A12 Chelmsford to A120 widening scheme

TR010060

7.3 Combined Modelling and Appraisal Report

Appendix D: Economic Appraisal Package Report

APFP Regulation 5(2)(q)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 7

August 2022

Infrastructure Planning

Planning Act 2008

A12 Chelmsford to A120 widening scheme

Development Consent Order 202[ ]

7.3 COMBINED MODELLING AND APPRAISAL REPORT APPENDIX D: ECONOMIC APPRAISAL PACKAGE REPORT

Regulation Reference	Regulation 5(2)(q)
Planning Inspectorate Scheme Reference	TR010060
Application Document Reference	TR010060/APP/7.3
Author	A12 Project Team, National Highways

Version	**Date**	**Status of Version**
Rev 1	August 2022	DCO Application

CONTENTS

LIST OF PLATES

LIST OF TABLES

1. Introduction

1.1 Purpose of report

The Economic Appraisal Package Report is one of a series of documents that set out the scheme's traffic modelling and economic assessment. These include:

- Transport Data Package Report
- Transport Model Package Report
- Transport Forecasting Package Report
- Economic Appraisal Package Report
- Appraisal Summary Table and Worksheets
- Distributional Impacts Report

Each of these documents are provided as appendices to the overall Combined Modelling and Appraisal (ComMA) Report.

The purpose of the Economic Appraisal Package is to report on the economic appraisal methodologies and results, for the economic assessment based on the new DCO model. It provides Benefit to Cost Ratios, which inform the scheme's overall Value for Money assessment reported in its Economic Case.

1.2 Structure of report

Following the introduction, the structure of this report is:

- Chapter 2 – Economic Appraisal Approach: a brief summary of the overarching approach taken to economic appraisal
- Chapter 3 – Estimation of Costs
- Chapter 4 – Estimation of Benefits: description of the methodologies used to assess scheme benefits
- Chapter 5 – Economic Appraisal Results (Core Scenario)
- Chapter 6 – Economic Appraisal Results (Sensitivity Tests)
- Chapter 7 – Summary and Conclusion

2. Economic Appraisal Approach

2.1 Introduction

This chapter gives a brief overview of the overarching economic appraisal approach. Detailed methodologies and results are provided in the subsequent chapters. This report provides results for the single scheme option at its current stage (known as PCF Stage 3, the stage of National Highways' Project Control Framework where a single scheme option is developed following a Preferred Route Announcement.

2.2 Use of traffic model

As part of PCF Stage 3, a new traffic model was developed to assess the A12 Chelmsford to A120 proposed scheme. The latest version of this is known as the 'DCO model'.

The development of the base year model is discussed in Appendix B 'Transport Model Package' of the ComMA report.

The development of the latest forecast year models is discussed in Appendix C 'Transport Forecasting Package' of the ComMA report. The updated traffic model has three forecast years: an opening year of 2027, design year of 2042 and a final modelled year of 2051.

The economic assessment described in this Economic Appraisal Package report is based on information extracted from that traffic model. Economic Assessment has been undertaken for the core, high growth and low growth model scenarios.

2.3 Impacts assessed

This report describes the methodologies and results of the following impacts:

- Travel time and Vehicle Operating Cost changes
- Delays during construction and maintenance
- Changes in indirect tax revenues
- Changes in accident numbers
- Greenhouse gas, noise and air quality impacts
- Changes in journey time reliability
- Wider Impacts (e.g. agglomeration impacts)

3. Estimation of Costs

3.1 Introduction

The estimation of scheme costs is a crucial part of the scheme appraisal. Economic assessment considers both the actual cost of the scheme (design, labour, materials, land etc.) together with any changes in the capital cost of maintenance in future years for the situations with and without the scheme in place.

3.2 Scheme costs used

Updated scheme costs were prepared towards by National Highways commercial division. They include costs for construction, land/property, preparation/administration and supervision, were provided in 2010 prices by National Highways commercial division.

Expenditure profiles were based upon cost estimates for each financial year prepared at a base date and then inflated to outturn costs using National Highways projected construction related inflation. These costs were then rebased to 2010 calendar year profiles for economic calculations, using the GDP-deflator series as published in the TAG Databook.

The costs exclude all VAT. Scheme costs received were given in the factor cost unit of account.

Historic costs were removed. All spend which had been forecast for previous years (2021 and earlier) was removed from the cost estimate. A small proportion of 2022 was also removed. This was based on the proportion of the forecast 2022 spend that had already been spent by the end of March 2022.

A summary of the scheme costs in 2010 prices is provided in Table 3-1.

Table 3-1 PCF Stage 3 TUBA input scheme costs in 2010 price (£000s)

Preparation	Supervision	Construction	Land	Total
£51,169	£14,137	£518,067	£71,363	**£654,737**

In addition to the direct costs of developing and building the scheme, the impact on road maintenance costs has also been considered. Road maintenance costs are incurred with and without the scheme in place. These costs are calculated for the full appraisal period of the scheme (60-years from the year of opening) and discounted back to 2010, in line with all other costs. These 'capital costs of maintenance' are included as part of the overall Present Value of Costs.

The costs were developed based on the profile of expected maintenance works used in the assessment of maintenance delay (see section 5.4).

The total discounted and undiscounted maintenance costs in 2010 prices are shown in Table 3-2 below.

Table 3-2 PCF Stage 3 - 60 year maintenance costs in 2010 prices (£000s)

Scenario	Undiscounted Cost (in factor prices)	Discounted Cost (in market prices)	Discounted Maintenance Cost Change vs Do Min (in market prices)
Do Minimum	£87,579	£27,405	-
Do Something	£73,785	£16,414	-£10,991

There are significant costs incurred in the Do Minimum scenario to reflect the major maintenance required if no A12 scheme is constructed. These costs are not incurred if the scheme is built. This results in the Do Minimum having higher overall maintenance costs than the Do Something scenario.

In addition, in the Do Minimum scenario the maintenance costs are incurred in earlier years, so these costs are not as heavily discounted. Its discounted costs are therefore higher compared to the discounted costs for the Do Something. This 'maintenance saving' in terms of discounted costs is subtracted from the overall Present Value of Costs, as described below.

All the costs described above were entered into TUBA in 2010 prices to be summed over the 60-year appraisal period, discounted to 2010, and converted to the market price unit of account. A summary of the Present Value of Costs (PVC) output by TUBA is provided in Table 3-3.

Table 3-3 PCF Stage 3 - Present Value of Costs in 2010 prices discounted to 2010 (£000s)

Option	Costs		
	Scheme	Change in Maintenance Costs	Total
Do Something	£463,113	-£10,991	£452,122

3.3 Summary

This section of the report has outlined the treatment of costs for inclusion in the cost benefit analysis. It has outlined how the scheme costs were adjusted for economic calculations, and how consideration was given to the change in maintenance costs with the scheme in place. The overall Present Value of Costs (PVC) is presented, which will be used to compare against the scheme's Present Value of Benefits to help understand the likely value for money.

4. Estimation of Benefits

4.1 Introduction

This chapter outlines the assessment approach used to quantify the monetary benefits generated from the scheme. This includes impacts on travel time, vehicle operating costs, user delays during construction and maintenance, accidents, indirect tax revenues, environmental impacts, journey time reliability and wider impacts.

4.2 Transport Economic Efficiency – travel time and vehicle operating costs

The Transport Economic Efficiency (TEE) benefits of a transport scheme consist of the following three key components:

- Travel time and Vehicle Operating Cost (VOC) benefits as a result of the scheme
- Travel time and VOC dis-benefits as a result of construction activities
- Travel time and VOC changes as a result of maintenance activities

The first of these impacts has been assessed using the DfT's Transport User Benefit Appraisal (TUBA) software, version 1.9.16. TUBA is the industry-standard software which considers the Business and Consumer Traveller Impacts, the Private Sector Provider Revenues and Costs, as well as the impact on Indirect Taxes discussed in section 5.6.

The impacts during construction and maintenance activities are discussed in sections 5.3 and 5.4.

4.3 TUBA user classes and scaling factors

TUBA requires time and distance skim matrices to be extracted from the model, as well as demand matrices. These were extracted for all modelled years, time periods and user classes.

A list of the user classes used in the TUBA assessment are shown in Table 4-1. The traffic model has a single user class representing all LGV trips. This was split out into two separate TUBA user classes – one for LGV freight trips and another for LGV personal trips. This split was based on TAG data book values in sheet A.1.3.4.

Similarly, HGV demand was split into separate OGV1 and OGV2 TUBA user classes based on count data.

Table 4-1 TUBA user classes

TUBA User Class	TUBA vehicle type	Model User Class	Model Vehicle Type
1	Car (Business)	UC1	Car (Business)
2	Car (Commute)	UC2	Car (Commute)
3	Car (Other)	UC3	Car (Other)
4	LGV (Personal)	UC4 (12%)	LGV
5	LGV (Freight)	UC4 (88%)	LGV
6	OGV1	UC5 (33%)	HGV
7	OGV2	UC5 (67%)	HGV

The model assumes a PCU factor of 2.5 for HGVs. A TUBA scaling factor was used to convert HGV from PCUs to Vehicles as required by TUBA.

Time and distance skims were produced in the units required by TUBA, so no factoring was required. A summary of the factors used in TUBA are shown in Table 4-2.

Table 4-2 TUBA scaling factors

Matrix type	User Classes	Skim matrix unit	TUBA unit	TUBA scaling factor
Vehicle Trips	1-5	PCU/hr	Vehicles/hr	1.0000
Vehicle Trips	6	PCU/hr	Vehicles/hr	0.1307 (=0.33/2.5)
Vehicle Trips	7	PCU/hr	Vehicles/hr	0.2693 (=0.67/2.5)
Time	1-7	Hours	Hours	1.0000
Distance	1-7	km	km	1.0000

4.4 Time slices and annualisation factors

The traffic model represents three time periods only: a weekday AM and PM peak hour, and a weekday average Interpeak hour (1000-1600). Annualisation factors have been used to allow the TUBA assessment to represent additional parts of the day.

A list of the time slices used in the TUBA assessment are shown in Table 4-3. An annualisation factor is also shown, i.e. how many hours in a year that time period can be considered to represent.

Time slices have also been included for AM and PM peak shoulders. This represents time either just before or after the peak where traffic is high, but not quite as high as in the peak hours. The distance, time and demand information for these periods is taken from the Interpeak model. However, the split of car demand between different journey purposes was adjusted. This reflects the fact that, for example, there is a higher proportion of commuting trips in the AM peak shoulder compared to the Interpeak.

TUBA benefits have also been calculated for weekend peaks. This represents the hours in the weekend when demand is at a similar level to weekday Interpeak. Interpeak model skims are therefore used, adjusted to reflect differing journey purposes during weekends.

