TRANSPORT FOR THE
South East

Report prepared to support the development of the Transport Strategy for the South East

Scenario forecasting technical report

tfse.org.uk/transport-strategy

Report
4 October 2019

Transport Strategy for the South East: Scenario Forecasting Technical Report

Transport for the South East
Our ref: 23433704
Client ref:

steer

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1 Introduction

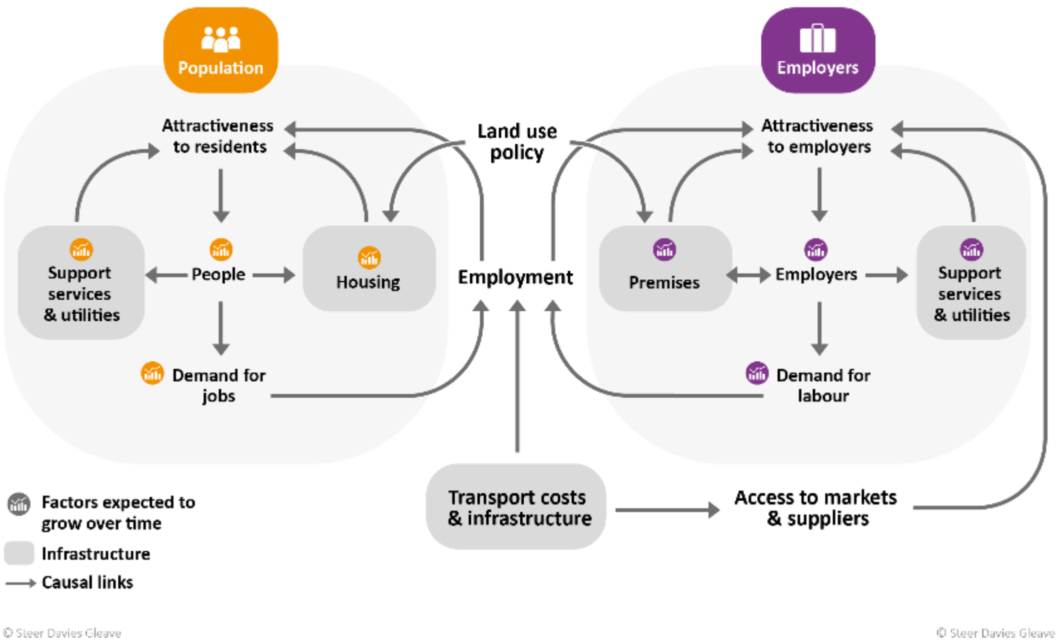
1.1 As part of the project to develop its Transport Strategy, Transport for the South East (TfSE) wanted to understand the location and scale of improved connectivity and infrastructure investment needed to support different scenarios of economic growth.

1.2 Steer was commissioned to develop a model that would determine the impact of such economic growth scenarios on employment, population and travel in the South East. This model was the South East Economy and Land Use Model (SEELUM).

1.3 SEELUM is a transport and land use model that simulates the interaction of transport, people, employers and land-use over periods of time. It is a customised application of Steer's Urban Dynamic Model (UDM), which was originally developed over fifteen years ago to explore the relationship between transport and economic activity and regeneration. The UDM has been applied widely in the UK, including across the whole of the North of England (for Transport for the North), West Yorkshire, Leeds City Region, Merseyside, Humberside, North East Scotland, and the Oxford to Cambridge corridor.

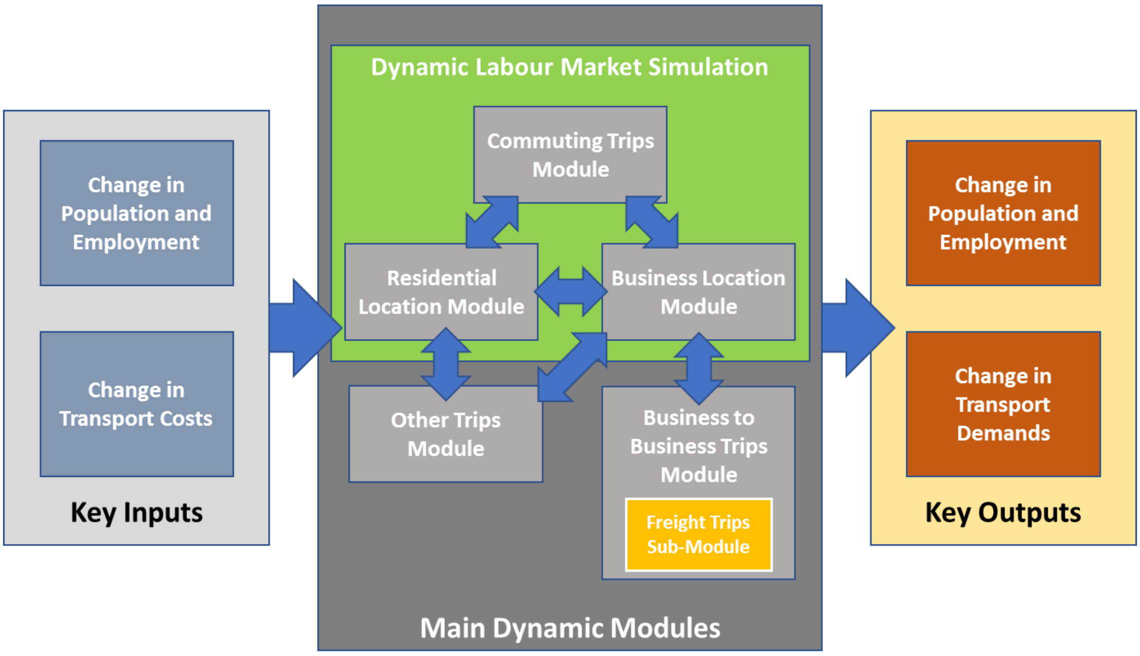
1.4 Figure 1.1 provides a high-level view of the linkages in the model. Figure 1.2 shows a high-level view of the key inputs and outputs when testing scenarios.

Figure 1.1: High level overview of the linkages in the model



1.5 The UDM's primary use is to test how investment in transport, sometimes coupled with changes to land-use policy, will affect the economic performance of a region, city or urban area. It does this principally by simulating how changes in patterns of connectivity and access affect how attractive different locations are for employers and/or households to locate in, how they respond, and what the consequences are. For example, if travel costs rise in a particular area (say, due to an exogenous input), depending on the other options available, people may change their mode of travel, change where they live or change where they work. In the extreme, if there are no other viable options to access work, people can become unemployed. Similarly, businesses can relocate to an area if transport costs reduce, increasing their accessibility to the potential workforce.

Figure 1.2: High level overview of scenario testing inputs and outputs



1.6 The UDM is a simulation of how an urban area evolves over time. It looks at how house builders and property developers provide new infrastructure, the inward and outward migration of households, and the start-up and closure of businesses. It includes internal models of highways, bus and rail services, walk and cycle, all connecting places together and influencing their relative advantages as places to live or work. It can incorporate planned land-use changes and investment in transport infrastructure or services.

1.7 It generates a set of outputs allowing detailed examination of how and why conditions change in the simulated area. Detailed reports are available on:

- Travel patterns, volumes and mode shares;
- Changes in land-use in each zone (i.e. the number of housing units and number of employment premises (business space));
- Changes in households, population and the workforce in each zone;
- Changes in employment (jobs filled) in each zone and the unemployment rates;
- Changes on CO_2 emissions from transport activity;
- Time savings benefits for appraisal, and the wider economic impacts on productivity and agglomeration.

1.8 The UDM is a simulation, which means that it attempts to replicate events in the real world using simplified representations of how people perceive their circumstances and decide how to react. It is also dynamic, which means it is concerned with how events unfold through time: as its internal clock rolls forward it calculates, step by step, how conditions change and how people respond. It does this for everything encompassed by the model, at every time step, simultaneously.

1.9 It can do this because it is built using System Dynamics, which is a type of computer simulation designed to handle complicated systems with many factors interacting over time. System Dynamics provides the language and tools to describe such systems and then simulate their behaviour.

1.10 A guiding principle of a model of this type is that all the mechanisms in it should have real-world counterparts; it is an attempt to describe what really happens. The UDM does this drawing on a wide pool of research by transport researchers and others. Its internal structure tells a story of how an urban area and the people in it behave, based on evidence and research.

1.11 Despite applying innovative technology for a transport model, the UDM does in fact borrow a lot from established transport modelling techniques. It includes network models that will be familiar to transport modelers, while choice processes are handled using the same nested logit models that are used widely in the field. The difference is that these models are put to work in a dynamic framework that links them to a broader set of processes such as migration and business start-ups.

The Role of SEELUM

1.12 SEELUM is a strategic model of the South East, designed to show how transport interacts with where people live and work, and also with 'land-use', meaning what gets built, and where. Its primary role is to show how large-scale, transformative, and integrated investment can reshape the South East's economy. Examples of potential uses include:

- Tests of alternative future economic and demographic growth scenarios;
- Testing major transport schemes: new rail lines, improved service frequencies, new motorway links etc;
- Changes to transport pricing, such as road pricing or rail fares;
- Changes to land use policy to increase the volume and/or change the mix of housing and commercial premises, on new sites and/or by densification;
- Adding value to major projects with supporting policies like improved access to stations, local densification etc;
- Supporting 'soft' measures, such as Smarter Choices, to change people's mode preferences, and re-training of the workforce to increase labour supply among higher skills groups;
- Diagnostic testing, to identify where, in future, problems are likely to arise (congestion, crowding, labour shortages, unemployment, housing shortages etc)
- Package tests of combinations of any or all of the above.

1.13 While SEELUM includes a multi-modal transport model, its role is not to replicate or replace existing detailed transport models available to TfSE, but to increase the range of analysis and scenario testing available to TfSE, and thereby increase confidence in the investment cases they can present.

2 Building SEELUM: The Data

Introduction

2.1 SEELUM simulates the interaction of transport, people, employers and land-use over time. The start year – or base year – for those simulations is 2018. The model is initialised for a base year of 2018 by providing it with information about the locations of the population, businesses and employers, and the travel costs between them. All of this data was obtained from a number of existing data sources; this section describes how that data was assembled.

Zones

2.2 The core study area is that which is covered by the TfSE area, namely the counties of:

- Berkshire
- Hampshire
- Surrey
- West Sussex
- East Sussex
- Kent

Figure 2.1: The Transport for the South East area (source: transportforthesoutheast.org.uk)

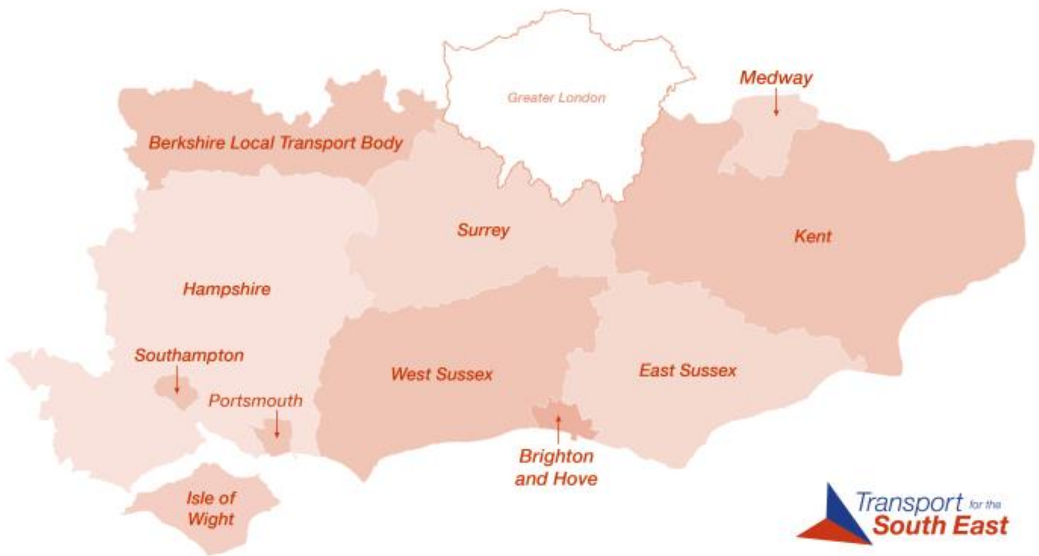


Figure 2.2: Internal zones

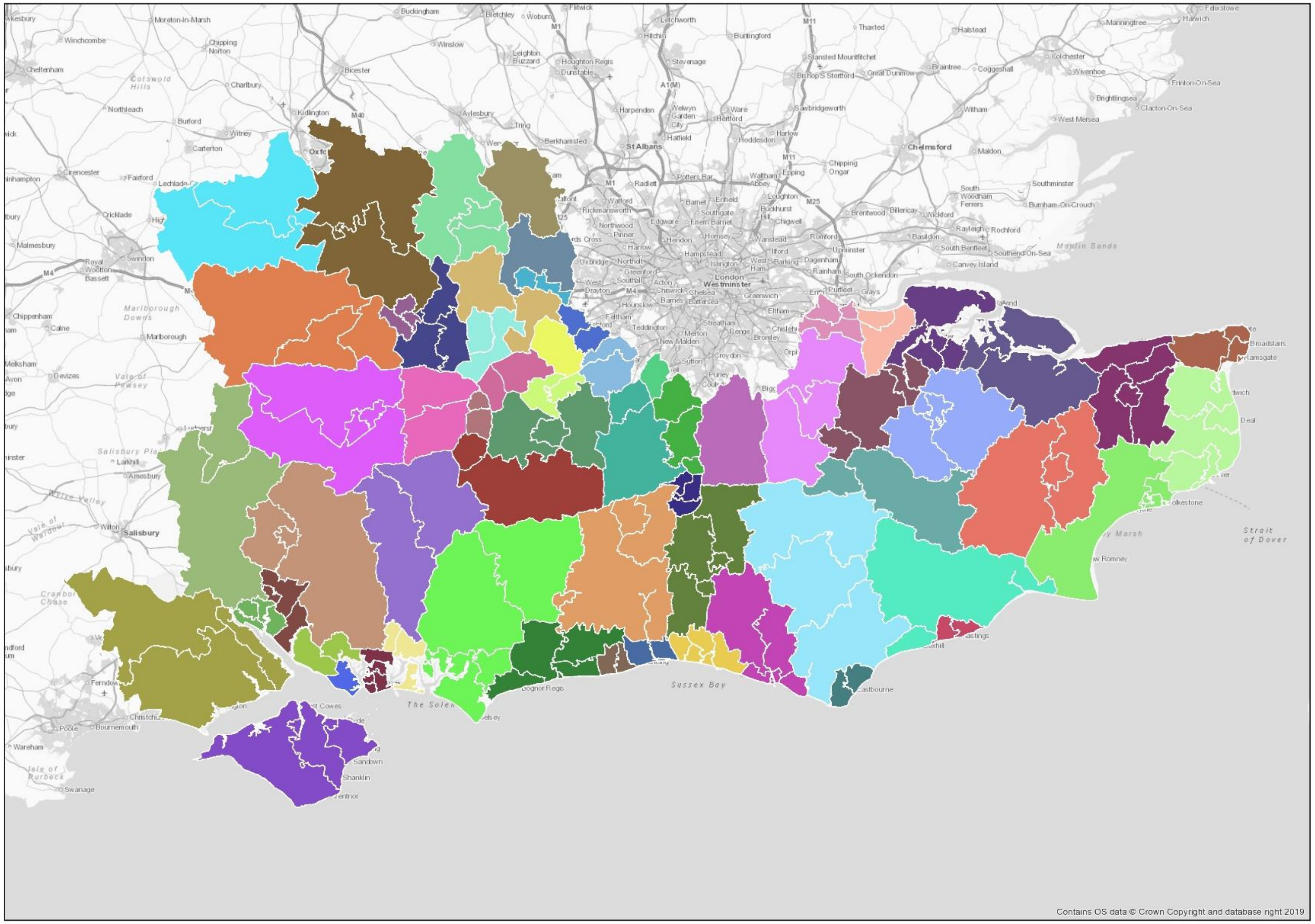
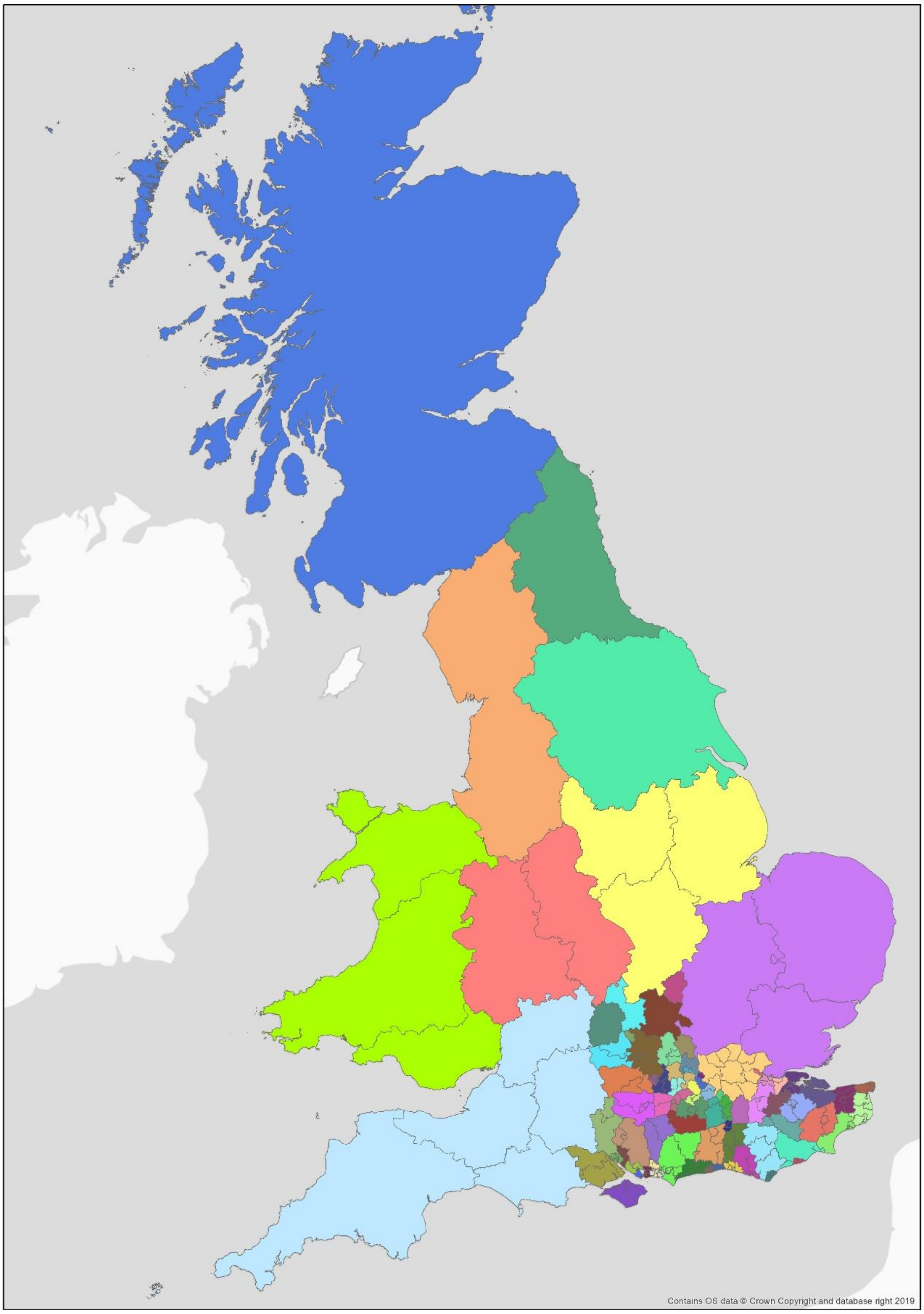


Figure 2.3: Internal and external zones



2.3 In addition, the districts of Vale of White Horse, South Oxfordshire, Wycombe, Chiltern and South Bucks have also been included. This is to enlarge the catchment area around Berkshire which, being on the edge of the TfSE region, may have otherwise suffered from boundary issues in the model. The core study area can be seen in Figure 2.2.

2.4 The core study area is divided into 167 'internal' zones (see Figure 2.2). The study area zones have been defined to capture key inter-district and intra-district (or hinterland to centre) transport flows to/from key urban centres, railway stations, seaports and airport. Zones were based on the disaggregation of Local Authority Districts into groups of MSOAs (Middle Super Output Areas). This approach means that model outputs can be presented at both the zone level and district level.

2.5 The area outside of the study area has been divided into 38 'external' zones. These zones are based on aggregations of districts in the regions of England (North East, North West, East, East Midlands, West Midlands, London, South West), Scotland, and Wales. These can be seen in Figure 2.3.

2.6 To assist with reviewing and sense checking model outputs during model calibration and scenario testing, the internal zones were also grouped into ten 'sectors' for high level review of data. A diagram of the sectors can be seen in Figure 2.4. Table 2.1 lists the districts within each sector.

2.7 The model allows 'full dynamics' to operate in the zones within the core study area. This means that all of the entities in these zones – households, housing, employers, commercial premises, recruitment, travel to work – can vary in response to changing conditions.

2.8 Outside that area, zones have a more restricted set of dynamics: employers can recruit from anywhere in the model, and people can choose to work anywhere, but numbers of households and employers do not vary in response to internal conditions. This is to avoid 'edge effects' close to the boundary of the modelled area. However, these households and employers can be forced to grow using externally imposed growth rates.

2.9 Each zone has a population-weighted centroid. This was calculated by aggregating 2018 mid-year population estimates at postcode level in each zone and using these to locate the centre of the zone based on its population. These weighted population centres were used when calculating the travel time matrices.

2.10 A database was built containing information about numbers of households, housing units, employers etc. in each zone in the base year (2018). This was sourced from published data such as the Census and the NOMIS website. The following sections describe how this was achieved and the sources used. Table 2.13, at the end of this chapter, provides a summary of the data headings and the segmentation used.

Figure 2.4: Model sectors

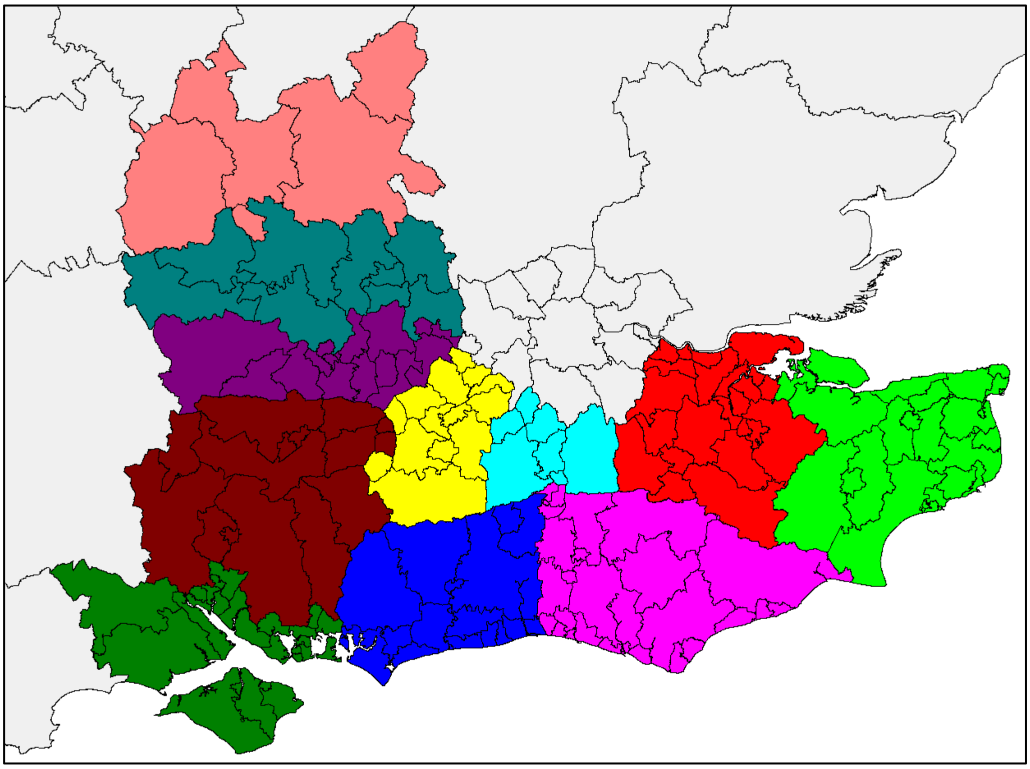


Table 2.1: Composition of model sectors

Sector	Districts in Sector
West Kent	Dartford, Gravesham, Maidstone, Medway, Sevenoaks, Tonbridge and Malling, Tunbridge Wells
East Kent	Ashford, Canterbury, Dover, Shepway[1], Swale, Thanet
West Sussex	Adur, Arun, Chichester, Horsham, Worthing
East Sussex	Brighton and Hove, Crawley, Eastbourne, Hastings, Lewes, Mid Sussex, Rother, Wealden
West Surrey	Elmbridge, Guildford, Runneymede, Spelthorne, Surrey Heath, Waverley, Woking
East Surrey	Epsom and Ewell, Mole Valley, Reigate and Banstead, Tandridge
North Hampshire	Basingstoke and Deane, East Hampshire, Hart, Rushmoor, Test Valley, Winchester
South Hampshire	Eastleigh, Fareham, Gosport, Havant, Isle of Wight, New Forest, Portsmouth, Southampton
Berkshire	Bracknell Forest, Reading, Slough, West Berkshire, Windsor and Maidenhead, Wokingham
Rest of SE internal[2]	Chiltern, South Bucks, South Oxfordshire, Vale of White Horse, Wycombe

[1] Shepway was renamed to Folkestone & Hythe in 2018. However, the publicly available datasets used still refer to it as Shepway. Therefore, to avoid confusion, we have used the name that appears in the data.

[2] These are the remainder of the model's internal zones that are not within the TfSE area

Households and Housing

2.11 The model was initialised with the following information about households in each zone:

- The number of households, split by category;
- The average number of people, split by skill category, for each type of household; and
- The number of premises, by type, needed to accommodate the households.

Households by Type by Zone

2.12 The model requires information on the number of households, categorised by type and by zone. Household types in SEELUM are based on the NS-SeC (National Statistics – Socio-economic Classification) used in the census. The NS-SeC is divided into nine categories. For SEELUM, these are aggregated to the five categories shown in Table 2.2.

Table 2.2: National Statistics Socio-economic Classification (NS-SeC)

SEELUM Category	NS-SeC Category
1-2	1. Higher managerial, administrative and professional occupations
1-2	2. Lower managerial, administrative and professional occupations
3-4-5	3. Intermediate occupations
3-4-5	4. Small employers and own account workers
3-4-5	5. Lower supervisory and technical occupations
6-7	6. Semi-routine occupations
6-7	7. Routine occupations
8	8. Never worked and long-term unemployed
Students	Full-time students

2.13 Data on the number of households by MSOA and by NS-SeC was obtained from Nomis[3]. The data was then converted to the model's zoning system and uplifted from 2011 to 2018 using NTEM[4] forecasts (from TEMPRO[5] 7.2) for growth in households. The data was then aggregated to the SEELUM household categories.

2.14 The format of the household data table used by the model is shown in Table 2.3

Table 2.3: Data table of households per zone (truncated)

SEELUM Zone	NS-SeC 1-2	NS-SeC 3-4-5	NS-SeC 6-7	NS-SeC 8	Students
Adur 01	8,387	9,202	6,184	675	141
Arun 01	7,681	8,016	5,312	595	162
Arun 02	7,990	9,105	6,732	842	257
Arun 03	4,600	4,023	2,160	266	48
Ashford 01	10,453	10,773	9,015	1,195	248
Etc.	Etc.	Etc.	Etc.	Etc.	Etc.

[3] https://www.nomisweb.co.uk/

[4] National Trip End Model

[5] Trip End Model Presentation PROgram – used to access NTEM data

Household Structure Table

2.15 Population itself is not an input to SEELUM; it is instead calculated within the model using the number of households and what is referred to as the 'household structure table'. This is a matrix that, when multiplied with the households table above, produces a table of population, by skill type, in every zone.

2.16 Skill types in SEELUM are based on census occupation data. There are nine occupation categories in the census. These have been aggregated to three skill categories in SEELUM, as shown in Table 2.4. The total population is made up of the population in these skill categories, plus students and people of non-working age.

Table 2.4: Skill Categories

SEELUM Category	Census Category
Expert	1. Managers, directors and senior officials
Expert	2. Professional occupations
Skilled	3. Associate professional and technical occupations
Skilled	4. Administrative and secretarial occupations
Skilled	5. Skilled trades occupations
Manual	6. Caring, leisure and other service occupations
Manual	7. Sales and customer service occupations
Manual	8. Process, plant and machine operatives
Manual	9. Elementary occupations

2.17 The household structure table is shown in Table 2.5. The values in the table were estimated using census NS-SeC and occupation data. Population data for these categories was first used to calculate row and column totals for the matrix. Furnessing[6] was then used to fill the matrix cells. Finally, each cell was divided by the number of households in the corresponding household type to give the average household size by skill and household type.

Table 2.5: The Household Structure Table

	Skill Type				
Household Type	Non-working age	Manual	Skilled	Expert	Students
NS-SeC 1-2	0.79	0.07	0.59	0.70	0.00
NS-SeC 3-4-5	1.16	0.12	0.73	0.37	0.00
NS-SeC 6-7	1.13	1.43	0.03	0.01	0.00
NS-SeC 8	1.34	2.08	0.03	0.01	0.00
Students	0.00	0.00	0.00	0.00	11.05

[6] This is an iterative method for infilling a matrix when the column and row totals of the matrix are known, but only approximate estimates of some of the cell values are available.

Economic Activity Rate by Skill Type by Zone

2.18 The economic activity rate (EAR) is the fraction of people of working age within each skill category who are economically active, meaning they are either in work or available for work. The model applies the activity rate to the population of working age in each zone to calculate the workforce in each zone. The layout of the table is shown in Table 2.6.

2.19 'Working age' is defined as people who are aged 16 to 64. 'Economically Active' people are those that are either in work or seeking work. Census data provides the total number of people and the numbers that are economically active. From this, the proportion that is economically active can be derived.

2.20 As economic activity is not available cross-tabulated with occupation (and hence SEELUM skill category) in the census, it is assumed that the same activity rate applies to each of the working skill types (i.e. manual, skilled, expert).

2.21 Additional checks and adjustments are described below in paragraph 2.36 to ensure a sensible job to workforce ratio.

Table 2.6: Data table for Economic Activity Rate (truncated)

SEELUM Zone	Skill Type				
	Non-Work Age	Manual	Skilled	Expert	Students
Adur 01	0.00	0.86	0.86	0.86	0.00
Arun 01	0.00	0.84	0.84	0.84	0.00
Arun 02	0.00	0.85	0.85	0.85	0.00
Arun 03	0.00	0.87	0.87	0.87	0.00
Ashford 01	0.00	0.86	0.86	0.86	0.00
Etc.	Etc.	Etc.	Etc.	Etc.	Etc.

Adjusting the Workforce to NTEM

2.22 The workforce is calculated in the model as a function of the economic activity rates, numbers of households and the household structure table. The number of households in each zone was therefore adjusted so that the model calculates the same size of workforce in 2018 as reported in NTEM (obtained from TEMPRO 7.2) for the same year.

Housing Supply by Zone

2.23 The model requires data on the number of housing units by type per zone. Data on housing unit types is available from the 2011 census. Five categories of housing unit were used for the model; the total numbers of units in each zone were scaled up to 2018 using the NTEM growth in households between 2011 and 2018. The table format is shown in Table 2.7.

2.24 Detached, semi-detached, terraced and flat are categories in the census data. There are two remaining categories of 'Caravan or other mobile and temporary structure' and 'Shared dwelling'. As these were an order of magnitude smaller than the other categories, they were included with the Flat category to create 'Flats & Other'. The number of student houses was assumed to be equal to the number of student households.

Table 2.7: Data table for housing supply by zone (truncated)

SEELUM Zone	Detached	Semi-Detached	Terrace	Flats & Other	Students
Adur 01	6,824	7,060	5,726	5,572	145
Arun 01	6,090	6,238	5,035	4,890	167
Arun 02	6,700	7,064	5,873	5,772	264
Arun 03	3,307	3,221	2,482	2,371	49
Ashford 01	8,445	8,887	7,565	7,481	255
Etc.	Etc.	Etc.	Etc.	Etc.	Etc.

2.25 A three percent uplift was applied to all of the housing unit values to allow for vacant properties, which are not captured in the census data. This provides the model with a realistic degree of 'slack' within which market turnover can operate; in practice housing vacancies tend to run at approximately 3%.

Housing Preference Table

2.26 The aim of this process was to estimate the relationship between household types and the types of housing units they prefer to occupy. The preference table is shown in Table 2.8. This matrix sets out the proportional preferences of each household type for housing. When new households arrive in a zone, the model will try to allocate them to a housing unit in this order of priority (so long as vacant units are available). The availability of housing unit types, weighted by these factors, is also used to assess how attractive each zone is for each type of household, based on their preference in housing units.

2.27 The cell values in Table 2.8 were calculated using Furnessing[7], operating on the total numbers of households, by type, and of housing units, by type, in the study area. The resulting values in the matrix cells were then divided by the total number of households in each household category to create the table.

Table 2.8: Housing preference table

	Housing Unit Type				
Household Type	Non-working age	Manual	Skilled	Expert	Students
NS-SeC 1-2	0.39	0.26	0.18	0.16	0.00
NS-SeC 3-4-5	0.30	0.35	0.19	0.16	0.00
NS-SeC 6-7	0.09	0.20	0.34	0.37	0.00
NS-SeC 8	0.09	0.20	0.29	0.43	0.00
Students	0.00	0.00	0.00	0.00	1.00

[7] Furnessing is an iterative method for infilling a matrix when the column and row totals of the matrix are known, but only estimates of some of the cell values themselves are available.

Summary of Data Sources

2.28 Table 2.9 provides a summary of the data sources used thus far for the households and housing model inputs.

Table 2.9: Summary of households and housing data sources

Model Requirement	Source	Year
Table of households, by type, by zone	Census data on number of households by NS-SeC by MSOA	2011 uplifted to 2018
Household structure table that relates household type to skill type	Census data on • Number of people in each occupation by MSOA • Number of households by NS-SeC by MSOA	2011 uplifted to 2018
Table of economic activity rate, by skill type, by zone	Census data on • Population of Working Age by MSOA • Economic Activity by MSOA	2011 uplifted to 2018
Workers check	NTEM number of workers by MSOA	2018
Table of the number housing units, by unit type, by zone	Census data on number of housing units by type, by MSOA	2011 uplifted to 2018
Housing preference table that relates housing type to household type	Census data on • Number of housing units by type, by MSOA • Number of households by NS-SeC by MSOA	2011 uplifted to 2018

Businesses and Business Units

2.29 The model was initialised with the following information about employers in each zone in 2018:

- The number of employers, split by employer category;
- The average number of employees, split by skill category, for each type of employer; and
- The number of premises, by type, needed to accommodate the employers.

Number of Businesses by Type by Zone

2.30 The model requires data on the number of businesses and other employers by type, by zone. Businesses in the model are grouped into nine categories derived from the Standard Industrial Classification of Economic Activities (SIC) 2007 codes. The mapping of SEELUM categories to SIC 2007 sections and divisions is shown in Appendix A.

2.31 The number of businesses by type in 2018 in each zone were taken from the UK Business Count data on the Nomis website. The format of the data table input to the model is shown in Table 2.10.

Table 2.10: Data table of businesses per zone (truncated)

SEELUM Zone	Advanced Manufacturing	Knowledge Service Sectors	Primary	Finance and Business	Education	Retail and Catering	Other Industry and Manufacturing	Other Services	Port Freight Handler
Adur 01	20	349	487	354	44	492	103	307	0.2
Arun 01	10	293	329	355	26	483	67	298	0.0
Arun 02	12	289	449	396	24	478	47	331	0.0
Arun 03	4	167	250	238	15	269	53	136	0.0
Ashford 01	23	541	557	711	62	735	124	611	0.0
Etc.	Etc.	Etc.	Etc.	Etc.	Etc.	Etc.	Etc.	Etc.	Etc.

Employer Structure Table

2.32 The employer structure table provides the model with the average number of jobs per business, by business type and skill type. It is used in conjunction with the table of businesses by type, to calculate the number of jobs, by skill type, by zone. The table was created using a combination of the census and UK Business Counts data from the Nomis website. A different process was used for 'Port Freight Handler' businesses, which is described from paragraph 2.42 below.

2.33 2018 UK Business Count data on the Nomis website provides the total number of businesses by SIC 2007 code. These codes were aggregated to SEELUM Business Types.

2.34 Skill types in the model are based on occupations. The census provides a table of the number of employees by occupation and SIC 2007 code for 2011. This data was uplifted to 2018 using NTEM growth in workers and aggregated to the SEELUM business and skill types. Each cell in the table was then divided by the total number of businesses in that business type to give the average employees per business by business type and skill type. The result is shown in Table 2.11.

Table 2.11: Employer Structure Table (Average jobs per business)

Business Type	Skill Type				
	Non-Work Age	Manual	Skilled	Expert	Students
Advanced Manufacturing	0	9.72	12.83	8.83	0
Knowledge Service Sectors	0	0.56	2.04	2.34	0
Primary	0	1.38	3.47	1.05	0
Finance and Business	0	0.68	2.50	1.79	0
Education	0	18.97	11.56	29.50	0
Retail and Catering	0	6.13	2.93	2.23	0
Other Industry and Manufacturing	0	6.07	6.56	2.97	0
Other Services	0	8.87	6.58	5.16	0
Port Freight Handler	0	174.99	129.37	16.02	0

Adjusting Number of Jobs to NTEM

2.35 The number of jobs is calculated in the model as a function of the number of businesses and the employer structure table. The number of businesses in each zone was therefore adjusted so that the model calculates the same number of jobs in 2018 as reported in NTEM (obtained from TEMPRO 7.2) for the same year.

2.36 However, the data for jobs described so far is for the number of *jobs* rather than Full Time Equivalents (FTEs). That is, if one person worked two jobs, the data would show two jobs with a workforce of one. This meant that the above process produced a workforce to jobs ratio of less than one. To address this, the workforce to *people employed* ratio was calculated using census data (uplifted to 2018) for the study area and the average jobs per business table (Table 2.11) was adjusted so that the model produced the right number of jobs to replicate the workforce to people employed ratio across the study area.

Employer Premises

2.37 The number of business premises in each zone was estimated using the number of businesses per zone and the premises preference table shown in Table 2.12. This table states, for example, that Advanced Manufacturing businesses will all locate in Research and Manufacturing premises, while Knowledge service sectors will be split between offices and Research premises. The main use of this information in the model is to constrain – or encourage – the types of employers that can move into a location once commercial premises have been built.

2.38 For instance, a zone where the premises consisted entirely of offices and shops, hotels and restaurants, could attract new employers in the Knowledge Service sector, Finance and Business, Retail and Catering, and Other services, but none of the others, unless existing premises were demolished and replaced with suitable new ones.

2.39 The values in the table are assumptions made by Steer, on the basis of reasonable assumptions about the scope for re-use of types of building.

2.40 A margin of 3% vacant stock was added to the totals to allow for normal market turnover. As with housing, this provides 'slack' for the market turnover in the model but is also similar to the actual long-run vacancy rates for commercial property.

Table 2.12: Assignment of employer classes to types of premises

	Business Unit Type				
Business Type	Commercial offices	Shops hotels & restaurants	Research & manufacturing premises	Other	Port freight premises
Advanced Manufacturing	0	0	1	0	0
Knowledge Service Sectors	0.8	0	0.2	0	0
Primary	0	0	1	0	0
Finance and Business	1	0	0	0	0
Education	0	0	0	1	0
Retail and Catering	0	1	0	0	0
Other Industry & Manufacturing	0	0	1	0	0
Other Services	0.2	0	0.2	0.6	0
Port Freight Handler	0	0	0	0	1

Summary of Data Sources

2.41 Table 2.13 provides a summary of the data sources used for business and business units described thus far.

Table 2.13: Summary of businesses and business units data sources

Model Requirement	Source	Year
Number of employers, by business category, by zone	• UK Business Count data on number of businesses by SIC 2007 by MSOA	2018
Employer structure table that relates type of business to number of jobs, by business, by skill type	• UK Business Count data on number of businesses by SIC 2007 by MSOA • Census data on number of employees by occupation and SIC 2007 code by MSOA	2018 2011 uplifted to 2018
Jobs check	• NTEM number of jobs by MSOA • Census data on number of people in employment	2018 2011 uplifted to2018
Business units by business type by zone	• UK Business Count data on number of businesses by SIC 2007 by MSOA	2018

Ports & Freight

2.42 The functionality of modelling freight trips to and from ports in the South East region was added into the UDM's capabilities for this project. This comprised of two steps:

- Calculating the number of 'Port Freight Handler businesses', and
- Calculating trip rates for these businesses.

