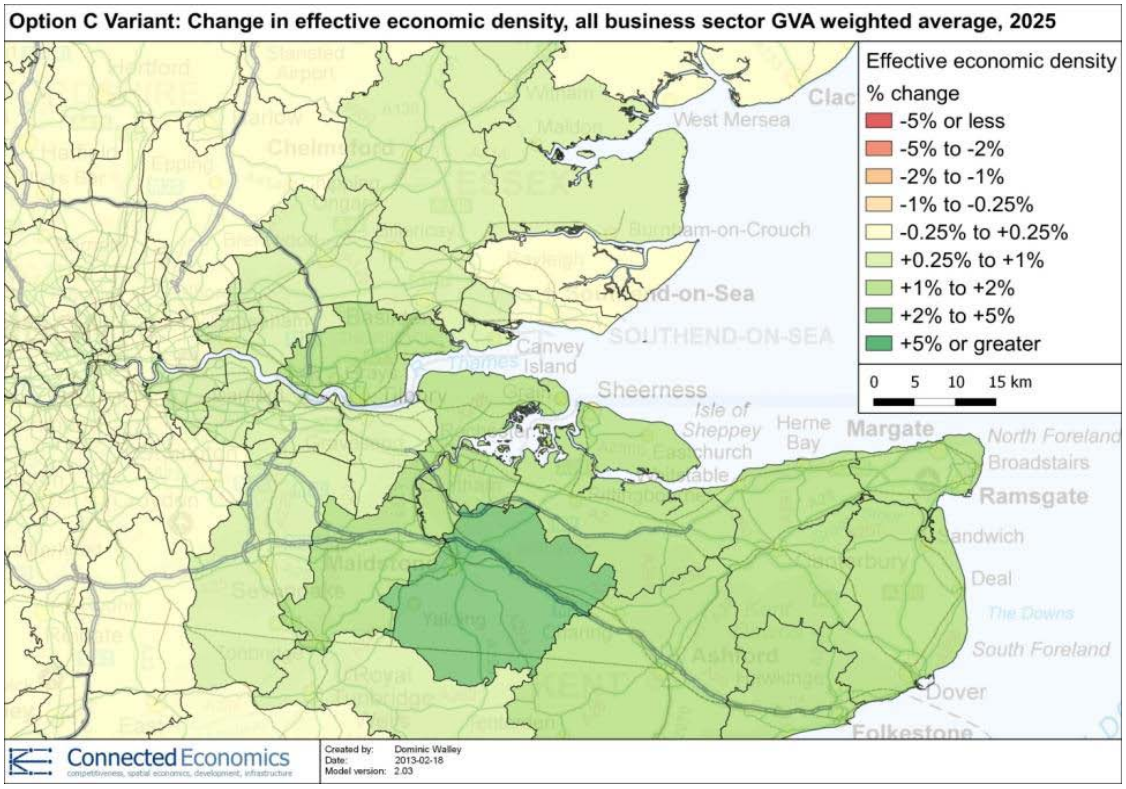
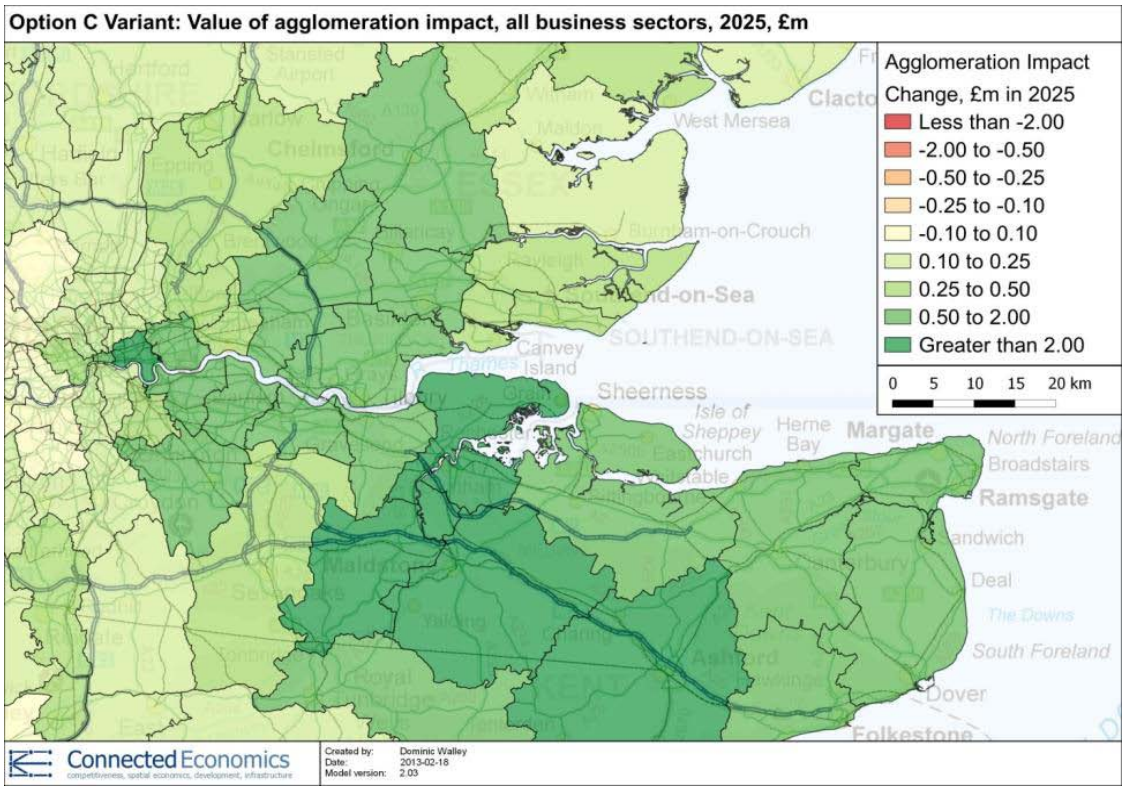


**Figure A1.8: Option Cvariant: Value of modelled agglomeration impact in 2025, £m, all business sectors**




1.1.39 Business user benefits associated with a new crossing at Option C are forecast to grow from £74m in 2025 to £98m in 2041 leading to an increase in outputs in imperfectly competitive markets of £7.4m, growing to £9.8m over this period. Impacts on labour supply are again expected to be small relative to other impacts. When taken together, Wider Impacts are forecast to generate an additional £46.4m of welfare benefits in 2025 and £64.2m in 2041 for Option C. For Option $C_{variant}$, these benefits are forecast to be increased to £57.7m and £83.6m respectively.

**Wider Impacts Summary**

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

1.1.41 In the case of Options B, C and $C_{variant}$, new journey opportunities are introduced which are forecast to lead to larger, more widespread and more persistent reductions in journey times between areas of economic importance. Agglomeration benefits in these cases are therefore expected to be considerably larger than for Option A. Options C and $C_{variant}$ are forecast to experience larger journey time benefits than Option B with more new journey opportunities opened up, explaining the much larger modelled agglomeration benefits, particularly in Kent around the Medway area[2].

[2] Note that agglomeration impacts need not vary consistently with journey time benefits because they represent the pattern of opportunities for business to trade with each other, rather than the pattern of actual trip making. In particular, where new journey opportunities arise from a new road network geometry, agglomeration may be supported even if trip making between these places is relatively small.

### Economy: Reliability Impact on Business Users

1.1.42 A quantitative, but non-monetised, assessment of the impact of the new crossings on reduced traffic stress has been made following the guidance in WebTAG 3.5.7 Annex F. (This is presented at section 4.4.21 of the main report.) Following the Annex F guidance and noting that the AADT on the existing crossing is around 167,000 vehicles, the reliability assessment is large beneficial, for all location options, albeit with greater benefits to performance expected for Option A.

### Economy: Regeneration

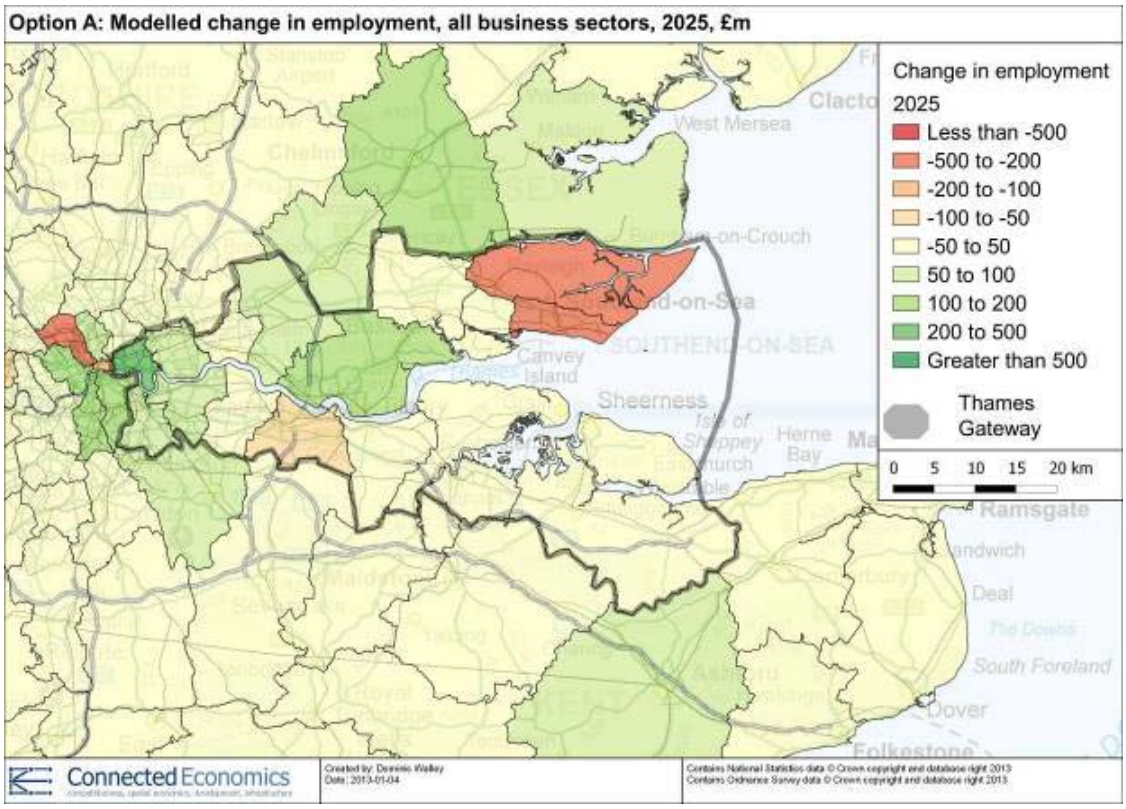
1.1.43 Regeneration impacts provide an indication of how a transport intervention could influence the distribution of jobs, particularly for residents of Regeneration Areas. This provides information relevant for policy decisions. Regeneration impacts are an equity consideration which does not form part of a monetised cost benefit analysis. It is not appropriate at this stage of analysis to undertake a full Regeneration Report as described in WebTAG Unit 3.5.8. The following section takes a proportionate approach which considers the implications of transport and land use modelling for regeneration. In particular, locations that are most affected have been highlighted and implications for regeneration, regional policy and equity have been examined[3]. Note that modelled changes in land are presented here to inform regeneration considerations. They have not been used in the calculation of wider impacts described in this section, but have been used for sensitivity testing of wider impacts presented in the appendix.

1.1.44 Option A: the pattern of journey times offers slightly larger benefits for northbound commuting traffic across the Thames. Consequently, connectivity to labour markets increases most in areas north of the river[4.] The largest impacts on employment are felt in areas of East London and Essex, particularly in Tower Hamlets (which has a large employment base and is served by the A13) and Thurrock as shown in Figure A1.9. Forecast employment gains in Thurrock are expected to be overwhelmingly in the consumer services sector while gains in Tower Hamlets are expected to be mainly in the producer services sector which includes, for example, business services and finance. This reflects the current business mix of these areas. However, increases in journey times in some areas and the relocation of business activity mean that some areas could see lower future employment levels compared to what would have otherwise occurred without the investment, for example in Southend and Rochford.

[3] Modelled changes in land are presented here to inform regeneration considerations. They have not been used in the calculation of wider impacts described in this section, but have been used for sensitivity testing of wider impacts presented in the appendix.

[4] Differences in impacts on the north and south of the river are the result of two effects. First, changing patterns on local traffic and congestion affect journey times differently on different sides of the river. Second, the assessed pattern of benefits is based on costs between commuting origins and workplace destinations so may not accurately reflect the overall cost of a return trip if southbound river crossings benefit to a different degree from Northbound crossings. The location of modelled impacts should therefore be taken to be indicative.

**Figure A1.9: Option A: modelled change in employment, 20255**



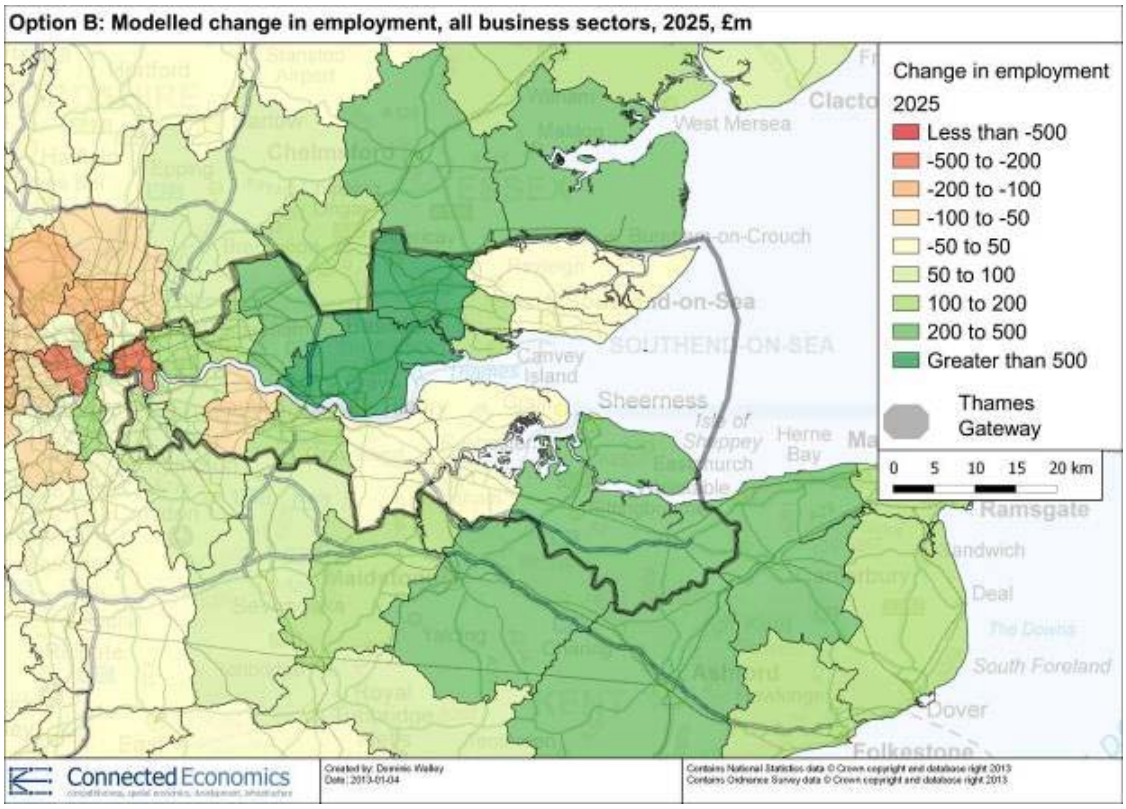

1.1.45 Overall, around 500 jobs are expected to relocate to the Thames Gateway[6] as a result of the scheme in 2025 with almost all of these being in the London Thames Gateway area. Growth occurs particularly in Tower Hamlets. By 2041, the changing pattern of journey time benefits increasingly favours areas in the rest of Kent and Essex suggesting that employment benefits for the Thames Gateway area may not persist in the longer term. Indeed, by 2041 employment impacts in the Thames Gateway are expected to be negative as jobs move to other parts of Kent and Essex where journey time benefits are more persistent, particularly Chelmsford, Maldon, Ashford and Canterbury.

1.1.46 Option B: a new connection between the Swanscombe Peninsula and the A1089 could have significant impacts for spatial development across a wide area of London and southeast England as shown in Figure A1.10. The Thames Gateway in particular is forecast to see an increase in employment as employment growth patterns shift eastwards.

[5] 2025 represents the opening year for a new crossing assumed for appraisal purposes.

[6] The Thames Gateway comprises sections of 16 different local government districts in three regions, including the London boroughs of Barking and Dagenham, Bexley, Havering, Lewisham, Greenwich, Newham and Tower Hamlets and in Kent and Essex, the non-metropolitan districts of Basildon, Castle Point, Rochford, Dartford, Gravesham and western parts of Swale; and the unitary authorities of Thurrock, Southend-on-Sea and Medway. The economic analysis is undertaken at district level and so all parts of the above districts are considered.

**Figure A1.10: Option B: modelled change in employment, 2025**




1.1.47 The largest gains in connectivity are forecast to be in southern and eastern areas of Essex and in southeast Kent. These are forecast to draw employment growth away from the Greater London area and the more agglomerated parts of Kent, Essex and the rest of the south east, particularly in the longer term. This could give rise to de-agglomeration which has been captured in sensitivity tests of the wider impacts drawing on the land use modelling. This is described in detail in the Wider Impacts Methodology Report in Appendix D.

1.1.48 The forecast eastward employment shift sees redistribution of employment within the Thames Gateway area itself. The Thames Gateway is expected to gain an additional 2,100 jobs in 2025 falling to around 800 in 2041 as an eastward shift in employment takes place. For example, while Thurrock is expected to gain around 650 jobs by 2025, Tower Hamlets is expected to lose around half this number.

1.1.49 Options C and $C_{variant}$ : widespread and significant journey time changes are forecast to have a significant impact on the connectivity of locations in the core study area and beyond. These are in turn expected to have a significant impact on land use, particularly in the easterly areas of Kent and Essex. The implications of this are national in scale and could affect many areas of policy interest and sub-regional growth areas including the Thames Gateway, Ashford and others. This is shown in Figure A1.11 for Option C and Figure A1.12 for Option $C_{variant}$.

**Figure A1.11: Option C: modelled change in employment, 2025**

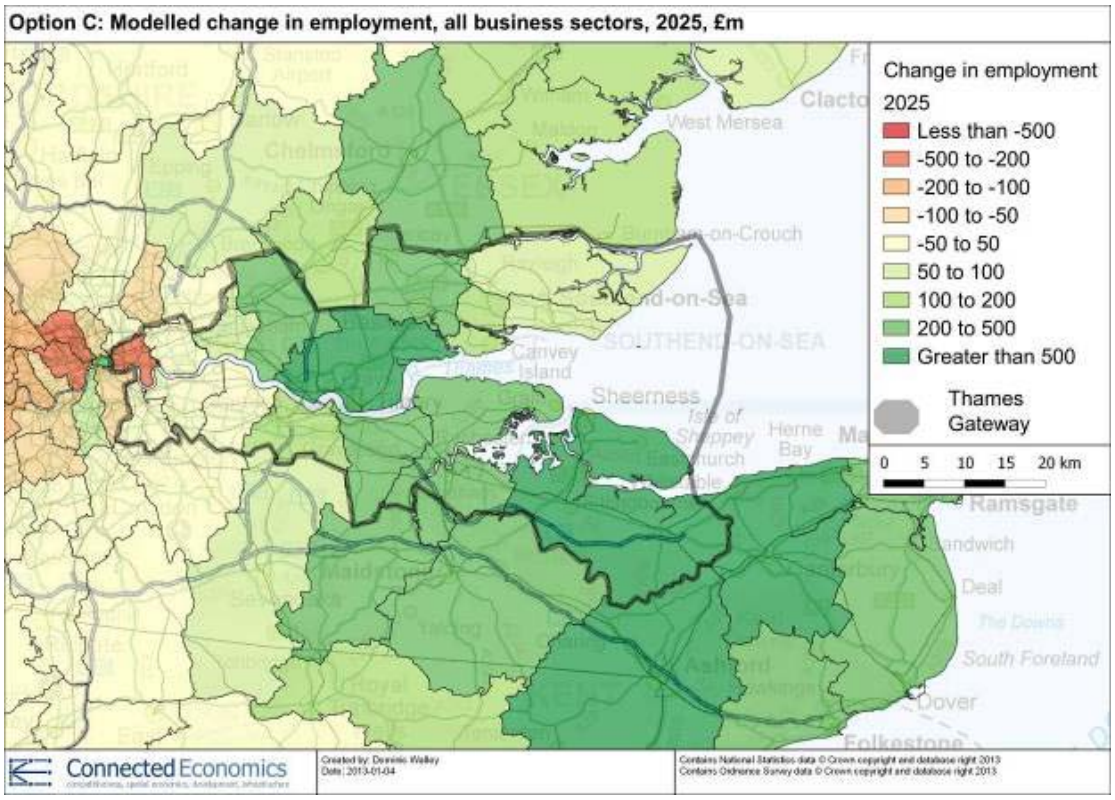
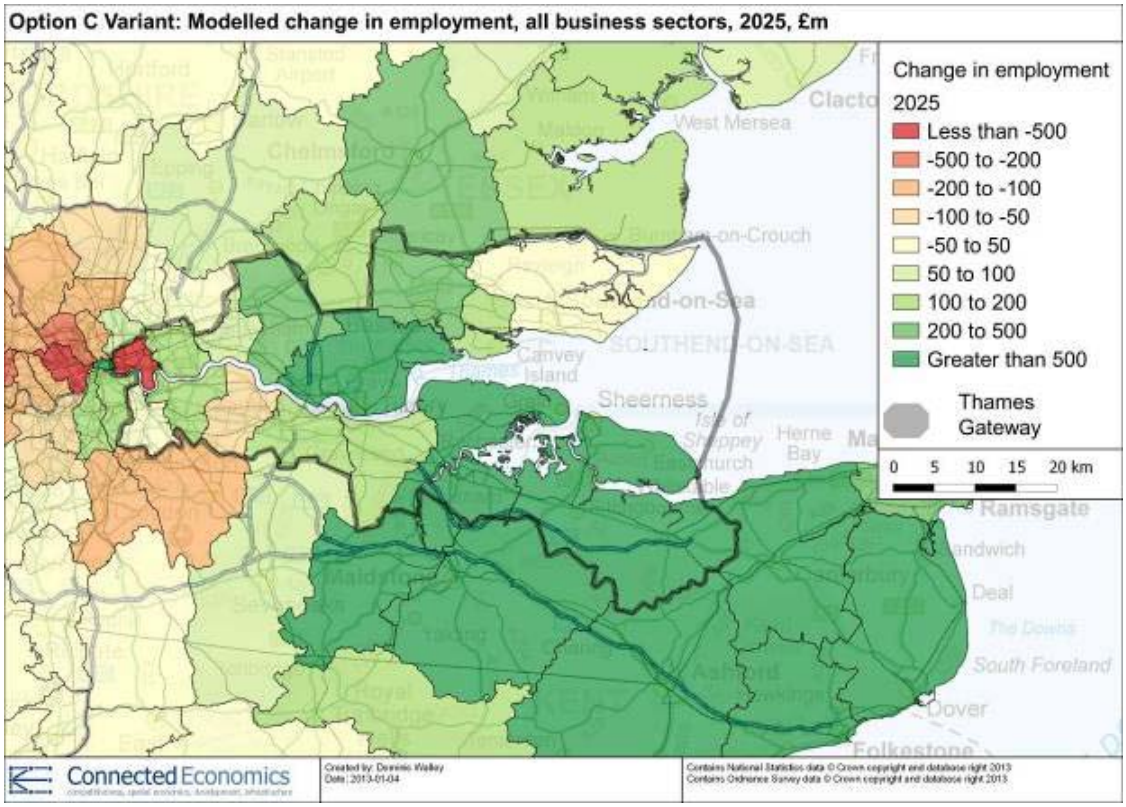



**Figure A1.12: Option Cvariant: modelled change in employment, 2025**




1.1.50 Overall, Option A is assessed as having a Slight Beneficial effect. Options B, C and $C_{variant}$ are assessed as having a Moderate Beneficial effect.

1.1.51 The scale of potential regeneration impacts and their wide area of coverage makes it difficult to provide a short summary of impacts which could be of policy importance, but some general features are worth noting:

- Around half of the modelled employment impacts within the Policy area are expected to be in the Thames Gateway;
- these impacts are expected to be concentrated in the Kent Thames Gateway, particularly in the scenario where the Option Cvariant is provided, and increasingly so over time;
- employment impacts in the rest of Kent and Essex are expected to be larger than those in the Thames Gateway; and
- significant redistribution of employment is expected away from other parts of London and the rest of the UK.

## 1.2 Appraisal: Environmental Impacts

1.2.1 The appraisal of environmental impacts is specified in WebTAG 3.3; the appraised sub-impacts are as follows:

- noise;
- air quality;
- greenhouse gases;
- landscape;
- townscape;
- biodiversity;
- heritage or historic resources; and
- water environment.

1.2.2 Noise, air quality and greenhouse gas effects have been monetised using LTCM traffic flow statistics and the guidance in WebTAG 3.3.2 to 3.3.5. Social and distributional impacts have also been assessed for noise and air quality. Other environmental impacts are assessed qualitatively.

**Environmental: Noise**

1.2.3 All options have been judged to have an adverse impact on noise. The noise impacts of the options have been assessed relative to the base case in the second modelled year (2041). The adverse noise impacts of Option A would be experienced primarily by residential properties close to the existing crossing. Option B would introduce a new link in the road network. It would involve moderately adverse noise impacts on properties in the area along new sections of road leading towards and away from the crossing, and an adverse noise impact on Thameside Infant School in Grays. Option C would also introduce a new road link and would cause adverse noise impacts in fairly rural areas. There could be some benefits in reduction of noise impacts along the A2.

1.2.4 Appraisal results are shown in Table A1.12.

**Table A1.12: Monetary Values and Net Noise Annoyance Change in 2041**

| Option | Present Value Of Noise Change (60 year period)[1] | Estimated Population Annoyed | | Net Noise Annoyance Change in 2041 (No; of people)[2] |
|---|---|---|---|---|
| | | Do-Minimum | Do-Something | |
| Option A | -£9m | 69,985 | 70,230 | 245 |
| Option B | -£70m | 69,985 | 71,842 | 1,857 |
| Option C | -£72m | 69,985 | 71,754 | 1,769 |
| Option $C_{variant}$ | -£79m | 69,985 | 71,916 | 1,932 |

[1] positive value reflects a net benefit (i.e. noise reduction)
[2] positive value reflects an increase in people annoyed by noise
Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

1.2.5 Low income can be a sign of social deprivation. A social distributional impacts (SDI) analysis was carried out to determine how each income group would be affected by a new crossing at each location option. Unlike the table above, which considers only those who will experience noise at levels which are likely to cause annoyance, the SDI analysis considers the total population which will experience any change in noise of 1 decibel (dB) or more relative to the base case, taking the second modelled year (2041) as the year of comparison. This assessment considers only the numbers of people expected to be affected by an increase or decrease in noise and which income group they are in; it does not consider how much worse or improved the level of noise forecast is. The results are shown in tables A1.14 – A1.17. The scores are based in the balance in each income group experiencing a net increase/decrease in noise with large adverse indicating a large net number of people experiencing an increase in noise, and large beneficial a large net number of people experiencing a decrease.

1.2.6 A key for the tables is provided below.

**Table A1.13**

| | | | |
|---|---|---|---|
| xxx | Large adverse | ✓✓✓ | Large beneficial |
| xx | Moderate adverse | ✓✓ | Moderate beneficial |
| x | Slight adverse | ✓ | Slight beneficial |

**Table A1.14: SDI Analysis (Do-Minimum 2041 versus Do-Something 2041), Option A**

| Option A | Index of Multiple Deprivation Income Domain Most deprived areas Least deprived areas | | | | | Total |
|---|---|---|---|---|---|---|
| | 0-20% | 20-40% | 40-60% | 60-80% | 80-100% | |
| Population in each group with increased noise [A] | 742 | 630 | 78 | 329 | 185 | 1964 |
| Population in each group with decreased noise [B] | 17 | 51 | 3 | 23 | 0 | 94 |
| Population in each group with no change in noise [C] | 47036 | 107895 | 84060 | 63583 | 68058 | 370632 |
| Net no of Winners / Losers in each group [D] = [B] – [A] | -725 | -579 | -75 | -307 | -185 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | -1870 |
| Net winners/losers in each area as % of total [F] = [D] / [E] | -39% | -31% | -4% | -16% | -10% | 100% |
| Share of Total Population of Study Area | 13% | 29% | 23% | 17% | 18% | 100% |
| Assessment | xxx | xx | x | xx | x | xx |

**Table A1.15: SDI Analysis (Do-Minimum 2041 versus Do-Something 2041), Option B**

| Option B | Index of Multiple Deprivation Income Domain Most deprived areas Least deprived areas | | | | | Total |
|---|---|---|---|---|---|---|
| | 0-20% | 20-40% | 40-60% | 60-80% | 80-100% | |
| Population in each group with increased noise [A] | 3393 | 8597 | 807 | 5023 | 1328 | 19148 |
| Population in each group with decreased noise [B] | 494 | 402 | 35 | 299 | 15 | 1245 |
| Population in each group with no change in noise [C] | 43908 | 99577 | 83298 | 58613 | 66901 | 352297 |
| Net no of Winners / Losers in each group [D] = [B] – [A] | -2898 | -8195 | -772 | -4724 | -1314 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | -17903 |
| Net winners/losers in each area as % of total [F] = [D] / [E] | -16% | -46% | -4% | -26% | -7% | 100% |
| Share of Total Population of Study Area | 13% | 29% | 23% | 17% | 18% | 100% |
| Assessment | xx | xxx | x | xxx | x | xx |

**Table A1.16: SDI Analysis (Do-Minimum 2041 versus Do-Something 2041), Option C**

| Option C | Index of Multiple Deprivation Income Domain Most deprived areas Least deprived areas | | | | | Total |
|---|---|---|---|---|---|---|
| | 0-20% | 20-40% | 40-60% | 60-80% | 80-100% | |
| Population in each group with increased noise [A] | 4069 | 5849 | 968 | 2588 | 1483 | 14957 |
| Population in each group with decreased noise [B] | 1838 | 3618 | 5094 | 2656 | 3343 | 16549 |
| Population in each group with no change in noise [C] | 41887 | 99109 | 78079 | 58692 | 63418 | 341185 |
| Net no of Winners / Losers in each group [D] = [B] – [A] | -2231 | -2232 | 4127 | 68 | 1860 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | 1592 |
| Net winners/losers in each area as % of total [F] = [D] / [E] | -140% | -140% | 259% | 4% | 117% | 100% |
| Share of Total Population of Study Area | 13% | 29% | 23% | 17% | 18% | 100% |
| Assessment | xxx | xxx | ✓✓✓ | ✓ | ✓✓✓ | ✓ |

**Table A1.17: SDI Analysis (Do-Minimum 2041 versus Do-Something 2041), Option $C_{variant}$**

| Option $C_{variant}$ | Index of Multiple Deprivation Income Domain Most deprived areas / Least deprived areas | | | | | Total |
|---|---|---|---|---|---|---|
| | 0-20% | 20-40% | 40-60% | 60-80% | 80-100% | |
| Population in each group with increased noise [A] | 3943 | 6209 | 1636 | 3490 | 3251 | 18529 |
| Population in each group with decreased noise [B] | 1778 | 4607 | 3688 | 3105 | 2175 | 15352 |
| Population in each group with no change in noise [C] | 42073 | 97760 | 78816 | 57340 | 62819 | 338809 |
| Net no of Winners / Losers in each group [D] = [B] – [A] | -2165 | -1602 | 2051 | -386 | -1076 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | -3177 |
| Net winners/losers in each area as % of total [F] = [D] / [E] | -68% | -50% | 65% | -12% | -34% | 100% |
| Share of Total Population of Study Area | 13% | 29% | 23% | 17% | 18% | 100% |
| Assessment | xxx | xxx | ✓✓✓ | xx | xxx | xx |

1.2.7 A new crossing at Option C is forecast to adversely affect the most deprived areas and positively affect the most affluent. Option A would adversely affect all income groups, but with lower income groups affected more. Option $C_{variant}$ and Option B are forecast to impacts for all income groups, although in both cases the assessment is still very slightly worse for lower income groups.

**Environmental: Local Air Quality**

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

1.2.9 Option A is forecast, on a modelled zonal basis in 2025, to improve NO2 and PM10 local air quality for 58% of zones, with deterioration for 29% of zones, when compared with the do-minimum scenario. Air Quality Management Areas[7] (AQMAs) have been declared for the A282 J1a-J1b by Dartford Borough Council and at locations adjacent to the A282 by Thurrock Council. If traffic flows increase on the A282 or M25 due to a potential future scheme, this is likely to

[7] AQMAs identify the areas where air quality is being managed by these local authorities in order to work towards achieving the Air Quality Strategy objectives. It should be noted that AQMAs can be larger than the areas that are expected to exceed the objectives.

worsen air quality in areas that have been declared as AQMAs. If Option A was to be taken forward, a plan level assessment would need to be carried out to identify the change in air quality within the AQMAs.

1.2.10 Option B is forecast to improve NO2 and PM10 local air quality for 49% of zones, with deterioration for 38% of zones. AQMAs have been declared for the A226 leading to the river crossing and at the Bean Interchange between the A2 and A296 by Dartford Borough Council. If traffic flows increase on the A226 or at the Bean Interchange due to a potential future scheme, this is likely to worsen air quality in areas that have been declared as AQMAs. If Option B was to be taken forward, a plan level assessment would need to be carried out to identify the change in air quality within the AQMAs.

1.2.11 Option C is forecast to improve NO2 and PM10 local air quality for 50% of zones, with deterioration for 44% of zones. AQMAs have been declared for the whole of London Borough of Havering and the A2 leading to the river crossing by Gravesham Borough Council. If traffic flows increase on the A2 due to a potential future scheme, this is likely to worsen air quality in areas that have been declared AQMAs. If Option C was to be taken forward, a plan level assessment would need to be carried out to identify the change in air quality within the AQMAs.

1.2.12 Option $C_{variant}$ is forecast to improve NO2 and PM10 local air quality for 65% of zones, with deterioration for 28% of zones. An AQMA has been declared for Maidstone by Maidstone Borough Council. If traffic flows increase on the A2 or in Maidstone due to a potential future scheme, this is likely to worsen air quality in areas that have been declared AQMAs. If Option $C_{variant}$ was to be taken forward, a plan level assessment would need to be carried out to identify the change in air quality within the AQMAs.

1.2.13 The monetised values for local air quality impacts associated with the Options are presented in Table A1.18.

**Table A1.18: Monetised Values of Local Air Quality Impacts, PV 60 years, £m, 2010 market prices**

| Option | PVB | Comments |
|---|---|---|
| Option A | 0 | Increased capacity of a crossing would reduce congestion and be beneficial to a greater proportion of the population in terms of improved air quality. The effect is, however, negligible; less than £0.5 million over 60 years. |
| Option B | -2 | Introduction of a new route into an area previously unaffected by traffic would outweigh any benefit of reduced air pollution on the population due to reduced congestion at the existing Dartford-Thurrock Crossing. |
| Option C | 8 | Displacement of traffic away from the current populated areas to less populated areas would be beneficial to a greater proportion of the population in terms of improved air quality. |
| Option $C_{variant}$ | 10 | Displacement of traffic away from the current populated areas to less populated areas would be beneficial to a greater proportion of the population in terms of improved air quality |

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

**Social and Distributional Impact (SDI) Analysis**

1.2.14 An SDI analysis was carried out to determine how each income group would be affected by changes in air quality associated with a new crossing at each location Option. Unlike the assessment in the AST, which describes which zones air quality would be expected to see an improvement or a deterioration in air quality, the SDI analysis considers the total population which

is forecast to experience any change in air quality relative to the do-minimum, taking the second modelled year (2041) as the year of comparison. This assessment considers only the numbers of people affected by an improvement or deterioration in air quality based on where they live and it analyses who gains or loses by which income group of the population; it does not consider the significance of the level of improvement or deterioration. The results are shown in the following tables. The scores are based in the balance in each income group experiencing a net improvement/deterioration in air quality with large adverse indicating a large net number of people is forecast to experience a deterioration in air quality, and large beneficial a large net number of people experiencing an improvement. The results are shown in tables A1.20-A1.23. A key for the tables is provided below.

**Table A1.19**

| | | | |
|---|---|---|---|
| xxx | Large adverse | ✓✓✓ | Large beneficial |
| Xx | Moderate adverse | ✓✓ | Moderate beneficial |
| X | Slight adverse | ✓ | Slight beneficial |

1.2.15 Option A: the effect on all income groups is assessed as beneficial with Q1, the highest income group, forecast to experience the largest beneficial effect.

**Table A1.20: SDI Analysis for Local Air Quality, Option A**

| **Option A** | **Index of Multiple Deprivation Income Domain Most deprived areas Least deprived areas** | | | | | **Total** |
|---|---|---|---|---|---|---|
| | **Q5 0-20%** | **Q4 20-40%** | **Q3 40-60%** | **Q2 60-80%** | **Q1 80-100%** | |
| No of properties with improved air quality [A] | 43284 | 54916 | 48459 | 35170 | 36036 | 217865 |
| No of properties with worse air quality [C] | 24091 | 23166 | 21184 | 26164 | 10169 | 104773 |
| No. of net winners / losers [D] = [A] – [C] | 19193 | 31751 | 27275 | 9006 | 25868 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | 113092 |
| Net winners/losers in each area as % of total [F] = [D] / [E] | 17% | 28% | 24% | 8% | 23% | 100% |
| Share of Total Pop'n of Study Area | 21% | 24% | 22% | 19% | 14% | 100% |
| Assessment | ✓✓ | ✓✓ | ✓✓ | ✓ | ✓✓✓ | ✓✓ |

1.2.16 For Option B, the lowest income group would experience a large beneficial effect whilst the middle income group is forecast to experience the largest adverse effect.

**Table A1.21: SDI Analysis for Local Air Quality, Option B**

| Option B | Index of Multiple Deprivation Income Domain | | | | | Total |
|---|---|---|---|---|---|---|
| | Most deprived areas | | | | Least deprived areas | |
| | Q5 0-20% | Q4 20-40% | Q3 40-60% | Q2 60-80% | Q1 80-100% | |
| No of properties with improved air quality [A] | 36,583 | 36,185 | 27,690 | 23,920 | 20,849 | 145,227 |
| No of properties with worse air quality [C] | 30,791 | 41,803 | 41,953 | 37,408 | 25,357 | 177,311 |
| No. of net winners / losers [D] = [A] – [C] | 5,792 | -5,618 | -14,263 | -13,488 | -4,508 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | -32085 |
| Net winners / losers in each area as % of total | 18% | -18% | -44% | -42% | -14% | 100% |
| Share of Total Pop'n of Study Area | 21% | 24% | 22% | 19% | 14% | 100% |
| Assessment | ✓✓✓ | x | xxx | xxx | Xx | xx |

1.2.17 Option C: the lowest income group is forecast to experience a large beneficial impact whilst the middle income group is forecast to experience the largest adverse impact.

**Table A1.22: SDI Analysis for Local Air Quality, Option C**

| Option C | Index of Multiple Deprivation Income Domain | | | | | Total |
|---|---|---|---|---|---|---|
| | Most deprived areas | | | | Least deprived areas | |
| | Q5 0-20% | Q4 20-40% | Q3 40-60% | Q2 60-80% | Q1 80-100% | |
| No of properties with improved air quality [A] | 38,754 | 38,514 | 30,516 | 27,833 | 24,540 | 160,157 |
| No of properties with worse air quality [C] | 36,416 | 46,620 | 50,395 | 40,232 | 27,944 | 201,607 |
| No. of net winners / losers [D] = [A] – [C] | 2,338 | -8,107 | -19,879 | -12,398 | -3,404 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | -41,450 |
| Net winners / losers in each area as % of total | 6% | -20% | -48% | -30% | -8% | 100% |
| Share of Total Pop'n of Study Area | 21% | 24% | 22% | 19% | 15% | 100% |
| Assessment | ✓✓✓ | Xx | xxx | xxx | x | xx |

1.2.18 Option $C_{variant}$: the lowest income income group is forecast to experience a large beneficial effect whilst all of the other income groups are forecast to experience a large adverse effect.

**Table A1.23: SDI Analysis for Local Air Quality, Option $C_{variant}$**

| Option $C_{variant}$ | Index of Multiple Deprivation Income Domain | | | | | Total |
|---|---|---|---|---|---|---|
| | Most deprived areas | | | | Least deprived areas | |
| | Q5 0-20% | Q4 20-40% | Q3 40-60% | Q2 60-80% | Q1 80-100% | |
| No of properties with improved air quality [A] | 52,728 | 29,593 | 16,320 | 21,118 | 16,069 | 135,828 |
| No of properties with worse air quality [C] | 27,336 | 63,362 | 60,546 | 42,506 | 34,506 | 228,256 |
| No. of net winners / losers [D] = [A] – [C] | 25,392 | -33,768 | -44,226 | -21,389 | -18,438 | - |
| Total number of Winners / Losers across all groups [E] = Σ[D] | - | - | - | - | - | -92,429 |
| Net winners / losers in each area as % of total | 27% | -37% | -48% | -23% | -20% | 100% |
| Share of Total Pop'n of Study Area | 22% | 26% | 21% | 17% | 14% | 100% |
| Assessment | ✓✓✓ | Xxx | xxx | xxx | xxx | xx |

**Environmental: Greenhouse Gases**

1.2.19 The present value of the additional emissions associated with a new crossing at each location Option is set out below:

**Table A1.24: Greenhouse Gas Emission Impacts, Present Value over 60 years, £m, 2010 market prices**

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

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

### Environmental: Landscape and Townscape

1.2.20 Option A: a landscape assessment has not been carried out due to the urban nature of the study area. However, a townscape assessment has been undertaken.

1.2.21 Option A is located within a townscape dominated by industry and commercial land uses. The main land uses are transport, industry, aggregates, and energy production. The area is dominated by very large industrial structures including the existing Dartford-Thurrock Crossing and elevated road infrastructure. Busy arterial roads filter onto quiet access lanes with rough patchy grass verges, yards surrounded by security fences and controlled gates or off road parking areas. There are some pockets of isolated and overgrown derelict land dominated by scrub. There is little public access within the area; people pass through the area mainly by road with limited footway provision. There are no known townscape features of cultural interest within the study area.

1.2.22 The area is allocated for industrial uses and development and therefore there is likely to be change in the future irrespective of a potential future new river crossing. However, although the layout and appearance of the area may change, it is likely to remain industrial.

1.2.23 A potential future new river crossing and associated new road infrastructure would introduce a new linear element in the townscape but is likely to fit well with the existing scale, character and appearance of the existing bridge and road infrastructure which is a dominant visual feature of the area. The overall impact of Option A on the townscape has been assessed as slight adverse for a bridge and neutral to slight adverse for an immersed or bored tunnel.