Table 4-3 TUBA Time slices with proposed skims, purposes and annualisation factors

Time Slice	Modelled Hours	Demand	Hrs / ave day	Skims	Purpose Split (Adjustment)	Annualisation Factor
AM Shoulder	0615-0645, 0915-1000	IP	1.25	IP	AM	316
AM Peak	0645-0915	AM	2.5	AM	None	633
IP	1000-1600	IP	6	IP	None	1,518
PM Peak	1600-1815	PM	2.25	PM	None	569
PM Peak Shoulder	1815 - 1900	IP	0.75	IP	PM	190
Weekend	Sat 0915-1815 Sun & BH 0945-1845	IP	9	IP	Weekend	999

4.5 Warnings and error checking

Whilst undertaking the calculations, TUBA produces a detailed list of warnings flagging any potentially unusual comparisons between the Do Minimum and Do Something inputs. Warnings are provided based on the ratio of DM to DS travel times and distances, and the modelled speeds.

The warning messages were checked to ensure that the results were logical. It was decided that warnings affecting a small demand (less than 5 trips) would not need as thorough investigation as they are unlikely to have a material impact on the results.

Table 4-4 shows the number of warnings obtained from TUBA which relate to the ratio of DM to DS travel times and distances. There are no serious warnings.

Table 4-4 TUBA warnings – ratio of DM to DS travel times and distances

Warning Type	Total Warnings	Serious Warnings	Serious Warnings (>5 trips)
Ratio of DM to DS travel time lower than limit	4,695	0	0
Ratio of DM to DS travel time higher than limit	2,760	0	0
Ratio of DM to DS travel distance lower than limit	9,144	0	0
Ratio of DM to DS travel distance higher than limit	2,709	0	0

Table 4-5 shows the number of warnings output from TUBA which relate to modelled speeds.

Table 4-5 TUBA warnings – modelled speeds

Warnings	Number
DM Speeds less than the limit	19,001
DS Speeds less than the limit	18,094
DM Speeds greater than the limit	1,034,212
DS Speeds greater than the limit	1,095,640

For DM and DS speeds less than the limit, there is a lot of consistency between those trip movements reported in the DM and DS. These have been investigated and are not a concern. Many of these warnings are for very short distance trips in highly congested area such as Brentwood near the M25, central Colchester and Braintree town centre. These are areas which are of lower significance for the proposed scheme and are places in which slow average speeds are reasonably expected to occur.

The warnings relating to trips in the DM and DS models with speeds greater than the limit are a result of a few links in the model which had neither a speed nor a capacity index assigned to them. This means that vehicles can effectively travel the distance of these links in zero seconds. Any short distance trips using these links would therefore have a very high speed for their overall trip. The links are in the buffer region, mainly near Southend-on-Sea. The links are not in the validation area of the model and are mainly links connected to zones. The issue exists in both the Do Minimum and Do something models and has no impact on reassignment of trips in these areas. Given this, it was considered unlikely to impact the appraisal of the scheme, and therefore not a concern.

4.6 Transport Economic Efficiency – delays during construction

Delays will be experienced by road users during the construction of the scheme. These delays can be kept to a minimum through the use of effective traffic management but are unlikely to be removed altogether. These delays are considered as part of the TEE impacts of the scheme.

During construction activities where the proposed traffic management includes road closures, QUeues And Delays at ROadworks (QUADRO) software was used to assess the impacts. This is because QUADRO can assess the impact of traffic moving to a well-defined signed diversion route.

However, for the long-term traffic management involving full-time narrow lanes and reduced speed-limits, the impact of these delays were assessed using the SATURN model and TUBA instead.

The two assessment methodologies are outlined in the sections below.

4.7 Assessment using QUADRO

As discussed above, QUADRO has been used to assess construction activities that involve road closures. QUADRO2021 Version 4.20.0.1 was used. QUADRO determines construction delay disbenefits by converting delays resulting from the construction process into a monetary value.

The key elements of the construction delay QUADRO are:

- Forecast Traffic Flows
- Construction Works Profiles and Durations
- Traffic Management Information
- Diversion Routes

QUADRO requires forecast traffic flows for the links affected by construction and diversion routes to be input as Annual Average Daily Traffic (AADT) flows and 16-hour weekday flows respectively. The data was obtained from the 2027 Do Minimum and Do Something traffic models.

Temporary full closures of the A12 are planned during some construction phases. During these closures, traffic would use a 37km diversion route via the A131 and A120.

The impact of the roadworks was calculated in QUADRO. Changes in travel time and vehicle operating costs for business and consumer users were extracted. No impact on the changes in accidents, carbon emissions or indirect taxes were extracted from QUADRO. For the purpose of the TEE table, QUADRO's consumer results were manually split between 'commuting' and 'other' purposes based on the proportion split between those journey purposes in the TUBA assessment.

The results are shown in Chapter 5 as a monetary value in 2010 prices, discounted to 2010.

4.8 Assessment using SATURN traffic model

Where construction works involve a long-term reduced speed limit and narrow lanes or contraflow – but no reduction in the number of lanes – the impact on user delay was modelled in the SATURN traffic model. Consistent with the main traffic model development, SATURN V11.4.07H was used.

Table 4-6 shows the phases of construction activity that were modelled in SATURN. Note that these are indicative construction phasing timelines based on very high-level construction plans. More detailed construction plans will be produced during the scheme development process.

Table 4-6 Construction phases modelled in SATURN

Construction Phase	Section	Traffic Management	Duration	From - To
1	Junction 20a to 24	2 lanes per direction, contraflow and narrow lanes, 40mph speed limit	15 months	Jan 2024 to Mar 2025
2	Junction 19 to 25	2 lanes per direction (3 lanes per direction J19-20a), contraflow and narrow lanes, 40mph speed limit	14 months	Mar 2025 to May 2026
3	Junction 20a to 25	2 lanes per direction, contraflow and narrow lanes, 40mph speed limit	13 months	May 2026 to Jun 2027

Each of the construction phases above was modelled in SATURN. The traffic management was coded into the 2027 Do Minimum models. To represent narrow lanes or contraflow, the speed-flow curve (SFC) capacity for those links was reduced by 10%. New SFCs were defined to represent the links with reduced capacity and reduced speed limits were applied in SATURN using its ‘FILVSD’ function.

Time and distance skims were extracted from the resultant construction models. These were run through TUBA along with the standard Do Minimum skims for comparison.

The same time slices and annualisation factors were used as for the main scheme TUBA assessment.

Results were output from TUBA for a single model year (2027). These results represent annual costs of delay and were therefore expanded based on the duration of each phase shown in Table 4-6.

It should be noted that the modelling assumes all works take place in the scheme opening year of 2027. In reality, the construction takes place in the years prior to this, where traffic would be expected to be lower. The results of the assessment may therefore slightly overestimate the impact caused by the construction.

4.9 Transport Economic Efficiency – delays during maintenance

Delays will be experienced by road users during periods of maintenance in the future both with and without the scheme. Without the scheme in place, delays caused by maintenance are likely to be significant due to the extensive maintenance that is required on the A12.

When the scheme is in place, the majority of the route will be upgraded from two to three lanes per direction. This new lane results in extra maintenance requirements. On the other hand, as the road is new there will be a “maintenance holiday” at the start of the appraisal period, meaning that the heavy maintenance which would be required early on in the Do Minimum scenario is not required. The presence of a third lane also provides flexibility in terms of traffic management, reducing the number of circumstances when the A12 has to close entirely.

A profile of the expected maintenance works in both the Do Minimum and Do Something is shown in Table 4-7. This is based on typical maintenance profiles provided in the QUADRO manual (DMRB Volume 14 Sec 1 Part 2 Chapter 4, Table 4/1). Given the much lower level of traffic predicted on the de-trunked A12 with the scheme in place, the impact of maintenance on those roads in terms of road user delay has been ignored. However, they have been considered when calculating the capital costs of maintenance. A 50% reduction in maintenance costs was assumed for the detrunked A12 compared to the mainline A12.

In the Do Something scenario, the maintenance profile is split into two parts: maintenance on Lane 1 (heavier maintenance due to the presence of HGVs in this lane) and maintenance on Lanes 2 and 3.

Table 4-7 Maintenance profiles in Do Minimum and Do Something

	Job description and year	Traffic Management	Diversion
Do Minimum			
Existing A12 (D2AP)	2027 (year 1) – Overlay (100mm) 2037 (year 11) – Inlay (50mm) 2047 (year 21) – Overlay (100mm) 2057 (year 31) – Inlay (50mm) 2067 (year 41) – Overlay (100mm) 2077 (year 51) – Inlay (50mm) 2086 (year 60) – Overlay (100mm)	Full closure	Full diversion via A130, A131, A120 Braintree Ring Road, A120 Coggeshall Road
Do Something			
Improved A12 (D3AP): Lane 1	2038 (year 12) – Inlay (50mm) 2048 (year 22) – Inlay (100mm) 2058 (year 32) – Inlay (50mm) 2067 (year 41) – Inlay (100mm) 2076 (year 50) – Inlay (50mm) 2085 (year 59) – Inlay (100mm)	1 lane remains open	Full diversion via A130, A131, A120 Braintree Ring Road, A120 Coggeshall Road
Improved A12 (D3AP): Lanes 2 and 3	2042 (year 15) – Inlay (50mm) 2057 (year 31) – Inlay (100mm) 2072 (year 46) – Inlay (50mm) 2086 (year 60) – Inlay (100mm)	Full closure	Full diversion via A130, A131, A120 Braintree Ring Road, A120 Coggeshall Road
De-trunked A12 Jn 22 to Jn 23 and Jn 24 to Jn 25 (D2AP):	2038 (year 12) – Thin Surfacing 2049 (year 23) – Inlay (50mm) 2059 (year 33) – Inlay (100mm) 2069 (year 43) – Inlay (50mm) 2079 (year 53) - Inlay (100mm)	N/A – used for calculation of costs but not delays	

QUADRO was used to derive the maintenance delay disbenefit for each maintenance activity. Traffic management arrangements and diversion routes were coded into QUADRO.

QUADRO requires forecast traffic flows for the links affected by construction and diversion routes to be input as Annual Average Daily Traffic (AADT) flows and 16-hour weekday flows respectively. AADT Flows were used instead of 16 hour flows for the diversion flows as a close proxy for this. The data was obtained from the traffic model closest to the year of works. Observed traffic data on the A12 was used to derive an hourly traffic profile for Monday-Thursday, Friday, Saturday and Sunday, by direction.

All maintenance activities use the same 37km diversion route used in the construction delay assessment. It has been assumed that the de-trunked A12 sections cannot be used as diversion routes.