Number of Businesses

2.43 To identify the number of Port Freight Handler businesses, the model zones listed in Table 2.14 were identified as being zones that contain a port. Estimates of the total number of employees in freight handler businesses were made, drawing on sources such as company websites and reports. The model uses average sized businesses, so an average business size was calculated across the nine port zones. Each port zone was then allocated the number of average sized businesses needed to generate the correct number of jobs, as shown in Table 2.14.

Table 2.14: Model zones containing a port

Model Zone	Port	Estimated Employees in Freight Handler Businesses	No. of businesses in SEELUM
Southampton 02	Southampton Port	1,145	6.7
Portsmouth 01	Portsmouth Port	100	1.8
Lewes 01	Newhaven Port	500	1.6
Dover 01	Dover Port	393	2.2
Thanet 01	Ramsgate Port	23	0.1
Port of London 01	Port of London	370	0.9
Shepway 02	Eurotunnel Folkestone	600	3.8
Adur 01	Shoreham Port	76	0.2
Medway 01	Medway Port	98	0.4
	TOTAL	3,305	17.7

Trip Rates

2.44 Trip rates for Port Freight Handler businesses were calculated using data from the Continuing Survey of Road Goods Transport (Great Britain) 2017 (CSRGT), supplemented by Department for Transport statistics on UK major port freight traffic.

2.45 The CSRGT data was used to tabulate tonnes of freight movements through the ports, outbound and inbound. Estimates were made of the average tonnage per movement to derive average numbers of vehicle movements per day. For inbound movements, trip rates per average port freight handler were calculated that generated the correct, observed total volumes in the model. The distribution of those trips, as generated by the model, was checked against the CSRGT data, comparing movements to destinations within the core SEELUM area and to locations beyond the core against the reference data.

2.46 Outbound trips are generated in the model by other businesses located across the country. Initial estimates of outbound freight trip rates, by business type, were estimated using CSRGT data; the model was run to generate flows of freight movements to the ports, and the trip rates adjusted to give the correct, observed, flows from within and beyond the SEELUM area to the ports.

Transport

Introduction

2.47 For the model to estimate how and where trips are made in the South East, it needs to know the cost of travel within and between the zones, in terms of time and money.

2.48 SEELUM has two internal multi-modal transport models, one for peak and one for off-peak. Each model represents four modes: highways, rail, bus and walk/cycle.

2.49 The model's transport cost inputs consist of matrices of travel times, and (where applicable) fares, between each pair of zones in the model. For the major rail and road corridors, an internal strategic network model is included that can vary travel times with the volume of trips using the corridor. For road, this represents delays caused by congestion, and for rail, it represents the discomfort of crowding.

2.50 SEELUM models peak and off-peak travel and so rail and road costs are provided separately for peak and off-peak travel periods. Each transport mode has its own matrix of transport costs, which have been calculated to and from the population-weighted centroid of each zone. Where a separate mode is used to get to and/or from the main mode used for a journey, the matrix also includes that additional travel time for access and egress. For example, the zone-to-zone travel costs in the rail matrix also include the cost to travel to/from the rail stations used. This means that there is only one travel cost per mode for each pair of zones for each period. Vehicle operating costs for cars are calculated by the model based on a matrix of distances within and between zones and a cost per kilometre.

2.51 The following sections describe how these costs were generated for each mode.

Road

2.52 Highway travel times between each zone pair in SEELUM are a combination of two components:

- Variable 'on-network' travel times; and
- Fixed[8] 'off-network' travel times;

2.53 Together they represent the Strategic and Major Road Networks in Figure 2.5.

2.54 The variable times represent the motorways and major A roads that are used for long distance travel within the study area. These times vary with congestion and will affect the travel mode choices of the people being modelled. The roads – or 'links' – modelled in this manner are shown in Figure 2.6. SEELUM contains 136 two-way links.

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[8] Or exogenously varied.

Figure 2.5: The Strategic and Major Road Networks and access network in the study area

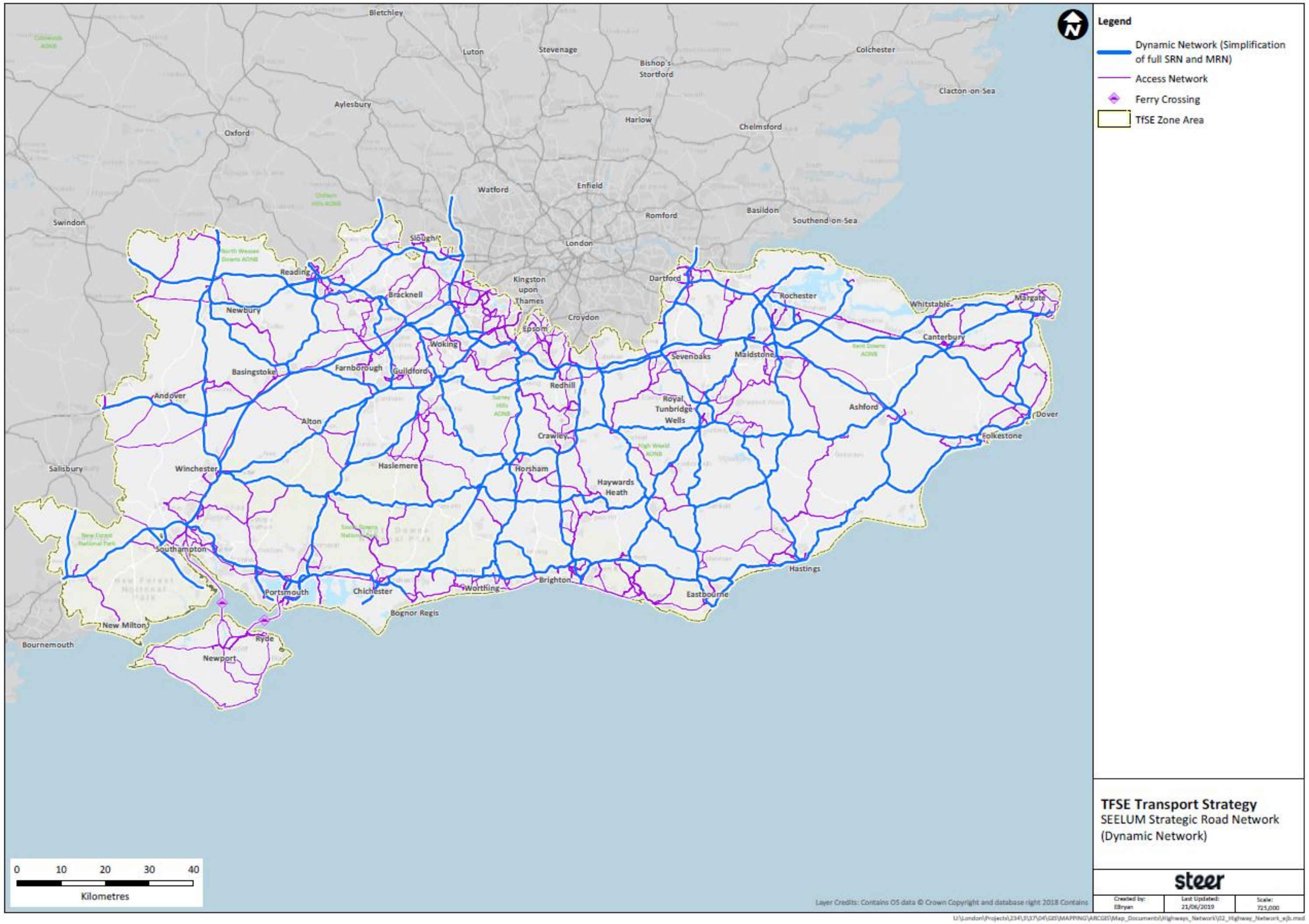
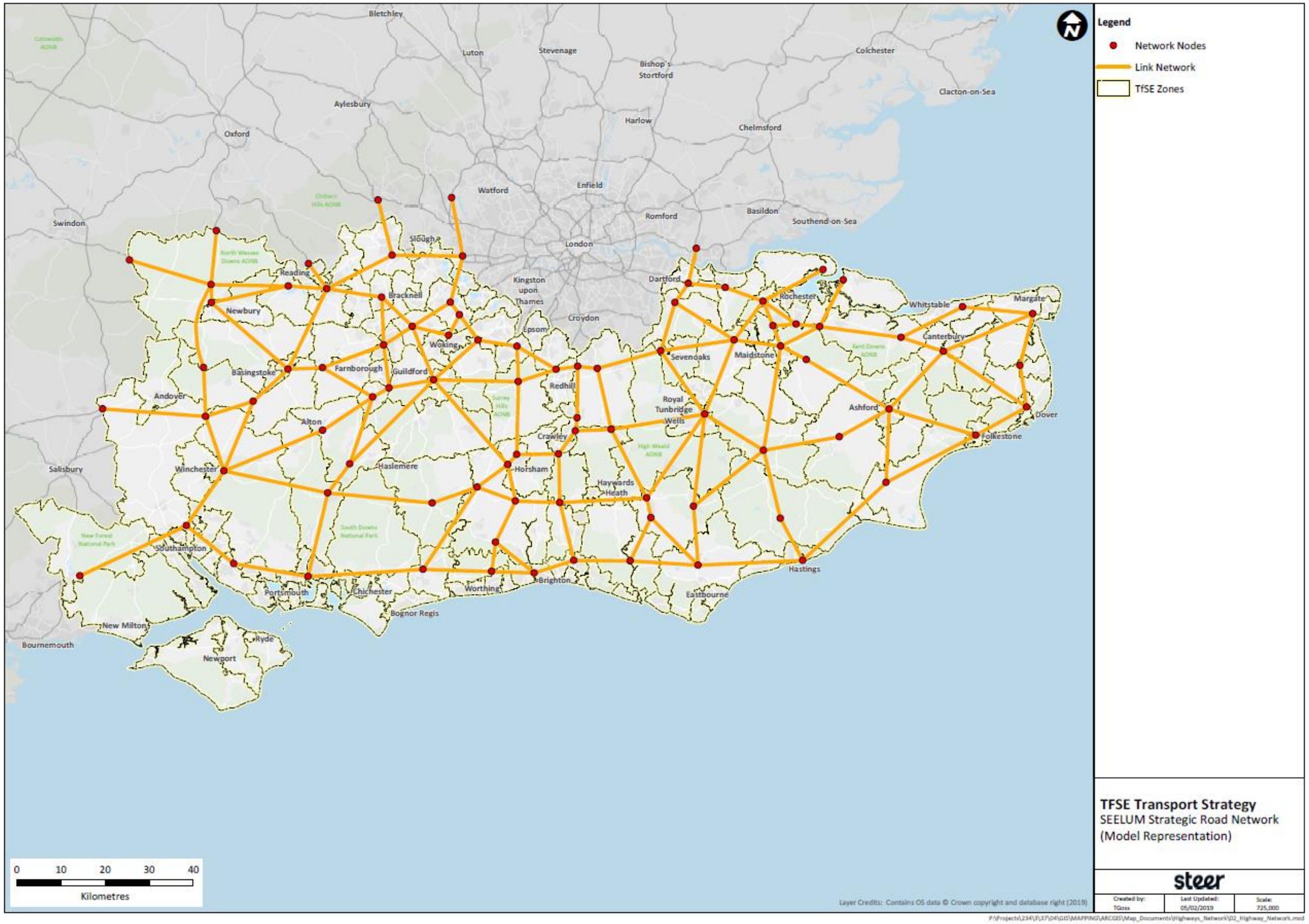


Figure 2.6: The 'on-network' links in SEELUM



2.55 Because the network is strategic[9], not all trips will be assigned to use it. This applies, for example, to many shorter trips, for which the drive time will be entirely 'off-network'. These trips will use fixed travel times that do not vary due to endogenous congestion. However, they can be varied exogenously, by, for example, imposing trend changes in drive speeds to reflect expected increases in congestion.

2.56 Trips that are assigned to the network, which tend to be longer distance trips that use a motorway or major A-road, will have a drive time made up of both fixed and variable times:

- An 'access leg', which is a fixed time representing the use of local roads to access the major road network from the trip origin;
- Travel time on the major road network, which varies based on the number of trips using the network in the model; and
- An 'egress leg', which is a fixed time representing the use of local roads between the major road network and the trip destination.

Fixed Travel Times

2.57 Network Analyst within ArcGIS was used to derive travel times between all zone pairs for trips that do not use the network and also for the access/egress legs noted above. The road network used in Network Analyst is derived from a dataset called Pitney Bowes Speed Profiles, which is sourced from TomTom data. The network uses historic observed average road speeds from TomTom to work out typical driving speeds across the road network. The road network adheres to one-way streets, road heights and observes a simple road hierarchy. The time periods used in the analysis were:

- Peak - 07:00 to 10:00
- Inter-peak - 10:00 to 16:00

2.58 The origin and destinations used to determine the zone-to-zone travel time matrices were represented by the population-weighted zone centroids described above. Network Analyst returned the quickest route between each zone pair in the model.

2.59 Network Analyst was also used to generate road travel times within zones. The software has functionality to generate a set of random points in each zone and travel times were calculated from the zone's centroid to these points. The resulting times to each random point were then averaged to obtain an intra-zonal travel time.

2.60 Vehicle operating costs are calculated in SEELUM based on distance and average fuel costs per kilometre[10]. These were converted to generalised minutes using values of time consistent with the latest version of WebTAG (November 2018).

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[9] All transport models have to be selective over how much network detail they include. There were two factors governing the choice for SEELUM. One is computing time. Although there is no theoretic limit to the number of links that can be included, model run times increase as their number increases. Set against that, a detailed network model is not really necessary for a model of this type, since the main requirement is to capture measures of connectivity within and between zones, and not, as in more traditional models, to replicate detailed network flows. Since the model was to be used primarily to look at longer distance movements, the decision was made to focus on the strategic network and allow all other drive times to be handled via the off-network elements.

[10] The model's fuel costs do not vary with speeds.

Variable Travel Times

2.61 The model needs to know which zone pairs will use its internal road network (and therefore have variable travel times) and the sequence of links used between them. To do this, a SATURN model was built with link travel times set to real-world congested times taken from Network Analyst. A flat matrix (i.e. a matrix of ones) was then assigned to the network, using an all-or-nothing assignment. This provided the best route[11] between each zone pair and a travel time in congested conditions.

2.62 These travel times from SATURN were then compared to the fixed travel times obtained from Network Analyst to identify where the link-based times were significantly longer and therefore not the correct route. Where this was the case, these zone pairs were assumed to not use the network in the model and the fixed travel times were used instead.

2.63 To calculate the variable travel times on links, the model requires inputs for capacity, distance and travel speed under free flow conditions. The actual travel time experienced by a trip is then calculated by the model as a function of the number of trips using that part of the network. As the number of trips increases, speed decreases and travel time increases, representing the effects of congestion.

2.64 Current speed in the model is calculated as follows:

$$Speed = Freeflow\ speed\ \times Speed\ multiplier$$

2.65 When flow is less than capacity, then the speed multiplier is equal to one. When flow is greater than capacity the speed multiplier reduces to a value between one and zero:

$$Speed\ multiplier = \frac{1}{1 + 0.5\left({}^{Flow}/_{Capacity} - 1\right)^2}$$

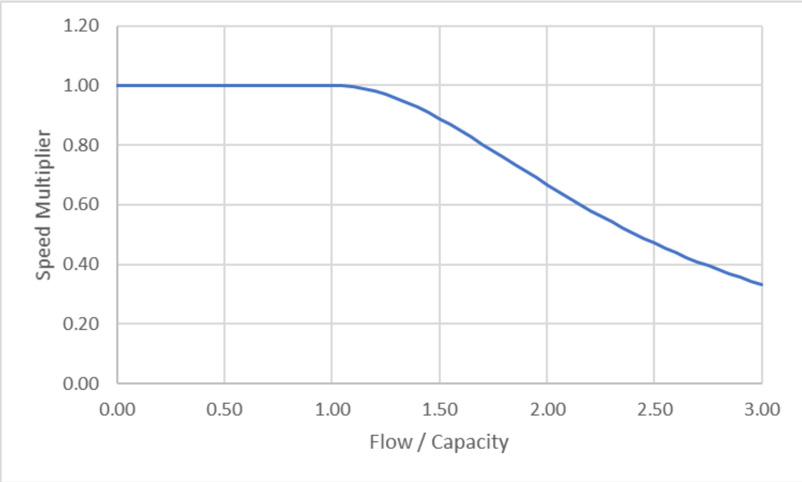
2.66 Capacity on each link is set so that, in 2018, the model replicates the observed congested speeds taken from Network Analyst when carrying the base year flows set up in the calibration process (described in Chapter 3).

2.67 The relationship between speed multiplier and the ratio of flow to capacity is shown in Figure 2.7.[12]

[11] Note that there is no route choice within SEELUM itself

[12] This approach, of using a multiplier, is a standard formulation in system dynamics models. At first sight it seems different to the speed-flow functions recommended in DMRB, but the multiplier has been formulated so that it can replicate reasonably closely how those functions operate, using the ratio of flow to capacity, rather than specifying types of roads and numbers of lanes.

Figure 2.7: Change in speed multiplier with change in flow/capacity ratio



Rail

Base Year Journey Time, Yield and Capacity Inputs

2.68 SEELUM represents the cost of travel by rail in two ways: using both a fixed and a dynamic network. In the fixed network, the cost of travel between model zones is represented with matrices of generalised journey times (GJTs) and fares. SEELUM also has an internalised dynamic strategic rail network model that can capture the effects of crowding on key rail routes in the South East of England. These two representations of rail travel are discussed below.

2.69 The model handles peak and off-peak travel separately and uses separately input peak and off-peak rail GJTs. The zone to zone rail times are represented by the GJT as defined in the Passenger Demand Forecasting Handbook (PDFH) v5.1[13]. GJT includes an in-vehicle time, a service interval penalty and an interchange time penalty. The sum of all these costs is the total GJT.

2.70 The journey time matrix in SEELUM was derived from MOIRA. MOIRA is the industry standard tool used for rail demand and revenue forecasting. There are number of different versions of MOIRA available, with each version being based around the geographical area of an individual Train Operating Company. A single version of MOIRA covering the entire TfSE area does not exist and so we sought permission from the Train Operating Companies operating in the region to use the data from their version of the tool. South Western Railway provided permission for us to use their version of the software in full. As this version of MOIRA covers the western area of the South East in more detail than the eastern area, some assumptions had to be made, which are discussed below.

2.71 For this project, MOIRA is not used as a forecasting tool, only the background data within MOIRA is used to form inputs to SEELUM. This includes a full year of demand and revenue data, along with detailed timetables used to calculate station to station generalised journey times.

[13] PDFH is an industry reference source for advice and supporting data for rail demand forecasting in the UK.

2.72 Using the demand and revenue data exported from MOIRA, an average yield was calculated for all station to station journeys within the model.

2.73 Station to station movements in the South East were defined for stations with greater than one million entries/exits in the 2018 Office of Rail and Road station usage statistics. The stations represented in SEELUM are shown in Figure 2.8.

2.74 The South Western Railway version of MOIRA was used as base data for the journey time and yield matrix. This had some limitations, whereby some in-scope stations are not included in the background data due to the geographical scope of that particular version of MOIRA. Therefore, manual adjustments were required to model selected stations in Kent and some long-distance flows. The following stations in the South East were not included in the MOIRA data:

- Folkestone Central
- Dover Priory
- Margate
- Rainham (Kent)
- Sittingbourne
- Faversham
- Tunbridge Wells
- Maidstone East
- Canterbury East
- Canterbury West

2.75 For these stations, GJTs were calculated manually, based on the GJT to/from the nearest large station that was included in MOIRA such as Ashford International, Ramsgate, Chatham, or Tonbridge. An additional journey time was added to represent travel to/from the missing station.

2.76 Average yields for these stations were calculated manually using the average yield to/from the nearest large station that was included in MOIRA, plus an additional yield based on the average yield per mile from similar flows.

2.77 Other stations that were also selected for inclusion in the model but were not included in the background data within MOIRA were the following external zone stations:

- Bangor
- Lincoln
- Nottingham

2.78 For these stations the GJT to/from central London was calculated manually using PDFH principles. For other locations within the South East to/from these missing locations, the GJT was calculated as:

[Missing station to/from station in South East GJT] = [missing station to/from London GJT] + ([station in South East to/from Manchester GJT] – [London – Manchester GJT])

2.79 London was selected as the pivot point because most flows between these external stations to the South East would be routed via London; any direct cross-country services that bypass London are slower and have lower frequency than traveling via London so the GJT is similar via either routing. Manchester is the largest city in the North and used as a benchmark for GJT to that region.

2.80 As with stations in the South East, the average yield for these stations were calculated manually based on an average yield per mile calculated from similar flows.

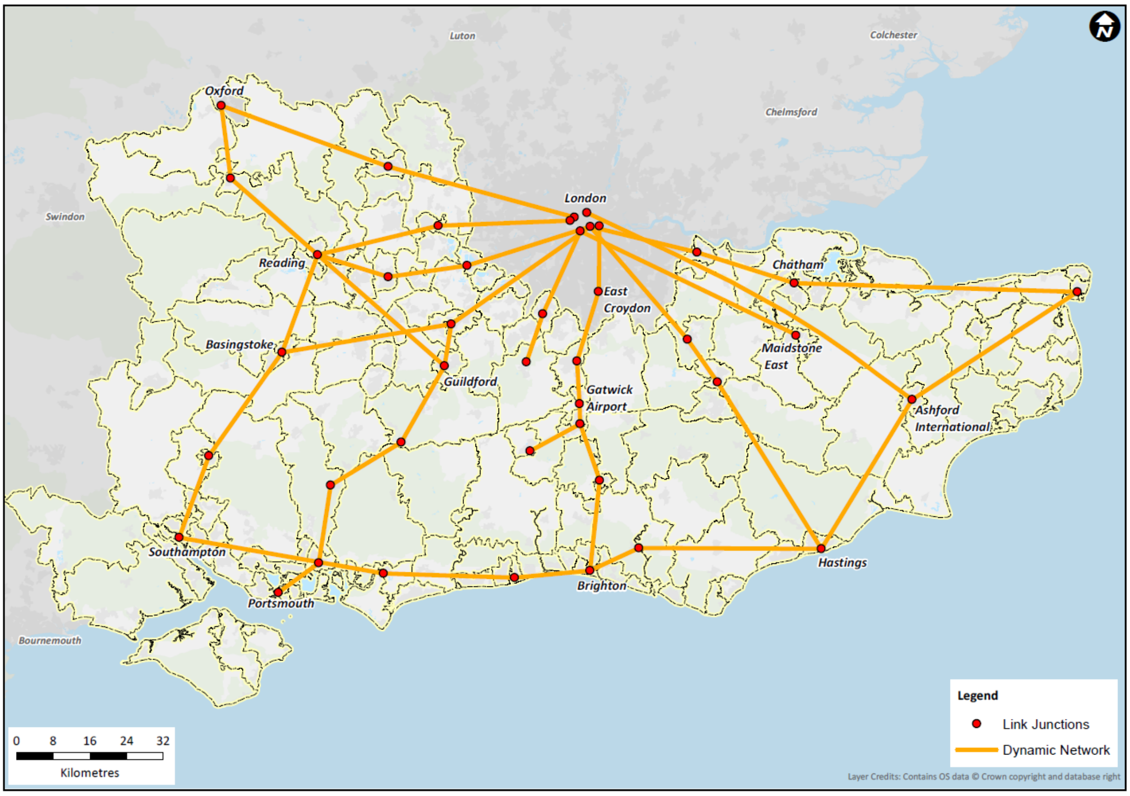
Dynamic Network

2.81 A dynamic network was developed for SEELUM representing the core route sections that are most likely to be affected by crowding. The network consists of 92 bidirectional links and is shown in Figure 2.8. Trips are loaded onto links based on the origin and destination, and the traffic on each link is compared to the available capacity to determine the degree of crowding. Very crowded journeys are represented as having higher GJT, in line with PDFH principles.

2.82 The available rail capacity on each link is based on a combination of Network Rail data and Steer calculations. The standing area provided by Network Rail has been converted to a standing capacity of 2.5 standees per m^2, per PDFH guidelines. Peak hour capacities were provided by Network Rail for most links. Off-peak capacities were calculated as a proportion of the peak capacity.

2.83 Network Rail data were available for 80 of the 92 links in the SEELUM model. For the remainder 12 links, capacity was estimated manually based on the service frequency of the route section and the capacity of the rolling stock known to be used on those services.

Figure 2.8: Stations and the SEELUM rail link network



Variable Generalised Journey Times

2.84 Within the dynamic network, the GJT of zone pairs connected by rail have two components: travel on the modelled network and residual travel outside the network, as in the following formula:

$$Total\ GJT = \sum(\text{IVT on links used to travel between stations}) + residual\ GJT$$

2.85 Trips where the whole journey is off the modelled network are represented by the same fixed off-network GJT and fare matrix. For trips routed through the network, the IVT on the links vary to reflect the impact of crowding.

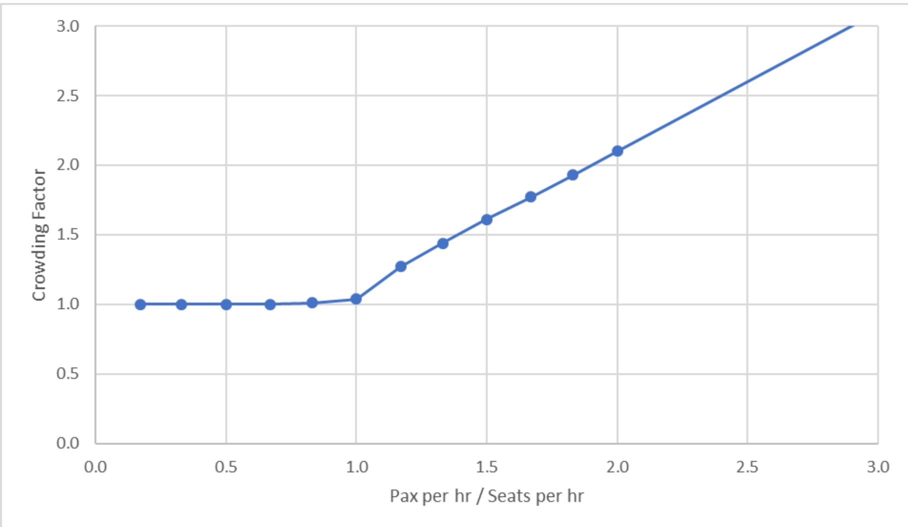
2.86 As shown in Figure 2.8, the dynamic network consists of 92 bidirectional links reflecting the major existing and proposed rail corridors within the study area. The journey times on each link were calculated using MOIRA data. The determination of which zone pairs would use the network and which links were used was based on the minimum journey time. For example, a trip from Ashford to central London would route via the High Speed 1 rail line.

2.87 The model calculates the ratio between passenger volume and the link's carrying capacity, in seats per hour, for peak and off-peak separately. This ratio is the measure used by the model to identify where crowding occurs. A crowding multiplier is calculated as a function of the ratio and the link travel time is multiplied by this multiplier to increase the perceived generalised time of travel on the link due to crowding. If the ratio is less than 1, the multiplier is 1; as the ratio rises above 1, so does the multiplier. Trip-makers will respond to increased journey times by either changing mode, moving home location, moving work location, or – if no other place of employment is accessible – becoming unemployed.

2.88 The multiplier on generalised journey time due to crowding has been setup using guidance in PDFH, section B6, and specifically the crowding function parameters in Table B6.2. We have assumed the characteristics of Regional services and used the corresponding table parameters. The resulting multiplier function is shown in Figure 2.9 below. The value on the y-axis is the multiplier applied to the generalised journey time. The curve has been extrapolated with the same gradient beyond the passengers to seats ratio of two (the maximum tabulated in PDFH).

2.89 Where links were shown to be over-capacity, these were sense-checked against their location on the network to ensure that crowding was occurring in expected locations.

Figure 2.9: The Rail Crowding Function

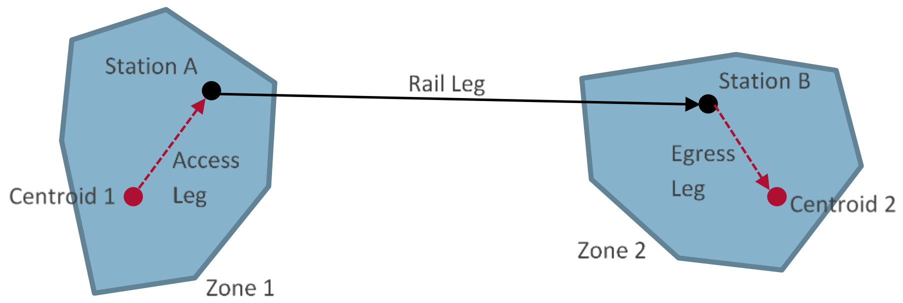


Access and Egress

2.90 To calculate a full GJT, access and egress times are added to the fixed and variable zone to zone times. TRACC[14] accessibility software was used to generate station access and egress travel times between zone centroids and the station locations for car and public transport and the quickest time was used.

2.91 The access and egress time for a pair of zones was then calculated as the access time from the origin zone centroid to the station plus the egress time from the destination station to the destination zone centroid. This is added to the zone to zone time, or 'rail leg', to generate the full GJT. This is shown diagrammatically in Figure 2.10.

Figure 2.10: Example of rail trip with access and egress legs



Intrazonal and within London Generalised Journey Times

2.92 Rail travel times within zones were calculated as the times required for the mode choice model to reproduce the mode shares seen in the 2011 census travel to work data for trips within a district, for districts in the South East; this method pivots off the within-zone car drive times, described earlier.

2.93 This approach was also used for rail trips *between* zones in London to represent trips by London Underground. This is because these travel times are not available from MOIRA. TRACC could have been used to calculate times, but it was more important to ensure these Underground travel times produced the right mode shares than the right travel times, hence the method used. This was to ensure that the right number of trips remained within London rather than travelling to the TfSE area during the calibration process (see Chapter 3).

Summarising for rail

2.94 For each pair of zones, the total rail generalised time between them will be:

- A travel time to access the origin station; plus
- the off-network rail generalised journey time; plus
- the on-network travel time (if any), adjusted to reflect crowding; plus
- a travel time to get from the station to the destination zone centroid; plus
- the zone to zone one-way fare, converted to time using a Value of Time.

[14] http://www.basemap.co.uk/tracc/

Bus and Coach

Travel Times

2.95 Zone to zone bus journey times were calculated using TRACC. Due to some of the zones being relatively large, zone-to-zone travel times were calculated between a set of multiple random points per zone and the average taken. This was done for both peak and interpeak journeys. There were a number of assumptions and parameters used in the process:

- Time-period 07:00 to 10:00 weekday
- 1000 metre maximum distance from point of boarding/alighting for origins and destinations
- 500 metre maximum interchange distance used between bus stops
- Maximum travel time of 180 minutes
- Walk speed 4.8km/h

2.96 Any journey that was not completed within the above parameters resulted in no time being recorded, implying that the journey could not be completed by bus. These cases are represented in the model with generalised journey times of 9999 minutes.

2.97 Bus and coach travel times within zones were calculated as the times required for the mode choice model to reproduce the mode shares seen in the 2011 census travel to work data for trips within the relevant district. This method pivots off the within-zone car drive times, described above.

2.98 This approach was also used for bus trips *between* zones in London. This was to ensure that the right number of trips remained within London rather than travelling to the TfSE area during the calibration process (see Chapter 3). TRACC could have been used to calculate these times but given the complexity of the London bus network and the relatively large size of the model's zones, this would not have been a proportionate approach.

Fares

2.99 Publicly available bus fare data was used to generate an equation that relates the distance between a zone pair and the pence per kilometre of the fare. The equation was of the form of a negative power function, meaning that shorter trips had a higher pence-per-kilometre cost than longer distance trips. This function was used to generate zone to zone bus fares based on the distance between the zone centroids.

Slow Modes

2.100 'Slow Modes' covers both walk and cycle. For travel within zones, times were calculated as the times required for the mode choice model to reproduce the mode shares seen in the 2011 census travel to work data for trips within a district. This method pivots off the within-zone car drive times, described above.

2.101 For zone to zone travel, distances were measured in GIS and times calculated using an assumed walking speed of 4.8km/h and a cycling speed of 15km/h. The average of the two resulting times was taken, and where it was less than 60 minutes, the time was input to the model. Where it was greater than 60 minutes, it was assumed that the walk and/or cycle distance between the zones was too great for walking/cycling to be a reasonable mode choice, and the time was set to 9999 minutes.

Summary of Zones and Segmentation

2.102 The model's dimensions are summarised in Table 2.15.

Table 2.15: SEELUM Dimensions

Attribute	Number of Elements	Classes
Zone	205	• 167 dynamic internal zones • 38 external zones
Employer types	9	• Advanced Manufacturing • Knowledge Service Sectors • Primary • Finance and Business • Education • Retail and Catering • Other Industry & Manufacturing • Other Services • Port Freight Handler
Commercial property types	5	• Commercial Offices • Shops Hotels & Restaurants • Research & Manufacturing Premises • Other • Port Freight Premises
Housing property types	5	• Detached • Semi-Detached • Terrace • Flats & Other • Student accommodation
Household types	5	• NS-SeC 1 & 2 • NS-SeC 3, 4 & 5 • NS-SeC 6 & 7 • NS-SeC 8 • NS-SeC L15 (Students)
Skill types (used for workforce and employment)	5	• Non-Work Age • Manual • Skilled • Expert • Students
Transport modes	4	• Highway (private) • Bus • Rail • Slow Modes (i.e. walk & cycle)
Highway network links	272	• N/A
Rail network links	92	• N/A
Time periods	2	• Peak • Off peak

3 Calibration

Outline of the Process

3.1 This section describes how the model was calibrated to its 2018 base year. The process was undertaken in two stages:

3.2 **Stage 1**, known as 'Dynamics off', uses a version of the model in which all the population and employer numbers are held fixed (i.e. the dynamic relationships are not active), in order to build a travel-to-work (TTW) trip matrix. Calibration at this stage is to ensure that:

- TTW matrices and mode shares produced by SEELUM match the trip distribution and mode shares in 2011 Census data (uplifted to 2018); and
- Trip volumes and mode shares for other trip purposes match data taken from NTEM.

3.3 **Stage 2,** known as the 'Stabilise run', takes the synthesised TTW trip matrix and allows all the internal dynamics to run to a position of equilibrium or near-equilibrium. Calibration at this stage is to ensure that the model is stable in terms of employers and households when the dynamic functionality is turned on.

3.4 This process is used because the model creates its own TTW matrix, given the base year disposition of households (and workforce), employers and the transport networks. In stage 1, it begins with everyone unemployed, and lets employers recruit a workforce. This method of building the TTW matrix will not work if numbers of households or employers are also allowed to vary at the same time.

3.5 Stage 2 then checks that the model is stable when given the TTW matrix and while allowing all the other dynamics to operate. The main test is that the model does not shift numbers of employers or households very far, if at all, from the initial input values given to it (the implicit assumption being that the economy of the South East is currently in near-equilibrium).

3.6 The end-point of the stabilise run then becomes the starting point for all subsequent runs of the model (using the 'Scenarios' model).

Travel to Work Patterns

3.7 SEELUM generates TTW patterns using its internal employer recruitment model. The resulting TTW matrices and mode shares are then compared to the 2011 TTW census data.

3.8 Because the absolute numbers in the 2011 census travel to work data and the 2018 SEELUM will not necessarily match (because they are for different years) the calibration has been based on the following criteria:

- The proportional distribution of destinations for TTW trips originating in each district; in other words, is the model sending commuters from each zone to the right destinations; and
- Mode shares for each origin-destination (OD) pair.

3.9 The census travel to work data is available at the district level, while SEELUM uses zones that are districts or smaller aggregations of MSOAs within each district. All the model's flows were therefore aggregated to the district-to-district level, to allow comparison against the census travel to work data.

The Process: Travel to Work

3.10 As there are nearly thirty thousand internal zone pairs and nearly four thousand internal district pairs in the model, and many of the flows are very small, a method was required to focus attention on the most important flows. The main criteria used to flag district pairs for attention were[15]:

i. For each district pair where the total census travel to work flow was at least 1,000 trips per day and at least 10% of the trips originating from the origin district, we highlighted pairs where the model was different to the census by ten percentage points (PP) or more. Out of a total of 4624 District OD pairs in the model, these criteria highlighted 31 pairs for further calibration.

ii. For each district pair where the total census travel to work flow was at least 10% of the trips originating from the origin district, we highlighted mode shares where there was at least a five or ten percentage points difference from the census travel to work mode share, depending on mode used. The criterion of ten percentage points was used for car due to the generally larger mode shares for car travel. The criterion of five percentage points was used for all other modes, where the mode share is generally much lower than that for car.

3.11 The criterion of 1,000 trips per day was chosen to filter out small flows where there would be uncertainty about volumes, even from the census, in order to avoid trying to calibrate against unreliable data.

3.12 The calibration process focusses on 'accessibility' between zones. 'Accessibility' is defined using a deterrence function. This function determines the proportion of commuters that would be willing to accept a given cost of travel to reach a job. Put simply, it says that the greater the separation, in time and/or money, between a residential location and an employer, the smaller the proportion of people willing to travel the distance (or pay the price). A graph illustrating two deterrence curves can be seen in Figure 3.1 below.

3.13 The axes of the chart represent the probability that individuals would be willing to travel (y-axis) in respect to the logsum of the generalised cost incurred[16] (x-axis). Therefore, from this chart we can infer that the blue curve represents individuals that are generally more willing to travel than those represented by the red curve.

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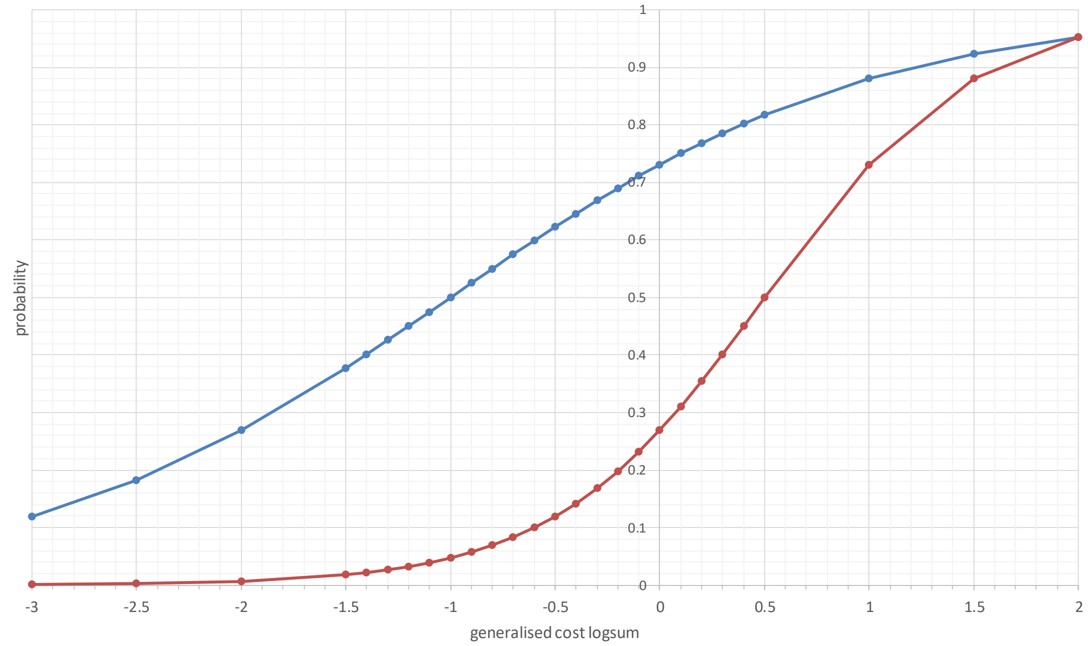
[15] Note that this does not mean that we *only* focussed on these district pairs. Improving these 'flagged' district pairs generally improved unflagged district pairs too.

[16] This is a generalised measure of the cost of travel between two zones, considering all available modes. It is framed as utility, so higher values correspond to lower generalised costs.

Figure 3.1: Illustration of deterrence curves



3.14 To get the right amount of flow between district pairs, we start by adjusting the deterrence curves for origin districts. The deterrence curves describe the willingness of people to accept given travel costs to make a trip; the parameters defining the deterrence curves can be varied by origin and destination Districts. However, the aim is to get as good a fit as possible with the minimum number of deterrence curves, to avoid overfitting, and minimise the number of assumptions about parameter values that must be carried forward to future years.