1.2.24 To mitigate any adverse impacts, there would need to be a high quality design for new road infrastructure.

1.2.25 Option B is located within a predominantly urban landscape and townscape with distinct areas of recreational and urban fringe green space. Residential areas to the north of the river are densely populated and intimate in scale with views contained by buildings and infrequent small pockets of amenity space in the form of parks, play areas or waterfront. The Thames river corridor is an expansive flat landscape of water, mudflats and marshes dominated by very large industrial and energy structures. To the south of the river, previously developed sites including a former open cast extraction site and a Scheduled Monument (the Roman town of Vagniacis), form a green corridor flanked by residential streets, road and rail infrastructure.

1.2.26 Residential areas have a low likelihood of change whereas other areas comprising numerous previously developed sites have a high likelihood of change due to allocations for development and therefore the townscape of the study area could change in the future irrespective of a potential future new river crossing.

1.2.27 A potential future new river crossing and associated new road infrastructure would introduce a new transport corridor and very large bridge or tunnel infrastructure and elevated road infrastructure in the landscape and townscape. The overall impact of Option B on the townscape and landscape has been assessed as moderate adverse. This score applies to any of the crossing structures. While the bridge would have a greater impact as a dominant feature visible over a wide area, all three options would introduce structures out of scale with the local townscape character, impacting directly and indirectly on locally valued townscape features including school grounds and recreational greenspace. The bridge infrastructure would also be a notable new element in the long open vistas of the Thames and the setting of local residential areas within the Grays area. These local townscape impacts would need to be addressed for any new crossing structure, in particular if a bridge was to be taken forward. All three types of crossing structure would also directly impact a Scheduled Monument of national importance (the Roman town of Vagniacis) resulting in the loss of the whole or part of this historic landscape feature.

1.2.28 To mitigate any adverse impacts, at a future design stage, detailed routeing should seek to minimise impacts on urban public space, the Roman town of Vagniacis Scheduled Monument

and recreational green space, and the scale of structure should be designed to minimise impacts on adjacent residential areas. Extensive mitigation planting should also be considered to preserve the green corridor.

1.2.29 For Option C a townscape assessment has not been undertaken due to the rural nature of the study area. A landscape assessment has been undertaken.

1.2.30 To the north of the Thames the assumed illustrative route passes through open rolling agricultural countryside with surviving areas of historic field patterns, minor roads and small settlements. Prominent features are arterial roads, pylons, and the distant urban edge of large settlements. The Thames river corridor is an expansive flat landscape of water, mudflats and marshes. The shore land consists of extensive wet pasture and open grazing with sparse scrub or tree cover protected by dykes and ditches. Man made elements include pylons, river traffic and distant views of docks, industry and settlements. To the south of the Thames the assumed illustrative route passes through open undulating farmland of agricultural fields with hedgerows and trees grouped in association with small settlements; rising to discrete areas of significant woodland on higher ground. Pylons and overhead electricity lines are noticeable features in the open countryside along with distant views. The existing A2 forms a transport corridor within the Kent Downs Area of Outstanding Natural Beauty (AONB).

1.2.31 A potential future new river crossing and associated new road infrastructure would introduce a significant change to the existing landscape. Retaining structures and bridge or tunnel infrastructure would be notable additional urban elements across the horizontal vista of the Thames marshes and would be visible over the local area. The new road corridor and junction infrastructure could impact directly and indirectly on locally and nationally valued landscape features including Scheduled Monuments, listed buildings, conservation areas, Ancient Woodlands, distinct areas of historic landscape patterns, Shorne Country Park and surviving Thames marshland.

1.2.32 The Kent Downs AONB is a nationally designated area of landscape value. Where existing road infrastructure (particularly motorways) forms part of the immediate setting of the AONB, any potential future road scheme is less likely to have a significant effect. However, there is potential for junction infrastructure at the A2 to adversely affect the setting of the adjacent historic designed landscape within the Cobham Hall Registered Park and Garden. Depending upon the scale of proposed junction improvements, there may also be potential for adverse effects on the tranquillity of the AONB.

1.2.33 The overall impact of Option C on the landscape has been assessed as moderate to large adverse for a bridge. This could be reduced to moderate adverse for an immersed or a bored tunnel.

1.2.34 If a new crossing was provided at Option C then, to mitigate any adverse impacts, the detailed design process would need to be used to minimise the loss of valued landscape features and to integrate new road infrastructure into the landscape. Offsite planting and woodland enhancement / management would also need to be considered as a compensatory measure.

1.2.35 Option Cvariant, : a townscape assessment has not been carried out due to the rural nature of the study area. The landscape impact is assessed identically to Option C. Road widening and additional junction infrastructure along the A229 could result in some loss of woodland screening and might have some direct and indirect impacts on residential areas in close proximity. However, changes would be in the context of the existing dual carriageway corridor and therefore are less likely to have a significant effect. The assessment is therefore unchanged.

**Environmental: Heritage or Historic Resources**

1.2.36 Option A: there are no Scheduled Monuments, listed buildings, Conservation Areas, Registered Parks and Gardens or Registered Battlefields within 500m of the assumed illustrative route for Option A. However, there are a number of previously recorded heritage assets which vary from prehistoric settlement/ritual sites through to World War II defence installations.

1.2.37 Option A would affect a limited number of known cultural heritage sites. However these could be direct physical effects potentially leading to a total loss of some assets. No setting impact on designated sites is likely although the setting of some undesignated sites could be affected. Overall Option A has therefore been judged to have a moderate adverse effect with respect to the heritage criteria. This is due to the potential direct loss of some assets. This score applies to any of the crossing structures.

1.2.38 Option B: there are no Registered Parks and Gardens, Conservation Areas or Registered Battlefields within 500m of the assumed illustrative route for Option B. There are Scheduled Monuments ranging from Palaeolithic find spots and Neolithic ritual monuments to a temple and the Roman town of Vagniacis, Listed Buildings and a number of previously recorded heritage assets.

1.2.39 The assumed illustrative route for Option B would affect a number of previously recorded cultural heritage sites including a Scheduled Monument (the Roman town of Vagniacis). The assumed illustrative route would also affect the setting of two Palaeolithic and Neolithic Scheduled Monuments. It is recognised that the assumed illustrative route for Option B transects an area where the occurrence of Palaeolithic material, including possible in situ knapping and butchery, is considerably higher than the national norm. Further remains within the vicinity, mainly from the former gravel and sand pits, demonstrate the proliferation of evidence within the Ebbsfleet area. If a new crossing at Option B was provided and works were required within previously undisturbed areas, intensive archaeological investigations would first be required.

1.2.40 Overall Option B has been judged to have a large adverse effect with respect to the heritage criteria. This score applies to any crossing structure.

1.2.41 Option C and $C_{variant}$: there are no Registered Battlefields within 500m of the assumed illustrative route. There are six Scheduled Monuments and an extensive Roman settlement known from crop marks associated with Option C and an additional three Scheduled Monuments associated with Option $C_{variant}$. Several Conservation Areas, a Registered Park and Garden (Cobham Hall) and a number of listed buildings are also recorded, along with a variety of non-designated assets.

1.2.42 The assumed illustrative route for Option C would impact directly on at least two Scheduled Monuments and pass in close proximity to a third, involving impacts on both physical remains and the setting of features. Given the length of a new crossing and associated link roads at Option C, the assumed illustrative route is likely to be more harmful to buried archaeological remains, the significance of which cannot yet be quantified. The setting of a number of Conservation Areas and a large number of listed buildings would also be affected. Overall Option C and Option $C_{variant}$ have therefore been judged to have a large adverse effect with respect to the heritage criteria. This score applies to any of the crossing structures.

**Environmental: Biodiversity**

1.2.43 This section provides an assessment of the impacts of the Options on the biodiversity of the areas in which they would be built. The assessment takes account of the current status and trends in conditions; this information was sourced from the Natural England Site of Special Scientific Interest (SSSI) Condition Summary report and other existing databases.

1.2.44 Option A: the assumed illustrative route could adversely affect three main biodiversity features:

- West Thurrock Lagoon and Marshes SSSI; considered to be one of the most important sites for wintering waders and wildfowl on the inner Thames Estuary. This site is located downstream of the assumed illustrative route and is currently declining. Natural England has assessed the site as being in unfavourable condition;

- The River Thames itself which is recommended as a Marine Conservation Zone (MCZ[8]) and nationally important for its marine wildlife, habitats, geology, and physical form and processes (also known as river geomorphology); and
- Intertidal mudflat which is a nationally important habitat with limited potential for substitution.

1.2.45 The assumed illustrative route passes through regionally important reedbed habitat. However, the impact of this has been assessed as neutral.

1.2.46 If a bridge was to be constructed, the main potential impacts would be on the areas of mudflat directly beneath the bridge. There could be some cumulative impact in conjunction with the existing Dartford-Thurrock Crossing in terms of impacts on the bird populations supported by the mudflat habitat during the operational phase including those supported by the West Thurrock Lagoon and Marshes SSSI.

1.2.47 If a bored tunnel was to be constructed, the main impacts would occur during the construction phase. The completed tunnel would be unlikely to impact upon the marine environment and coastal and terrestrial impacts could be reduced in comparison to the erection of a bridge. This would depend upon the location of the tunnel entrance points above ground.

1.2.48 Construction of an immersed tunnel has the potential for large adverse impacts on the recommended MCZ and its associated species and habitats and the West Thurrock Lagoon and Marshes SSSI.

1.2.49 Overall the effect of Option A on the biodiversity of the area is judged to be large adverse. This is based upon the worst case scenario of the river crossing being an immersed tunnel or a bridge. This could be reduced to slight adverse if it was a bored tunnel.

1.2.50 Option B: the assumed illustrative route could adversely affect the following biodiversity features:

- Coastal and floodplain grazing marsh, a regionally important habitat which is important for waders and wintering wildfowl;
- The River Thames itself which is recommended as a MCZ and nationally important for marine wildlife, habitats, geology;
- West Thurrock Lagoon and Marshes SSSI (see para 1.2.43 for details);
- Intertidal mudflat which is a nationally important habitat with limited potential for substitution;
- Ebbsfleet Marshes Local Wildlife Site; and
- Ancient Woodland at Chadwell Wood and Parkhill Wood.

1.2.51 The assumed illustrative route also passes through regionally important reedbed habitat although the impact of this has been assessed as neutral.

1.2.52 If a bridge was to be constructed, the main potential impacts would be on the areas of mudflat habitat and their associated bird populations, including those supported by the West Thurrock Lagoon and Marshes SSSI, due to increased disturbance from traffic during the operational phase.

1.2.53 If a bored tunnel was to be constructed, the main impacts would be likely to occur in the construction phase. A completed tunnel is not likely to impact on the marine environment and the coastal/terrestrial impacts are likely to be of a lower magnitude in comparison to the erection of a bridge. The magnitude of impacts upon intertidal mudflats would depend upon the location of the tunnel entrance points. If situated well away from this habitat, the potential impacts upon mudflats and their associated bird populations could be significantly reduced.

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

1.2.54 Construction of an immersed tunnel has the potential for large adverse impacts on the recommended MCZ and its associated species and habitats. The impacts include habitat loss or deterioration and disturbance. The significance of the potential effects is uncertain at this stage due to lack of detailed information about the ecological baseline in the proximity of the tunnel and how construction of the tunnel could affect river processes. However, given the extent of the recommended MCZ, it is unlikely that its integrity would be affected by an immersed tunnel assuming appropriate levels of avoidance, mitigation and compensation were put in place.

1.2.55 There is potential for a slight adverse effect on Ancient Woodland at Chadwell Wood and Parkhill Wood due to increased pollution due to larger volumes of traffic and therefore air, salt spray and noise pollution.

1.2.56 Construction of the road links to the river crossing could also have a moderate adverse effect on coastal and floodplain grazing marsh, and the Ebbsfleet Marshes Local Wildlife Site.

1.2.57 Overall the effect of Option B on the biodiversity of the area is judged to be large adverse. This is based upon the worst case scenario of the river crossing being an immersed tunnel or a bridge. This could be reduced to moderate adverse if it was a bored tunnel.

1.2.58 Option C: the proposed crossing location could potentially adversely affect the following biodiversity features:

- coastal and floodplain grazing marsh, a regionally important habitat which is important for waders and wintering wildfowl.
- the River Thames itself which is recommended as an MCZ and nationally important for marine wildlife, habitats, geology, physical form and processes;
- intertidal mudflat which is a nationally important habitat with limited potential for substitution;
- South Thames Estuary and Marshes SSSI which supports outstanding numbers of internationally important waterfowl, and rare and scarce plants and invertebrates. The SSSI is considered to be improving although some units near the assumed illustrative route are declining;
- Thames Estuary and Marshes Ramsar Site (which includes Shorne Marshes RSPB Reserve and Canal and Grazing Marsh, Higham Local Wildlife Site);
- Thames Estuary and Marshes Special Protection Area (SPA) which supports an important assemblage of wintering water birds and is also important in spring and autumn migration periods; and
- Shorne and Ashenbank Woods SSSI, a complex of ancient and plantation woodland with an important and diverse invertebrate fauna. This site is considered to be improving.
- Cobham Woods SSSI, an outstanding assemblage of plants is present at this site which is also of importance for its breeding birds. This site is considered to be improving.
- Ancient Woodland habitat at Claylane Wood. This is a regionally important habitat.

1.2.59 Great Crabbles Wood SSSI is unlikely to be adversely affected; the impact on this site has therefore been assessed as neutral.

1.2.60 The assumed illustrative route also passes through regionally important reedbed habitat although the impact of this has also been assessed as neutral.

1.2.61 In summary, the assumed illustrative route for Option C could bisect a number of important habitats leading to increased disturbance, habitat loss and habitat fragmentation. The key impacts are outlined below.

1.2.62 The construction of a bridge within the Thames Estuary and Marshes Ramsar/SSSI could cause a number of negative impacts including direct habitat loss and impacts on bird populations, including those supported by the Thames Estuary and Marshes SPA, which may not be easily mitigated. These impacts could result in a large adverse effect on the habitats and species

supported by these sites. However, it is unlikely that the integrity of the Ramsar/SSSI would be significantly affected as the assumed illustrative route for a crossing involving a bridge at location Option C is at the western extent of the site, which is currently agricultural land.

1.2.63 Construction of an immersed or a bored tunnel would also have a large adverse impact on the Thames Estuary and Marshes Ramsar/SSSI. This is due to direct habitat loss as a result of construction of the north-bound road linking the tunnel to the existing road network. However, the longer-term coastal and terrestrial impacts, such as impacts on bird populations, including those supported by the Thames Estuary and Marshes SPA, could potentially be reduced in comparison to the erection of a bridge.

1.2.64 For the bored tunnel, the location of the tunnel entrance points would be critical to any future design stage. Micro-siting of tunnel entrance points would need to be considered in order to avoid or minimise habitat loss/deterioration and disturbance to the Thames Estuary and Marshes Ramsar/SSSI.

1.2.65 Construction of an immersed tunnel has the potential for large adverse impacts on the recommended MCZ and its associated species and habitats. The impacts include habitat loss or deterioration and disturbance. The significance of the potential effects is uncertain at this stage due to lack of detailed information about the ecological baseline in proximity to the tunnel and how construction of the tunnel could affect river processes. However, given the extent of the recommended MCZ, it is unlikely that its integrity would be affected by an immersed tunnel assuming appropriate levels of avoidance, mitigation and compensation were put in place. It is unlikely that a completed bored tunnel would impact upon the marine environment.

1.2.66 Construction of the roads needed to link a new crossing at Option C with the existing road network could have a very large adverse effect on the Shorne and Ashenbank Woods SSSI due to the loss of irreplaceable Ancient Woodland. There could also be a large adverse effect on Ancient Woodland habitat at Claylane Wood. While this habitat is not legally protected, national planning policy is very clear that development of such sites should be as a last resort[9].

1.2.67 There could also be a moderate adverse effect on coastal and floodplain grazing marsh due to construction of link roads.

1.2.68 Option $C_{variant}$: widening of the A229 between the M2 and M20 could affect three additional biodiversity features. There could be a large adverse effect on the Wouldham to Detling SSSI and Ancient Woodland within 2km of the assumed illustrative route, particularly at Bridge Wood and a slight adverse effect on the North Downs Woodlands Special Area of Conservation (SAC) and Boxley Warren Local Nature Reserve (LNR):

- Wouldham to Detling SSSI, a 10km chalk escarpment which includes representative examples of woodland, scrub and unimproved grassland habitats on chalk and supports a number of rare and scarce species of plants and invertebrates. This site is considered to be improving;
- North Downs Woodlands SAC (including Boxley Warren LNR which is designated for its ancient beech forests and yew woodland and also semi-natural dry grasslands and scrubland;
- Ancient Woodland habitat within 2km of the assumed illustrative route including Kit's Coty LWS and Bridge Wood.

1.2.69 Due to its potential impacts on nationally and internationally important features, the effect of Option C and $C_{variant}$ on the biodiversity of the area is judged to be very large adverse. This score is due to the impact that the road needed to link a new crossing with the A2/M2 would have on the Shorne and Ashenbank Woods SSSI.

[9] The National Planning Policy Framework states that "planning permission should be refused if it leads to the loss or deterioration of irreplaceable habitats such as Ancient Woodland or aged or veteran trees found outside Ancient Woodland, unless the need for, and benefits of, the development in that location clearly outweigh the loss".

**Environmental: Water Environment**

1.2.70 The River Thames is an important river of national significance with commercial and social value. It is used as a depository for effluent discharges, for abstraction of water supply, recreation and navigation. It is also designated under the Freshwater Fish Directive and recommended as an MCZ. The Thames is designated as a heavily modified water body under the EU Water Framework Directive (WFD) and is considered to have a moderate ecological potential. The main potentially significant impact for any of the options would be changes to the physical form and processes of the River Thames as a result of a potential future river crossing.

1.2.71 An immersed tunnel could potentially have significant effects on the physical form and processes of the River Thames, if not completely submerged underneath the river bed. Although not considered specifically within the WebTAG appraisal, the risk from construction activities associated with an immersed tunnel is also expected to be greater than either a bridge or bored tunnel. If a bridge was taken forward, then bridge piers would need to be located as far as practicable from the river bed to reduce impacts on the river form. If possible, an open span bridge (that is, a bridge with no piers in the river channel) should be considered at a future design stage for Option A in particular given the shorter crossing distance.

1.2.72 Bridge and immersed tunnel crossing structure types are also likely to require a Water Framework Directive appraisal due to the potential for direct effects on biological, chemical and physical Water Framework Directive parameters.

1.2.73 New crossings at Options A, B, C and $C_{variant}$ could affect Source Protection Zones (SPZs) although it is possible that any impact would be diluted due to the distance of the assumed illustrative routes to the SPZs. If a new crossing was provided at any of these locations then a quantitative risk assessment would need to be carried out to account for dilution and attenuation effects. The potential impacts on SPZs would be greater if a bridge was taken forward. This is because tunnels are likely to have a more enclosed drainage system (less risk of pollutants escaping which could enter the groundwater and migrate to receptors such as SPZs) than a bridge for the operational phase. Also, during construction and possibly during operation, tunnel structures would have a groundwater dewatering system which would draw local groundwater flows towards the tunnel. This would prevent any contaminants entering the groundwater from migrating away towards receptors such as SPZs.

1.2.74 All three potential crossing structure types and location Options could be affected by flooding from the River Thames and other watercourses including the Mar Dyke and smaller watercourses. They could also increase flood risk elsewhere by affecting existing flood defences, river flows or by reducing the amount of floodplain available to store water during a flood event.

1.2.75 These impacts are considered to be significant at this stage (as they are potentially of moderate magnitude). This is a precautionary appraisal however and it is possible that with appropriate design and further detailed investigation, these potentially significant adverse effects could be overcome through a range of mitigation measures at a future detailed design stage.

1.2.76 Overall the effect of any of the options on the water environment is judged to be large adverse. This is based upon the worst case scenario of the river crossing being an immersed tunnel due to potential scale of impacts on the recommended River Thames MCZ. This could be reduced to moderate adverse if the river crossing was a bridge and or a bored tunnel.

**Environment: Summary**

1.2.77 A summary of the appraisal scores for landscape, townscape, heritage of historic resources, biodiversity and water environment is provided in the table below.

**Table A1.25: Summary of environmental appraisal scores**

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

## 1.3 Appraisal: Social Impacts

1.3.1 The appraisal of social impacts is specified in WebTAG 3.3, 3.4, 3.5 and 3.6; the appraised sub-impacts are as follows:

- commuting and other users (i.e. non-commuting);
- reliability impact on commuting and other users;
- physical activity;
- journey quality;
- accidents;
- security;
- access to services;
- affordability;
- severance; and
- option values.

1.3.2 The potential social impacts on commuting and other users and transport providers, and accident impacts have been monetised. Other economic impacts are assessed qualitatively. Social and distributional impacts (SDIs) have been assessed quantitatively for impacts on commuting and other users and for accident impacts.

**Social: Commuting and Other Users (i.e. non-commuting)**

1.3.3 The economic appraisal of the impact of a new crossing at each location Option on transport users has been carried out using the DfT's TUBA software with outputs from the LTC Model. The methodology is discussed in detail in Appendix B.

1.3.4 Time benefits that accrue to consumer travellers are summarised in the tables below. Values are for a 60 year appraisal and include delays during construction of the schemes. Benefits are quoted by modelled household income band (low, medium and high); these are discussed in more detail in paragraph 1.3.10.

1.3.5 A new crossing at each location would provide positive time benefits for commuting and other users. A significant non-fuel operating cost disbenefit is also generated; this often exceeds the total time benefit. This arises because the modelling and appraisal of highway travel assumes that commuting and other users do not perceive the non-fuel vehicle operating costs of their journeys (maintenance and depreciation) in making the decision of whether, where and how to travel. .A summary of consumer benefits associated with a new crossing at each location Option is provided in tables Table A1.26 to Table A1.29 below:

**Table A1.26: Consumer Benefits, Option A, £m, 2025-2084**

| Purpose | Commuters | | | Non-Commuting | | | |
|---|---|---|---|---|---|---|---|
| Income | Low | Medium | High | Low | Medium | High | Totals |
| Time | 3 | 11 | 10 | 44 | 65 | 55 | 187 |
| Toll | -1 | -4 | -3 | -11 | -11 | -7 | -37 |
| Fuel Costs | 0 | 1 | 1 | 6 | 6 | 4 | 17 |
| Non-Fuel Operating Cost | -1 | 1 | 1 | 8 | 12 | 8 | 29 |
| Construction Delay | -0 | -0 | -0 | -0 | -1 | -1 | -2 |
| **Total Benefit** | **1** | **9** | **8** | **46** | **71** | **59** | **194** |

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

**Table A1.27: Consumer Benefits, Option B, £m, 2025-2084**

| Purpose | Commuters | | | Non-Commuting | | | |
|---|---|---|---|---|---|---|---|
| Income | Low | Medium | High | Low | Medium | High | Totals |
| Time | -0 | -3 | -2 | 17 | 15 | 12 | 38 |
| Toll | -4 | -11 | -8 | -30 | -31 | -19 | -103 |
| Fuel Costs | -0 | -3 | -2 | -3 | -6 | -5 | -20 |
| Non-Fuel Operating Cost | -7 | -18 | -13 | -70 | -72 | -49 | -230 |
| Construction Delay | 0 | 0 | 0 | -2 | -1 | -1 | -3 |
| **Total Benefit** | **-11** | **-35** | **-25** | **-88** | **-97** | **-62** | **-318** |

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

**Table A1.28: Consumer Benefits, Option C, £m, 2025-2084**

| Purpose | Commuters | | | Non-Commuting | | | |
|---|---|---|---|---|---|---|---|
| Income | Low | Medium | High | Low | Medium | High | Totals |
| Time | 4 | 19 | 18 | 85 | 93 | 76 | 296 |
| Toll | -4 | -11 | -7 | -33 | -33 | -20 | -108 |
| Fuel Costs | 1 | 1 | 0 | 17 | 10 | 4 | 33 |
| Non-Fuel Operating Cost | -8 | -22 | -15 | -81 | -83 | -57 | -267 |
| Construction Delay | -0 | -2 | -2 | -9 | -10 | -8 | -31 |
| **Total Benefit** | **-7** | **-15** | **-6** | **-21** | **-23** | **-5** | **-77** |

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

**Table A1.29: Consumer Benefits, Option $C_{variant}$, £m, 2025-2084**

| Purpose | Commuters | | | Non-Commuting | | | |
|---|---|---|---|---|---|---|---|
| Income | Low | Medium | High | Low | Medium | High | Totals |
| Time | 10 | 42 | 38 | 186 | 230 | 183 | 689 |
| Toll | -4 | -11 | -7 | -34 | -34 | -21 | -112 |
| Fuel Costs | 3 | 4 | 2 | 28 | 22 | 11 | 69 |
| Non-Fuel Operating Cost | -12 | -32 | -21 | -118 | -121 | -80 | -384 |
| Construction Delay | -1 | -2 | -2 | -10 | -12 | -9 | -35 |
| **Total Benefit** | **-4** | **1** | **9** | **52** | **85** | **84** | **227** |

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

1.3.6 The new crossings generate significant time benefit for non-business travellers crossing the river, of the order of £300 to £600m. However, this is offset by congestion for short distance trips on either side of the river and non-fuel operating cost disbenefit from induced traffic. Overall, Option A, Option B, Option C and Option $C_{variant}$ generate £194m, -£318m, -£77m and £227m, respectively, in consumer benefit.

1.3.7 It should be noted that these are aggregate totals, and that some individual journeys benefit significantly. This is illustrated in Table A1.30, which contains time benefits broken down by movements across the River Thames.

**Table A1.30: Consumer Time Benefits, By Thames Movement, £m, 2025-2084**

| | Option A | Option B | Option C | Option $C_{variant}$ |
|---|---|---|---|---|
| Crossing South to North | 336 | 401 | 500 | 537 |
| Crossing North to South | 86 | 134 | 198 | 248 |
| Non-Crossing North | -114 | -229 | -263 | -230 |
| Non-Crossing South | -120 | -268 | -139 | 135 |
| Total Time Benefit | **187** | **38** | **296** | **689** |

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

1.3.8 All Options provide significant consumer time benefit for users crossing the river (and Option $C_{variant}$ also does so for trips south of the river due to the A229 upgrade). However this is countered by significant disbenefit for non-crossing travellers. For example, in the case of Option B the time disbenefit is almost as great as the benefit, and when operating costs and tolls are accounted for the overall effect is a disbenefit.

1.3.9 Significantly more benefit accrues to northbound than southbound travellers due to the capacity constraints that currently exist for northbound traffic associated with the tunnels.

**Social and Distributional Impact (SDI) Analysis**

1.3.10 Table A1.26 to Table A1.29 distinguish benefits by household income. It should be noted that three income bands have been constructed for transport modelling represent broadly equal volumes of traffic, but are not equal in terms of UK population. The lowest income band contains almost half of the population. The approximate population proportions are 45%, 36% and 19% for low, medium and high bands respectively.

1.3.11 Differences in benefits by income band relate to differences in total travel and travel patterns, not to different values of time at different levels of affluence.

1.3.12 The location Options that provide overall benefit (Options A and $C_{variant}$) tend to benefit people in the low income band significantly less than people in the high income band. This suggests that new crossings at these locations would provide less time benefit to less affluent travellers, and significantly more operating cost disbenefit. This operating cost disbenefit would also be perceived by the less affluent to a greater extent, due to their lower income.

1.3.13 The Options that disbenefit consumer users overall (Options B and C) tend to disbenefit people in the higher income band more than people in the lower income band, albeit to a lesser degree than the positive benefits.

1.3.14 The effect of each Option upon users by income band is quite similar, in that all Options provide both proportionally more benefit and proportionally more disbenefit to more affluent people than to less affluent people. However, new crossings at two location Options would provide overall disbenefit and new crossings at two location Options would provide overall benefit.

1.3.15 This asymmetry is probably inevitable for strategies of this kind. The location Options are strategic, designed for long-distance travel, which itself tends to be used by more affluent travellers. Furthermore, the location Otions have been assumed to be tolled in this appraisal, providing further disincentive for less affluent travellers to use them.

1.3.16 Measures to mitigate this effect may usefully be considered in future work. However the appraisal work carried out to date suggests that location Options are unlikely to significantly benefit the least affluent people.

1.3.17 Tables providing a breakdown of user benefits by income band are provided below:

**Table A1.31: SDI Assessment, Consumer User Benefits broken down by income segment, Options A and B, 2025-2084**

| | Option A | | | Option B | | |
|---|---|---|---|---|---|---|
| **Income** | **Low** | **Med** | **High** | **Low** | **Med** | **High** |
| Benefit | **47** | **80** | **67** | **-99** | **-132** | **-87** |
| Benefit Share | 24% | 41% | 35% | 31% | 41% | 27% |
| Population | 45% | 36% | 19% | 45% | 36% | 19% |
| Assessment | ✓ | ✓✓✓ | ✓✓✓ | x | xxx | xxx |

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

**Table A1.32: SDI Assessment, Consumer User Benefits broken down by income segment, Option C and $C_{variant}$, 2025-2084**

| | Option C | | | Option $C_{variant}$ | | |
|---|---|---|---|---|---|---|
| **Income** | **Low** | **Med** | **High** | **Low** | **Med** | **High** |
| Benefit | **-27** | **-38** | **-11** | **48** | **86** | **93** |
| Benefit Share | 36% | 50% | 15% | 21% | 38% | 41% |
| Population | 45% | 36% | 19% | 45% | 36% | 19% |
| Assessment | x | xxx | xx | ✓ | ✓✓ | ✓✓✓ |

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

**Table A1.33: SDI Assessment Key**

| | | | |
|---|---|---|---|
| ✓ | Slight Benefit | x | Slight Disbenefit |
| ✓✓ | Moderate Benefit | xx | Moderate Disbenefit |
| ✓✓✓ | Large Benefit | xxx | Large Disbenefit |

**Social: Reliability Impact on Commuting and Other Users**

1.3.18 The assessment of consumer reliability benefit is identical with the assessment for business users in Section 1.1.42

**Social: Physical Activity**

1.3.19 As a new crossing would primarily serve longer distance traffic, the likely physical activity impacts are considered to be small. Such impacts will require more detailed consideration during detailed option design, and therefore can only be assessed to a limited extent at this stage.

1.3.20 No direct impact on pedestrian routes would occur unless the detailed scheme design were to sever local access roads or paths. Given that Highways Agency design standards seek to protect rights of way, this risk is expected to be negligible.

1.3.21 The location Options actually result in a reduction in short-distance trips because they are forecast to generate congestion on the strategic road network and benefit only the longer distance trips using the river crossing. It might be expected that some of these short-distance trips would transfer from car to either walk or cycle.

1.3.22 Accordingly, very slight physical activity impact benefit is expected, but this is likely to be extremely small relative to other effects of the scheme. The overall physical activity assessment is therefore considered to be neutral.

**Social: Journey Quality**

1.3.23 For all location Options, a bridge-based engineering solution would improve the views available to some users since part of the existing Dartford-Thurrock Crossing is a tunnel. This would thus have a slight beneficial impact.

1.3.24 A tunnel-based engineering solution would, conversely, restrict the view available to some users, and would thus have a slight adverse impact.

1.3.25 For all location Options, additional capacity is expected to deliver a similar traveller experience to the existing Dartford-Thurrock Crossing; although journey time and journey time reliability are expected to improve, these aspects are assessed elsewhere in the appraisal.

1.3.26 Option A: the impact on journey quality is assessed as being neutral overall.

1.3.27 Options B, C and $C_{variant}$: a new crossing at these locations is expected to involve a similar driving experience to the existing Dartford-Thurrock Crossing. There are, therefore, limited implications for journey quality. However, a new crossing at these locations could involve:

- reduced access to the motorway service area (MSA) at Thurrock; and
- changes in route uncertainty with additional routeing options.

1.3.28 The additional routeing complexity and risk that some trips might not be able to access the MSA might be expected to have a small negative impact.. Overall, therefore, the impact upon journey quality is assessed as slight adverse.

1.3.29 No other influences on journey quality are anticipated.

**Social: Accidents**

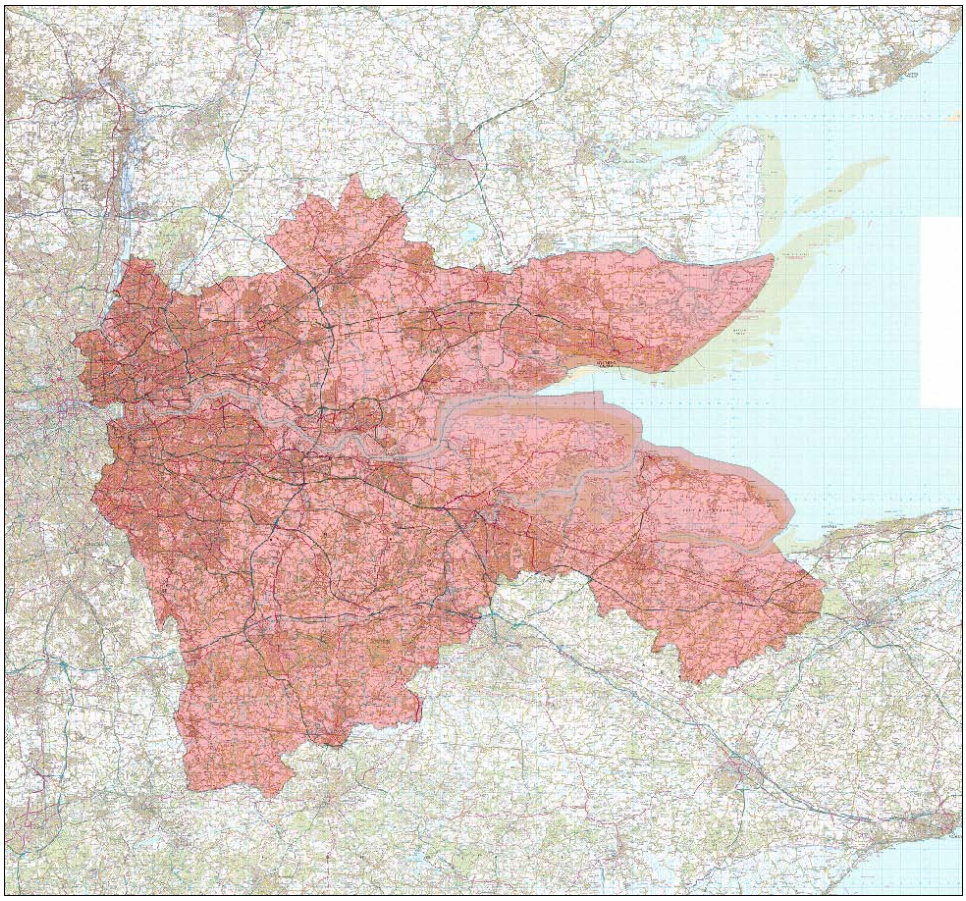
1.3.30 Accident impacts have been monetised using COBA accident rates, WebTAG guidance, and outputs from the LTC Model. A new crossing can be expected to be built to a similar standard to existing roads, and thus to have similar accident rates[10].

1.3.31 However, new crossings are expected to induce a significant amount of additional traffic. This can be expected to result in proportionally more accidents (as the number of accidents rises broadly in proportion to traffic volumes). Consequently the accident impact is assessed as negative despite there being no increase in accident rates anywhere on the network.

1.3.32 Accident effects have been assessed for all roads combined within the Policy Area, shown in Figure A1.13 below:

[10] The assessment has not considered differential accident rates by type of infrastructure (bridge or tunnel); this may be worthy of future exploration. COBA rates do not distinguish bridges or tunnels from standard dual carriageway highways.

**Figure A1.13: The Policy Area, highlighted in red**



1.3.33 Forecast accidents and casualties associated with new crossing options are shown in Table A1.34. Accidents are forecast to occur across the whole Policy Area due to the increase in total traffic on roads within the Policy Area, not just at new crossings.

**Table A1.34: Forecast Total Accident Impacts of the Options, 2025-2084, Option vs. No New Crossing**

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

1.3.34 Increases in accidents and casualties have been monetised, and 60-year appraisal figures derived. Between 2025 and 2041, accident values have been interpolated. Beyond 2041, accident value has been increased in line with GDP growth; the numbers of accidents and casualties are assumed unchanged.

1.3.35 Over the 60 year appraisal period, at 2010 prices and values, the accident disbenefits associated with Option A, Option B Option C and Option $C_{variant}$ are assessed as being worth £117m, £282m, £292m and £283m, respectively.

1.3.36 For Option $C_{variant}$ accidents are slightly reduced by the upgrade of the A229. This is, however, more than counterbalanced by the increase in traffic across the network due to the new crossing.

1.3.37 New crossings at all location Options are expected to have negligible impacts on urban traffic volumes and pedestrian and cycle users are excluded from motorways and the existing Dartford-Thurrock Crossing. Similarly a future scheme would not be expected materially to affect traffic volumes on local roads near schools or old people's homes. There would be negligible impact, therefore, on pedestrians, cyclists, young or old. The accident rate for motorcyclists relative to other vehicles would not be expected to differ for the crossing compared with trunk roads in general. As such, an SDI for accidents has been screened out.

**Social: Security**

1.3.38 As the new crossings at all location Options would comprise new major highway infrastructure and as traffic will not be required to stop (as free-flow tolling is assumed), the security impact is assessed as neutral.

**Social: Access to Services**

1.3.39 A new crossing at any of the location Options under consideration would have no direct impact on public transport services or access to them.

1.3.40 Local bus services are unlikely to be affected by provision of a new crossing, unless the detailed scheme design was to sever local access roads or paths. Given that Highways Agency design standards seek to protect rights of way, this risk is expected to be negligible and the accessibility impacts are assessed as neutral.

**Social: Affordability**

1.3.41 Option A: a new crossing is expected to be of similar length to the existing crossing, and, in the central case, a toll equivalent to the charges at the existing crossing has been assumed. Affordability impacts are therefore expected to be small. A new crossing would generate some decongestion which in-turn would reduce fuel costs slightly for non-business travellers (as discussed under 'Social: Commuting and Other Users'). However, this is small compared to other effects. The overall affordability impact is therefore assessed in the central case as slight beneficial.

1.3.42 Option B: in the central case, a toll equivalent to the charges at the existing crossing has been assumed. Affordability impacts are therefore expected to be small. A new crossing would generate some congestion for short distance trips, especially to the north of the new location Option, which would in turn increases fuel costs slightly for non-business travellers (as discussed under 'Social: Commuting and Other Users'). A discount scheme for local residents has been assumed, similar to the existing Dartford and Thurrock Local Residents' scheme. This would involve a slight beneficial impact. However, as it is uncertain whether a discount scheme would be provided, the overall affordability impact is assessed in the central case as slight adverse; primarily due to increased congestion for short distance journeys.

1.3.43 Option C and $C_{variant}$ : in the central case, a toll equivalent to the charges at the existing crossing has been assumed. Affordability impacts are therefore expected to be small. In common with Option A, a new crossing at location Option C and $C_{variant}$ would generate some decongestion, which would in-turn reduce fuel costs slightly for non-business travellers (as discussed under 'Social: Commuting and Other Users'). In common with Option B a discount scheme for local residents has also been assumed for appraisal purposes, which would involve a slight beneficial impact.

1.3.44 However, both of these considerations are expected to be small compared with other effects. The overall affordability impact is therefore assessed in the central case as slight beneficial.

**Social and Distributional Impact (SDI) Analysis**

1.3.45 SDI analysis of commuting and other user benefits is presented in 'Social: Commuting and Other Users'. The analysis shows no significant disproportionate fuel price benefit or disbenefit across

income bands. Toll disbenefit is larger for lower-income travellers and will be perceived more strongly. However as no crossing options are assumed to have experienced increases in tolls as a result of the location Option, this cannot be treated as an affordability effect.

1.3.46 Significant non-fuel operating cost disbenefit is observed and this is larger for lower income travellers. However, these costs are assumed not to be perceived by users (see paragraph 1.3.5), and this too cannot, therefore, be interpreted an as an affordability disbenefit, since neither the perceived nor the actual cost for any given traveller increases. Accordingly, though, as discussed in 'Social: Commuting and Other Users', the overall SDI impact of the new crossings at all location Options under consideration is negative, there are no significant affordability issues.

**Social: Severance**

1.3.47 None of the locations for a new crossing under consideration would have a direct impact on pedestrian routes or access. Pedestrians are unlikely to be permitted to use new crossing infrastructure. A system exists on the existing Dartford-Thurrock Crossing to ferry cyclists across the River Thames free of charge and it is assumed that a similar system would be retained if a crossing were to be provided at Option A and would be introduced if a crossing were to be provided at Options B, C and $C_{variant}$, (although it seems unlikely that it would be heavily used or would constitute a significant benefit).

1.3.48 Pedestrians are unlikely to be significantly affected by a new crossing at any location unless the detailed scheme design involved severing local access roads or paths. Given that Highways Agency design standards seek to protect rights of way, this risk is expected to be negligible. Increases in traffic generated by the scheme are likely to be mainly on trunk roads, and thus not affect pedestrians.

1.3.49 The overall severance impacts associated with all locations and crossing structure types are assessed as neutral.

**Social: Option Values**

1.3.50 Option Values are discussed in WebTAG 3.6.1 and refer to the perceived value people place on having an option that they would not normally use available for use in exceptional circumstances.

1.3.51 Option A: a new crossing would be located at broadly the same point as the existing Dartford-Thurrock Crossing, and as such would not generate any new journey options. The option values impact is thus assessed as neutral.

1.3.52 Option B: a new crossing would create a road transport link that does not currently exist. However, it would be only around 4 kilometres from the existing Dartford-Thurrock Crossing. Some local residents on either side of the River Thames at Option B may value the connection quite highly, but the number of people affected by this is expected to be small by comparison with the overall usage of the new crossing, and a new crossing at this location would not enable a mode of travel that would otherwise be impossible. The option values impact is thus assessed as neutral.

1.3.53 Option C and $C_{variant}$ : a new crossing would create a road transport link that does not currently exist. However, the crossing would have limited usability for very local trips, since there would be no access to it on the immediate north bank of the River Thames. A few local residents on either side of the new crossing might value the connection quite highly, but the number of people affected by this is expected to be small by comparison with the overall usage of a new crossing at this location. Again, a new crossing at this location would not enable a mode of travel that would otherwise be impossible. The option values impact is therefore assessed as neutral.

## 1.4 Appraisal: Public Accounts Impacts

1.4.1 The appraisal of public accounts impacts is specified in WebTAG 3.5.1; the appraised sub-impacts are as follows:

- cost to broad transport budget; and

- indirect tax revenues.

1.4.2 The potential public accounts impacts on both the broad transport budget and indirect tax revenues are clearly significant, and therefore both of these impacts have been monetised.

**Public Accounts: Cost to Broad Transport Budget**

1.4.3 As noted previously, as funding arrangements are yet to be determined it is assumed that the costs associated with a new crossing and the toll revenues have been assumed to accrue to central government.