Maintenance delay disbenefits were calculated for both the Do Minimum and Do Something scenarios. The difference in delay disbenefits between these scenarios was taken as the maintenance benefit of the scheme. For the purpose of the TEE table, QUADRO's consumer results were manually split between 'commuting' and 'other' purposes based on the proportion split between those journey purposes in the TUBA assessment. No impact on the changes in accidents, carbon emissions or indirect taxes were extracted from QUADRO.

The results are shown in Chapter 5 as a monetary value in 2010 prices, discounted to 2010.

The maintenance profile in Table 4-7 was also used to inform the Capital Costs of Maintenance assessment discussed in Chapter 3.

4.10 Indirect tax revenues

TUBA also calculates the changes in Indirect Taxes as a result of changes in speed and distance travelled. These changes affect the amount of fuel being used and therefore affect the amount of taxes the Government receives.

The results, as a monetary value in 2010 prices discounted to 2010, are shown in Chapter 5. The results are included within the AMCB and PA tables and form part of the initial BCR.

4.11 Accident impact

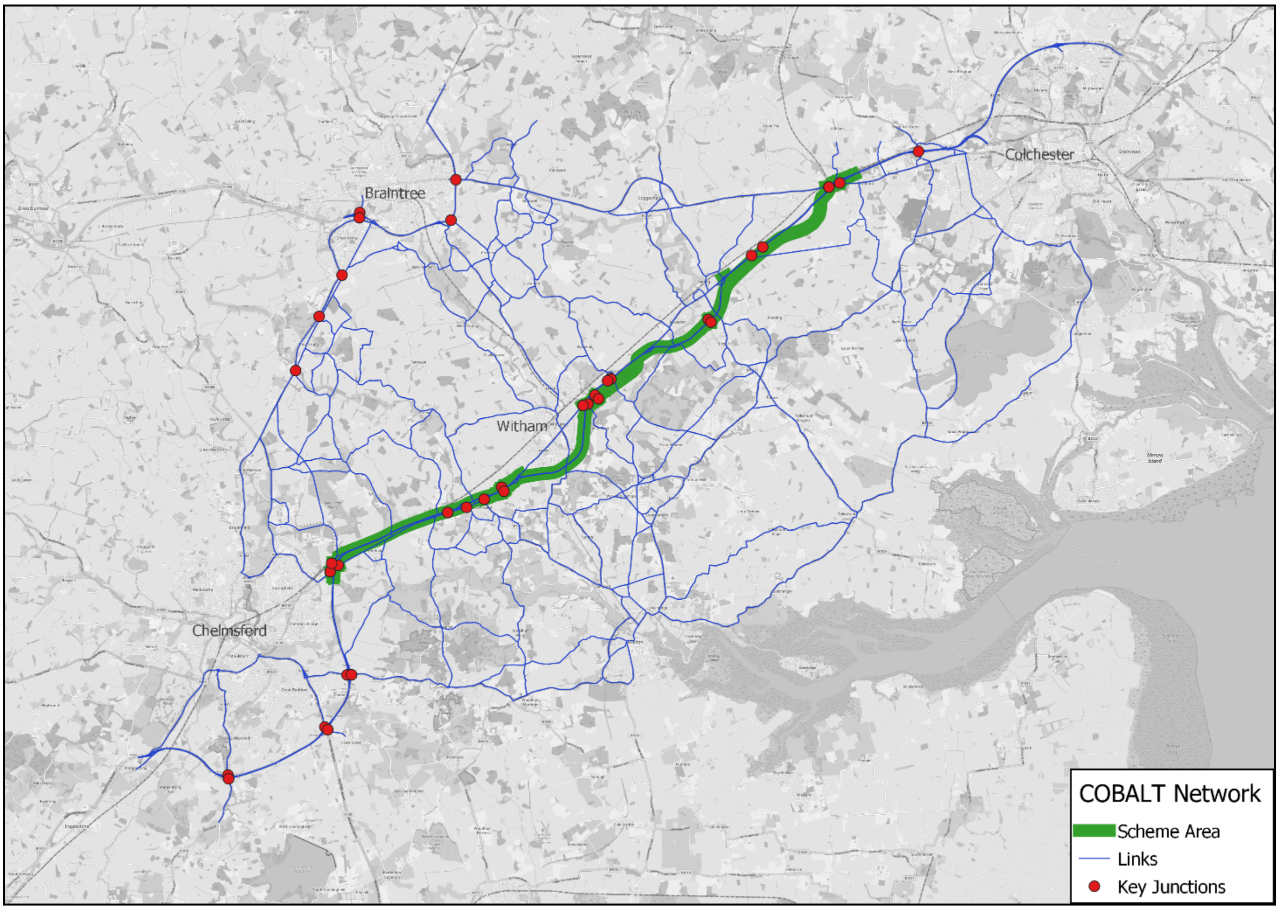
An accident impacts assessment has been undertaken using COst and Benefit to Accidents – Light Touch (COBALT) software. COBALT Version 2.1 was used, with an economic parameters file based on the July 2021 TAG databook.

The COBALT study area was based on the SATURN model network area. The study area was chosen with the aim of including:

- major roads within modelled network area,
- links with AADT traffic flows changes more than 10% between Do Minimum and Do Something scenarios,
- links validated during traffic model validation process,
- key junctions along the A12 and A120/A130/A131 roads.

The COBALT link network with key junctions is shown in Plate 4-1.

Plate 4-1 COBALT study area



COBALT calculates the number of accidents over the 60-year period from either default (national average) or observed (local) accident rates. Observed accident rates for key links and junctions in the study area were calculated from Personal Injury Accident data (PIA) for the five-year period 2015-2019.

PIA data was plotted in GIS and assigned to the COBALT links and junctions as appropriate to derive observed accident rates. If there are no accidents on a link or junction then default accident rates are used.

For the links on the A12 which are widened to three lanes, the observed accident rate was used in the Do Minimum scenario. However, in the Do Something scenario the accident rate used was based on the national default accident rate for a three-lane dual carriageway, but adjusted due to technology included in the scheme. The Project Safety Control Review Group (PSCRG) recommended the implementation of the following technology between junctions 21 and 25:

- 'triple pack' technology (VMS, MIDAS and CCTV) for several purposes including departure mitigation at junction merges,
- stopped vehicle detection (SVD),
- variable mandatory speed limit (VMSL),

- emergency bays at 1.2 – 1.6 km spacings,
- routine patrol and response (e.g. vehicle broken down in lane).

This targeted technology is expected to reduce safety risk. Based on advice in a DMRB Interim Advice Note1, the default accident rate between junctions 21 and 25 has been reduced by 26% compared to a situation with no technology.

On the section between A12 J19 and J21 no additional technology is planned, only concrete barriers. Therefore, the default accident rates within COBALT were applied.

Analysis during previous stages of scheme development showed that there was a significantly higher proportion of serious casualties on the A12 than would normally be expected. This analysis was refreshed by analysing the number of accidents on the existing two-lane section of the A12 between J20a and J25, compared to the COBALT default rate for this road type. To ensure a large enough sample size and therefore greater statistical confidence in these numbers, data for an nine-year period from 2011 to 2019 was analysed. Table 4-8 shows the number of observed collisions and casualties on A12 links between J19 and J25.

Table 4-8 Observed collisions and casualties between junctions 20a and 25

Item	Fatal	Serious	Slight	Total
Collisions (2011 - 2019)	4	36	206	246
Casualties (2011 - 2019)	7	68	304	379

Based on this, the average number of fatal, serious and slight casualties per collision on this section of road were calculated and are shown with a comparison to the COBALT default severity split in Table 4-9.

Table 4-9 Casualties per collision - observed and COBALT default between junctions 20a-25

Item	Fatal	Serious	Slight	Total
Observed data (rebased to 2009 for consistency with default values)	0.031	0.303	1.251	**1.585**
COBALT default values	0.031	0.161	1.328	**1.520**

This observed casualty severity split was applied in the Do Minimum scenario for J20a-J25. For the Do Something scenario, the new A12 links were assumed to revert to national default severity splits.

As well as local values for the number of casualties per collision, local values were also calculated for the ‘accident proportions’ input to COBALT. This shows the proportion of the total number of collisions which are fatal, serious and slight collisions.

[1] Interim Advice Note 160/12 Revision 1: Appraisal of Technology Schemes. A12 scheme technology has been assumed to align with that for ‘Controlled Motorway’ in this advice note.

The scheme includes several new all-movement junctions along the A12, which include pairs of dumbbell roundabouts. Analysis of the observed accident data at existing dumbbell roundabouts on this section of A12 showed that they typically have accident rates significantly lower than the national average. It was assumed that this pattern would also be true at the proposed new roundabouts. To account for this, the accident rates for the new dumbbell roundabouts in the Do Something scenario have been adjusted. The default roundabout accident rate was multiplied by the ratio between observed and default rates at the existing roundabouts, which was found to be 43%. This approach was only used for the new dumbbell roundabouts. All other new junctions used default accident rates.

The traffic flows used for accident analysis were AADTs calculated from the modelled flows discussed in the Transport Forecasting Package. They are consistent with the AADTs used in other elements of economic analysis contained within this report.

Information on speed limits, distances, carriageway standard, junction type etc. was obtained from GIS and Google Earth.

COBALT outputs the number of accidents and casualties with and without the scheme, and the net change in accidents and casualties. The costs of these accidents and casualties to society are also calculated. Costs are discounted to 2010 values and summed over the 60-year assessment period. The results are shown in Chapter 5.

4.12 Greenhouse gas, noise and air quality impacts

Changes in traffic flow and speed can result in changes in greenhouse gas (GHG) emissions. The change in GHG emissions from vehicles over a 60 year period as a result of the scheme can be assessed using traffic model outputs. The change in carbon dioxide emissions (tonnes) was calculated using the Emissions Factor Toolkit (EFT) v11, as described in the Environmental Statement. The standard TAG Greenhouse Gases Spreadsheet (November 2021) has been used to calculate monetary impact of this over the 60 year appraisal period. The spreadsheet outputs the impact as a monetary value (PVB). A sensitivity test around the impact of the government’s Transport Decarbonisation Plan has also been produced and is presented in Chapter 6.

Changes in traffic flow and speed can also result in changes in noise. The standard TAG Noise Spreadsheet A3 (November 2021) has been used to calculate the impact from a change in noise levels during the life of the scheme as a monetary value.

The monetary impact from changes in Air Quality have been calculated in accordance with TAG Unit A3 - Environmental Impact Appraisal (July 2021) using the Air Quality Evaluation Worksheet (November 2021). Traffic data for emissions modelling were obtained from the traffic model. National Highways speed-banded emission factors (v3.1) were applied (based on EFT v10). The EFT emission factors predict up to 2030, hence future years beyond 2030 are represented by 2030 emission factors. Speed banded emission factors are not available for PM2.5. Therefore PM10 has been used for PM emissions.