3.15 Because the model is building a TTW matrix during calibration, setting deterrence curves by origin is adjusting how far/long people who live in those districts are willing to travel to find employment. The idea is that it is differences in the attitudes of resident populations that lead to differences in willingness to travel, and this can be captured by allowing the curves to vary by origin

3.16 The process for adjusting the deterrence curves is iterative. District pairs were identified that met criterion 1 above and their deterrence function was adjusted for the origin district. The model was then re-run and the results output and analysed. Further adjustments were then made if necessary.

3.17 To avoid over-fitting the model, calibration generally ends with the best result that can be obtained by adjusting the deterrence curves by origin only and not by district pair. However, this approach did not yield the desired effect for London.

3.18 London is an attractive destination due to its concentration of businesses and higher wages. This causes individuals to be more willing to travel further distances when seeking employment there. Due to this we adjusted the London zones not only by origin but also by destination zone in order to obtain a better fit to the high number of long-distance trips seen in the census travel to work data than would otherwise be possible with a curve only set by origin[17].

3.19 For mode share, SEELUM has functionality to scale bus, rail and walk/cycle generalised times, to represent mode specific constants. The process of adjusting the mode factors was also iterative. Districts pairs were identified that met criterion 2 above and the destination district's mode factors adjusted. The model was run with the new values and the outputs interrogated. Further adjustments were then made based on those outputs.

3.20 Mode constants can be set by origins or destinations, but not by origin-destination pair. Therefore, we adjusted by destination due to the influence of trips to London noted above.

Results

3.21 In Table 3.1 to Table 3.9 we provide a summary of some key metrics to demonstrate the level of calibration achieved. Appendix B contains further tables showing comparisons of model travel to work demand and mode share compared to census travel to work demand and mode share.

3.22 There are 67 districts in the South East. Table 3.1 looks at flows within and between those districts and also London (treated as one 'district' in this table). This table shows, for example, that out of the 4,624 flows (i.e. 64^2), 4,000 flows have a volume of less than 500 and all 4,000 of those district pairs are within 5 percentage points of their trip distribution from the census travel to work data. Overall, out of the 4,624 flows, only 31 have a distribution of 10 percentage points or greater compared to the census.

3.23 Table 3.2 shows similar information for the 62 districts that comprise the model's internal zones. Of the 3,844 district pairs, 3,791 are within 5 percentage points of the census travel to work trip distribution.

3.24 Although London is an external zone in the model, it acts as a large trip attractor and producer. Therefore, we wanted to ensure the model's flows between the TfSE zones and London were reasonable. Table 3.3 is for Table 3.4 show flows between the 62 districts that comprise the model's internal zones and London. Flows from internal zones to London are larger than in the opposite direction and the majority of these flows calibrate within 5 percentage points of the census travel to work trip distribution. Flows in the opposite direction are all within 5 percentage points of their census distribution.

[17] In effect, this approach means that people who live in a district will only travel a certain distance to employment, *unless*, it's to London, in which case they are willing to travel further/longer.

Table 3.1: District pair flows within and between all South East and London zones

	Flow Size								
Number of District Pairs	**Less than 500**	**Between 500 & 1,000**	**Between 1,000 and 5,000**	**Between 5,000 and 10,000**	**Between 10,000 and 20,000**	**Between 20,000 and 30,000**	**Between 30,000 and 40,000**	**Greater than 40,000**	**Total**
Total	4000	136	343	61	40	26	9	9	**4,624**
With less than 5pp difference to census distribution	4000	134	312	48	26	12	5	4	**4,541**
Between 5pp and 10pp difference to census distribution	0	2	25	9	7	6	0	3	**52**
With greater than 10pp diff. to census distribution	0	0	6	4	7	8	4	2	**31**

Table 3.2: District pair flows within and between internal zones

	Flow Size								
Number of District Pairs	**Less than 500**	**Between 500 & 1,000**	**Between 1,000 and 5,000**	**Between 5,000 and 10,000**	**Between 10,000 and 20,000**	**Between 20,000 and 30,000**	**Between 30,000 and 40,000**	**Greater than 40,000**	**Total**
Total	3362	121	265	33	26	24	7	6	**3,844**
With less than 5pp difference to census distribution	3362	121	246	28	16	11	4	3	**3,791**
Between 5pp and 10pp difference to census distribution	0	0	17	3	5	6	0	2	**33**
With greater than 10pp diff. to census distribution	0	0	2	2	5	7	3	1	**20**

Table 3.3: District pair flows from internal zones to London

	Flow Size								
Number of Flows	Less than 500	Between 500 & 1,000	Between 1,000 and 5,000	Between 5,000 and 10,000	Between 10,000 and 20,000	Between 20,000 and 30,000	Between 30,000 and 40,000	Greater than 40,000	Total
Total	1	5	29	16	10	1	0	0	**62**
With less than 5pp difference to census distribution	1	4	21	12	6	1	0	0	**45**
Between 5pp and 10pp difference to census distribution	0	1	6	4	2	0	0	0	**13**
With greater than 10pp diff. to census distribution	0	0	2	0	2	0	0	0	**4**

Table 3.4: District pair flows from London to internal zones

	Flow Size								
Number of District Pairs	Less than 500	Between 500 & 1,000	Between 1,000 and 5,000	Between 5,000 and 10,000	Between 10,000 and 20,000	Between 20,000 and 30,000	Between 30,000 and 40,000	Greater than 40,000	Total
Total	26	5	21	7	3	0	0	0	**62**
With less than 5pp difference to census distribution	26	5	21	7	3	0	0	0	**62**
Between 5pp and 10pp difference to census distribution	0	0	0	0	0	0	0	0	**0**
With greater than 10pp diff. to census distribution	0	0	0	0	0	0	0	0	**0**

3.25 In Table 3.5 we show that the mode share for all trips originating in the TfSE area is very close to the mode share for the same trips in the census.

Table 3.5: Mode share of travel to work trips originating from the TfSE area

Data	Car	Rail	Bus	Walk & Cycle
SEELUM	73%	9%	6%	12%
Census TTW	71%	9%	5%	15%

3.26 Similarly, in Table 3.6 we show that the mode share of all trips arriving in the TfSE area is very close to the mode share for the same trips in the census.

Table 3.6: Mode share of travel to work trips arriving in the TfSE area

Data	Car	Rail	Bus	Walk & Cycle
SEELUM	77%	4%	6%	13%
Census TTW	74%	4%	5%	17%

3.27 In Table 3.7 we show that the mode split between car and rail for trips to and from London are also very close to their values in the census data.

Table 3.7: Mode share of travel to work trips to/from London

Data	Direction	Car	Rail
SEELUM	TfSE area to London	55%	45%
Census TTW	London to TfSE area	51%	49%
SEELUM	TfSE area to London	94%	6%
Census TTW	London to TfSE area	81%	19%

3.28 In Table 3.8 we show that there is a good match between model and census travel to work mode shares for trips arriving in the South East and London districts.

Table 3.8: South East and London districts within specified percentage points difference to census mode share for travel to work trips arriving

Percentage Point Difference to Census Mode share	Number of Districts (out of a total of 68)			
	Car	Rail	Bus	Walk
≤ 2.5 pp	32/68	47/68	37/68	23/68
≤ 5.0 pp	47/68	61/68	60/68	58/68
≤ 7.5 pp	53/68	68/68	63/68	65/68
≤ 10.0 pp	59/68	68/68	67/68	67/68

3.29 In Table 3.9 we show how well flows of different magnitudes compare to the census travel to work data. We are less concerned about larger percentage errors on small flows and have focussed on ensuring we only have small percentage errors on the larger flows.

Table 3.9: District pair demand compared to census

	Where SEELUM District Pair Demand is...								
Criteria	<500	>500 <1000	>1,000 <5,000	>5,000 <10,000	>10,000 <20,000	>20,000 <30,000	>30,000 <40,000	>40,000	Total
% of Total District pairs	86.5%	2.9%	7.4%	1.3%	0.9%	0.6%	0.2%	0.2%	**100%**
% of these district pairs where demand difference to census is less than 5%	86.5%	2.9%	6.7%	1.0%	0.6%	0.3%	0.1%	0.1%	**98%**
% of these district pairs where demand difference to census is between 5% and 10%	0.0%	0.0%	0.5%	0.2%	0.2%	0.1%	0.0%	0.1%	**1%**
% of these district pairs where demand difference to census is greater than 10%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.1%	0.0%	**1%**

Additional Validation Against NTEM

3.30 We conducted further analysis to benchmark the model against NTEM data. The intention was to base the model, so far as possible, to be consistent with NTEM.

3.31 Table 3.10 shows trip volumes, by purpose, for SEELUM and NTEM (absolute values taken from TEMPRO 7.2).

Table 3.10: 2018 Trip volumes from internal zones (millions per day)

Source	Commuting	Other	Business	Total
SEELUM	4.1	16.9	0.9	21.8
NTEM	4.4	14.6	0.9	19.9

3.32 Commuting trip volumes were taken from the calibrated model described above. As we noted in paragraph 2.22, we ensure that the size of the workforce in the model aligns with the NTEM workforce size. When this workforce travels to work, the volume should be consistent with NTEM travel to work trips. However, Table 3.10 shows that the numbers commuting in the model are lower than NTEM. This is due to unemployment levels.

3.33 At the end of the calibration process, some of the workforce in the model remain unemployed. This happens when we have to compromise between workers travelling to the "wrong" locations (and hence affecting trip distribution calibration) or not travelling at all. We take this approach as we believe that it is better to focus on ensuring trip distributions are well calibrated, especially on the major flows.

3.34 Other home-based trips and business to business trips are generated in SEELUM as a function of trip rates for producer-attractor combinations. These trip rates were scaled so that the total number of trips originating in the study area produced by the model aligned with NTEM trip totals. (NTEM does not provide trip matrix data, only trip *end* volumes). Business trips are a good match. Other purpose trips are slightly higher than NTEM and so there is scope to improve this in a future iteration of the model.

3.35 Table 3.11 shows that there is a close match between the mode shares for SEELUM and NTEM trips arriving[18] in the model's internal zones.

[18] Mode shares are presented by trips arriving as mode constants were adjusted by destination due to the major influence of London (see paragraphs 3.19 and 3.20).

Table 3.11: Mode share to internal zones by purpose

Source	Purpose	Car	Rail	Bus	Walk + Cycle	Total
SEELUM	Commuting	79%	4%	5%	11%	100%
	Other	65%	1%	6%	28%	100%
	Business	96%	4%	n/a	n/a	100%
	Total	70%	2%	5%	23%	100%
NTEM	Commuting	77%	5%	5%	13%	100%
	Other	67%	1%	6%	25%	100%
	Business	94%	6%	n/a	n/a	100%
	Total	70%	2%	6%	22%	100%

3.36 The tables in Appendix C provide district level comparisons between SEELUM and NTEM (TEMPRO 7.2), for trip volumes and mode shares. The tables are for trips originating in each District.

Stabilise Run

3.37 The next stage was to test if the model is stable when all the dynamics are activated. This test starts with the travel matrices built in the 'Dynamics-off' run, and then runs the model with all the dynamics operating. The main test is that after a length of simulated time, the numbers of people and jobs have not drifted too far from the starting values.

The Result

3.38 The stabilise model was run for 30 years, which is long enough to let any residual imbalances settle down. In effect, this puts the model into a near-equilibrium version of 2018. Table 3.12 shows how much the numbers of 'jobs filled' and workforce changed in this process, for each of the 62 Districts that form internal zones of the model.

3.39 In reaching equilibrium, the model lost 1.7% of employment and 0.3% of the workforce overall, which is a good result. Variations for individual Districts were both positive and negative. Of the 62 districts:

- 54 had a change in employment of between -5% and +5%
- 8 had a change in employment of between +/-10% and +/-10%
- 1 had a change in employment of -17%
- 57 had a change in workforce between -5% and +5%
- 4 had a change in workforce between +/-10% and +/-10%

3.40 The change of -17% in employment occurs in the district of Shepway[19]. During calibration, this was a district that was very sensitive to the shape of the deterrence curve being used and so the calibration is a compromise between matching calibration data for longer journeys versus matching calibration data for shorter journeys. This has resulted in the district being further from its stable position at the start of the stabilise run.

[19] Renamed in 2018 to Folkestone & Hythe – see footnote number 1

Table 3.12: Changes in jobs filled and workforce in the Stabilise run

	Jobs Filled			Workforce		
District	Start	End	% Diff.	Start	End	% Diff.
Adur	22,000	21,783	-1.0%	28,571	28,349	-0.8%
Arun	48,408	47,402	-2.1%	24,613	24,630	0.1%
Ashford	53,546	53,326	-0.4%	28,547	28,510	-0.1%
Basingstoke and Deane	82,330	81,795	-0.6%	12,868	12,877	0.1%
Bracknell Forest	59,502	59,383	-0.2%	36,848	35,743	-3.0%
Brighton and Hove	147,776	151,602	2.6%	8,639	8,391	-2.9%
Canterbury	65,783	65,732	-0.1%	19,044	17,859	-6.2%
Chichester	60,398	58,880	-2.5%	99,814	99,814	0.0%
Chiltern	34,290	34,028	-0.8%	23,292	23,076	-0.9%
Crawley	77,524	75,842	-2.2%	35,602	35,092	-1.4%
Dartford	55,060	52,327	-5.0%	24,025	23,344	-2.8%
Dover	42,504	39,545	-7.0%	11,171	10,800	-3.3%
East Hampshire	46,652	45,388	-2.7%	41,975	41,692	-0.7%
Eastbourne	42,793	43,479	1.6%	22,377	21,931	-2.0%
Eastleigh	63,492	63,736	0.4%	30,600	30,694	0.3%
Elmbridge	56,507	56,280	-0.4%	47,755	47,823	0.1%
Epsom and Ewell	30,630	29,426	-3.9%	19,390	19,370	-0.1%
Fareham	50,486	50,704	0.4%	23,628	23,645	0.1%
Gosport	25,945	26,020	0.3%	21,863	21,908	0.2%
Gravesham	32,061	31,751	-1.0%	19,285	18,722	-2.9%
Guildford	74,949	75,386	0.6%	36,478	35,026	-4.0%
Hart	40,325	40,287	-0.1%	7,935	7,643	-3.7%
Hastings	36,056	36,020	-0.1%	9,761	9,456	-3.1%
Havant	45,508	44,595	-2.0%	79,796	79,796	0.0%
Horsham	55,041	53,744	-2.4%	13,830	13,757	-0.5%
Isle of Wight	56,514	54,468	-3.6%	15,918	15,624	-1.8%
Lewes	38,831	35,085	-9.6%	9,801	9,491	-3.2%
Maidstone	76,322	76,078	-0.3%	13,538	13,178	-2.7%
Medway	98,938	98,335	-0.6%	44,234	43,751	-1.1%
Mid Sussex	61,068	60,863	-0.3%	3,958	3,932	-0.7%
Mole Valley	45,468	44,538	-2.0%	34,089	33,659	-1.3%
New Forest	72,969	69,860	-4.3%	17,952	17,882	-0.4%
Portsmouth	105,391	104,033	-1.3%	9,845	9,039	-8.2%
Reading	89,907	89,788	-0.1%	30,956	29,258	-5.5%
Reigate and Banstead	67,458	66,711	-1.1%	14,248	13,325	-6.5%
Rother	31,204	29,582	-5.2%	7,985	7,905	-1.0%
Runnymede	47,351	43,695	-7.7%	14,978	14,775	-1.4%
Rushmoor	49,256	49,306	0.1%	14,726	14,585	-1.0%
Sevenoaks	46,428	45,050	-3.0%	7,970	7,893	-1.0%
Shepway	42,771	35,512	-17.0%	9,927	9,840	-0.9%

District	Jobs Filled			Workforce		
	Start	End	% Diff.	Start	End	% Diff.
Slough	74,638	74,283	-0.5%	33,504	33,299	-0.6%
South Bucks	32,801	32,231	-1.7%	25,830	25,717	-0.4%
South Oxfordshire	60,078	59,856	-0.4%	849,491	849,491	0.0%
Southampton	112,021	112,461	0.4%	316,034	316,034	0.0%
Spelthorne	41,951	41,073	-2.1%	983,641	983,641	0.0%
Surrey Heath	43,765	43,904	0.3%	37,462	37,020	-1.2%
Swale	51,385	50,942	-0.9%	8,923	8,727	-2.2%
Tandridge	33,446	31,810	-4.9%	844,886	844,886	0.0%
Test Valley	55,347	52,049	-6.0%	1,340,727	1,340,727	0.0%
Thanet	46,242	43,489	-6.0%	716,030	716,030	0.0%
Tonbridge and Malling	59,547	59,415	-0.2%	4,922	4,847	-1.5%
Tunbridge Wells	52,697	52,295	-0.8%	23,767	23,226	-2.3%
Vale of White Horse	58,847	55,678	-5.4%	38,187	37,739	-1.2%
Waverley	50,303	48,932	-2.7%	43,157	42,269	-2.1%
Wealden	52,013	48,749	-6.3%	22,058	21,633	-1.9%
West Berkshire	87,449	87,260	-0.2%	40,361	39,782	-1.4%
Winchester	74,036	71,167	-3.9%	27,446	27,188	-0.9%
Windsor and Maidenhead	75,509	75,084	-0.6%	27,657	27,133	-1.9%
Woking	43,514	43,669	0.4%	39,862	38,858	-2.5%
Wokingham	69,662	69,579	-0.1%	40,492	38,332	-5.3%
Worthing	48,312	48,770	0.9%	10,722	9,968	-7.0%
Wycombe	80,104	79,608	-0.6%	38,077	38,034	-0.1%
TOTAL	**3,583,106**	**3,523,671**	**-1.7%**	**6,491,070**	**6,468,665**	**-0.3%**

Summary

3.41 In summary, by the end of the stabilise run (or, equivalently, the model's representation of the 2018 base year) the position is:

- A good representation of the TTW trip distribution and mode shares;
- A good representation of Other home-based trip volumes by origin, and of their mode shares;
- A good representation of Business to Business trip volumes by origin, and of their mode shares;
- A simulated base year position that is in stable equilibrium and close to the actual conditions of 2018, in terms of workforce and employment.

4 Validation Tests

4.1 A series of tests was run to see how sensitive the model is to changes in fares and generalised times. The results are reported as elasticities, which are a measure of the sensitivity of demand to changes in cost[20]. The elasticities can be compared to independently observed, empirical evidence. The purpose of these tests is to demonstrate that the model's responses to changes are realistic when benchmarked against observed evidence.

4.2 The following tests were run[21]:

- Rail fares and generalised times were varied by plus and minus 10%;
- Car fuel costs and generalised times were varied by plus and minus 10%; and
- Bus fares and generalised times were varied by plus and minus 10%;

4.3 In all cases the model was run with no other trend changes – no growth in land and no trend changes to fares, values of time etc. This means the tests are, so far as possible, 'pure' tests of the effects of the input changes and not, for example, of land use effects; this helps ensure compatibility between the test results and published evidence.

4.4 Comparisons with the base case were made five years after the test changes were introduced.

4.5 In all case the changes to times and fares were applied universally (i.e. within and between all zones in the model, including zones outside the TfSE core area). However, the results are reported for travel between zone pairs lying within the TfSE core area. In each case the response elasticities implied by the model were calculated as the ratio of the percentage change in demand to the percentage change in cost. 'Own-mode' elasticities would be expected to be negative (increases/decreases in costs will reduce/increase demand) while cross-mode elasticities would tend to be positive (increases/decreases in a mode's costs will tend to increase/decrease demand on other modes).

4.6 Sources for empirical benchmarking data are listed at the end of this chapter.

Rail

4.7 Table 4.1 summarises the elasticities of the responses generated by the model. It shows the 'own-mode' elasticities (in bold) and the cross-mode elasticities.

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[20] A negative elasticity means that demand changes in the opposite direction to cost e.g. if rail fares increase, rail demand decreases. A positive elasticity means that demand changes in the same direction as cost e.g. if rail fares increase, car travel increases.

[21] The tests were all run as one-off incremental changes in fares or times, not combinations of them.

4.8 SEELUM's rail fares elasticities are -0.37 to -0.38 for Travel to Work (TTW), -0.81 to -0.90 for Other Home-Based and are -0.21 for Business to Business (B2B). This ordering seems intuitively plausible. PDFH 5.1 does not provide directly comparable elasticities, although for South East England (outside London) it suggests -0.6 for commuting, -1.1 for non-commute and -0.6 for business, while noting that local values could be higher or lower depending on local circumstances, particularly the availability of alternatives. SEELUM rail fare elasticities are lower in comparison.

4.9 TRL [Reference 1] reported an overall UK average of -0.46, while noting there is a wide range around this; they also reported -0.34 for peak and -0.79 for off-peak. The peak value is very similar to SEELUM's TTW value. The off-peak value is also very similar to that for SEELUM's Other Home-Based trips (which mostly occur in the off-peak).

4.10 There is evidence elsewhere of lower elasticities than these; for example, the Victoria Transport Policy Institute [Reference 2] argues that rail fare elasticities are low in urban areas, suggesting -0.18. SEELUM rail fares elasticities are higher in comparison.

4.11 Given the range of empirical results, that PDFH does not have a directly comparable result, but SEELUM is on the low side of the closest values it does offer, we believe the SEELUM results are satisfactory.

Table 4.1: Travel Response Elasticities generated by SEELUM for rail.

Test	Travel to Work					Other Home-Based					B2B	
	Car	Rail	Bus	Walk	Total	Car	Rail	Bus	Walk	Total	Car	Rail
Rail fares +10%	0.02	**-0.37**	0.03	0.03	0.01	0.02	**-0.81**	0.01	0.02	0.01	0.01	**-0.21**
Rail fares -10%	0.02	**-0.38**	0.03	0.03	0.01	0.02	**-0.90**	0.02	0.02	0.01	0.01	**-0.21**
Rail GJT +10%	0.04	**-1.20**	0.05	0.06	0.00	0.01	**-1.07**	0.01	0.02	0.00	-0.03	**-1.19**
Rail GJT -10%	0.05	**-1.45**	0.06	0.08	0.00	0.01	**-1.29**	0.02	0.02	0.00	-0.04	**-1.42**
Rail Access/ Egress Time +10%	0.02	**-0.45**	0.02	0.02	0.00	0.01	**-0.56**	0.01	0.01	0.00	-0.01	**-0.53**
Rail Access/ Egress Time -10%	0.02	**-0.48**	0.02	0.02	0.00	0.01	**-0.62**	0.01	0.01	0.00	-0.01	**-0.57**

Own-mode elasticities are in bold.

4.13 Rail GJT elasticities are slightly asymmetric and range from -1.07 to -1.45. PDFH 5.1 does not offer directly comparable values, but suggests -1.35 for to/from London, and -1.2 for journeys over 20 miles outside London. We judge SEELUM's values to be satisfactory in comparison. We note also that, apart from B2B, the cross-mode elasticities are all small and positive, as expected. The elasticity of car B2B trips with respect to rail GJT is negative (albeit, very small), which is not what might be expected at first sight. It arises because the increase in rail costs suppresses the level of business activity, and hence reduces B2B trips by a small amount. The result is that even though the car mode share increases, the overall number of trips falls, giving a small negative elasticity.

4.14 Rail access / egress elasticities are between -0.45 and -0.62 for all trip purposes. We do not have empirical values to compare against but given their reasonably conservative magnitudes we judge these elasticities to be acceptable.

4.15 Table 4.2 shows the elasticities of employment with respect to changes in rail costs and times. They are all very small. We do not have examples of the equivalent measures observed empirically, but we are aware of two studies [References 3 and 4] that reported elasticities of employment with respect to public transport accessibility at between +0.02 and +0.04; these are not directly comparable to the SEELUM's results but do confirm that the elasticity effect can be expected to be small.

Table 4.2: Elasticities of employment with respect to rail costs

	Rail fares +10%	Rail fares -10%	Rail GJT +10%	Rail GJT -10%
Elasticity of employment	-0.003	-0.003	-0.013	-0.012

Road Traffic

4.16 The tests for road traffic consisted of applying the following changes:

- +/-10% to all road traffic total generalised journey times (i.e. including fuel cost)
- +/-10% to only the fuel cost element of the generalised journey times

4.17 Table 4.3 summarises the results. For Travel to Work (TTW) and Other Home-Based trips, these apply to car trips, while for Business to Business (B2B) they apply to cars and goods vehicles.

Table 4.3: Response Elasticities Generated by SEELUM for road traffic

Test	Travel to Work					Other Home-Based					B2B	
	Car	Rail	Bus	Walk	Total	Car	Rail	Bus	Walk	Total	Car	Rail
Fuel Cost +10%	**-0.04**	0.16	0.17	0.17	0.02	**-0.12**	0.16	0.29	0.39	0.06	**-0.02**	0.04
Fuel Cost -10%	**-0.03**	0.16	0.17	0.18	0.02	**-0.12**	0.17	0.30	0.40	0.06	**-0.02**	0.04
Road Traffic GJT Change +10%	**-0.28**	0.39	0.45	0.49	-0.10	**-0.20**	0.17	0.35	0.52	0.05	**-0.56**	0.32
Road Traffic GJT Change -10%	**-0.12**	0.56	0.60	0.62	0.06	**-0.14**	0.22	0.42	0.58	0.11	**-0.23**	0.67

Own-mode elasticities are in bold.

4.19 There is a mixture of negative and positive elasticities. The negative own-mode elasticities for car indicate that demand changes in the opposite direction of the change in input (e.g. fuel cost *in*creases; car demand *de*creases). The positive cross-mode elasticities indicate a change in the same direction as the input change (e.g. fuel costs *in*crease, rail demand also *in*creases due to mode shift).

4.20 The fuel price elasticity is -0.03 to -0.04 for TTW, -0.12 for Other Home-Based trips and -0.02 for B2B. The ordering of these elasticities seems plausible. A literature review carried out by

RAND in 2014 [Reference 5] reported a range for fuel price elasticities of -0.1 to -0.5 for car travel, while for freight, the range was +0.1 to -0.6 (i.e. ranged from positive to negative). SEELUM's elasticities for commuting and Other home-based travel are at the low end of the RAND range, while the Business elasticity lies with the RAND range. We consider this to be acceptable.

4.21 The generalised journey time elasticity is slightly asymmetric, and from -0.12 to -0.28 for TTW and -0.14 to -0.20 for Other Home Based. For B2B the elasticities are -0.56 for journey time increases and -0.23 for decreases. In this latter case the model only offers road and rail as options, and the asymmetry reflects the relative volumes and availability of the two modes; when times increase, some people can move to rail, while some other trips are suppressed; when times reduce, some trips are generated, but new travellers are mainly drawn from the rail market, which has a minority share.

4.22 In its review of evidence, the Victoria Transport Policy Institute [Reference 6], quoting Goodwin, reported elasticities for car travel with respect to time of -0.27 and -0.67 for urban and rural roads respectively, in the short run, rising to -0.57 and -1.33 in the long run. SEELUM's response is at the low end of these ranges.

4.23 The cross-mode elasticities are positive due to mode shift. When the cost of car travel increases, demand on other modes increases. When the cost of car travel decreases, demand on other modes decreases. The changes are larger than for the rail tests because car is the dominant mode, and relatively small shifts from car can be large proportional impacts on the other modes. The process works in reverse when car costs are reduced.

4.24 Table 4.4 shows the elasticities of employment with respect to changes in fuel costs and generalised drive time. The fuel effect is very small, as might be expected. The generalised journey time effect is asymmetric, being larger for time increase (-0.24) than for decreases (-0.10). This is intuitively plausible: there is more scope for increased travel times to suppress economic activity than for time reductions to increase it. However, empirical evidence is scarce. The 'What Works' report [References 7 and 8] quoted two examples where road investment had had a positive impact on employment; in one, a 10% improvement in 'business accessibility' increased the number of businesses by 3% up to 30km from site of improvement, leading to an increase in employment of up to 10%. (The link between 3% businesses and 10% employment was not clear; no figures were quoted for the second example.)

4.25 On balance, given the modest impacts, the plausible asymmetry, and that the values, while small, are larger than for rail, we propose that these elasticities are acceptable.

Table 4.4: Elasticities of employment in SEELUM with respect to car costs

	Fuel costs +10%	Fuel costs -10%	Car GJT +10%	Car GJT -10%
Elasticity of employment	-0.03	-0.02	-0.24	-0.10

Bus

4.26 Table 4.5 shows the results for buses.

Table 4.5: Response elasticities generated by SEELUM for Buses

Test	Travel to Work					Other Home-Based					B2B	
	Car	Rail	Bus	Walk	Total	Car	Rail	Bus	Walk	Total	Car	Rail
Bus fares +10%	0.02	0.02	**-0.36**	0.03	0.00	0.04	0.03	**-0.79**	0.08	0.00	n/a	n/a
Bus fares -10%	0.02	0.02	**-0.37**	0.03	0.00	0.04	0.04	**-0.86**	0.09	0.00	n/a	n/a
Bus GJT +10%	0.09	0.07	**-1.49**	0.16	-0.01	0.07	0.06	**-1.46**	0.15	-0.01	n/a	n/a
Bus GJT -10%	0.10	0.08	**-1.81**	0.19	-0.01	0.08	0.07	**-1.76**	0.18	-0.01	n/a	n/a

Own-mode elasticities are in bold

4.28 Bus fare elasticities are around -0.37 for TTW, and between -0.79 to -0.86 for Other Home Based. (Bus is not available for B2B in the model.) The relativities between TTW and Other Home Based are plausible, while values are within observed ranges. For example, TRL [Reference 9] reported bus fare elasticities of -0.2 to -0.3 in the short term, rising to -0.7 and -0.9 after 5 to 30 years.

4.29 The bus generalised journey time elasticities are around -1.4 or more. TRL [Reference 10] quotes various elasticities with respect to bus Generalised Cost, which includes fare, of -0.4 to -0.8 for travel to work, and -1.3 to -1.7 for other home-based trips. SEELUM's generalised time does not include fare, so comparisons are not exact, but it may be that SEELUM's values are high. If test changes to bus generalised times are made with SEELUM's, it may be worth considering whether adjustments should be made to scale the response down.

4.30 Table 4.6 shows the employment elasticities. As would be expected, they are very small. Johnson et al. (Reference 4) quoted panel data that estimated elasticities of employment with respect to bus travel times of around -0.016 for England outside London, SEELUM's elasticity is on the lower scale of this, however seeing as these elasticities are so close to zero, we do not see cause for concern regarding these elasticities.

Table 4.6: Elasticities of employment in SEELUM with respect to bus costs

	Bus fares +10%	Bus fares -10%	Bus GJT +10%	Bus GJT -10%
Elasticity of employment	-0.001	-0.001	-0.004	-0.005

References for Chapter 4

4.31 References referred to in the text are listed here. Many of them were secondary, having been cited in the report What Works, Centre for Local Economic Growth, Evidence Review 7: Transport, July 2015.

4.32 The Passenger Demand Forecasting Handbook version 5.1 is also referenced in the text, abbreviated to PDFH.

1: The Demand for Public Transport: A Practical Guide, TRL, 2004, Table 6.5, page 51

2: Understanding Transport Demands and Elasticities, Victoria Transport Policy Institute, 2017, page 51

3: Ozbay, K., Ozmen, D., and Berechman, J. (2006). "Modeling and Analysis of the Link between Accessibility and Employment Growth." J. Transp. Eng., 132(5), 385–393.

4: Johnson, D., Mackie, P. & Ercolani, M. (2014) 'Buses and the Economy II: Econometric Analysis', Institute for Transport Studies, University of Leeds

5: Dunkerley, F., Rohr, C. & Daly, A. (2014) Road traffic demand elasticities: A rapid evidence assessment, RAND Europe

6: Understanding Transport Demands and Elasticities, Victoria Transport Policy Institute, 2017, Table 29, page 48

7: Chalermpong, S. (2002). Economic Spillovers of Highway Investment: A Case Study of the Employment Impacts of Interstate 105 in Los Angeles County. University of California Transportation Center

8: Gibbons, S., Lyytikainen, T., Overman, H. G., & Sanchis-Guarner, R. (2012). New road infrastructure: the effects on firms.

9: The Demand for Public Transport: A Practical Guide, TRL, 2004, Table 6.3, page 50.

10: The Demand for Public Transport: A Practical Guide, TRL, 2004, Table 7.23, page 79.

5 Building a Baseline for Future Scenario Tests

Introduction

5.1 The SEELUM 'Scenarios' model is used for conducting scenario tests, beginning from the end of the stabilise run, which is taken to be the model's representation of 2018. The model is run for thirty-two years to provide forecasts up to 2050.

5.2 The Scenarios model includes options for inputting changes to transport costs and times etc. However, before this can be done a baseline run has to be constructed that includes three things:

- The impacts of Do Minimum (DM) transport schemes;
- The current best estimate of future growth in employment and population that is expected to occur for reasons not related to transport; and
- The effect of trend changes to values of times and costs.

5.3 Tests of Do Something (DS) scenarios can then be run and compared against the baseline run to understand the impact of the DS scheme.

Do Minimum Inputs

Highways

5.4 The creation of base year highway cost matrices is described in Chapter 2. To represent changes to highway travel times in the Do Minimum, a matrix of travel time changes is overlaid on the base times at selected years during the model run.

5.5 The matrix of travel time changes was derived through analysis of outputs of a version of the South East Regional Traffic Model (SERTM) containing committed RIS1 Highway Schemes. Travel times for the base year of 2015 and forecast years of 2031 and 2041 were derived to represent a notional uncongested network to represent the time it would take to travel across the network if no other vehicles were present. This is not a standard SERTM output and has been created by the TfSE team. This approach is used because SEELUM itself models congestion and so it is the changes in *uncongested* times that need to be inputted to the model. The travel times were also converted from the SERTM zoning system to the (more aggregate) SEELUM zoning system.

5.6 The travel time changes between 2015 and 2031 and between 2015 and 2041 were then calculated as percentages and overlaid on the model's base times in 2031 and 2041 respectively. As the model runs, when it reaches these years, the percentage changes in travel time are applied going forwards.

5.7 Although SERTM's base year is 2015, we considered it proportionate to the task to assume that it could be used to represent 2018.

5.8 Below is a list of relevant schemes included in SERTM and hence are accounted for in SEELUM DM highway travel times.

- A2 Bean and Ebbsfleet
- A21 Tonbridge to Pembury
- A27 Arundel Bypass
- A27 East of Lewes
- A30 Temple to Carblake
- A31 Ringwood
- M2 junction 5 Improvement
- M20 Junction 10a
- M20 junctions 3-5
- M23 junctions 8-10
- M25 Junction 10/A3 Wisley interchange
- M25 Junction 25 improvement
- M25 Junction 28 improvement
- M25 Junction 30
- M25 junctions 10-16
- M27 junctions 4-11
- M27 Southampton Junctions
- M271 / A35 Redbridge roundabout upgrade
- M3 junction 10-11 improved sliproads
- M3 Junction 9 improvement
- M3 junctions 12-14 improved sliproads
- M3 junctions 2-4A
- M3 junctions 9-14
- M4 Heathrow slip road
- M4 junctions 3-12

Rail

5.9 The creation of base year rail cost matrices is described in Chapter 2. To represent changes to rail travel times in the Do Minimum, a matrix of absolute travel time changes is overlaid on the base times. These changes take account of Thameslink timetable changes and the opening of Crossrail.

Thameslink

5.10 The Do Minimum includes GJT changes to represent the Full Thameslink Programme as per the proposed December 2019 Timetable, which should start operating in mid-December 2019.

5.11 In reality, Thameslink has seen a staged introduction, with many new services actually starting to operate in May 2018. In SEELUM the base year GJTs represent pre-May 2018, and the Do Minimum represents post December 2019.

5.12 Changes in GJT were calculated using a South Eastern TOC version of MOIRA (compared to South Western Railway for the base). Timetable data was based on a publicly available December 2018 timetable, plus manual edits to represent proposed May 2019 and December 2019 changes described on the Thameslink Programme website.

5.13 Specifically, this matrix contains the 'minutes difference' between the two MOIRA versions for OD pairs where the GJT is at least 10% and 10 minutes lower (faster) in Thameslink, except the OD pairs where we think the impact is not due to Thameslink.

5.14 Thameslink mainly affects north to south flows through London such as Brighton to Cambridge, Croydon to Bedford etc.

Crossrail

5.15 The Do Minimum includes GJT changes to represent the proposed final Crossrail Timetable which was planned to start operating in mid-December 2019 (although this has since been delayed).

5.16 Crossrail will also be a staged introduction; some short services will run from May 2019, but we have modelled the proposed end state in the Do Minimum.

5.17 Details of the proposed final timetable are less clear than we expected but we have managed to piece together the key service patterns which would affect SEELUM. Changes in GJT have therefore been calculated manually.

5.18 There are three separate scenarios where a GJT change has been created:

- **Great Western Main Line inner services – Central London**: Zones between Reading/Slough and Central London gain an 8-minute reduction in journey time. This is to represent not having to interchange at Paddington onto Underground/Bus.
- **Great Western Main Line inner services – East London**: Zones between Reading/Slough and East London gain new GJTs calculated from information on the Crossrail website and PDFH parameters to calculate new Reading – Stratford and new Slough – Stratford GJTs. Note that Slough – Stratford is direct but Reading – Stratford still requires an interchange in central London. Despite this it still gains a good journey time reduction.
- **Great Western Main Line Long Distance services – Central/East London:** Any zones in West England or Wales where access to London would be via London Paddington to Central/East London have been given a 5-minute reduction. For long distance journeys the impact of Crossrail is minor as passengers would still be expected to interchange at London Paddington. However, the journey time from Paddington to central/east London, is reduced compared to getting the Underground/Bus.

Bus & Active Modes

5.19 Bus and active modes costs are unchanged in future years.

Forecasts of Population and Employment Growth

5.20 Population and employment growth are represented in the model through the provision of additional land in each zone, giving the model additional capacity to develop more housing and business premises. This leads to population and job growth.

5.21 Forecasts of population and employment growth were taken from NTEM (TEMPRO 7.2). Data for 2018 and 2050 was obtained from NTEM at MSOA level and then converted to SEELUM zones. In order to stimulate and accommodate this growth, the model was supplied with proportional increases in the land available for housing and commercial use in each zone, equal to the proportional growth implied by NTEM. The new land is assumed to become available linearly from 2018 to 2050.

5.22 Note that providing new land does not necessarily lead to growth in the model. Other factors need to be in place to support the growth. For example, if a zone is earmarked for housing growth but has poor transport connections to locations with employment, growth may not occur.

Meeting NTEM Target Growth

5.23 An 'Unconstrained' Do-Minimum run was set up to see how well the model reaches the NTEM (TEMPRO 7.2) growth targets for employment and population for each District, without any background growth in transport costs[22].

5.24 Table 5.1 shows how well this was achieved for the sectors[23] in the model. In summary, across the South East, SEELUM achieved 13% growth in population, compared to NTEM's 18%, and 14% growth in jobs compared to NTEM's projected growth of 11%.

5.25 This occurs because NTEM predicts a larger growth in population (18%) than in employment (11%). The implication is that there will be many more people unemployed, or out of the workforce for other reasons. The SEELUM model, however, tries to keep a more even balance between population (or, more accurately, the workforce) and employment. If unemployment rises too far this will deter inward migration, since it assumes that people will not be attracted to a location with high unemployment. Employers, on the other hand, seeing a plentiful supply of labour, will be attracted, since recruitment is one of the key factors affecting how attractive locations are to them.

5.26 The net result is that the model cannot reproduce NTEM exactly but reaches a position of balance with rather less population than NTEM predicts (albeit still more than in the base year) and rather more employment. We experimented with different configurations of the model to explore this balance, and Table 5.1 represents the closest to NTEM we were able to achieve.

Table 5.1: Meeting the NTEM target growth projections: % growth achieved

	Population		Jobs Filled	
Model Sector	NTEM	SEELUM	NTEM	SEELUM
West Kent	19%	11%	11%	13%
East Kent	19%	14%	11%	13%
West Sussex	17%	15%	10%	15%
East Sussex	16%	12%	11%	13%
West Surrey	15%	8%	10%	13%
East Surrey	14%	8%	10%	13%
North Hampshire	20%	17%	11%	15%
South Hampshire	15%	11%	11%	15%
Berkshire	20%	15%	10%	15%
Rest of SE internal	22%	17%	11%	17%
All Internal Zones	18%	13%	11%	14%

[22] Hence the term 'Unconstrained'. This run has no increases in fares, fuel costs or congestion.