1.4.4 The impacts upon the transport budget are twofold; the cost of construction, operation (Opex) and maintenance of new crossings, and the revenue generated. These are reported below as present values over 60 years – these figures should therefore not be taken directly as any indication of the net financial position that each option would create. The costs are summarised below for a bridge structure, at each location Option. Toll revenues reported here are the forecast increment in revenues from additional demand crossing the Thames induced by the provision of additional capacity (i.e. figures for toll revenue do not include revenue from the charges that apply at the existing Dartford-Thurrock Crossing).

**Table A1.35: Costs to Broad Transport Budget, £m, Bridge Structure, from Construction Start to 2084**

| Element | Option A | Option B | Option C | Option $C_{variant}$ |
|---|---|---|---|---|
| Toll Revenue | 484 | 649 | 709 | 732 |
| Construction | -787 | -1,115 | -2,050 | -3,172 |
| Opex & Maintenance | -124 | -183 | -286 | -365 |
| **Total Transport Budget** | **-427** | **-650** | **-1,627** | **-2,805** |

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

**Public Accounts: Indirect Tax Revenues**

1.4.5 A new crossing at each locations Option would generate additional traffic. New crossings would therefore generally increase the total amount of fuel used in road transport, and consequently increase government tax revenue. The impact on indirect tax revenues over 60 years is estimated to have a 2010 value of -£9m, £66m, £112m and £173m for Options A, B, C and $C_{variant}$ respectively.

1.4.6 Public Accounts tables can be found in Appendix F.

## 1.5 Sensitivity and Risk Profile

1.5.1 The preceding discussion and the ASTs set out in the review report present results largely for a “central case” or most likely scenario. Uncertainty underpinning significant assumptions has been considered with the likely impact on the appraisal. These assessed uncertainties are:

- the level of toll charged on the new crossing;
- the level of traffic growth that occurs over time; and
- the presence of a future Silvertown Crossing, east of the Blackwall Tunnel; and

1.5.2 These assumptions have been tested by running the LTC Model with revised inputs. The LTC Model impacts are discussed in more detail in the ’Review of Lower Thames Crossing Options: Central Forecasts and Sensitivity Tests Report’.

**Toll Level**

1.5.3 A sensitivity test was carried out to consider the impacts of charging a significantly higher toll on both the new crossing and on the existing Dartford-Thurrock Crossing; an 80% higher toll (than

the toll assumed in the central case) was tested. Option $C_{variant}$ was not assessed in this sensitivity assessment.

1.5.4 Charging a significantly higher toll is forecast to reduce traffic, as expected, but not very strongly, with an elasticity of around -0.18; that is, the 80% higher tolls is only forecast to suppress traffic by around 14%. It is forecast, therefore, that any increases in tolls within reasonable limits would result in higher outturn revenue.

1.5.5 This has a significant effect on much of the economic appraisal. A full TUBA appraisal was conducted for the 60 year period; however accidents and environmental effects were not reassessed as the effect would be limited and the scale of these impacts is modest. The user benefit and public accounts impacts are summarised in Table A1.36 to Table A1.38. Public accounts have been split into Construction, Maintenance and Operating costs ("C+M"); and "Revenue", which includes both toll revenue and indirect tax revenue relating to fuel.

**Table A1.36: High Toll Sensitivity Assessment Economic Impacts, Option A, £m, 2024-2085**

| | Central Case | | | High Toll | | |
|---|---|---|---|---|---|---|
| | **Consumer** | **Business** | **Total** | **Consumer** | **Business** | **Total** |
| Time | 187 | 705 | 892 | 379 | 1,145 | 1,524 |
| Toll | -37 | -64 | -101 | -791 | -1,303 | -2,093 |
| Fuel Costs | 17 | 25 | 42 | 17 | 12 | 29 |
| Non-Fuel Operating Costs | 29 | 25 | 55 | 56 | 40 | 96 |
| Construction Delay | -2 | -21 | -23 | -2 | -21 | -23 |
| **Total User Benefit** | 194 | 671 | **866** | -341 | -126 | **-467** |
| **Public Accounts** | -911 | 475 | **-436** | -911 | 1,780 | **868** |
| | **C+M** | **Revenue** | **Total** | **C+M** | **Revenue** | **Total** |

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

**Table A1.37: High Toll Sensitivity Assessment Economic Impacts, Option B, £m, 2024-2085**

| | Central Case | | | High Toll | | |
|---|---|---|---|---|---|---|
| | **Consumer** | **Business** | **Total** | **Consumer** | **Business** | **Total** |
| Time | 38 | 1,100 | 1,138 | 343 | 1,688 | 2,031 |
| Toll | -103 | -72 | -175 | -1,167 | -1,720 | -2,887 |
| Fuel Costs | -20 | 81 | 61 | -8 | 61 | 53 |
| Non-Fuel Operating Costs | -230 | 74 | -156 | -123 | 93 | -29 |
| Construction Delay | -3 | -10 | -14 | -3 | -10 | -14 |
| **Total User Benefit** | -318 | 1,172 | **854** | -958 | 112 | **-846** |
| **Public Accounts** | -1,299 | 715 | **-584** | -1,299 | 2,048 | **749** |
| | **C+M** | **Revenue** | **Total** | **C+M** | **Revenue** | **Total** |

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

**Table A1.38: High Toll Sensitivity Assessment Economic Impacts, Option C, £m, 2024-2085**

| | Central Case | | | High Toll | | |
|---|---|---|---|---|---|---|
| | **Consumer** | **Business** | **Total** | **Consumer** | **Business** | **Total** |
| Time | 296 | 1,867 | 2,163 | 688 | 2,546 | 3,233 |
| Toll | -108 | -117 | -225 | -1,168 | -1,824 | -2,992 |
| Fuel Costs | 33 | 343 | 376 | 44 | 336 | 379 |
| Non-Fuel Operating Costs | -267 | 165 | -102 | -173 | 186 | 13 |
| Construction Delay | -31 | -83 | -113 | -31 | -83 | -113 |
| **Total User Benefit** | -77 | 2,175 | **2,099** | -641 | 1,161 | **520** |
| **Public Accounts** | -2,336 | 821 | **-1,515** | -2,336 | 2,175 | **-161** |
| | **C+M** | **Revenue** | **Total** | **C+M** | **Revenue** | **Total** |

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

1.5.6 The tables above show that user benefits are substantially reduced due to large toll disbenefits which are only partly forecast to be offset by user time savings. Options A and B generate an overall user disbenefit. It is worth noting, however, that user time benefit is significantly increased because the congestion relief is greater. There is no significant difference in the pattern of benefits between commuters and other non-work trips; both are disbenefited.

1.5.7 To a large extent the financial disbenefits to users are transferred to the additional revenues generated. However, the overall NPVs differ somewhat from the central toll case for Options A and B, as shown in the table below.

**Table A1.39: High Toll Sensitivity Assessment, Net Present Values, Bridge Structure, 2024-2085**

| Toll Level | Option A | Option B | Option C |
|---|---|---|---|
| Central Case | 335 | -144 | 505 |
| High Tolls | 307 | -511 | 281 |

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

1.5.8 The NPVs in the higher toll case vary by Option. The NPV for the higher toll case for Option A is fairly similar to the NPV for Option A in the central case. Option B's NPV is substantially worsened by the higher tolls. In all cases, the NPV is lower in these 80% increased toll tests; this does not, of course, mean that it is necessarily not possible to produce a higher NPV with different higher toll assumptions.

1.5.9 With the exception of Affordability and Reliability, higher tolls have a negligible impact on the non-monetised elements of the appraisal. Charging higher tolls would involve a substantial negative impact upon Affordability. As all existing users of the crossing would have to pay more, the overall affordability impact would become large adverse because of the high number of users. There would be some positive effect on Reliability. However, this would not change the assessment score as the higher toll would suppress traffic.

1.5.10 It will be essential in full appraisal of a new crossing at any location Option for the toll level to be considered carefully. Evidence here suggests that higher tolls are unlikely to influence traffic levels very strongly (though the effect is certainly not negligible). However higher tolls would have large impacts on how a new crossing would be funded and would have implications for future transport budgets. Higher tolls would also have less desirable social and distributional impacts (SDIs).

**Traffic Growth Level**

1.5.11 The central case appraisal makes a number of assumptions, implicitly and explicitly, regarding future economic conditions and transport situation, concerning:

- GDP growth;
- car ownership growth;
- fuel prices;
- engine fuel efficiency;
- investment in the transport network; and
- level of development in the vicinity of the crossings.

1.5.12 These assumptions have not been tested individually. Rather, following guidance in WebTAG 3.15.5 and discussion with the DfT, "Optimistic" and "Pessimistic" scenarios for the 2041 forecast year have been constructed with high and low levels of overall traffic growth to test the sensitivity of the appraisal to these assumptions. These are discussed in more detail in the Central Forecasts and Sensitivity Tests Report.

1.5.13 Substantial traffic congestion is evident in the 2041 model. Due to the level of congestion, the variation in traffic levels across the Policy Area in the Optimistic and Pessimistic cases is only around 4.5%. The congestion has a particularly marked effect on the flows crossing the river; these vary by only by 1-3%. This suggests that the strategic transport network in the vicinity of a new crossing at each location Option would be operating sufficiently close to capacity in 2041 that assumptions about drivers of traffic growth are not strongly influential on the level of crossing traffic.

1.5.14 Sensitivity tests were run only for the year 2041. The effects are shown below, presenting discounted numbers for 2041 only. Public accounts impacts are limited to toll and tax revenue collected, and environmental impacts are not included.

1.5.15 Generally the Optimistic test shows more benefit than the Core, and the Pessimistic less, as expected. The breakdown by user benefits and toll revenue varies by test, however; in Option C, the Optimistic test produces more user benefit than the Core, but less revenue; in Option A the reverse is true.

**Table A1.40: User Benefits and Public Accounts Impacts, Optimistic and Pessimistic Traffic Growth, 2041 only, £m**

| | | Option A | Option B | Option C |
|---|---|---|---|---|
| **User Benefits** | Pessimistic | 10 | 16 | 44 |
| | Core | 18 | 17 | 42 |
| | Optimistic | 17 | 22 | 51 |
| **Public Accounts** | Pessimistic | 9 | 13 | 15 |
| | Core | 9 | 14 | 16 |
| | Optimistic | 11 | 12 | 14 |
| **Total *** | Pessimistic | 20 | 29 | 59 |
| | Core | 26 | 30 | 58 |
| | Optimistic | 27 | 34 | 64 |

* User benefits + public account impacts
Monetary values in millions of pounds sterling, in 2010 market prices and values, rounded to the nearest million

1.5.16 The overall variation is around 5-10% of total annual benefit, except for the pessimistic Option A test, which produces substantially less user benefit and 25% less total benefit. Because Option A derives benefits wholly from congestion relief, even a slightly less congested scenario will produce significantly less benefit.

1.5.17 The scale of uncertainty in the total level of forecast trip generation represented in these tests is considerably in excess of the level of demand resulting from changes in land use forecast to arise from the improved journey times provided by a new crossing. It would appear reasonably unlikely

therefore, that potential demand arising from developments associated with a new crossing would materially affect the economic case for providing a new crossing. Nevertheless the risks should be reviewed further in detailed design to consider further the adequacy of the assumed capacity for a new crossing structure.

**Silvertown Crossing**

1.5.18 A test of the model with the proposed Silvertown Crossing immediately to the east of the Blackwall Tunnel was carried out.

1.5.19 This demonstrated negligible strategic re-routeing. Almost all the forecast traffic change is located around the proposed new crossing and the Blackwall Tunnel as traffic moves from the Blackwall Tunnel onto the new Silvertown Crossing. The overall flow across the tolled Blackwall and Silvertown crossings falls by around 20% in the test due to the assumed introduction of a toll at the Silvertown Crossing and Blackwall Tunnel (which is currently free to use) when the Silvertown Crossing is completed. The impact on the Dartford-Thurrock Crossing, however, is extremely weak, of the order of 0.3%.

1.5.20 Accordingly, it is concluded that the presence of the Silvertown Crossing has no material effect on the appraisal of any location Options for a new crossing.

# Appendix B: Economic Appraisal Methodology

## Economic Appraisal Methodology

### 1.1 Introduction

1.1.1 Economic appraisal has been carried out largely using TUBA software. Inputs to TUBA have been taken from the Lower Thames Crossing Model (LTC Model), a computer model of the highway transport network. The LTC Model is discussed in detail in the Model Capability Report.

1.1.2 Version 1.9 of the TUBA software has been used for compatibility with the August 2012 release of WebTAG 3.5.6, which includes consideration of electric cars within the vehicle fleet.

1.1.3 Time, distance, toll and person traveller matrices were extracted from LTC Model and used as inputs to TUBA.

### 1.2 Interface

1.2.1 Data from the Lower Thames Crossing Model (LTC Model) are supplied to TUBA as inputs.

1.2.2 Matrices for origin to destination traveller demand are extracted from the LTC Model demand model for the three modelled time periods of AM Peak (08:00-09:00), Interpeak (average hour 10:00-16:00) and PM Peak (17:00-18:00). Time, distance and road toll skims are extracted from the SATURN assignment models at an origin-destination level.

### 1.3 Segmentation

1.3.1 TUBA has been run for 10 user classes, listed below. These do not correspond perfectly with those in LTC Model: non-home-based and home-based trips have been aggregated and heavy goods vehicles disaggregated into two; they are otherwise, however, the same.

- commuting – low value of time;
- commuting – medium value of time;
- commuting – high value of time;
- other non-business – low value of time;
- other non-business – medium value of time;
- other non-business – high value of time;
- employers' business;
- light goods vehicles;
- heavy goods vehicles (rigid and 3 or fewer axles); and
- heavy goods vehicles (articulated or more than 3 axles).

1.3.2 It was necessary to edit the TUBA economics file to permit segmentation by value of time[11], otherwise the segmentation was compatible with the default TUBA setup. Values of time were taken from LTC Model (derived from advice in WebTAG 3.12.2C, Annex A), and are provided below.

**Table B1.41: Values of Time, Pence/Hour, 2010 prices**

| Segment | Low | Medium | High | TUBA |
|---|---|---|---|---|
| Commuting | 448 | 618 | 784 | 646 |
| Other Non-Business | 505 | 581 | 645 | 571 |

[11] TUBA analysis has also been undertaken using a single appraisal value of time, resulting in only very marginal differences in reported user benefits.

1.3.3 Three time periods have been used; these are discussed further under Annualisation.

## 1.4 Annualisation

1.4.1 The TUBA appraisal requires annualisation factors to estimate the total annual benefit to transport users of the schemes as a function of the benefit for the modelled hours of the day. Annualisation factors have also been used for other purposes, such as annualising environmental impacts; the same process and data have been used to ensure consistency.

1.4.2 LTC Model contains three validated time periods, for an average weekday in October 2009:

- AM peak hour (0800-0900);
- average inter-peak hour (average of 1000-1600); and
- PM peak hour (1700-1800).

1.4.3 The demand model in addition represents AM peak (0700-1000), PM peak (1600-1900), and average off-peak hour (1900-0700) periods, but as these are not validated, they are not used in appraisal. Annualisation factors have therefore been derived for the three validated time periods.

1.4.4 Factors have been derived from observed traffic flows from two sources: transaction data on the Dartford-Thurrock Crossing obtained from the existing Dartford-Thurrock Crossing operator, and TRADS count data on motorways in the area of influence. Neither source is able to fully and robustly distinguish between heavy and light vehicles; the transaction data classifies vehicles, but only during the day when charges are in operation; and TRADS data has heavy vehicle proportions, but these are considered to be relatively poor as automatic traffic counters are generally not good at identifying heavy vehicles.

1.4.5 Annualisation factors have been derived to bring the three modelled hours to an annual 2009 total.

1.4.6 It is assumed that the modelled AM and PM peak hours are the source of benefits for the AM and PM periods (0700-1000 and 1600-1900 respectively) during working weekdays over the year. The modelled inter-peak hour is used for all other times and days.

1.4.7 Factors have been derived separately for “busy” and “quiet” hours of the year, as the schemes act to relieve capacity.

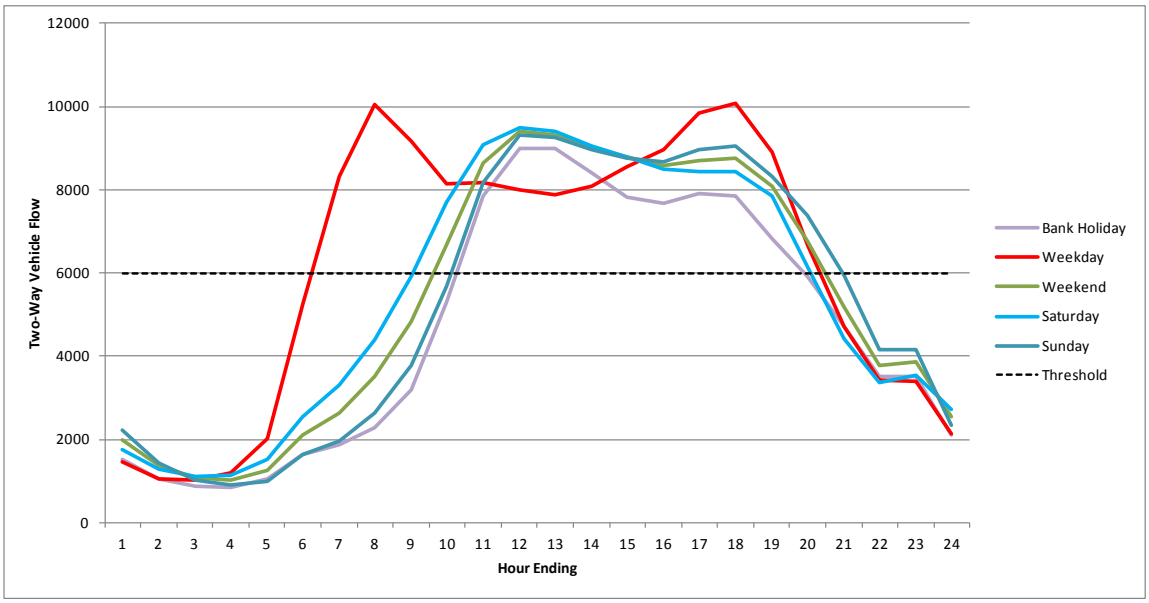
1.4.8 Non-user benefits, such as indirect tax revenues, accrue for all time periods of all days of the year.

1.4.9 Free-flow periods have been defined as those in which the flow is less than 70% of the inter-peak average flow. The observed two-way inter-peak flow in 2009 is around 8,000 vehicles/hr. The model predicts that this will increase to 10,400 vehicles/hr in 2041, which implies a threshold of 7,200 vehicles/hr, or 3,600 per direction, which is around 70% of the crossing capacity. The periods considered "busy" under this logic are summarised below in Table B1.42 and Figure B1.14.

**Table B1.42: Busy Periods (derived from Dartford-Thurrock Crossing transaction data)**

| Day Type | Busy Hours |
|---|---|
| Weekday | 0600-2000 |
| Weekend | 0900-2000 |
| Bank Holiday | 1000-1900 |

**Figure B1.14: Daily Profile of Traffic (derived from Dartford-Thurrock Crossing transaction data)**




1.4.10 Saturdays and Sundays have been checked separately, and imply the same busy period of 0900-2000.

1.4.11 Factors have also been derived separately for charged and uncharged periods of the day; the existing Dartford-Thurrock Crossing, and, it is assumed, new crossing, charges/tolls, are applied between 0600-2200 on all days. These are necessary for calculation of revenue. Note that all "busy" times are charged, but all charged times are not classed as "busy".

1.4.12 The factors used are the ratio of vehicle flow on some specified stretches of road over the period to be expanded to, to traffic in the modelled period.

1.4.13 Factors derived from the Dartford-Thurrock Crossing itself are shown in the table below:

**Table B1.43: Dartford-Thurrock Crossing Transaction Data, Annualisation Factors**

| Annualisation Period | All vehicles | Light Vehicles, 2 axles | Heavy Vehicles 3+ axles |
|---|---|---|---|
| AM Peak Period | 730 | 724 | 777 |
| PM Peak Period | 700 | 691 | 779 |
| Weekday Interpeak | 1471 | 1461 | 1523 |
| Weekday Off-Peak Busy | 444 | 452 | 378 |
| Weekday Off-Peak Quiet Charged | 241 | 244 | 207 |
| Weekday Off-Peak Quiet Free | 521 | - | - |
| Weekend / Bank Holiday Busy | 1114 | 1252 | 300 |
| Weekend / Bank Holiday Quiet Charged | 350 | 375 | 201 |
| Weekend / Bank Holiday Quiet Free | 196 | - | - |

1.4.14 "Weekend / Bank Holiday" includes all weekends and bank holidays. "Weekday Off-Peak" includes the 1900-0700 night-time period for all weekdays.

1.4.15 The Heavy Vehicle toll category, based on vehicles having 3 or more axles, tends to have slightly higher factors in the peaks, because the heavy vehicle traffic is less peaked within the periods than other traffic; consequently the factors are closer to 253*3. However, this effect is relatively small.

1.4.16 The most notable difference between light and heavy vehicles is that the heavy vehicle factors are significantly lower for non-working-days. This suggests, given that a significant proportion of user benefits are likely to accrue to HGVs, that separate annualisation factors by vehicle type will be preferable. It was not possible to produce separate factors for the uncharged periods by vehicle type, but the factors implied in these periods are relatively small.

1.4.17 Data for all vehicles have been extracted from some TRADS sites, reported below next to the Dartford-Thurrock Crossing transaction data. Note that data for the A2 were not available for 2009; the TRADS counter appeared to be disabled or malfunctioning.

**Table B1.44: TRADS Data, Annualisation Factors, All Vehicles**

| All Vehicles Period | 2009 DC TD | 2010 A2 | 2009 M2 J1 | 2009 A13 | 2009 M25 J29 | 2009 M25 J3 |
|---|---|---|---|---|---|---|
| AM Peak Period | 730 | 718 | 710 | 690 | 772 | 670 |
| PM Peak Period | 700 | 617 | 686 | 675 | 742 | 701 |
| Weekday Interpeak | 1471 | 1480 | 1617 | 1479 | 1519 | 1504 |
| Weekday Off-Peak Busy | 444 | 414 | 460 | 485 | 415 | 446 |
| Weekday Off-Peak Quiet Charged | 241 | 332 | 266 | 269 | 242 | 224 |
| Weekday Off-Peak Quiet Free | 521 | 426 | 442 | 528 | 478 | 374 |
| Weekend / Bank Holiday Busy | 1114 | 1020 | 1178 | 1019 | 1096 | 1137 |
| Weekend / Bank Holiday Quiet Charged | 350 | 312 | 336 | 327 | 347 | 358 |
| Weekend / Bank Holiday Quiet Free | 196 | 179 | 169 | 183 | 180 | 162 |

DC TD – Dartford-Thurrock Crossing Transaction Data

1.4.18 The most notable pattern is that the Dartford-Thurrock Crossing transaction data appears to have a much higher proportion of night-time (uncharged) traffic than the surrounding M25. This is quite logical, as the variation in toll will push some demand into the 2200-0600 period when there is no charge.

1.4.19 However, since all modelled crossings will be charged, it seems more reasonable to use the Dartford-Thurrock Crossing figures than those for non-charged motorways for the purposes of appraisal.

1.4.20 It is also worth noting that the M2 factors are in significantly higher than those for any other site for the main inter-peak periods.

1.4.21 Factors for heavy vehicles are compared below.

**Table B1.45: TRADS Data, Annualisation Factors, Heavy Vehicles**

| Heavy Vehicles Period | 2009 DC TD | 2010 A2 | 2009 M2 J1 | 2009 A13 | 2009 M25 J29 | 2009 M25 J3 |
|---|---|---|---|---|---|---|
| AM Peak Period | 777 | 724 | 891 | 728 | 803 | 615 |
| PM Peak Period | 779 | 752 | 956 | 696 | 762 | 799 |
| Weekday Interpeak | 1523 | 1431 | 1897 | 1427 | 1481 | 1523 |
| Weekday Off-Peak Busy | 378 | 319 | 416 | 269 | 388 | 362 |
| Weekday Off-Peak Quiet Charged | 207 | 157 | 197 | 93 | 204 | 127 |
| Weekday Off-Peak Quiet Free | 521 | 518 | 724 | 437 | 799 | 543 |
| Weekend / Bank Holiday Busy | 300 | 280 | 370 | 180 | 318 | 271 |
| Weekend / Bank Holiday Quiet Charged | 201 | 144 | 186 | 98 | 167 | 136 |
| Weekend / Bank Holiday Quiet Free | 196 | 119 | 165 | 77 | 168 | 117 |

DC TD – Dartford-Thurrock Crossing Transaction Data

1.4.22 There is considerable variation in some of the smaller factors, but little indication that the Dartford figures are significantly exceptional, except perhaps for the free period on Weekends, where there is a good explanation for the difference. Some of the sites (A13 especially) seem to have very low proportions of travel on non-working days; again the Dartford proportion is considered more applicable to the appraisal.

1.4.23 The factors for other sites in the area being not significantly different from those implied by the Dartford-Thurrock Crossing transaction data, and the latter being most applicable to toll roads, it has been decided to use the transaction data values.

1.4.24 It is considered desirable to use separate factors by vehicle size, given the reduced levels of heavy vehicles on non-working days. It should be noted that proportions of business users are likely to be similarly lower on non-working days, and that none of the data enables distinct factors to be derived because count data does not distinguish traveller purpose. This is relevant to appraisal; it means the annualised figures are likely to be an overstatement, because business travellers have a higher value of time, and if they are in lower proportion on non-working days, then the time savings on non-working days will be over-valued.

1.4.25 This effect is roughly quantified in summarising results.

1.4.26 These conclusions imply the following annualisation factors.

**Table B1.46: Annualisation Factors used in Appraisal**

| Annualisation Period | Applied to... | Car/LGV | HGV |
|---|---|---|---|
| AM Peak Period | All | 724 | 777 |
| PM Peak Period | All | 691 | 779 |
| Interpeak, Busy Only | User Benefits in Option A | 3165 | 2200 |
| Interpeak, Charged | Revenue | 3784 | 2608 |
| Interpeak, All | Option B/C, Indirect Tax, Carbon, Accidents | 4501 | 3325 |

1.4.27 Because it is not possible in TUBA to apply annualisation factors separately by user class or by type of benefit, it is necessary to apply the annualisation externally to TUBA. TUBA is run using

annualisation factors of 1 for all three time periods, and the factors applied post-TUBA in a spreadsheet.

## 1.5 Modelled Years and Extrapolation

1.5.1 Two model years were used, 2025 and 2041, and a full 60-year appraisal was run in TUBA, using annualisation factors of unity as discussed above. The default TUBA assumption beyond the last modelled year of 2041 is that travel times and demand remain constant, but that values of time continue to increase. This assumption has been retained, and also applied in the areas of appraisal not done directly in TUBA, such as accidents.

1.5.2 The potential range of results associated with extrapolating traffic flows beyond 2041 using the 2025-2041 growth has been investigated. Since the congestion evident in the network in 2041 is considerable, there is little change in crossing traffic between the two years, and the expected effect on total discounted benefits of extrapolating traffic growth is of the order of 3%.

## 1.6 Transport Model Noise/Convergence and Masking

1.6.1 Generating robust estimates of user benefit using TUBA or a similar methodology generally requires extremely well-converged transport model results. In this assessment, the strategy under consideration represents a large intervention, which makes obtaining a robust result easier, but the model does represent the entirety of Great Britain, meaning that convergence is still important.

1.6.2 Transport model convergence is discussed in more detail in the Model Capability Report; the model is run to a demand/supply gap of 0.15% for trips produced in the Policy Area[12] (shown in Figure B1.15), which is a considered reasonable, though not exceptionally tight, level. Attention has been paid to the degree of noise and variability in the TUBA appraisal results, through a number of checks:

- Benefits have been examined by movement to ensure plausibility and to check that large benefits are not accruing to movements well outside the Policy Area or which would not be expected to benefit.
- TUBA has been run for two successive iterations of a converged model run to assess the likely scale of convergence “noise”.
- Benefits have been compared between similar, but not identical TUBA runs (for example, where minor errors were spotted in earlier model runs), to ensure large changes in output did not occur as a results of small changes in input.

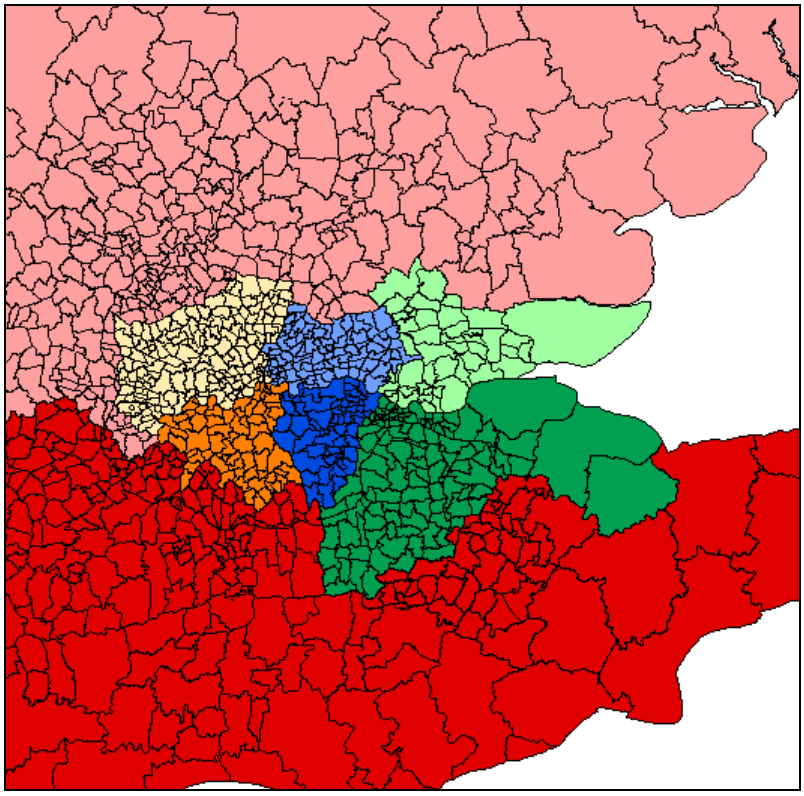
1.6.3 This has led to a few interventions. Firstly, intra-zonal movements (movements wholly within a single model zone), have been excluded from the TUBA analysis altogether. The model cannot by nature produce reliable forecasts for such movements, and their inclusion results in large “noise” benefits being generated within large external zones, such as Scotland.

1.6.4 Secondly, non-fuel and indirect tax benefits, which are calculated using a simple arithmetic subtraction, have been excluded where they are wholly a long way outside the Policy Area (the excluded area is in pink and red in Figure B1.15 below). These too generally produced implausibly large values for movements considered unlikely to be affected in practice.

1.6.5 It proved unnecessary to exclude rule-of-half benefits in the same way, since LTC Model does not model dynamic changes in costs outside the model simulation area, so no benefits can be generated for wholly external movements. Toll revenue, which is calculated via simple subtraction, derives only from the Dartford-Thurrock Crossing and new river crossing options assessed in the model and therefore cannot generate external benefits, so likewise need not be excluded.

[12] The Policy Area comprises North Kent, South Essex, North East London and South East London.

**Figure B1.15: TUBA Sectoring System**



## 1.7 Construction Delays

1.7.1 Delays accruing to users during construction of the scheme have also been estimated using TUBA. Likely lane-closures and speed restrictions for the construction of each option were estimated and coded into the SATURN network. Single 2025 assignments, without demand model feedback (which would have been inappropriate for a short-term response of this kind), were then used as inputs to TUBA and annual disbenefit estimated.

1.7.2 Annualisation factors and TUBA economics files were identical to the main appraisal; however, a different segmentation was used due to the absence of the demand model, based only on the SATURN assignment segmentation:

- employers' business car;
- other car;
- light goods vehicles;
- heavy goods vehicles (rigid and 3 or fewer axles); and
- heavy goods vehicles (articulated or more than 3 axles).

1.7.3 It was assumed that the lane closures and speed restrictions remain in place for a period of two years in each case.

**Option A:**

- a 50mph speed-limit assumed for at least 1 kilometre south of M25 Junction 1a; and
- a 50mph speed-limit assumed for at least 1 kilometre north of the north-facing slip-roads at M25 Junction 30.

**Option B:**

- speed restrictions to 50mph assumed on the eastbound A2 carriageway for roughly 1 kilometre either side of the proposed tie-in locations;
- on the A1089, 50mph speed-limit assumed 2 kilometres north of Marshfoot Interchange and for the entirety of the A1089 south of Marshfoot to Tilbury docks to allow for the construction of the new over-bridge; and
- temporary signalisation and temporary diversions at the Ebbsfleet junction due to reconstruction of this location.

**Option C:**

- speed restrictions to 50mph assumed for a 6-7 kilometre section of the A2/M2 at the assumed tie-in location;
- at the northern end of the Option linking with the M25, speed restrictions to 50mph either side of the new junction;
- approximately 3-4 kilometres of the A13 subject to speed restrictions in the vicinity of Orsett Cock interchange;
- Orsett Cock interchange speed limits reduced to 40mph and reduced circulating capacity at least on the southern side; and
- the A226 in Kent affected where construction of a bridge is required, a speed restriction of 40mph assumed;

**Option $C_{variant}$:**

- around 4 kilometres of the M2 subject to 50mph speed restrictions;
- around 3 kilometres of the M20 subject to 50mph speed restrictions; and
- the A229 subject to 40mph speed limits for its entire length between the M2 and M20 due to the poorer condition of the route and the higher number of access/egress points.

## 1.8 Accidents

1.8.1 The value of changes in road accidents generated by the options was assessed using WebTAG 3.4.1 and COBA accident rates. The latest accident valuations from WebTAG 3.4.1, as of October 2012, were used, for consistency with the 2010 price base used elsewhere in appraisal.

1.8.2 COBA accidents rates were replaced for some road types with those derived in the free-flow tolling study work, as follows (new accident rates in green, COBA rates in black). These were based on observed accident data in and around the Dartford-Thurrock Crossing.

**Table B1.47: Accident Rates**

| | Urban | | Rural | |
|---|---|---|---|---|
| | **Pia/mvkm** | **β** | **Pia/mvkm** | **β** |
| D2 Motorway | 0.098 | 1.001 | 0.098 | 1.001 |
| D3 Motorway | 0.108 | 1.001 | 0.108 | 1.001 |
| D4 Motorway | 0.098 | 1.001 | 0.098 | 1.001 |
| Modern S2 Roads | 0.761 | 0.984 | 0.293 | 0.973 |
| Modern S2 Roads with HS | 0.761 | 0.984 | 0.232 | 0.973 |
| Modern WS2 Roads | 0.761 | 0.984 | 0.190 | 0.973 |
| Modern WS2 Roads with HS | 0.761 | 0.984 | 0.171 | 0.973 |
| Older S2 A Roads | 0.761 | 0.984 | 0.381 | 0.973 |
| Other S2 Roads | 0.761 | 0.983 | 0.404 | 0.998 |
| Modern D2 Roads | 1.004 | 0.984 | 0.363 | 0.973 |
| Modern D2 Roads with HS | 1.004 | 0.984 | 0.363 | 0.973 |
| Older D2 Roads | 1.004 | 0.984 | 0.363 | 0.973 |
| Modern D3+ Roads | 1.004 | 0.984 | 0.151 | 0.973 |
| Modern D3+ Roads with HS | 1.004 | 0.984 | 0.151 | 0.973 |
| Older D3+ Roads | 1.004 | 0.984 | 0.151 | 0.973 |

1.8.3 Accident changes were calculated only for the Policy Area (shaded red in Figure A1.13); external accidents were not assessed.

## 1.9 Journey Time Reliability

1.9.1 Journey time reliability was not assessed in monetary terms. A quantitative assessment of the impact of the new crossings on reduced traffic stress has been made following the guidance in WebTAG 3.5.7 Annex F. The modelled average annual daily traffic (AADT) is compared to the "Congested Reference Flow", a measure of the daily flow at which significant capacity problems are likely to be observed in the peak hours, and network stress calculated as the ratio of the two.

1.9.2 Hourly road vehicle capacities are required as part of the calculation of Congested Reference Flow. For the existing Dartford-Thurrock Crossing these were taken from the LTC Model. Capacities for new crossings were derived using the parameters in Annex F. These are shown below, averaged over the two directions.

1.9.3 Option B has a higher capacity, because the forecast heavy vehicle proportion is lower than the other location Options. The capacities of Option B and C were not material in the assessment, since both routes are significantly under-capacity.

**Table B1.48: Stress Calculation Vehicle Capacities for Crossing Infrastructure (per direction)**

| Crossing | Capacity | Lanes[13] | Cap/lane |
|---|---|---|---|
| Dartford-Thurrock | 5,753 | 4 | 1,438 |
| Option A | 9,321 | 6 | 1,553 |
| Option B | 3,802 | 2 | 1,901 |
| Option C | 3,565 | 2 | 1,783 |

[13] Option A is represented as having 6 lanes in each direction. This is because providing 2 lanes in each direction at Option A gives a total of 6 lanes in each direction overall once the existing 4 lanes in each direction at the existing Dartford-Thurrock Crossing are taken into account.

# Appendix C: Environmental Appraisal Methodology

## Environmental Methodology

### 1.1 Environmental: Noise

1.1.1 The noise assessment was carried out using the Method for Strategies guidance in WebTAG Unit 3.3.2, Section 1.8. In addition, in accordance with WebTAG Unit 3.3.2, Section 3, Index of Multiple Deprivation (IMD) data was used to determine the social distributional impact of the proposals in relation to the estimated population likely to be annoyed in the longer term.

1.1.2 Noise predictions were undertaken in accordance with the procedures detailed in the 'Calculation of Road Traffic Noise' (CRTN) published in 1988 adopting a single source line approach. At the strategic level, this calculates a Basic Noise Level (BNL) for each road link to estimate changes in noise emission levels alongside the existing highway network. To supplement this, the road links were modelled using Cadna-A noise modelling software which employs the CRTN methodology to predict road traffic noise for both the Do-Minimum and Do-Something scenarios. The strategic methodology provides an assessment based on population density of settlements, assuming 2.36 people per household. Settlements are shown on Figure 6 of the Design and Costing report. Individual receptors have not been considered in the analysis.

1.1.3 The study area included all road links that had at least a 1 dB(A)[14] change in noise due to a change in traffic flow when comparing the Do-Something scenario with the Do-Minimum in that year, all new links and all links which were by-passed by any new link. The same road links were analysed for each of the options and years. This amounted to 2242 road links. Only these road links have been analysed out of the total of 44,000 links provided as the remainder have been screened out.

1.1.4 The Cadna-A noise model was developed as a 2-dimensional model, that is, with no buildings or ground plane modelling. Noise contours were calculated at 3 dB(A) band intervals as required in the WebTAG guidance. These allowed noise levels to be estimated for all areas within 600m of the 2242 road links. Areas which were further than 600m from any road link were assigned a noise level of <45 dB(A).

1.1.5 It has been assumed that by 2025 (the assumed year of opening for appraisal purposes) all Highways Agency road schemes will have a low-noise road surface. This assumption has also been used for all road scheme options in 2041 (the design year). The correction for low-noise road surfaces follows the current advice described in the DMRB15.

1.1.6 To avoid any spurious errors due to extrapolating the mean traffic speed outside the valid speed range of CRTN (20 to 130 km/h), those road links which were identified with mean traffic speeds less than 20 km/h were modelled at 20km/h.

1.1.7 A comparison of the Do-Minimum and option scenarios has been undertaken so that the options can be appraised in terms of annoyance and economic cost as a result of changes in road traffic noise levels.

[14] Between the quietest audible sound and the loudest tolerable sound, there is a million to one ratio in sound pressure (measured in pascals, Pa). Because of this wide range, a noise level scale based on logarithms is used in noise measurement called the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB. The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB(A).

[15] See DMRB Volume 11, Section 3, Part 7: HD 213/11 – Revision 1: Noise and Vibration paragraphs A4.25, A4.26, A4.27 and A4.29

## 1.2 Environmental: Air Quality

1.2.1 The local air quality assessment was carried out using the Method for Strategies guidance in WebTAG Unit 3.3.3. This used the DMRB regional air quality spreadsheet version 1.03c to estimate emissions on selected links. The road links selected for analysis were those that had at least a 10% change in traffic flows with at least one scenario compared with the Do-Minimum in that year. This amounted to 1941 road links out of a total of 44000 links provided. The same road links were analysed for the present year (taken to be 2009) and opening year (2025). The emissions were calculated using Average Annual Daily Traffic (AADT) traffic flows, traffic speeds, daily average HDV content and link length. It was assumed that all roads were motorways or A roads when determining the fleet composition.

1.2.2 Data on population and income level were obtained from GIS software at a superoutput level. Population data from the 2001 census and income data from 2010 were used in the analysis. The population and income level associated with each road link was determined. The population near each link was calculated using the assumption that the population is evenly distributed within each superoutput area and that the population affected is within 200m of each link. Assuming 2.3 people per household, the number of properties affected was calculated (applicable in 2006, Household projections to 2031, England, Communities and Local Government). No account was taken of the overlap of areas between each road link so the number of people and properties affected will have been overestimated, however, this does not affect the ranking of results, emissions or monetisation of impacts.

1.2.3 Worksheet 2 was completed at a strategy level to assess the pollution index. Each zone was taken to represent one road link due to the level of detail in the traffic model. The number of links with a positive or negative index was calculated for each pollutant. The index is the mass of emissions multiplied by the population and divided by the area. A large index indicates a large change in population exposure with a negative number indicating an improvement in air quality.

1.2.4 The monetary value of the change in air quality was assessed. This makes use of the economic valuation evidence published by the Inter Departmental Group on Costs and Benefits (IGCB). The costs were calculated using WebTAG's U3_3x2_air-quality.xls.

1.2.5 Low income can be a sign of social deprivation. A social distributional impacts (SDI) analysis was carried out to determine how each income group would be affected by each of the options.

## 1.3 Environmental: Greenhouse Gases

1.3.1 Greenhouse gas emissions (tonnes of carbon dioxide equivalent, tCO2e) were calculated in accordance with WebTAG Unit 3.3.5. The calculated mass of carbon from vehicle emissions[16] was calculated for the do-minimum and each option in the opening and design years. Data for other years was estimated based upon these two sets of calculations so that 60 years of data was available. The calculations were carried out using the DMRB regional spreadsheet version 1.03c and WebTAG's U3_3_5x_greenhouse-gases.xls.

## 1.4 Environmental: Landscape/Townscape

1.4.1 Landscape and townscape appraisal has been undertaken in accordance with WebTAG Units 3.3.7 and 3.3.8. The study area for this appraisal was 1km either side of the assumed illustrative route for each option. Baseline data was collected within the study area from Ordnance Survey maps and aerial photographs, online data including the MAGIC website to identify landscape designations and other designated sites, relevant Kent and Essex Historic Landscape Characterisation data, and relevant Local Planning Authority data. A site visit was also undertaken. The Methodology for Plans was followed and Worksheet 1 from the WebTAG guidance was completed.