The monetary values of these environmental results are reported in Chapter 5 of this report. The results are also included within the AMCB table and the initial BCR.

4.13 Journey time reliability

In addition to the 'conventional' travel time savings (as calculated by TUBA), journey time reliability benefits require quantification.

Reliability in this context is defined as variation in journey times that transport users are unable to predict. This unpredictable variation incurs extra costs on travellers. By reducing this unreliability, a transport improvement scheme can provide monetised reliability benefits.

In order to assess the reliability benefits of the scheme, the industry-standard MotorwaY Reliability Incidents and Delay (MyRIAD) program has been used. MyRIAD 2021 has been used, using economic parameters from the July 2021 TAG databook.

MyRIAD calculates three types of benefit

- Incident Delay Benefits on the links in the scheme;
- Incident Delay Benefits in the diversion area;
- Travel Time Variability (TTV) benefits not caused by incidents but fluctuations in demand, weather etc.

MyRIAD uses a simple link-based network to represent the sections of the road network that would be improved as part of the scheme. It uses traffic flows and trip length distributions, as well as standard economic parameters such as incident frequencies published by the DfT, to calculate the change in Delay Benefits and TTV between the future year Do-Minimum and Do-Something scenarios.

Details of the methodology used within the MyRIAD assessment are provided below.

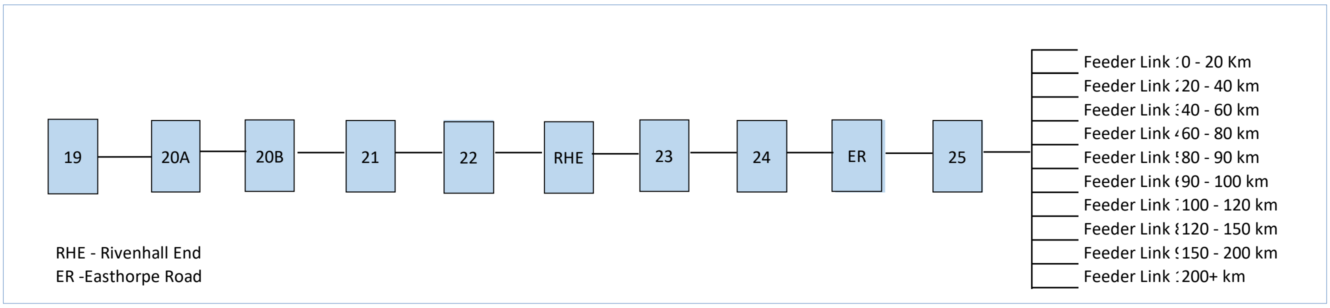
Link structure

A simplified network structure has been derived for the MyRIAD assessment. A schematic of the network is provided in Plate 4-2, with blue squares representing each A12 junction and the links between them which form the MyRIAD network. Feeder links (explained in section 4.8.3) are also shown.

Traffic flows on each MyRIAD scheme link have been obtained from the SATURN traffic model. The simplified MyRIAD scheme links each represent several links in the SATURN traffic model. Where flows have been required from the traffic model for use in the MyRIAD assessment, a single representative traffic model link was chosen to represent each MyRIAD link.

Note that this simplified assessment does not consider the impact on the 'old A12' route which would be de-trunked. This is due to the constraints of the MyRIAD software in dealing with new route choice.

Plate 4-2 MyRIAD network structure



Traffic movements

MyRIAD requires information on the amount of traffic making each possible movement by direction within the assessed area, e.g. how much travels from Junction 21 to Junction 22, and how much travels from Junction 21 to Junction 24. The amount of traffic using each of these routes was calculated by a series of Select Link Analyses (SLAs) produced from the SATURN model, extracting all traffic movements made on the section of A12 being assessed. Information for each year from individual time period models were obtained for each movement.

Feeder links

Reliability calculations require a representation of entire journeys. MyRIAD uses a series of feeder links to replicate the portion of the journey not included within the MyRIAD model. The reason for using feeder links is that journey time variability is affected by total journey time, and not just the journey time on the links affected by the scheme. On shorter journeys, changes in journey time variability are valued more highly. Feeder links are used to represent the length of the remaining part of the trip before and after the MyRIAD network links. Assumptions have been made about the road type of each feeder link based on the length. Journeys with an additional 'non-A12' distance of 100 km or less are assumed to spend the non-A12 section of their trip on a dual carriageway with two lanes (D2AP). All other trips are assumed to travel their non-A12 section of trip on a motorway with three lanes (D3M). Ten different feeder links have been used, with each representing a different journey length so that the variety of different trip lengths using the network links are fully represented.

Calculation of trip length distribution

All information regarding the feeder links have been extracted from trip length distributions based on the Do Minimum 2042 SATURN model and this trip length distribution has been assumed to be consistent for all forecast years.

The distances were skimmed from the AM, IP and PM matrices and averaged. A Select Link Analysis was also undertaken for all of these time periods at a single point mid scheme to calculate AADT traffic flows. The SLA was undertaken in both directions at a point just north of Rivenhall in the DM network.

The average distance spent on the A12 was calculated to be 10.2 km. This was subtracted from each of the individual distance skims to leave the non-A12 distance element of the trip. It is these distances which were used to calculate the trip length distribution profiles for the feeder links.

The feeder links are defined in Table 4-10.

Table 4-10 Feeder Link Summary

Feeder Link	Proportion of Trips	Mid band Trip Length (km)	Assumed Number of Lanes	Assumed Link Type
A	26.6%	10	2	23. D2AP Without MIDAS, Without CCTV, Without VMS
B	16.2%	30	2	23. D2AP Without MIDAS, Without CCTV, Without VMS
C	12.2%	50	2	23. D2AP Without MIDAS, Without CCTV, Without VMS
D	8.2%	70	2	23. D2AP Without MIDAS, Without CCTV, Without VMS
E	4.6%	80	2	23. D2AP Without MIDAS, Without CCTV, Without VMS
F	3.8%	90	2	23. D2AP Without MIDAS, Without CCTV, Without VMS
G	7.2%	110	3	5. D3M Without MIDAS, Without CCTV, With VMS
H	7.3%	135	3	5. D3M Without MIDAS, Without CCTV, With VMS
I	6.3%	175	3	5. D3M Without MIDAS, Without CCTV, With VMS
J	7.4%	375	3	5. D3M Without MIDAS, Without CCTV, With VMS

The feeder links are assumed to have a typical capacity per lane (2100 PCUs per hour for D2AP and 2300 PCUs per hour for D3M). The default V/C ratio of 0.6 given by MyRIAD for the busiest periods is used to calculate the traffic flow on the feeder links.

Traffic flows

Reliability impacts will vary throughout the day depending on the level of traffic flow. Traffic flows are input on each link on the A12 between each pair of junctions, for junctions 19 to 25, in each direction for each of five peaks: AM, Interpeak, PM, off peak and weekend. These were based on the traffic flow information provided as part of the Transport Forecasting Package. HGV percentages for the Do Minimum scenario were also entered for each link.

Annualisation factors were entered into MyRIAD, based on those used in the TUBA assessment. Off peak annualisation factors were required in MyRIAD but not in TUBA – these were calculated by assuming any of the 8,760 hours per year which are not covered by TUBA annualisation factors are part of the off peak.

Diversion routes

MyRIAD also requires information on diversion routes. For each consecutive pair of junctions along the scheme, the length of the diversion route vehicles would be required to make if an incident occurred was input into MyRIAD. For some short sections of road, there is an offline alternative route that vehicles can use. However, for most incidents on the A12, the long diversion route used in the construction and maintenance delay assessments was assumed.

Full details of the MyRIAD results are provided in section 5.10.

4.14 Wider impacts

TAG identifies a number of 'Wider Impacts' of transport schemes, which are not captured in a conventional transport economic appraisal as carried out using TUBA.

The Analytical Requirements Report described the economic context of the area likely to be affected by the scheme. It set out justification for which wider economic impacts are expected to occur, and how these should be assessed.

It stated that three of these wider impacts should be assessed:

- Productivity improvements due to agglomeration impacts ('static clustering')
- Labour supply impacts (more people entering the labour market due to reduced commuting costs)
- Increased business output ('output change in imperfectly competitive markets')

WITA was used to carry out the assessments. WITA is a software package provided by the DfT for the use in assessing static wider impacts.

WITA requires information from the traffic model about travel conditions with and without the scheme in place. This is largely based on the inputs prepared for the scheme's TUBA assessment of user benefits, although the calculation of Wider Impacts does require some additional data. The methodology used for the WITA analysis is provided below.

The assessment was undertaken using the most recently released version of the software (version 2.2).