[23] Figure 2.4 shows the model's sectors

Trend Assumptions

5.27 The trends in SEELUM for costs, values of time etc. are listed in Table 5.2.

Table 5.2: Trend assumptions in the model

Factor	Value	Source
Annual change in personal value of time	2.20%pa	WebTAG Table A1.3.2, November 2018
Annual change in business value of time	2.20%pa	WebTAG Table A1.3.2, November 2018
Annual change in vehicle operating costs (fuel)	0.07%pa	WebTAG Table A1.3.12 November 2018
Annual change in GVA per job	2.10%pa	Real GDP Index, Annual Parameters, WebTAG Unit A 1.3, DataBook November 2018.
Annual increase in rail fares	1.0%pa	Assumed to increase in real terms at RPI +1%
Annual increase in bus fares	0.8%pa	Steer assumption
Rate of increase in congestion	0.19%pa	Derived from NRTF

5.28 A new run was undertaken using these trend changes in costs, plus the model's internally generated congestion and crowding on the highways and rail networks. This suppresses some of the Unconstrained growth, opening a 'gap', representing the loss of growth that would occur if no action were taken to counter the cost increases.

5.29 Table 5.3 shows the impact on population and employment, comparing the unconstrained and constrained runs.

Table 5.3: Changes in population and jobs due to rising transport costs (constrained minus unconstrained, 2050)

District / Area	Change in population		Change in jobs filled	
	Number	%	Number	%
West Kent	11,224	1.1%	-1,948	-0.5%
East Kent	-3,536	-0.4%	-3,828	-1.3%
West Sussex	-1,219	-0.2%	-3,561	-1.5%
East Sussex	420	0.0%	-6,216	-1.3%
West Surrey	13,144	1.7%	-3,783	-1.1%
East Surrey	6,501	1.7%	-2,162	-1.3%
North Hampshire	-1,435	-0.2%	-7,349	-2.2%
South Hampshire	-1,489	-0.1%	-7,771	-1.5%
Berkshire	4,381	0.5%	-2,659	-0.6%
Rest of SE internal	2,831	0.5%	-2,783	-1.1%
All Internal Zones	30,824	0.4%	-42,059	-1.2%

5.30 The main effect is a moderate suppression of growth in employment by 42,000, or -1.2%.

5.31 This 'constrained' run is used as the baseline case against which future scenario tests will be undertaken.

6 Scenarios

Introduction

6.1 TfSE sought support from stakeholders to develop alternative future scenarios which could describe how the economy, spatial distribution of people and jobs and demand for travel in the South East could vary in the future. This approach – known as 'scenario planning' – recognizes that forecasting future conditions is highly uncertain and that a wide range of factors will influence actual outcomes.

6.2 Scenario planning can be applied in a variety of ways. For instance, identifying what seem to be the most probable futures based on today's conditions can be helpful in testing whether strategies, plans and interventions are robust across the most likely range of outcomes. The approach used here went beyond simply extrapolating existing trends to identify a range of possible futures based loosely on 'Business-as-Usual'. Instead, stakeholders were challenged to work to identify plausible disruptions to trends that would lead to a wider spectrum of future outcomes – and then used the insight gained to derive a preferred future which would drive TfSE's development of strategy, policy and intervention.

6.3 Two stakeholder workshops were held, involving a total of 18 stakeholders representing a wide variety of public and private sector organisations with expertise and interest in the future of transport in the study area. Table 6.1 details the 14 organisations in attendance.

Table 6.1: Stakeholder workshops – Participating organisations

• Brighton and Hove City Council	• Solent LEP
• TfSE	• Hampshire Chamber of Commerce
• Network Rail	• Transport Focus
• Hampshire County Council	• Kent County Council
• Enterprise M3	• Brighton and Hove Buses
• West Sussex County Council	• Highways England
• Thames Valley Berkshire LEP Ltd	• Slough Borough Council

6.4 The first workshop was held with the following objectives:

- To explore the drivers that stakeholders believe will drive changes in transport demand between now and 2050
- To map the drivers according to their level of importance and uncertainty
- To explore and define the most important dimensions (axes) of uncertainty

6.5 Opinions and discussions from the initial workshop were used to scope out four plausible future scenarios. A second workshop was held to shape and refine scenarios through the following aims:

- To share the emerging scenarios with stakeholders and get feedback

- To give stakeholders the opportunity to refine the scenarios
- To understand what "policy levers" would be consistent with the outcomes of each scenario (these would then be later used to operationalise each scenario within the SEELUM model)
- To name the scenarios

6.6 Each of these aspects are described in more detail in the following section of the report.

Scenario Development

Step 1: Driver Mapping

6.7 The first step in developing the future scenarios was to set out the drivers that are anticipated to shape the future of the South East. In advance of the workshop, Steer held an internal workshop with senior experts in transport policy and forecasting to identify the 22 most important drivers:

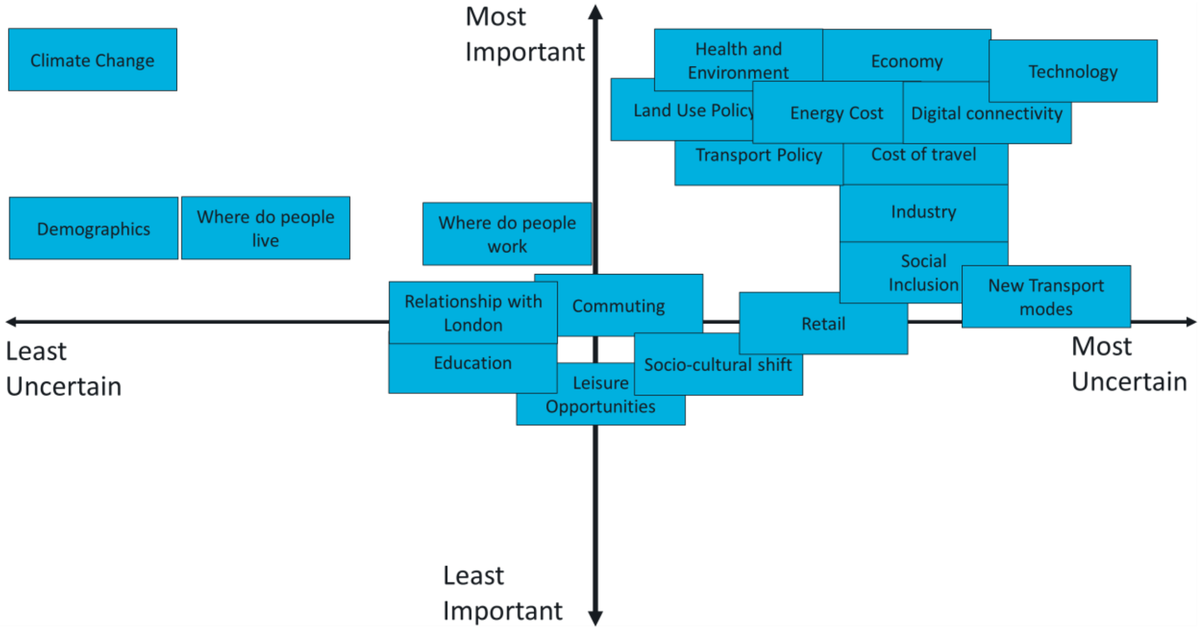
1. Economy
2. Industry
3. Relationship with London
4. Where do people work?
5. Where do people live?
6. Commuting
7. Cost of travel
8. Land use policy
9. Transport policy
10. Technology
11. Digital connectivity
12. Mobility-as-a-Service
13. New transport mode
14. Demographics
15. Health and environment
16. Socio-cultural shift
17. Social inclusion
18. Leisure opportunities
19. Climate change
20. Energy cost
21. Education
22. Retail

6.8 The stakeholders were split into four groups to map these drivers to an importance and certainty matrix, based on how important the driver is in defining the future of the South East and how certain the outcome of each one is.

6.9 Once the individual groups had decided their position, there was then a facilitated discussion between all stakeholders to come to a common view on each driver's placement within the importance and certainty matrix.

6.10 The resulting importance and uncertainty matrix is displayed in Figure 6.1.

Figure 6.1: Stakeholder workshops - Importance and uncertainty matrix of key drivers



6.11 The drivers in the top right quadrant represent those which are considered both the most important to the future of the South East and the most uncertain in outcome. Eight drivers were identified as the most important and uncertain:

- Health and Environment
- Economy
- Technology
- Digital Connectivity
- Energy Cost
- Land Use Policy
- Transport Policy
- Cost of travel

6.12 These drivers were carried forwards into Step 2: Axes of uncertainty. Drivers which were identified as important but relatively certain were retained for usage across all scenarios (e.g. in later modelling, the assumption on demographics is the same in all SEELUM scenarios).

Step 2: Axes of uncertainty

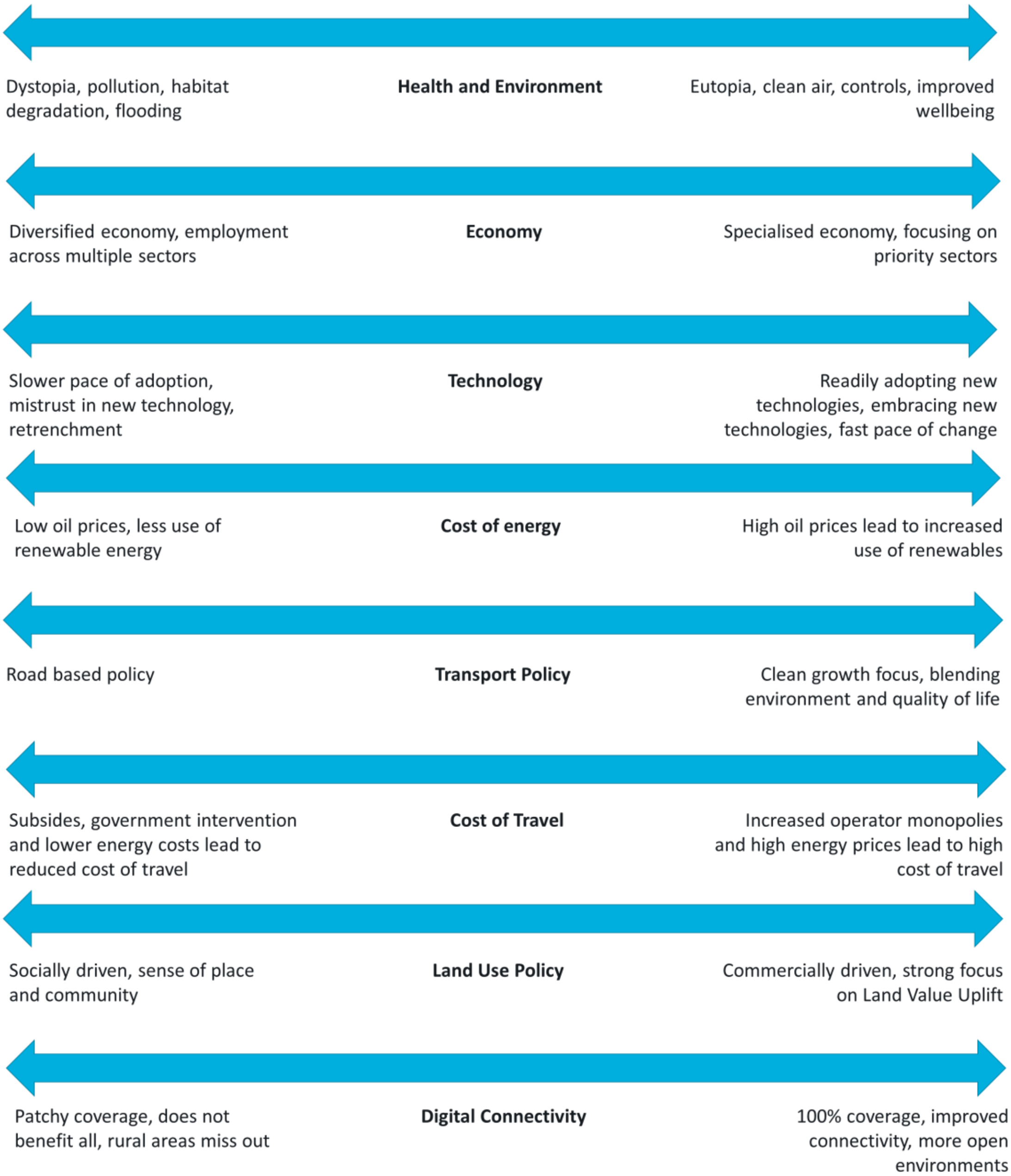
6.13 Having determined the key drivers that could, and will, affect the future of the South East in Step 1, the next step was to identify the alternative ways in which the driver could play out in the future.

6.14 There are three steps to this process, with two completed in the initial workshop, and a third completed in a subsequent workshop:

- Develop a long list of axes of uncertainty
- Draw up a short list of axes of uncertainty
- Agree a scenario matrix

6.15 The axes of uncertainty developed in the workshop for each driver are shown in Figure 6.2 below.

Figure 6.2: Stakeholder workshops – Axes of uncertainty for key drivers



6.16 A theme that emerged throughout these discussions was the overlap between axes within a driver, and also overlap between some of the drivers. It was agreed that the axes for *Technology* and *Digital Connectivity* were linked and could therefore be condensed into one axis.

6.17 *Health and* Environment was deemed to be very important for the South East transport strategy. Stakeholders agreed that this needed to be considered carefully in any future strategy. It was also noted and agreed that *Cost of Travel* is a lever to *Transport Policy*, as opposed to a driver in its own right, and hence could be considered through the *Transport Policy* axis.

6.18 When considering *Land Use Policy*, it was decided that this was more certain than the other axes, although clear links between *Land Use Policy* and *Transport Policy* were noted, especially how one can influence and drive the other.

6.19 Following discussion therefore, four dimensions were prioritised, which were used to scope out the future scenarios:

- Economy and employment
- Technology & digital connectivity
- Health and environment
- Transport policy

Step 3: Scenario Development

6.20 A second stakeholder workshop was held to refine the emerging scenarios. Stakeholders did not reject any of the scenarios but, instead offered enhancements or further areas to consider. These suggestions were incorporated into the narratives developed on each of the scenarios.

6.21 It was also noted by stakeholders that there were aspects of the scenarios that overlapped between them. This was particularly noted with scenario two and four. It was considered as to whether these scenarios could / should be merged. Following the second group exercise, it was accepted that these scenarios should remain separate.

6.22 The final key point noted among stakeholders was the likelihood that the *actual* future will take aspects of all of these scenarios and be positioned somewhere in the middle. This was recognised and stakeholders accepted that the purpose of the scenarios would be to *test the extremes* and ensure that the transport strategy was resilient to these potential futures.

6.23 The second step in the workshop was to understand the policy and other levers that would need to be prioritised in each of the scenarios. Each group of stakeholders were given a set of policy levers (as well as the opportunity to develop their own). Out of the 24 levers, plus any additional, groups were asked to prioritise up to ten of the most important for each scenario.

6.24 The results of the exercise are displayed in Figure 6.3.

Figure 6.3: Stakeholder workshops – Scenario policy levers.

Scenario 1	Scenario 2	Scenario 3	Scenario 4
Placemaking – Invest in social infrastructure	Increased level of devolution to the South East	Free market economics	Increased level of devolution to the South East
Placemaking – Invest in public realm	Placemaking	Roll out 5G--->20G	Placemaking
More affordable housing	Land-Use Policy	Technology – Some areas highly regulated	Skills / education
Mobility as a service	Environment – Carbon Taxes	Technology – Some areas of low regulation	Mobility as a service
Land Use Policy - Relaxed	Environment – Subsidies for renewables	Skills / education	More affordable housing
Placemaking – Invest in Coastal communities	More affordable housing	Lifelong learning / apprenticeship and training	Land Use Policy - Relaxed
Energy supply policy	Road Pricing - All	Improved digital knowledge for businesses	Diversity in labour markets
High levels of business support in priority sectors	High levels of business support in priority sectors	High levels of business support in priority sectors	High levels of business support in priority sectors
Increased devolution of health budget	Behavioural change	Low levels of labour market regulation	Environmental regulation
		Environment – Subsidies for renewables	Improved access to personalised healthcare

6.25 The final stage of the workshop was to name the scenarios.

6.26 Following the workshops, a detailed narrative was developed for each scenario and agreed with TfSE. The characteristics of the established scenarios were translated into impacts on the level and distribution of transport demand, as well as population and employment forecasts for each of the futures. The methodologies for this stage are set out in the following section of this report.

Scenario Specifications

6.27 Table 6.2 sets out the economic features of each scenario. Cambridge Econometrics provided[24] growth estimates of employment and population by zone for each scenario from 2020 to 2050. These growth projections were used in the model in each respective scenario in place of the baseline NTEM growth in employment and population described in Chapter 5 (starting at paragraph 5.20).

6.28 Following an initial round of quantitative testing in the SEELUM model, a fifth preferred scenario was developed that was a hybrid of the Sustainable Future and Our Route to Growth scenarios.

6.29 Table 6.3 sets out the transport changes applied in SEELUM in each of the scenarios. In each scenario, the changes are assumed to be present throughout the whole model run from 2018 to 2050. The changes are also applied in addition to the Do Minimum transport changes, also described in Chapter 5 (starting at paragraph 5.4).

6.30 As noted in paragraph 6.22, stakeholders accepted that the purpose of the scenarios is to test the extremes and ensure that the transport strategy was resilient to these potential futures. Therefore, as part of this work, we do not comment on the costs and feasibility of schemes

[24] See Appendix D for a description of the work to produce this data

required to realise the scenarios. However, they would require major upgrades to the following corridors:

- M2/A2/Chatham Main Line (Dartford – Dover)
- A28/A299/Chatham Main Line (Faversham – Ramsgate)
- M20/A20/High Speed 1/South Eastern Main Line (Dover – Sidcup)
- A21/Hastings Line (Hastings – Sevenoaks)
- M23/A23/Brighton Main Line (Brighton – Coulsdon)
- A3/A27/M275/Portsmouth Direct Line (Portsmouth – Surbiton)
- M3/M27/M271/A33/A326/South Western Main Line (Southampton – Sunbury)
- M4/Great Western Main Line/Reading – Taunton Line (Newbury – Slough)
- M25 (Dartford – Slough)
- Redhill – Tonbridge Line/South Eastern Main Line (Ashford – Redhill)
- A25/North Downs Line (Guildford – Redhill)
- A31/A322/A329/A331/North Downs Line (Guildford – Reading)
- A27/A259/A2070/East Coastway Line/Marshlink Line (Ashford – Brighton)
- M27/A27/A31/West Coastway Line/East Coastway Line (Brighton – Ringwood)

Table 6.2: Economic Scenarios

	The London Hub	Sustainable Futures	Digital Future	Our Route to Growth	Sustainable Route to Growth
Economy & Employment	• Focussed on London Growth • Local employment serves local population • Low local productivity • High wages • Local employment in enabling sectors – construction, retail, education and health	• Ethical economy • Thriving local businesses • Reasonable productivity • Local employment in enabling sectors – strong retail sector, tourism	• Highly productive • Efficient • Short term labour market disruption • Low short-term employment • Inequality – haves & have nots	• Growth concentrated in large Urban Areas • Specialised economy • Service based – IT, Finance and professional • Export-led growth	• Growth concentrated in large Urban Areas • Investment in targeted tradeable sectors and specific deprived urban areas • Boost to public/third sectors and construction
Health & Environment	• Quality of life is key consideration • Making the South East attractive to London's high paid workers • Rising health inequality	• Protect & enhance the environment • Reduce carbon footprint • Improve health outcomes	• Environment is not priority, but fares well from technology advancements • Ageing society grows • Health inequality	• Developed Urban Areas with protected natural landscape	• Reduction in energy generation/heavy industry/transport demand • Protect & enhance the environment • Reduce carbon footprint
Technology	• Business focussed technology solutions • Digital connectivity improves	• Environmentally focussed technology solutions • Clean-tech • Agri-tech • Using data and smart technologies in a citizen-centred manner	• Industry 4.0 • Very fast adoption of technology • Technology focussed solutions • Convenience driven technology	• Growing Tech Sector	• Growing Tech Sector
Transport Policy	• Facilitate radial travel • Improved infrastructure	• Introduce road pricing • Encourage active modes • Encourage sustainable transport	• Facilitate CAVs • More demand responsive	• Favour International Gateways • Improved regional connectivity	• Introduce road pricing + Facilitate CAVs • Encourage active modes and sustainable transport

Table 6.3: Comparison of Sustainable Future, Our Route to Growth and Sustainable Route to Growth scenarios

	Sustainable Future	Our Route to Growth	Sustainable Route to Growth
Key Adjustments to Model	• Reduction/reallocation of energy generation • Reduction in activity in heavy industry • Reduction in demand for transport • Reduction in output of distribution activities • Investment targeting specific deprived urban areas • Boost to Public Services & Third Sector	• High levels of investment and employment growth in targeted tradeable sectors in key cities/areas • Growth focused around densifying key urban areas in the South East • Limited corresponding growth of urban population – implying reduction in out-commuting	• Reduction/reallocation of energy generation • Reduction in activity in heavy industry • Reduction in demand for transport • Investment targeting specific deprived urban areas • Boost to Public Services & Third Sector • Boost to Construction • High levels of investment and employment growth in targeted tradeable sectors in key cities/areas* • Growth focused around densifying key urban areas in the South East • Limited corresponding growth of urban population – implying reduction in out-commuting
Target Locations and Sectors	• N/A	• Basingstoke and Deane: Manufacturing and Industry, Media and Technology • Brighton and Hove: Media and Technology, Law, Finance and Management • Crawley: Transport and Logistics • Hart: Manufacturing and Industry, Media and Technology • Medway: Transport and Logistics • Portsmouth: Science and Health, Transport and Logistics • Reading: Media and Technology, Law, Finance and Management • Southampton: Science and Health, Transport and Logistics	• Basingstoke and Deane: Manufacturing and Industry, Media and Technology • Brighton and Hove: Media and Technology, Law, Finance and Management • Hart: Manufacturing and Industry, Media and Technology • Medway: Business Services • Hastings and Ashford: Business Services • Portsmouth: Science and Health • Reading: Media and Technology, Law, Finance and Management • Southampton: Science and Health

Table 6.4: Transport principles and levers per scenario

Scenario	Key transport principle:	Supported by:	Modelled through:
London Hub	Radial travel	• Rail metro-isation • Access to rail • Commuter rail quality • Road capacity	• Double rail capacity on radials to London • Reduce access time/cost to rail stations by 20% • Reduce rail journey times by 20% • Increase road capacity on radials to London by 50%
Sustainable Future	Demand management	• Road pricing • Road space reallocation • PT fare subsidisation • Better bus	• Double vehicle operating costs • Bus fare reduction of 50% • 50% reduction in rail fare • Reduce intra-zonal rail/bus/active GJT by 20%
Digital Future	CAV network	• No policy constraints on CAV/MAAS • Pedestrianised urban centres	• Reduce car GJT by 20% • Increase road capacity by 20% • Reduce all rail, bus, active GJT by 30%
Our Route to Growth	Orbital travel	• Improved orbital road • Improved orbital rail • High quality urban transit	• Reduce orbital rail GJT by 20% • Increase orbital rail capacity by 50% • Increase orbital road capacity by 50% • Reduce intra-zonal rail/bus/active GJT by 20% • Reduce car GJT by 20%
Sustainable Route to Growth	Mode shift	• Road pricing • PT fare subsidisation • No policy constraints on CAV/Maas • Road space reallocation • Better bus/ high quality urban transit • Pedestrianised urban centres	• Double vehicle operating costs • Rail and bus fare reduction of 50% • Reduce car GJT by 20% • Increase road capacity by 20% • Reduce all rail, bus, active GJT by 30%

7 Results

Transport Impacts

7.1 This section provides the transport-based impacts of the tested scenarios. Table 7.1 to Table 7.5 below provide the absolute numbers and percentage changes in trips for different types of movement. The following naming conventions are used for the scenarios in the tables:

- Base Case: This is NTEM growth and only do minimum transport interventions
- Do Minimum: This is scenario growth and only do minimum transport interventions
- Do Something: This is scenario growth plus a package of do something transport interventions specific to each scenario (see Table 6.4 for details).

7.2 The following sections provide a brief commentary on the high-level results.

London Hub

7.3 Trips within the TfSE area remain steady both with and without the transport package (+10%). Trips into and out of the TfSE area increase (+3% and +7% respectively), mainly to London, with a larger increase when the transport package is included (+11% and +16% respectively).

7.4 Without the transport package, there's a modest increase (+8%) in trips from the TfSE area into London by 2050. There is a slight reduction (-1%) in trips in the opposite direction.

7.5 With the addition of the transport package, which focuses on radial transport improvements to/from London, +8% increases to +22% from the TfSE area into London. In the opposite direction, -1% increases to +19% for trips from London to the TfSE area. This is due to the radial improvements being in both directions, increasing accessibility of jobs in the TfSE area for those in London.

Digital Future

7.6 The transport package in this scenario focuses on the introduction of CAV (Connected Autonomous Vehicles) and MaaS (Mobility-as-a-Service), reducing road transport costs.

7.7 Trips within the TfSE area decrease both with and without the transport package (-6% and -2% respectively). Trips into the TfSE area see a small reduction (-2%) with no impact (0%) showing on trips out of the TfSE area. There is a material increase in trips into and out of the TfSE area with the addition of the transport package, with the larger increase being on trips into the TfSE area (+28%) than out of it (+19%).

7.8 Without the transport package, there's a small increase (+1%) in trips from the TfSE area into London by 2050. There is a reduction (-3%) in trips in the opposite direction. With the transport package, trips to London see a large increase of +23%. Trips from London to the TfSE area see an even larger increase of +45%.

Our Route to Growth

7.9 The transport package in this scenario focuses on east-west travel within the TfSE area.

7.10 Trips within the TfSE area increase slightly more without the transport package (+7% versus +4%). With the transport package, there is a very large increase in trips into the TfSE area (+46%) and also a large increase in trips out of it (+21%).

7.11 Without the transport package, there's a small increase (+1%) in trips from the TfSE area into London by 2050. There is a larger increase (+8%) in trips in the opposite direction.

7.12 With the addition of the transport package, trips to London see a large increase of +23%. Trips from London to the TfSE area see an even larger increase of +67%.

Sustainable Future

7.13 The transport package in this scenario focuses on demand management with mode shift to active and more sustainable modes.

7.14 Trips within the TfSE area see very little change both with and without the transport package (+1% in both scenarios). Trips into the TfSE area see a small increase (+3%) with no impact (0%) showing on trips out of the TfSE area. There is a material decrease in trips into the TfSE area with the addition of the transport package (-24%), with also a modest decrease out of the TfSE area (-16%).

7.15 Without the transport package, there is no impact (0%) on trips from the TfSE area into London by 2050. There is a small increase (+6%) in trips in the opposite direction.

7.16 Trips to and from London see reductions (-14% and -11% respectively). In fact, the only movement with a trip end within the TfSE area that sees an increase in trips is intrazonal movements with a modest +6%.

Sustainable Route to Growth

7.17 This scenario aims to combine the positive aspects of Our Route to Growth and Sustainable Future.

7.18 Trips within the TfSE area see a small increase both with and without the transport package (+4% and +5% respectively). Trips into the TfSE area see a modest increase (+13%) with the transport package compared to a slight increase (+5%) without it. Trips out of the TfSE area decrease both with and without the transport package (-4% and -1% respectively).

7.19 There is a small decrease in trips to London (-1%) without the transport package, and small increase with it (+1%). Trips from London to the TfSE area see a small increase without the transport package (+7%) and a material increase with it (+47%).

7.20 The transport package in this scenario focuses on encouraging mode shift to public transport. The impact of this is an increase in rail travel and a decrease in road travel. This is best illustrated in the Corridor Analysis section below.

Table 7.1: London Hub – Trips by all modes and purposes

	NUMBER OF TRIPS (000s)				% CHANGE 2018 TO...			% CHANGE BASE 2050 TO...		% CHANGE 2050 DO MINIMUM TO 2050 DO SOMETHING
MOVEMENT TYPE	2018	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	DO MINIMUM 2050	DO SOMETHING 2050	
Intrazonals within TfSE area	13,782	14,689	16,181	16,042	7%	17%	16%	10%	9%	-1%
Movements within TfSE area (exc. intrazonals)	2,855	3,761	4,161	4,334	32%	46%	52%	11%	15%	4%
TfSE area to London	1,649	2,009	2,171	2,456	22%	32%	49%	8%	22%	13%
London to TfSE area	443	551	546	658	24%	23%	49%	-1%	19%	20%
Rest to TfSE area	1,411	1,998	2,089	2,167	42%	48%	54%	5%	8%	4%
TfSE area to Rest	716	924	982	946	29%	37%	32%	6%	2%	-4%
Rest to Rest (exc. intrazonals)	32,027	57,874	57,862	58,441	81%	81%	82%	0%	1%	1%
Rest to Rest intrazonal	108,511	100,744	100,807	100,087	-7%	-7%	-8%	0%	-1%	-1%
Total	161,393	182,550	184,799	185,132	13%	15%	15%	1%	1%	0%
Total within TfSE area	16,637	18,450	20,342	20,377	11%	22%	22%	10%	10%	0%
Trips into TfSE area	1,854	2,549	2,636	2,825	37%	42%	52%	3%	11%	7%
Trips out of TfSE area	2,364	2,933	3,153	3,402	24%	33%	44%	7%	16%	8%
Total TfSE	20,856	23,932	26,130	26,604	15%	25%	28%	9%	11%	2%

Table 7.2: Digital Future – Trips by all modes and purposes

	NUMBER OF TRIPS (000s)				% CHANGE 2018 TO...			% CHANGE BASE 2050 TO...		% CHANGE 2050 DO MINIMUM TO 2050 DO SOMETHING
MOVEMENT TYPE	2018	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	DO MINIMUM 2050	DO SOMETHING 2050	
Intrazonals within TfSE area	13,782	14,689	14,383	13,184	7%	4%	-4%	-2%	-10%	-8%
Movements within TfSE area (exc. intrazonals)	2,855	3,761	3,688	4,240	32%	29%	48%	-2%	13%	15%
TfSE area to London	1,649	2,009	2,028	2,479	22%	23%	50%	1%	23%	22%
London to TfSE area	443	551	534	799	24%	21%	80%	-3%	45%	50%
Rest to TfSE area	1,411	1,998	1,964	2,464	42%	39%	75%	-2%	23%	25%
TfSE area to Rest	716	924	915	1,024	29%	28%	43%	-1%	11%	12%
Rest to Rest (exc. intrazonals)	32,027	57,874	57,815	64,954	81%	81%	103%	0%	12%	12%
Rest to Rest intrazonal	108,511	100,744	100,704	92,948	-7%	-7%	-14%	0%	-8%	-8%
Total	161,393	182,550	182,031	182,092	13%	13%	13%	0%	0%	0%
Total within TfSE area	16,637	18,450	18,071	17,424	11%	9%	5%	-2%	-6%	-4%
Trips into TfSE area	1,854	2,549	2,498	3,263	37%	35%	76%	-2%	28%	31%
Trips out of TfSE area	2,364	2,933	2,943	3,503	24%	24%	48%	0%	19%	19%
Total TfSE	20,856	23,932	23,512	24,190	15%	13%	16%	-2%	1%	3%

Table 7.3: Our Route to Growth – Trips by all modes and purposes

	NUMBER OF TRIPS (000s)				% CHANGE 2018 TO…			% CHANGE BASE 2050 TO…		% CHANGE 2050 DO MINIMUM TO 2050 DO SOMETHING
MOVEMENT TYPE	2018	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	DO MINIMUM 2050	DO SOMETHING 2050	
Intrazonals within TfSE area	13,782	14,689	15,640	14,545	7%	13%	6%	6%	-1%	-7%
Movements within TfSE area (exc. intrazonals)	2,855	3,761	4,042	4,623	32%	42%	62%	7%	23%	14%
TfSE area to London	1,649	2,009	2,024	2,481	22%	23%	50%	1%	23%	23%
London to TfSE area	443	551	594	923	24%	34%	108%	8%	67%	55%
Rest to TfSE area	1,411	1,998	2,197	2,803	42%	56%	99%	10%	40%	28%
TfSE area to Rest	716	924	920	1,064	29%	29%	49%	0%	15%	16%
Rest to Rest (exc. intrazonals)	32,027	57,874	57,794	64,779	81%	80%	102%	0%	12%	12%
Rest to Rest intrazonal	108,511	100,744	100,609	92,805	-7%	-7%	-14%	0%	-8%	-8%
Total	161,393	182,550	183,821	184,022	13%	14%	14%	1%	1%	0%
Total within TfSE area	16,637	18,450	19,682	19,168	11%	18%	15%	7%	4%	-3%
Trips into TfSE area	1,854	2,549	2,791	3,726	37%	51%	101%	9%	46%	33%
Trips out of TfSE area	2,364	2,933	2,944	3,545	24%	25%	50%	0%	21%	20%
Total TfSE	20,856	23,932	25,418	26,438	15%	22%	27%	6%	10%	4%

Table 7.4: Sustainable Future – Trips by all modes and purposes

	NUMBER OF TRIPS (000s)				% CHANGE 2018 TO...			% CHANGE BASE 2050 TO...		% CHANGE 2050 DO MINIMUM TO 2050 DO SOMETHING
MOVEMENT TYPE	2018	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	BASE 2050	DO MINIMUM 2050	DO SOMETHING 2050	DO MINIMUM 2050	DO SOMETHING 2050	
Intrazonals within TfSE area	13,782	14,689	14,895	15,606	7%	8%	13%	1%	6%	5%
Movements within TfSE area (exc. intrazonals)	2,855	3,761	3,805	3,096	32%	33%	8%	1%	-18%	-19%
TfSE area to London	1,649	2,009	2,007	1,718	22%	22%	4%	0%	-14%	-14%
London to TfSE area	443	551	583	489	24%	32%	10%	6%	-11%	-16%
Rest to TfSE area	1,411	1,998	2,034	1,450	42%	44%	3%	2%	-27%	-29%
TfSE area to Rest	716	924	921	756	29%	29%	6%	0%	-18%	-18%
Rest to Rest (exc. intrazonals)	32,027	57,874	57,825	43,122	81%	81%	35%	0%	-25%	-25%
Rest to Rest intrazonal	108,511	100,744	100,628	115,910	-7%	-7%	7%	0%	15%	15%
Total	161,393	182,550	182,698	182,146	13%	13%	13%	0%	0%	0%
Total within TfSE area	16,637	18,450	18,699	18,702	11%	12%	12%	1%	1%	0%
Trips into TfSE area	1,854	2,549	2,617	1,939	37%	41%	5%	3%	-24%	-26%
Trips out of TfSE area	2,364	2,933	2,928	2,474	24%	24%	5%	0%	-16%	-15%
Total TfSE	20,856	23,932	24,244	23,115	15%	16%	11%	1%	-3%	-5%

Table 7.5 Sustainable Route to Growth

	NUMBER OF TRIPS (000s)				% CHANGE 2018 TO…			% CHANGE BASE 2050 TO…		% CHANGE 2050 DO MINIMUM TO 2050 DO SOMETHING
MOVEMENT TYPE	**2018**	**BASE 2050**	**DO MINIMUM 2050**	**DO SOMETHING 2050**	**BASE 2050**	**DO MINIMUM 2050**	**DO SOMETHING 2050**	**DO MINIMUM 2050**	**DO SOMETHING 2050**	
Intrazonals within TfSE area	13,782	14,689	15,509	15,327	7%	13%	11%	6%	4%	-1%
Movements within TfSE area (exc. intrazonals)	2,855	3,761	3,895	3,809	32%	36%	33%	4%	1%	-2%
TfSE area to London	1,649	2,009	1,999	2,034	22%	21%	23%	-1%	1%	2%
London to TfSE area	443	551	591	813	24%	33%	83%	7%	47%	37%
Rest to TfSE area	1,411	1,998	2,092	2,070	42%	48%	47%	5%	4%	-1%
TfSE area to Rest	716	924	917	792	29%	28%	11%	-1%	-14%	-14%
Rest to Rest (exc. intrazonals)	32,027	57,874	57,801	53,278	81%	80%	66%	0%	-8%	-8%
Rest to Rest intrazonal	108,511	100,744	100,594	104,958	-7%	-7%	-3%	0%	4%	4%
Total	161,393	182,550	183,399	183,081	13%	14%	13%	0%	0%	0%
Total within TfSE area	16,637	18,450	19,404	19,136	11%	17%	15%	5%	4%	-1%
Trips into TfSE area	1,854	2,549	2,683	2,883	37%	45%	55%	5%	13%	7%
Trips out of TfSE area	2,364	2,933	2,916	2,826	24%	23%	20%	-1%	-4%	-3%
Total TfSE	20,856	23,932	25,003	24,845	15%	20%	19%	4%	4%	-1%

Socio-Economic impacts

7.21 This section provides – in Table 7.6 to Table 7.8 – an overview of the impact on the number of people in employment (i.e. 'jobs filled'), population and Gross Values Added (GVA) in each scenario. Figures are provided for 2018 (as calculated by the model) and 2050 with do minimum transport interventions and the scenario transport packages.

Jobs Filled

Table 7.6: Jobs filled in the TfSE area

		Do Minimum Transport Inputs			Do Something Transport Inputs		
Growth Scenario	**2018 (000s)**	**2050 (000s)**	**Absolute Growth (000s)**	**% Growth**	**2050 (000s)**	**Absolute Growth (000s)**	**% Growth**
Base Case	3,262	3,664	402	12%	*n/a*	*n/a*	*n/a*
London Hub	3,262	3,886	623	19%	3,948	685	21%
Digital Future	3,262	3,577	315	10%	3,725	463	14%
Our Route to Growth	3,262	4,055	792	24%	4,285	1,023	31%
Sustainable Future	3,262	3,818	556	17%	3,722	460	14%
Sustainable Route to Growth	3,262	3,977	714	22%	4,138	876	27%

7.22 With the Do Minimum transport package, the Sustainable Future (+17%), London Hub (+19%), Sustainable Route to Growth (+22%) and Our Route to Growth (+24%) scenarios experience larger growth in jobs filled than the Base Case (+12%), with Our Route to Growth seeing the largest increase. Digital Future (+10%) has slightly lower growth than the Base Case.

7.23 When we also apply each scenario's Do Something transport package, four scenarios see higher growth in jobs filled. London Hub increases to +21%, Sustainable Route to Growth increases to 27% and Our Route to Growth increases to +31%. Digital Future now increases above the Base Case to +14%. Sustainable Future decreases to +14%.

Population

Table 7.7: Population in the TfSE area

		Do Minimum Transport Inputs			Do Something Transport Inputs		
Growth Scenario	2018 (000s)	2050 (000s)	Absolute Growth (000s)	% Growth	2050 (000s)	Absolute Growth (000s)	% Growth
Base Case	7,755	8,723	968	12%	*n/a*	*n/a*	*n/a*
London Hub	7,755	9,649	1,894	24%	9,729	1,974	25%
Digital Future	7,755	8,595	841	11%	8,494	739	10%

		Do Minimum Transport Inputs			Do Something Transport Inputs		
Growth Scenario	2018 (000s)	2050 (000s)	Absolute Growth (000s)	% Growth	2050 (000s)	Absolute Growth (000s)	% Growth
Our Route to Growth	7,755	9,146	1,391	18%	9,098	1,343	17%
Sustainable Future	7,755	8,764	1,009	13%	8,606	851	11%
Sustainable Route to Growth	7,755	9,031	1,276	16%	8,814	1,059	14%

7.24 With the Do Minimum transport package, the Sustainable Future (+13%), Sustainable Route to Growth (+16%), Our Route to Growth (+18%) and London Hub (+24%) scenarios experience larger growth in population than the Base Case (+12%), with London Hub seeing the largest increase. Digital Future (+11%) has slightly lower growth than the Base Case.

7.25 When we also apply each scenario's Do Something transport package, only one scenario sees higher growth. London Hub increases to +25%. Digital Future (+10%) and Sustainable Future (+11%) decrease below the Base Case (12%).

GVA

Table 7.8: GVA in the TfSE area

		Do Minimum Transport Inputs			**Do Something Transport Inputs**		
Growth Scenario	**2018 (£bn)**	**2050 (£bn)**	**Absolute Growth (£bn)**	**% Growth**	**2050 (£bn)**	**Absolute Growth (£bn)**	**% Growth**
Base Case	183	399	217	119%	*n/a*	*n/a*	*n/a*
London Hub	183	421	239	131%	430	248	136%
Digital Future	183	388	206	113%	411	229	125%
Our Route to Growth	183	446	263	144%	481	298	164%
Sustainable Future	183	417	235	129%	404	221	121%
Sustainable Route to Growth	183	433	250	137%	458	276	151%

7.26 With the Do Minimum transport package, all scenarios apart from Digital Future experience larger growth in GVA than the Base Case (+119%). Our Route to Growth sees the largest increase (144%). Digital Future (+113%) has slightly lower growth than the Base Case.