[16] This strategic level of study has not undertake detailed design or construction methods for the new crossing and link roads that would be required to consider embedded carbon.

## 1.5 Environmental: Heritage of Historic Resources

1.5.1 A heritage of historic resources appraisal has been undertaken for each option in accordance with WebTAG Unit 3.3.9. The study area for this appraisal was 500m either side of the assumed illustrative route for each option. Baseline data was collected within the study area from the National Monuments Record, Kent and Essex Historic Environment Records, English Heritage Rapid Coastal Assessment Survey for the South East and online sources including MAGIC and the National Heritage list. The Methodology for Plans was followed and Worksheet 1 from the WebTAG guidance was completed.

## 1.6 Environmental: Biodiversity

1.6.1 A biodiversity appraisal has been undertaken for each location Option in accordance with WebTAG Unit 3.3.10. The study area for this appraisal was 5km either side of the assumed illustrative routes for international designations and 2km either side of the assumed illustrative routes for national and non-statutory nature conservation designations and Biodiversity Action Plan (BAP) habitats. Baseline data was collected within the study area from Information from the MAGIC website and Nature on the Map (Natural England website). Information on non-statutory designated sites and protected species records was obtained from a review commissioned by Kent, Essex and Thurrock Councils[17]. The Methodology for Plans was followed and Worksheet 1 from the WebTAG guidance was completed.

## 1.7 Environmental: Water Environment

1.7.1 A water environment appraisal has been undertaken for each option in accordance with WebTAG Unit 3.3.11. The study area for this appraisal was 1km either side of the assumed illustrative route for each option. Baseline data was collected within the study area including information on nationally and internationally designated sites from the MAGIC website and Natural England's Nature on the Map website, Environment Agency information including flood maps, the Thames Estuary 2100 Flood Risk Management Plan, EU designated fisheries, SPZs, existing flood defences, and Local Authority Strategic Flood Risk Assessments. The Methodology for Plans was followed and Worksheet 1 from the WebTAG guidance was completed considering the operational impacts on the water environment. Qualitative comments were also made on potential construction impacts.

[17] Review of Environmental Impacts of Lower Thames Crossing Options (March 2012), prepared by Mouchel for Kent County Council, Essex County Council and Thurrock Council.

# Appendix D: Wider Impacts Methodology

# Wider Impacts and Regeneration Methodology

## 1.1 Introduction

1.1.1 This Appendix describes the methodology employed in the calculation of Wider Impacts and regeneration impacts. A key feature in the sensitivity testing of Wider Impacts and in the assessment of regeneration impacts is examination of potential changes in land use, and specifically the location and scale of employment impacts. This appendix therefore also sets out the methodology used in the estimation of changes in employment location.

## 1.2 Background and Report Objectives

1.2.1 A new crossing at any of the location Options under consideration could change levels of congestion or network geometry in ways that have significant implications for patterns of journey times. Changing patterns of connectivity and relationships between businesses and their employees, customers and suppliers, could, in turn, have wider economic consequences that give rise to additional implications for policy, equity objectives and the calculation of welfare impacts.

### Wider Impacts

1.2.2 Department for Transport guidance[18] has been developed to capture the wider implications of changes in the transport system. WebTAG Unit 3.5.14 describes how economic consequences can occur as a result of:

- Changes in labour supply (GP1);
- Move to more/less productive jobs (GP3);
- Agglomeration (WI1);
- Increased Competition (WI2); and
- Change in output in imperfectly competitive markets (WI3).

1.2.3 These can have welfare impacts that can be monetised and incorporated into a quantitative cost benefit appraisal. The impacts labelled WI1, WI2 and WI3 have direct welfare impacts. Impacts GP1 and GP2 reflect changes in individual decisions that may have implications for economic output, although the welfare benefits to the decision maker will be captured within transport user benefits. However additional tax generated as a result of these activities is an additional welfare impact that arises due to the distortions created by the tax system. These are known as the tax wedge on labour market impacts (WI4).

1.2.4 This report sets out how these monetised welfare impacts have been calculated.

### Regeneration

1.2.5 Guidance on regeneration impacts provides an indication of how a transport intervention could influence the distribution of jobs, particularly for residents of Regeneration Areas. This provides information relevant for policy decisions but is not incorporated into a monetised cost benefit analysis.

1.2.6 This report considers the implications of transport and land use modelling for regeneration but is not intended as a full Regeneration Report as described in WebTAG Unit 3.5.8. Following WebTAG, it has not been considered appropriate to undertake a full quantified Regeneration

[18] Particularly WebTAG Units 3.5.8 (Regeneration Impacts)), 3.5.14 (The Wider Impacts Sub-Objective) and 3.5.16 (Appraisal in the Context of Housing Development)

Report for the Strategic Outline Business Case[19], but to focus attention more heavily on the strategic case for the scheme. A full Regeneration Report would be expected if the scheme progresses to Outline Business Case level.

**Land Use Change**

1.2.7 The transport changes brought about by a new Lower Thames Crossing could have important implications for business and residential location decisions and for development activity in the Thames Gateway and beyond. This change in land use could affect the welfare impacts of the new crossing. In the approach adopted for this review to investigate the potential land use impacts the transport and land use models operate independently and the transport model provides inputs to the land use model. Changes in land use have not been fed back into the transport model to capture any further feedback effects, for example through changes in congestion patterns as a result of induced changes in land use patterns. The sensitivities of Wider Impacts to changes in land use therefore only reflect the impacts of land use changes through the change in the pattern of employment and not of any further induced journey time changes.

**Data**

1.2.8 The calculation of wider impacts relies on a range of different datasets. These come from two main sources:

- The LTC Model which provides highway journey times and demand data; and
- The DfT Wider Impacts datasets which contains relevant economic data and parameters for the analysis.

1.2.9 In addition to these it has been necessary to source other data, to make assumptions and to develop parameters for the land use modelling using statistical modelling techniques. This information is provided below.

## 1.3 Overview

1.3.1 This Appendix follows the internal logic of the welfare calculations, beginning with the data sets used and the processing of these into a suitable format for the wider impacts calculations. It goes on to explain how guidance has been implemented to assess the different Wider Impacts and then explains the modelling of land use impacts and the welfare analysis sensitivities that are based on this. This appendix concludes with an examination of regeneration impacts.

1.3.2 Table D1., Table D1. and Table D1.51 overleaf contains the wider impacts checklists which contains references to where the appropriate descriptions of methodology can be found.

[19] Department for Transport, 2011, *Transport Analysis Guidance: Guidance for the Senior Responsible Officer*, http://www.dft.gov.uk/webtag/documents/expert/pdf/guidance-senior-responsible-officer.pdf [accessed 7th December 2012]

**Table D1.49: Data checklist**

| Issues | Check |
|---|---|
| Look at the components of generalised cost:<br>If the inputs are components of generalised journey cost (such as generalised journey time), check how these are converted into generalised costs. | See description of traffic model in the Appraisal Summary Report. Generalised costs for bus, rail and walk/cycling are described in section 1.6. |
| Look and confirm that the generalised costs are comparable (same units) across the modes and purposes (including passenger/goods vehicles) that need to be considered. | Generalised costs for all modes are expressed in consistent units (minutes for one way trips including an element for financial costs converted to minutes using appropriate values of time). See section 1.6. |
| Determine which journey purposes are included | Journey purpose segments from the traffic modelling are described in section 1.6. |
| Determine which modes are included | Private car and freight trips are captured using data from the highway model (see section 1.6.1). Other modes included in the generalised cost calculations include bus, rail and walk/cycle (see section 1.6.5). |
| Check the definitions of any segmentation by car-ownership or car-availability levels, or by any other dimensions like time of day or socio-economic group, since it will be necessary to average over these segments to provide the generalised costs for use in the WIs calculations. | Generalised costs used in the WI calculations average over all income and car availability segments included in the transport model. |
| Find out how intra-zonal values have been obtained (e.g. using values that were used in the transport modelling or estimated/assumed values).<br>The documentation needs to make clear how intra-zonals have been treated. | The WI calculations are undertaken at district level. District to district generalised costs are calculated using a weighted sum of the generalised costs from the transport model which are available at a more disaggregate level.<br>The generalised costs of intra-zonal trips within the traffic model are assumed to be equal to half of the cost of a trip to the nearest zone. |
| Confirm if the values are for one-way travel or for round trips.<br>The values should be estimated in a consistent way. | All journey times are based on one way trips. In the calculation of GP1 (labour supply impacts) annual commuting costs are calculated by doubling the one way trip cost and annualising (see section 1.7.3). |

**Table D1.50: Completeness of data**

| Issues | Check |
|---|---|
| Walk mode is often not modelled, but walk times can often be calculated from network distances, which are nearly always available. In some areas, cycling is also significant and needs to be considered. | Treatment of walking and cycling modes is discussed in section 1.6.11. |
| Transport models are often less detailed outside the main area of interest, whilst land-use and WIs analysis typically attempts to cover a larger are and typically needs variables to be consistent across the whole area. Problems that can arise (and have arisen in practice) include:<br>- Some modes being omitted outside the core area of the transport model,<br>- Congestion not being considered outside the core area'<br>- Only modelling the corridor of interest: in this case the narrowness of the transport modelling will be insufficient for WIs analysis. | Model geography is considered sufficient for an accurate analysis of Wider Impacts. The wider impacts model geography is described in section 1.5. See also the Appraisal Methodology Report for a more detailed description of the transport model geography and zoning system.<br>Congestion is modelled throughout the network. See the Appraisal Methodology Report for more information. |

**Table D1.51: Consistency of data**

| Issues | Check |
|---|---|
| Checks should be made to ensure that the differences in generalised costs show reasonable patterns, in particular:<br>- Do generalised costs generally increase for longer journeys?<br>- Do the differences in generalised costs across modes look reasonable?<br>- What, if any, generalised costs are supplied where the mode data is not immediately available from the model?<br>- Do generalised costs change in the expected directions if transport supply improvements are introduced? | A description of the generalised costs and generalised cost changes derived from the traffic model can be found in the Model Testing Report. |
| Particular care needs to be taken when dealing with incremental transport models, where changes in travel behaviour are driven by changes in generalised costs, because in these the transport modellers may not need to think about the absolute generalised costs. For example, walking time may be ignored (i.e. assumed zero) for all possible journeys.<br>For Wider Impacts analysis, the absolute generalised costs must be correctly specified. | |

## 1.4 Introduction to Geography

1.4.1 This section describes the data sources used within the wider impact calculations and land use modelling. It explains:

- The geographical scope of the wider impacts calculations and land use modelling and how data has been processed to be consistent with this;
- How the input data is segmented and the segmentation that has been used in the wider impacts and land use modelling; and
- The time periods of the data used, annualisation and the approach taken to discounting.

## 1.5 Geography

1.5.1 The LTC Model is comprised of 1146 zones, of which 655 are in London, Kent and Essex. At locations which are more remote from the M25, the size of the zones increases so that, for example, Scotland is represented by a single zone.

1.5.2 The economic data provided in the Wider Impacts economic dataset is at district level, comprising 408 districts in England, Scotland and Wales.

1.5.3 The Wider Impacts model has been constructed broadly at district level in line with the Wider Impacts economic dataset. There are two exceptions to this:

- In London, the South East and East of England where LTC Model zones span different districts: In this case, districts have been aggregated together to form larger zones. An example of this is LTC Model zone 39005 (Stowmarket) which spans Mid Suffolk and Waveney districts; and
- Outside of London, the South East and East of England where LTC Model zones span different districts: In this case, the model has been constructed at either county or regional level depending on the distance from Dartford.

1.5.4 Following this approach, the wider impacts model has 148 zones, of which 129 are in London, the South East and East of England (almost all at district level) and 19 zones outside of this area.

1.5.5 All journey time and demand data has been aggregated to this level using demand weightings. Journey time changes have been masked to exclude those which do which do not have an origin or destination within Kent, Essex or certain London boroughs[20]. This enables net national Wider Impacts to be captured while avoiding spurious results from small changes in journey times in remote locations. Journey time data has also been averaged across outbound and reciprocal directions. This ensures that asymmetric changes in journey times have an appropriate effect on areas at both ends of the trip.

1.5.6 All reported Wider Impacts have been calculated to reflect net national changes. In sensitivity testing, the land use model can give rise to changes in employment across the UK because the land use model allows for redistribution of employment to and from a core study area of London, Kent and Essex while constraining total employment at the UK level. It is therefore necessary to capture potential agglomeration and disagglomeration impacts at a national level and also to capture changes from moves to more or less productive jobs at this level.

## 1.6 Segmentation

### Journey Purpose

1.6.1 Data for highway journey times and demand has been sourced from the LTC Model. Journey time data has been sourced for 13 segments:

- Low income commuters;
- Middle income commuters;
- High income commuters;
- Home based business trip makers;
- Low income home based trip makers for other journey purposes;
- Middle income home based trip makers for other journey purposes;
- High income home based trip makers for other journey purposes;
- Non-home based business trip makers
- Low income non-home based trip makers for other journey purposes;
- Middle income non-home based trip makers for other journey purposes;
- High income non-home based trip makers for other journey purposes;
- Light goods vehicles; and
- Heavy goods vehicles.

1.6.2 Demand data has also been sourced for these segments.

[20] Tower Hamlets, Newham, Redbridge, Barking & Dagenham, Havering, Lewisham, Greenwich, Bexley and Bromley

1.6.3 After being processed into the appropriate model geography these segments have been combined using trip weightings to create four segments that have been used in subsequent analysis:

- All segments;
- Commuters;
- Business trip makers; and
- Freight.

1.6.4 Following WebTAG 3.5.14 the calculation of wider impacts assumes that there are no changes in freight costs or demand, except in sensitivity testing (described later).

**Other Modes**

1.6.5 The calculation of wider impacts requires data for journey times averaged across all modes. Data for transport costs and demand for non-highway modes is not present in the LTC Model. The wider impacts modelling is undertaken at district level (see below), so a mechanism was required to estimate bus, rail and waking and cycling generalised costs and demand at this level.

1.6.6 Data has been sourced from the National Travel Survey (NTS) to construct the appropriate matrices for bus and rail journeys. Individual journey records from the National Travel Survey contain information about the time and distance of journeys made by different modes, together with their starting and ending points. However, small sample sizes have necessitated aggregating this data to the regional level to examine average inter and intra-regional trips. In order to estimate district to district level generalised costs and demand for bus and rail, aggregated NTS data was combined with data from the LTC Model. At a regional level, using data from the NTS, first measures were created of:

- Bus demand as a share of car demand;
- Rail demand as a share of car demand;
- Bus generalised cost as a share of car generalised cost; and
- Rail generalised cost as a share of car generalised cost.

1.6.7 The generalised cost estimates derived from NTS are based on assumptions about values of time, average vehicle operating costs per kilometre and average vehicle occupancies. The assumptions used in this analysis are shown in Table D1.52 below.

**Table D1.52: Assumption used to calculate generalised costs for other modes**

| Parameter | Units | Source | Value |
|---|---|---|---|
| Average Value of Time | Pence per minute, 2009 value, 2010 prices | LTC Model | 10.185 |
| Car vehicle operating cost | Pence per km, 2009 value, 2010 prices | LTC Model | 11.89 |
| Car Occupancy | Persons per car, average weekday, average car per vkm | WebTAG 3.5.6 | 1.48 |
| Bus Fare estimate | Pence per km, 2009 value, 2010 prices | Estimate | 30.00 |
| Rail Fare estimate | Pence per km, 2009 value, 2010 prices | Estimate | 60.00 |

1.6.8 The results of this analysis are shown in Table D1.53 below.

**Table D1.53: NTS inter and intra-regional generalised cost data for different modes**

| Mode | Origin | Destination | Av. Distance | Av. Time | Estimated av. generalised cost | Trips |
|---|---|---|---|---|---|---|
| Bus | Eastern | Eastern | 8.7 | 34.2 | 59.7 | 1,203.3 |
| Bus | Eastern | London | 19.5 | 54.4 | 111.8 | 20.8 |
| Bus | Eastern | South East | 26.9 | 89.9 | 169.0 | 5.4 |
| Bus | London | Eastern | 19.2 | 52.8 | 109.4 | 10.2 |
| Bus | London | London | 5.9 | 37.2 | 54.5 | 6,398.5 |
| Bus | London | South East | 25.9 | 63.7 | 139.9 | 92.8 |
| Bus | South East | Eastern | 22.3 | 72.3 | 137.9 | 5.4 |
| Bus | South East | London | 25.2 | 73.1 | 147.4 | 104.6 |
| Bus | South East | South East | 7.0 | 30.4 | 51.1 | 2,015.3 |
| Car | Eastern | Eastern | 11.6 | 17.8 | 93.3 | 23,761.9 |
| Car | Eastern | London | 32.5 | 45.1 | 137.1 | 1,036.6 |
| Car | Eastern | South East | 78.9 | 73.3 | 201.9 | 352.5 |
| Car | London | Eastern | 31.6 | 43.6 | 134.9 | 1,039.1 |
| Car | London | London | 7.1 | 20.9 | 92.9 | 13,986.2 |
| Car | London | South East | 34.5 | 43.1 | 136.6 | 1,382.0 |
| Car | South East | Eastern | 79.3 | 73.3 | 202.2 | 351.2 |
| Car | South East | London | 34.9 | 44.2 | 138.1 | 1,367.6 |
| Car | South East | South East | 11.0 | 17.8 | 92.9 | 32,723.1 |
| Rail | Eastern | Eastern | 36.8 | 65.0 | 281.5 | 158.9 |
| Rail | Eastern | London | 54.7 | 83.8 | 405.9 | 403.2 |
| Rail | Eastern | South East | 159.9 | 185.0 | 1126.7 | 8.6 |
| Rail | London | Eastern | 55.5 | 85.7 | 412.4 | 396.3 |
| Rail | London | London | 14.2 | 52.4 | 136.1 | 5,270.0 |
| Rail | London | South East | 62.0 | 92.7 | 457.7 | 495.9 |
| Rail | South East | Eastern | 171.2 | 217.4 | 1226.0 | 10.7 |
| Rail | South East | London | 62.4 | 92.7 | 460.1 | 497.6 |
| Rail | South East | South East | 30.6 | 59.9 | 240.4 | 452.2 |

1.6.9 As average journey lengths are different between these different modes, these have been converted to average cost per kilometre. From the NTS data the ratio between average generalised costs per kilometre for bus trips and the average generalised cost per kilometre for car trips is then derived. This is applied to highway costs from the LTC Model to derive a matrix of district level bus generalised costs which has been used in the modelling. The same process has been used to derive district to district rail generalised costs.

1.6.10 District to district bus and rail demand is similarly based on the highway trips in the LTC Model and ratios derived from the regionally aggregated NTS data. This will be inaccurate where district to district mode shares differ substantially from region to region mode shares. However, no data is easily available to improve these more local estimates of mode share.

1.6.11 Walking and cycling modes have been treated differently. Walking generalised costs are estimated using a rate of 15 minutes per kilometre and cycling at a rate of 4 minutes per kilometre. Distances have been sourced from the LTC Model. The average value of time for car trips derived from the LTC Model has been used to convert these times into generalised costs.

1.6.12 Demand for walking and cycling modes has been based on national trip making data from Transport Statistics Great Britain 2011. This describes how mode shares vary with distance. From this data, a relationship has been developed which estimates walking and cycling demand as a share of car demand at different trip distances. It is assumed that no walk or cycle trips are made for journeys over 25km.

1.6.13 No data has been estimated for any other modes of transport and they are therefore implicitly assumed to have zero trips.

**Business sectors**

1.6.14 Economic data has been sourced for four business sectors from the wider impacts economic dataset. The wider impacts model and the land use model are both based on these four sectors which represent:

- Construction;
- Consumer services;
- Manufacturing; and
- Producer services.

## 1.7 Time

**Model Time Periods**

1.7.1 To reflect traffic throughout the day, 24 hour average generalised costs have been sourced from the LTC Model.

1.7.2 LTC Model data has been collected for 2009, 2025 and 2041. Data has been sourced for each of these years for a Reference Case and for 2025 and 2041 for the scenario cases.

**Annualisation**

1.7.3 Annualisation assumptions are required in the calculation of GP1 (labour market impacts) to convert commuting costs into an equivalent annual commuting costs per commuter. An annualisation factor of 233 has been selected to capture weekdays minus eight bank holidays and an estimated twenty days of annual leave per year. The approach taken to annualisation in the calculation of Wider Impacts is different from annualisation in the traffic model because the two serve different purposes. When calculating Wider Impacts, annualisation is only used to convert a daily commuting cost for an individual commuter into an average annual commuting cost per commuter so that it can be considered as part of the overall returns to working.

**Profiling and Discounting**

1.7.4 Wider impacts are discounted to 2010 at a discount rate of 3.5% to 2041 and 3.0% thereafter. This is based on WebTAG guidance and is in line with the treatment of other costs and benefits.

1.7.5 Impacts are interpolated between 2025 and 2041 in the same way as other benefits. After 2041, wider impacts are assumed to grow over time as follows:

- Agglomeration (WI1): grown by the weighted average of work and non-work value of time[21];
- Change in output in imperfectly competitive markets (WI3): grown by work value of time; and
- Tax wedge on labour market impacts (WI4): grown by non-work value of time.

1.7.6 All monetary values are expressed in 2010 prices.

[21] This is based on the 2041 share of traffic across the model matrix. Business trips make up 19.2% of all business and commuting trips in 2041. Where changes in freight costs have been analysed as sensitivity tests, freight trips have been included as work trips bringing this share to 29.9%.

## 1.8 Introduction to Segmentation and Time

1.8.1 Wider impacts have been calculated in line with WebTAG Unit 3.5.14. In line with this, the impacts of the transport change on increasing levels of competition (WI2) and the impact of transport change on people working longer hours (GP2) are assumed to be zero.

## 1.9 GP1: Labour Supply Impact

1.9.1 In line with WebTAG unit 3.5.14, decisions about whether to take a job are assumed to be taken based on the combination of wages and commuting costs. As the costs of commuting change, these decision can change resulting in a potential increase or decrease in the supply of labour. Reductions in journey time or cost will increase the returns from the combination of working and commuting and are likely to result in greater labour supply. The benefits to the individual are assumed to be captured in user benefits. GP1 therefore reflects change in economic output, not an additional welfare impact.

1.9.2 GP1 has been calculated according to WebTAG guidance, drawing on information in the Wider Impacts economic dataset. The calculation proceeds in eight stages.

- First, the level of commuting by all modes from origin i to destination j is used to estimate the number of workers in zone i that work in zone j (let us call this X);
- Second, the difference in annualised all mode commuting costs between the reference case and the scenario case is derived for this zone pair from the processed journey time data (call this Y);
- Third, the total change in the cost of commuting between this zone pair is estimated by multiplying X and Y;
- Fourth, the total workplace earnings after tax of workers in i commuting to j is calculated based on the average salary of workers in zone j, the number of people that commute from i to j, and a parameter, $\tau 1$, reflecting the average tax rate on earnings;
- Fifth, the cost change is calculated as a share of total earnings;
- Sixth, the change in labour supply of workers living in zone i and working in zone j is calculated using a parameter reflecting the elasticity of labour supply ($\varepsilon LS$);
- Seventh, the total earnings of these new workers living in zone i commuting to zone j is calculated using the median gross wage of the marginal worker in zone j derived from the Wider Impacts economic dataset (using parameter $\eta$ reflecting the ratio of the marginal wage to average wage); and
- Finally, the results are aggregated for the core study area of London, Kent and Essex, then profiled and discounted.

1.9.3 The parameters used in this analysis are shown in Table D1.54 below.

**Table D1.54: Labour supply impacts parameters**

| Parameter | Description | Units | Source | Value |
|---|---|---|---|---|
| $\tau^1$ | Average tax rate on earnings | % | WebTAG 3.5.14 | 0.3 |
| $\tau^2$ | Tax take on labour supply | % | | 0.4 |
| H | Pay of marginal worker compared to average worker | % | | 0.69 |
| $\varepsilon^{LS}$ | Elasticity of labour supply | % | | 0.1 |

1.9.4 GP1 is an impact on economic output and not an additional welfare impact, although its tax implications are captured later in WI4. $\tau 2$ is used later to calculate the additional welfare impacts of GP1 through the tax wedge.

## 1.10 GP3: Move to More Productive Jobs

1.10.1 In the central case appraisal, no land use changes are modelled so there is no employment redistribution. Hence the impact of moves to more productive jobs is zero.

1.10.2 In the sensitivity analysis in which land use changes are modelled, redistribution of employment between different locations can have consequences for productivity. If a transport change leads to a shift of employment from more productive areas to less productive areas then there is a negative impact on productivity. Conversely, if the change precipitates a move of employment from less productive areas to more productive areas, then an increase in productivity can occur.

1.10.3 The land use model described in Section 1.2 of this Appendix calculates the change in employment in four broad sectors of the economy in the model zones which together cover all of mainland United Kingdom. GP3 is calculated based on the total change in employment within each zone. The transport and land use models operate independently and the transport model provides inputs to the land use model. Changes in land use have not been fed back into the transport model to capture any further feedback effects, for example through changes in congestion patterns as a result of changes in land use patterns.

1.10.4 For the calculation of GP3 sensitivity test, employment impacts in different sectors have been added together to provide the total employment change. The impact of GP3 is calculated across all model zones and hence reflects the net national impact of changes in employment location.

1.10.5 In the sensitivity test with land use change, no new employment is estimated at the UK level (except that created by GP1). The move to more productive jobs therefore occurs purely a result of modelled redistribution of employment between model zones with different productivity characteristics.

1.10.6 Productivity in each model zone has been calculated for the model zones from the district level data provided in the Wider Impacts economic dataset and weighted by employment where model zones are made up of combined districts.

1.10.7 Total output in the reference case and the scenario case has been calculated by multiplying employment and output per worker in each zone. The move to more productive jobs is simply the difference between the measures of total output between the reference case and the scenario case.

## 1.11 WI1: Agglomeration

1.11.1 Where improved transport connections increase the effective density of businesses available to trade with, wider benefits can arise from increased productivity. These agglomeration benefits have been captured using the guidance provided in WebTAG Unit 3.5.14 chapter 2.

1.11.2 The level of agglomeration is calculated for 2025 and 2041 for both the reference case and the scenario cases. This is done across all model zones in the UK to ensure that the result represents the net national impact.

1.11.3 Effective densities have been calculated using weighted average 24 hour all mode generalised costs (excluding freight), employment data from the Wider Impacts economic dataset and the parameters provided in WebTAG unit 3.5.14. Changes in productivity have then been calculated using the agglomeration elasticities provided in WebTAG.

1.11.4 These are shown in Table D1.55 below.

**Table D1.55: Agglomeration Parameters**

| Parameter | Description | Source | Value |
|---|---|---|---|
| $\alpha^{manufacturing}$ | Parameter governing exponential decay of effective density with generalised costs for different sectors | WebTAG 3.5.14 | 1.097 |
| $\alpha^{construction}$ | | | 1.562 |
| $\alpha^{consumer\ services}$ | | | 1.818 |
| $\alpha^{producer\ services}$ | | | 1.746 |
| $\rho^{manufacturing}$ | Agglomeration elasticity for different sectors | | 0.021 |
| $\rho^{construction}$ | | | 0.034 |
| $\rho^{consumer\ services}$ | | | 0.024 |
| $\rho^{producer\ services}$ | | | 0.083 |

1.11.5 Some effective densities for the 2025 base case for the producer services sector are shown in Table D1.56 below.

**Table D1.56: Sample reference case producer services effective densities in 2025**

| Zone number | Zone name | Effective density |
|---|---|---|
| **5 most agglomerated zones in London, Kent and Essex** | | |
| 1 | City of London | 28,559 |
| 7 | Camden | 28,348 |
| 22 | City of Westminster | 27,839 |
| 28 | Lambeth | 27,038 |
| 33 | Southwark | 26,557 |
| **5 least agglomerated zones in London, Kent and Essex** | | |
| 57 | Ashford | 4,255 |
| 64 | Shepway | 3,874 |
| 60 | Dover | 3,487 |
| 66 | Thanet | 3,291 |
| 45 | Tendring | 2,951 |

## 1.12 WI3: Change in Output in Imperfectly Competitive Markets

1.12.1 The change in output in imperfectly competitive markets occurs where transport using firms have some market power over pricing and do not set prices equal to marginal costs as would occur under conditions of perfect competition.

1.12.2 The change in output in imperfectly competitive markets has been calculated based on the modelled vale of business travel time savings. Calculations follow guidance in WebTAG Unit 3.5.14 and assume that 10% of the change in business costs is passed onto consumers as an additional welfare benefit.

## 1.13 WI4: Tax Wedge on Labour Market Impacts GP1 and GP3

1.13.1 Labour market impacts GP1 and GP3 can affect economic output but do not directly affect welfare. However, as decision makers are assumed to base their decisions on post-tax income, there is an additional welfare impact that arises because of the distortionary impact of the tax system. The additional economic output has a tax benefit that does not accrue to the individual.

1.13.2 WI4 is calculated to be equal to:

- 40% of GP1; plus
- 30% of GP3.

## 1.14 Introduction to land use Change

1.14.1 The proposed lower Thames crossing could have significant impacts on the pattern of connectivity offered to businesses by the transport network. This could in turn have significant impacts on where businesses choose to locate.

1.14.2 Simulating the effects of the transport network on business location decisions is a complex area with different potential modelling approaches. The approach taken was to examine the direct statistical link between access to employment or access to other businesses (as measures of transport connectivity) and employment density (as a measure of where businesses choose to locate). This link is used, in conjunction with assumptions about redistribution, to estimate impacts of generalised costs changes on employment distribution.

1.14.3 Many other factors could affect business location decisions which this approach does not capture. For example, economic processes related to competition for land and price feedback effects are not captured.

## 1.15 Data

1.15.1 The quality of generalised costs data available from the LTC Model is highest in locations closest to the proposed crossing locations. The core study area selected for the estimation of the land use model is the 59 model zones within London, Kent and Essex.

1.15.2 The land use model has been estimated based on data for car highway generalised costs only. Other mode generalised costs are derived from highway journey times and are not expected to improve the explanatory power of the model.

1.15.3 Highway generalised costs have been derived for commuting, business travel and freight trip making. These have been constructed by trip weighting the individual segments described in Section 1.5.

1.15.4 The land use model has been split into four sectors: manufacturing; construction; consumer services; and producer services. Employment data for these four sectors was sourced from the Wider Impacts economic dataset for 2009, 2025 and 2041. Model zone land areas were used to convert this into employment density in terms of jobs per square kilometre. Working age population data for 2009, 2025 and 2041 was sourced from TEMPRO version 6.2.

## 1.16 Measuring Connectivity

1.16.1 Measures of connectivity for each zone have been developed from the vector of generalised costs to or from that zone and from vectors of ‘opportunities’ in the different model zones. Connectivity has been calculated as the weighted sum of opportunities present in other zones. Weights are related to the generalised costs by a deterrence function.

### Generalised costs deterrence function

1.16.2 A deterrence function transforms measures of generalised cost into weights that can be applied to opportunities to construct a connectivity measure. There is no a priori reason why this

relationship should have a particular shape, although it would be expected to be downward sloping so that opportunities at a higher generalised cost contribute less to connectivity than ones which were at a lower generalised cost.

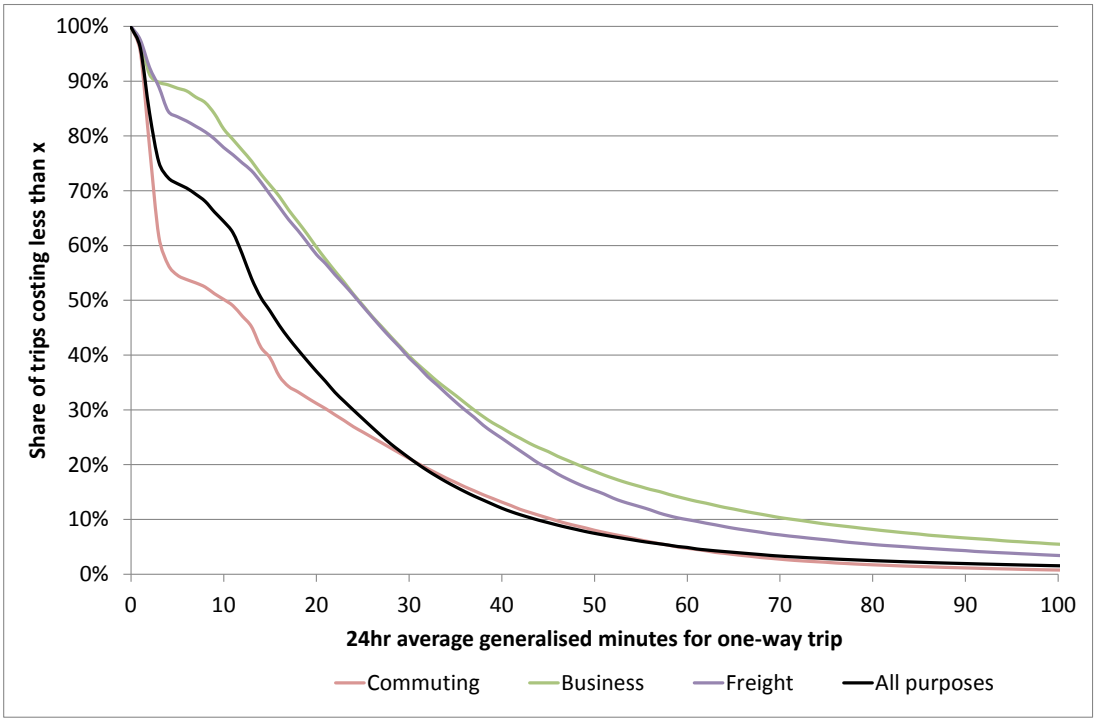
1.16.3 Two different methods of weighting have been examined. First, weightings have been based on exponential decay relationships. This is the same approach used to calculate effective density for the purpose of calculating agglomeration impacts. The weights are the given by the formula:

$$w_{i,j}^{k,S,f} = \left(g_{i,j}^{S,f}\right)^{\alpha^k}$$

1.16.4 Where i represents the origin zone, j represents the destination zone, S represents the scenario, f represents the forecast year, k represents the business sector and αk represents a sector dependent decay parameter. The parameters αk have been draw from the WebTAG guidance for the calculation of agglomeration and which are presented in Table D1.55.

1.16.5 The second approach is based on the observed pattern of trip making. In this case, journey data for journeys with an origin and destination in either London, Kent or Essex was selected. From this data, in Figure D1.1 generalised cost is plotted against the share of people who currently travel for less than or equal to this level of generalised cost. This data is shown in Table D1.57 below.

**Figure D1.1: Observed decay of trip making with generalised cost**




1.16.6 Business trip making and freight trip making decline more slowly with generalised cost than commuting trips. All of the curves exhibit a 'hump' between around 2 and 15 minutes. This may be related to poorly modelled intra-zonal trips rather than reflecting the true distribution of highway trips.

1.16.7 A smooth s-curve has been estimated for each of these segments. Each s-curve has three parameters (a, b and c) which govern the slope, height and horizontal position of the s-curves. The s-curve equation is given by:

$$w_{i,j}^{p,S,f} = -b^p - \frac{b^p}{\left(1 + b^p e^{-a^p\left(g_{i,j}^{s,f} - c^p\right)}\right)}$$

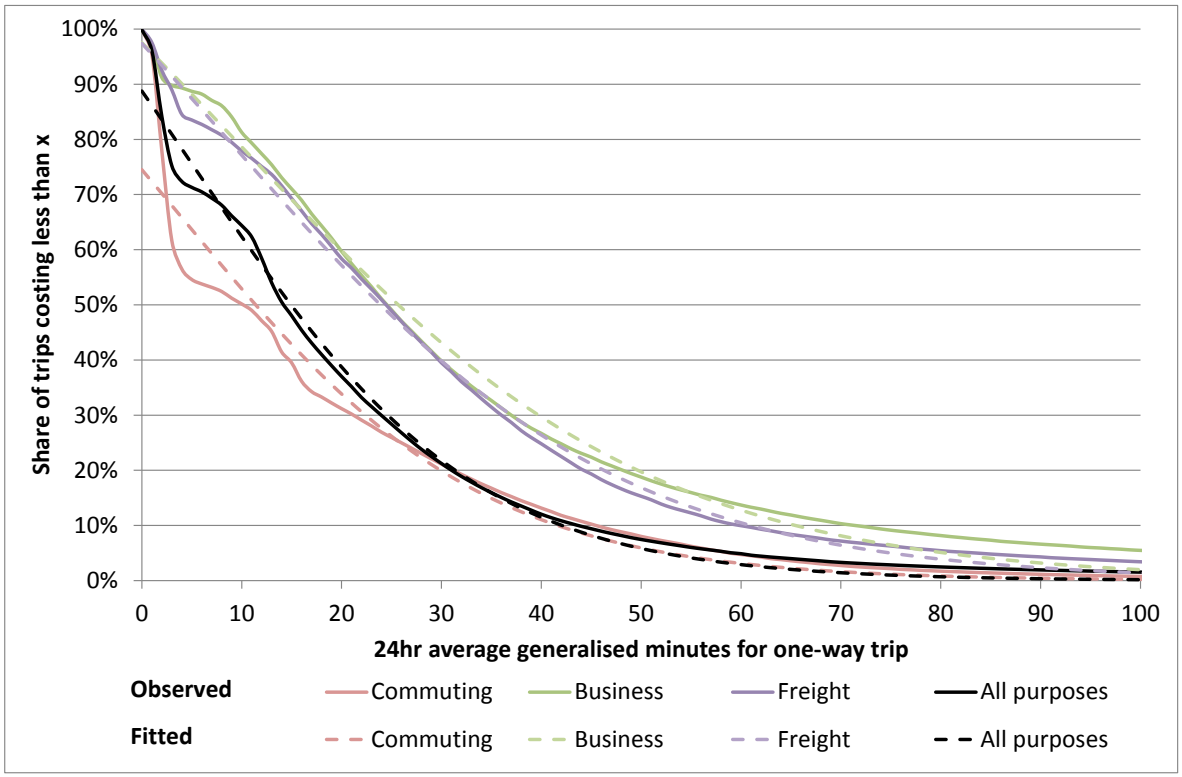
1.16.8 These s-curves serve the same purpose as the αk parameters in the exponential decay formulation, that is, they convert generalised journey time measures into a unitless factor which can be used to weight the importance of opportunities located at different generalised costs. The s-curve approach however is not based on any information which is specific to business sectors (k) so these parameters are applied to all businesses sectors. However, they do distinguish between different journey purposes (p).

1.16.9 The parameters are shown in Table D1.57 and the graphs of these s-curves are shown in Figure D1. below.

**Table D1.57: S-curve parameters**

| Purpose | $a^p$ | $b^p$ | $c^p$ |
|---|---|---|---|
| Commuting | 0.07 | 1.31 | 0.00 |
| Business | 0.05 | 1.59 | 0.00 |
| Freight | 0.05 | 1.59 | 0.00 |

**Figure D1.2: Observed generalised cost deterrence and fitted s-curves**




1.16.10 Sensitivity tests have been undertaken to understand the sensitivity of model results to these two approaches to generalised cost decay relationships. These are presented in Section 5..

### Connectivity Measures

1.16.11 Connectivity measures have been derived using both deterrence function formulations. Where the exponential formulation is used, these are different for different sectors. For each business sector measures have been derived to reflect:

- Connectivity to labour markets;
- Business trip access to other businesses;
- Freight access to other businesses; and
- A general purpose access measure to other businesses.

1.16.12 Connectivity to labour markets has been calculated using the vector of inbound journey generalised costs to each zone to reflect inward commuting. Measures based on access to other businesses are based on the outbound vectors of generalised costs.

1.16.13 Connectivity measures have been constructed using the decay relationships for each business sector and a measure of opportunity in each zone. The combinations of opportunity and journey purpose that have been used in the analysis are summarised in Table D1.58 below.

**Table D1.58: Combinations of opportunity measures and journey purposes that have been used to create connectivity measures**

| | | Opportunity type | |
|---|---|---|---|
| | | Workplace based employment | Residence based workforce aged 16 to 65 |
| **Journey purpose segment** | Commuting | ✗ | ✓ Residence based workforce aged 16 to 65 in origin zones are weighted based on inbound commuting generalised costs to simulate access to residence based workforce |
| | Business | ✓ Workplace based employment in destination zones are weighted based on outbound business trip generalised costs to simulate business trip access to other businesses | ✗ |
| | Freight | ✓ Workplace based employment in destination zones are weighted based on outbound freight trip generalised costs to simulate freight access to other businesses | ✗ |
| | All purposes combined | ✓ Workplace based employment in destination zones are weighted based on outbound all journey purpose trip generalised costs to simulate all purpose access to other businesses | ✗ |

1.16.14 For the 2009 reference case scenario, this gives 40 different measures of connectivity for each zone. This comes about because there are five business sectors (manufacturing, construction, consumer services, producer services and all sectors), four journey purposes (commuting,

business trips, freight trips, and all purposes) and two different approaches to deterrence functions (see Table D1.59 below).

1.16.15 Sensitivity tests have been undertaken to different combinations. These are presented in section 1.21.

## 1.17 Statistical Approach and Findings

1.17.1 Statistical analysis of the relationships between transport connectivity and employment density in 2009 has been undertaken using the form:

$$ln(E^k) = \alpha + \beta ln\left(C^{k,p}_{i\ or\ j}\right)$$

Where $\mathbf{E^{k,p}}$ is employment density in sector k and $\mathbf{C^{k,p}_{i\ or\ j}}$ is connectivity calculated for sector k, using generalised costs by journey purpose p from origins i or to destinations j. This formulation enables the β parameter to be interpreted as an elasticity of employment density with respect to the transport connectivity measure.