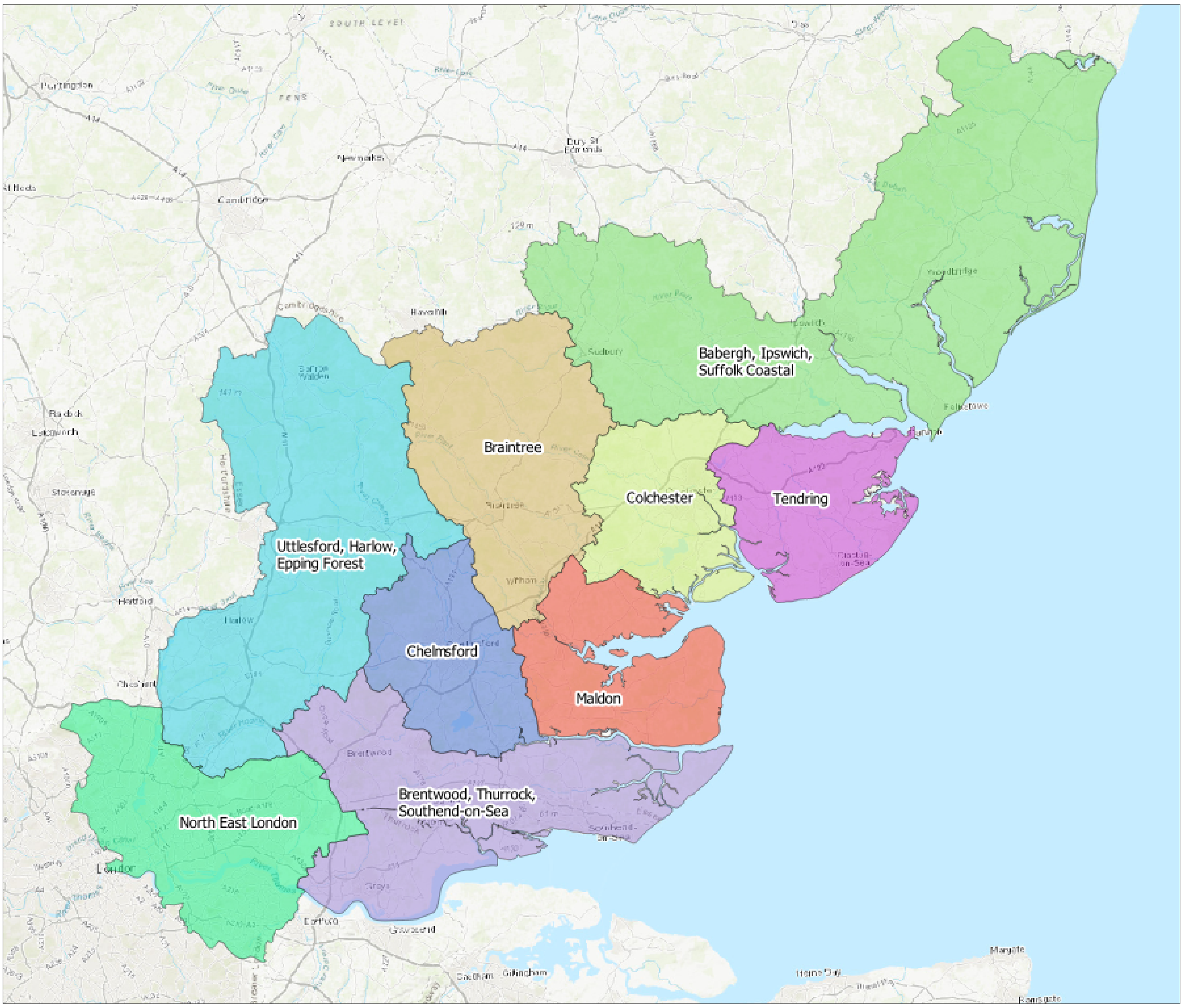
Zoning system and geographic study area

A WITA zoning system is required in order to reconcile the traffic model data, based on the model zoning system, and economic data, which is provided at Local Authority District (LAD) level. The WITA zone boundaries follow either the traffic model zone or LAD boundaries, whichever is larger.

Agglomeration calculations are based on the idea of 'effective density', which is a measure of how well an area is connected to everywhere else. An incorrect estimation of the base generalised costs would lead to an incorrect base case level of effective density, and hence an incorrect estimation of the impact resulting from any changes in agglomeration caused by the transport intervention.

For this reason, the benefits from WITA were extracted only for a core area for which the number of trips and generalised cost of travel to, from or within this core area were modelled in detail. This was based on areas of the traffic model with a detailed zoning structure. This 'core' area is shown in Plate 4-3.

Plate 4-3 WITA core area



Use of existing TUBA assessment

Information on the cost and demand of travel input into WITA was based on the traffic model. Demand, time and distance TUBA skims from the traffic model were prepared for each relevant user class and time period.

WITA aggregates these skims to the WITA zone level to use in its economic calculations.

Intra-zonal costs within the skims output from the models were zero, however, intra-zonal costs are important in calculating wider impacts. WITA calculates the intra-zonal costs for each origin as the larger value of either the 'minimum intrazonal cost' set at £2.50, or half the value of the smallest inter-zonal cost to/from that zone.

Having carried out the assessment, similar warnings were seen as those in the TUBA assessment. There were a few instances where OD costs within the time and distance skims were zero. These were investigated, and adjusted to a small value in order to allow WITA to run.

In line with TAG advice, freight movements were excluded from central estimates of Wider Impacts. Any reference to freight demand or costs of travel have therefore been removed from the TUBA scheme file. Similarly, car 'other' (i.e. not business or commuting trips) were also excluded.

Non-car modes

TAG recommends that non-car modes should be considered in the estimation of Wider Impacts. The WITA assessment incorporated these by using the rail demand and cost information that was used in the scheme's variable demand (VDM) traffic modelling. This VDM information was originally based on that used in the M3/M27 SMART motorway scheme model. Rail demand (which is ultimately based on PLANET rail data) was provided per time period, while time and fare costs were provided as a weekday average hour.

24hr commuting matrix

As part of the calculation of labour market impacts, WITA requires a 24hr commuting demand between Local Authorities. This information was derived based on 2011 Census 'Journey to Work Matrix' information. As recommended in WITA guidance, this matrix was factored up to be consistent with the employment data input elsewhere in WITA.

Employment and economic parameters

All employment and economic data parameters required by WITA have been taken from the standard "wider impacts" economic dataset provided by the DfT (July 2021). The economics parameter file is based on TAG databook v1.16.

4.15 Summary

This chapter of the report has outlined the approach to assess the benefits of the proposed scheme improvements, how these relate to the A12 transport model, and the logic checks undertaken to ensure a robust assessment. It detailed the elements that are included in the quantitative assessment, the assumptions behind these and the software used. The following chapters of this report present the results of these assessments.

5. Economic Appraisal Results – Core Scenario

5.1 Introduction

This section of the report presents the results of the assessments carried out and how they have been used to derive the overall BCR for the scheme. The BCR will inform the 'Value for Money (VfM)' case for the scheme.

This chapter presents the results for the Core demand scenario. All costs and benefits presented in this section have been assessed over a 60-year project lifetime. Unless otherwise stated, all costs and benefits are shown in 2010 market prices, discounted to 2010.

Results from the high and low growth scenarios are provided in Chapter 6.

5.2 Transport Economic Efficiency – travel time and vehicle operating costs

Travel time benefits – summary

The scheme provides significant travel time benefits. The total travel time benefits are presented in Table 5-1 below.

Table 5-1 Summary of travel time benefits in 2010 prices discounted to 2010 (£000s)

	Benefits (£000's)
Travel Time Benefits	£523,670

The travel time benefits are analysed in more detail in the following sections of the report.

Analysis of travel time benefits

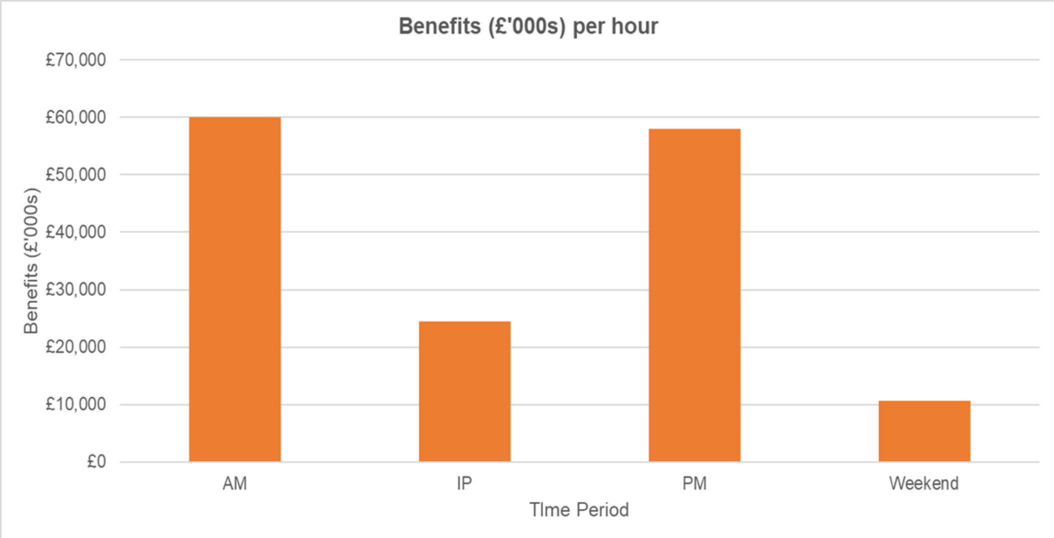
Analysis of the travel time benefits by time period is shown in Table 5-2.

Table 5-2 Profile of travel time benefits in 2010 prices discounted to 2010 (£000s)

Period	Time Period			
	AM	IP	PM	Weekend
60-years	£149,954	£146,859	£130,603	£96,254
% of total	29%	28%	25%	18%

The interpeak benefits are similar to those for the AM and PM peak. This is due to the significantly higher annualisation factors for the interpeak (i.e. it occurs for a longer period each day). The 'benefits per hour' are shown in *Plate 5-1*. This shows that the level of benefits during the AM and PM peak hours are considerably higher than during the interpeak. This reflects the fact that the scheme provides the most benefits during periods of heavy congestion. Weekend benefits per hour are lower than interpeak, even though they are based on the same demand, time and distance skims from the traffic model. This is because the weekend demand was adjusted to have a lower proportion of business and commuter trips (which have higher values of time than leisure trips).

Plate 5-1 Travel time benefits per hour



Analysis of the travel time benefits by trip purpose shown in Table 5-3 indicates that, in the core scenario, the largest proportion of benefits come from business trips, while commute trip purposes account for the lowest proportion of benefits. This reflects the higher values of time for business trips compared to other trip purposes.

Table 5-3 Profile of travel time benefits by journey purpose in 2010 prices discounted to 2010 (£000s)

Period	Purpose		
	Business	Commute	Other
60-years	£238,828	£115,778	£169,064
% of total	46%	22%	32%

The travel time benefits have been also assessed against the level of time saved which are shown in *Table 5-4*. Analysis of the benefits showed that most of benefits are associated with savings in travel time of between two to five minutes, followed by travel time savings of between zero and two minutes. These time savings are consistent with the information reported in the Transport Forecasting Package. The disbenefits due to trips with increases in journey times are likely to be due to the closure or relocation of junctions for local traffic.

Table 5-4 Travel time benefits by journey purpose in 2010 prices discounted to 2010 (£000s)

Purpose	< -5 mins	-5 to -2 mins	-2 to 0 mins	0 to 2 mins	2 to 5 mins	> 5 mins	Total
Business	-£1,549	-£5,287	-£66,111	£63,927	£164,781	£83,067	£238,828
Commuting	-£18	-£3,223	-£62,308	£62,735	£68,824	£49,766	£115,778
Other	-£132	-£4,404	-£87,735	£80,309	£131,014	£50,012	£169,064
Total	**-£1,699**	**-£12,914**	**-£216,154**	**£206,971**	**£364,619**	**£182,845**	**£523,670**

Sector analysis of time saving benefits

In order to confirm that the geographic distribution of user benefits for the A12 scheme is sensible and that the economic user benefits of the scheme are reliable and robust, a sector-to-sector analysis based on 18 sectors has been undertaken.

Benefits accrue to most sector movements, with some of the largest benefits seen between Chelmsford and Colchester and vice versa. Trips between these locations spend the majority of their journey using the improved A12 and so a large benefit between these sectors is expected.