7.27 When we also apply each scenario's Do Something transport package, four of the scenarios see higher growth, with Our Route to Growth having the largest increase. Sustainable Future sees a decrease in GVA.

Corridor Analysis

Demand

7.28 Demand is output from SEELUM in the form of person trips between each zone pair for each scenario. SEELUM provides forecasts for car commuting, rail commuting, car non-work, rail non-work, peak car business, off-peak car business, rail business and off-peak rail business and these are converted to all-day demand forecasts for each corridor.

7.29 Demand between each origin and destination is assigned to the same fixed road and rail paths defined by SEELUM, and the routeing is consistent across all scenarios. For both rail and road corridors, we derive total daily two-way demand for each corridor and each future scenario, allowing comparisons to be made between years and between scenarios.

Base Case – 2018 to 2050

7.30 The Base Case represents NTEM growth in population and employment across the South East and is expected to increase demand across the network.

7.31 Figure 7.1 shows that the greatest increase in road demand is expected to the west of the study area and, to a lesser extent, in the Kent corridors where demand for road space increases more than 30%. The majority of the network sees an increase in road demand of more than 20%.

7.32 Forecasts of increased rail demand are similar, with increases in rail passengers in excess of 40% to the west of the study area and in Kent with general increase of 20-40% across the rest of the key rail network.

London Hub

7.33 Figure 7.2 shows that, for roads, the London Hub impacts are not as widespread as the Digital Future's results, with the greatest increases in demand compared to the Base 2050 scenario occurring in the east. Compared to the Base 2018 scenario, an increase in excess of 30% is predicted across the majority of the network.

7.34 Demand for rail is also increased compared to the Base 2050 scenario, with a more than doubling of passenger demand in the M4 corridor and in Kent. Most of the rail network sees an increase in passenger demand of 10-20%. Compared to the Base 2018 scenario, an increase in excess of 100% is predicted across the majority of the network.

Digital Future

7.35 Figure 7.3 shows that the Digital Futures scenario is predicted to put more pressure on the key road corridors, with each corridor seeing a greater increase in road demand above the Base 2050 scenario. The largest increases are seen on radial routes within the M25, with increases in excess of 30% also predicted in the west of the area around Winchester. Compared to the Base 2018, demand for road traffic increases by more than 30% across the network.

7.36 Demand for rail is also increased compared to the Base 2050 scenario, with the greatest increase seen along the south coast and between Guildford and Reading. Compared to the Base 2018, the majority of the rail network sees an increase in demand of at least 50%.

Our Route to Growth

7.37 Figure 7.4 shows that the Our Route to Growth scenario sees increases in demand for road of at least 20% across most of the network when compared to the 2050 Base. The greatest increases are predicted within and along the M25 as well as the central corridor between Brighton and London. Compared to the Base 2018 scenario, an increase in excess of 30% is predicted across the whole network.

7.38 The impacts on rail are less pronounced with much of the network seeing increase in passenger numbers of less than 50% compared to the Based 2050 scenario. The exceptions are, like the Digital Future scenario, along the South Coast and the Guildford to Reading route.

Sustainable Future

7.39 Figure 7.5 shows that the greatest changes are seen in the Sustainable Future scenario. Although some road corridors predict a modest increase in demand of less than 10% when compared to the 2018 Base, reductions in demand are seen across the whole road network when compared to the 2050 Base Case. Corresponding increases in rail passenger demand are predicted for 2050.

Sustainable Route to Growth

7.40 Figure 7.6 Sustainable Route to Growth has a similar effect on the road network as the Sustainable Future scenario, with reductions in demand across most of the network when compared to the Base Case.

7.41 The greatest increase in rail demand is predicted under the Sustainable Route to Growth scenario.

Figure 7.1: Base Case – 2018 to 2050

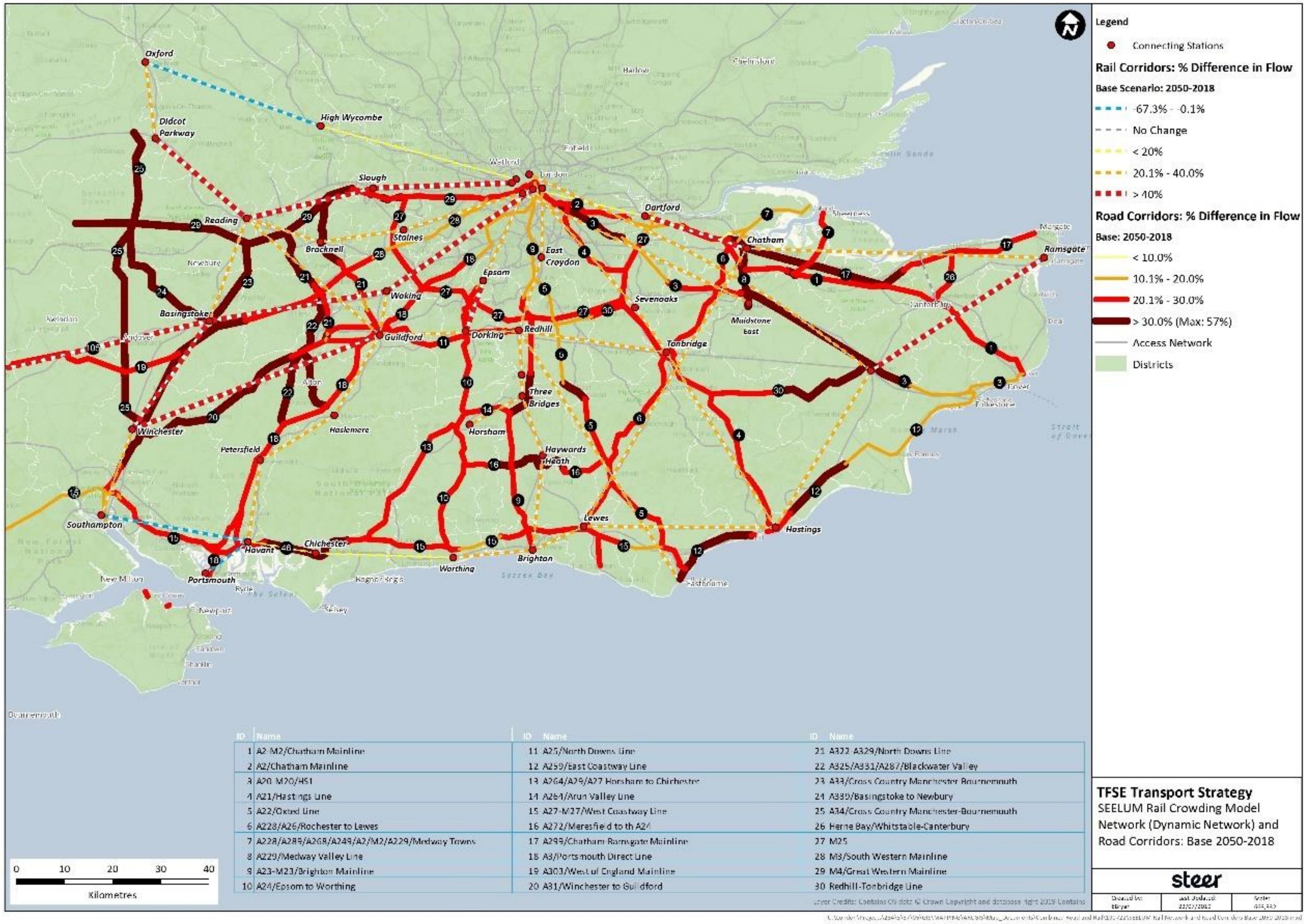


Figure 7.2: London Hub – Base 2050 to Do Something 2050

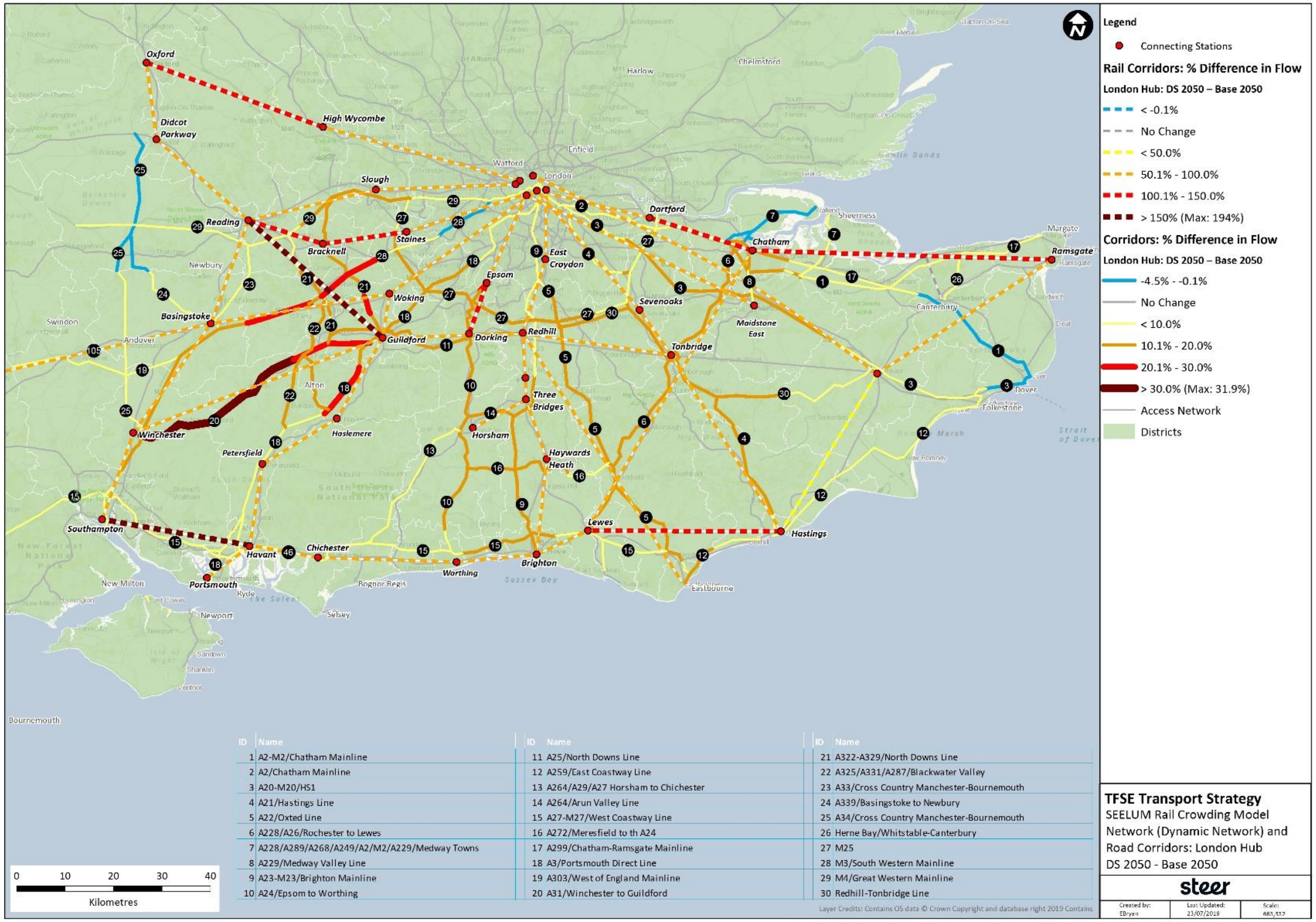


Figure 7.3: Digital Future – Base 2050 to 2050 DS

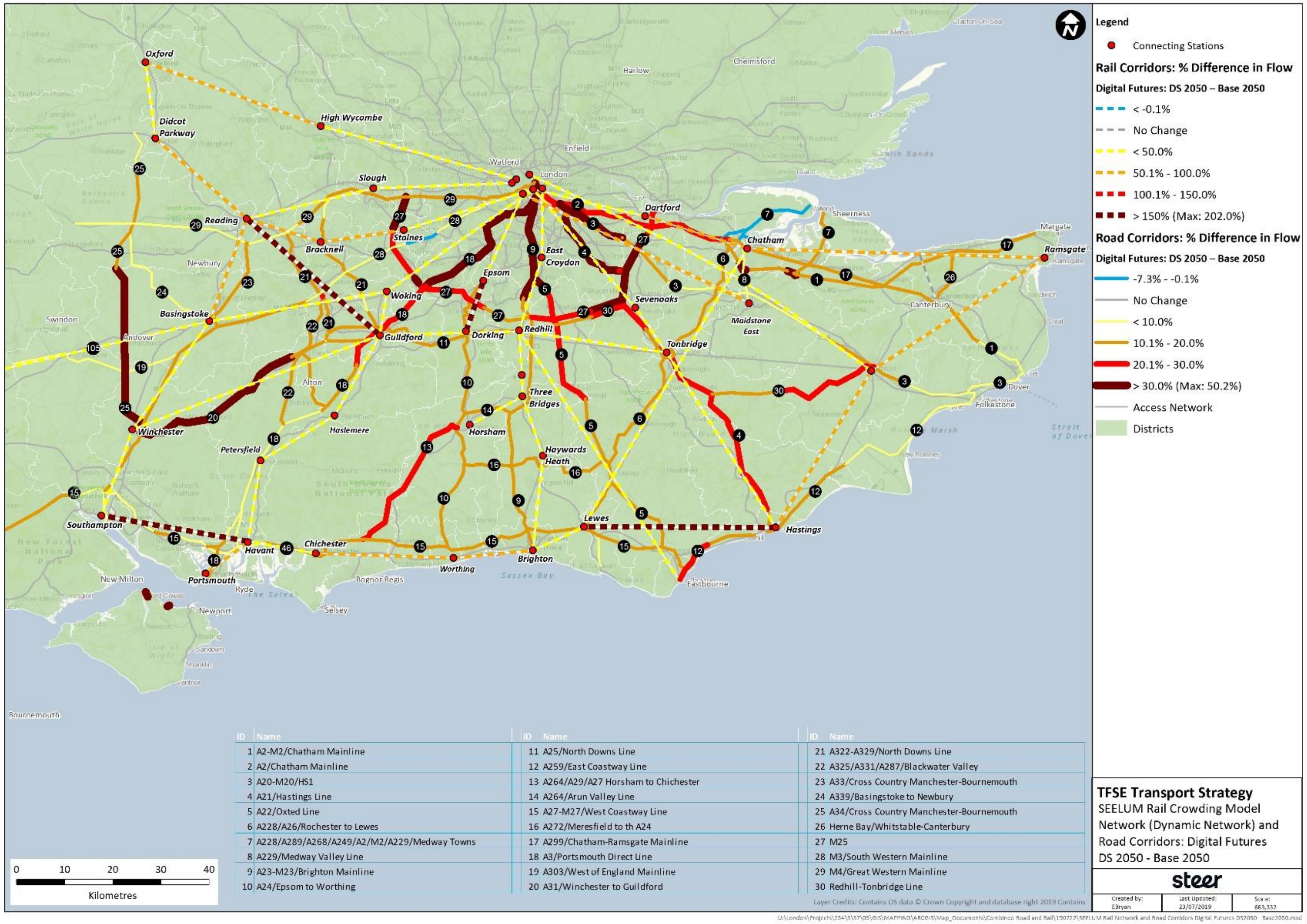


Figure 7.4: Our Route to Growth – Base 2050 to Do Something 2050

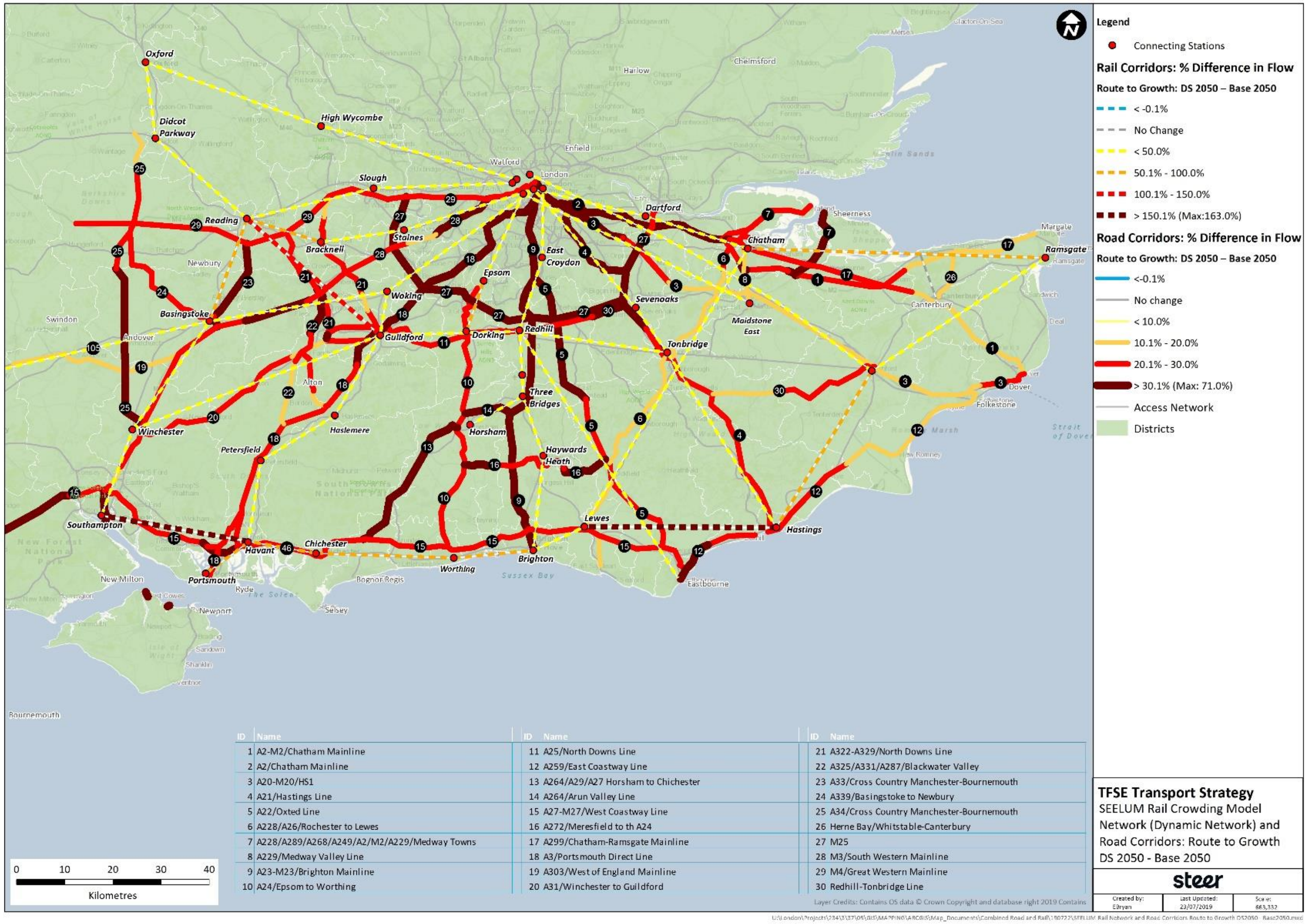


Figure 7.5: Sustainable Future – Base 2050 to Do Something 2050

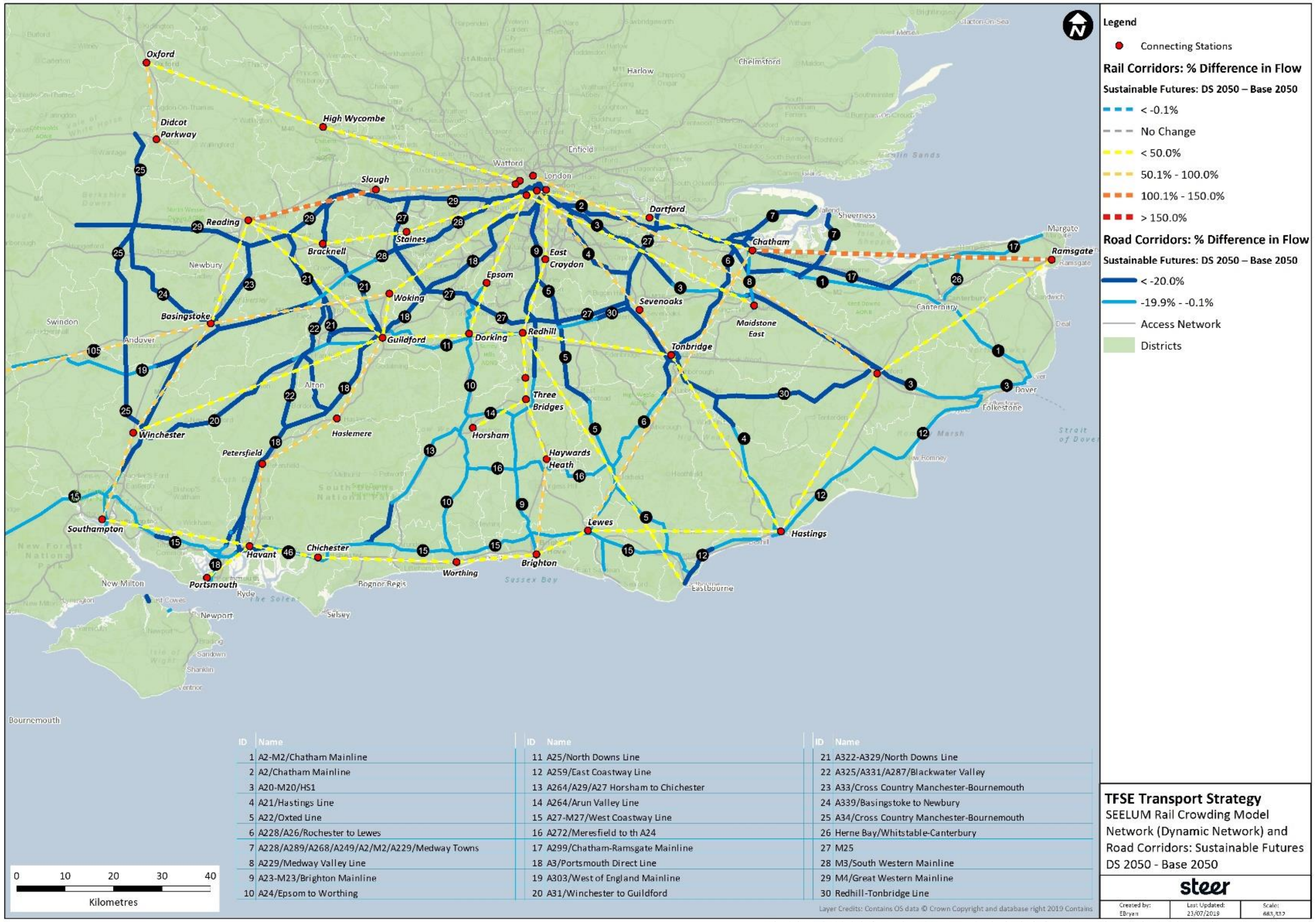
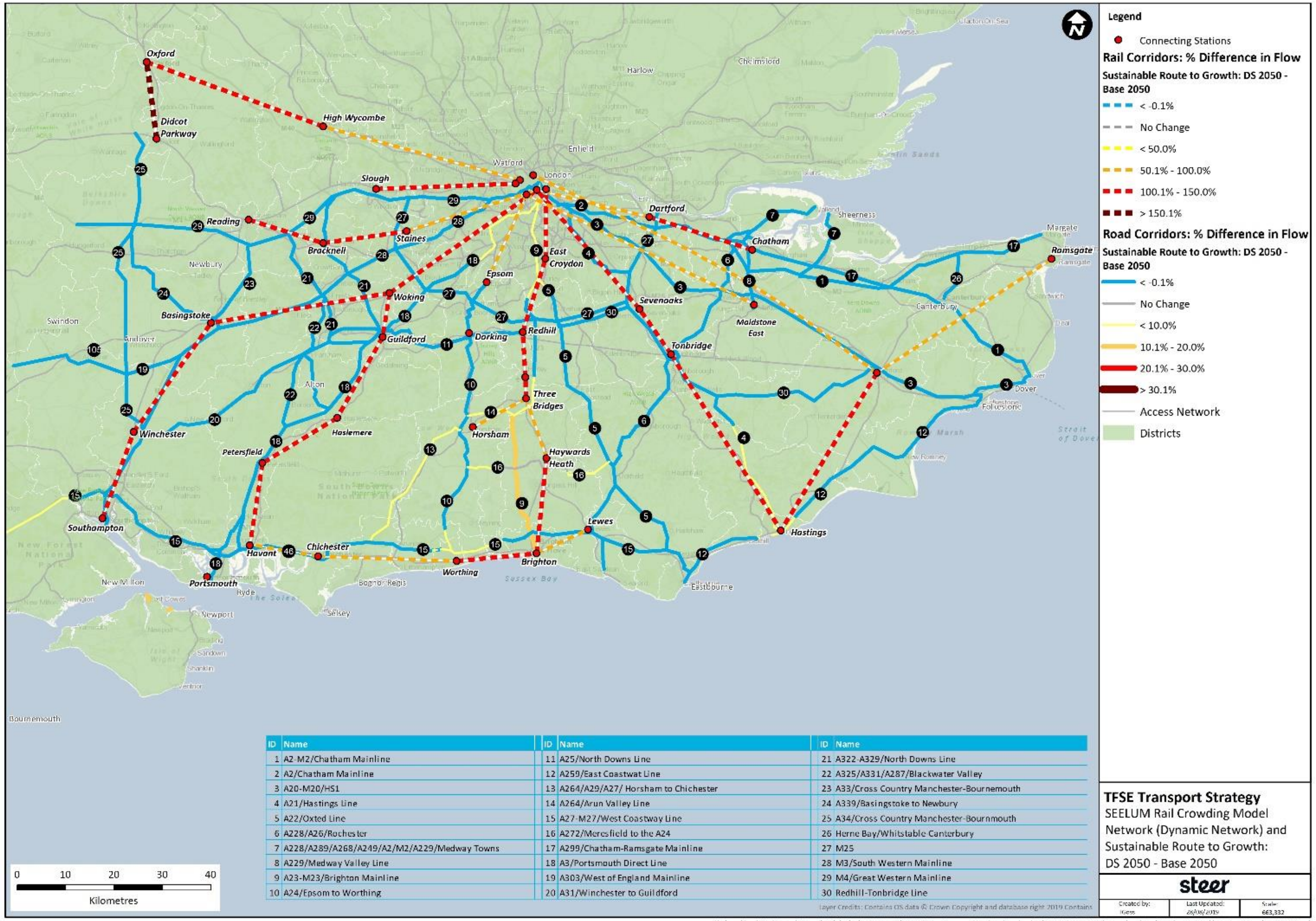


Figure 7.6: Sustainable Route to Growth



Capacity

Road Corridors

7.42 To estimate road capacity, each corridor has been split into sections according to the district it passes through and the predominant road standard for each section identified, noting numbers of lanes and differences between single and dual carriageway arrangements.

7.43 Reference to DMRB[25] (Design Manual for Roads and Bridges) then provides peak hour capacities for each section, which is doubled to give estimates for two-way traffic on dual carriageway routes and a 60:40 ratio by peak direction is assumed for single carriageway routes.

7.44 Car people trips are converted to vehicle trips using car occupancy factors consistent with SEELUM assumptions of 1.10 for commute trips, 1.86 for non-work trips and 1.0 for business trips.

7.45 SEELUM provides forecasts for constrained demand in each corridor in each modelled year and this is used to derive an implied growth rate, which is applied to observed flow on identified corridor roads. Base 2018 observed flows are extracted from the DfT database[26] giving a Base volume over capacity (V/C) against which future increases or decreases in constrained demand along each corridor can be pivoted.

7.46 The following diagrams illustrate sections of road corridors where this demand is expected to be approaching or exceeding capacity across the day by 2050. Table 7.9 summarises the model inputs for each scenario that will impact the road V/C ratio.

Table 7.9: Road volume and capacity impacts by scenario

Scenario	Impact on Road Volume	Impact on Road Capacity
London Hub	• Double rail capacity on radials to London • Reduce access time/cost to rail stations by 20% • Reduce rail journey times by 20%	• Increase road capacity on radials to London by 50%
Sustainable Future	• Double vehicle operating costs • Bus fare reduction of 50% • 50% reduction in rail fare • Reduce intra-zonal rail/bus/active GJT by 20%	
Digital Future	• Reduce car GJT by 20% • Reduce all rail, bus, active GJT by 30%	• Increase road capacity by 20%
Our Route to Growth	• Reduce orbital rail GJT by 20% • Increase orbital rail capacity by 50% • Reduce intra-zonal rail/bus/active GJT by 20% • Reduce car GJT by 20%	• Increase orbital road capacity by 50%

[25] Volume 5 Section 1, Part 3, TA 79/99 Amendment No 1 "Traffic Capacity of Urban Roads", Tables 1 and 2

[26] https://roadtraffic.dft.gov.uk/regions/9

Scenario	Impact on Road Volume	Impact on Road Capacity
Sustainable Route to Growth	• Double vehicle operating costs • Rail and bus fare reduction of 50% • Reduce car GJT by 20% • Reduce all rail, bus, active GJT by 30%	• Increase road capacity by 20%

Base Case – 2050

7.47 Figure 7.7 shows that with NTEM growth, a number of corridors will operate at between 100% and 125% of capacity, most noticeably around the districts of Tonbridge and Malling, Dartford, Surrey Heath, Wokingham and in Portsmouth.

7.48 When the V/C on a link exceeds 85% there is a likelihood that the route will experience periods of poor performance such as when there is an incident on the road or at peak times of the day. A value of 100% implies that demand has reached the theoretical capacity of the road and values above 100% will result in periods of instability on most days with increased congestion.

London Hub, Digital Future and Our Route to Growth

7.49 Future calculations of V/C on road corridors give similar results for the Digital Future, London Hub and Our Route to Growth scenarios, which can be seen in Figure 7.8 to Figure 7.10. In each case a worsening of conditions is seen along sections identified as being at capacity in the Base 2050 scenario with additional pressures seen around the Medway towns and in districts to the west of London such as Slough and Runneymede. The Digital Future scenario also introduces additional pressures to the network around Heathrow.

Sustainable Future

7.50 Figure 7.11 shows that the Sustainable Future scenario would provide significant relief to the network of road corridors in the South East with all routes operating within capacity in 2050 except for short sections in Surrey Heath.

Sustainable Route to Growth

7.51 The Sustainable Route to Growth scenario still offers relief to much of the road network, with conditions improved over the Base Case and only relatively short sections operating above capacity.

Figure 7.7: Base Case – 2050 – V/C Roads

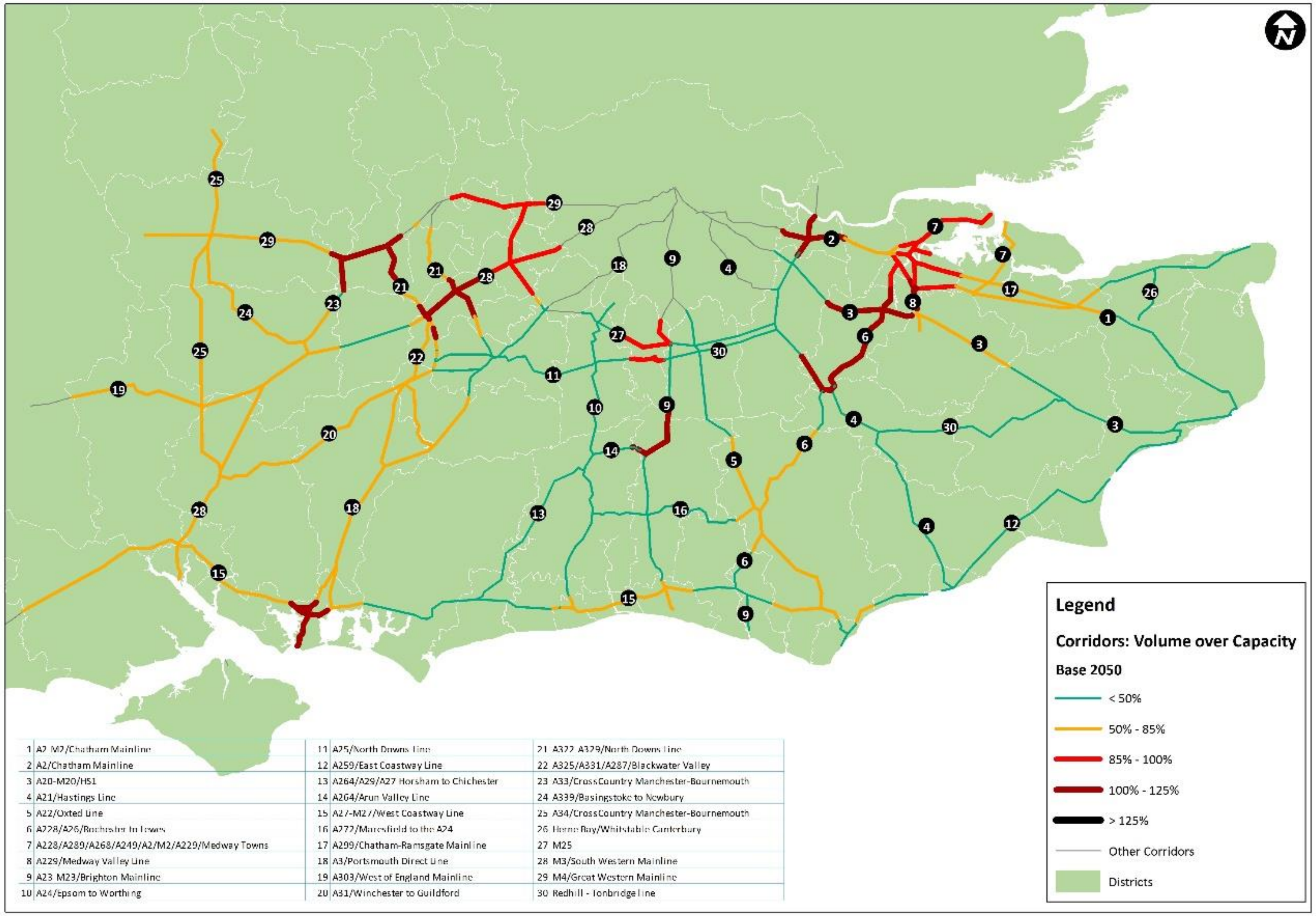


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Figure 7.8: London Hub – 2050 – V/C Roads

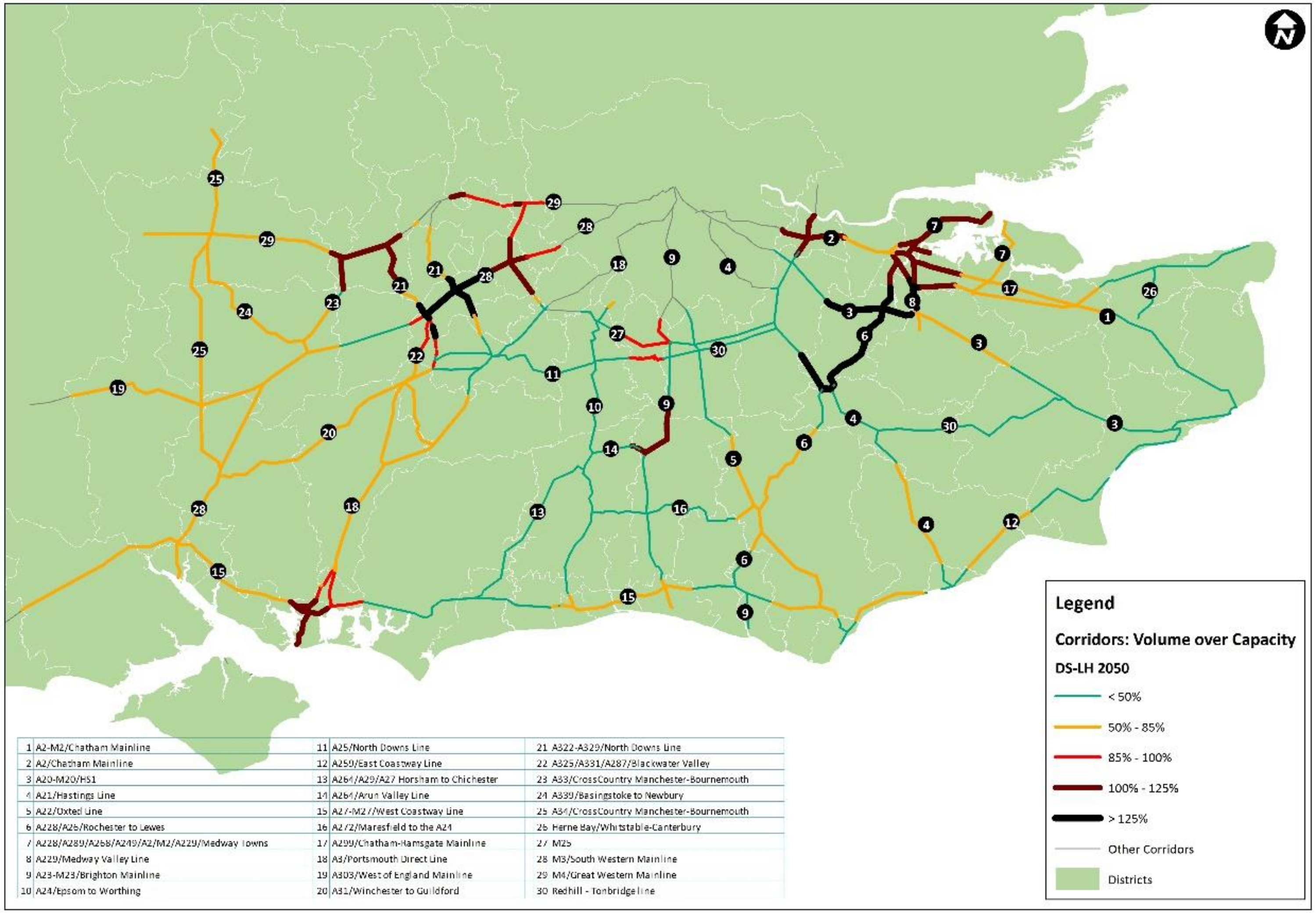

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Figure 7.9: Digital Future – 2050 – V/C Roads

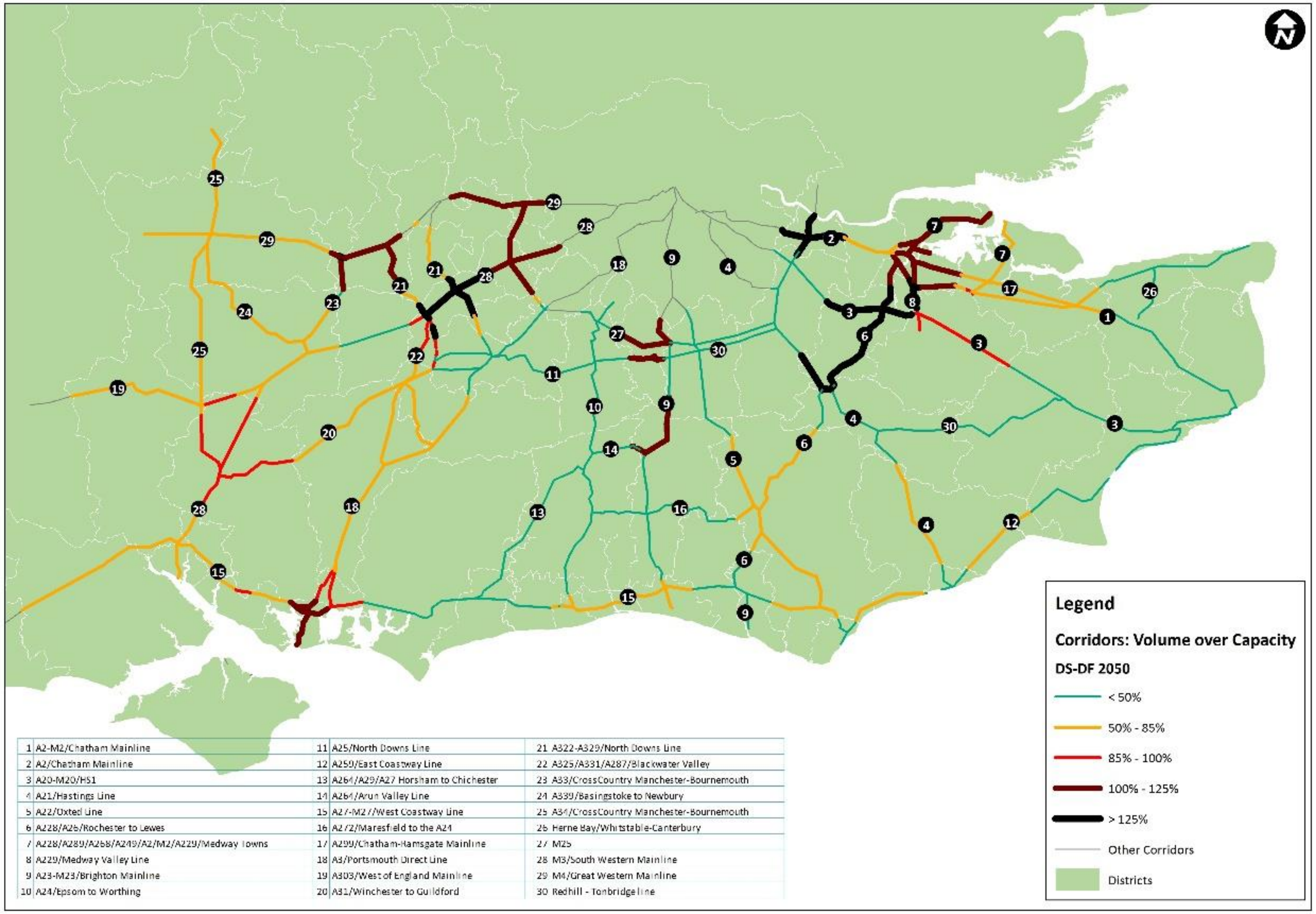

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Figure 7.10: Our Route to Growth – 2050 – V/C Roads