1.17.2 The results of this analysis are shown in Table D1.59 below.

**Table D1.59: Relationships between connectivity measures and employment density, 2009**

| Decay curve type | Purpose | Sector | Intercept | | Coefficient | | $R^2$ |
|---|---|---|---|---|---|---|---|
| | | | Value | T-Stat | Value | T-Stat | |
| Exponential | Commuting | Construction | -8.63 | -7.63 | 1.27 | 11.42** | 69.6% |
| Exponential | Commuting | Consumer services | -8.75 | -6.25 | 1.29 | 9.34** | 60.5% |
| Exponential | Commuting | Manufacturing | -8.62 | -7.78 | 1.27 | 11.66** | 70.4% |
| Exponential | Commuting | Producer services | -8.88 | -5.09 | 1.31 | 7.59** | 50.3% |
| Exponential | Commuting | Total | -8.89 | -4.98 | 1.31 | 7.43** | 49.2% |
| Exponential | Business | Construction | -6.73 | -4.83 | 1.13 | 7.90** | 52.3% |
| Exponential | Business | Consumer services | -6.57 | -3.98 | 1.12 | 6.61** | 43.4% |
| Exponential | Business | Manufacturing | -6.75 | -4.93 | 1.13 | 8.05** | 53.2% |
| Exponential | Business | Producer services | -6.41 | -3.25 | 1.11 | 5.46** | 34.4% |
| Exponential | Business | Total | -6.39 | -3.18 | 1.11 | 5.36** | 33.5% |
| Exponential | Freight | Construction | -5.15 | -4.83 | 1.03 | 7.90** | 55.1% |
| Exponential | Freight | Consumer services | -5.02 | -3.98 | 1.02 | 6.61** | 45.8% |
| Exponential | Freight | Manufacturing | -5.17 | -4.93 | 1.03 | 8.05** | 56.1% |
| Exponential | Freight | Producer services | -4.88 | -3.25 | 1.01 | 5.46** | 36.4% |
| Exponential | Freight | Total | -4.87 | -3.18 | 1.01 | 5.36** | 35.4% |
| Exponential | All purposes | Construction | -6.21 | -4.93 | 1.08 | 8.34** | 55.0% |
| Exponential | All purposes | Consumer services | -6.08 | -4.05 | 1.07 | 6.94** | 45.8% |
| Exponential | All purposes | Manufacturing | -6.23 | -5.04 | 1.08 | 8.51** | 55.9% |
| Exponential | All purposes | Producer services | -5.95 | -3.30 | 1.06 | 5.72** | 36.5% |
| Exponential | All purposes | Total | -5.93 | -3.23 | 1.06 | 5.60** | 35.5% |
| S-Curve | Commuting | Construction | -9.35 | -7.76 | 1.07 | 11.31** | 69.2% |
| S-Curve | Commuting | Consumer services | -9.44 | -6.31 | 1.08 | 9.20** | 59.7% |
| S-Curve | Commuting | Manufacturing | -9.34 | -7.93 | 1.07 | 11.56** | 70.1% |
| S-Curve | Commuting | Producer services | -9.52 | -5.11 | 1.09 | 7.45** | 49.3% |
| S-Curve | Commuting | Total | -9.53 | -5.00 | 1.09 | 7.29** | 48.2% |
| S-Curve | Business | Construction | -8.88 | -4.14 | 0.97 | 6.20** | 60.2% |
| S-Curve | Business | Consumer services | -8.83 | -4.14 | 0.96 | 6.20** | 51.0% |
| S-Curve | Business | Manufacturing | -8.88 | -4.14 | 0.97 | 6.20** | 61.2% |
| S-Curve | Business | Producer services | -8.78 | -4.14 | 0.96 | 6.20** | 41.3% |
| S-Curve | Business | Total | -8.77 | -4.14 | 0.96 | 6.20** | 40.3% |
| S-Curve | Freight | Construction | -7.21 | -4.14 | 0.90 | 7.90** | 65.5% |
| S-Curve | Freight | Consumer services | -7.17 | -3.98 | 0.90 | 6.61** | 55.5% |
| S-Curve | Freight | Manufacturing | -7.22 | -4.93 | 0.90 | 8.05** | 66.5% |

| Decay curve type | Purpose | Sector | Intercept | | Coefficient | | $R^2$ |
|---|---|---|---|---|---|---|---|
| | | | Value | T-Stat | Value | T-Stat | |
| S-Curve | Freight | Producer services | -7.12 | -3.25 | 0.90 | 5.46** | 45.0% |
| S-Curve | Freight | Total | -7.12 | -3.18 | 0.90 | 5.36** | 43.9% |
| S-Curve | All purposes | Construction | -7.24 | -4.93 | 0.91 | 8.34** | 63.1% |
| S-Curve | All purposes | Consumer services | -7.18 | -4.05 | 0.91 | 6.94** | 53.4% |
| S-Curve | All purposes | Manufacturing | -7.24 | -5.04 | 0.92 | 8.51** | 64.1% |
| S-Curve | All purposes | Producer services | -7.13 | -3.30 | 0.91 | 5.72** | 43.2% |
| S-Curve | All purposes | Total | -7.12 | -4.00 | 0.91 | 6.45** | 42.2% |

** indicates a result that is robust at the 99% level

1.17.3 The equation with the best fit is the relationship between the exponential decay measure of commuting connectivity and employment density on the manufacturing sector (the third row of Table D1.59). This displays an r2 of 70.4%, indicating that 70.4% of the pattern of employment density in the manufacturing sector can be explained by this measure of connectivity.

1.17.4 An element of the connectivity score is driven by the number of opportunities within the zone itself. If intra-zonal journeys are very short and the deterrence function reduces quickly, then these own zone opportunities could significantly affect the derived connectivity measures and observed relationships. In this case, local employment could be a significant part of an explanatory variable influencing local employment density. To investigate this, further analysis was undertaken to examine whether removing the 'own zone' element of the connectivity score affected the results.

1.17.5 This analysis found that the 'own zone' element of the connectivity score reduced the overall fit of the models by around 5% and reduced the coefficient of connectivity by around one third. A snapshot of this analysis for the exponential decay curve analysis of the commuting measure is shown in Table D1.60 below. The value of the coefficients are still robust at the 99% confidence level.

**Table D1.60: Comparison of results with 'own zone' opportunities removed**

| Decay curve type | Purpose | Sector | Intercept | | Coefficient | | $R^2$ |
|---|---|---|---|---|---|---|---|
| | | | Value | T-Stat | Value | T-Stat | |
| **Results of main analysis** | | | | | | | |
| Exponential | Commuting | Construction | -8.63 | -7.63 | 1.27 | 11.42** | 69.6% |
| Exponential | Commuting | Consumer services | -8.75 | -6.25 | 1.29 | 9.34** | 60.5% |
| Exponential | Commuting | Manufacturing | -8.62 | -7.78 | 1.27 | 11.66** | 70.4% |
| Exponential | Commuting | Producer services | -8.88 | -5.09 | 1.31 | 7.59** | 50.3% |
| Exponential | Commuting | Total | -8.89 | -4.98 | 1.31 | 7.43** | 49.2% |
| **Results of alternative analysis with 'own zone' opportunities removed** | | | | | | | |
| Exponential | Commuting | Construction | -5.88 | -5.80 | 0.81 | 10.04** | 63.9% |
| Exponential | Commuting | Consumer services | -5.95 | -4.86 | 0.82 | 8.41** | 55.4% |
| Exponential | Commuting | Manufacturing | -5.87 | -5.90 | 0.81 | 10.22** | 64.7% |
| Exponential | Commuting | Producer services | -6.02 | -4.03 | 0.83 | 6.95** | 45.9% |
| Exponential | Commuting | Total | -6.03 | -3.95 | 0.83 | 6.82** | 44.9% |

** indicates a result that is robust at the 99% level

1.17.6 Again, sensitivity tests have been undertaken to understand the sensitivity of the land use and Wider Impact results to this assumption. Sensitivities including and excluding these 'own zone' opportunities are presented in section 1.21.

## 1.18 Selection of Relationships for Forecasting Model

1.18.1 A forecasting model has been constructed from the relationships examined.

1.18.2 Examination of the data shown that the different connectivity measures are serially correlated to each other. For example, areas which tend to have good access to other businesses also tend to have easy access to a resident workforce. This has made it impossible to disentangle the effects of different types of connectivity within the statistical analysis and forces a single connectivity measure to be used to forecast each business sector.

1.18.3 The labour market equations provide the best model fit. Choice of deterrence function makes little difference to the model fit, although the exponential decay based formulation does provide a slightly improved fit.

1.18.4 The 'own zone' element is an important element of connectivity and intra-zonal journey times have been built up from disaggregate journey time data from the LTC Model. It was therefore decided that it was appropriate to maintain this element of connectivity.

1.18.5 The selected model was therefore based on the exponential deterrence function labour market connectivity measures for different sectors shown in rows 1 to 4 in Table D1.59.

1.18.6 There are many other variables that could also influence employment density including for example, the quality and topography of the land, historic settlements and networks (such as ancient roads, river crossings and settlement patterns), planning policy, intangible local variable such as the entrepreneurial atmosphere, and other variables. The r2 of the equations provides an indication of the strength of the relationships between the connectivity measures and the observed employment density.

## 1.19 Growth and Redistribution

1.19.1 The cross sectional quantitative analysis provides evidence of the correlation between business location and connectivity. However, it is not true to say that a change in connectivity will simply result in a change in employment density or the number of workplace jobs.

1.19.2 Even if the relationships represent causal relationships, a change in connectivity could simply result in a redistribution of jobs rather than new jobs being created. One way to interpret this is that the relationships describe the relative attractiveness of business locations. In order to assess how changes in connectivity are likely to translate into changes in the pattern of employment within the study area, assumptions must be made about this redistribution.

1.19.3 The land use model assumes that changes in connectivity do not lead to any new employment at a national level, but only lead to redistribution. To capture this, it is assumed that a share of the modelled employment change is redistributed from outside of the core study area of London, Kent and Essex.

1.19.4 Unfortunately, there are very few dynamic studies of business mobility and relocation decisions, partly because time series data for transport journey times is often difficult to obtain. It is therefore not possible to consult the academic evidence directly to inform this parameter. Instead, the geographical distribution of businesses has been investigated to estimate what share may be able to relocate in response to changes in business conditions. The hypothesis is that the region with the lowest share of businesses in a certain sector represents the minimum required to serve a local market and that other businesses in this region are 'footloose'. At a regional level, for example, only 11.1% of employment in Northern Ireland is in banking, finance and insurance (the lowest share) compared to 16.1% on average. Nationally, it is therefore inferred that 5.0% of all jobs can be considered footloose jobs in the banking, finance and insurance sector. This analysis suggests that some 24.2% of jobs could be considered mobile between regions on this measure. Similar analysis conducted at a county level suggests that some 53.1% are mobile between counties.

1.19.5 From this analysis it can be tentatively concluded that around one third of jobs within the core study area could be mobile in and out of this area and have used this assumption to estimate the share of modelled employment which is drawn from outside the core study area. Sensitivity tests

of the land use model results and consequent impacts on wider impacts results have been undertaken using different values for this mobility assumption. These are shown in section 1.21

## 1.20 Modelling Land Use Change

1.20.1 Using the assumptions described above, changes in generalised costs are translated into measures of changes in connectivity to labour. For each zone the changes in connectivity to labour are then used to forecast unconstrained changes in employment by business sector based on the forecasting equations. Total change in employment in the core study area is then calculated using the redistribution factor (one third). A factor is then derived to convert unconstrained to constrained employment across the core study area and applied to unconstrained employment all core area zones. Finally, employment in the rest of the UK is then adjusted down proportionally to reflect redistribution of employment to the core study area.

## 1.21 Introduction to Sensitivity Analysis

1.21.1 This chapter describes the sensitivity testing that has been undertaken to better understand the sensitivity of the modelled Wider Impacts results to the assumptions that have been made.

1.21.2 There are two types of sensitivity tests have been undertaken:

- Standard sensitivity testing has been undertaken for all scenarios to represent: the inclusion of changes in freight generalised costs and demand; modelled changes in land use; and faster decay of agglomeration effects as generalised costs increase; and
- Additional sensitivities for the $C_{variant}$ scenario to better understand a range of model parameters.

1.21.3 The $C_{variant}$ scenario shows the largest modelled changes in generalised costs and hence arguably provides the best test for further model sensitivities. The relative modelled benefits under different modelling assumptions for the $C_{variant}$ scenario help inform an overall understanding of the sensitivity of the modelling.

## 1.22 Standard sensitivity tests

1.22.1 WebTAG unit 3.5.14 stipulates four standard sensitivity tests as part of the presentation of Wider Impacts results. These are:

- A sensitivity where a land use model is available (as described above);
- A sensitivity in which higher decay parameters are used for calculating agglomeration;
- A sensitivity in which changes in freight costs and demand are included; and
- A combined sensitivity which in which all of the above three assumptions are made.

1.22.2 The higher decay parameters for the agglomeration sensitivity were based on the average of the agglomeration parameters for consumer services and producer services sectors as required by WebTAG unit 3.5.14.

1.22.3 In the freight sensitivity, three changes were made in the modelling. First, the freight user benefits were included in the calculation of WI3 (business cost reductions giving rise to a change in output in imperfectly competitive markets). Second, freight journey times and demand were used in the calculation of weighted generalised costs that feed into the agglomeration calculation. Finally, freight trips were included in the calculation of weighted average work and non-work values of time which are used to grow agglomeration benefits.

1.22.4 Table D1.61 below shows how the results of sensitivity tests for scenario A.

**Table D1.61: Sensitivity analysis of scenario A, £m**

| | | Scenario A central case | Standard sensitivities | | | |
|---|---|---|---|---|---|---|
| | | | Preferred land use modelling assumption | High agglomeration decay parameters | Freight cost changes included | Combined sensitivity |
| WI1 | Agglomeration | 195 | 158 | 189 | 242 | 201 |
| WI3 | Imperfect competition | 56 | 56 | 56 | 67 | 67 |
| WI4 | Tax wedge on labour supply | 0 | 0 | 0 | 0 | 0 |
| | Tax wedge on move to more/less productive jobs | 0 | -30 | 0 | 0 | -30 |
| Total | | 251 | 183 | 245 | 309 | 237 |

1.22.5 In the central case, the net present value of wider impacts is £251m. Agglomeration benefits make up the largest part while the benefits of increased output in imperfectly competitive markets are also significant. The tax wedge on increased labour supply due to reduced commuting costs is insignificant. The tax wedge on the move to more productive jobs is zero in this case because changes in employment location are assumed not assumed to occur in the central case.

1.22.6 In 2041, the agglomeration impacts are largest in the Medway Towns, Bromley and Bexley. However, negative impacts also occur in some places as the pattern of journey time changes shows positives and negatives.

1.22.7 The impact on imperfect competition arises due to reductions in business costs in imperfectly competitive markets as a result of improved transport conditions. WI3 is assumed to be 10% of total business user benefits. In the central case, freight user benefits are excluded from the analysis.

1.22.8 The tax wedge on labour supply is insignificant. This is driven by commuting generalised cost changes only. These show a mixture of positive and negative impacts leading to a slight overall negative impact. For example, commuting journey times from Bexley to Dartford decline slightly in option A.

1.22.9 The impact of the land use sensitivity is significant, both in reducing the agglomeration benefit and in supporting a shift in employment to less productive locations. Together these serve to reduce the Wider Impacts by 27%. Using alternative assumptions about agglomeration reduces the modelled agglomeration benefit by £67m. The introduction of freight costs into the generalised costs substantially increases the wider benefits of option A, primarily through a substantial impact on agglomeration. The net present value of the agglomeration benefit grows from £195m in the central case to £242m if reduced freight costs are included. This is due to improved freight journey times, mainly in 2041, which improve journey times primarily in Essex, but also to a lesser extent in Kent and east London. The inclusion of changes to freight generalised costs also contributes to the wider benefits through the impact that they have of WI3 (impact on output in imperfectly competitive markets).

1.22.10 The sensitivity test using different agglomeration decay parameters only has a marginal effect on modelled Wider Impacts.

1.22.11 Table D1.62 below shows the results in sensitivity tests for scenario B.

**Table D1.62: Sensitivity analysis of scenario B, £m**

| | | Scenario B central case | Standard sensitivities | | | |
|---|---|---|---|---|---|---|
| | | | Preferred land use modelling assumptions | High agglomeration decay parameters | Freight cost changes included | Combined sensitivity |
| WI1 | Agglomeration | 507 | 230 | 504 | 530 | 243 |
| WI3 | Imperfect competition | 99 | 99 | 99 | 117 | 117 |
| WI4 | Tax wedge on labour supply | 0 | 0 | 0 | 0 | 0 |
| | Tax wedge on move to more/less productive jobs | 0 | -237 | 0 | 0 | -237 |
| Total | | 607 | 92 | 604 | 647 | 123 |

1.22.12 The impact of land use is again to substantially reduce the benefits via a reduction in agglomeration and a move to less productive jobs. Agglomeration benefits fall from a present value of £507m in the central case to £230m when potential land use changes are introduced. The fall is around 40% in 2025, but around 60% in 2041 as employment shifts to less agglomerated locations. Combined with a significant impact from a move to less productive jobs, the overall present value of Wider Impacts falls from £607m to £92m, reducing them to a small share of their value in the central case.

1.22.13 The impact of faster decay of agglomeration is small, increasing agglomeration benefits by less than 1%. However, introducing changes in freight generalised costs does have a significant impact on the Wider Impacts, raising them by around 7%. This is due both to the increase in agglomeration benefits by around £23m (from £507m in the central case to £530m in the sensitivity case), and the increase in WI3 of £18m. The combined sensitivity includes both the substantial decline in agglomeration and the move to less productive jobs which characterised the land use change sensitivity and sees Wider Impacts reduce substantially to £123m.

1.22.14 Table D1.63 below shows the results of sensitivity analysis for scenario C.

**Table D1.63: Sensitivity analysis of scenario C, £m**

| | | Scenario C central case | Standard sensitivities | | | |
|---|---|---|---|---|---|---|
| | | | Preferred land use modelling assumptions | High agglomeration decay parameters | Freight cost changes included | Combined sensitivity |
| WI1 | Agglomeration | 999 | 613 | 1,002 | 1,069 | 675 |
| WI3 | Imperfect competition | 162 | 162 | 162 | 218 | 218 |
| WI4 | Tax wedge on labour supply | 1 | 1 | 1 | 1 | 1 |
| | Tax wedge on move to more/less productive jobs | 0 | -322 | 0 | 0 | -322 |
| Total | | 1,162 | 453 | 1,165 | 1,287 | 571 |

1.22.15 In scenario C, the land use change sensitivity also serves to reduce the overall economic benefits by encouraging workplace employment to shift eastward to locations that are modelled to be less agglomerated and less productive. The impact of this is to reduce overall wider impacts by around 60% compared to the central case. The impact is split relatively evenly between the reduction in agglomeration benefits and the move to less productive jobs. The impact of faster decay of agglomeration impacts is negligible and in this sensitivity the agglomeration impact changes by less than half of one percent. However the impact of introducing freight journey time changes serves to increase the total Wider Impacts by around 11%. Around half of this impact comes from reduced freight costs feeding into agglomeration and half from a reduction in business costs supporting an increase in output in imperfectly competitive markets.

1.22.16 Table D1.64 below shows the results of sensitivity testing for the $C_{variant}$ scenario.

**Table D1.64: Standard sensitivity analysis of the $C_{variant}$ scenario, £m**

| | | Scenario $C_{variant}$ central case | Standard sensitivities | | | |
|---|---|---|---|---|---|---|
| | | | Preferred land use modelling assumptions | High agglomeration decay parameters | Freight cost changes included | Combined sensitivity |
| WI1 | Agglomeration | 1,275 | 796 | 1,287 | 1,318 | 837 |
| WI3 | Imperfect competition | 227 | 227 | 227 | 291 | 291 |
| WI4 | Tax wedge on labour supply | 2 | 2 | 2 | 2 | 2 |
| | Tax wedge on move to more/less productive jobs | 0 | -420 | 0 | 0 | -420 |
| Total | | 1,504 | 605 | 1,516 | 1,611 | 710 |

1.22.17 In the central case where there are no land use changes, the discounted value of total Wider Impacts is estimated to be £1,504m. This is dominated by the agglomeration impact already discussed. The impact of reductions in business costs on output in imperfectly competitive markets is estimated to be £227m while a small impact on labour supply leads to a tax benefit of £2m which is not captured elsewhere. There is no movement to more or less productive jobs because no changes in employment location are assumed.

1.22.18 The land use sensitivity again has a very significant effect on the modelled Wider Impacts of Option Cvariant which is of a similar proportion to that seen in Option C. The net result of this is to reduce the agglomeration benefit of the scheme as the change in land use shifts employment from more productive locations in London to less productive locations to the east of London. There is also a significant tax disbenefit from this movement of jobs to less productive locations which is captured through WI4. The overall impact is to reduce Wider Impacts from £1,504 in the central case to £605 in the land use change sensitivity using the preferred assumptions in the land use model.

1.22.19 Again, the impact of faster decay of agglomeration impacts is negligible. The agglomeration impact of the Cvariant scenario changes by less than 1%. However the impact of introducing freight journey time changes serves to increase the total Wider Impacts by around 7%. Around two fifths of this impact comes from reduced freight costs feeding into agglomeration and three fifths from a reduction in business costs supporting an increase in output in imperfectly competitive markets.

## 1.23 Sensitivities to assumptions about generalised costs

1.23.1 The key assumptions that have been made in the calculation of Wider Impacts, additional to those made in the transport model, are the assumptions regarding other modes of transport. Two sensitivities to these assumptions have been tested:

- faster walking speeds; and
- lower bus and rail fares.

1.23.2 The central case wider impacts calculations assume a walking speed of 4 kilometres per hour or 15 minutes per kilometre. In the sensitivity case, it has been assumed that walking speeds are 7.5 kilometres per hour or 8 minutes per kilometre.

1.23.3 The central case wider impacts calculations assume bus fares are 30 pence per kilometre and rail fares are 60 pence per kilometre in 2010 prices and current values. A sensitivity test has been calculated in which bus fares and rail fares are halved to 15 and 30 pence per kilometre respectively.

1.23.4 Changes in journey times of other modes only affect the calculation of WI1 (agglomeration) by affecting overall weighted generalised costs and hence effective densities. Other Wider Impacts are not affected. Labour supply impacts, for example are driven by the absolute change in average commuting costs which is not dependent on assumptions about other modes which are assumed to be invariant between the investment scenario and the reference case against which it is compared. The results of these sensitivities are shown in Table D1.65 below.

**Table D1.65: Wider Impacts in central case and sensitivity analysis, £m, discounted**

| | | **$C_{variant}$ scenario central case** | **Journey time sensitivities** | |
|---|---|---|---|---|
| | | | **Fast walking speed** | **Low bus and rail fares** |
| WI 1 | Agglomeration | 1,275 | 1,149 | 1,411 |

1.23.5 In the $C_{variant}$ scenario central case, agglomeration impacts are estimated to have a discounted value of £1,275m.

1.23.6 The increase in walking speeds reduces the generalised cost for walk trips and therefore reduces overall weighted generalised costs across all modes. This will disproportionately affect shorter journeys which have a significant walking mode share. Lower weighted generalised costs increase effective densities in both the $C_{variant}$ scenario and the reference case against which it is compared, as well as increasing the relative importance of shorter trips in the calculation of effective densities. The result of faster walking speeds is to reduce the impact of road journey time improvements on agglomeration in the $C_{variant}$ scenario from £1,275m to £1,149m, a reduction of around 10%.

1.23.7 Lower bus and rail fares also reduce weighted average generalised costs. However, this tends to affect longer journeys rather than shorter ones. The change in the pattern of generalised costs in scenario $C_{variant}$ leads to higher agglomeration benefits under these assumptions. Discounted agglomeration benefits rise from £1,275 in the central case to £1,411 if lower bus and rail fares are assumed, an increase of 11%.

## 1.24 Sensitivities to land use model assumptions

1.24.1 Sensitivity tests have also been undertaken using different assumptions in the land use model to better understand how these assumptions affect both the land use model outcomes and the Wider Impacts sensitivity tests which the land use model informs. The sensitivity tests undertaken include:

- Using parameters to reflect different levels of mobility of employment in and out of the study area in response to changes in connectivity;
- Using forecasting parameters which exclude the 'own zone' element of the connectivity measures;
- Using forecasting parameters based on the alternative S-curve decay function; and
- Using forecasting parameters based on weighted journey time changes for all journey purposes rather than the commuting journey time changes which provide the best model fit.

1.24.2 Table D1.66 below shows how the changes in these assumptions affect the modelled employment outcomes and the modelled Wider Impacts.

**Table D1.66: Land use sensitivity analysis**

| | | Scenario $C_{variant}$ central case | Land use model sensitivities | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Preferred land use modelling assumptions | Mobility in and out of study area = 0% | Mobility in and out of study area = 50% | Exclude 'own zone' connectivity from connectivity measures | S-curve decay approach | Connectivity based on all journey purposes |
| **Employment impact, k, 2025** | | | | | | | | |
| London | | - | -4,700 | -8,700 | -2,700 | -6,200 | -3,800 | -4,000 |
| Kent | | - | 8,900 | 8,200 | 9,200 | 12,800 | 10,200 | 7,300 |
| Essex | | - | 1,200 | 500 | 1,600 | 2,100 | 400 | 1,300 |
| Core study area total | | - | 5,400 | 0 | 8,100 | 8,700 | 6,800 | 4,600 |
| **Wider Impacts, £m, discounted** | | | | | | | | |
| WI1 | Agglomeration | 1,275 | 796 | 519 | 935 | 590 | 852 | 834 |
| WI3 | Imperfect competition | 227 | 227 | 227 | 227 | 227 | 227 | 227 |
| WI4 | Tax wedge on labour supply | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Tax wedge on move to more/less productive jobs | 0 | -420 | -581 | -340 | -702 | -438 | -379 |
| Total | | 1,503 | 605 | 167 | 824 | 117 | 644 | 683 |

1.24.3 All of the land use model sensitivities show a reduction in Wider Impacts compared to the central case scenario. This is due to the consistent effect of relocation of employment towards less productive locations which both reduces the agglomeration benefit and creates a disbenefit through the tax system.

1.24.4 Under the preferred land use assumptions, Option Cvariant attracts around 5,400 jobs to the core study area in 2025. It also leads to a redistribution of these jobs towards Kent, and to a lesser extent towards Essex and away from London. This reduces the Wider Impacts considerably as it mitigates agglomeration benefits and shifts jobs towards less productive areas.

1.24.5 The assumed mobility of businesses into and out of the core study area (London, Kent and Essex) has a proportionate impact on the employment forecasts within this area. If mobility in and out of the study area in response to changes in connectivity is assumed to be zero then there is no net movement of businesses into and out of this area from the rest of the UK. This has the result of increasing the attraction of businesses away from London. This reduces the agglomeration benefits by around 35% compared to the preferred land use assumptions increases the negative impact from the move to less productive jobs by 38%. By contrast, if there

is more mobility in and out of the study area, the modelled employment change in this area rises proportionally from 5,400 (assuming one third of businesses are mobile in and out of this area) to 8,100 (assuming 50% mobility). This reduces relocation from London and hence reduces the disbenefits associated with the land use change.

1.24.6 Excluding the 'own zone' element of the connectivity measure has the effect of making the land use model more sensitive and also has a significant impact on the land use model results, increasing relocation to the study area by around 60% from 5,400 to 8,700. The result of this is again to exacerbate the shift towards less productive locations and further reduce the Wider Impacts.

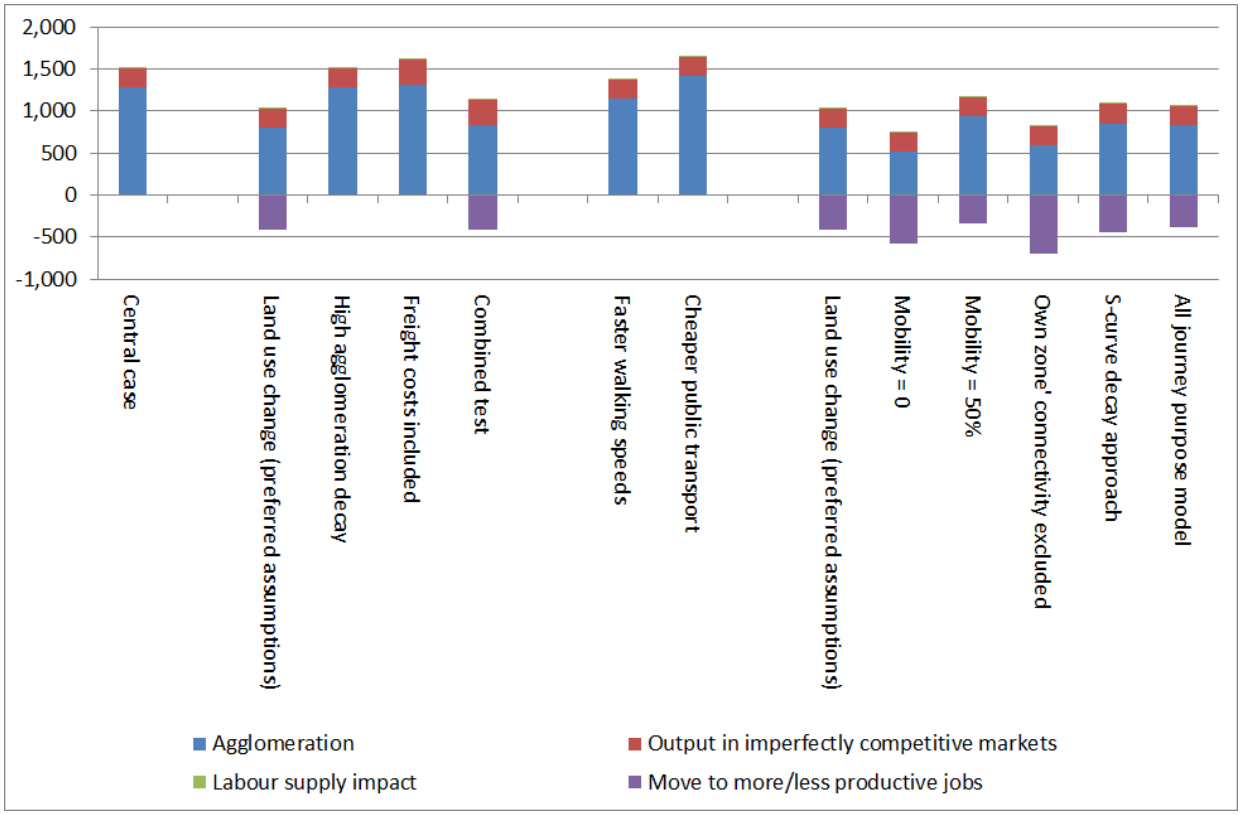
1.24.7 The S-curve decay approach also increases the sensitivity of the land use model, increasing employment impacts in the London, Kent and Essex by around 1,400 and reducing wider impacts by around 6% compared to the preferred land use sensitivity.

1.24.8 Finally, the use of all journey purposes to drive the connectivity measures in the model tends to reduce relocation to the study area by reducing the connectivity gains of the investment. This tends to reduce the shift in employment from London and from the rest of the country to Kent. The net impact of this is that the disbenefits associated with potential land use change are somewhat mitigated and the Wider Impacts are around 13% higher than under the preferred land use modelling assumptions.

## 1.25 Summary of sensitivity test results

1.25.1 Figure D1.3 below summarises the sensitivity tests on the value of Wider Impacts of the Cvariant scenario.

**Figure D1.3: Summary of sensitivity test results, £m, discounted**




1.25.2 Figure D1.3 shows that the journey time, freight cost and agglomeration decay sensitivities have a relatively limited effect on modelled Wider Impacts while changes in land use could have a more significant effect.

## 1.26 Regeneration Approach

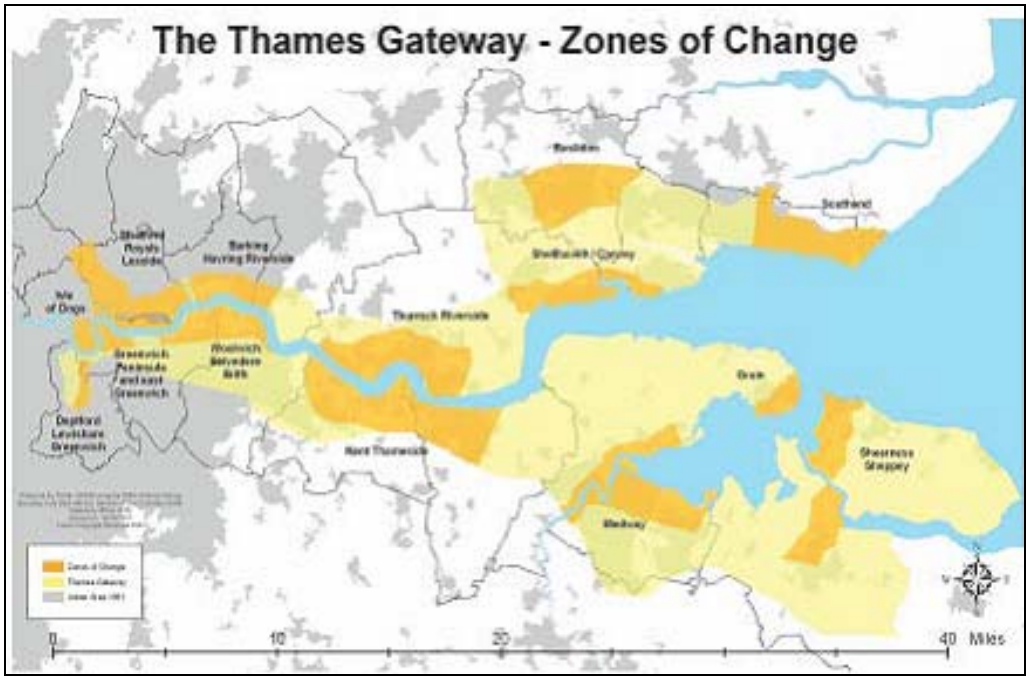
1.26.1 The Lower Thames Crossing options have the potential to bring about change in journey opportunities, employment opportunities and land use across a wide area, both locally in the Thames Gateway and more widely across London, Kent, Essex and beyond.

1.26.2 In transport appraisal, regeneration refers specifically to the redistribution of economic activity or employment that results in an increase in employment of residents of a Regeneration Area. A specific approach to calculating this is provided in WebTAG Unit 3.5.8. WebTAG Unit 2.8 also notes that "an additional measure which may also be useful is the change in the number of jobs in the RA." This methodology is particularly suited to specific, relatively small, with a specific policy designation or where a high proportion of local wards fall into the lowest tiers of the index of multiple deprivation.

1.26.3 Given the potentially complex, uncertain and widespread impacts associated with a new crossing at the location Options under consideration, it has not been considered appropriate to undertaken a Regeneration Report consistent with WebTAG Units 2.8 and 3.5.8 or to attempt to define a specific Regeneration Area for the purpose of evaluating regeneration impacts. Instead, here a qualitative approach is taken based on estimated change in employment from the land use modelling and accessibility plots which capture employment opportunities for residents.

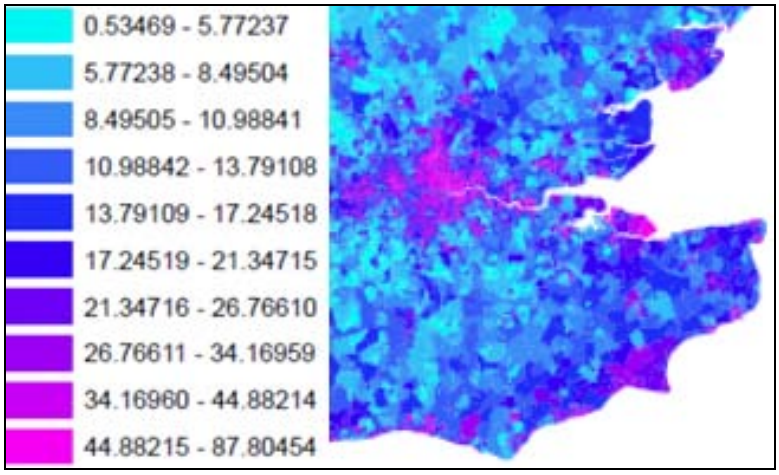
1.26.4 The Thames Gateway area contains a variety of locations which are anticipated to host significant new commercial and residential development, and contains some 3,000 hectares of brownfield land in areas stretching from relatively central areas of London such as the Isle of Dogs as far east as Southend and Sheppy.

**Figure D1.4: The Thames Gateway Development Area**




1.26.5 These areas host a wide range of levels of deprivation as measured by the Index of Multiple deprivation.

**Figure D1.5: Index of Multiple Deprivation in Thames Gateway area, 2010**




1.26.6 Figure D1.5 shows the distribution of multiple deprivation throughout London, the Thames Gateway and adjoining areas in the wider south east and east of England. Deprivation is concentrated in the London Thames Gateway and is significant in the areas close to the existing crossing in Grays and West Thurrock. Other pockets of significant deprivation are seen in the Isles of Grain and Sheppy and around Chatham and Sittingbourne in the south and in Southend, Basildon and Billericay to the north.

1.26.7 The land use model provides estimates of land use change at a district level. To gain an understanding of the regeneration impacts of the proposed crossing interventions, modelled changes in employment in the Thames Gateway area as a whole are reported, in specific areas that affect the zones of change and in surrounding areas which have significant social challenges.

# Appendix E: Transport Economic Efficiency (TEE) Tables

# Transport Economic Efficiency (TEE) Tables

## Option A

| Economic Efficiency of the Transport System (TEE) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Non-business: Commuting** | **ALL MODES** | | **ROAD** | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | | **Passengers** | **Passengers** | | |
| Travel time | 24,232,806 | | 24,232,806 | | 0 | 0 | | 0 |
| Vehicle operating costs | 3,372,206 | | 3,372,206 | | | | | 0 |
| User charges | -8,543,835 | | -8,543,835 | | 0 | 0 | | 0 |
| During Construction & Maintenance | -237,426 | | -237,426 | | 0 | 0 | | 0 |
| **NET NON-BUSINESS BENEFITS: COMMUTING** | 18,823,751 | *(1a)* | 18,823,751 | | 0 | 0 | | 0 |
| **Non-business: Other** | **ALL MODES** | | **ROAD** | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | | **Passengers** | **Passengers** | | |
| Travel time | 163,152,682 | | 163,152,682 | | 0 | 0 | | 0 |
| Vehicle operating costs | 43,037,815 | | 43,037,815 | | | | | 0 |
| User charges | -28,943,669 | | -28,943,669 | | 0 | 0 | | 0 |
| During Construction & Maintenance | -1,598,519 | | -1,598,519 | | 0 | 0 | | 0 |
| **NET NON-BUSINESS BENEFITS: OTHER** | 175,648,309 | *(1b)* | 175,648,309 | | 0 | 0 | | 0 |
| **Business** | | | | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | | | **Goods Vehicles** | **Business Cars & LGVs** | **Passengers** | **Freight** | **Passengers** | |
| Travel time | 705,015,807 | | 101,515,716 | 603,500,090 | 0 | 0 | 0 | 0 |
| Vehicle operating costs | 50,451,762 | | 38,924,606 | 11,527,156 | | | | 0 |
| User charges | -63,505,584 | | -27,127,578 | -36,378,006 | 0 | 0 | 0 | 0 |
| During Construction & Maintenance | -20,837,444 | | -1,973,340 | -18,864,105 | 0 | 0 | 0 | 0 |
| **Subtotal** | 671,124,540 | *(2)* | 111,339,405 | 559,785,135 | 0 | 0 | 0 | 0 |
| ***Private sector provider impacts*** | | | | | | | | |
| Revenue | 0 | | | | | | | |
| Operating costs | 0 | | | | | | | |
| Investment costs | 0 | | | | | | | |
| Grant/subsidy | 0 | | | | | | | |
| **Subtotal** | 0 | *(3)* | | | | | | |
| ***Other business impacts*** | | | | | | | | |
| Developer contributions | 0 | *(4)* | 0 | | 0 | 0 | | 0 |
| **NET BUSINESS IMPACT** | 671,124,540 | *(5) = (2) + (3) + (4)* | | | | | | |
| **TOTAL** | | | | | | | | |
| Present Value of Transport Economic Efficiency Benefits (TEE) | 865,596,600 | *(6) = (1a) + (1b) + (5)* | | | | | | |
| | Notes: Benefits appear as positive numbers, while costs appear as negative numbers. | | | | | | | |
| | All entries are discounted 2010 prices and values. | | | | | | | |

# Option B

**Economic Efficiency of the Transport System (TEE)**

| **Non-business: Commuting** | **ALL MODES** | | **ROAD** | | **BUS and COACH** | **RAIL** | | **OTHER** |
|---|---|---|---|---|---|---|---|---|
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | | **Passengers** | **Passengers** | | |
| Travel time | -5,865,886 | | -5,865,886 | | 0 | 0 | | 0 |
| Vehicle operating costs | -44,066,751 | | -44,066,751 | | | | | 0 |
| User charges | -22,385,806 | | -22,385,806 | | 0 | 0 | | 0 |
| During Construction & Maintenance | 536,890 | | 536,890 | | 0 | 0 | | 0 |
| **NET NON-BUSINESS BENEFITS: COMMUTING** | -71,781,553 | *(1a)* | -71,781,553 | | 0 | 0 | | 0 |
| **Non-business: Other** | **ALL MODES** | | **ROAD** | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | | **Passengers** | **Passengers** | | |
| Travel time | 43,856,686 | | 43,856,686 | | 0 | 0 | | 0 |
| Vehicle operating costs | -205,894,763 | | -205,894,763 | | | | | 0 |
| User charges | -80,377,819 | | -80,377,819 | | 0 | 0 | | 0 |
| During Construction & Maintenance | -4,014,095 | | -4,014,095 | | 0 | 0 | | 0 |
| **NET NON-BUSINESS BENEFITS: OTHER** | -246,429,992 | *(1b)* | -246,429,992 | | 0 | 0 | | 0 |
| **Business** | | | | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | | | **Goods Vehicles** | **Business Cars & LGVs** | **Passengers** | **Freight** | **Passengers** | |
| Travel time | 1,100,119,044 | | 130,352,170 | 969,766,874 | 0 | 0 | 0 | 0 |
| Vehicle operating costs | 154,188,537 | | 84,038,184 | 70,150,353 | | | | 0 |
| User charges | -71,871,887 | | -35,290,265 | -36,581,622 | 0 | 0 | 0 | 0 |
| During Construction & Maintenance | -10,235,402 | | -773,796 | -9,461,606 | 0 | 0 | 0 | 0 |
| **Subtotal** | 1,172,200,293 | *(2)* | 178,326,293 | 993,874,000 | 0 | 0 | 0 | 0 |
| ***Private sector provider impacts*** | | | | | | | | |
| Revenue | 0 | | | | | | | |
| Operating costs | 0 | | | | | | | |
| Investment costs | 0 | | | | | | | |
| Grant/subsidy | 0 | | | | | | | |
| **Subtotal** | 0 | *(3)* | | | | | | |
| ***Other business impacts*** | | | | | | | | |
| Developer contributions | 0 | *(4)* | 0 | | 0 | 0 | | 0 |
| **NET BUSINESS IMPACT** | 1,172,200,293 | *(5) = (2) + (3) + (4)* | | | | | | |
| **TOTAL** | | | | | | | | |
| Present Value of Transport Economic Efficiency Benefits (TEE) | 853,988,748 | *(6) = (1a) + (1b) + (5)* | | | | | | |
| | Notes: Benefits appear as positive numbers, while costs appear as negative numbers. | | | | | | | |
| | All entries are discounted 2010 prices and values. | | | | | | | |