Significant benefits are also seen for longer distance trips which use the scheme, for example between Suffolk (which includes the ports) and the London area. Trips which already use the A12 route benefit from travel time savings. But there are also some trips which would re-route to the A12 to take advantage of the time savings available, i.e. away from alternate routes via the M11, A120, A11 or A14.

Internal trips within the Colchester and Chelmsford sectors experience time disbenefits. This is likely due to changes in patterns of movements caused by the scheme which impacts adversely on short distance trips within Chelmsford or Colchester. However, on a per vehicle basis, the disbenefit of such internal trips is very small. Overall trips to/from Colchester and Chelmsford (i.e. not just internal trips within those sectors) do receive time benefits due to the scheme.

Vehicle operating costs

The scheme is expected to result in an increase in vehicle operating costs (VOC), resulting in a disbenefit to users. These results are shown in Table 5-5.

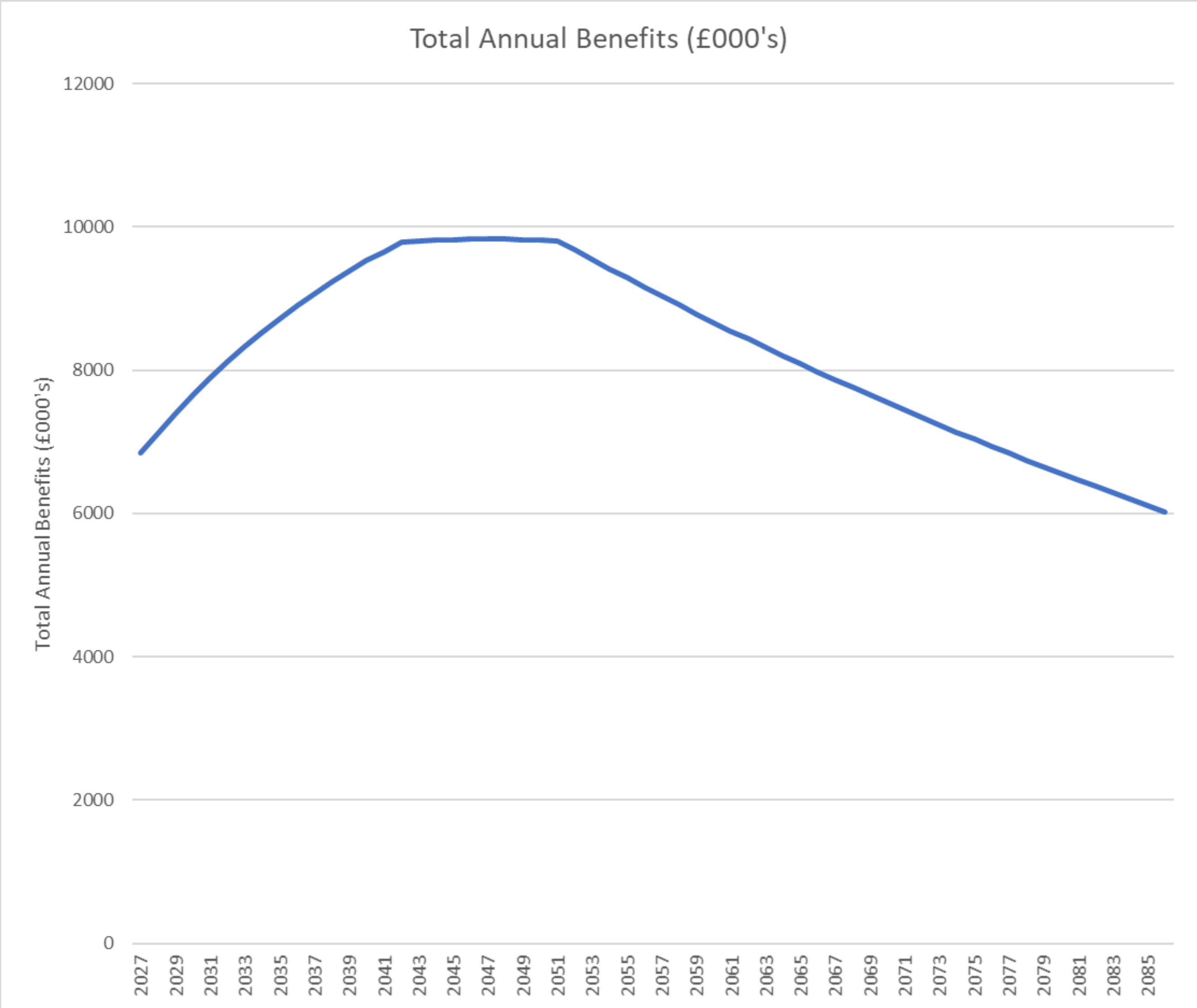
Table 5-5 Changes in Vehicle Operating Costs in 2010 prices discounted to 2010 (£000s)

Vehicle Operating Costs	Benefits (£000's)
Fuel VOC	-£8,051
Non-Fuel VOC	-£49,888
Total VOC	-£57,939

Profile of benefits over the appraisal period

The benefit profile over a scheme's life is used to determine whether the benefits of the scheme occur earlier or later in the scheme's life. The benefit profile over the 60-year assessment period is shown in Plate 5-2.

Plate 5-2 Profile of benefits



The benefit profile indicates that the benefits increase until the intermediate modelled year (2042), stay flat up the final modelled year (2051) and steadily decline after that. The two main reasons for the shape of this profile are:

- Increasing congestion in future years without the scheme in place, resulting in increased benefits once the scheme is in place; and
- The impact of discounting over time

Without the scheme in place, congestion would increase between 2027 and 2042. This means that the effect of the scheme would be greater in 2042, producing larger benefits than in 2027. However, the increase in benefits is eroded by the effect of discounting. Beyond 2051, it has been assumed that there is no increase in traffic. Journey time changes are therefore constant, but the effect of discounting means that, beyond 2051, the annual benefit falls. It should be noted that this means there still are benefits, merely of a lower value.

5.3 Transport Economic Efficiency – delays during construction

As discussed in section 4.3, the impact of additional road user delays during construction has been assessed using both QUADRO and the SATURN model/TUBA.

Results for the total construction delay disbenefits are summarised in Table 5-6.

Table 5-6 Construction Delays in 2010 prices discounted to 2010 (£000s)

Assessment	Commuter Disbenefits (£000's)	Other Disbenefits (£000's)	Business Disbenefits (£000's)	Total Disbenefits (£000's)
QUADRO Construction Delay	-£2,343	-£3,514	-£2,422	-£8,279
SATURN Construction Delay	-£10,960	-£17,494	-£24,124	-£52,578
Construction Delay Total	-£13,303	-£21,008	-£26,546	-£60,857

The disbenefits from the SATURN construction assessment are higher. This reflects the fact that this assesses longer term full-time traffic management as opposed to isolated night-time or weekend closures.

5.4 Transport Economic Efficiency – delays during maintenance

As discussed in section 4.4, the scheme will result in a change in the amount of road user delays during road maintenance. The maintenance delay results for Do Minimum and Do Something scenario were calculated in QUADRO, and are shown in Table 5-7. This table also shows the resultant maintenance benefit that Do Something provides over the Do Minimum.

Table 5-7 Maintenance Benefits in 2010 prices discounted to 2010 (£000s)

	Maintenance Delay Cost	Maintenance Benefit of scheme compared to Do Minimum
Do Minimum	£81,111	-
Do Something	£51,149	£29,962

The Do Something scenario provides a benefit over the Do Minimum. This reflects the 'maintenance holiday' once the scheme is newly built, and the additional traffic management flexibility offered by an extra lane.

The split of benefits between business, commuter and other users for the purpose of the TEE table is shown in Table 5-8.

Table 5-8 Maintenance Benefits in 2010 prices discounted to 2010 split by purpose (£000s)

Assessment	Commuter Benefits (£000's)	Other Benefits (£000's)	Business Benefits (£000's)	Total Benefits (£000's)
Maintenance Delay Total	£6,860	£10,290	£12,811	£29,962

5.5 Transport Economic Efficiency (TEE) Table

The Transport Economic Efficiency (TEE) benefits described above are reported in a standard table known as the TEE table. A summary of this table is presented in Table 5-9 for the scheme.

Table 5-9 Summary TEE Table, in 2010 prices discounted to 2010 (£000s)

User Benefits	
Non-Business (Commuting)	
Travel time	£115,778
Vehicle operating costs	-£31,030
User charges	£0
During Construction and Maintenance	-£6,443
NET NON-BUSINESS BENEFITS: COMMUTING	**£78,305**
Non-Business (Other)	
Travel time	£169,064
Vehicle operating costs	-£37,269
User charges	£0
During Construction and Maintenance	-£10,717
NET NON-BUSINESS BENEFITS: OTHER	**£121,078**
Business	
Travel time	£238,828
Vehicle operating costs	£10,360
User charges	£0
During Construction and Maintenance	-£13,734
NET BUSINESS BENEFITS IMPACT	**£235,454**
Present Value of Transport Economic Efficiency Benefits (TEE)	**£434,836**

5.6 Indirect tax

As discussed in section 4.5, there is likely to be an increase in indirect tax revenues as vehicles travel faster with the scheme in place. This change in indirect taxes is assessed in TUBA, calculated from the change in times and distances between zones. This is included within the overall scheme benefits.

The monetary impact is shown in Table 5-10 below in 2010 prices, discounted to 2010. It should be noted that the result is the same as that shown in the Public Accounts table, but with the opposite sign for entry into the AMCB table as this is a summary of benefits to society rather than the impact on the government's accounts.

Table 5-10 Indirect Tax Revenues in 2010 prices discounted to 2010 (£000s)

	Benefits (£000's)
Indirect tax	£29,140

5.7 Greenhouse gas, noise and air quality

As discussed in Section 4.7, Greenhouse Gas emissions, Air Quality and Noise benefits are derived by using standard TAG environmental spreadsheets.

The results output from the Greenhouse Gas emissions spreadsheet for the study area predict an increase in carbon dioxide emissions, giving a monetary disbenefit of -£113.4m.

The results output from the noise spreadsheet show that there is predicted to be a disbenefit from an increase in noise levels, equating to -£6.6m over 60 years.

The results from the Air Quality spreadsheet predicts a disbenefit due to increases in PM10 (Particulate Matter < 10μm) and NOx emissions, due to changes in traffic flows, distances and speeds once the proposed scheme is in place. The total value of the change in Air Quality is a disbenefit of -£16.3m over 60 years.

Further details on the derivation of these environmental impacts are provided in the detailed worksheets within the scheme's Appraisal Summary Table.

The results of Noise, Air Quality and Greenhouse Gases are included within the AMCB Table 5-15 and the initial BCR.