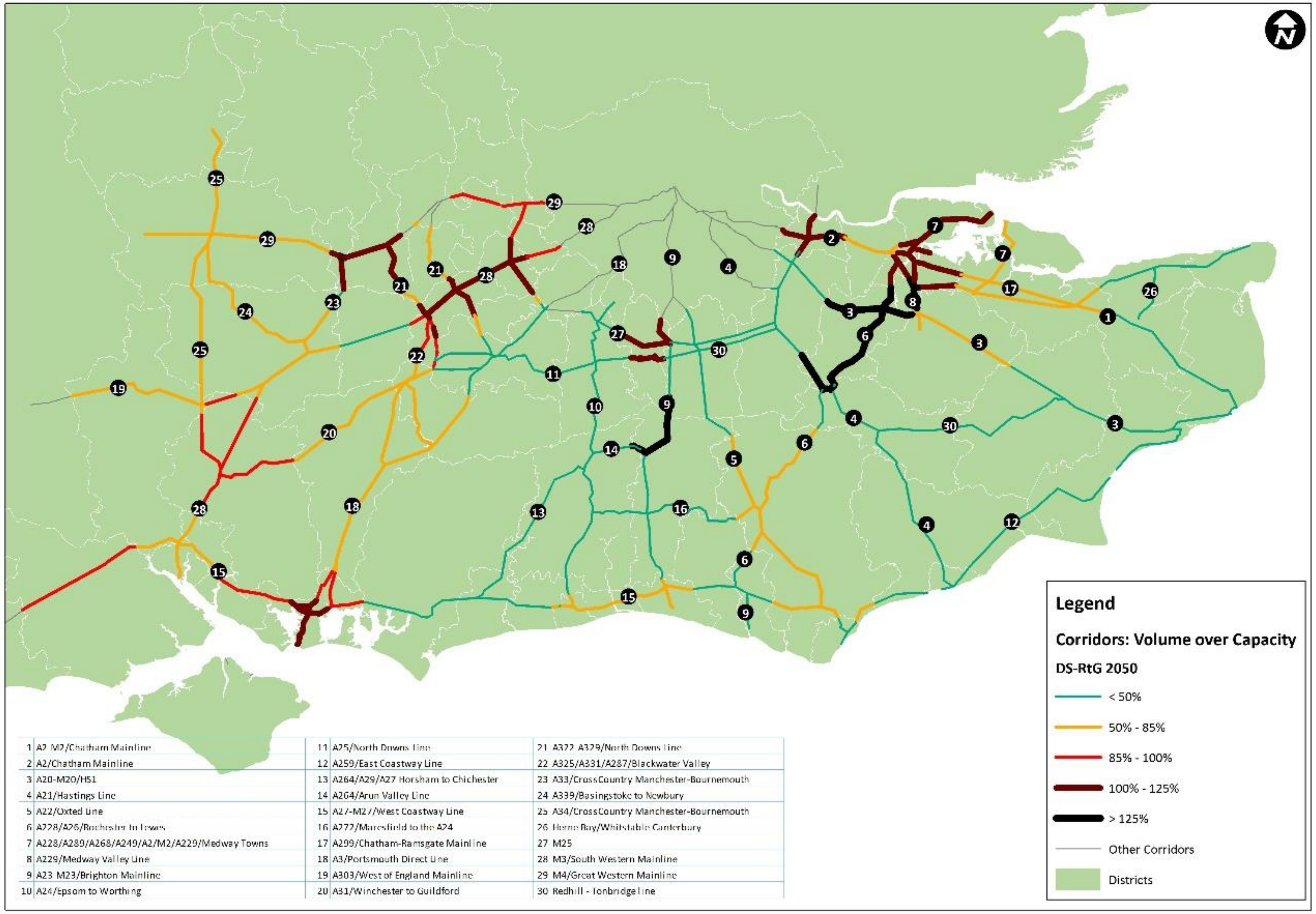

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Figure 7.11: Sustainable Future – 2050 – V/C Roads

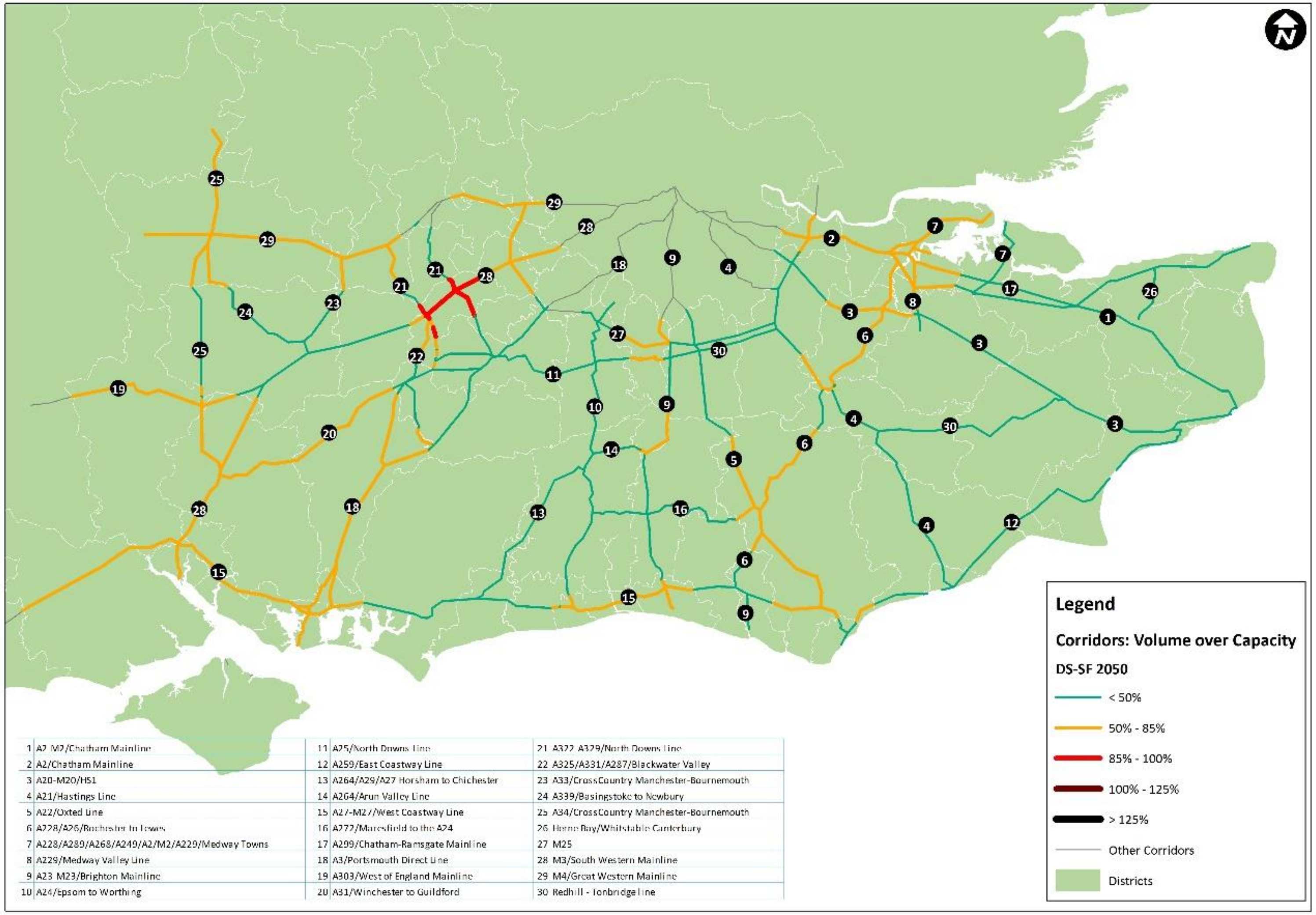

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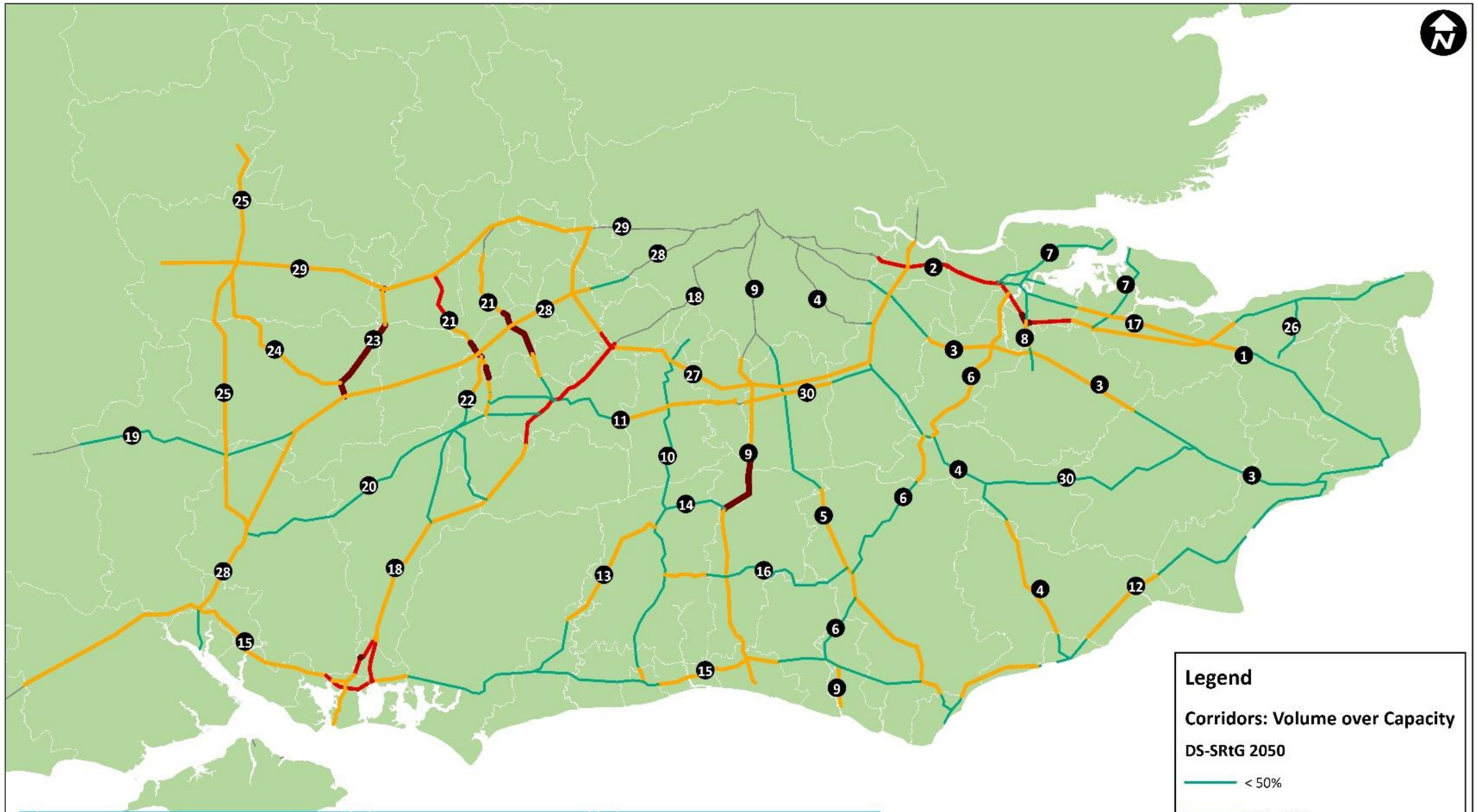
Figure 7.12: Sustainable Route to Growth – 2050 – V/C Roads



ID	Name	ID	Name	ID	Name
1	A2-M2/Chatham Mainline	11	A25/North Downs Line	21	A322-A329/North Downs Line
2	A2/Chatham Mainline	12	A259/East Coastway Line	22	A325/A331/A287/Blackwater Valley
3	A20-M20/HS1	13	A264/A29/A27 Horsham to Chichester	23	A33/CrossCountry Manchester-Bournemouth
4	A21/Hastings Line	14	A264/Arun Valley Line	24	A339/Basingstoke to Newbury
5	A22/Oxted Line	15	A27-M27/West Coastway Line	25	A34/CrossCountry Manchester-Bournemouth
6	A228/A26/Rochester to Lewes	16	A272/Maresfield to the A24	26	Herne Bay/Whitstable-Canterbury
7	A228/A289/A268/A249/A2/M2/A229/Medway Towns	17	A299/Chatham-Ramsgate Mainline	27	M25
8	A229/Medway Valley Line	18	A3/Portsmouth Direct Line	28	M3/South Western Mainline
9	A23-M23/Brighton Mainline	19	A303/West of England Mainline	29	M4/Great Western Mainline
10	A24/Epsom to Worthing	20	A31/Winchester to Guildford	30	Redhill - Tonbridge line

steer

Rail Corridors

7.52 Our source of rail capacity information is MOIRA, which, for the key rail sections, provides numbers of seats and standing capacity for peak and off-peak services. These represent 2 and 7 hours respectively and the totals are doubled to create estimates of total daily capacity across an 18-hour period, assuming that services do not operate through the night.

7.53 For volumes, a similar approach has been taken to the roads analysis above. MOIRA is used to extract base data in the form of annual passenger numbers for each rail section. These have been divided by 300 to give equivalent daily values for comparison with the daily capacity calculations against which future increases/decreases in demand can be pivoted.

7.54 The following diagrams illustrate the effect of growth in passenger demand on rail corridors across the day by 2050. The values represent constrained demand in each corridor provided by the SEELUM model. The diagrams present passenger demand against numbers of seats, although it is recognised that parts of the network already experience standing, particularly in the peaks. As a general rule across the South East rail network, maximum standing capacity is around 85% higher than seated capacity.

7.55 In the model, when the ratio of demand per seat increases above one, a multiplier is applied to the trip's generalised journey time (see paragraph 2.87 and 2.88). Increases in trip cost such as this can subsequently lead to people in the model changing their mode of travel or even changing their work or home location.

7.56 Table 7.10 summarises the model inputs for each scenario that will impact the rail V/C ratio.

Table 7.10: Road volume and capacity impacts by scenario

Scenario	Impact on Rail Demand	Impact on Rail Capacity
London Hub	• Reduce access time/cost to rail stations by 20% • Reduce rail journey times by 20% • Increase road capacity on radials to London by 50%	• Double rail capacity on radials to London
Sustainable Future	• Double vehicle operating costs • Bus fare reduction of 50% • 50% reduction in rail fare • Reduce intra-zonal rail/bus/active GJT by 20%	
Digital Future	• Reduce car GJT by 20% • Reduce all rail, bus, active GJT by 30% • Increase road capacity by 20%	
Our Route to Growth	• Reduce orbital rail GJT by 20% • Reduce intra-zonal rail/bus/active GJT by 20% • Reduce car GJT by 20% • Increase orbital road capacity by 50%	• Increase orbital rail capacity by 50%
Sustainable Route to Growth	• Double vehicle operating costs • Rail and bus fare reduction of 50% • Reduce car GJT by 20%	•

Scenario	Impact on Rail Demand	Impact on Rail Capacity
	• Reduce all rail, bus, active GJT by 30% • Increase road capacity by 20%	

Base Case – 2050

7.57 Figure 7.13 shows that by 2050, large sections of the network are expected to be operating in excess of total seated capacity across the day, particularly on radial routes into London from Dartford, Ashford, Gatwick, Slough and Oxford. High passenger demands are also noted along the south coast between Havant and Worthing and between Reading and Guildford.

London Hub

7.58 Figure 7.14 shows that for the London Hub scenario, the main difference between the 2050 Base is a worsening of conditions on south coast routes.

Digital Future

7.59 Figure 7.15 shows that the Digital Future scenario predicts an increase in rail passenger demand by 2050, above Base 2050 levels. Increased congestion is expected on south coast routes to the east of Lewes and west of Havant with further worsening of conditions on Kent lines and through Tonbridge and Sevenoaks. Passenger numbers are expected to exceed seated capacity by more than 150% across most of the key rail network.

Our Route to Growth

7.60 Figure 7.16 shows that the Our Route to Growth scenario has a very similar effect on the rail network as shown in the Digital Future results. Again, we see an increase in rail passenger demand by 2050, above Base 2050 levels and passenger numbers are expected to exceed seated capacity by more than 150% across most of the key rail network.

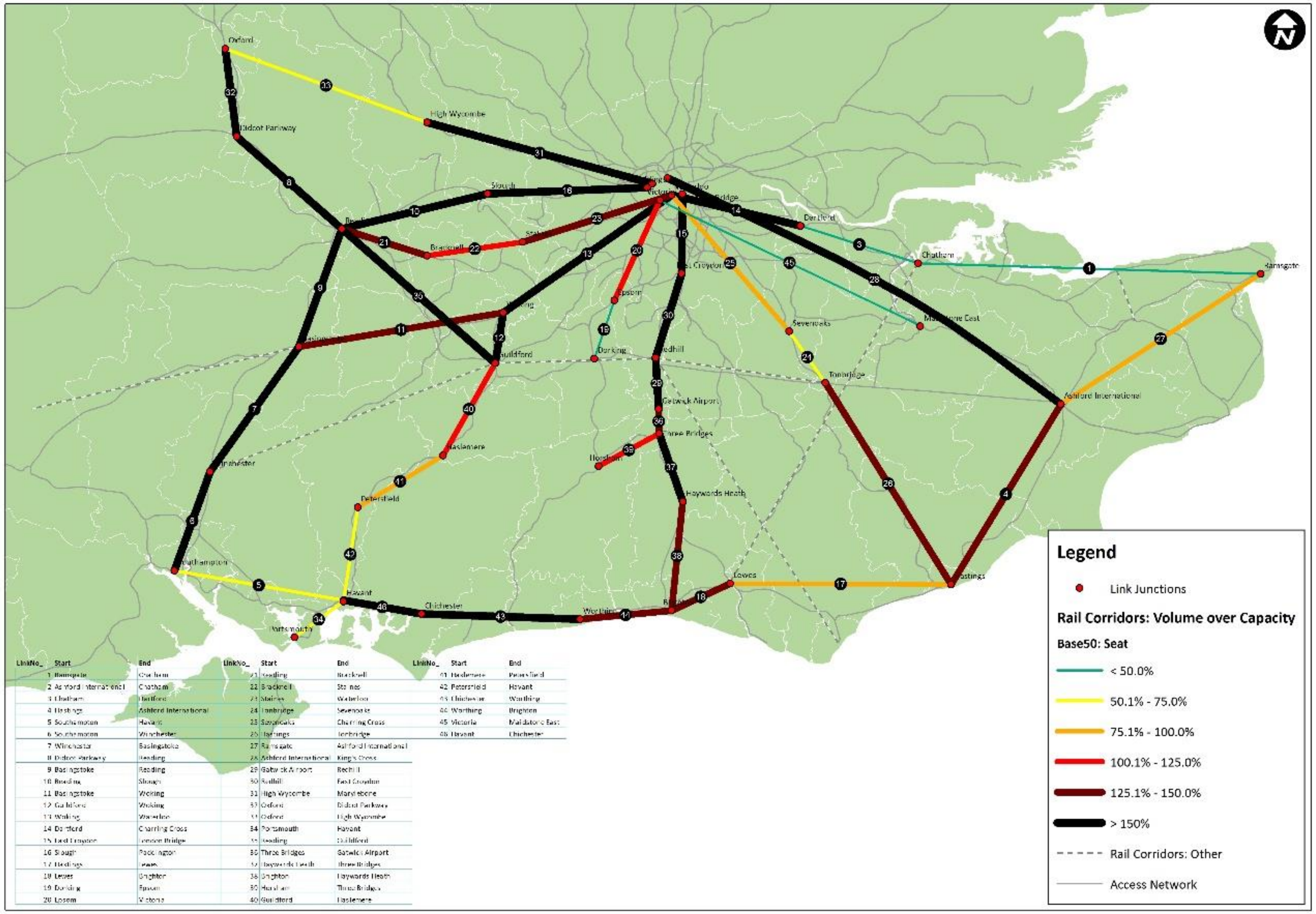
Sustainable Future

7.61 Figure 7.17 shows that the Sustainable Future scenario sees the greatest switch between road and rail and the largest impact on rail V/C calculations. Demand for most of the network will exceed seated capacity by more than 150% with only small sections of the key rail network near Chatham and Dorking operating at less than 75% of capacity.

Sustainable Route to Growth

7.62 The Sustainable Route to Growth scenario results in an increase in rail passenger demand with greater congestion than the Base Case across much of the network, and in particular along south coast routes.

Figure 7.13: Base Case – 2050 – V/C Rail



LinkNo_	Start	End
1	Ramsgate	Chatham
2	Ashford International	Chatham
3	Chatham	Dartford
4	Hastings	Ashford International
5	Southampton	Havant
6	Southampton	Winchester
7	Winchester	Basingstoke
8	Didcot Parkway	Reading
9	Basingstoke	Reading
10	Reading	Slough
11	Basingstoke	Woking
12	Guildford	Woking
13	Woking	Waterloo
14	Dartford	Charring Cross
15	East Croydon	London Bridge
16	Slough	Paddington
17	Hastings	Lewes
18	Lewes	Brighton
19	Dorking	Epsom
20	Epsom	Victoria
21	Reading	Bracknell
22	Bracknell	Staines
23	Staines	Waterloo
24	Tonbridge	Sevenoaks
25	Sevenoaks	Charring Cross
26	Hastings	Tonbridge
27	Ramsgate	Ashford International
28	Ashford International	King's Cross
29	Gatwick Airport	Redhill
30	Redhill	East Croydon
31	High Wycombe	Marylebone
32	Oxford	Didcot Parkway
33	Oxford	High Wycombe
34	Portsmouth	Havant
35	Reading	Guildford
36	Three Bridges	Gatwick Airport
37	Haywards Heath	Three Bridges
38	Brighton	Haywards Heath
39	Horsham	Three Bridges
40	Guildford	Haslemere
41	Haslemere	Petersfield
42	Petersfield	Havant
43	Chichester	Worthing
44	Worthing	Brighton
45	Victoria	Maidstone East
46	Havant	Chichester

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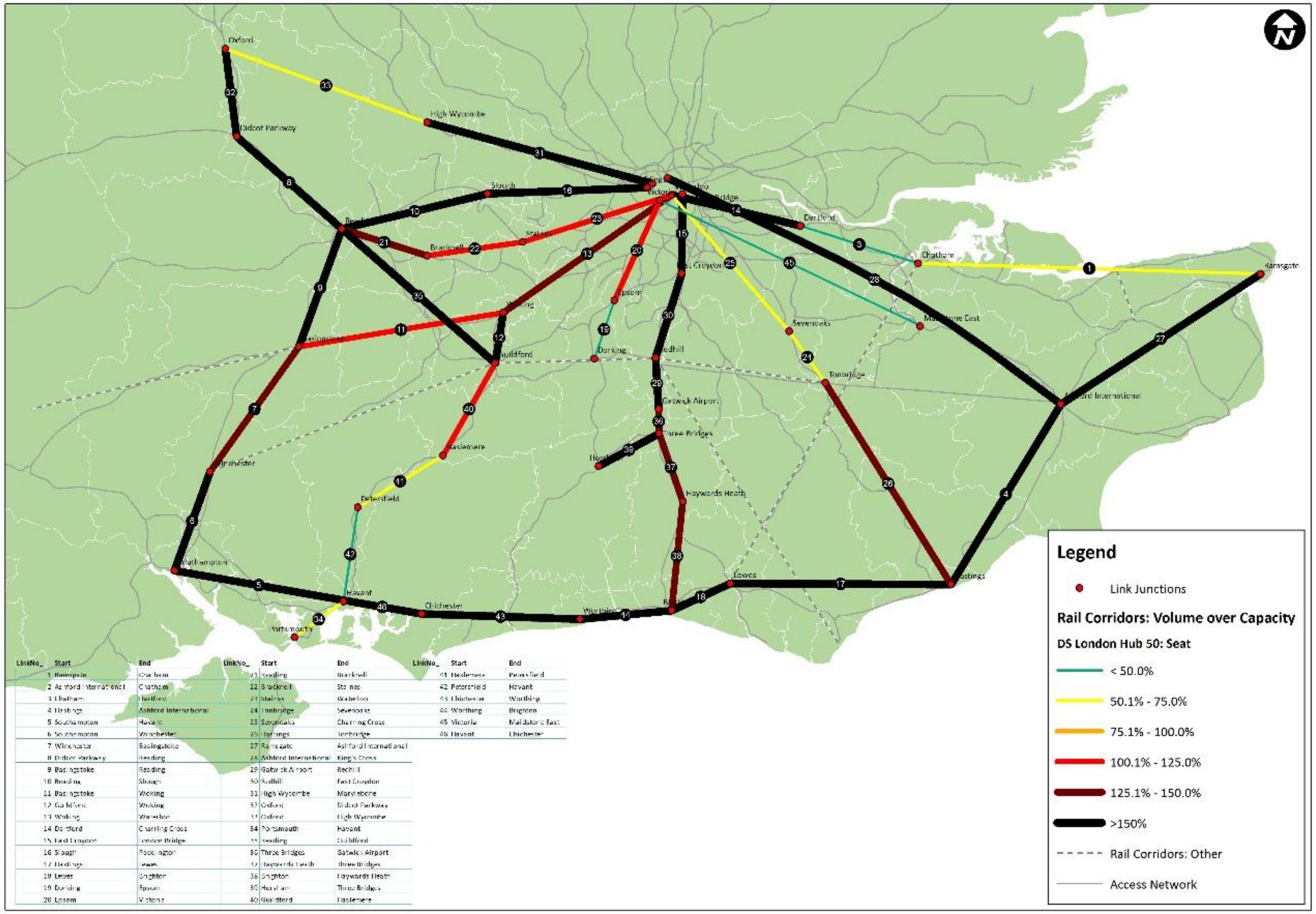
Figure 7.14: London Hub – 2050 – V/C Rail



LinkNo_	Start	End
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2	Ashford International	Chatham
3	Chatham	Dartford
4	Hastings	Ashford International
5	Southampton	Havant
6	Southampton	Winchester
7	Winchester	Basingstoke
8	Didcot Parkway	Reading
9	Basingstoke	Reading
10	Reading	Slough
11	Basingstoke	Woking
12	Guildford	Woking
13	Woking	Waterloo
14	Dartford	Charring Cross
15	East Croydon	London Bridge
16	Slough	Paddington
17	Hastings	Lewes
18	Lewes	Brighton
19	Dorking	Epsom
20	Epsom	Victoria
21	Reading	Bracknell
22	Bracknell	Staines
23	Staines	Waterloo
24	Tonbridge	Sevenoaks
25	Sevenoaks	Charring Cross
26	Hastings	Tonbridge
27	Ramsgate	Ashford International
28	Ashford International	King's Cross
29	Gatwick Airport	Redhill
30	Redhill	East Croydon
31	High Wycombe	Marylebone
32	Oxford	Didcot Parkway
33	Oxford	High Wycombe
34	Portsmouth	Havant
35	Reading	Guildford
36	Three Bridges	Gatwick Airport
37	Haywards Heath	Three Bridges
38	Brighton	Haywards Heath
39	Horsham	Three Bridges
40	Guildford	Haslemere
41	Haslemere	Petersfield
42	Petersfield	Havant
43	Chichester	Worthing
44	Worthing	Brighton
45	Victoria	Maidstone East
46	Havant	Chichester

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Figure 7.15: Digital Future – 2050 – V/C Rail

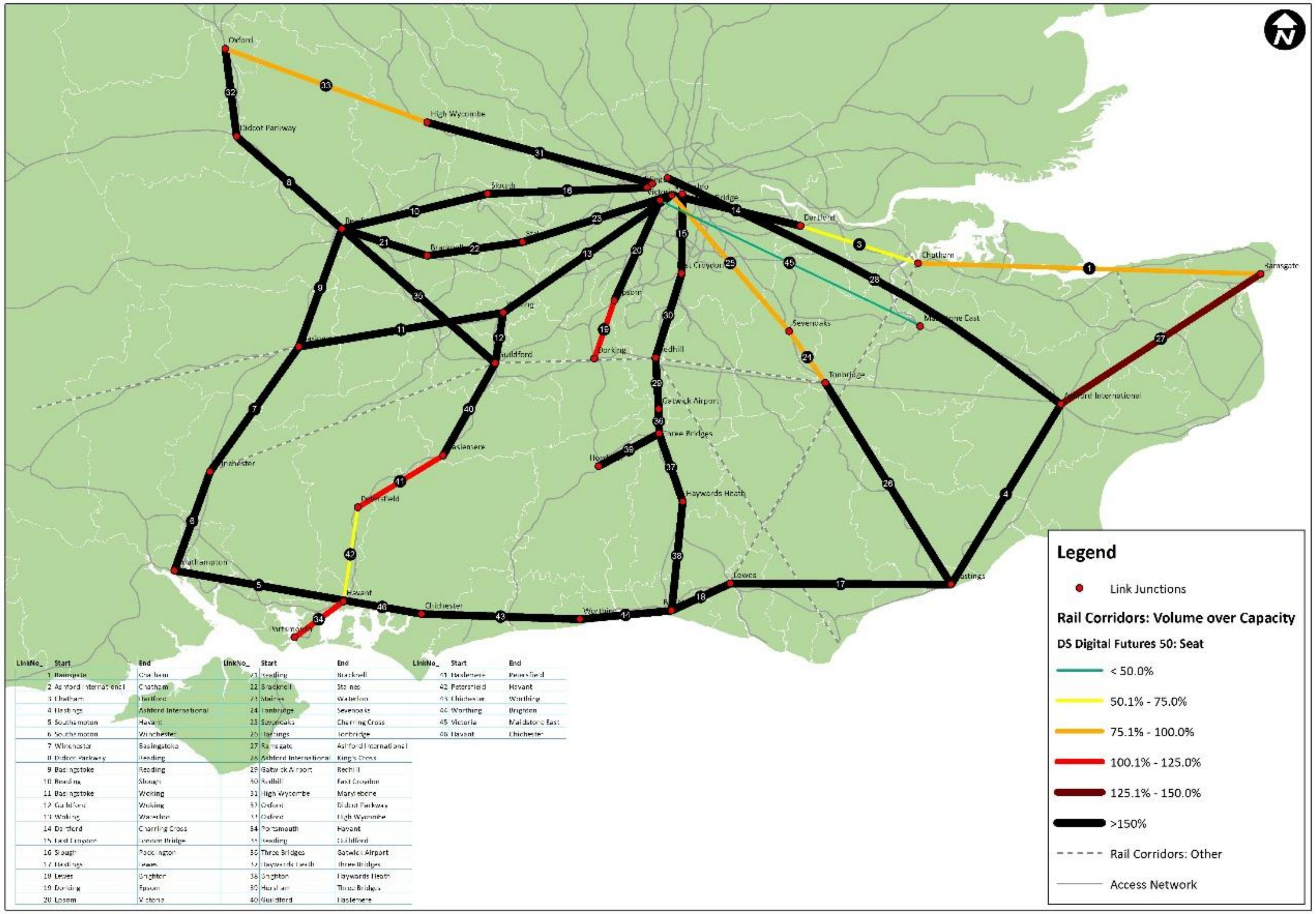

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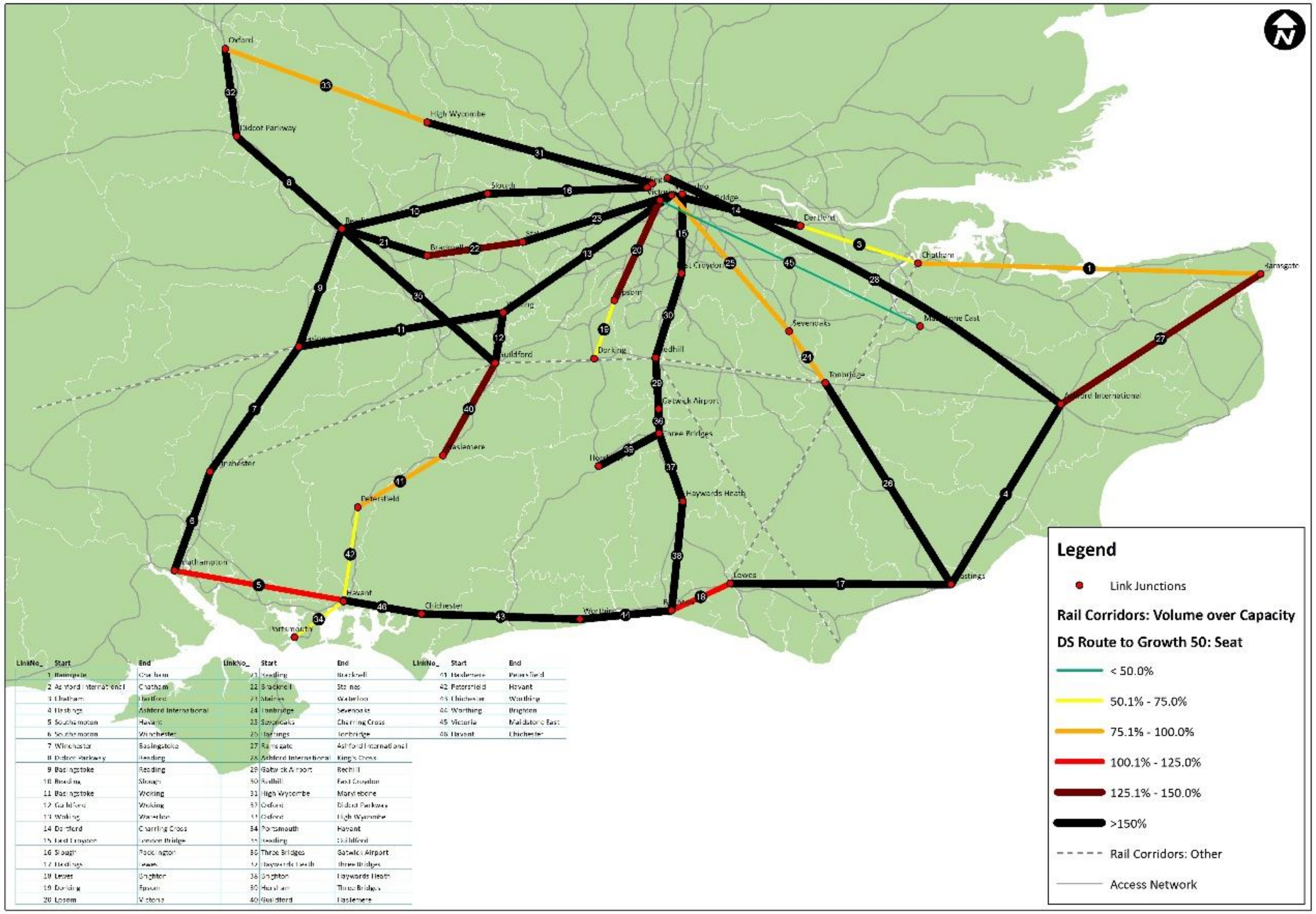
Figure 7.16: Our Route to Growth – 2050 – V/C Rail



LinkNo_	Start	End
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3	Chatham	Dartford
4	Hastings	Ashford International
5	Southampton	Havant
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7	Winchester	Basingstoke
8	Didcot Parkway	Reading
9	Basingstoke	Reading
10	Reading	Slough
11	Basingstoke	Woking
12	Guildford	Woking
13	Woking	Waterloo
14	Dartford	Charring Cross
15	East Croydon	London Bridge
16	Slough	Paddington
17	Hastings	Lewes
18	Lewes	Brighton
19	Dorking	Epsom
20	Epsom	Victoria
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38	Brighton	Haywards Heath
39	Horsham	Three Bridges
40	Guildford	Haslemere
41	Haslemere	Petersfield
42	Petersfield	Havant
43	Chichester	Worthing
44	Worthing	Brighton
45	Victoria	Maidstone East
46	Havant	Chichester

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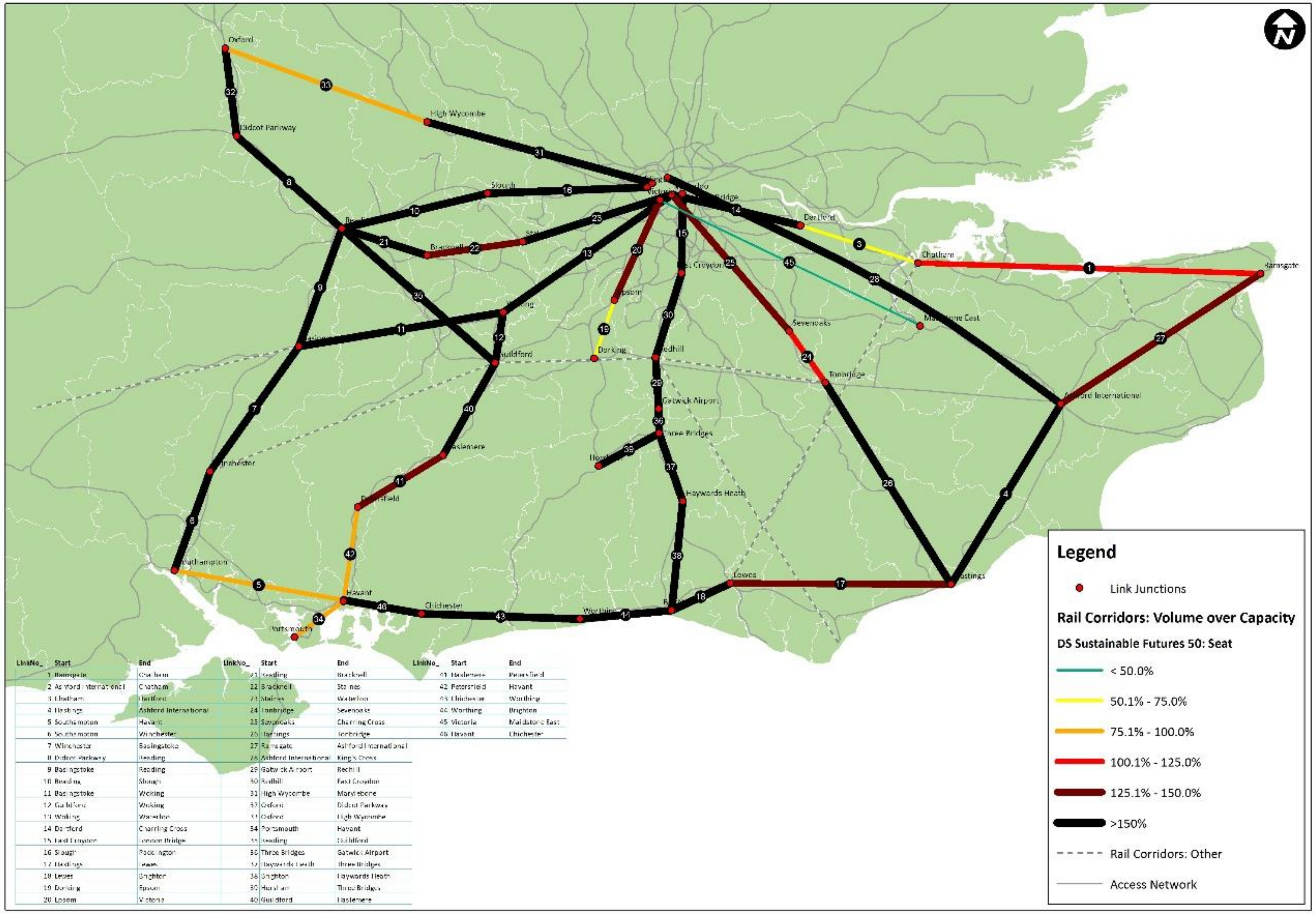
Figure 7.17: Sustainable Future – 2050 – V/C Rail



LinkNo_	Start	End	LinkNo_	Start	End	LinkNo_	Start	End
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3	Chatham	Dartford	23	Staines	Waterloo	43	Chichester	Worthing
4	Hastings	Ashford International	24	Tonbridge	Sevenoaks	44	Worthing	Brighton
5	Southampton	Havant	25	Sevenoaks	Charring Cross	45	Victoria	Maidstone East
6	Southampton	Winchester	26	Hastings	Tonbridge	46	Havant	Chichester
7	Winchester	Basingstoke	27	Ramsgate	Ashford International			
8	Didcot Parkway	Reading	28	Ashford International	King's Cross			
9	Basingstoke	Reading	29	Gatwick Airport	Redhill			
10	Reading	Slough	30	Redhill	East Croydon			
11	Basingstoke	Woking	31	High Wycombe	Marylebone			
12	Guildford	Woking	32	Oxford	Didcot Parkway			
13	Woking	Waterloo	33	Oxford	High Wycombe			
14	Dartford	Charring Cross	34	Portsmouth	Havant			
15	East Croydon	London Bridge	35	Reading	Guildford			
16	Slough	Paddington	36	Three Bridges	Gatwick Airport			
17	Hastings	Lewes	37	Haywards Heath	Three Bridges			
18	Lewes	Brighton	38	Brighton	Haywards Heath			
19	Dorking	Epsom	39	Horsham	Three Bridges			
20	Epsom	Victoria	40	Guildford	Haslemere			

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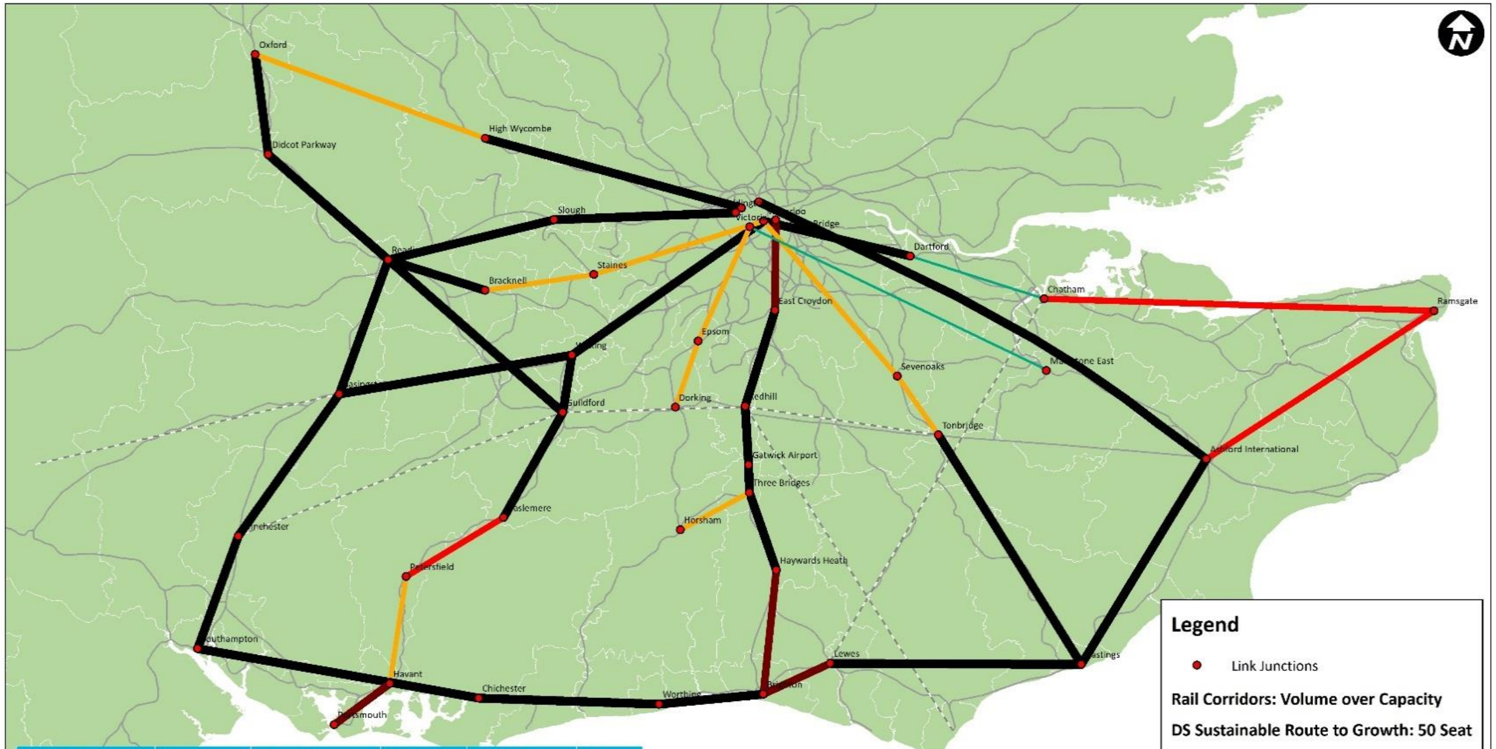
Figure 7.18: Sustainable Route to Growth – 2050 – V/C Rail



LinkNo_	Start	End	LinkNo_	Start	End	LinkNo_	Start	End
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9	Basingstoke	Reading	29	Gatwick Airport	Redhill			
10	Reading	Slough	30	Redhill	East Croydon			
11	Basingstoke	Woking	31	High Wycombe	Marylebone			
12	Guildford	Woking	32	Oxford	Didcot Parkway			
13	Woking	Waterloo	33	Oxford	High Wycombe			
14	Dartford	Charring Cross	34	Portsmouth	Havant			
15	East Croydon	London Bridge	35	Reading	Guildford			
16	Slough	Paddington	36	Three Bridges	Gatwick Airport			
17	Hastings	Lewes	37	Haywards Heath	Three Bridges			
18	Lewes	Brighton	38	Brighton	Haywards Heath			
19	Dorking	Epsom	39	Horsham	Three Bridges			
20	Epsom	Victoria	40	Guildford	Haslemere			

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8 Concluding Remarks

8.1 This report has described how the South East Economy and Land Use Model, SEELUM was built. It describes the primary data sources used, and the process of building the model, and the construction of a Do-Minimum baseline against which scenario tests were then compared.