# Option C

**Economic Efficiency of the Transport System (TEE)**

| **Non-business: Commuting** | **ALL MODES** | | **ROAD** | **BUS and COACH** | **RAIL** | **OTHER** |
|---|---|---|---|---|---|---|
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | **Passengers** | **Passengers** | |
| Travel time | 41,386,331 | | 41,386,331 | 0 | 0 | 0 |
| Vehicle operating costs | -43,206,445 | | -43,206,445 | | | 0 |
| User charges | -22,377,188 | | -22,377,188 | 0 | 0 | 0 |
| During Construction & Maintenance | -4,283,343 | | -4,283,343 | 0 | 0 | 0 |
| **NET NON-BUSINESS BENEFITS: COMMUTING** | -28,480,645 | *(1a)* | -28,480,645 | 0 | 0 | 0 |

| **Non-business: Other** | **ALL MODES** | | **ROAD** | **BUS and COACH** | **RAIL** | **OTHER** |
|---|---|---|---|---|---|---|
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | **Passengers** | **Passengers** | |
| Travel time | 254,716,914 | | 254,716,914 | 0 | 0 | 0 |
| Vehicle operating costs | -190,481,564 | | -190,481,564 | | | 0 |
| User charges | -85,894,709 | | -85,894,709 | 0 | 0 | 0 |
| During Construction & Maintenance | -26,362,327 | | -26,362,327 | 0 | 0 | 0 |
| **NET NON-BUSINESS BENEFITS: OTHER** | -48,021,686 | *(1b)* | -48,021,686 | 0 | 0 | 0 |

| **Business** | | | | | **BUS and COACH** | **RAIL** | | **OTHER** |
|---|---|---|---|---|---|---|---|---|
| ***User benefits*** | | | **Goods Vehicles** | **Business Cars & LGVs** | **Passengers** | **Freight** | **Passengers** | |
| Travel time | 1,867,331,223 | | 279,122,138 | 1,588,209,085 | 0 | 0 | 0 | 0 |
| Vehicle operating costs | 507,385,755 | | 331,637,332 | 175,748,423 | | | | 0 |
| User charges | -116,680,440 | | -51,717,308 | -64,963,132 | 0 | 0 | 0 | 0 |
| During Construction & Maintenance | -82,829,615 | | -5,748,844 | -77,080,771 | 0 | 0 | 0 | 0 |
| **Subtotal** | 2,175,206,923 | *(2)* | 553,293,318 | 1,621,913,605 | 0 | 0 | 0 | 0 |
| ***Private sector provider impacts*** | | | | | | | | |
| Revenue | 0 | | | | | | | |
| Operating costs | 0 | | | | | | | |
| Investment costs | 0 | | | | | | | |
| Grant/subsidy | 0 | | | | | | | |
| **Subtotal** | 0 | *(3)* | | | | | | |
| ***Other business impacts*** | | | | | | | | |
| Developer contributions | 0 | *(4)* | 0 | | 0 | 0 | | 0 |
| **NET BUSINESS IMPACT** | 2,175,206,923 | *(5) = (2) + (3) + (4)* | | | | | | |

| **TOTAL** | | |
|---|---|---|
| Present Value of Transport Economic Efficiency Benefits (TEE) | 2,098,704,593 | *(6) = (1a) + (1b) + (5)* |
| | Notes: Benefits appear as positive numbers, while costs appear as negative numbers. | |
| | All entries are discounted 2010 prices and values. | |

# Option $C_{variant}$

**Economic Efficiency of the Transport System (TEE)**

| **Non-business: Commuting** | **ALL MODES** | | **ROAD** | | **BUS and COACH** | **RAIL** | | **OTHER** |
|---|---|---|---|---|---|---|---|---|
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | | **Passengers** | **Passengers** | | |
| Travel time | 89,521,006 | | 89,521,006 | | 0 | 0 | | 0 |
| Vehicle operating costs | -56,100,863 | | -56,100,863 | | | | | 0 |
| User charges | -22,720,933 | | -22,720,933 | | 0 | 0 | | 0 |
| During Construction & Maintenance | -4,586,862 | | -4,586,862 | | 0 | 0 | | 0 |
| **NET NON-BUSINESS BENEFITS: COMMUTING** | 6,112,348 | *(1a)* | 6,112,348 | | 0 | 0 | | 0 |
| **Non-business: Other** | **ALL MODES** | | **ROAD** | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | **TOTAL** | | **Private Cars and LGVs** | | **Passengers** | **Passengers** | | |
| Travel time | 599,290,201 | | 599,290,201 | | 0 | 0 | | 0 |
| Vehicle operating costs | -258,461,473 | | -258,461,473 | | | | | 0 |
| User charges | -89,242,624 | | -89,242,624 | | 0 | 0 | | 0 |
| During Construction & Maintenance | -30,706,330 | | -30,706,330 | | 0 | 0 | | 0 |
| **NET NON-BUSINESS BENEFITS: OTHER** | 220,879,773 | *(1b)* | 220,879,773 | | 0 | 0 | | 0 |
| **Business** | | | | | **BUS and COACH** | **RAIL** | | **OTHER** |
| ***User benefits*** | | | **Goods Vehicles** | **Business Cars & LGVs** | **Passengers** | **Freight** | **Passengers** | |
| Travel time | 2,551,437,652 | | 332,361,214 | 2,219,076,438 | 0 | 0 | 0 | 0 |
| Vehicle operating costs | 574,660,491 | | 365,328,016 | 209,332,475 | | | | 0 |
| User charges | -124,837,312 | | -52,885,233 | -71,952,079 | 0 | 0 | 0 | 0 |
| During Construction & Maintenance | -90,722,153 | | -6,427,181 | -84,294,972 | 0 | 0 | 0 | 0 |
| **Subtotal** | 2,910,538,678 | *(2)* | 638,376,817 | 2,272,161,862 | 0 | 0 | 0 | 0 |
| ***Private sector provider impacts*** | | | | | | | | |
| Revenue | 0 | | | | | | | |
| Operating costs | 0 | | | | | | | |
| Investment costs | 0 | | | | | | | |
| Grant/subsidy | 0 | | | | | | | |
| **Subtotal** | 0 | *(3)* | | | | | | |
| ***Other business impacts*** | | | | | | | | |
| Developer contributions | 0 | *(4)* | 0 | | 0 | 0 | | 0 |
| **NET BUSINESS IMPACT** | 2,910,538,678 | *(5) = (2) + (3) + (4)* | | | | | | |
| **TOTAL** | | | | | | | | |
| Present Value of Transport Economic Efficiency Benefits (TEE) | 3,137,530,799 | *(6) = (1a) + (1b) + (5)* | | | | | | |
| | Notes: Benefits appear as positive numbers, while costs appear as negative numbers. | | | | | | | |
| | All entries are discounted 2010 prices and values. | | | | | | | |

# Appendix F: Public Accounts Tables

# Option A, Bridge

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | **TOTAL** | | **INFRASTRUCTURE** | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -484,141,821 | | -484,141,821 | | | 0 |
| Operating costs | 124,126,581 | | 124,126,581 | | | 0 |
| Investment Costs | 787,069,852 | | 787,069,852 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 427,054,612 | *(8)* | 427,054,612 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | 9,150,168 | *(9)* | 0 | 0 | 0 | 9,150,168 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 427,054,612 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | 9,150,168 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted 2010 prices and values.

# Option A, Immersed Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -484,141,821 | | -484,141,821 | | | 0 |
| Operating costs | 205,737,082 | | 205,737,082 | | | 0 |
| Investment Costs | 1,005,135,735 | | 1,005,135,735 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 726,730,996 | *(8)* | 726,730,996 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | 9,150,168 | *(9)* | 0 | 0 | 0 | 9,150,168 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 726,730,996 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | 9,150,168 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted 2010 prices and values.

# Option A, Bored Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | **TOTAL** | | **INFRASTRUCTURE** | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -484,141,821 | | -484,141,821 | | | 0 |
| Operating costs | 198,892,288 | | 198,892,288 | | | 0 |
| Investment Costs | 971,546,574 | | 971,546,574 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 686,297,041 | *(8)* | 686,297,041 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | 9,150,168 | *(9)* | 0 | 0 | 0 | 9,150,168 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 686,297,041 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | 9,150,168 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted 2010 prices and values.

## Option B, Bridge

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -648,651,388 | | -648,651,388 | | | 0 |
| Operating costs | 183,032,120 | | 183,032,120 | | | 0 |
| Investment Costs | 1,115,519,819 | | 1,115,519,819 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 649,900,551 | *(8)* | 649,900,551 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -66,362,051 | *(9)* | 0 | 0 | 0 | -66,362,051 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 649,900,551 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -66,362,051 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted 2010 prices and values.

# Option B, Immersed Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -648,651,388 | | -648,651,388 | | | 0 |
| Operating costs | 276,943,966 | | 276,943,966 | | | 0 |
| Investment Costs | 1,263,447,784 | | 1,263,447,784 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 891,740,361 | *(8)* | 891,740,361 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -66,362,051 | *(9)* | 0 | 0 | 0 | -66,362,051 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 891,740,361 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -66,362,051 | *(11) = (9)* | | | | |
| | | | | | | |
| | Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers. | | | | | |
| | All entries are discounted 2010 prices and values. | | | | | |

# Option B, Bored Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | **TOTAL** | | **INFRASTRUCTURE** | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -648,651,388 | | -648,651,388 | | | 0 |
| Operating costs | 285,607,610 | | 285,607,610 | | | 0 |
| Investment Costs | 1,334,955,066 | | 1,334,955,066 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 971,911,288 | *(8)* | 971,911,288 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -66,362,051 | *(9)* | 0 | 0 | 0 | -66,362,051 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 971,911,288 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -66,362,051 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted 2010 prices and values.

## Option C, Bridge

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -709,089,092 | | -709,089,092 | | | 0 |
| Operating costs | 284,607,039 | | 284,607,039 | | | 0 |
| Investment Costs | 2,004,496,412 | | 2,004,496,412 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 1,580,014,359 | *(8)* | 1,580,014,359 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -112,366,618 | *(9)* | 0 | 0 | 0 | -112,366,618 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 1,580,014,359 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -112,366,618 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted 2010 prices and values.

## Option C, Immersed Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -709,089,092 | | -709,089,092 | | | 0 |
| Operating costs | 427,724,262 | | 427,724,262 | | | 0 |
| Investment Costs | 1,955,662,757 | | 1,955,662,757 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 1,674,297,927 | *(8)* | 1,674,297,927 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -112,366,618 | *(9)* | 0 | 0 | 0 | -112,366,618 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 1,674,297,927 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -112,366,618 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted 2010 prices and values.

## Option C, Bored Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -709,089,092 | | -709,089,092 | | | 0 |
| Operating costs | 429,543,112 | | 429,543,112 | | | 0 |
| Investment Costs | 1,961,984,139 | | 1,961,984,139 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 1,682,438,159 | *(8)* | 1,682,438,159 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -112,366,618 | *(9)* | 0 | 0 | 0 | -112,366,618 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 1,682,438,159 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -112,366,618 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted 2010 prices and values.

## Option Cvariant, Bridge

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -731,735,487 | | -731,735,487 | | | 0 |
| Operating costs | 363,809,975 | | 363,809,975 | | | 0 |
| Investment Costs | 3,117,814,036 | | 3,117,814,036 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 2,749,888,524 | *(8)* | 2,749,888,524 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -172,618,342 | *(9)* | 0 | 0 | 0 | -172,618,342 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 2,749,888,524 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -172,618,342 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted 2010 prices and values.

## Option $C_{variant}$, Immersed Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -731,735,487 | | -731,735,487 | | | 0 |
| Operating costs | 506,927,198 | | 506,927,198 | | | 0 |
| Investment Costs | 3,068,980,381 | | 3,068,980,381 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 2,844,172,093 | *(8)* | 2,844,172,093 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -172,618,342 | *(9)* | 0 | 0 | 0 | -172,618,342 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 2,844,172,093 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -172,618,342 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.

All entries are discounted 2010 prices and values.

## Option $C_{variant}$, Bored Tunnel

**Public Accounts**

| | ALL MODES | | ROAD | BUS and COACH | RAIL | OTHER |
|---|---|---|---|---|---|---|
| **Local Government Funding** | TOTAL | | INFRASTRUCTURE | | | |
| Revenue | 0 | | 0 | | | 0 |
| Operating Costs | 0 | | 0 | | | 0 |
| Investment Costs | 0 | | 0 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 0 | *(7)* | 0 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Transport** | | | | | | |
| Revenue | -731,735,487 | | -731,735,487 | | | 0 |
| Operating costs | 508,746,048 | | 508,746,048 | | | 0 |
| Investment Costs | 3,075,301,763 | | 3,075,301,763 | | | 0 |
| Developer and Other Contributions | 0 | | 0 | 0 | 0 | 0 |
| Grant/Subsidy Payments | 0 | | 0 | 0 | 0 | 0 |
| **NET IMPACT** | 2,852,312,324 | *(8)* | 2,852,312,324 | 0 | 0 | 0 |
| | | | | | | |
| **Central Government Funding: Non-Transport** | | | | | | |
| Indirect Tax Revenues | -172,618,342 | *(9)* | 0 | 0 | 0 | -172,618,342 |
| | | | | | | |
| **TOTALS** | | | | | | |
| **Broad Transport Budget** | 2,852,312,324 | *(10) = (7) + (8)* | | | | |
| **Wider Public Finances** | -172,618,342 | *(11) = (9)* | | | | |

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted 2010 prices and values.

# Appendix G1: Biodiversity Worksheets

## Worksheet 1 Environment: Biodiversity – Plan Level

### Option A

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| SSSI (West Thurrock Lagoon & Marshes) | Wintering waders and wildfowl.<br>Other important bird species.<br>Mudflat habitat.<br>Reedbed habitat.<br>Saltmarsh habitat. | National | High<br>One of the most important sites for wintering waders and wildfowl on the inner Thames Estuary. | Declining | High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |
| Recommended Marine Conservation Zone (MCZ) | Marine habitats and associated aquatic and terrestrial species. | National | High<br>Nationally important for marine wildlife, habitats, geology and geomorphology. | Unknown | High | Bridge: Minor negative | Slight adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |
| Intertidal Mudflats | Highly productive areas which, together with other intertidal habitats, support large numbers of predatory birds and fish. They provide feeding and resting areas for internationally important populations of migrant and wintering waterfowl, and are also important nursery areas for flatfish. | National | High<br>Limited potential for substitution<br>UK and Local BAP Habitat | Static | High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Reedbeds | Reedbeds are wetlands dominated by stands of the common reed *Phragmites australis*, wherein the water table is at or above ground level for most of the year. They tend to incorporate areas of open water and ditches, and small areas of wet grassland and carr woodland may be associated with them.<br>Reedbeds are amongst the most important habitats for birds in the UK. Five GB Red Data Book invertebrates are also closely associated with reedbeds including red leopard moth *Phragmataecia castanaea* and a rove beetle *Lathrobium rufipenne*. | Regional | Medium<br>UK and Local BAP Habitat | Unknown – likely improving | Medium | Bridge: Neutral | Neutral |
| | | | | | | Bored tunnel: Neutral | Neutral |
| | | | | | | Immersed tunnel: Neutral | Neutral |

**Reference Source(s):** WebTag TAG Unit 3.3.10 The Biodiversity Sub-objective, Department for Transport, December 2004,

SSSI trend information is taken from the Natural England website. Natural England assessed the condition of all SSSIs and the trend has been assigned as the condition assessment into which the greatest percentage of the area falls according to the Natural England SSSI Condition Summary report.

- West Thurrock Lagoon & Marshes: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1006132
- Habitat trend information is taken from Regional and Local Biodiversity Action Plans
- Intertidal Mudflats: http://strategy.sebiodiversity.org.uk/pages/coastal-mudflats.html, specifically the document titled "Extent and condition of inter-tidal habitats"
- Reedbeds: http://www.kentbap.org.uk/habitats-and-species/priority-habitat/reedbeds/

**Summary assessment score:**

**Bridge:** Large Adverse **Bored tunnel**: Slight Adverse **Immersed tunnel:** Large Adverse

**Qualitative comments:**

The assumed illustrative route for Option A runs parallel to the existing river crossing. It runs in close proximity to the West Thurrock Lagoon and Marshes SSSI and would potentially cross directly over adjacent mudflats. Specific comments on the potential engineering options for a new river crossing are outlined below:

**Bridge:** The main impacts are likely to be on the areas of mudflat directly beneath the bridge, with some cumulative impact in conjunction with the existing Dartford-Thurrock Crossing.

**Bored tunnel:** The main impacts are likely to occur in the construction phase. The completed tunnel is unlikely to impact on the marine environment and impacts on coastal/terrestrial ecology are likely to be of a lower magnitude in comparison to the erection of a bridge. The magnitude of impacts would depend upon the location of the tunnel entrance points above ground.

**Immersed tunnel:** The construction of an immersed tunnel has the potential for large adverse impacts on the recommended Marine Conservation Zone (MCZ) and its associated species and habitats due to habitat loss/deterioration and disturbance. While the significance of the potential effects is uncertain, the size of the recommended MCZ is such that it is unlikely that the integrity of the recommended MCZ would be affected by an immersed tunnel assuming appropriate levels of avoidance, mitigation and compensation were put in place.

## Worksheet 1 Environment: Biodiversity – Plan Level

### Option B

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Coastal and Floodplain Grazing Marsh | Grazing marsh is important for waders and wintering wildfowl. May contain both species poor improved grassland and floristically rich semi-improved grassland, depending on how the land is managed. The ditches may have a range of salinities and thus support a diverse & interesting mixture of plants and invertebrates including many nationally scarce and threatened species | Regional | Medium<br><br>UK and Local BAP Habitat | Unknown – likely declining | Medium | Bridge: Intermediate negative due to severance caused by road link. | Moderate adverse |
| | | | | | | Bored tunnel: Intermediate negative due to severance caused by road link. | Moderate adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to severance caused by road link. | Moderate adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| SSSI (West Thurrock Lagoon & Marshes) | Wintering waders and wildfowl.<br>Other important bird species.<br>Mudflat habitat.<br>Reedbed habitat.<br>Saltmarsh habitat. | National | High<br>One of the most important sites for wintering waders and wildfowl on the inner Thames Estuary. | Declining | High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |
| Recommended Marine Conservation Zone (MCZ) | Marine habitats and associated aquatic and terrestrial species. | National | High<br>Nationally important for marine wildlife, habitats, geology and geomorphology. | Unknown | High | Bridge: Minor negative | Slight adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Intermediate negative | Large adverse |
| Intertidal Mudflats | Highly productive areas which, together with other intertidal habitats, support large numbers of predatory birds and fish. They provide feeding and resting areas for internationally important populations of migrant and wintering waterfowl, and are also important nursery areas for flatfish. | National | High (limited potential for substitution)<br>UK and Local BAP Habitat | Static | High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Intermediate negative | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Reedbeds | Reedbeds are wetlands dominated by stands of the common reed *Phragmites australis.*<br>Where in the water table is at or above ground level for most of the year. They tend to incorporate areas of open water and ditches, and small areas of wet grassland and carr woodland may be associated with them.<br>Reedbeds are amongst the most important habitats for birds in the UK. Five GB Red Data Book invertebrates are also closely associated with reedbeds including red leopard moth *Phragmataecia castanaea* and a rove beetle *Lathrobium rufipenne*. | Regional | Medium<br>UK and Local BAP Habitat | Unknown – likely improving | Medium | Bridge: Neutral | Neutral |
| | | | | | | Bored tunnel: Neutral | Neutral |
| | | | | | | Immersed tunnel: Neutral | Neutral |
| Ancient Woodland (Chadwell Wood and Parkhill Wood) | Ancient Woodland | Regional | Medium<br>UK and Local BAP Habitat | Unknown | High | Bridge: Minor negative due to link road. | Slight Adverse |
| | | | | | | Bored tunnel: Minor negative due to link road. | Slight Adverse |
| | | | | | | Immersed tunnel: Minor negative due to link road. | Slight Adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Ebsfleet Marshes | Local Wildlife Site | Local | Medium | Unknown | Medium | Bridge: Intermediate negative due to link road. | Moderate Adverse |
| | | | | | | Bored tunnel: Intermediate negative due to link road. | Moderate Adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to link road. | Moderate Adverse |

**Reference Source(s):** WebTag TAG Unit 3.3.10 The Biodiversity Sub-objective, Department for Transport, December 2004

SSSI trend information is taken from the Natural England website. Natural England assessed the condition of all SSSIs and the trend has been assigned as the condition assessment into which the greatest percentage of the area falls according to the Natural England SSSI Condition Summary report.

- West Thurrock Lagoon & Marshes: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1006132

Habitat trend information is taken from Regional and Local Biodiversity Action Plans:

- Coastal and floodplain grazing marsh: http://www.essexbiodiversity.org.uk/species-and-habitats/coastal-grazing-marsh/
- Intertidal Mudflats: http://strategy.sebiodiversity.org.uk/pages/coastal-saltmarsh.html, specifically the document titled “Extent and condition of inter-tidal habitats”
- Reedbeds: http://www.kentbap.org.uk/habitats-and-species/priority-habitat/reedbeds/

**Summary assessment score:**

**Bridge:** Large Adverse **Bored tunnel:** Moderate Adverse **Immersed tunnel:** Large Adverse

**Qualitative comments:**

The assumed illustrative route for Option B crosses over and bisects the recommended Marine Conservation Zone (MCZ), a local wildlife site and a number of Biodiversity Action Plan habitats, potentially leading to habitat loss and fragmentation. Specific comments on the potential engineering options for a new river crossing are outlined below:

**Bridge:** A bridge would avoid most major impacts upon the recommended MCZ. There is however potential for impacts upon mudflat habitats and their associated bird populations due to increased disturbance from traffic.

**Bored tunnel:** The main impacts would be likely to occur in the construction phase. Once completed a tunnel would not be likely to impact on the marine environment and coastal/terrestrial impacts are likely to be of a lower magnitude in comparison to the erection of a bridge. The magnitude of impacts upon intertidal mudflats would depend upon the location of the tunnel entrance points. If situated well away from this habitat, the potential impacts on mudflats and their associated bird populations could be significantly reduced.

**Immersed tunnel:** The construction of an immersed tunnel has the potential for large adverse impacts on the recommended MCZ and its associated species and habitats due to habitat loss/deterioration and disturbance. The significance of the potential effects is uncertain. However, the size of the recommended MCZ is such that it is unlikely that the integrity of the recommended MCZ would be affected by an immersed tunnel, assuming appropriate levels of avoidance, mitigation and compensation were put in place.

**Link roads:** The potential exists for slight adverse effects on Ancient Woodland due to increased pollution from larger volumes of traffic (i.e. air, salt spray and noise pollution).

## Worksheet 1 Environment: Biodiversity – Plan Level

### Option C

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Coastal and Floodplain Grazing Marsh | Grazing marsh is important for waders and wintering wildfowl. May contain both species poor improved grassland and floristically rich semi-improved grassland, depending on how the land is managed. The ditches may have a range of salinities and thus support a diverse & interesting mixture of plants and invertebrates including many nationally scarce and threatened species | Regional | Medium<br>UK and Local BAP Habitat | Unknown – likely declining | Medium | Bridge: Intermediate negative due to severance caused by road link. | Moderate adverse |
| | | | | | | Bored tunnel: Intermediate negative due to severance caused by road link. | Moderate adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to severance caused by road link. | Moderate adverse |
| Recommended Marine Conservation Zone (MCZ) | Marine habitats and associated aquatic and terrestrial species. | National | High<br>Nationally important for marine wildlife, habitats, geology and geomorphology. | Unknown | High | Bridge: Minor negative | Slight adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Intertidal Mudflats | Highly productive areas which, together with other intertidal habitats, support large numbers of predatory birds and fish. They provide feeding and resting areas for internationally important populations of migrant and wintering waterfowl, and are also important nursery areas for flatfish. | National | High (limited potential for substitution)<br>UK and Local BAP Habitat | Static | High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |
| Reedbeds | Reedbeds are wetlands dominated by stands of the common reed *Phragmites australis*, wherein the water table is at or above ground level for most of the year. They tend to incorporate areas of open water and ditches, and small areas of wet grassland and carr woodland may be associated with them.<br>Reedbeds are amongst the most important habitats for birds in the UK. Five GB Red Data Book invertebrates are also closely associated with reedbeds including red leopard moth *Phragmataecia castanaea* and a rove beetle *Lathrobium rufipenne*. | Regional | Medium<br>UK and Local BAP Habitat | Unknown – likely improving | Medium | Bridge: Neutral | Neutral |
| | | | | | | Bored tunnel: Neutral | Neutral |
| | | | | | | Immersed tunnel: Neutral | Neutral |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| South Thames Estuary and Marshes SSSI | Important as an extensive mosaic of grazing marsh, saltmarsh, mudflat and shingle, characteristic of the North Kent Marshes. The SSSI supports outstanding numbers of internationally important waterfowl, and rare and scarce plants and invertebrates. | National | High (internationally important waterfowl) | Improving | High | Bridge: Major negative | Large adverse |
| | | | | | | Bored tunnel: Major negative (due to road link). | Large adverse |
| | | | | | | Immersed tunnel: Major negative (due to road link). | Large adverse |
| The Thames Estuary and Marshes Ramsar Site. Includes Shorne Marshes RSPB Reserve and Canal & Grazing Marsh, Higham (LWS). | It encompasses brackish, floodplain, grazing marsh, ditches and saline lagoons as well as intertidal saltmarsh and mudflat habitats. | Inter-national | High | Unknown | Very High | Bridge: Major negative | Large adverse |
| | | | | | | Bored tunnel: Major negative (due to road link). | Large adverse |
| | | | | | | Immersed tunnel: Major negative (due to road link). | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| The Thames Estuary and Marshes SPA | The SPA supports an important assemblage of wintering waterbirds including grebes, geese, ducks and waders. The site is also important in spring and autumn migration periods. The marshes include intertidal areas, brackish grazing and flooded chalk and clay pits. A small extent of saltmarsh is also present. | Inter-national | High | Unknown | Very High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Minor negative | Slight adverse |
| Shorne and Ashenbank Woods SSSI | Designated for its complex of ancient and plantation woodland and includes a variety of stand types associated with Tertiary gravels, clays and sands. The site supports an important and diverse invertebrate fauna, especially its Coleoptera, Hemiptera and Odonata. | National | High | Improving | High | Bridge: Major negative due to road link. | Very large adverse |
| | | | | | | Bored tunnel: Major negative due to road link. | Very large adverse |
| | | | | | | Immersed tunnel: Major negative due to road link. | Very large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Great Crabbles Wood SSSI | Habitats supporting scarce plants occur, including lady orchid *Orchis purpurea* and man orchid *Aceras anthropophorum.* | National | High | Improving | High | Bridge: Neutral due to road link. | Neutral |
| | | | | | | Bored tunnel: Neutral due to road link. | Neutral |
| | | | | | | Immersed tunnel: Neutral due to road link. | Neutral |
| Cobham Woods SSSI | An outstanding assemblage of plants is present at this site which is also of importance for its breeding birds. | National | High | Improving | High | Bridge: Minor negative due to road link. | Slight adverse |
| | | | | | | Bored tunnel: Minor negative due to road link | Slight adverse |
| | | | | | | Immersed tunnel Minor negative due to road link. | Slight adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Ancient Woodland (Claylane Wood) | Ancient Woodland | Regional | Medium<br>UK and Local | Unknown | High | Bridge: Intermediate negative due to road link. | Large adverse |
| | | | | | | Bored tunnel: Intermediate due to road link. | Large adverse |
| | | | | | | Immersed tunnel: Intermediate due to road link. | Large adverse |

**Reference Source(s):** WebTag TAG Unit 3.3.10 The Biodiversity Sub-objective, Department for Transport, December 2004

SSSI trend information is taken from the Natural England website. Natural England assessed the condition of all SSSIs and the trend has been assigned as the condition assessment into which the greatest percentage of the area falls according to the Natural England SSSI Condition Summary report.

- South Thames Estuary and Marshes SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1003874
- Shorne and Ashenbank Woods SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1001250
- Great Crabbles Wood SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1003716
- Cobham Woods SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1003501

Habitat trend information is taken from Regional and Local Biodiversity Action Plans:

- Coastal and floodplain grazing marsh: http://www.kentbap.org.uk/habitats-and-species/priority-habitat/coastal-floodplain-grazing-marsh/ and http://www.essexbiodiversity.org.uk/species-and-habitats/coastal-grazing-marsh/
- Intertidal Mudflats: http://strategy.sebiodiversity.org.uk/pages/coastal-saltmarsh.html, specifically the document titled “Extent and condition of inter-tidal habitats”
- Reedbeds: http://www.kentbap.org.uk/habitats-and-species/priority-habitat/reedbeds/ and http://www.essexbiodiversity.org.uk/species-and-habitats/reedbeds

**Summary assessment score:**

**Bridge:** Very Large Adverse **Bored tunnel:** Very Large Adverse **Immersed tunnel:** Very Large Adverse

(Very Large Adverse is the worst case score and has been assessed as such due to the impact that the assumed illustrative route of the link road connecting a new crossing at location Option C with the A2/M2 would have on Shorne and Ashenbank Woods SSSI)

**Qualitative comments:**

The assumed illustrative route for Option C bisects a number of designated sites and areas of Biodiversity Action Plan habitat. These include an area of the Thames Estuary and Marshes which is designated as an internationally important Ramsar site and SSSI, and which is also a RSPB reserve. The assumed illustrative route could therefore bisect a number of important habitats leading to increased disturbance, habitat loss and habitat fragmentation. Specific comments on the potential engineering options for a new river crossing are outlined below:

**Bridge:** The construction of a bridge at the western extents of the Ramsar/Thames Estuary and Marshes SSSI could cause a number of negative impacts which may not be easily mitigated, such as habitat loss/deterioration and disturbance. It should also be noted that intertidal mudflat habitat is difficult to replace and compensate for. However, there is potential for offset mitigation by enhancing land adjacent to the Ramsar site. It is also unlikely that a new

bridge crossing would significantly affect the integrity of the Ramsar site as the assumed illustrative route passes through the western extent of the site, which is currently agricultural land.

Habitat loss and fragmentation of Shorne and Ashenbank Woods SSSI associated with the assumed illustrative route of a link road connecting a new crossing with the A2/M2 would involve a very large adverse effect on Ancient Woodland that is irreplaceable. While not legally protected, planning policy is very clear that such sites should only be developed as a last resort.

**Bored tunnel:** The main impacts are likely to occur in the construction phase. A completed tunnel would not impact the marine environment and the coastal/terrestrial impacts would be reduced in comparison to the erection of a bridge. The location of the tunnel entrance points is critical, and micro-siting of these entrance points would be considered in order to avoid impacts of habitat loss/deterioration and disturbance to the Ramsar/Thames Estuary and Marshes SSSI. However there is potential for offset mitigation by enhancing land adjacent to the site and it is unlikely that the works would significantly affect the integrity of the site as it is on the western extent which is currently agricultural land.

Habitat loss and fragmentation of Shorne and Ashenbank Woods SSSI due to the assumed illustrative route of the link road to a new crossing from the A2/M2 would involve a very large adverse effect on Ancient Woodland that is irreplaceable as discussed above.

**Immersed tunnel:** The construction of an immersed tunnel has the potential for large adverse impacts on the recommended Marine Conservation Zone (MCZ) and its associated species and habitats due to habitat loss/deterioration and disturbance. The significance of the potential effects is uncertain. However, the size of the recommended MCZ is such that it is unlikely that the integrity of the recommended MCZ would be affected by an immersed tunnel, assuming appropriate levels of avoidance, mitigation and compensation were put in place.

The road impact may also be similar to that of the bridge, as the tunnel entrances may not be able to be situated away from the Thames Estuary and Marshes.

**Link road:** Habitat loss and fragmentation of Shorne and Ashenbank Woods SSSI associated with the assumed illustrative route of a link road connecting the A2/M2 with a new crossing would involve a very large adverse effect on Ancient Woodland that is irreplaceable as discussed above. Claylane Wood (Ancient Woodland) also has potential for large adverse effect depending on the construction details.

## Worksheet 1 Environment: Biodiversity – Plan Level

### Option: $C_{variant}$

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Coastal and Floodplain Grazing Marsh | Grazing marsh is important for waders and wintering wildfowl. May contain both species poor improved grassland and floristically rich semi-improved grassland, depending on how the land is managed. The ditches may have a range of salinities and thus support a diverse & interesting mixture of plants and invertebrates including many nationally scarce and threatened species | Regional | Medium<br>UK and Local BAP Habitat | Unknown – likely declining | Medium | Bridge: Intermediate negative due to severance caused by road link | Moderate adverse |
| | | | | | | Bored tunnel: Intermediate negative due to severance caused by road link | Moderate adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to severance caused by road link | Moderate adverse |
| Recommended Marine Conservation Zone (MCZ) | Marine habitats and associated aquatic and terrestrial species. | National | High<br>Nationally important for marine wildlife, habitats, geology and geomorphology. | Unknown | High | Bridge: Minor negative | Slight adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Intertidal Mudflats | Highly productive areas which, together with other intertidal habitats, support large numbers of predatory birds and fish. They provide feeding and resting areas for internationally important populations of migrant and wintering waterfowl, and are also important nursery areas for flatfish. | National | High (limited potential for substitution)<br>UK and Local BAP Habitat | Static | High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Major negative | Large adverse |
| Reedbeds | Reedbeds are wetlands dominated by stands of the common reed *Phragmites australis*, wherein the water table is at or above ground level for most of the year. They tend to incorporate areas of open water and ditches, and small areas of wet grassland and carr woodland may be associated with them.<br>Reedbeds are amongst the most important habitats for birds in the UK. Five GB Red Data Book invertebrates are also closely associated with reedbeds including red leopard moth *Phragmataecia castanaea* and a rove beetle *Lathrobium rufipenne*. | Regional | Medium<br>UK and Local BAP Habitat | Unknown – likely improving | Medium | Bridge: Neutral | Neutral |
| | | | | | | Bored tunnel: Neutral | Neutral |
| | | | | | | Immersed tunnel: Neutral | Neutral |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| South Thames Estuary and Marshes SSSI | Important as an extensive mosaic of grazing marsh, saltmarsh, mudflat and shingle, characteristic of the North Kent Marshes. The SSSI supports outstanding numbers of internationally important waterfowl, and rare and scarce plants and invertebrates. | National | High (internationally important waterfowl) | Improving | High | Bridge: Major negative | Large adverse |
| | | | | | | Bored tunnel: Major negative (due to road link). | Large adverse |
| | | | | | | Immersed tunnel: Major negative (due to road link). | Large adverse |
| The Thames Estuary and Marshes Ramsar Site. Includes Shorne Marshes RSPB Reserve and Canal & Grazing Marsh, Higham (LWS). | It encompasses brackish, floodplain, grazing marsh,ditches and saline lagoons as well as intertidal saltmarsh and mudflat habitats. | International | High | Unknown | Very High | Bridge: Major negative | Large adverse |
| | | | | | | Bored tunnel: Major negative (due to road link). | Large adverse |
| | | | | | | Immersed tunnel: Major negative (due to road link). | Large adverse |
| The Thames Estuary and Marshes SPA | The SPA supports an important assemblage of wintering waterbirds including grebes, geese, ducks and waders. The site is also important in spring and autumn migration periods. The marshes include intertidal areas, brackish grazing and flooded chalk and clay pits. A small extent of saltmarsh is also present. | International | High | Unknown | Very High | Bridge: Intermediate negative | Large adverse |
| | | | | | | Bored tunnel: Minor negative | Slight adverse |
| | | | | | | Immersed tunnel: Minor negative | Slight adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Shorne and Ashenbank Woods SSSI | Designated for its complex of ancient and plantation woodland and includes a variety of stand types associated with Tertiary gravels, clays and sands. The site supports an important and diverse invertebrate fauna, especially its Coleoptera, Hemiptera and Odonata. | National | High | Improving | High | Bridge: Major negative due to road link. | Very large adverse |
| | | | | | | Bored tunnel: Major negative due to road link. | Very large adverse |
| | | | | | | Immersed tunnel: Major negative due to road link. | Very large adverse |
| Great Crabbles Wood SSSI | Habitats supporting scarce plants occur, including lady orchid *Orchis purpurea* and man orchid *Aceras anthropophorum*. | National | High | Improving | High | Bridge: Neutral due to road link. | Neutral |
| | | | | | | Bored tunnel: Neutral due to road link. | Neutral |
| | | | | | | Immersed tunnel: Neutral due to road link. | Neutral |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Cobham Woods SSSI | An outstanding assemblage of plants is present at this site which is also of importance for its breeding birds. | National | High | Improving | High | Bridge: Minor negative due to road link. | Slight adverse |
| | | | | | | Bored tunnel: Minor negative due to road link | Slight adverse |
| | | | | | | Immersed tunnel Minor negative due to road link. | Slight adverse |
| Ancient Woodland (Claylane Wood) | Ancient Woodland | Regional | Medium<br>UK and Local | Unknown | High | Bridge: Intermediate negative due to road link. | Large adverse |
| | | | | | | Bored tunnel: Intermediate due to road link. | Large adverse |
| | | | | | | Immersed tunnel: Intermediate due to road link. | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Ancient Woodland (Bridge wood) | Ancient semi-natural woodland | Regional | High | Unknown | High | Bridge: Intermediate negative due to widening of link road. | Large adverse |
| | | | | | | Bored tunnel: Intermediate negative due to widening of link road. | Large adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to widening of link road. | Large adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Wouldham to Detling SSSI | This 10 km stretch of the chalk escarpment to the north of Maidstone includes representative examples of woodland, scrub and unimproved grassland habitats on chalk, which support a number of rare and scarce species of plants and invertebrates. | National | High | Improving | High | Bridge: Intermediate negative due to widening of link road. | Large adverse |
| | | | | | | Bored tunnel: Intermediate negative due to widening of link road. | Large adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to widening of link road. | Large adverse |
| North Downs Woodlands SAC / Boxley Warren LNR | This SAC is primarily designated for its ancient beech forests and yew woodland. Semi-natural dry grasslands and scrubland facies on calcareous substrate are also present as a secondary qualifying feature. | Inter-national | High | Unknown | Very High | Bridge: Minor negative due to widening of link road. | Slight adverse |
| | | | | | | Bored tunnel: Minor negative due to widening of link road. | Slight adverse |
| | | | | | | Immersed tunnel: Minor negative due to widening of link road. | Slight adverse |

| Area | Description of feature / attribute | Scale (at which attribute matters) | Importance (of attribute) | Trend (in relation to target) | Biodiversity and earth heritage value | Magnitude of impact | Assessment score |
|---|---|---|---|---|---|---|---|
| Ancient Woodland within 2km of the assumed illustrative route (including Kit's Coty LWS) | Ancient Woodland and pasture. | Regional | High | Unknown | High | Bridge: Intermediate negative due to widening of link road. | Large adverse |
| | | | | | | Bored tunnel: Intermediate negative due to widening of link road. | Large adverse |
| | | | | | | Immersed tunnel: Intermediate negative due to widening of link road. | Large adverse |

**Reference Source(s):** WebTag TAG Unit 3.3.10 The Biodiversity Sub-objective, Department for Transport, December 2004

SSSI trend information is taken from the Natural England website. Natural England assessed the condition of all SSSIs and the trend has been assigned as the condition assessment into which the greatest percentage of the area falls according to the Natural England SSSI Condition Summary report.

- South Thames Estuary and Marshes SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1003874
- Shorne and Ashenbank Woods SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1001250
- Great Crabbles Wood SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1003716
- Cobham Woods SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1003501
- Wouldham to Detling SSSI: http://www.sssi.naturalengland.org.uk/special/sssi/reportAction.cfm?report=sdrt18&category=S&reference=1001339

Habitat trend information is taken from Regional and Local Biodiversity Action Plans

- Coastal and floodplain grazing marsh: http://www.kentbap.org.uk/habitats-and-species/priority-habitat/coastal-floodplain-grazing-marsh/ and http://www.essexbiodiversity.org.uk/species-and-habitats/coastal-grazing-marsh/
- Intertidal Mudflats: http://strategy.sebiodiversity.org.uk/pages/coastal-saltmarsh.html, specifically the document titled “Extent and condition of inter-tidal habitats”
- Reedbeds: http://www.kentbap.org.uk/habitats-and-species/priority-habitat/reedbeds/ and http://www.essexbiodiversity.org.uk/species-and-habitats/reedbeds

**Summary assessment score:**

**Bridge:** Very Large Adverse **Bored tunnel:** Very Large Adverse **Immersed tunnel:** Very Large Adverse

(Very Large Adverse is the worst case score and has been assessed as such due to the impact that the assumed illustrative route of the link road connecting a new crossing at location Option C with the A2/M2 would have on Shorne and Ashenbank Woods SSSI)

**Qualitative comments:**

The assumed illustrative route for Option C bisects a number of designated sites and areas of Biodiversity Action Plan habitat. This includes an area of the Thames Estuary and Marshes which is designated as an internationally important Ramsar site and SSSI, and which is also a RSPB reserve. The assumed illustrative route could therefore bisect a number of important habitats leading to increased disturbance, habitat loss and habitat fragmentation. Specific comments on the potential engineering options for a new river crossing are outlined below:

**Bridge:** The construction of a bridge at the western extents of the Ramsar/Thames Estuary and Marshes SSSI could cause a number of negative impacts which may not be easily mitigated, such as habitat loss/deterioration and disturbance. It should also be noted that intertidal mudflat habitat is difficult to replace and compensate for. However, there is potential for offset mitigation by enhancing land adjacent to the site. It is also unlikely that a new bridge crossing would significantly affect the integrity of the Ramsar site as the assumed illustrative route passes through the western extent of the site, which is currently agricultural land.

Habitat loss and fragmentation of Shorne and Ashenbank Woods SSSI associated with the assumed illustrative route of a link road connecting a new crossing with the A2/M2 would involve a very large adverse effect on Ancient Woodland that is irreplaceable. While not legally protected, planning policy is very clear that such sites should only be developed as a last resort.

**Bored tunnel:** The main impacts are likely to occur in the construction phase. A completed tunnel would not impact the marine environment and the coastal/terrestrial impacts would be reduced in comparison to the erection of a bridge. The location of the tunnel entrance points is critical, and micro-siting of these entrance points would be considered in order to avoid impacts of habitat loss/deterioration and disturbance to the Ramsar/Thames Estuary and Marshes SSSI. However there is potential for offset mitigation by enhancing land adjacent to the site and it is unlikely that the works would significantly affect the integrity of the site as it is on the western extent which is currently agricultural land.

Habitat loss and fragmentation of Shorne and Ashenbank Woods SSSI due to the assumed illustrative route of the link road to a new crossing from the A2/M2 would involve a very large adverse effect on Ancient Woodland that is irreplaceable as discussed above.

**Immersed tunnel:** The construction of an immersed tunnel has the potential for large adverse impacts on the recommended Marine Conservation Zone (MCZ) and its associated species and habitats due to habitat loss/deterioration and disturbance. The significance of the potential effects is uncertain. However, the size of the recommended MCZ is such that it is unlikely that the integrity of the recommended MCZ would be affected by an immersed tunnel, assuming appropriate levels of avoidance, mitigation and compensation were put in place.

The road impact may also be similar to that of the bridge, as the tunnel entrances may not be able to be situated away from the Thames Estuary and Marshes.