5.8 Accident impact

As discussed in Section 4.6, an assessment was made of the numbers of accidents, and their associated costs, for the situations both with and without the scheme. The total change in the number of accidents due to the scheme is shown in Table 5-11. This shows there would be an increase in the total number of accidents with the scheme in place.

Table 5-11 Accident changes due to the scheme

Change in the number of accidents (PIA's) due to the scheme
+262

The scheme's impact on the number of casualties over the 60-year appraisal period, split by severity, is shown in Table 5-12. This shows there is predicted to be a decrease in the number of fatal and serious casualties, but an increase in the number of slight casualties.

Table 5-12 Casualty changes due to the scheme

Severity	Predicted change in the number of casualties
Fatal	-2
Serious	-200
Slight	+496

Table 5-13 below shows the change in the monetary cost of accidents over the 60-year assessment period.

Table 5-13 Monetary benefits due to accident savings in 2010 prices discounted to 2010 (£000s)

Section	Benefits (£000's)
Links - A12 J19-J25	£1,983
Links - A12 J15-J19 & J25-J28	-£2,862
Links - Wider Study Area	£18,324
All Links	**£17,445**
All Junctions	**-£4,355**
Total	**£13,090**

The reduction in fatal and serious number of casualties brought about by the scheme results in an overall monetary benefit of £13.1m. On the A12 links between junctions 19 and 25, there is an overall benefit. Despite the increase on traffic on the A12, an improvement in accident rate leads to this benefit.

On the A12 outside of junctions 19-25, there is a disbenefit. This is because the amount of traffic increases, while accident rates remain unchanged. This results in more accidents.

On the wider non-A12 links in the network, there is an accident benefit as traffic reduces on those links and starts to use the improved A12 instead.

The impact on junctions is negative overall. This is primarily due to the introduction of new junctions, as shown in Table 5-14.

Table 5-14 A12 accident impact on junctions (in 2010 prices discounted to 2010)

Junction	Benefits (£000's)	Description
J19	£890	Some tweaks made to junction – accident rate assumed not to change
J20a & J20b	£5,703	Removed
J21	-£2,287	New dumbbell roundabout junction
J22	-£2,024	New dumbbell roundabout junction
Rivenhall End	£1,082	A12 no longer passes through this junction
J24	-£586	New dumbbell roundabout junction
Easthorpe Rd	£2,204	Junction removed
J25	-£9,462	Existing Station Rd roundabout replaced with a new signalised junction

Table 5-14 shows there is predicted to be a large benefit of £5.7m due to the removal of the existing J20a and J20b. There are also benefits at Rivenhall End and Easthorpe Road junctions.

A large disbenefit of £9.5m is predicted at A12 junction 25 due to it changing from a roundabout to a signalised junction. Within COBALT, the national default accident rate for signalised junctions was assumed for this new junction. This is higher than the observed accident rate for the existing roundabout.

It is important to note that while this COBALT assessment can be used to support the overall economic assessment of the scheme, it is based mainly on accident parameters that reflect national average conditions for different broad categories of road. It is not a substitute for the detailed operational safety assessment undertaken as part of the scheme development.

5.9 Analysis of Monetised Costs & Benefits (AMCB) Table

Many of the economic analysis results for the scheme are incorporated into the standard Analysis of Monetised Costs and Benefits (AMCB) table. This table is summarised in Table 5-15. All values are provided in 2010 prices, discounted to 2010.

Table 5-15 AMCB Table in 2010 prices discounted to 2010 (£000s)

AMCB	Scheme
Noise	-£6,550
Local Air Quality	-£16,325
Greenhouse Gases	-£113,418
Journey Quality	-
Accidents	£13,090
Economic Efficiency: Consumer Users (Commuting)	£78,305
Economic Efficiency: Consumer Users (Other)	£121,078
Economic Efficiency: Business Users and Providers	£235,454
Wider Public Finances (Indirect Taxation Revenues)	£29,140
Initial Present Value of Benefits (PVB)	**£340,773**
Broad Transport Budget	£452,122
Present Value of Costs (PVC)	£452,122
Initial Net Present Value (NPV)	-£111,349
Initial Benefit to Cost Ratio (BCR)	**0.8**

5.10 Journey time reliability

As described in section 4.7, MyRIAD was used to assess the impact of the scheme on journey time reliability. The results for the core scenario are provided in Table 5-16. The results are disaggregated by the benefits derived from changes in incident delay benefit and those from changes in Travel Time Variability. The results represent monetary benefits over 60 years, and are provided in 2010 prices, discounted to 2010.

Table 5-16 Journey time reliability benefits in 2010 prices, discounted to 2010 (£000s)

Benefit Type	Benefit (£000's)
Incident Delay Benefit, MyRIAD Links	£87,927
Incident Delay Benefit- Diversion Area	£22,630
Travel Time Variability	£70,190
Total	**£180,747**

The results show that the reduction in congestion caused by the scheme will lead to reduced day to day variability in travel times, generating economic benefit. The scheme will also lead to a reduction in incident delays, as a greater number of lanes and greater technology means delays are shorter when incidents do occur.

Benefits are also predicted to occur on routes that are used as diversions when incidents do occur.

Table 5-17 presents the journey time reliability benefits by trip purpose. The table shows that benefits to Commuting and Other trips are slightly higher than those to Business trips.

Table 5-17 Journey time reliability benefits by trip purpose: Core Scenario - in 2010 prices, discounted to 2010 (£000s)

Benefits by Trip Purpose	Benefit (£000's)
Business	£78,929
Commuting & Other	£101,818
Total	**£180,747**

The Journey Time Reliability results are not included within the initial BCR or the AMCB tables. The results are however included within the overall Value for Money assessment and are reported in the AST.

5.11 Wider impacts

WITA outputs monetary values for each of the Wider Impacts assessed. In common with the results of the TUBA assessment, the results are for a 60-year appraisal period and are provided in 2010 prices discounted to 2010.

A summary of the results for each Wider Impact is provided in Table 5-18 below. The agglomeration benefits are split by the various employment sectors.

Table 5-18 Wider impact summary, benefits over 60-year appraisal period, in 2010 prices, discounted to 2010 (£000s)

Wider Economic Impact	Benefit (£000's)
Agglomeration - Manufacturing	£12,937
Agglomeration - Construction	£24,027
Agglomeration - Consumer Services	£64,995
Agglomeration - Producer Services	£114,262
Total Agglomeration ('static clustering')	**£216,222**
Labour supply impacts	£6,257
Increased business output (output change in imperfectly competitive markets	£31,438
Total Wider Impact Benefits	**£253,917**

It can be seen that – in line with guidance – agglomeration results are by far the largest source of wider impact benefit.

The majority of agglomeration benefits accrue to the "Producer Services" employment sector. This reflects the higher agglomeration elasticity value for Producer Services, i.e. it is more sensitive than other employment sectors to changes in agglomeration.

TAG Unit A2.4 states that based on previous experience, productivity impacts are generally in the range of 10% to 30% of total TEE user benefits. For the A12 J19-25, the agglomeration benefits represent nearly 50% of total TEE user benefits. However, the results are in line with expected results as per The Highways England Economic Growth Technical Annex (February 2018*),* which states that, based on evidence from previous schemes, WITA results are typically between 20% and 107% of the standard Business User benefits. For the A12 J19-25, the agglomeration benefits represent 92% of Business User benefits. Including labour supply and increased business outputs, the total WITA results represent 108% of the Business User Benefits.

The WITA results are therefore at the top end of the typically expected range. However, the scheme's economic narrative has provided context-specific evidence which suggests that benefits from wider impacts such as agglomeration would be material. Overall, it is considered that the scale of benefits is plausible given the spatial distribution of benefits and the robustness of the model used.

The A12 improves journey times between two major conurbations in Chelmsford and Colchester, each of which are listed as DfT core Functional Urban Regions. The area around Chelmsford is also part of the wider London Functional Urban Region hinterland.

The scheme delivers major journey time savings, with up to 8 minutes southbound in the AM and 10 minutes northbound in the PM being saved by 2042.

Benefits to other areas may be driven by improved connectivity to London. However, this is to be expected as their geographic locations are such that they are within the journey time limits at which agglomeration benefits typically disappear.

The agglomeration and labour supply benefits split by zone are provided in Table 5-19 as well as shown geographically in *Plate 5-3*.

Table 5-19 Agglomeration ('static clustering') and Labour Supply benefits over 60-year appraisal period, in 2010 prices, discounted to 2010 (£000s)

WITA Sector	Agglomeration & Labour Supply Benefits
Colchester	£116,576
Chelmsford	£16,432
Maldon	-£1,938
Braintree	£1,064
Tendring	£27,725
Brentwood, Thurrock, Southend-on-Sea	£7,908
Uttlesford, Harlow, Epping Forest	£7,341
Babergh, Ipswich, Suffolk Coastal	£29,786
North East London	£17,585
Total	**£222,479**

Plate 5-3 Agglomeration ('static clustering') and Labour Supply benefits over 60-year appraisal period, in 2010 prices, discounted to 2010 (£000s)