8.2 It reports the work done to calibrate the model against the Census Travel to Work data and against information taken from NTEM (TEMPRO 7.2). The model generates trip matrices, by mode, for travel-to-work, other home-based trips and business to business (B2B); the report shows that a good match has been obtained against these empirical sources.

8.3 A series of tests was run to demonstrate how the model responds to marginal changes in travel times and costs and the implied elasticities of travel demand and of employment compared to empirical evidence. The model's performance matched empirical evidence well.

8.4 The report also describes how a Do-Minimum baseline was set up incorporating NTEM growth in population and employment, and future trend changes in costs, congestion and values of time.

8.5 In an 'unconstrained' test in which costs and congestion were held fixed, across the South East, SEELUM achieved 13% growth in population, compared to NTEM's 18%, and 14% growth in jobs compared to NTEM's projected growth of 11%. This occurs because NTEM predicts a larger growth in population (18%) than in employment (11%). The result is that the model cannot reproduce NTEM exactly but reaches a position of balance between population (or, more accurately, the workforce) and employment.

8.6 A 'constrained' run then allows costs and congestion to rise, leading to a moderate suppression of employment growth. This constrained run is the baseline to which Do-Minimum schemes have been added.

8.7 The 'gap' in employment between the constrained and unconstrained runs is a soft target for growth that can be recovered by targeted investment in transport, the argument being that the growth projected, will not be achieved without new investment in transport because of rising costs and congestion. It is a 'soft' target because with additional, targeted measures, particularly land use changes that can amplify the effect of transport alone, it is possible to exceed the target.

8.8 To that end, scenario tests were conducted that consisted of combinations of background growth forecasts and supporting transport interventions. Table 8.1 provides a summary of the results in terms of changes between 2018 and 2050.

8.9 An initial round of quantitative testing of the first four scenarios in the SEELUM model showed that the Our Route to Growth scenario resulted in the greatest change in GVA. Subsequently, a fifth preferred scenario – Sustainable Route to Growth - was developed that combined the positive aspects of both the Our Route to Growth and the Sustainable Future Scenarios.

Table 8.1: Summary of changes in trips and GVA per scenario for 2018 to 2050

Scenario	Trip Growth from 2018 to 2050						GVA in 2050	GVA Growth 2018-2050
	Within TfSE	TfSE to London	London to TfSE	TfSE to Other	Other to TfSE	Total TfSE		
Base Case	11%	22%	24%	29%	42%	15%	£399bn	119%
London Hub	22%	49%	49%	32%	54%	28%	£430bn	136%
Digital Future	5%	50%	80%	43%	75%	16%	£411bn	125%
Our Route to Growth	15%	50%	108%	49%	99%	27%	£481bn	164%
Sustainable Future	12%	4%	10%	6%	3%	11%	£404bn	121%
Sustainable Route to Growth	15%	23%	83%	11%	47%	19%	£458bn	151%

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Appendices

A Employer Classes

Employer Classes

A.1 The table below provides details of the assumed correspondence between 2007 Standard Industry Classification of Economic Activities (SIC) and SEELUM employer classes.

Table A.1: Correspondence of 2007 SIC codes to employer classes

SIC Section Code	SIC Section Name	SIC Division Code	SIC Division Name	Final Categorisation
A	AGRICULTURE, FORESTRY AND FISHING	01	Crop and animal production, hunting and related service activities	Primary
A	AGRICULTURE, FORESTRY AND FISHING	02	Forestry and logging	Primary
A	AGRICULTURE, FORESTRY AND FISHING	03	Fishing and aquaculture	Primary
B	MINING AND QUARRYING	05	Mining of coal and lignite	Primary
B	MINING AND QUARRYING	06	Extraction of crude petroleum and natural gas	Primary
B	MINING AND QUARRYING	07	Mining of metal ores	Primary
B	MINING AND QUARRYING	08	Other mining and quarrying	Primary
B	MINING AND QUARRYING	09	Mining support service activities	Primary
C	MANUFACTURING	10	Manufacture of food products	Other Industry and Manufacturing
C	MANUFACTURING	11	Manufacture of beverages	Other Industry and Manufacturing
C	MANUFACTURING	12	Manufacture of tobacco products	Other Industry and Manufacturing
C	MANUFACTURING	13	Manufacture of textiles	Other Industry and Manufacturing
C	MANUFACTURING	14	Manufacture of wearing apparel	Other Industry and Manufacturing
C	MANUFACTURING	15	Manufacture of leather and related products	Other Industry and Manufacturing
C	MANUFACTURING	16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	Other Industry and Manufacturing
C	MANUFACTURING	17	Manufacture of paper and paper products	Other Industry and Manufacturing
C	MANUFACTURING	18	Printing and reproduction of recorded media	Other Industry and Manufacturing
C	MANUFACTURING	19	Manufacture of coke and refined petroleum products	Other Industry and Manufacturing
C	MANUFACTURING	20	Manufacture of chemicals and chemical products	Advanced Manufacturing

SIC Section Code	SIC Section Name	SIC Division Code	SIC Division Name	Final Categorisation
C	MANUFACTURING	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Advanced Manufacturing
C	MANUFACTURING	22	Manufacture of rubber and plastic products	Other Industry and Manufacturing
C	MANUFACTURING	23	Manufacture of other non-metallic mineral products	Other Industry and Manufacturing
C	MANUFACTURING	24	Manufacture of basic metals	Other Industry and Manufacturing
C	MANUFACTURING	25	Manufacture of fabricated metal products, except machinery and equipment	Other Industry and Manufacturing
C	MANUFACTURING	26	Manufacture of computer, electronic and optical products	Advanced Manufacturing
C	MANUFACTURING	27	Manufacture of electrical equipment	Other Industry and Manufacturing
C	MANUFACTURING	28	Manufacture of machinery and equipment n.e.c.	Advanced Manufacturing
C	MANUFACTURING	29	Manufacture of motor vehicles, trailers and semi-trailers	Advanced Manufacturing
C	MANUFACTURING	30	Manufacture of other transport equipment	Advanced Manufacturing
C	MANUFACTURING	31	Manufacture of furniture	Other Industry and Manufacturing
C	MANUFACTURING	32	Other manufacturing	Other Industry and Manufacturing
C	MANUFACTURING	33	Repair and installation of machinery and equipment	Other Industry and Manufacturing
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	35	Electricity, gas, steam and air conditioning supply	Primary
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	36	Water collection, treatment and supply	Primary
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	37	Sewerage	Primary
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	38	Waste collection, treatment and disposal activities; materials recovery	Primary
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	39	Remediation activities and other waste management services.	Primary
F	CONSTRUCTION	41	Construction of buildings	Primary

SIC Section Code	SIC Section Name	SIC Division Code	SIC Division Name	Final Categorisation
F	CONSTRUCTION	42	Civil engineering	Primary
F	CONSTRUCTION	43	Specialised construction activities	Primary
G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	45	Wholesale and retail trade and repair of motor vehicles and motorcycles	Retail and Catering
G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	46	Wholesale trade, except of motor vehicles and motorcycles	Retail and Catering
G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	47	Retail trade, except of motor vehicles and motorcycles	Retail and Catering
H	TRANSPORTATION AND STORAGE	49	Land transport and transport via pipelines	Other Services
H	TRANSPORTATION AND STORAGE	50	Water transport	Other Services
H	TRANSPORTATION AND STORAGE	51	Air transport	Other Services
H	TRANSPORTATION AND STORAGE	52	Warehousing and support activities for transportation	Other Services
H	TRANSPORTATION AND STORAGE	53	Postal and courier activities	Other Services
I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	55	Accommodation	Retail and Catering
I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	56	Food and beverage service activities	Retail and Catering
J	INFORMATION AND COMMUNICATION	58	Publishing activities	Knowledge Service Sectors
J	INFORMATION AND COMMUNICATION	59	Motion picture, video and television programme production, sound recording and music publishing activities	Knowledge Service Sectors
J	INFORMATION AND COMMUNICATION	60	Programming and broadcasting activities	Other Services
J	INFORMATION AND COMMUNICATION	61	Telecommunications	Knowledge Service Sectors
J	INFORMATION AND COMMUNICATION	62	Computer programming, consultancy and related activities	Knowledge Service Sectors
J	INFORMATION AND COMMUNICATION	63	Information service activities	Knowledge Service Sectors
K	FINANCIAL AND INSURANCE ACTIVITIES	64	Financial service activities, except insurance and pension funding	Finance and Business
K	FINANCIAL AND INSURANCE ACTIVITIES	65	Insurance, reinsurance and pension funding, except compulsory social security	Finance and Business

SIC Section Code	SIC Section Name	SIC Division Code	SIC Division Name	Final Categorisation
K	FINANCIAL AND INSURANCE ACTIVITIES	66	Activities auxiliary to financial services and insurance activities	Finance and Business
L	REAL ESTATE ACTIVITIES	68	Real estate activities	Finance and Business
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	69	Legal and accounting activities	Finance and Business
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	70	Activities of head offices; management consultancy activities	Finance and Business
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	71	Architectural and engineering activities; technical testing and analysis	Knowledge Service Sectors
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	72	Scientific research and development	Knowledge Service Sectors
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	73	Advertising and market research	Knowledge Service Sectors
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	74	Other professional, scientific and technical activities	Knowledge Service Sectors
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	75	Veterinary activities	Knowledge Service Sectors
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	77	Rental and leasing activities	Finance and Business
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	78	Employment activities	Finance and Business
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	79	Travel agency, tour operator and other reservation service and related activities	Retail and Catering
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	80	Security and investigation activities	Other Services
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	81	Services to buildings and landscape activities	Other Services
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	82	Office administrative, office support and other business support activities	Finance and Business
O	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	84	Public administration and defence; compulsory social security	Other Services
P	EDUCATION	85	Education	Education
Q	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	86	Human health activities	Other Services
Q	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	87	Residential care activities	Other Services
Q	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	88	Social work activities without accommodation	Other Services

SIC Section Code	SIC Section Name	SIC Division Code	SIC Division Name	Final Categorisation
R	ARTS, ENTERTAINMENT AND RECREATION	90	Creative, arts and entertainment activities	Knowledge Service Sectors
R	ARTS, ENTERTAINMENT AND RECREATION	91	Libraries, archives, museums and other cultural activities	Knowledge Service Sectors
R	ARTS, ENTERTAINMENT AND RECREATION	92	Gambling and betting activities	Retail and Catering
R	ARTS, ENTERTAINMENT AND RECREATION	93	Sports activities and amusement and recreation activities	Retail and Catering
S	OTHER SERVICE ACTIVITIES	94	Activities of membership organisations	Other Services
S	OTHER SERVICE ACTIVITIES	95	Repair of computers and personal and household goods	Other Services
S	OTHER SERVICE ACTIVITIES	96	Other personal service activities	Other Services
T	ACTIVITIES OF HOUSEHOLDS AS EMPLOYERS; UNDIFFERENTIATED GOODS-AND SERVICES-PRODUCING ACTIVITIES OF HOUSEHOLDS FOR OWN USE	97	Activities of households as employers of domestic personnel	Other Services
T	ACTIVITIES OF HOUSEHOLDS AS EMPLOYERS; UNDIFFERENTIATED GOODS-AND SERVICES-PRODUCING ACTIVITIES OF HOUSEHOLDS FOR OWN USE	98	Undifferentiated goods- and services-producing activities of private households for own use	Other Services
U	ACTIVITIES OF EXTRATERRITORIAL ORGANISATIONS AND BODIES	99	Activities of extraterritorial organisations and bodies	Other Services

B District Level Comparisons Between SEELUM and Census

Table B.1: Comparison of model demand to census travel to work demand

Origin District	Census TTW Demand					Model TTW Demand				
	Car	Bus	Rail	Walk & Cycle	Total	Car	Bus	Rail	Walk & Cycle	Walk & Cycle
Adur	22490	1165	1804	4295	29754	17928	3816	2062	2428	26236
Arun	53163	1966	2917	10526	68572	48723	4189	3373	6399	62685
Ashford	56984	1720	2420	8656	69780	45432	2008	1619	7581	56640
Basingstoke and Deane	82126	3818	4047	11373	101364	63314	7340	4611	9394	84660
Bracknell Forest	56480	3384	2556	7569	69989	46631	2909	2578	5883	58001
Brighton and Hove	94462	7879	23263	36943	162547	65680	8226	17317	42642	133865
Canterbury	63928	2262	5156	13898	85244	46959	206	5987	11934	65086
Chichester	53491	1842	2054	7706	65093	36866	2168	2047	7106	48187
Chiltern	37636	1753	1148	4552	45089	31350	4359	1381	3467	40557
Crawley	61426	3820	5035	8355	78636	33936	6067	5733	5787	51523
Dartford	46292	8297	5139	4837	64565	34734	6666	928	2771	45100
Dover	45965	1412	2660	8785	58822	39369	6070	3218	4041	52698
East Hampshire	49429	1544	1566	6757	59296	45472	2692	1830	5257	55252
Eastbourne	41150	1836	3272	8968	55226	28113	3109	3156	8086	42463
Eastleigh	59833	2669	3221	8258	73981	47461	2237	4457	6698	60853
Elmbridge	49523	10181	3006	5968	68678	42699	11695	357	4186	58938
Epsom and Ewell	27112	6757	2576	4132	40577	25681	7917	1209	2321	37127
Fareham	48434	2162	2845	7124	60565	39429	2079	4881	4195	50585
Gosport	27522	1259	2672	6884	38337	25646	1551	2874	5840	35911
Gravesham	33122	6722	3201	5198	48243	34467	5128	966	2372	42933
Guildford	67383	6341	3197	10338	87259	47137	6941	4234	9247	67559
Hart	42259	1888	1083	4880	50110	34949	3056	2423	3334	43762
Hastings	33481	1400	2891	7864	45636	24675	1590	3182	6239	35686
Havant	46022	2196	3805	7805	59828	42003	4887	3366	2939	53195
Horsham	59221	1601	1785	7186	69793	46828	6493	2583	6388	62292
Isle of Wight	50681	1365	3637	11971	67654	37937	151	3759	11866	53713
Lewes	37659	1428	2156	7051	48294	31919	3240	2621	3836	41616
Maidstone	77276	2360	4109	11644	95389	59493	5739	4587	8064	77882
Medway	111644	4059	6845	20722	143270	94403	5476	8486	11893	120258
Mid Sussex	62841	2587	2235	9302	76965	44001	7876	3282	8250	63409
Milton Keynes	143991	4034	8543	19664	176232	86902	26099	12585	5702	131288
Mole Valley	39893	4488	1581	4784	50746	27771	5946	1848	4429	39993

Origin District	Census TTW Demand					Model TTW Demand				
	Car	Bus	Rail	Walk & Cycle	Total	Car	Bus	Rail	Walk & Cycle	Walk & Cycle
New Forest	71721	2073	2652	10027	86473	57961	4854	1266	5475	69556
Portsmouth	79096	5831	12396	23908	121231	66461	5653	7632	14065	93812
Reading	66258	10214	10322	17153	103947	45514	6072	8296	17222	77104
Reigate and Banstead	62510	6398	3581	8170	80659	43614	10886	3288	6192	63981
Rother	32269	1088	1309	4775	39441	25102	3647	1179	3694	33622
Rushmoor	47328	2733	2204	7597	59862	33262	3733	3114	6963	47073
Sevenoaks	50088	1624	1570	6167	59449	36480	10477	481	2615	50053
Shepway	44134	1260	2910	8267	56571	37981	6885	1953	2720	49539
Slough	66535	5003	4445	10543	86526	44350	9522	4364	8659	66895
South Bucks	31523	1857	1093	3256	37729	24908	4776	681	1358	31723
South Oxfordshire	60719	2040	2086	9070	73915	52403	3295	1137	9754	66589
Southampton	91244	6690	14811	23938	136683	70672	1932	11712	22710	107026
Spelthorne	35028	9427	3300	3952	51707	30900	7633	922	2387	41842
Surrey Heath	41943	2424	1636	4787	50790	34150	1961	2703	3112	41925
Swale	56338	1782	1936	10011	70067	43682	8482	619	6554	59338
Tandridge	34244	3384	1790	3610	43028	28299	7012	684	2438	38434
Test Valley	55057	1545	2060	7502	66164	47255	3796	2554	3829	57434
Thanet	48744	1736	4440	11489	66409	41049	6282	3925	4872	56129
Tonbridge and Malling	60705	1856	1968	7687	72216	46848	4267	3908	4404	59427
Tunbridge Wells	53301	1907	2477	9350	67035	36313	7841	2598	7599	54352
Vale of White Horse	58362	1810	2406	8856	71434	53025	4408	1826	5687	64947
Waverley	52279	2545	1516	6932	63272	41200	5376	3101	5219	54896
Wealden	57707	1217	1609	6929	67462	49830	5448	1697	4830	61805
West Berkshire	79077	3417	2959	9814	95267	57195	4012	3068	8828	73102
Winchester	60657	3524	3210	8003	75394	38652	1785	4946	8357	53739
Windsor and Maidenhead	69102	6405	2487	8931	86925	48160	9784	2449	8223	68617
Woking	36125	10844	2668	4881	54518	30631	9062	2583	5697	47973
Wokingham	71176	4632	3410	8743	87961	59671	6235	4048	9542	79496
Worthing	42734	2265	3402	9498	57899	30893	3721	3463	7965	46042
Wycombe	78620	2837	3574	10528	95559	55587	7585	5181	8254	76607

Table B.2: Comparison of model mode share to census travel to work mode share

Origin District	Model Mode Share				Census Mode Share			
	Car	Bus	Rail	Walk & Cycle	Car	Bus	Rail	Walk & Cycle
Adur	76%	4%	6%	14%	68%	15%	8%	9%
Arun	78%	3%	4%	15%	78%	7%	5%	10%
Ashford	82%	2%	3%	12%	80%	4%	3%	13%
Basingstoke and Deane	81%	4%	4%	11%	75%	9%	5%	11%
Bracknell Forest	81%	5%	4%	11%	80%	5%	4%	10%
Brighton and Hove	58%	5%	14%	23%	49%	6%	13%	32%
Canterbury	75%	3%	6%	16%	72%	0%	9%	18%
Chichester	82%	3%	3%	12%	77%	4%	4%	15%
Chiltern	83%	4%	3%	10%	77%	11%	3%	9%
Crawley	78%	5%	6%	11%	66%	12%	11%	11%
Dartford	72%	13%	8%	7%	77%	15%	2%	6%
Dover	78%	2%	5%	15%	75%	12%	6%	8%
East Hampshire	83%	3%	3%	11%	82%	5%	3%	10%
Eastbourne	75%	3%	6%	16%	66%	7%	7%	19%
Eastleigh	81%	4%	4%	11%	78%	4%	7%	11%
Elmbridge	72%	15%	4%	9%	72%	20%	1%	7%
Epsom and Ewell	67%	17%	6%	10%	69%	21%	3%	6%
Fareham	80%	4%	5%	12%	78%	4%	10%	8%
Gosport	72%	3%	7%	18%	71%	4%	8%	16%
Gravesham	69%	14%	7%	11%	80%	12%	2%	6%
Guildford	77%	7%	4%	12%	70%	10%	6%	14%
Hart	84%	4%	2%	10%	80%	7%	6%	8%
Hastings	73%	3%	6%	17%	69%	4%	9%	17%
Havant	77%	4%	6%	13%	79%	9%	6%	6%
Horsham	85%	2%	3%	10%	75%	10%	4%	10%
Isle of Wight	75%	2%	5%	18%	71%	0%	7%	22%
Lewes	78%	3%	4%	15%	77%	8%	6%	9%
Maidstone	81%	2%	4%	12%	76%	7%	6%	10%
Medway	78%	3%	5%	14%	79%	5%	7%	10%
Mid Sussex	82%	3%	3%	12%	69%	12%	5%	13%
Milton Keynes	82%	2%	5%	11%	66%	20%	10%	4%
Mole Valley	79%	9%	3%	9%	69%	15%	5%	11%

Origin District	Model Mode Share				Census Mode Share			
	Car	Bus	Rail	Walk & Cycle	Car	Bus	Rail	Walk & Cycle
New Forest	83%	2%	3%	12%	83%	7%	2%	8%
Portsmouth	65%	5%	10%	20%	71%	6%	8%	15%
Reading	64%	10%	10%	17%	59%	8%	11%	22%
Reigate and Banstead	77%	8%	4%	10%	68%	17%	5%	10%
Rother	82%	3%	3%	12%	75%	11%	4%	11%
Rushmoor	79%	5%	4%	13%	71%	8%	7%	15%
Sevenoaks	84%	3%	3%	10%	73%	21%	1%	5%
Shepway	78%	2%	5%	15%	77%	14%	4%	5%
Slough	77%	6%	5%	12%	66%	14%	7%	13%
South Bucks	84%	5%	3%	9%	79%	15%	2%	4%
South Oxfordshire	82%	3%	3%	12%	79%	5%	2%	15%
Southampton	67%	5%	11%	18%	66%	2%	11%	21%
Spelthorne	68%	18%	6%	8%	74%	18%	2%	6%
Surrey Heath	83%	5%	3%	9%	81%	5%	6%	7%
Swale	80%	3%	3%	14%	74%	14%	1%	11%
Tandridge	80%	8%	4%	8%	74%	18%	2%	6%
Test Valley	83%	2%	3%	11%	82%	7%	4%	7%
Thanet	73%	3%	7%	17%	73%	11%	7%	9%
Tonbridge and Malling	84%	3%	3%	11%	79%	7%	7%	7%
Tunbridge Wells	80%	3%	4%	14%	67%	14%	5%	14%
Vale of White Horse	82%	3%	3%	12%	82%	7%	3%	9%
Waverley	83%	4%	2%	11%	75%	10%	6%	10%
Wealden	86%	2%	2%	10%	81%	9%	3%	8%
West Berkshire	83%	4%	3%	10%	78%	5%	4%	12%
Winchester	80%	5%	4%	11%	72%	3%	9%	16%
Windsor and Maidenhead	79%	7%	3%	10%	70%	14%	4%	12%
Woking	66%	20%	5%	9%	64%	19%	5%	12%
Wokingham	81%	5%	4%	10%	75%	8%	5%	12%
Worthing	74%	4%	6%	16%	67%	8%	8%	17%
Wycombe	82%	3%	4%	11%	73%	10%	7%	11%

C District Level Comparisons Between SEELUM and NTEM

Table C.1: Trips originating in each district by purpose, by mode

	SEELUM				NTEM				Comparison (SEELUM /NTEM)			
District	**TTW**	**Other**	**B2B**	**Total**	**TTW**	**Other**	**B2B**	**Total**	**TTW**	**Other**	**B2B**	**Total**
Adur	27,036	113,085	5,750	145,871	29,754	101,416	5,433	136,603	91%	112%	106%	107%
Arun	64,041	265,959	11,963	341,962	68,572	268,379	12,620	349,571	93%	99%	95%	98%
Ashford	57,246	255,615	13,874	326,735	69,780	231,989	14,331	316,100	82%	110%	97%	103%
Basingstoke and Deane	91,007	360,670	20,131	471,808	101,364	330,658	20,447	452,469	90%	109%	98%	104%
Bracknell Forest	61,034	246,257	15,354	322,645	69,989	204,131	13,980	288,100	87%	121%	110%	112%
Brighton and Hove	136,697	607,227	30,834	774,758	162,547	542,663	23,289	728,499	84%	112%	132%	106%
Canterbury	65,098	326,595	14,210	405,903	85,244	340,466	16,073	441,783	76%	96%	88%	92%
Chichester	49,271	210,287	15,281	274,839	65,093	239,516	14,305	318,914	76%	88%	107%	86%
Chiltern	51,797	221,875	9,354	283,026	45,089	157,030	9,241	211,360	115%	141%	101%	134%
Crawley	59,038	226,576	18,059	303,673	78,636	200,118	16,124	294,878	75%	113%	112%	103%
Dartford	67,319	317,209	16,815	401,342	64,565	204,694	14,541	283,800	104%	155%	116%	141%
Dover	61,710	238,230	10,858	310,799	58,822	216,684	11,363	286,869	105%	110%	96%	108%
East Hampshire	58,092	227,407	12,332	297,831	59,296	202,286	12,261	273,843	98%	112%	101%	109%
Eastbourne	43,954	193,517	9,440	246,911	55,226	222,294	10,160	287,680	80%	87%	93%	86%
Eastleigh	61,248	258,233	12,822	332,304	73,981	229,683	14,657	318,321	83%	112%	87%	104%
Elmbridge	86,713	329,693	16,564	432,970	68,678	220,881	15,044	304,603	126%	149%	110%	142%
Epsom and Ewell	54,325	230,538	9,819	294,683	40,577	131,747	8,593	180,917	134%	175%	114%	163%
Fareham	50,598	212,525	12,146	275,269	60,565	189,803	11,649	262,017	84%	112%	104%	105%
Gosport	35,926	159,916	6,046	201,888	38,337	132,667	6,152	177,156	94%	121%	98%	114%
Gravesham	62,948	269,038	8,860	340,846	48,243	173,960	9,817	232,020	130%	155%	90%	147%
Guildford	76,597	301,638	20,601	398,836	87,259	276,060	18,607	381,926	88%	109%	111%	104%
Hart	46,445	184,456	10,183	241,084	50,110	160,749	10,273	221,132	93%	115%	99%	109%
Hastings	36,609	171,710	7,924	216,243	45,636	173,870	7,986	227,492	80%	99%	99%	95%

	SEELUM				NTEM				Comparison (SEELUM /NTEM)			
District	**TTW**	**Other**	**B2B**	**Total**	**TTW**	**Other**	**B2B**	**Total**	**TTW**	**Other**	**B2B**	**Total**
Havant	57,454	231,016	11,986	300,456	59,828	220,894	11,272	291,994	96%	105%	106%	103%
Horsham	68,497	260,368	14,532	343,397	69,793	239,667	14,614	324,074	98%	109%	99%	106%
Isle of Wight	53,718	261,816	11,031	326,565	67,654	291,096	12,671	371,421	79%	90%	87%	88%
Lewes	43,842	177,175	10,947	231,964	48,294	174,844	9,368	232,506	91%	101%	117%	100%
Maidstone	84,267	346,740	19,740	450,747	95,389	304,186	18,914	418,489	88%	114%	104%	108%
Medway	125,559	580,325	25,244	731,128	143,270	506,135	26,177	675,582	88%	115%	96%	108%
Mid Sussex	70,299	278,065	16,043	364,407	76,965	262,276	15,241	354,482	91%	106%	105%	103%
Mole Valley	50,604	176,973	13,304	240,881	50,746	153,456	11,428	215,630	100%	115%	116%	112%
New Forest	79,216	310,884	16,870	406,971	86,473	326,257	18,285	431,015	92%	95%	92%	94%
Portsmouth	99,027	437,698	25,159	561,884	121,231	386,687	20,393	528,311	82%	113%	123%	106%
Reading	80,524	351,927	19,091	451,542	103,947	304,577	19,231	427,755	77%	116%	99%	106%
Reigate and Banstead	81,593	347,380	20,169	449,142	80,659	235,519	16,401	332,579	101%	147%	123%	135%
Rother	36,899	151,444	8,052	196,394	39,441	165,184	8,127	212,752	94%	92%	99%	92%
Runnymede	47,829	198,234	12,471	258,534	51,609	158,056	11,633	221,298	93%	125%	107%	117%
Rushmoor	49,026	208,431	11,872	269,329	59,862	170,455	11,209	241,526	82%	122%	106%	112%
Sevenoaks	73,666	320,365	13,745	407,776	59,449	198,884	12,494	270,827	124%	161%	110%	151%
Shepway	61,862	293,372	12,630	367,863	56,571	195,706	10,781	263,058	109%	150%	117%	140%
Slough	84,271	343,167	17,658	445,096	86,526	240,499	16,842	343,867	97%	143%	105%	129%
South Bucks	41,754	192,211	8,862	242,827	37,729	126,399	8,333	172,461	111%	152%	106%	141%
South Oxfordshire	68,654	278,483	15,163	362,300	73,915	240,619	14,852	329,386	93%	116%	102%	110%
Southampton	107,381	520,459	25,657	653,496	136,683	456,763	23,052	616,498	79%	114%	111%	106%
Spelthorne	59,248	254,720	11,858	325,826	51,707	153,844	10,888	216,439	115%	166%	109%	151%
Surrey Heath	46,975	175,697	10,523	233,195	50,790	162,347	10,707	223,844	92%	108%	98%	104%
Swale	69,874	285,848	14,261	369,983	70,067	235,607	13,932	319,606	100%	121%	102%	116%

	SEELUM				NTEM				Comparison (SEELUM /NTEM)			
District	**TTW**	**Other**	**B2B**	**Total**	**TTW**	**Other**	**B2B**	**Total**	**TTW**	**Other**	**B2B**	**Total**
Tandridge	52,052	226,032	10,621	288,706	43,028	145,314	9,446	197,788	121%	156%	112%	146%
Test Valley	63,398	241,612	13,909	318,920	66,164	211,627	13,641	291,432	96%	114%	102%	109%
Thanet	62,098	265,693	10,737	338,528	66,409	274,042	11,810	352,261	94%	97%	91%	96%
Tonbridge and Malling	65,818	275,701	16,240	357,760	72,216	226,717	15,465	314,398	91%	122%	105%	114%
Tunbridge Wells	65,834	235,904	14,578	316,316	67,035	237,582	13,446	318,063	98%	99%	108%	99%
Vale of White Horse	67,186	258,039	14,208	339,433	71,434	217,536	14,142	303,112	94%	119%	100%	112%
Waverley	59,575	227,232	13,926	300,733	63,272	227,844	13,304	304,420	94%	100%	105%	99%
Wealden	68,710	258,597	15,211	342,518	67,462	250,839	14,367	332,668	102%	103%	106%	103%
West Berkshire	77,345	315,168	21,833	414,347	95,267	292,825	20,289	408,381	81%	108%	108%	101%
Winchester	54,359	234,394	16,342	305,096	75,394	250,873	16,635	342,902	72%	93%	98%	89%
Windsor and Maidenhead	86,561	305,438	19,431	411,429	86,925	283,547	18,764	389,236	100%	108%	104%	106%
Woking	58,194	208,907	10,575	277,675	54,518	162,995	11,348	228,861	107%	128%	93%	121%
Wokingham	84,934	328,457	18,214	431,605	87,961	268,061	17,559	373,581	97%	123%	104%	116%
Worthing	47,134	198,069	10,589	255,791	57,899	191,688	10,675	260,262	81%	103%	99%	98%
Wycombe	90,619	374,255	20,668	485,541	95,559	312,096	19,081	426,736	95%	120%	108%	114%

Table C.2: Mode share of trips arriving in districts: travel to work trips

	SEELUM				NTEM				SEELUM minus NTEM			
District	Car	Rail	Bus	Walk	Car	Rail	Bus	Walk+ Cycle	Car	Rail	Bus	Walk+ Cycle
Adur	75%	6%	8%	11%	76%	4%	6%	15%	-1%	2%	2%	-4%
Arun	78%	4%	5%	13%	78%	3%	4%	16%	0%	1%	1%	-2%
Ashford	78%	5%	3%	14%	82%	2%	3%	12%	-4%	2%	0%	2%
Basingstoke and Deane	81%	2%	5%	11%	81%	4%	4%	11%	0%	-1%	1%	0%
Bracknell Forest	82%	4%	5%	10%	81%	5%	3%	11%	1%	-1%	1%	-1%
Brighton and Hove	52%	7%	12%	29%	57%	5%	15%	23%	-5%	2%	-2%	6%
Canterbury	69%	4%	9%	18%	75%	3%	6%	16%	-6%	1%	2%	2%
Chichester	79%	5%	5%	12%	82%	3%	3%	12%	-4%	2%	1%	0%
Chiltern	85%	2%	3%	10%	83%	4%	2%	10%	2%	-2%	0%	0%
Crawley	75%	9%	9%	7%	79%	5%	6%	10%	-3%	4%	3%	-3%
Dartford	94%	2%	1%	3%	72%	12%	8%	8%	21%	-10%	-7%	-5%
Dover	81%	3%	6%	10%	78%	2%	4%	15%	2%	1%	2%	-5%
East Hampshire	82%	3%	3%	11%	83%	3%	3%	11%	-1%	1%	1%	0%
Eastbourne	69%	5%	7%	19%	74%	3%	6%	16%	-6%	1%	1%	3%
Eastleigh	82%	2%	7%	10%	81%	4%	4%	11%	0%	-2%	3%	-1%
Elmbridge	89%	6%	0%	5%	73%	14%	4%	9%	16%	-8%	-4%	-4%
Epsom and Ewell	86%	8%	1%	4%	67%	16%	6%	11%	19%	-7%	-5%	-6%
Fareham	82%	1%	9%	8%	80%	3%	5%	12%	2%	-2%	4%	-3%
Gosport	69%	2%	6%	23%	72%	3%	7%	19%	-2%	-1%	-1%	4%
Gravesham	90%	2%	2%	5%	70%	13%	7%	11%	20%	-10%	-4%	-6%
Guildford	75%	7%	6%	12%	77%	8%	4%	12%	-2%	-1%	3%	1%
Hart	85%	5%	3%	8%	84%	4%	2%	10%	0%	1%	0%	-1%
Hastings	70%	4%	8%	17%	73%	3%	6%	17%	-3%	1%	2%	0%

	SEELUM				NTEM				SEELUM minus NTEM			
District	**Car**	**Rail**	**Bus**	**Walk**	**Car**	**Rail**	**Bus**	**Walk+ Cycle**	**Car**	**Rail**	**Bus**	**Walk+ Cycle**
Havant	84%	2%	8%	6%	77%	4%	6%	13%	7%	-1%	1%	-7%
Horsham	81%	4%	4%	12%	85%	2%	3%	10%	-4%	1%	1%	1%
Isle of Wight	72%	0%	7%	21%	74%	2%	6%	18%	-3%	-1%	1%	3%
Lewes	79%	6%	6%	10%	78%	3%	5%	14%	1%	3%	1%	-5%
Maidstone	80%	4%	6%	10%	81%	2%	4%	12%	-1%	1%	1%	-2%
Medway	78%	3%	7%	11%	78%	3%	5%	14%	0%	1%	3%	-3%
Mid Sussex	77%	5%	4%	13%	82%	3%	3%	12%	-5%	2%	1%	1%
Mole Valley	80%	7%	4%	9%	79%	8%	3%	9%	1%	-1%	1%	-1%
New Forest	89%	2%	1%	8%	83%	2%	3%	12%	6%	-1%	-2%	-4%
Portsmouth	74%	3%	9%	13%	65%	5%	10%	20%	9%	-2%	-1%	-6%
Reading	59%	9%	10%	22%	63%	11%	10%	16%	-4%	-1%	0%	6%
Reigate and Banstead	87%	3%	3%	7%	78%	8%	4%	10%	9%	-4%	-2%	-3%
Rother	81%	3%	4%	12%	82%	3%	3%	12%	-1%	0%	1%	0%
Runnymede	83%	7%	2%	8%	72%	16%	4%	8%	11%	-9%	-2%	0%
Rushmoor	76%	4%	8%	12%	79%	5%	4%	13%	-4%	0%	5%	-1%
Sevenoaks	89%	6%	1%	4%	85%	3%	3%	10%	4%	3%	-2%	-6%
Shepway	85%	3%	6%	6%	78%	2%	5%	15%	7%	1%	0%	-8%
Slough	85%	3%	5%	7%	77%	6%	5%	12%	8%	-3%	0%	-5%
South Bucks	88%	5%	2%	5%	83%	5%	3%	8%	4%	0%	-1%	-4%
South Oxfordshire	80%	2%	2%	16%	82%	3%	3%	12%	-2%	-1%	-1%	4%
Southampton	65%	4%	10%	21%	67%	5%	11%	17%	-1%	-1%	-1%	3%
Spelthorne	89%	7%	1%	4%	68%	17%	6%	8%	21%	-11%	-5%	-4%
Surrey Heath	83%	3%	7%	7%	83%	5%	3%	9%	1%	-2%	3%	-2%
Swale	82%	4%	1%	13%	81%	2%	3%	14%	1%	2%	-1%	-2%