**Link road:** Habitat loss and fragmentation of Shorne and Ashenbank Woods SSSI associated with the assumed illustrative route of a link road connecting the A2/M2 with a new crossing would involve a very large adverse effect on Ancient Woodland that is irreplaceable as discussed above. There may be large adverse effects on Ancient Woodland within 2km of the assumed illustrative route; particularly at Bridge Wood (Ancient Woodland) and the Wouldham to Detling SSSI due to habitat loss and increased noise and disturbance caused by road widening. Claylane Wood (Ancient Woodland) also has potential for large adverse effect depending on the construction details.

# Appendix G2: Townscape Worksheets

## Worksheet 1 Environment: Townscape

### Option: A

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Layout | The existing Queen Elizabeth II Bridge and elevated road forms a strong linear visual feature within a very large scale industrial townscape with pockets of overgrown derelict ground. | Local | Common | Low at a local level | High | The area is zoned in the Thurrock Unitary Development Plan (UDP) for industrial use and it is likely that further industrial development would arise. | Neutral /Slight Adverse<br>The additional road infrastructure would involve some change to current industrial and energy related development, however would fit well within the existing layout. | |
| Density and mix | Industry and commercial uses only.<br>Very large industrial units or energy related infrastructure including pylons, power station and storage towers are located within compounds and industrial estates. | Local | Common | Low at a local level | High | Although the area is likely to remain industrial, structures and layouts are likely to change over time. | Neutral<br>A road development in this location would not change the existing mix and density. | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Scale | The area is dominated by very large structures including storage tanks, industrial units, chimneys and cooling towers. The Queen Elizabeth II Bridge forms a prominent landmark with existing elevated road structures and pylons providing further vertical scale within the townscape. | local | Common | Low at a local level | High | The scale of the townscape is likely to remain unchanged with large scale structures dominating. | Neutral<br>A road development in this location would not change the existing scale. | |
| Appearance | The area is dominated by very large industrial structures including, the Queen Elizabeth II Bridge and elevated road infrastructure. Building materials are varied and include brick, concrete and metal and are 20/21 century in appearance. Busy arterial roads filter onto | Local | Common | Low at a local level | High | The townscape is likely to remain industrial in its appearance with further industrial development continuing to be evident. | Bored Tunnel: Neutral /Slight Adverse<br>There would be some change to the existing appearance visible over a local area, although it would fit well visually within the existing context. | High quality design of road infrastructure |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| | quiet access lanes with street lighting, rough patchy grass verges, yards surrounded by security fences and controlled gates or areas of off road parking. There are isolated areas of enclosed rough ground dominated by scrub. | | | | | | Immersed Tunnel: Neutral /Slight Adverse.<br>There would be some change to the existing appearance visible over a local area, although it would fit well visually within the existing context. | |
| | | | | | | | Bridge: Slight Adverse<br>There would be some change to the existing appearance visible over a wider area including the river corridor to the east, although it would fit well visually with the existing scale and bridge structures. | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Human interaction | Low levels of human interaction, circulation is mainly by road with limited footway provision. There is no public access to the foreshore. . | Local | Common | Low at a local level | High | Little change is likely with the townscape remaining industrial in character with limited public access. | Slight Adverse A road development in this location would not change the existing levels of human interaction and may increase traffic flows within the area. | Consider local pedestrian/ cycle access and benefits in the design where feasible and appropriate |
| Cultural | There are no known townscape features of cultural interest within the study area although areas of archaeological interest have been noted within the constraints study. | Local | Common | Low at a local level | High | No changes are anticipated | Neutral | |
| Land use | Main uses include transport, industry, aggregates, energy generation, pylons and overhead electricity lines | Local | Common | Low at a local level | High | Change is unlikely with the area zoned for industrial use and development in Thurrock UDP | Neutral | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Summary of character | The area on both the north and south sides of the Thames is a large scale industrial townscape dominated by the existing linear structure of the Queen Elizabeth II Crossing.<br>The Thames foreshore is dominated by industry and dockland with little public access. | Local | Common | Low at a local level | High | The area is zoned for industrial use and development in the Thurrock UDP. Whilst structures and layouts are likely to change, the overriding character of the area is likely to remain industrial and so is likely to remain unchanged. | Bored Tunnel: Neutral/ Slight Adverse<br>There would be a slight change to the existing character of industrial and energy related development. The road and tunnel infrastructure would be visible over a local area but would fit well within the existing scale and layout, and would not change the existing density and mix. | High quality design of road and crossing infrastructure |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Summary of character (cont) | See above | See above | See above | See above | See above | See above | Immersed Tunnel: Neutral/ Slight Adverse: a slight change to the existing character of industrial and energy related development. Road and tunnel infrastructure would be visible over a local area but fit well within the existing scale and layout, and not change the existing density and mix.<br><br>Bridge: Slight Adverse<br>There would be a slight change to the existing character of industrial and energy related development. The road and bridge infrastructure would be visible over a wider area but would fit well within the existing scale and appearance. | See above |

**Reference Source(s):** WebTag TAG Unit 3.3.8 The Townscape Sub-objective, Department for Transport, December 2004, OS Mapping, Aerial Photography, Thurrock Unitary Development Plan (UDP),

**Summary assessment score:**

**Bridge:** Slight Adverse **Bored Tunnel:** Neutral / Slight Adverse **Immersed Tunnel:** Neutral / Slight Adverse

**Qualitative comments:**

The new road and tunnel infrastructure would introduce a new linear element in the townscape, with minor changes to the local character. Although a new bridge crossing would be noticeable over a wider area than tunnel infrastructure, a bridge would fit well with the existing scale, character and appearance of the existing Queen Elizabeth II bridge and road infrastructure which are dominant visual features in the area.

## Worksheet 1 Environment: Townscape

### Option: B

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Layout | North of the river the assumed illustrative route is close to dense residential streets to the west and north with industrial and dockland development along the river foreshore to the east. The assumed illustrative route passes through a former industrial site, public recreational ground and school grounds to meet with the A1089 next to Brett Farm in the open countryside. To the south of the river the assumed illustrative route passes through low lying open marsh-land fragmented by industrial development. After crossing the rail-way corridors it passes through a former open cast extraction site and areas of enclosed rough grassland and hard standing, with dense residential streets to the west before joining the A2. | Local | Common on a local level | Medium importance at a local level | Some areas such as local recreational and school grounds within the urban fabric would be difficult to substitute. | Industrial and vacant sites are likely to change over time however layout of residential areas and urban recreational areas are unlikely to change. | Slight /Moderate Adverse<br>Although the assumed illustrative route avoids direct impacts on the layout of residential streets, the loss of public recreational green space within the urban fabric would adversely affect the layout of the townscape. | Modify route; avoid conflicts and minimise impacts on urban public space |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Density and mix | Dense pattern of residential streets/ public recreational greenspace and urban fringe agriculture. Large scale waterfront industry, dockland and energy infrastructure, with open green areas of Thames marshland. Rail infrastructure related previously developed land and urban fringe green space flanked by dense residential streets. | Local | Rare on a local level (public recreational greenspace/ Thames Marshland) | High at a Local Level | Low | Likelihood to change varies along the route Residential areas are likely to remain unchanged, other areas such as brownfield and industrial areas are likely to change over time. | Moderate Adverse Impacts on density and mix due to the loss of recreational and publicly accessible greenspace within a densely populated urban area and increased density caused by infilling of greenspace corridors. | Consider routing options that avoid impacts on greenspace in relation to residential areas |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Scale | Scale :dense 2-4 storey small scale residential streets - individual multi-storey flats.<br>Large, open expansive waterfront is dominated by the docks and associated large warehouses, industry, power stations and pylons.<br>To the south views of enclosed previously developed land and urban fringe green space are limited by topography with a medium scale predominating. | Local | Common | Low at a local level | Scale may be substituted along much of the route but would be more difficult in proximity to dense residential areas | The scale is unlikely to change | Immersed Tunnel and Bored Tunnel: Slight / Moderate Adverse<br><br>The scale of A1089 and A226 road bridges and road infrastructure would be out of scale with residential areas in proximity to the route.<br><br>Bridge: Moderate Adverse<br><br>Although the scale would be in keeping with large port and industrial development along the river corridor the large bridge and elevated road infrastructure | Consider routing options that minimise indirect impacts on residential areas |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Appearance | Residential areas north of the Thames are mainly 20-21C streets and estates with waterfront flats. There are long, open, expansive horizontal views along the river foreshore dominated by large scale dock, industry, pylons and overhead electricity lines. The river is busy with recreational and commercial boats. South of the river large sections of the route consists of brownfield and urban fringe greenspace. The former opencast site is densely vegetated; other areas consist of open meadow, marsh or rough grass with sparse shrubs. | Local | Common | Medium on a local level | It would be possible to substitute the visual appearance of much of the route | There is some likelihood of appearance to change over time | Immersed Tunnel and Bored Tunnel: Slight Adverse<br>The A1089 and A226 road bridges would create notable changes, potentially visible from residential areas in proximity to the route which would not be possible to mitigate for.<br>There would also be a loss of trees and vegetation forming the setting of residential property on the edge of Thurrock. | Extensive mitigation planting to preserve the green corridor and screen road infrastructure . |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Appearance (cont) | See above | See above | See above | See above | See above | See above | Bridge : Moderate Adverse<br>The large bridge and elevated road infrastructure would be a notable new element in the long open vistas of the Thames visible over distance.<br>The A1089 and A226 road bridges would create notable changes, potentially visible from residential areas in proximity to the route which would not be possible to mitigate for. | See above |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Human interaction | Human interaction varies along the route with high levels of interaction north of the river and areas of both high and low interaction south of the river.<br>Public access along the river front in the form of walkways, waterfront amenity greenspace and viewpoints, is a valuable resource and particularly evident on the north side of the river. | Local | Common | High on a local level | Medium | Likelihood of human interaction to change is Low | Immersed Tunnel, Bored Tunnel and Bridge: Slight / Moderate Adverse<br>There is potential for the road development to sever existing walking and cycle routes in areas of high interaction | Incorporate safe walking and cycling route connections to the existing pedestrian / cycle network including in particular connections to the waterfront and Ebbsfleet International Station. |
| Cultural | 1 listed building within 500m<br>Scheduled monument Roman town of Vagniacis. | National | Rare | High on a National level | Low | Cultural elements are unlikely to change | Immersed Tunnel, Bored Tunnel and Bridge: Large Adverse<br>The assumed illustrative route would impact directly on a<br>Scheduled Monument of national importance resulting in the loss of the whole or part of the Scheduled Monument. | Modify route to avoid damage or destruction of the ancient monument and minimise impacts on locally valued educational and recreational facilities. |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Land use | North - land use consists primarily of dense residential streets to the west with pockets of public recreational space and urban fringe agriculture with large scale industrial and dockland development along the river frontage (east). Thurrock Unitary Development Plan identifies recreational greenspace affected:<br>-LRT4<br>-RIV6(a-e)<br>-LRT3<br>-CFU3(a-e)School Site<br>Thurrock Yacht Club is near the assumed illustrative route.<br>South - river waterfront consists of large scale industry, and energy infrastructure, interspersed with marshland. Hinterland consists of industry, rail infrastructure, brown field and urban fringe greenspace flanked by dense residential areas. | Local | Common | Medium on a local level | Some areas such as recreational open space within the urban fabric would be difficult to substitute however it would be possible to substitute other areas such as brownfield sites. | Likelihood to change of landuse varies along the route. Residential areas are unlikely to change, whereas other areas such as brownfield and industrial areas are likely to change. | Immersed Tunnel, Bored Tunnel and Bridge:<br><br>Slight Adverse due to the loss of locally valued recreational and publicly accessible greenspace within a densely populated urban area. | Consider routing options that avoid impacts on recreational and publicly accessible greenspace. |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Changes in do minimum | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|---|
| Summary of character | Predominantly urban character, distinct areas of residential, industrial and urban fringe greenspace. Residential areas typically dense streets of terraced houses, estates of low rise flatted developments or individual high rise blocks. Properties mainly from 20-21C. | Local | Common in a local context | High on a local level | Some areas such as recreational open space within the urban fabric would be difficult to substitute however it would be possible to substitute other areas such as brownfield sites. | Likelihood to change of character varies along the route.<br><br>Residential areas are unlikely to change, whilst other areas such as brownfield sites have a higher likelihood of change. | Immersed Tunnel and Bored Tunnel: Moderate Adverse<br>A1089 and A226 road bridges would be notable changes to the setting of residential areas flanking the route that cannot be mitigated for.<br>Bridge: Moderate Adverse<br>The large bridge and road infrastructure would be a notable new element in the long open vistas of the Thames and the setting of residential areas that cannot be mitigated for.<br>For all structures The road corridor would impact directly on locally valued urban green space and a nationally valued Scheduled Monument. | Consider routing options that avoid impacts on residential areas and valued townscape /landscape features. |
| | Thames river corridor has a strong identity with large expansive horizontal vistas dominated by very large energy, dock and industrial structures. Mudflats and grassland of the Thames fragmented by waterfront development. | Local | Common in a local context | High on a local level | | | | |
| | Brownfield sites enclosed by security fencing form a corridor of natural grassland or scrub vegetation. | Local | Common in a local context | Low | | | | |
| | Scheduled Monument forms extensive area of natural rough grass and scrub close to A2 (former roman road). | National | Rare in a national context | High on a National Level | | | | |

**Reference Source(s):** WebTag TAG Unit 3.3.8 The Townscape Sub-objective, Department for Transport, December 2004, OS Mapping, Aerial Photography, Thurrock Unitary Development Plan

**Summary assessment score:**

**Bridge:** Moderate Adverse **Bored Tunnel:** Moderate Adverse **Immersed Tunnel**: Moderate Adverse

**Qualitative comments:**

A new cossing at location Option B would introduce either a bored tunnel, immersed tunnel or bridge along with new transport corridors and associated infrastructure into an urban and sub-urban townscape which would affect the setting and local visual amenity of the residential areas. Whilst a bridge would have a greater impact as a dominant feature visible over a wide area, all three crossing types would introduce structures out of scale with the local townscape character, impacting directly and indirectly on locally valued townscape features including school grounds and recreational greenspace. New bridge infrastructure would also be a notable new element in the long open vistas of the Thames and the setting of local residential areas. All three crossing types would also directly impact a Scheduled Monument of national importance; resulting in the loss of the whole or part of this historic landscape feature.

# Appendix G3: Heritage Worksheets

## Worksheet 1 Environment: Heritage of Historic Resources – Plan Level

### Option A

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale it matters** | **Significance** | **Rarity** | **Impact** |
| Form | There are a number of previously recorded heritage assets within 500m of the assumed illustrative route. These vary from prehistoric settlement/ritual sites through to World War II defence installations.<br>No Scheduled Monuments, listed buildings, Registered Parks and Gardens or Registered Battlefields are located within 500m of the assumed illustrative route. | Local and Regional | Although not designated, the number and types of sites are of significance for the information it provides regarding settlement patterns and information of specific site types. | Most of the asset forms are relatively common in terms of frequency. | The assumed illustrative route is likely to impact on assets where previous activity or development has not already done so. In addition, sites in proximity to the assumed illustrative route may suffer impacts on their setting. Those sites directly impacted by the assumed illustrative route are likely to suffer a moderate adverse effect on their form. |
| Survival | The range of survival levels for sites varies with some being poor with no surviving elements whilst other assets can be substantially or wholly preserved within the landscape and have good survival. | Local and Regional | Sites with good survival would usually have higher significance due to the amount of knowledge and/or benefit it can provide to the public. | Uncommon. The differential levels of survival within the assumed illustrative route are possibly slightly worse here than other areas due to the levels of prior development. | The assumed illustrative route is likely to have a moderate or large adverse effect on the survival of those affected cultural heritage sites and lead to a total loss of some assets. |
| Condition | The conditions of the heritage assets range from unmanaged and subject to unmonitored development or agriculture to well protected and preserved. | Local and Regional | Assets in good condition are considered to be of more significant as information would be retained. Sites of poorer condition are likely to be less significant. | Slightly uncommon set of asset conditions. | The assumed illustrative route is likely to cause a slight adverse effect on the condition of assets within the corridor. |

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale it matters** | **Significance** | **Rarity** | **Impact** |
| Complexity | Complexity of individual sites is generally quite limited except where multi-phase sites are known or which have seen repeated exploitation, possibly episodic or seasonal, or types of remains consisting of prolonged settlement. A variety of site types are represented suggesting good complexity. | Local and Regional | The variety of sites would allow different aspects of the past to be examined. Overall an area with a variety of sites would allow greater understanding of the archaeology present. | Typical levels of complexity for the region. | The types of assets affected are present in the area so loss of features would not affect the complexity of the archaeology or built heritage. |
| Context | The context of the known heritage resource is currently fairly urbanised with isolated pockets of rural land. | Local and Regional | Survival of sites is improved in the rural sections of the study area. Other sites have been discovered due to development in the area. These are typical settings for the built heritage sites. | This context is common within the region. | A number of sites would have their setting affected. This is likely to result in a slight adverse effect where sites are separated from interrelated assets and the legibility of the assets is reduced. |
| Period | Periods represented range from the prehistoric through to the modern (20th century). | Local and Regional | Typical periods for these forms of sites. | Typical of the region. | Slight adverse. |

**Reference Source(s):** WebTag TAG Unit 3.3.9 The Heritage or Historic Resources Sub-objective, Department for Transport, June 2003. Data from the National Monuments Record, Essex Historic Environment Record and Kent Historic Environment Record.

**Summary assessment score:** Moderate Adverse

**Qualitative comments:** The assumed illustrative route would only be likely to affect a limited number of known cultural heritage sites. However there would be direct physical effects. No setting impact on designated sites is anticipated although some undesignated sites could be affected. The summary assessment score is based on the worst impact.

## Worksheet 1 Environment: Heritage of Historic Resources – Plan Level

### Option B

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale** | **Significance** | **Rarity** | **Impact** |
| Form | The forms of the heritage assets vary in relation to the period in which they belong. The Scheduled Monuments range from Palaeolithic find spots and Neolithic ritual monuments to a temple and the Roman town of Vagniacis. Forms of listed buildings reflect the purpose for which they were constructed. | Local, Regional and National | There are four Scheduled Monuments and numerous listed buildings. The variety of sites allows information about past settlement to be identified. | Some of the known forms are rare, even nationally, such as Vagniacis, whilst other forms are typical on a regional and national basis. | The impact on the form of heritage assets would vary depending on the proximity and amount of physical overlap between sites and the assumed illustrative route. Any direct impact would result in an adverse effect. Moderate adverse. |
| Survival | Survival rates range from none/poor to good. A number of sites are known as subsurface remains whose survival level is unknown and could range from completely truncated to good *in situ* preservation such as the Palaeolithic butchery site at Southfleet Road. | Local, Regional and National | The level of survival is likely to be directly related to the significance of the site with those particularly good examples being designated or of equal significance. | Common | A number of sites are likely to have their survival level directly affected by the assumed illustrative route. |
| Condition | Condition of the sites varies. Some areas are degraded, while other features are better protected through management and upkeep. Others have been demolished. Some structures are still in use. The condition of subsurface remains is not monitored and thus unknown. | Local, Regional and National | Some sites built over or removed. Condition of other sites unknown. Many of these sites have been disturbed by farming or building. Good condition and management of other sites means they would continue to survive and provide information. | Common | The assumed illustrative route is likely to have an adverse effect on some of the historic resource although may have beneficial aspects by improving access to others or removing traffic from current areas of built heritage allowing better management of their condition. |

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale** | **Significance** | **Rarity** | **Impact** |
| Complexity | Multiple styles and periods are represented in the area with buildings and monuments from many different periods being seen including the Scheduled Monument and listed buildings. | Local, Regional and National | The variety of sites would allow different aspects of the past to be examined. Overall an area with a variety of sites would allow greater understanding of the archaeology present. | Common | The types of assets affected are present in the area so loss of features would not affect the complexity of the archaeology or built heritage. |
| Context | Mainly rural on the fringe of urban areas although some parts are also previous quarry/mineral extraction sites now used as nature reserves/heritage parks. | Local, Regional and National | Survival of sites is improved in the rural sections of the study area. Other sites have been discovered due to development in the area. These are typical settings for the built heritage sites. | Common | The alteration of the context of many of the sites would lead to an adverse impact. |
| Period | Every period is represented within the known heritage record within the assumed illustrative route from lower Palaeolithic to the 20th century. | Local, Regional and National | Generally typical for the periods represented although the Palaeolithic sites are of greater significance due to their rarity. | Rare in terms of the Palaeolithic and Neolithic Scheduled Monuments which are not well represented nationally. Sites of other date common. | The loss of or disturbance to sites of nationally rare periods is likely to result in a large adverse impact. Other impacts on more frequently represented period types are anticipated to be lower. |

**Reference Source(s):** WebTag TAG Unit 3.3.9 The Heritage of Historic Resources Sub-objective, Department for Transport, June 2003. Data from the National Monuments Record, Essex Historic Environment Record and Kent Historic Environment Record.

**Summary assessment score:** Large Adverse

**Qualitative comments:** The assumed illustrative route would likely to impact on a number of previously recorded cultural heritage sites including the Scheduled Roman settlement of Vagniacis. The assumed illustrative route would affect the setting of several more heritage sites including two Palaeolithic and Neolithic Scheduled Monuments. The summary assessment score is based on the worst impact.

## Worksheet 1 Environment: Heritage of Historic Resources - Plan Level

### Option: C

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale it matters** | **Significance** | **Rarity** | **Impact** |
| Form | The forms represented within 500m of the assumed illustrative route include several Scheduled Monuments and an extensive Roman settlement known from cropmarks. Several Conservation Areas and a number of listed buildings are also recorded, along with a variety of non-designated assets. | Local, Regional & National | There are six Scheduled Monuments and numerous listed buildings. The variety of sites allows information about past settlement to be identified. | Causeway enclosures are rare although at least three are known from Essex.<br>The majority of other site types are common. | Impacts on form are considered to be large adverse on the Neolithic causewayed enclosure and the Iron Age settlement and the Bronze or Iron Age spring field style enclosures near to Orsett. There is a lower level of impact on other sites. |
| Survival | Survival ranges from none/poor to good. Examples of sites with those sites with poor survival include find spots whilst the good survival of some areas has directly lead to their status as conservation areas. Survival levels of subsurface archaeological sites are unclear. | Local, Regional & National | Good preservation would be a factor in the designation of sites and structures and the continued use of others. Features which survive better would yield more information. However, there are non-designated archaeological sites of potential national importance within 500m of the assumed illustrative route. | Common | A number of sites along the assumed illustrative route would be directly impacted. These impacts are likely to be slight to large adverse. |

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale it matters** | **Significance** | **Rarity** | **Impact** |
| Condition | The condition varies although a number of the designated sites are under protection and are in good condition. However, the Orsett causewayed enclosure is on the English Heritage 'At Risk' register. | Local, Regional & National | Some sites built over or removed. Condition of other sites unknown. Many of these sites have been disturbed by farming or building. Good condition and management of other sites means they would continue to survive and provide information. | Common | The assumed illustrative route is likely to have an adverse effect on the condition of any asset encountered. This is due to the partial or complete loss, particularly of those assets already in poor condition who are vulnerable to change. |
| Complexity | Multiple styles and periods are represented in the area with buildings and monuments from many different periods being seen including the Scheduled Monuments and listed buildings. | Local, Regional & National | The variety of sites would allow different aspects of the past to be examined. Overall an area with a variety of sites would allow greater understanding of the archaeology present. | Uncommon | The types of assets affected are present in the area so loss of features would not affect the complexity of the archaeology or built heritage. |
| Context | The context of the route and sites is now mainly rural alongside small well-preserved villages. | Local, Regional & National | The rural nature of much of the route corridor has led to the survival of features which increases their significance. | Common | The alteration of the context of many of the sites would lead to an adverse impact. |
| Period | All periods from prehistoric to the 20th century are represented. | Local, Regional & National | Typical periods for these forms of sites. | Common | Loss of part of entire of any period specific or multi-period site would be particularly damaging. |

**Reference Source(s):** WebTag TAG Unit 3.3.9 The Heritage of Historic Resources Sub-objective, Department for Transport, June 2003. Data from the National Monuments Record, Essex Historic Environment Record and Kent Historic Environment Record.

**Summary assessment score:** Large Adverse Effect

**Qualitative comments:** The assumed illustrative route would impact directly on at least two Scheduled Monuments and pass in close proximity to a third. A new crossing at location Option C would involve impacts on both the physical remains and the setting of features. The setting of a number of Conservation Areas and listed buildings would also be affected. The summary assessment score is based on the worst impact.

## Worksheet 1 Environment: Heritage of Historic Resources - Plan Level

### Option $C_{variant}$

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale it matters** | **Significance** | **Rarity** | **Impact** |
| Form | The forms represented within 500m of the assumed illustrative route include several Scheduled Monuments and an extensive Roman settlement known from cropmarks. Several conservation areas and a number of listed buildings are also recorded, along with a variety of non-designated assets. | Local, Regional and National | There are nine Scheduled Monuments and numerous listed buildings. The variety of sites allows information about past settlement to be identified. | Causeway enclosures are rare although at least three are known from Essex.<br>The majority of other site types are common. | Impacts on form are considered to be large adverse on the Neolithic causewayed enclosure and Iron Age settlement and the Bronze or Iron Age spring field style enclosures near to Orsett. There is a lower level of impact on other sites. |
| Survival | Survival ranges from none/poor to good. Examples of sites with those sites with poor survival include find spots whilst the good survival of some areas has directly lead to their status as conservation areas. Survival levels of subsurface archaeological sites are unclear. | Local, Regional and National | Good preservation would be a factor in the designation of sites and structures and the continued use of others. Features which survive better would yield more information. However, there are non-designated archaeological sites of potential national importance within 500m of the assumed illustrative route. | Common | A number of sites along the assumed illustrative route would be directly impacted These impacts are likely to be slight to large adverse. |

| Part 1 | | Part 2 | | | Part 3 |
|---|---|---|---|---|---|
| **Feature** | **Description** | **Scale it matters** | **Significance** | **Rarity** | **Impact** |
| Condition | The condition varies although a number of the designated sites are under protection and are in good condition. However, the Orsett causewayed enclosure is on the English Heritage 'At Risk' register. | Local, Regional and National | Some sites built over or removed. Condition of other sites unknown. Many of these sites have been disturbed by farming or building. Good condition and management of other sites means they would continue to survive and provide information. | Common | The assumed illustrative route is likely to have an adverse effect on the condition of any asset encountered. This is due to the partial or complete loss, particularly of those assets already in poor condition who are vulnerable to change. |
| Complexity | Multiple styles and periods are represented in the area with buildings and monuments from many different periods being seen including the Scheduled Monuments and listed buildings. | Local, Regional and National | The variety of sites would allow different aspects of the past to be examined. Overall an area with a variety of sites would allow greater understanding of the archaeology present. | Uncommon | The types of assets affected are present in the area so loss of features would not affect the complexity of the archaeology or built heritage. |
| Context | The context of the assumed illustrative route and sites is now mainly rural alongside small well-preserved villages. | Local, Regional and National | The rural nature of much of the assumed illustrative route has led to the survival of features which increases their significance. | Common | The alteration of the context of many of the sites would lead to an adverse impact. |
| Period | All periods from prehistoric to the 20th century are represented. | Local, Regional and National | Typical periods for these forms of sites. | Common | Loss of part of entire of any period specific or multi-period site would be particularly damaging. |

**Reference Source(s):** WebTag TAG Unit 3.3.9 The Heritage of Historic Resources Sub-objective, Department for Transport, June 2003. Data from the National Monuments Record, Essex Historic Environment Record and Kent Historic Environment Record.

**Summary assessment score:** Large Adverse Effect

**Qualitative comments:** The assumed illustrative route would impact directly on at least two Scheduled Monuments and pass in close proximity to a third. A new crossing at location Option C, including widening the A229 between the M2 and M20, would involve impacts on both the physical remains and the setting of features. The setting of a number of Conservation Areas and listed buildings would also be affected. The summary assessment score is based on the worst impact.

# Appendix G4: Water Environment Worksheets

## Worksheet 1 Environment: Water Environment – Plan Level

### Option A

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Morphological changes to River Thames due to river crossing | River Thames | Water supply / biodiversity / recreation / conveyance of flow | **High**<br>Marine Conservation Zone. Heavily modified water body at Moderate Ecological Potential and failing Chemical Status. Designated under the Freshwater Fish Directive Important river of national significance with commercial and social value, including depository for effluent discharges, abstraction of water supply, recreation and, navigation. | Regional | Rare | N/A | Very Important | Bridge: Minor (in the context of the size of this water body and similar nearby structures) | Significant (a WFD appraisal will also be required for this option) |
| | | | | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Immersed tunnel: Moderate | Highly Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | River Thames | Water supply / biodiversity / recreation / conveyance of flow | **High**<br>Marine Conservation Zone.<br>Heavily modified water body at Moderate Ecological Potential and failing Chemical Status.<br>Designated under the Freshwater Fish Directive<br>Important river of national significance with commercial and social value, including depository for effluent discharges, abstraction of water supply, recreation and, navigation. | Regional | Rare | N/A | Very Important | Bridge: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed when discharged following being pumped from the tunnel. | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Immersed tunnel: Negligible (see comment for bored tunnel) | Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Mar Dyke<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | Mar Dyke and associated drainage ditches | Biodiversity / recreation / conveyance of flow | The Mar Dyke is currently at Moderate Ecological Status under the WFD.<br>Designated under the Freshwater Fish Directive. | Local | Not rare | N/A | High | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |
| Study Area: Possible drain along A282<br>Potential Impacts: Morphological changes to possible drain along A282 | Possible drain along A282 | Biodiversity / recreation / conveyance of flow | Medium (precautionary)<br>No water quality data available at this stage. Could support protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | Medium | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridge could reduce this effect) | Low Significance |
| Study Area: Possible drain along A282<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | | | | Local | Not rare | N/A | Medium | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Groundwater abstraction for public supply or food/drink production at some distance (SPZ3).<br>Potential Impacts will be greater for the bridge option than either tunnel; effect likely to be diluted due to distance from abstraction, though impact possible. | Ground-water | Groundwater abstraction | In area of SPZ3 in the southern portion of route. | Local | No infor-mation avail-able | No information available – assume substitution not possible | Medium | Minor | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account). Potential Impacts: Direct risk of flooding to highway or construction site from watercourse or tidal source (Thames). | Fluvial and tidal floodplain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant floodplain associated with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Bridge: Moderate | Significant |
| | | | | | | | | Bored tunnel: Moderate | Significant |
| | | | | | | | | Immersed tunnel: Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Loss of flood storage volume (including loss through impedance of flood flows) due to the development or due to spoil storage during construction, leading to increased flooding elsewhere. | Fluvial and tidal floodplain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant floodplain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Bridge: Moderate | Significant |
| | | | | | | | | Bored tunnel: Moderate | Significant |
| | | | | | | | | Immersed tunnel: Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Increasing flood risk by affecting flood defences or river flows during construction or operation. | Fluvial and tidal floodplain to the north and south of the River Thames.<br>Defences along the north and south banks of the River Thames. | Conveyance and storage of flood flows.<br>Defence against flood flows. | Significant floodplain associated with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Bridge: Moderate | Significant |
| | | | | | | | | Bored tunnel: Moderate | Significant |
| | | | | | | | | Immersed tunnel: Moderate | Significant |
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of afflux flooding (upstream) due to crossing of watercourse or land drain. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of increased runoff to watercourse or land drain causing increase in flood risk from watercourse. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of flooding resulting from change in watercourse/drain flow regime due to morphological changes for development | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Areas surrounding proposed route.<br>Potential Impacts: Risk of flooding from overland surface water flows. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible<br>(assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from groundwater. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible<br>(assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from drains, sewers, and water mains. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible<br>(assuming appropriate design) | Insignificant – Low Significance |

**Reference Source(s):** WebTag TAG Unit 3.3.11 The Water Environment Sub-objective, Department for Transport, June 2003

**Summary assessment score:**

**Bridge:** Moderate Adverse **Bored tunnel**: Moderate Adverse **Immersed tunnel:** Large Adverse

**Qualitative comments:**

**Surface water**

An immersed tunnel could have significant effects on the hydromorphology of River Thames, if not completely submerged underneath the river bed. Although not considered specifically within the above WebTAG table (since this covers only operational effects), the risk from construction activities is also expected to be greater than either a bridge or bored tunnel.

If a new bridge crossing was provided, the design would need to be developed to minimise any impact on sensitive intertidal and riparian margins to the River Thames.

Both bridge and immersed tunnel crossings would be likely to require a Water Framework Directive appraisal due to the potential for direct effects on biological, chemical and physical WFD parameters.

In terms of operation, it is assumed that during the drainage design appropriate risk assessment of runoff and spillage risk would be carried out in accordance with the DMRB's HD45/09, to ensure that adequate treatment and spillage containment facilities are provided. These could include sustainable drainage systems (SuDS) such as swales, ponds, wetlands, or conventional measures such as storage tanks and oil interceptors where there are space constraints.

**Groundwater**

A Source Protection Zone 3 (SPZ3) is potentially affected by the assumed illustrative route to the south of the River Thames. An impact is considered possible although the effect is likely to be diluted due to the distance from the abstraction. If a new crossing was provided at location Option A, a quantitative risk assessment would need to be undertaken to account for dilution and attenuation effects. Potential impacts on this groundwater abstraction would be greater for a bridge crossing than for a tunnel. This is because a tunnel crossing would be likely to have a more enclosed drainage system (less risk of pollutants escaping which could enter the groundwater and migrate to receptors such as SPZs) than a bridge for the operational phase. Also, during construction and possibly during operation, a tunnel would have a groundwater dewatering system which would draw local groundwater flows towards the tunnel. This would prevent any contaminants entering the groundwater from migrating away towards receptors such as SPZs.

**Flood risk**

All three potential crossing types involve a risk of increasing flood risk or being impacted upon by flood risk. Appropriate design would be required to ensure that the overall impact on flood risk was reduced to a negligible level at a future design stage. The potential impacts are considered to be significant at this stage (as they are potentially of moderate magnitude) and would need to be mitigated at design stage. It is possible that with appropriate design these potential significant adverse effects could be overcome, although more detailed information would be required and further investigation to be carried out, to overcome the current uncertainty.

## Worksheet 1 Environment: Water Environment – Plan Level

### Option B

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Morphological changes to River Thames due to river crossing | River Thames | Water supply/ Biodiversity/ Recreation/ Conveyance of flow | **High**<br>Marine Conservation Zone.<br>Heavily modified water body at Moderate Ecological Potential & failing Chemical Status.<br>Designated under the Freshwater Fish Directive<br>Important river of national significance with commercial and social value, including depository for effluent discharges, abstraction of water supply, recreation and, navigation | Regional | Rare | N/A | Very Important | Bridge: Minor (in the context of the size of this water body and similar nearby structures) | Significant (a WFD appraisal will also be required for this option) |
| | | | | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Immersed tunnel: Moderate | Highly Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | See above | See above | See above | Regional | Rare | N/A | Very Important | Bridge: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed when discharged following being pumped from the tunnel. | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Immersed tunnel: Negligible (see comment for bored tunnel) | Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Minor watercourses, drainage ditches and ponds at Swanscombe Marshes<br>Potential Impacts: Morphological changes to minor watercourses, drainage ditches and ponds at Swanscombe Marshes | Minor watercourses, drainage ditches and ponds at Swans-combe Marshes | Biodiversity / recreation / conveyance of flow | **Medium (precautionary)**<br>No water quality data available at this stage. Could support Protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | Medium | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridged could reduce this effect) | Low Significance |
| Study Area: Minor watercourses, drainage ditches and ponds at Swanscombe Marshes<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | Minor watercourses, drainage ditches and ponds at Swans-combe Marshes | Biodiversity / recreation / conveyance of flow | **Medium (precautionary)**<br>No water quality data available at this stage. Could support Protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | Medium | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Groundwater abstraction for public supply or food/drink production (SPZ1) is clipped by route in the south.<br>Potential Impacts will be similar for all three options, as it is only a portion of the supporting road network that encounters the SPZ1. | Ground-water | Groundwater abstraction | Abstraction for public supply or food/drink production | local | No infor-mation avail-able | No information available – assume substitution not possible | High | Minor | Low Significance (could be mitigated by shifting route to the west, and downgraded to Insignificant) |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Direct risk of flooding to highway or construction site from watercourse or tidal source (Thames). | Fluvial and tidal flood plain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant flood plain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Bridge: Moderate | Significant |
| | | | | | | | | Bored tunnel: Moderate | Significant |
| | | | | | | | | Immersed tunnel: Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Loss of flood storage volume (including loss through impedance of flood flows) due to the development or due to spoil storage during construction, leading to increased flooding elsewhere. | Fluvial and tidal flood plain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant flood plain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Bridge: Moderate | Significant |
| | | | | | | | | Bored tunnel: Moderate | Significant |
| | | | | | | | | Immersed tunnel: Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account). Potential Impacts: Increasing flood risk by affecting flood defences or river flows during construction or operation. | Fluvial and tidal flood plain to the north and south of the River Thames. Defences along the north and south banks of the River Thames. | Conveyance and storage of flood flows. Defence against flood flows | Significant flood plain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Bridge: Moderate | Significant |
| | | | | | | | | Bored tunnel: Moderate | Significant |
| | | | | | | | | Immersed tunnel: Moderate | Significant |
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches. Potential Impacts: Risk of afflux flooding (upstream) due to crossing of watercourse or land drain. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of increased runoff to watercourse or land drain causing increase in flood risk from watercourse. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of flooding resulting from change in watercourse/drain flow regime due to morphological changes for development | -<br>Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from overland flow. | - People and property | Various flood plains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from groundwater. | People and property | Various flood plains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from drains, sewers, and water mains. | People and property | Various flood plains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |

**Reference Source(s):** WebTag TAG Unit 3.3.11 The Water Environment Sub-objective, Department for Transport, June 2003

**Summary assessment score:**

**Bridge:** Moderate Adverse **Bored tunnel**: Moderate Adverse **Immersed tunnel:** Large Adverse

**Qualitative comments:**

**Surface water**

An immersed tunnel could have significant effects on the hydromorphology of River Thames, if not completely submerged underneath the river bed. Although not considered specifically within the above WebTAG table (since this covers only operational effects), the risk from construction activities is also expected to be greater than either a bridge or bored tunnel.

If a new bridge crossing was provided, the design would need to be developed to minimise any impact on sensitive intertidal and riparian margins to the River Thames.

Both bridge and immersed tunnel crossings would be likely to require a Water Framework Directive appraisal due to the potential for direct effects on biological, chemical and physical WFD parameters.

In terms of operation, it is assumed that during the drainage design appropriate risk assessment of runoff and spillage risk would be carried out in accordance with the DMRB's HD45/09, to ensure that adequate treatment and spillage containment facilities are provided. These could include sustainable drainage systems (SuDS) such as swales, ponds, wetlands, or conventional measures such as storage tanks and oil interceptors where there are space constraints.

**Groundwater**

A Source Protection Zone 1 (SPZ1) is potentially affected by the assumed illustrative route to the south of the River Thames. SPZ1 could be avoided by moving the assumed illustrative route slightly to the west. Potential impacts on this groundwater abstraction would be similar for all three river crossing types (bridge, bored tunnel or immersed tunnel).

**Flood risk**

All three potential crossing types involve a risk of increasing flood risk or being impacted upon by flood risk. Appropriate design would be required to ensure that the overall impact on flood risk was reduced to a negligible level at a future design stage. The potential impacts are considered to be significant at this stage (as they are potentially of moderate magnitude) and would need to be mitigated at design stage. It is possible that with appropriate design these potential significant adverse effects could be overcome, although more detailed information would be required and further investigation to be carried out, to overcome the current uncertainty.

## Worksheet 1 Environment: Water Environment – Plan Level

### Option C

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Morphological changes to River Thames due to road crossing | River Thames | Water supply / biodiversity / recreation / conveyance of flow | **High**<br>Marine Conservation Zone.<br>Heavily modified water body at Moderate Ecological Potential &<br>failing Chemical Status.<br>Designated under the Freshwater Fish Directive<br>Important river of national significance with commercial and social value, including depository for effluent discharges, abstraction of water supply, recreation and, navigation | Regional | Rare | N/A | Very Important | Bridge: Minor (in the context of the size of this water body and similar nearby structures) | Significant (a WFD appraisal will also be required for this option) |
| | | | | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible | Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Morphological changes to River Thames due to road crossing<br>(contd) | See above | See above | See above | Regional | Rare | N/A | Very Important | Immersed tunnel: Moderate | Highly Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Routine runoff and spillage risk during operation of the new road | See above | See above | See above | Regional | Rare | N/A | Very Important | Bridge:<br>Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Bored / Immersed tunnel: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed when discharged following being pumped from the tunnel. | Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Mar Dyke<br>Potential Impacts: Morphological changes to Mar Dyke due to road crossing | Mar Dyke and associated drainage ditches | Biodiversity / recreation / conveyance of flow | Mar Dyke is currently at Moderate Ecological Status under the WFD.<br>Designated under the Freshwater Fish Directive. | Local | Not rare | N/A | High | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridged could reduce this effect) | Significant |
| Study Area: Mar Dyke and West Tilbury Main<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | See above | See above | See above | Local | Not rare | N/A | High | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Minor watercourses and drainage ditches at West / East Tilbury Marshes<br>Potential Impacts: Morphological changes due to diversions and crossings | Minor watercourses and drainage ditches at Swans-combe Marshes | Biodiversity / recreation / conveyance of flow | **Medium (precautionary)** No water quality data available at this stage. Could support protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | Medium | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridged could reduce this effect) | Low Significance |
| Study Area: Minor watercourses and drainage ditches at West / East Tilbury Marshes<br>Potential Impacts:<br>Routine runoff and spillage risk during operation of the new road | | | | Local | Not rare | N/A | Medium | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Minor watercourses and drainage ditches at Shorne Marshes<br>Potential Impacts: Morphological changes to minor watercourses and drainage ditches at Swanscombe Marshes | Minor water-courses and drainage ditches at Swans-combe Marshes | Biodiversity / recreation / conveyance of flow | **Medium (precautionary)**<br>No water quality data available at this stage. Drainage ditches form part of the Shorne – Ashenbank Woods SSSI. Could also support Protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | High | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridged could reduce this effect) | Significant |
| Study Area: Minor watercourses and drainage ditches at Shorne Marshes<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | | | | Local | Not rare | N/A | High | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |
| Pond and possible recreational fishing lake at Shorne Wood Country Park in Randall Wood<br>Potential Impacts: Morphological changes due to road alignment | Pond and fishing lake | Biodiversity / Recreation | No information | Local | Not rare | Substitutable | Medium | Minor (assumed illustrative route passes close to but does not go through this water body) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Groundwater abstraction for public supply or food/drink production at some distance (SPZ3).<br>Potential impacts to groundwater abstraction will be greater for the bridge option than either tunnel; effect likely to be diluted due to distance from abstraction, though impact possible. | Ground-water | Groundwater abstraction | In areas of SPZ3 for two abstractions | Local | No infor-mation avail-able | No information available- assume substitution not possible | Medium | Minor | Insignificant |
| Study Area: Groundwater feeding a SSSI.<br>Potential impacts to groundwater feeding the SSSI will be greater for the two tunnels than for the bridge. | Ground-water in the vicinity of South Thames Estuary and Marshes | South Thames Estuary and Marshes SSSI | Unknown | National | Rare | No information available- assume substitution not possible | High | Minor | Low Significance (no easy mitigation predicted) |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Direct risk of flooding to highway or construction site from watercourse or tidal source (Thames). | Fluvial and tidal floodplain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant floodplain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Loss of flood storage volume (including loss through impedance of flood flows) due to the development or due to spoil storage during construction, leading to increased flooding elsewhere. | Fluvial and tidal floodplain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant floodplain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Increasing flood risk by affecting flood defences or river flows during construction or operation. | Fluvial and tidal floodplain to the north and south of the River Thames.<br>Defences along the north and south banks of the River Thames. | Conveyance and storage of flood flows. Defence against flood flows | Significant floodplain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Direct risk of flooding to highway or construction site from watercourse. | - Fluvial Flood-plain around Mar Dyke | Conveyance and storage of flood flows. | Significant floodplain associate with mar Dyke and smaller watercourses. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Loss of flood storage volume (including loss through impedance of flood flows) due to the development or due to spoil storage during construction, leading to increased flooding elsewhere. | - Fluvial Flood-plain around Mar Dyke | Conveyance and storage of flood flows. | Significant floodplain associate with mar Dyke and smaller watercourses. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Increasing flood risk by affecting flood defences or river flows during construction or operation. | Fluvial floodplain around Mar Dyke<br>Defences around Mar Dyke and smaller water-courses | Conveyance and storage of flood flows. Defence against flood flows | Significant floodplain associate with mar Dyke and smaller watercourses. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of afflux flooding (upstream) due to crossing of watercourse or land drain. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main Drainage network around Mar Dyke. Various drainage features around the northern end of the route. Various drainage features around the southern end of the route. | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of increased runoff to watercourse or land drain causing increase in flood risk from watercourse. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main<br>Drainage network around Mar Dyke.<br>Various drainage features around the northern end of the route.<br>Various drainage features around the southern end of the route. | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br><br>Potential Impacts: Risk of flooding resulting from change in watercourse/drain flow regime due to morphological changes for development | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main<br>Drainage network around Mar Dyke.<br>Various drainage features around the northern end of the route.<br>Various drainage features around the southern end of the route. | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from overland flow. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from groundwater. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from drains, sewers, and water mains. | - People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |

**Reference Source(s):** WebTag TAG Unit 3.3.11 The Water Environment Sub-objective, Department for Transport, June 2003

**Summary assessment score:**

**Bridge:** Moderate Adverse **Bored tunnel**: Moderate Adverse **Immersed tunnel:** Large Adverse

**Qualitative comments:**

**Surface water**

An immersed tunnel could have significant effects on the hydromorphology of River Thames, if not completely submerged underneath the river bed. Although not considered specifically within the above WebTAG table (since this covers only operational effects), the risk from construction activities is also expected to be greater than either a bridge or bored tunnel.