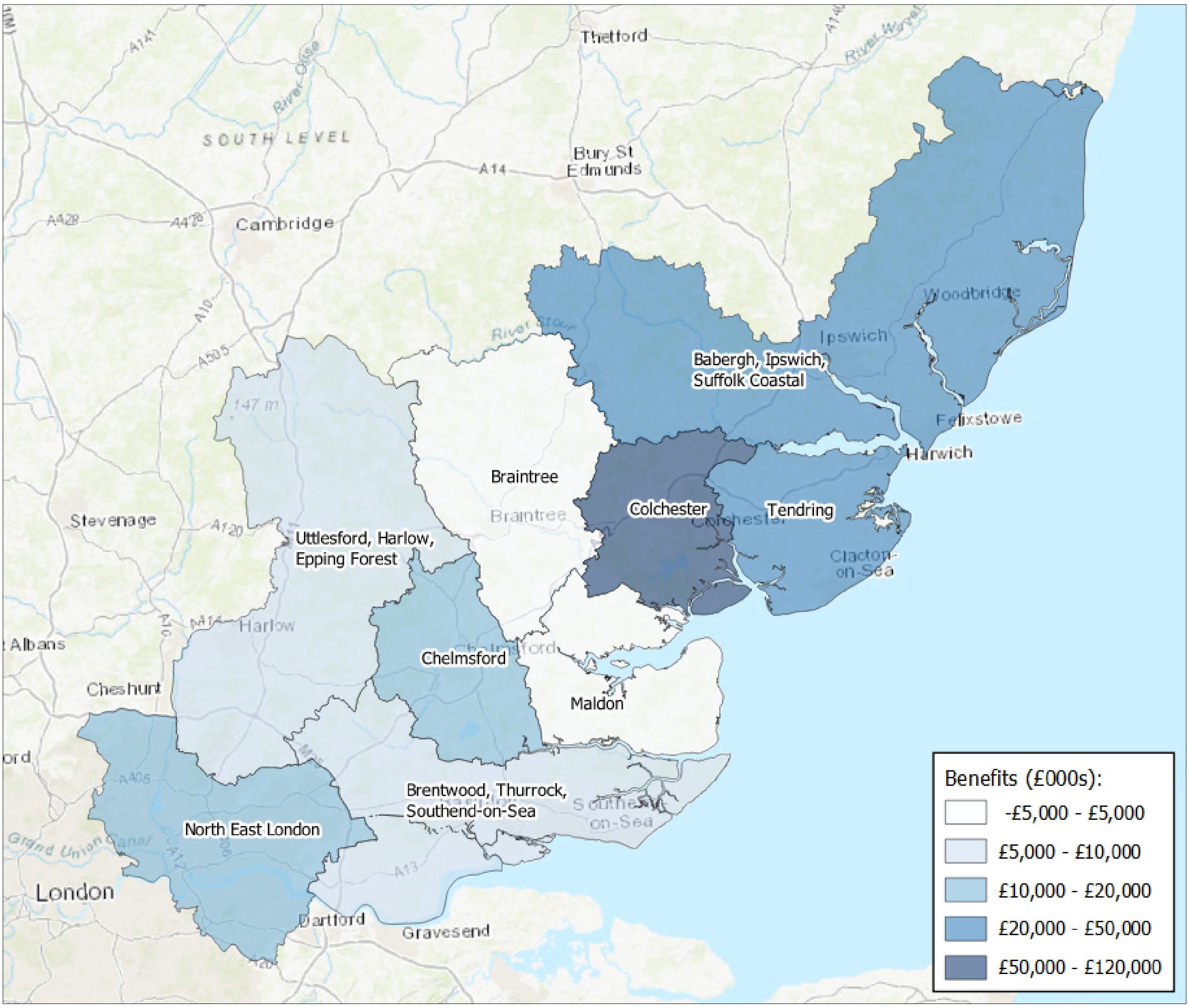


Table 5-19 and Figure *5-3* show that Colchester receives the largest agglomeration benefits from the scheme. Due to the scheme, Colchester, Tendring and Barbergh/Ipswich/Suffolk Coastal all become better connected to Chelmsford and London, getting the full time savings offered by the scheme. Chelmsford becomes better connected to Colchester and the north. However, it has a slight worsening in connectivity in London due to small increases in journey times on the A12 west of junction 19 as traffic increases. This means its agglomeration benefits are lower than Colchester. Greater London and western Essex benefit from an increase in connectivity towards Colchester and beyond to the ports. Other areas such as Braintree and Maldon receive smaller benefits overall.

As recommended, a sensitivity test was undertaken whereby WITA was run for highway only (i.e., excluding non-car modes). This would result in an under-estimate of the base-case level of effective density, and therefore mean that the proportional improvement in connectivity offered by the scheme will be over-stated. This should result in agglomeration benefits being higher than if non-car modes are included.

The sensitivity test found that agglomeration benefits are 38% higher if non-car modes are excluded. This provides additional confidence in the agglomeration results.

The Wider Impact benefits are not included within the initial BCR or the AMCB tables. The results are however included within the overall Value for Money assessment and are reported in the AST.

5.12 Adjusted benefit to cost ratio

This chapter of the report has so far presented the results of the economic appraisal undertaken for the A12 Chelmsford to A120 improvement scheme.

The AMCB table showed the Initial BCR is 0.8. Table 5-20 shows an Adjusted BCR of 1.7 which takes into account Journey Time Reliability benefits and Wider Impacts.

Table 5-20 Adjusted BCR and overall PVBs in 2010 prices, discounted to 2010 (£000s)

	Benefit (£000's)
Initial Present Value of Benefits (PVB)	**£340,773**
Present Value of Costs (PVC)	£452,122
Initial Benefit to Cost Ratio (BCR)	**0.8**
Wider Impacts (WI)	£253,917
Journey Time Reliability Benefits (JTR)	£180,747
Adjusted Present Value of Benefits (PVB)	**£775,438**
Adjusted Benefit to Cost Ratio (BCR) including JTR and WI	**1.7**

6. Economic Appraisal Results – Sensitivity Tests

6.1 Introduction

Sensitivity tests have been undertaken around the assumptions used in the core economic assessment. These tests are:

- High and Low traffic growth sensitivity tests
- Greenhouse Gas – Transport Decarbonisation Plan

6.2 High and low growth

The economic assessment described above is based on the "most likely" traffic forecast scenario known as the Core Scenario. The results provided in chapter 5 refer to this Core Scenario.

In line with TAG, two additional traffic forecast scenarios have been developed to take into account lower and higher demand as a result of uncertainty regarding forecasts of population, households, employment, GDP growth and fuel price trends and their impact on future traffic growth. These sensitivity tests are known as the 'Low Growth' and 'High Growth' scenarios respectively.

The results of these sensitivity tests are provided in Table 6-1 below, together with the core scenario results for comparison purposes.

Table 6-1 High and Low Growth Scenario Economic Results (2010 prices, discounted to 2010)

	Low Growth Scenario	Core Scenario	High Growth Scenario
Travel time and Vehicle Operating Costs	£367,139	£465,731	£674,521
Delays during construction and maintenance	-£28,162	-£30,895	-£49,033
Change in accidents	£14,428	£13,090	£10,566
Noise, Air Quality and Greenhouse Gases*	-£136,294	-£136,294	-£136,294
Change in Indirect Tax Revenues	£28,034	£29,140	£32,135
Initial Present Value of Benefits	**£245,146**	**£340,773**	**£531,896**
Present Value of Costs	**£452,122**	**£452,122**	**£452,122**
Initial Benefit to Cost Ratio (BCR)	**0.5**	**0.8**	**1.2**
Wider Impacts	£222,832	£253,917	£291,837
Journey Time Reliability	£174,042	£180,747	£172,214
Adjusted Present Value of Benefits (PVB) including JTR and WI	**£642,020**	**£775,438**	**£995,947**
Adjusted Benefit to Cost Ratio (BCR) including JTR and WI	**1.4**	**1.7**	**2.2**

** Core scenario results assumed to apply across all scenarios*

As expected, the low growth scenario predicts a lower BCR than the 'most likely' core scenario, while the high growth scenario predicts a higher BCR.

6.3 Greenhouse Gas – Transport Decarbonisation Plan

The Greenhouse Gas calculation assessment within the core economic assessment is based the DfT's latest approved calculation tools (use of Defra's Emissions Factor Toolkit v11). This predicts that the scheme would cause an increase of 1,535,559 tonnes of carbon dioxide emissions over 60 years, giving a monetary disbenefit of -£113.4m.

A sensitivity test has been undertaken to test the impact that the government's Transport Decarbonisation Plan (TDP) would have on the scheme's Greenhouse Gas emissions. This sensitivity test assumes a greater take-up of electric vehicles than the core assessment. The results of this test show that the scheme would still increase Greenhouse Gas emissions, but to a much lower extent. Using the midpoint of estimates for the annual transport emissions, the results predict that the scheme would cause an increase of 292,376 tonnes of carbon dioxide emissions over 60 years, giving a monetary disbenefit of -£30.0m. Further details on this TDP sensitivity test are provided in the scheme's Environmental Statement.

Incorporating this result into the core scenario would give an increase in the total scheme benefits and a resultant increase in the BCR, as shown in Table 6-2.

Table 6-2 Greenhouse Gas – TDP sensitivity test economic results (2010 prices, discounted to 2010)

	Core Scenario	Core Scenario with TDP assumptions for GHG
Initial Present Value of Benefits	£340,773	£424,233
Present Value of Costs	£452,122	£452,122
Initial Benefit to Cost Ratio (BCR)	0.8	0.9
Adjusted Present Value of Benefits (PVB) including JTR and WI	£775,438	£858,897
Adjusted Benefit to Cost Ratio (BCR) including JTR and WI	1.7	1.9

The values presented above use the midpoint of estimates for annual emissions from the TDP sensitivity tests. Further tests have been carried out using the lower and upper estimates. Results using the lower estimate predict that the scheme would cause an increase of 209,520 tonnes of carbon dioxide emissions over 60 years, giving a monetary disbenefit of -£22.7m. Using the upper estimate, the scheme would cause an increase of 346,492 tonnes of carbon dioxide emissions over 60 years, giving a monetary disbenefit of -£34.7m.

7. Summary and Conclusion

7.1 Summary

The economic assessment of the A12 Chelmsford to A120 (J19 to 25) scheme included consideration of the following impacts:

- **Transport Economic Efficiency (TEE) benefits**, consisting of two elements:
  - Travel time and Vehicle Operating Cost (VOC) benefits and disbenefits;
  - Travel time and VOC disbenefits as a result of construction and maintenance activities;
- Changes in **Indirect Taxes**;
- The impacts of the scheme on **Accidents**;
- The **Environmental Impacts**
  - Noise
  - Air quality
  - Greenhouse gases;
- The **Wider Impacts** of the scheme;
- The impacts of the scheme on **Journey Time Reliability**;
- The **Costs** of the scheme, consisting of construction, land and compensation, preparation and supervision costs, and changes to future maintenance costs.

A summary of the economic assessment results is provided in Table 7-1 below.

Table 7-1 Summary of Economic Assessment Results – Core Scenario (2010 prices, discounted to 2010)

		Benefit (£m)
	Total Costs (PVC)	£452.1m
Excluding Journey Time Reliability and Wider Impacts	Total Initial Benefits (PVB)	£340.8m
	Initial Benefit to Cost Ratio (BCR)	**0.8**
Including Journey Time Reliability and Wider Impacts	Adjusted Benefits (PVB)	£775.4m
	Adjusted Benefit to Cost Ratio (BCR)	**1.7**

7.2 Conclusion

This report has set out the economic assessment results at PCF Stage 3 of the A12 Chelmsford to A120 (J19-25) scheme.

This shows that the scheme produces a present value of benefits of £340.8m, or £775.4m if benefits from journey time reliability and wider impacts are included. The present value of costs are estimated at £452.1m. This considers both the cost of the scheme itself and the change in ongoing maintenance costs.

The scheme therefore provides an initial benefit to cost ratio (BCR) of 0.8. If benefits from journey time reliability and wider impacts are included, the BCR is 1.7.

Low and high growth sensitivity tests were also undertaken. As expected, the low growth scenario predicts a lower BCR than the 'most likely' core scenario, while the high growth scenario predicts a higher BCR.