If a new bridge crossing was provided, the design would need to be developed to minimise any impact on sensitive intertidal and riparian margins to the River Thames.

Both bridge and immersed tunnel crossings would be likely to require a Water Framework Directive appraisal due to the potential for direct effects on biological, chemical and physical WFD parameters.

In terms of operation, it is assumed that during the drainage design appropriate risk assessment of runoff and spillage risk would be carried out in accordance with the DMRB's HD45/09, to ensure that adequate treatment and spillage containment facilities are provided. These could include sustainable drainage systems (SuDS) such as swales, ponds, wetlands, or conventional measures such as storage tanks and oil interceptors where there are space constraints.

**Groundwater**

Two Source Protection Zones 3 (SPZ3s) are potentially affected by the assumed illustrative route. An impact is considered possible although the effect is likely to be diluted due to the distance from the abstraction. If a new crossing was provided at location Option C then a quantitative risk assessment would need to be undertaken to account for dilution and attenuation effects. Potential impacts on this groundwater abstraction would be greater for a bridge crossing than for a tunnel. This is because a tunnel crossing would be likely to have a more enclosed drainage system (less risk of pollutants escaping which could enter the groundwater and migrate to receptors such as SPZs) than a bridge for the operational phase. Also, during construction and possibly during operation, a tunnel would have a groundwater dewatering system which would draw local groundwater flows towards the tunnel. This would prevent any contaminants entering the groundwater from migrating away towards receptors such as SPZs.

Groundwater feeding the South Thames Estuary and Marshes could be affected. The impact is likely to be greater for a bored tunnel, followed by the immersed tunnel. A bridge crossing would be likely to have minimal impact on any groundwater feeding the SSSI.

**Flood risk**

All three potential crossing types involve a risk of increasing flood risk or being impacted upon by flood risk. Appropriate design would be required to ensure that the overall impact on flood risk was reduced to a negligible level at a future design stage. The potential impacts are considered to be significant at this stage (as they are potentially of moderate magnitude) and would need to be mitigated at design stage. It is possible that with appropriate design these potential significant adverse effects could be overcome, although more detailed information would be required and further investigation to be carried out, to overcome the current uncertainty.

## Worksheet 1 Environment: Water Environment – Plan Level

### Option $C_{variant}$

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Morphological changes to River Thames due to road crossing | River Thames | Water supply / biodiversity / recreation / conveyance of flow | **High**<br>Marine conservation Zone.<br>Heavily modified water body at Moderate Ecological Potential & failing Chemical Status.<br>Designated under the Freshwater Fish Directive<br>Important river of national significance with commercial and social value, including depository for effluent discharges, abstraction of water supply, recreation and, navigation | Regional | Rare | N/A | Very Important | Bridge: Minor (in the context of the size of this water body and similar nearby structures) | Significant (a WFD appraisal will also be required for this option) |
| | | | | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Immersed tunnel: Moderate | Highly Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: River Thames<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | | | | Regional | Rare | N/A | Very Important | Bridge: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Low Significance |
| See above | See above | See above | See above | Regional | Rare | N/A | Very Important | Bored tunnel: Negligible (assuming appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed when discharged following being pumped from the tunnel. | Low Significance |
| | | | | Regional | Rare | N/A | Very Important | Immersed tunnel: Negligible (see comment for bored tunnel) | Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Mar Dyke<br>Potential Impacts: Morphological changes to Mar Dyke due to road crossing | Mar Dyke and associated drainage ditches | Biodiversity / recreation / conveyance of flow | The Mar Dyke is currently at Moderate Ecological Status under the WFD.<br>Designated under the Freshwater Fish Directive. | Local | Not rare | N/A | High | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridged could reduce this effect) | Significant |
| Study Area: Mar Dyke and West Tilbury Main<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | Mar Dyke and associated drainage ditches | Biodiversity / recreation / conveyance of flow | The Mar Dyke is currently at Moderate Ecological Status under the WFD.<br>Designated under the Freshwater Fish Directive. | Local | Not rare | N/A | High | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Minor watercourses and drainage ditches at West / East Tilbury Marshes<br>Potential Impacts: Morphological changes due to diversions and crossings | Minor watercourses and drainage ditches at Swans-combe Marshes | Biodiversity / recreation / conveyance of flow | **Medium (precautionary)**<br>No water quality data available at this stage. Could support protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | Medium | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridge could reduce this effect) | Low Significance |
| Study Area: Minor watercourses and drainage ditches at West / East Tilbury Marshes<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | | | | Local | Not rare | N/A | Medium | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Minor watercourses and drainage ditches at Shorne Marshes<br>Potential Impacts: Morphological changes to minor watercourses and drainage ditches at Swanscombe Marshes | Minor water-courses and drainage ditches at Swans-combe Marshes | Biodiversity / recreation / conveyance of flow | **Medium (precautionary)**<br>No water quality data available at this stage. Drainage ditches form part of the Shorne – Ashenbank Woods SSSI. Could also support protected ecological species. It is not known whether these water bodies have any intrinsic social or economic value. | Local | Not rare | N/A | High | Moderate (assuming that part of the water body will be directly impacted by the placement of a new structure (open span bridged could reduce this effect) | Significant |
| Study Area: Minor watercourses and drainage ditches at Shorne Marshes<br>Potential Impacts: Routine runoff and spillage risk during operation of the new road | | | | Local | Not rare | N/A | High | Negligible (assume appropriate assessment of the new roads runoff and spillage risk is carried out and treatment / containment measures proposed) | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Pond and possible recreational fishing lake at Shorne Wood Country Park in Randall Wood<br>Potential Impacts: Morphological changes due to road alignment | Pond and fishing lake | Biodiversity / Recreation | No information | Local | Not rare | Substitutable | Medium | Minor (assumed illustrative route passes close to but does not go through this water body) | Insignificant |
| Study Area: Groundwater abstraction for public supply or food/drink production at some distance (SPZ3).<br>Potential Impacts to groundwater abstraction will be greater for the bridge option than either tunnel; effect likely to be diluted due to distance from abstraction, though impact possible. | Ground-water | Groundwater abstraction | In areas of SPZ3 for two abstraction | Local | No inform ation avail-able | No information available- assume substitution not possible | Medium | Minor | Insignificant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Groundwater feeding a SSSI.<br>Potential impacts to groundwater feeding the SSSI will be greater for the two tunnels than for the bridge. | Ground-water in the vicinity of South Thames Estuary and Marshes | South Thames Estuary and Marshes SSSI | Unknown | National | Rare | No information available- assume substitution not possible | High | Minor | Low Significance (no easy mitigation predicted) |
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Direct risk of flooding to highway or construction site from watercourse or tidal source (Thames). | Fluvial and tidal floodplain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant floodplain associate with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Loss of flood storage volume (including loss through impedance of flood flows) due to the development or due to spoil storage during construction, leading to increased flooding elsewhere. | Fluvial and tidal floodplain to the north and south of the River Thames. | Conveyance and storage of flood flows. | Significant floodplain associated with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Increasing flood risk by affecting flood defences or river flows during construction or operation. | Fluvial and tidal floodplain to the north and south of the River Thames.<br>Defences along the north and south banks of the River Thames. | Conveyance and storage of flood flows. Defence against flood flows | Significant floodplain associated with the River Thames and smaller watercourses including West Tilbury Main. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Direct risk of flooding to highway or construction site from watercourse. | - Fluvial Floodplain around Mar Dyke | Conveyance and storage of flood flows. | Significant floodplain associate with mar Dyke and smaller watercourses. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Loss of flood storage volume (including loss through impedance of flood flows) due to the development or due to spoil storage during construction, leading to increased flooding elsewhere. | Fluvial floodplain around Mar Dyke | Conveyance and storage of flood flows. | Significant floodplain associate with Mar Dyke and smaller watercourses. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Flood Zone 2/3 and associated defences (Note that area at risk may be greater than the current Flood Zone 2/3 extent when climate change projections are taken into account).<br>Potential Impacts: Increasing flood risk by affecting flood defences or river flows during construction or operation. | Fluvial floodplain around Mar Dyke<br>Defences around Mar Dyke and smaller water-courses | Conveyance and storage of flood flows. Defence against flood flows | Significant floodplain associate with Mar Dyke and smaller watercourses. | Local | N/A | Limited potential for substitution | High | Moderate | Significant |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of afflux flooding (upstream) due to crossing of watercourse or land drain. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main<br>Drainage network around Mar Dyke.<br>Various drainage features around the northern end of the route.<br>- Various drainage features around the southern end of the route. | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of increased runoff to watercourse or land drain causing increase in flood risk from watercourse. | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main<br>Drainage network around Mar Dyke.<br>Various drainage features around the northern end of the route.<br>Various drainage features around the southern end of the route. | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Area surrounding Main Rivers, Ordinary Watercourses, land drains and ditches.<br>Potential Impacts: Risk of flooding resulting from change in watercourse/drain flow regime due to morphological changes for development | Drainage networks within the land to the north and south of the River Thames, including West Tilbury Main<br>Drainage network around Mar Dyke.<br>Various drainage features around the northern end of the route.<br>Various drainage features around the southern end of the route. | Drainage of surface water | Provides drainage of significant area of land | Local | N/A | Limited potential for substitution | Low - High | Minor | Insignificant – Low Significance |

| Description of study area / Summary of potential impacts | Feature | Attributes / Services | Quality | Scale | Rarity | Substitutability | Importance | Magnitude | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from overland flow. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from groundwater. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |
| Study Area: Entire route.<br>Potential Impacts: Risk of flooding from drains, sewers, and water mains. | People and property | Various floodplains and surface water drainage areas | Located across multiple flood zones | Local | N/A | N/A | Low – Very High | Negligible (assuming appropriate design) | Insignificant – Low Significance |

**Reference Source(s):** WebTag TAG Unit 3.3.11 The Water Environment Sub-objective, Department for Transport, June 2003

**Summary assessment score:**

**Bridge:** Moderate Adverse **Bored tunnel**: Moderate Adverse **Immersed tunnel:** Large Adverse

**Qualitative comments:**

**Surface water**

An immersed tunnel could have significant effects on the hydromorphology of River Thames, if not completely submerged underneath the river bed. Although not considered specifically within the above WebTAG table (since this covers only operational effects), the risk from construction activities is also expected to be greater than either a bridge or bored tunnel.

If a new bridge crossing was provided, the design would need to be developed to minimise any impact on sensitive intertidal and riparian margins to the River Thames.

Both bridge and immersed tunnel crossings would be likely to require a Water Framework Directive appraisal due to the potential for direct effects on biological, chemical and physical WFD parameters.

In terms of operation, it is assumed that during the drainage design appropriate risk assessment of runoff and spillage risk would be carried out in accordance with the DMRB's HD45/09, to ensure that adequate treatment and spillage containment facilities are provided. These could include sustainable drainage systems (SuDS) such as swales, ponds, wetlands, or conventional measures such as storage tanks and oil interceptors where there are space constraints. The assumed widening of the A229 between the M2 and the M20 would need to be assessed to ensure that any improvements to the drainage system that required were included in the proposal. No direct effects on any water bodies are expected to be involved as any widening of the A229 would be contained within the existing road alignment.

**Groundwater**

Two Source Protection Zones 3 (SPZ3s) are potentially affected by the assumed illustrative route. An impact is considered possible although the effect is likely to be diluted due to the distance from the abstraction. If a new crossing was provided at location Option C then a quantitative risk assessment would need to be undertaken to account for dilution and attenuation effects. Potential impacts on this groundwater abstraction would be greater for a bridge crossing than for a tunnel. This is because a tunnel crossing would be likely to have a more enclosed drainage system (less risk of pollutants escaping which could enter the groundwater and migrate to receptors such as SPZs) than a bridge for the operational phase. Also, during construction and possibly during operation, a tunnel would have a groundwater dewatering system which would draw local groundwater flows towards the tunnel. This would prevent any contaminants entering the groundwater from migrating away towards receptors such as SPZs.

Groundwater feeding the South Thames Estuary and Marshes could be affected. The impact is likely to be greater for a bored tunnel, followed by the immersed tunnel. A bridge crossing would be likely to have minimal impact on any groundwater feeding the SSSI.

**Flood risk**

All three potential crossing types involve a risk of increasing flood risk or being impacted upon by flood risk. Appropriate design would be required to ensure that the overall impact on flood risk was reduced to a negligible level at a future design stage. The potential impacts are considered to be significant at this stage (as they are potentially of moderate magnitude) and would need to be mitigated at design stage. It is possible that with appropriate design these potential significant adverse effects could be overcome, although more detailed information would be required and further investigation to be carried out, to overcome the current uncertainty.

# Appendix G5: Landscape Worksheets

## Worksheet 1 Environment: Landscape

### Option: B

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Pattern | North of the river the assumed illustrative route is in close proximity to residential streets to the west and north; with more open large scale dockland development along the river foreshore to the east.<br>The route passes through a green corridor on the edge of the residential fabric, consisting of a public park, school grounds and public greenspace; to meet with the A1089 in the open countryside of agricultural fields.<br>The Thames river corridor comprises an expansive flat landscape of water, mudflats and marshes dominated by very large industrial and energy related structures including pylons, power station and storage towers.<br>To the south, previously developed sites and a scheduled monument form a green corridor through the urban conurbation with residential streets, road and rail infrastructure to the east and west. | Local | Common | Medium in a local context | Low | Slight Adverse<br>As the road and crossing proposals would directly impact surviving areas of Thames Marshland and accessible public greenspace. The road infrastructure would also potentially infill green corridors within the urban fabric. | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Tranquillity | The route includes urban fringe agricultural landscape, public greenspace and naturalised brown field areas with areas of quiet space, however, the area is not tranquil with urban development, industry and rail infrastructure apparent. | Local | Common in a local context | Low | Low | Bored Tunnel and Immersed Tunnel: Slight / Moderate Adverse<br>As although the area is not tranquil the road and tunnel proposals would impact directly on quieter areas within the urban fabric | |
| | | | | | | Bridge: Moderate Adverse<br>As although the area is not tranquil the road and bridge proposal would impact directly on quieter areas within the urban fabric and would contribute to the increased urbanisation | |
| Cultural | Scheduled monument Roman town of Vagniacis. | National | Rare | High at a National level | Low | Large Adverse<br>As the road and crossing proposals would impact directly on a Scheduled Monument of national importance resulting in the loss of the whole or part of the scheduled monument. | Modify route to avoid damage or destruction of the Scheduled Monument |
| | 1 listed building within 500m | Local | Rare | High at a local level | | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Landcover | Residential areas typically consist of dense streets with small gardens or communal landscaped or grassed areas with small parks or playgrounds. Small parks and playing fields with grass, amenity planting and trees are interspersed throughout the residential area. Thurrock Unitary Development Plan identifies recreational greenspace affected by the route as the following policy areas<br>LRT4 Existing Open Space<br>-RIV6(a-e) Riverside Open Space<br>-LRT3 Additional Open Space<br>CFU3(a-e) School Site<br>Thurrock Yacht Club located close to the assumed illustrative route. | Local | Rare | High on a local level | Some features like school grounds, recreational open space, and Thames Marshland would be difficult to replace,<br>Other areas such as urban fringe farmland, and vegetated Previously developed sites could more easily be substituted. | Moderate Adverse<br>Due to the loss of recreational and publicly accessible greenspace within a densely populated urban area and direct impacts on surviving areas of Thames Marshland.<br>The road would also remove or impact on locally valued greenspace including a local park and school grounds. | Extensive mitigation planting to preserve the green corridor.<br><br>Minimise impacts on locally valued educational and recreational facilities. |
| | Locally characteristic mudflats and grassland of Thames fragmented by waterfront development. | Local | Rare in a local context | High on a local level | | | |
| | The river corridor is dominated by large scale industry, dockland and energy related development along the river foreshore with areas of residential waterfront to the north. | Local | Common in a local context | Low on a local level | | | |
| | To the south previously developed sites form a corridor of natural grassland or scrub vegetation within the urban fabric. | Local | Common in a local context | Low on a local level | | | |
| | The Scheduled Monument site forms an extensive area of natural rough grass and scrub close to the A2 corridor. | National | Rare in a national context | High in a National context | | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character | The character of the assumed illustrative route is predominantly urban with distinct areas of recreational and urban fringe greenspace. | Local | Common in a local context | Low to high | Some areas like residential areas with public recreational open space, Thames Marshland and the Ancient Monument would not be possible to substitute for.<br><br>Other areas such as urban fringe farmland, industrial and vegetated previously developed sites would be easier to replace. | Bored Tunnel and Immersed Tunnel: Moderate Adverse<br>A1089, A226 bridges would be notable changes to the setting of residential areas close to the route. The proposed road corridor would also directly impact on locally valued landscape features that cannot be mitigated for. | Consider routing options that avoid impacts on residential areas, urban public space and valued cultural landscape features.<br><br>Consider scale of structures in relation to adjacent residential areas.<br><br>Extensive mitigation planting to preserve the green corridor. |
| | To the north, residential areas are densely populated and intimate in scale with views contained by buildings with infrequent small pockets of amenity space in the form of parks, play areas or waterfront. | Local | Common in a local context | High in a local context | | | |
| | The Thames river corridor has a strong identity with large expansive horizontal vistas dominated by the interplay of water and sky with very large structures including pylons, docks, industry and the existing Queen Elizabeth II bridge. | Local | Common in a local context | High in a local context | | Bridge: Moderate Adverse<br>New road bridge over the river would be a dominant feature visible over a wide area, contributing to increased urbanisation of the river corridor. The bridge infrastructure and A1089 and A226 road bridges would be notable changes to the setting of residential areas in close proximity to the route.<br>The proposed road corridor would also directly impact on locally valued landscape features that cannot be mitigated for. | |
| | To the south the former open cast extraction site, bing, car park and Scheduled Monument site are enclosed by security fencing or road infrastructure. The sites form a corridor of natural grassland or scrub vegetation which is visible from surrounding areas but not readily accessible. Views medium in scale, limited by topography. | Local | Common in a local context | Low in a local context | | | |
| | The Scheduled Monument site forms an extensive area of natural rough grass and scrub close to the A2 (a former roman road). | National | Rare in a National context | High in a national context | | | |

**Reference Source(s):** WebTag TAG Unit 3.3.7 The Landscape Sub-objective, Department for Transport, December 2004, OS Mapping, Aerial Photography, Thurrock Unitary Development Plan

**Summary assessment score:**

**Bridge:** Moderate Adverse **Bored Tunnel:** Moderate Adverse **Immersed Tunnel:** Moderate Adverse

**Qualitative comments:**

A new crossing at location Option B would directly impact locally valued landscape features including school grounds, recreational greenspace and surviving Thames Marshland. The proposals would also directly impact a Scheduled Monument of national importance resulting in the loss of the whole or part of the site.

A new bridge crossing and associated infrastructure would contribute to the increased urbanisation of the river corridor and would affect the setting and local visual amenity of the residential areas which lie adjacent to the assummed illustrative route. A new bored or immersed tunnel would be visible over a smaller local area. However, road bridges associated with tunnel options would still involve a notable change to the setting of residential areas.

## Worksheet 1 Environment: Landscape

### Option: C

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Pattern | The assumed illustrative route passes through open rolling countryside of medium sized, enclosed fields and small settlements passing close to the village of Orsett and curving south through the open countryside towards the Thames. | Local | Common | Medium in a local context | Varies along the route as substitutability of historic parkland and field patterns by Orsett are low but elsewhere the pattern of rolling fields are more easily restored. | Moderate Adverse<br>There would be direct and indirect impacts on locally valued landscape patterns which would not be possible to mitigate.<br>For example the historic parkland that forms the setting of Orsett Conservation Area Thames marshes, Ancient Woodland and the Registered Park and Garden at Cobham. | Consider routing options to avoid impacts on locally valued landscape patterns |
| | Adjacent to Orsett the route cuts through the historic parkland landscape that forms the setting of the village. | Local | Rare | High in a local context | | | |
| | The Thames river corridor consists of raised dykes along the river edge backed by expansive flat open marshlands with rough grazing and sparse scrub. | Local | Rare in a local context | High in a local context | Low | | |
| | Open undulating farmland of agricultural fields rising to the densely wooded ridge of Shorne and Cobham to the south. | Local | Rare in a local context | High in a local context | Low | | |
| | South of the A2 is Cobham Hall Registered Park and Gardens, comprising intact 18C parkland, gardens, estate woodlands, and golf course. | National | Rare | High in national context | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Tranquillity | Although the assumed illustrative route is not tranquil with built intrusions such as pylons, distant road traffic noise, river traffic and distant views of urban conurbations, the small villages and country lanes are peaceful, and the long, expansive vistas gained from footpaths along the Thames dykes have an epic scale and sense of isolation. | Local | Common | Low | Low | Bored Tunnel and Immersed Tunnel: Slight Adverse<br>Although the landscape has a number of detractors, away from the existing road infrastructure the character is peaceful.<br>New road infrastructure would contribute an urbanising effect on the rural landscape.<br><br>Bridge: Slight/ Moderate Adverse<br>Although the landscape has a number of detractors, away from the existing road infrastructure the character is peaceful. The bridge would also form a visually dominant structure within the river corridor visible over a greater distance.<br>Both the bridge and new road infrastructure would contribute an urbanising effect on the rural landscape. | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Cultural | Shorne, Randall Wood, Shorne Wood and Cobham Park are all part of the Kent Downs Area of Outstanding Natural Beauty (AONB) | National | Rare | High in a national context | Low | Moderate / Large<br>Adverse as there are direct and indirect impacts on nationally important landscapes of recognised quality such as the AONB, Cobham Park, and Scheduled Monuments<br>The assumed illustrative route would directly impact Ancient Woodland at Shorne and Randall Wood<br>The assumed illustrative route also impact on locally valued landscapes such as the Thames marshes and the setting of conservation areas Orsett, West Tilbury, Queens Farm (Shorne), Chestnut Green (Shorne), Shorne (Village), Abbey Gate.<br>Where existing road infrastructure (particularly motorways) forms part of the immediate setting of such features, the proposals are less likely to have a significant effect. | Consider routing options to avoid impacts on locally and nationally valued landscapes.<br><br>Integration of the road into the landscape through ground modelling / tunnelling; use of vernacular materials to match local landscape character; vertical alignment or vertical greening at tunnel entrances. |
| | Cobham Park Registered Park and Gardens | National | Rare | High in a national context | Low | | |
| | Scheduled Monuments within 1 km of the assumed illustrative route (particularly at Orsett and Tilbury) | National | Rare | High in a national context | Low | | |
| | Ancient Woodland and ancient replanted woodland - Shorne and Randall Wood | Local | Rare | High in a local context | Re-instatement of replanted Ancient Woodland is possible however loss of Ancient Woodland can only be partially compensated for | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Cultural (cont) | conservation areas (within 1km of the assumed illustrative route) - Orsett, West Tilbury, Queens Farm (Shorne), Chestnut Green (Shorne), Shorne (Village), Abbey Gate<br>Thurrock Unitary Development identifies the landscape setting of Orsett as Plan Policy area<br>NEN 16 Area of Local Conservation Significance | Local | Rare | High in a local context | Low | See above | See above |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Landcover | Landcover of the hinterland north of the river consists of open rolling agricultural fields with hedges and boundary trees. | Local | Common | Low | Potentially could be substituted for | Slight Moderate adverse<br>It would impact directly on locally valued landcover in a way that cannot be mitigated for including local recreational facilities at Shorne Country Park.<br>The Thurrock UDP coastal protection zone places stringent restrictions on development on the rural and undeveloped Thames coastline with a presumption against adversely affecting the open and rural character | Modify assumed illustrative route to minimise loss of valued or vulnerable landcover.<br><br>Offsite planting and woodland enhancement / management as a compensatory measure where tree planting is appropriate. |
| | The characteristic landcover of the Thames river corridor consists of open flat marshes and rough grazing with sparse scrub or tree cover.<br>Identified in Thurrock Unitary Development Plan as Policy area RIV8 Coastal Protection Zone (Thames River corridor) | Local | Rare | High in a Local context | Low | | |
| | The hinterland to the south consists of agricultural farmland with hedgerows and with trees grouped arround small settlements. | Local | Common | Low in a local context | High | | |
| | Landcover at Shorne and Randal woods where the assumed illustrative route joins the A2, consists of dense mature woodland and includes extensive Ancient Woodland or replanted woodland.<br>A large area of the woodland lies within Shorne Country Park, with visitor centre, recreation facilities and walks. | Local | Rare | High in a local context | Low | | |
| | South of the A2 is Cobham Hall Registered Park and Gardens, on the Register of Historic Parks and Gardens with golf course, estate woodland, parkland and gardens. | National | Rare | High in a National Context | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character | The hinterland to the north of the Thames consists of open rolling agricultural countryside with surviving areas of historic field patterns, minor roads and small settlements. Prominent features consist of arterial roads, pylons, and the distant urban edge of large settlements. | Local | Common | Low | Landscape quality varies along the route, with distinct elements such as historic landscape patterns difficult to substitute for. Open agricultural fields would potentially be easier to substitute. | Bored Tunnel and Immersed Tunnel: Moderate Adverse. Road infrastructure would introduce locally visible urban elements in the open horizontal vista of the Thames marshes. Distinct features within the landscape may be lost or diminished such as historic landscape patterns, Scheduled Monuments and Ancient Woodland particularly at Orsett, Tillbury and Shorne. Kent Downs AONB is a nationally designated area of landscape value. Where existing road infrastructure (particularly motorways) form part of the immediate setting of such features, the proposals are less likely to have a significant effect.<br>There is potential for junction infrastructure at the A2 to adversely affect the setting of the adjacent registered Historic Park and Garden at Cobham. | Modify assumed illustrative route to minimise loss of valued landscape features.<br>Integration of the road into the landscape through ground modelling / tunnelling; use of vernacular materials to match local landscape character; vertical alignment or vertical greening at tunnel. |
| | The Thames river corridor has a strong identity with large expansive horizontal vistas dominated by the interplay of water and sky. Shore land consists of extensive wet pasture and open grazing with sparse scrub or tree cover protected by dykes and ditches. Man made elements include pylons, river traffic and distant views of docks, industry and settlements. | Local | Common | High | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character (cont) | The hinterland to the south consists of open undulating farmland of agricultural fields with hedgerows and trees grouped in association with small settlements; rising to discrete areas of significant woodland on higher ground.<br>Pylons and overhead electricity lines are noticeable features in the open countryside along with distant views. The woodlands and polices at Shorne and Cobham form part of the Kent Downs AONB.<br>The existing A2 forms a transport corridor within the AONB. | Local | Common | High | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character (cont) | See above | See above | See above | See above | See above | Bridge: Moderate/Large Adverse<br>A bridge would introduce a significant new large vertical element in the horizontal vista of the Thames marshes visible over a considerable distance that would diminish the distinctive character of the local landscape.<br>Distinct features within the landscape may be lost or diminished such as historic landscape patterns, Scheduled Monuments and Ancient Woodland particularly at Orsett, Tilbury and Shorne.<br>Kent Downs AONB is a nationally designated area of landscape value.<br>Where existing road infrastructure (particularly motorways) form part of the immediate setting of such features, the proposals are less likely to have a significant effect. | See above |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character (cont) | See above | See above | See above | See above | See above | (cont from above)<br>There is potential for junction infrastructure at the A2 to adversely affect the setting of the adjacent registered Historic Park and Garden at Cobham. | See above |

**Reference Source(s):** WebTag TAG Unit 3.3.7 The Landscape Sub-objective, Department for Transport, December 2004, OS Mapping, Aerial Photography, Thurrock Unitary Development Plan, National Character Area 111 Northern Thames Basin, National Character Area 81 Greater Thames Estuary , National Character Area 113 North Kent Plain

**Summary assessment score:**

**Bridge:** Moderate/Large Adverse **Bored Tunnel:** Moderate Adverse **Immersed Tunnel:** Moderate Adverse

**Qualitative comments:**

A new crossing at location Option C would introduce a significant change to the existing landscape, comprising a new transport corridor and tunnel or bridge crossing structure . Retaining structures and infrastructure associated with either a bored or immersed tunnel would be notable as additional built elements in the horizontal vista of the Thames marshes, visible over the local area. A new bridge would introduce a significant new vertical element visible over a considerable distance that would diminish the distinctive character of the local landscape.

The new road corridor and junction infrastructure associated with a crossing at Option C would impact directly and indirectly on locally and nationally valued landscape features including Scheduled Monuments, listed buildings, conservation areas, Ancient Woodlands , distinct areas of historic landscape patterns, the Kent Downs AONB, Cobham Hall Registered Park and Garden, Shorne County Park and surviving Thames marshland.

## Worksheet 1 Environment: Landscape

### Option: $C_{variant}$

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Pattern | The assumed illustrative route passes through open rolling countryside of medium sized, enclosed fields and small settlements passing close to the village of Orsett and curving south through the open countryside towards the Thames. | Local | Common | Medium in a local context | Varies along the assumed illustrative route as substitutability of historic parkland and field patterns by Orsett are low but elsewhere the pattern of rolling fields are more easily restored. | Moderate Adverse<br>There could be direct and indirect impacts on locally valued landscape patterns which may not be possible to mitigate.<br>For example the historic parkland that forms the setting of Orsett Conservation Area; Thames marshes, Ancient Woodland and the Registered Park and Garden at Cobham.<br>Where the assumed illustrative route consists of alterations to existing road infrastructure (particularly motorways or dual carriageway) such as upgrading the existing A229; there is less likely to be a significant effect. | Consider routing options to avoid impacts on locally valued landscape patterns |
| | Adjacent to Orsett the assumed illustrative route cuts through the historic parkland landscape that forms the setting of the village. | Local | Rare | High in a local context | | | |
| | The Thames river corridor consists of raised dykes along the river edge backed by expansive flat open marshlands with rough grazing and sparse scrub. | Local | Rare in a local context | High in a local context | Low | | |
| | Open undulating farmland of agricultural fields rising to the densely wooded ridge of Shorne and Cobham to the south. | Local | Rare in a local context | High in a local context | Low | | |
| | South of the A2 is Cobham Hall Registered Park and Gardens, comprising intact 18C parkland, gardens, estate woodlands, and golf course. This area forms part of the Kent Downs Area of Outstanding Natural Beauty (AONB) | National | Rare | High in national context | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Pattern (cont) | The assumed illustrative route for the M2 - M20 link follows the existing A229, a dual carriageway within a wooded road corridor set in a landscape of large open rolling agricultural fields with small settlements, enclosed by a wooded ridge to the north and the urban edge of Maidstone to the south. This area forms part of the Kent Downs Area of Outstanding Natural Beauty (AONB) | National | Common | High in a National context | It would be possible to compensate for the loss of the landscape pattern comprising the existing road corridor | See above | See above |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Tranquillity | Although the assumed illustrative route is not tranquil with built intrusions such as pylons, distant road traffic noise, river traffic and distant views of urban conurbations, the small villages and country lanes are peaceful, and the long expansive vistas gained from footpaths along the Thames dykes have an epic scale and sense of isolation. | Local | Common | Low | Low | Bored Tunnel and Immersed Tunnel: Slight Adverse<br>Although the landscape has a number of detractors, away from the existing road infrastructure the character is peaceful.<br>New road infrastructure would contribute an urbanising effect on the rural landscape. | |
| | | As above | As above | As above | As above | Bridge: Slight/ Moderate Adverse<br>Although the landscape has a number of detractors, away from the existing road infrastructure the character is peaceful. A bridge would be a visually dominant structure within the river corridor visible over distance.<br>Both the bridge and new road infrastructure would contribute an urbanising effect on the rural landscape. | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Cultural | Shorne, Randall Wood, Shorne Wood and Cobham Park and the A229 link are all part of the Kent Downs Area of Outstanding Natural Beauty (AONB) | National | Rare | High in a national context | Low | Moderate / Large Adverse<br>There would be direct and indirect impacts on nationally important landscapes of recognised quality such as the AONB, Cobham Park, and Scheduled Monuments | Consider routing options to avoid impacts on locally and nationally valued landscapes.<br>(cont below) |
| | Cobham Park Registered Park and Gardens | National | Rare | High in a national context | Low | | |
| | Scheduled Monuments within 1km of the assumed illustrative route (particularly at Orsett and Tilbury) | National | Rare | High in a national context | Low | | |
| | Ancient Woodland and ancient replanted woodland Shorne and Randall Wood | Local | Rare | High in a local context | Re-instatement of replanted Ancient Woodland is possible however loss of Ancient Woodland can only be partially compensated for. | The assumed illustrative route would directly impact upon Ancient Woodland at Shorne and Randall Wood.<br>The assumed illustrative route would also impact on locally valued landscapes such as the setting of conservation areas: Orsett, West | Integration of the road into the landscape through ground modelling / tunnelling; use of vernacular materials to match local landscape character; vertical |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| | Conservation areas (within 1km of route assumed illustrative route) - Orsett, West Tilbury, Queens Farm (Shorne), Chestnut Green (Shorne), Shorne (Village), Abbey Gate<br>Thurrock Unitary Development identifies the landscape setting of Orsett as Plan Policy area<br>NEN 16 Area of Local Conservation Significance | Local | Rare | High in a local context | Low | Tilbury, Queens Farm (Shorne), Chestnut Green (Shorne), Shorne (Village), Abbey Gate.<br>Where existing road infrastructure (particularly motorways) form part of the immediate setting of such features, significant effects are less likely. | alignment or vertical greening at tunnel entrances. |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Landcover | Landcover of the hinterland north of the river consists of open rolling agricultural fields with hedges and boundary trees. | Local | Common | Low | Potentially could be substituted for | Slight / Moderate Adverse<br>The assumed illustrative route would impact directly on locally valued landcover in a way that may not be mitigated for including local recreational facilities at Shorne country park.<br>Widening of the A229 link may adversely affect the setting of the Tyland Barn Wildlife Trust. | Modify assumed illustrative route to minimise loss of valued or vulnerable landcover<br>(cont below) |
| | The characteristic landcover of the Thames river corridor consists of open flat marshes and rough grazing with sparse scrub or tree cover.<br>Identified in Thurrock Unitary Development Plan as Policy area<br>RIV8 Coastal Protection Zone (Thames River corridor) | Local | Rare | High in a Local context | Low | | |
| | The hinterland to the south consists of agricultural farmland with hedgerows and with trees grouped arround small settlements; | Local | Common | Low in a local context | Landcover could potentially be substituted | | Offsite planting and woodland enhancement / management as a compensatory measure where tree planting is appropriate.<br>Retention and reinforcement of wooded corridor on M2-M20 link<br>Align road widening on A229 to avoid impacts on Tyland Barn Wildlife Trust |
| | Landcover at Shorne and Randal woods where the assumed illustrative route joins the A2 consists of dense mature woodland and includes extensive Ancient Woodland or replanted woodland.<br>A large area of the woodland lies within Shorne Country Park, with visitor centre, recreation facilities and walks. | Local | Rare | High in a local context | Low | See above | |
| | South of the A2 is Cobham Park, on the Register of Historic Parks and Gardens with golf course, estate woodland, parkland and gardens. | National | Rare | High in a National Context | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Landcover (contd) | Landcover along the assumed illustrative route of the M2-M20 link consists of large open agricultural fields with gappy hedgerows and boundary trees. The existing A2269 corridor is flanked with dense deciduous and evergreen woodland. | Local | Common | Low | High | | |
| | Tyland Barn Wildlife Trust, visitor centre, nature park and SSSI. | Local | Rare | High in a local context | Low | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character | The hinterland to the north of the Thames consists of open rolling agricultural countryside with surviving areas of historic field patterns, minor roads and small settlements, prominent features are arterial roads, pylons, and the distant urban edge of large settlements. | Local | Common in a local context | Medium on a local level | Landscape quality varies along the assumed illustrative route, with distinct elements such as historic landscape patterns and locally valued landscapes arround Orsett which are difficult to substitute but open agricultural fields would potentially be easier to substitute. | Bored Tunnel and Immersed Tunnel: Moderate Adverse<br>Road infrastructure would introduce locally visible urban elements in the open horizontal vista of the Thames marshes.<br>Distinct features within the landscape may be lost or diminished such as historic landscape patterns, Scheduled Monuments and Ancient Woodland particularly at Orsett, Tilbury and Shorne.<br>Kent Downs AONB is a nationally designated area of landscape value.<br>Where existing road infrastructure (particularly motorways) form part of the immediate setting of such features, significant effects are less likely.<br>There is potential for junction infrastructure at the A2 to adversely affect the setting of the adjacent registered Historic Park and Garden at Cobham. | Modify assumed illustrative route to minimise loss of valued landscape features.<br>Integration of the road into the landscape through ground modelling / tunnelling; use of vernacular materials to match local landscape character; vertical alignment or vertical greening at tunnel. |
| | The Thames river corridor has a strong identity with large expansive horizontal vistas dominated by the interplay of water and sky. Shoreland consists of extensive wet pasture and open grazing with sparse scrub or tree cover protected by dykes and ditches. Man made elements include pylons, river traffic and distant views of docks, industry and settlements. | Local | Common in a local context | High on a local level | Not possible to easily substitute for | | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character (cont) | The hinterland to the south consists of open undulating farmland of agricultural fields with hedgerows and trees grouped in association with small settlements; rising to discrete areas of significant woodland on higher ground.<br>Pylons and overhead electricity lines are noticeable features in the open countryside along with distant views. | Local | Common | High on a local level | It may be possible to restore or substitute some landscape elements | Bridge: Moderate/Large Adverse<br>A bridge would introduce a significant new large vertical element in the horizontal vista of the Thames marshes visible over a considerable distance that would diminish the distinctive character of the local landscape.<br>Distinct features within the landscape may be lost or diminished such as historic landscape patterns, Scheduled Monuments and Ancient Woodland particularly at Orsett, Tillbury and Shorne. | |

| Features | Description | Scale it matters | Rarity | Importance | Substitutability | Impact | Additional Mitigation |
|---|---|---|---|---|---|---|---|
| Summary of character (cont) | The woodlands and polices at Shorne and Cobham form part of the Kent Downs AONB.<br>The existing A2 and A229 form transport corridors within the AONB. | National | Rare | High on a national level | It may be possible to substitute some elements such as woodland along the road corridors | Kent Downs AONB is a nationally designated area of landscape value.<br>Where existing road infrastructure (particularly motorways) form part of the immediate setting of such features, significant effects are less likely.<br>There is potential for junction infrastructure at the A2 to adversely affect the setting of the adjacent registered Historic Park and Garden at Cobham. | |

**Reference Source(s):** WebTag TAG Unit 3.3.7 The Landscape Sub-objective, Department for Transport, December 2004, OS Mapping, Aerial Photography, Thurrock Unitary Development Plan, National Character Area 111 Northern Thames Basin, National Character Area 81 Greater Thames Estuary , National Character Area 113 North Kent Plain

**Summary assessment score:**

**Bridge:** Moderate/Large Adverse **Bored Tunnel**: Moderate Adverse **Immersed Tunnel:** Moderate Adverse

**Qualitative comments:**

A new crossing at location Option C, including widening to the A229 between the M2 and the M20, would introduce a significant change to the existing landscape, comprising a new transport corridor and tunnel or bridge crossing structure . Retaining structures and infrastructure associated with either a bored or immersed tunnel;would be notable as additional built elements in the horizontal vista of the Thames marshes, visible over the local area. A new bridge would introduce a significant new vertical element visible over a considerable distance that would diminish the distinctive character of the local landscape.

The new road corridor and junction infrastructure associated with a crossing at Option $C_{variant}$ would impact directly and indirectly on locally and nationally valued landscape features including Scheduled Monuments, listed buildings, conservation areas, Ancient Woodlands , distinct areas of historic landscape patterns, the Kent Downs AONB, Cobham Hall Registered Park and Garden, Shorne County Park and surviving Thames marshland.

Widening the A229 between the M2 and the M20 and associated junction infrastructure could result in some loss of woodland screening and might have some direct and indirect impacts on some residential areas. However, any change would be in the context of the existing dual carriageway corridor and would therefore be less likely to have a significant effect.

## Appendix G6: Noise Tables and Calculations

## Appendix G7: Greenhouse Gases Tables and Calculations

## Appendix G8: Air Quality Tables and Calculations

These are provided as separate .zip files