	SEELUM				NTEM				SEELUM minus NTEM			
District	**Car**	**Rail**	**Bus**	**Walk**	**Car**	**Rail**	**Bus**	**Walk+ Cycle**	**Car**	**Rail**	**Bus**	**Walk+ Cycle**
Tandridge	90%	4%	1%	5%	80%	7%	4%	8%	10%	-3%	-3%	-3%
Test Valley	86%	2%	5%	7%	83%	2%	3%	11%	3%	0%	2%	-4%
Thanet	77%	3%	9%	11%	74%	2%	7%	17%	4%	1%	3%	-7%
Tonbridge and Malling	82%	5%	6%	7%	85%	3%	3%	10%	-2%	2%	3%	-3%
Tunbridge Wells	75%	6%	6%	14%	80%	3%	4%	14%	-5%	3%	2%	0%
Vale of White Horse	86%	2%	3%	10%	82%	2%	3%	12%	4%	-1%	0%	-3%
Waverley	81%	2%	5%	12%	83%	4%	2%	11%	-2%	-2%	3%	1%
Wealden	84%	3%	3%	9%	86%	2%	2%	10%	-1%	1%	1%	-1%
West Berkshire	85%	1%	4%	10%	83%	4%	3%	10%	2%	-2%	1%	-1%
Winchester	76%	5%	8%	11%	80%	5%	4%	10%	-4%	0%	4%	1%
Windsor and Maidenhead	83%	3%	3%	11%	79%	8%	3%	10%	4%	-4%	0%	1%
Woking	77%	6%	5%	13%	67%	19%	5%	9%	10%	-14%	0%	3%
Wokingham	81%	4%	5%	11%	81%	5%	4%	10%	0%	-1%	1%	1%
Worthing	70%	5%	8%	16%	74%	4%	6%	17%	-4%	1%	3%	0%
Wycombe	80%	3%	6%	10%	82%	3%	4%	11%	-2%	1%	3%	-1%

Table C.3: Mode share of trips arriving in districts: other journey purpose

District	SEELUM				NTEM				SEELUM minus NTEM			
	Car	Rail	Bus	Walk	Car	Rail	Bus	Walk+ Cycle	Car	Rail	Bus	Walk+ Cycle
Adur	62%	1%	6%	31%	67%	1%	6%	25%	-6%	0%	-1%	6%
Arun	65%	1%	6%	28%	69%	1%	5%	24%	-4%	0%	0%	4%
Ashford	66%	1%	3%	30%	68%	1%	6%	26%	-2%	0%	-2%	4%
Basingstoke and Deane	65%	0%	6%	28%	70%	1%	6%	23%	-4%	-1%	1%	5%
Bracknell Forest	72%	0%	5%	23%	69%	1%	5%	25%	3%	-1%	0%	-2%
Brighton and Hove	40%	2%	9%	49%	55%	1%	11%	33%	-14%	0%	-2%	16%
Canterbury	54%	0%	8%	37%	60%	1%	8%	31%	-5%	-1%	0%	6%
Chichester	69%	1%	6%	24%	73%	1%	5%	21%	-4%	0%	1%	3%
Chiltern	82%	1%	2%	15%	72%	1%	4%	23%	11%	-1%	-2%	-8%
Crawley	62%	2%	12%	24%	68%	1%	7%	24%	-6%	1%	5%	0%
Dartford	79%	1%	3%	18%	68%	3%	9%	21%	11%	-2%	-7%	-2%
Dover	69%	1%	7%	23%	65%	1%	6%	28%	4%	-1%	1%	-5%
East Hampshire	71%	1%	3%	24%	72%	1%	4%	23%	0%	0%	-1%	1%
Eastbourne	57%	1%	7%	36%	66%	1%	7%	27%	-9%	0%	0%	9%
Eastleigh	76%	1%	6%	17%	71%	1%	5%	23%	5%	-1%	1%	-6%
Elmbridge	70%	1%	1%	28%	69%	3%	6%	22%	1%	-2%	-5%	6%
Epsom and Ewell	66%	2%	5%	27%	62%	3%	8%	27%	4%	-2%	-3%	0%
Fareham	74%	0%	9%	16%	70%	1%	5%	24%	5%	-1%	3%	-7%
Gosport	55%	1%	5%	39%	64%	1%	7%	29%	-9%	0%	-1%	10%
Gravesham	71%	1%	4%	24%	61%	3%	8%	28%	10%	-2%	-4%	-4%
Guildford	62%	1%	6%	30%	68%	2%	5%	25%	-6%	-1%	1%	5%
Hart	76%	1%	3%	20%	73%	1%	4%	22%	3%	-1%	-1%	-2%
Hastings	60%	1%	8%	32%	64%	1%	7%	29%	-4%	0%	1%	3%

District	SEELUM				NTEM				SEELUM minus NTEM			
	Car	Rail	Bus	Walk	Car	Rail	Bus	Walk+ Cycle	Car	Rail	Bus	Walk+ Cycle
Havant	75%	0%	9%	16%	67%	1%	7%	25%	8%	-1%	2%	-9%
Horsham	63%	1%	4%	32%	75%	1%	4%	20%	-12%	0%	0%	11%
Isle of Wight	54%	0%	6%	40%	66%	1%	6%	27%	-12%	-1%	0%	13%
Lewes	69%	1%	6%	24%	67%	1%	6%	26%	2%	0%	0%	-2%
Maidstone	70%	1%	6%	23%	67%	1%	6%	26%	3%	0%	0%	-3%
Medway	66%	1%	8%	25%	63%	1%	6%	29%	2%	0%	1%	-4%
Mid Sussex	58%	1%	4%	37%	71%	1%	4%	23%	-14%	0%	0%	14%
Mole Valley	62%	1%	5%	31%	68%	2%	5%	24%	-6%	-1%	0%	8%
New Forest	91%	2%	1%	6%	73%	1%	4%	22%	18%	1%	-4%	-16%
Portsmouth	60%	1%	9%	31%	58%	1%	9%	32%	1%	-1%	0%	-1%
Reading	46%	2%	8%	44%	59%	2%	9%	30%	-13%	0%	-1%	13%
Reigate and Banstead	65%	1%	4%	30%	69%	2%	6%	23%	-4%	-1%	-2%	6%
Rother	71%	1%	4%	24%	72%	1%	5%	22%	-1%	0%	-1%	2%
Runnymede	70%	2%	2%	26%	69%	3%	6%	21%	1%	-2%	-4%	4%
Rushmoor	65%	1%	9%	25%	68%	1%	5%	26%	-3%	0%	4%	-1%
Sevenoaks	76%	1%	2%	21%	70%	1%	5%	24%	6%	0%	-3%	-3%
Shepway	79%	1%	8%	12%	65%	1%	7%	27%	14%	0%	1%	-15%
Slough	70%	0%	7%	23%	66%	1%	6%	26%	4%	-1%	0%	-4%
South Bucks	78%	0%	4%	17%	73%	2%	5%	20%	5%	-1%	-1%	-3%
South Oxfordshire	68%	1%	1%	29%	71%	1%	5%	24%	-2%	0%	-3%	6%
Southampton	54%	1%	8%	37%	58%	1%	9%	31%	-5%	0%	-1%	6%
Spelthorne	70%	1%	4%	25%	68%	3%	8%	21%	2%	-3%	-4%	5%
Surrey Heath	74%	1%	7%	18%	72%	2%	5%	21%	2%	-1%	3%	-3%
Swale	71%	2%	1%	27%	66%	1%	5%	28%	5%	0%	-4%	-1%

District	SEELUM				NTEM				SEELUM minus NTEM			
	Car	Rail	Bus	Walk	Car	Rail	Bus	Walk+ Cycle	Car	Rail	Bus	Walk+ Cycle
Tandridge	77%	1%	3%	20%	70%	2%	6%	22%	7%	-1%	-3%	-2%
Test Valley	85%	1%	5%	9%	72%	1%	5%	22%	13%	0%	0%	-13%
Thanet	63%	0%	9%	27%	60%	1%	8%	31%	3%	-1%	2%	-4%
Tonbridge and Malling	76%	1%	8%	15%	69%	1%	5%	25%	7%	0%	3%	-10%
Tunbridge Wells	62%	1%	6%	31%	65%	1%	6%	28%	-3%	-1%	0%	3%
Vale of White Horse	83%	1%	4%	13%	69%	1%	5%	25%	13%	0%	-1%	-12%
Waverley	68%	0%	6%	25%	71%	1%	4%	24%	-2%	-1%	2%	1%
Wealden	77%	0%	3%	19%	74%	1%	4%	21%	3%	-1%	-1%	-2%
West Berkshire	76%	0%	3%	21%	72%	1%	5%	22%	4%	-1%	-2%	-1%
Winchester	69%	1%	8%	23%	71%	1%	6%	22%	-2%	-1%	2%	1%
Windsor and Maidenhead	65%	0%	3%	31%	71%	2%	5%	22%	-6%	-2%	-1%	9%
Woking	59%	0%	6%	35%	68%	4%	6%	23%	-9%	-3%	0%	12%
Wokingham	70%	0%	4%	25%	71%	2%	5%	23%	-1%	-1%	-1%	2%
Worthing	57%	0%	8%	34%	66%	1%	6%	27%	-9%	-1%	2%	7%
Wycombe	72%	0%	6%	21%	70%	1%	5%	24%	2%	-1%	1%	-2%

Table C.4: Mode share of trips arriving in districts: business to business trips

District	SEELUM		NTEM		SEELUM minus NTEM	
	Car	Rail	Car	Rail	Car	Rail
Adur	97%	3%	95%	5%	2%	-2%
Arun	97%	3%	96%	4%	1%	-1%
Ashford	95%	5%	97%	3%	-2%	2%
Basingstoke and Deane	96%	4%	95%	5%	1%	-1%
Bracknell Forest	97%	3%	94%	6%	4%	-4%
Brighton and Hove	92%	8%	88%	12%	4%	-4%
Canterbury	97%	3%	96%	4%	1%	-1%
Chichester	98%	2%	96%	4%	2%	-2%
Chiltern	93%	7%	95%	5%	-2%	2%
Crawley	90%	10%	92%	8%	-2%	2%
Dartford	97%	3%	93%	7%	4%	-4%
Dover	100%	0%	97%	3%	2%	-2%
East Hampshire	97%	3%	97%	3%	0%	0%
Eastbourne	93%	7%	95%	5%	-2%	2%
Eastleigh	99%	1%	95%	5%	4%	-4%
Elmbridge	93%	7%	91%	9%	2%	-2%
Epsom and Ewell	93%	7%	88%	12%	4%	-4%
Fareham	99%	1%	96%	4%	4%	-4%
Gosport	98%	2%	96%	4%	2%	-2%
Gravesham	94%	6%	92%	8%	2%	-2%
Guildford	96%	4%	87%	13%	9%	-9%
Hart	95%	5%	95%	5%	-1%	1%
Hastings	93%	7%	96%	4%	-2%	2%
Havant	99%	1%	95%	5%	4%	-4%
Horsham	96%	4%	97%	3%	-1%	1%
Isle of Wight	99%	1%	97%	3%	2%	-2%
Lewes	97%	3%	95%	5%	2%	-2%
Maidstone	99%	1%	97%	3%	1%	-1%
Medway	98%	2%	97%	3%	1%	-1%
Mid Sussex	91%	9%	95%	5%	-4%	4%
Mole Valley	94%	6%	93%	7%	1%	-1%
New Forest	99%	1%	97%	3%	2%	-2%
Portsmouth	99%	1%	91%	9%	8%	-8%
Reading	90%	10%	79%	21%	11%	-11%
Reigate and Banstead	96%	4%	91%	9%	5%	-5%
Rother	95%	5%	96%	4%	-1%	1%
Runnymede	93%	7%	92%	8%	1%	-1%
Rushmoor	96%	4%	94%	6%	2%	-2%
Sevenoaks	92%	8%	96%	4%	-4%	4%
Shepway	100%	0%	97%	3%	2%	-2%

District	SEELUM		NTEM		SEELUM minus NTEM	
	Car	Rail	Car	Rail	Car	Rail
Slough	97%	3%	92%	8%	6%	-6%
South Bucks	92%	8%	93%	7%	-1%	1%
South Oxfordshire	97%	3%	96%	4%	1%	-1%
Southampton	96%	4%	90%	10%	6%	-6%
Spelthorne	97%	3%	90%	10%	7%	-7%
Surrey Heath	98%	2%	95%	5%	3%	-3%
Swale	99%	1%	96%	4%	2%	-2%
Tandridge	97%	3%	93%	7%	3%	-3%
Test Valley	98%	2%	97%	3%	1%	-1%
Thanet	100%	0%	97%	3%	3%	-3%
Tonbridge and Malling	98%	2%	96%	4%	1%	-1%
Tunbridge Wells	99%	1%	96%	4%	3%	-3%
Vale of White Horse	99%	1%	97%	3%	2%	-2%
Waverley	99%	1%	94%	6%	5%	-5%
Wealden	100%	0%	98%	2%	2%	-2%
West Berkshire	98%	2%	96%	4%	2%	-2%
Winchester	97%	3%	91%	9%	6%	-6%
Windsor and Maidenhead	96%	4%	90%	10%	6%	-6%
Woking	95%	5%	89%	11%	6%	-6%
Wokingham	99%	1%	93%	7%	6%	-6%
Worthing	99%	1%	95%	5%	4%	-4%
Wycombe	93%	7%	97%	3%	-3%	3%

D Cambridge Econometrics Report - Economic Scenario Modelling of South East England

Transport for South East

Economic Scenario Modelling of South East England

cambridge econometrics
clarity from complexity

Final Report

July
2019

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Authorisation and Version History

Version	Date	Authorised for release by	Description
1.0	25/06/19	BG	Draft ready for client comments

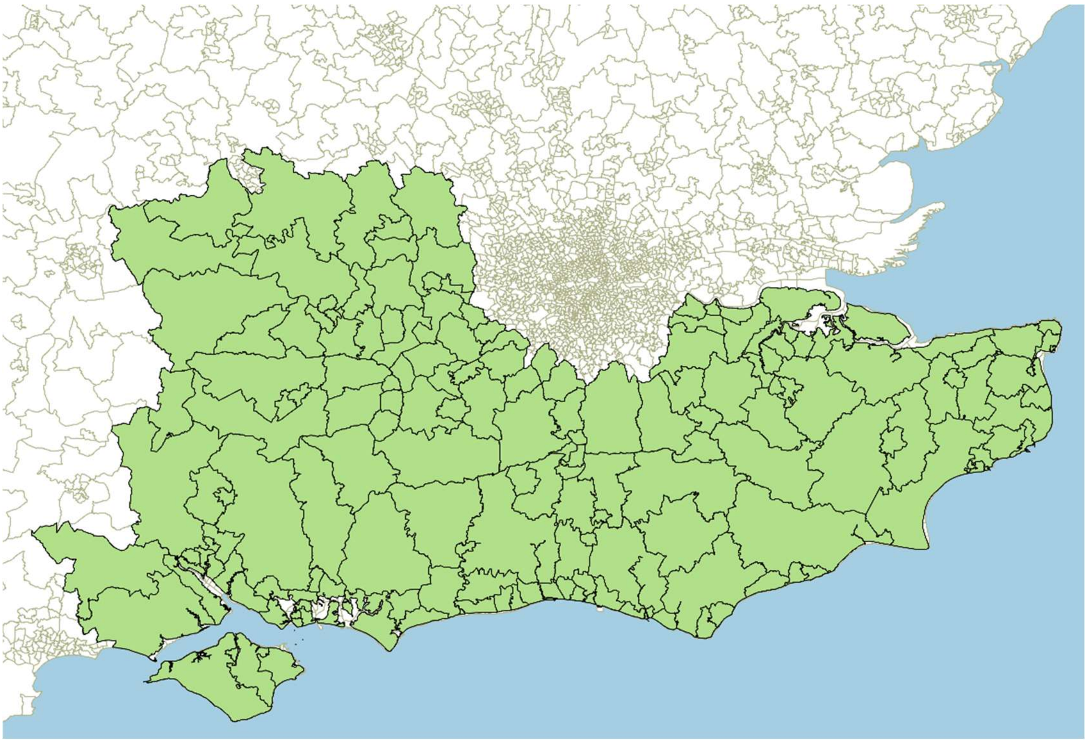
Contents

1 Introduction

1.1 The Transport for the South East study area

The Transport for the South East (TfSE) study area is closely aligned with the NUTS1 region of South East England, with some small differences (excluded districts are Milton Keynes, Aylesbury Vale, Cherwell, Oxford and Oxfordshire).

Figure 1 Error! Use the Home tab to apply 0 to the text that you want to appear here.**.1 The TfSE**



Source: ONS, Steer Group

The total study area is shown in the map above (green area), disaggregated into 167 zones which are combinations of MSOA(s).

1.2 Current Economic Characteristics

The two figures below show the trend of historical employment and GVA in TfSE area. Overall, growth in both employment and GVA in the area are very similar. Employment has seen more volatility, with a particular drop in the 90-93 recession, whereas GVA has grown more steadily.

Figure 1.2.1 Employment growth in the TfSE area since 1981

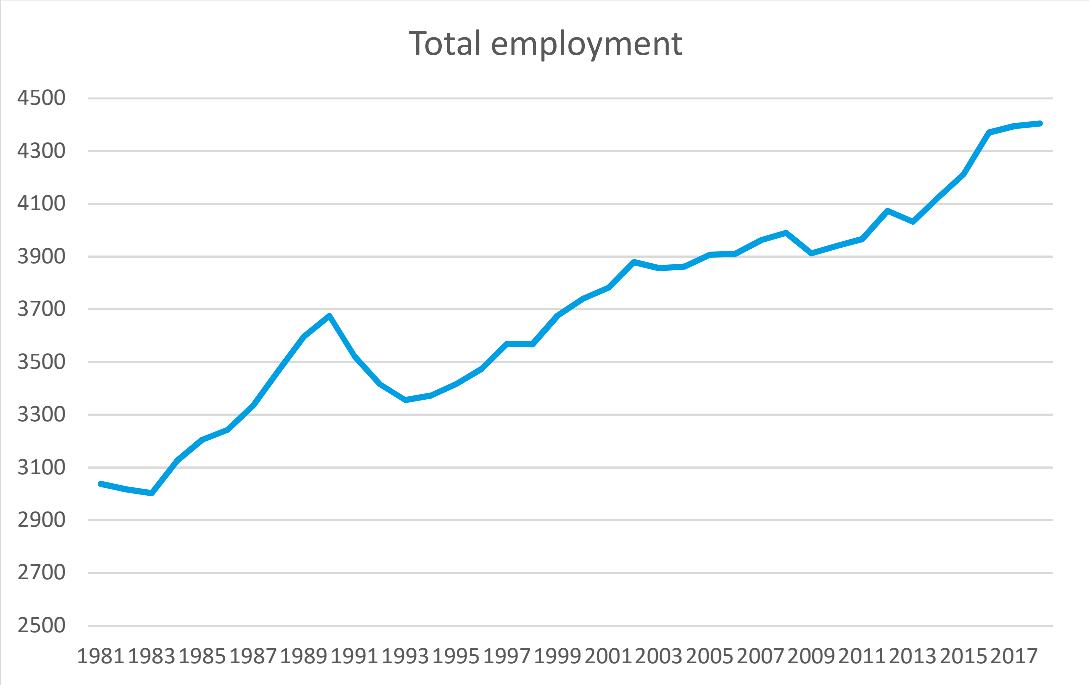
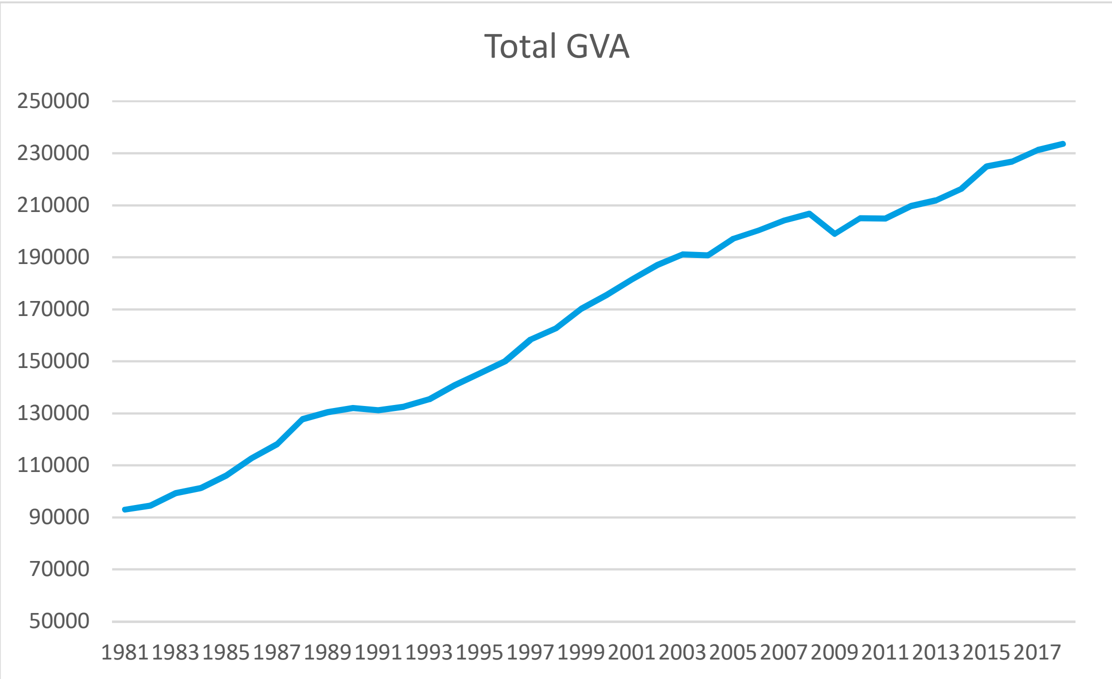
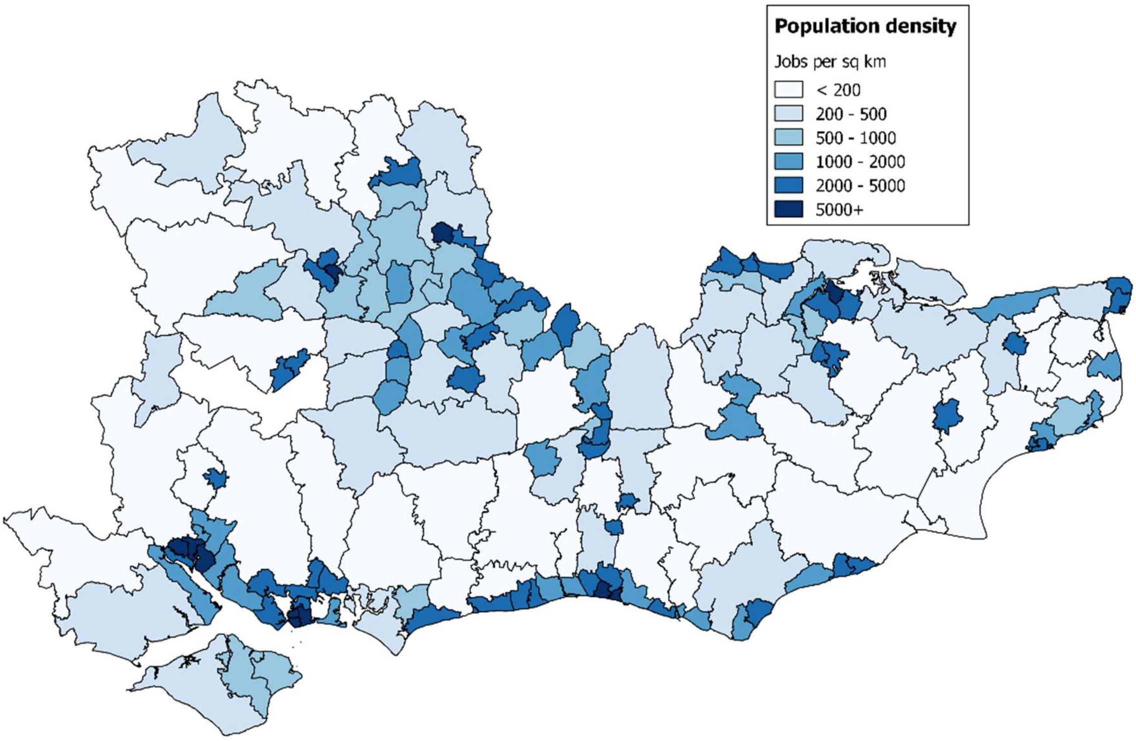


Figure 1.2.2. GVA growth in the TfSE area since 1981



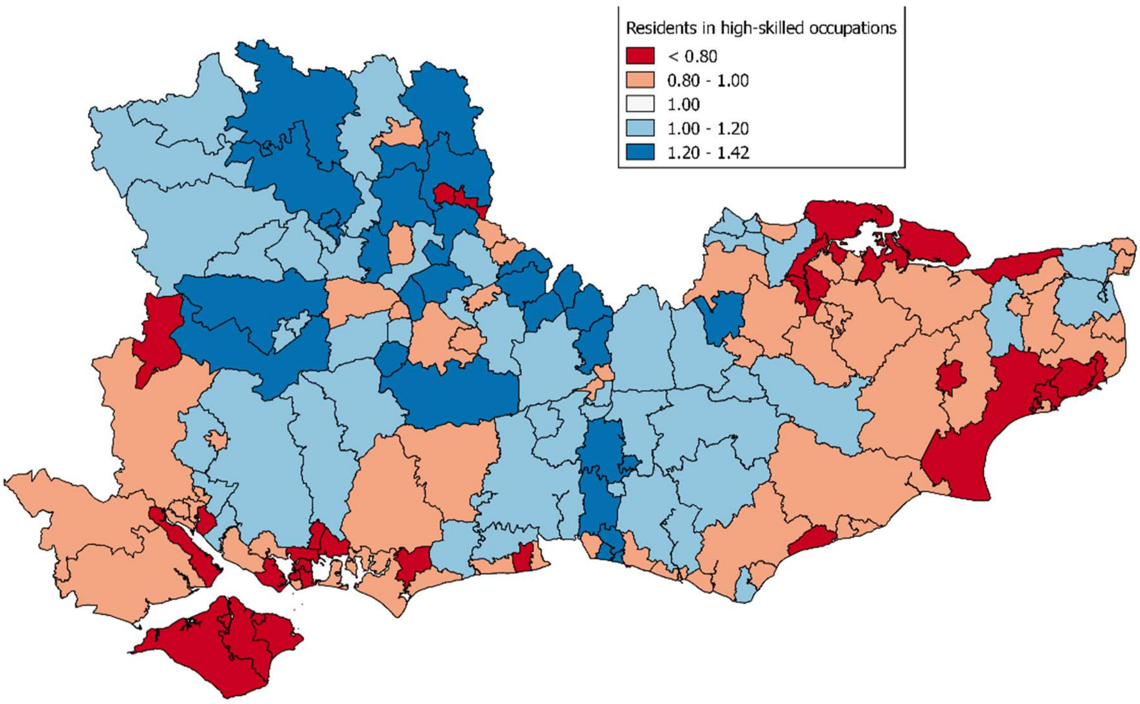
The most densely populated areas (Figure 1.2.3) of the South East are in two main areas - a string of towns and cities along the south coast from Southampton to Eastbourne, and the area of the region abutting onto Greater London, from Berkshire, Surrey, Sussex to North-West Kent. A central belt of rural hinterlands across Hampshire, Sussex and central Kent areas have lower densities.

Figure 1.2.3 Population density in the TfSE area



Although the major cities/towns in the TfSE area have dense employment, the residents with high-skilled occupations are most highly represented in the commuter belt to the south and west of Greater London, particularly in West Sussex, Surrey, Hampshire and Berkshire. Kent, the Isle of Wight and other coastal areas tend to see higher proportions of mid- and low-skill residents compared to the TfSE area as a whole (Figure 1.).

Figure 1.2.5 Distribution of Residents in High-Skill Occupations (SOC 1-3)



Note: Blue = greater than TfSE average, Red = less than TfSE average

2 Methodology

2.1 Model summary

Baseline Forecast

The baseline scenario was generated using CE's latest Local Economy Forecasts, which are updated every 6 months to reflect changes to the UK economy. Since CE data are only available up to Local Authority District level, employment data at MSOAs level are estimated based on data from the Business Register and Employment Survey (BRES) and CE projection. Assuming that the productivity of any given sector is the same for all MSOA within a district, GVA baseline projection is calculated and scaled to CE's projection at LAD level. The baseline projections were then converted from CE's 45 industries to 11 growth sectors.

Modelling Scenarios

The model used is a sectoral growth model which estimates the wider economic impact of various policy and investment scenarios, under differing assumptions of technological and societal trends.The following mechanisms are captured within the model. These mechanisms have all been tested and verified using extensive econometric analysis of local sectoral growth rates in the UK economy between 1981 and 2017. Coefficients used in the modelling are derived in-house using econometric techniques and validated by comparison with the wider literature.

- The impacts of additional housing development can be captured by adjusting the population growth rates in line with the new housing build-out rate. Within the model, this produces growth in both labour supply and demand for local services within neighbouring LADs. Population increase also directly induces a rise in employment in a range of non-tradeable sectors in the same period as the market for these services expands.
- There is a cumulative feedback mechanism between local levels of employment and productivity in certain tradeable sectors. Local agglomerations of firms with high levels of productivity are more likely to hire additional workers, whilst larger agglomerations (in employment terms) tend to experience positive localisation economies and stronger future productivity growth.
- Strong productivity and GVA growth in some sectors of a local economy often "spills over" to other sectors within the same local area, through a combination of direct business-to-business spending or local wage growth inducing growth in demand for local services.
- By using empirically derived and calibrated coefficients, the model then captures agglomeration economies due to expanded access to both labour pools and sector-specific firm-firm interactions. This feeds directly into local sectoral productivity growth rates through the process of localisation agglomeration.
- Feedback mechanisms between productivity and employment growth are incorporated into the model on a spatial-sectoral basis at LAD level, along with employment and productivity spill-over impacts both between sectors and between local areas, based around empirically derived input/output tables.
- Changes to occupational composition of residential population are also projected in the model. The implication here is that growth in high skill occupations by workplace will lead to an increase of higher-skill residents in neighbouring areas.

2.2 Scenario overview

Below is a summary of the outputs produced by CE using the growth model:

Five scenarios are included: a baseline scenario and four alternate scenarios.

- The scenarios were produced for 5-year increments from 2020 to 2050.
- The model was used to estimate the growth across all 167 internal zones within the TfSE area. Each zone is made up of one or several MSOAs.
- Data are projected forward for all sectors of the economy in details based on the output of our MDM model which project future sectoral trends at the national level: by assessing exactly how this will impact on the TfSE economy specially, the projections will be provided for employment, productivity and GVA by 11 aggregated sectors.
- The latest insight into technologically-driven changes to working practice and organisational structure is used to convert these sectors into 9 occupations using a time-variant SIC-SOC conversion matrix based on *Working Futures* research.
- Projections for resident population by occupation and age-band are also produced for each internal zone, based around existing patterns of occupation of different residential areas and projected changes to regional occupational and age structure.

Sectors Modelled

The following sectoral groups were modelled.

Sectoral Group Name	Component Sub-sectors
Agrifood	Fish and other fishing products; aquaculture products; support services to fishing
Agrifood	Products of agriculture, hunting and related services
Agrifood	Products of forestry, logging and related services
Agrifood	Food production
Business Support	Security and investigation services
Business Support	Services to buildings and landscape
Business Support	Other professional, scientific and technical services
Business Support	Office administrative, office support and other business support services
Construction	Manufacture of non-metallic products
Construction	Construction
Consumer Services	Beverages & Tobacco products
Consumer Services	Retail trade services, except of motor vehicles and motorcycles
Consumer Services	Accommodation services
Consumer Services	Food and beverage serving services
Consumer Services	Gambling and betting services
Consumer Services	Sports services and amusement and recreation services
Consumer Services	Other personal services
Finance, Law and Management	Financial services, except insurance and pension funding

Finance, Law and Management	Insurance and reinsurance, except compulsory social security & Pension funding
Finance, Law and Management	Services auxiliary to financial services and insurance services
Finance, Law and Management	Real estate
Finance, Law and Management	Legal services and accounting
Finance, Law and Management	Services of head offices; management consulting services
Manufacturing and Industry	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials
Manufacturing and Industry	Paper and paper products
Manufacturing and Industry	Rubber and plastic products
Manufacturing and Industry	Manufacture of Metals
Manufacturing and Industry	Manufacture of Metal products
Manufacturing and Industry	Machinery and equipment n.e.c.
Manufacturing and Industry	Motor vehicles, trailers and semi-trailers
Manufacturing and Industry	Furniture
Manufacturing and Industry	Repair of machinery
Manufacturing and Industry	Textiles
Manufacturing and Industry	Wearing apparel
Manufacturing and Industry	Chemicals
Manufacturing and Industry	Leather and related products
Media & Technology	Printing and recording services
Media & Technology	Computer, electronic and optical products
Media & Technology	Electrical equipment
Media & Technology	Other manufactured goods
Media & Technology	Publishing services
Media & Technology	Motion Picture, Video & TV Programme Production, Sound Recording & Music Publishing Activities & Programming And Broadcasting Activities
Media & Technology	Telecommunications services
Media & Technology	Computer programming, consultancy and related services
Media & Technology	Information services
Media & Technology	Advertising and market research services
Media & Technology	Repair services of computers and personal and household goods
Media & Technology	Creative, arts and entertainment services
Public Services	Public administration and defence services; compulsory social security services
Public Services	Education services
Public Services	Residential Care & Social Work Activities
Public Services	Libraries, archives, museums and other cultural services
Public Services	Services furnished by membership organisations
Science & Health	Basic pharmaceutical products and pharmaceutical preparations
Science & Health	Architectural and engineering services; technical testing and analysis services
Science & Health	Scientific research and development services

Science & Health	Veterinary services
Science & Health	Human health services
Transport & Logistics	Other transport
Transport & Logistics	Water transport services
Transport & Logistics	Air transport services
Transport & Logistics	Travel agency, tour operator and other reservation services and related services
Transport & Logistics	Wholesale and retail trade and repair services of motor vehicles and motorcycles
Transport & Logistics	Land Transport
Transport & Logistics	Warehousing and support services for transportation
Transport & Logistics	Postal and courier services
Transport & Logistics	Rental and leasing services
Transport & Logistics	Wholesale trade services, except of motor vehicles and motorcycles
Utilities & Extraction	Crude Petroleum And Natural Gas & Metal Ores
Utilities & Extraction	Mining support services
Utilities & Extraction	Coke and refined petroleum products
Utilities & Extraction	Electricity & Gas
Utilities & Extraction	Natural water; water treatment and supply services
Utilities & Extraction	Other mining and quarrying products
Utilities & Extraction	Sewerage services; sewage sludge
Utilities & Extraction	Waste collection, treatment and disposal services; materials recovery services
Utilities & Extraction	Remediation services and other waste management services
Utilities & Extraction	Coal and lignite

3 Model Results

3.1 Scenario Details

In order to create different scenarios of the future, we adjusted our starting parameters either at the beginning or throughout the study period. Modifications includes population growth rates and employment growths in key sectors on the basis of each scenario. These are specified by individual spatial node or evenly distributed across the TfSE region. The following sections specify the assumptions implied in each scenario and their outcome

Table 3.1 Key Adjustments to Baseline Assumptions by Scenario and Resulting Impacts

	The London Hub	Sustainable Future	Digital Future	Our Route to Growth	Scenario 5
Key Adjustments to Model	Significant Population (and housing) growth above baseline Population increase ranges between 10 and 30 percent and it is based on the distance from the MSOAs to the London zone All else as baseline	Reduction/reallocation of energy generation Reduction in activity in heavy industry Reduction in demand for transport Reduction in output of distribution activities Investment targeting specific deprived urban areas Boost to Public Services & Third Sector	Assumption of rapid global adoption of new technologies Acceleration of productivity growth multiplier Deceleration of employment growth multiplier Acceleration of shift to future occupational structures	High levels of investment and employment growth in targeted tradeable sectors in key cities/areas Growth focused around densifying key urban areas in the South East Limited corresponding growth of urban population – implying reduction in out-commuting	Reduction/reallocation of energy generation Reduction in activity in heavy industry Reduction in demand for transport Boost to Public Services & Third Sector Boost to Construction High levels of investment and employment growth in targeted tradeable sectors in key cities/areas* Growth focused around densifying key urban areas in the South East Limited corresponding growth of urban population – implying reduction in out-commuting

Key Outcomes	Population, Employment and GVA all higher than baseline Limited impact on productivity Growth in net out-commuting	3rd highest level employment growth GVA higher than baseline, but productivity lower Compatible with higher welfare, although this is not explicitly captured	Highest level of productivity growth 3rd highest level of GVA growth Lowest level of employment growth	Highest level of GVA growth Highest level of employment growth 2nd highest level of productivity growth	Employment, GVA and Productivity growth all roughly midway between Sustainable future and Our Route to Growth scenario 2nd highest levels of GVA and employment growth

London Hub Scenario

This scenario explored the implications of a policy of extensive and ambitious housebuilding programme centred around Greater London. To simulate this scenario, we enhanced the growth rate of population in each zone in the South East based on their distance to the centre of London. For this scenario, population increase by three bands: 7%, 5% and 3% per annum above baseline projections, decreasing with distance from the City of London. By 2050, this resulted in net increases above baseline population projections of 30%, 20% and 10% respectively.

The impact of the designated population growth patterns was to induce significant additional demand for local services sectors, leading to net additional employment growth across the study area. However, this employment growth was not high enough to provide jobs for all the additional working age population, implying a significant growth in net commuting out of the study area, assumed to be to London, as the scenario name suggests, although this is not explicitly captured in the model.

Our Route to Growth Hub Scenario

This scenario simulated the impacts of a policy of high levels of investment and employment growth in the targeted tradeable sectors in 8 core cities of the study area. For this scenario, we input additional employment growth in different sectors for different cities:

- Basingstoke and Deane: Manufacturing and Industry, Media and Technology
- Brighton and Hove: Media and Technology, Law, Finance and Management
- Crawley: Transport and Logistics
- Hart: Manufacturing and Industry, Media and Technology
- Medway: Transport and Logistics
- Portsmouth: Science and Health, Transport and Logistics
- Reading: Media and Technology, Law, Finance and Management
- Southampton: Science and Health, Transport and Logistics

We also make the assumption that these significant additional jobs will induce additional population growth in whole study area as some staff are recruited from outside the TfSE area. The knock-on impacts on total employment, net commuting, productivity and GVA are then calculated. Increased levels of both Marshallian and Jacobian agglomeration economies result in increased productivity growth within the target cities.

Digital Future Scenario

The Digital Future scenario maintains baseline levels of population growth, but tests the implications of rapid global technological advance and adoption for the way in which people live, work and travel, and the demand for different types of occupational roles. Changes in working practices and occupational shifts in the workplace are accelerated, leading to faster productivity growth, but labour demand in “routine” occupations drops at greater than the natural retirement rate, leading to an increase in involuntary unemployment.

Sustainable Future Scenario

The main goal of this scenario is to represent a more ethical and environmentally sustainable economy. Key assumptions therefore are a reduction in the consumption of material goods, leading to a fall in GVA in associated supply chains, a switch to renewable and distributed energy consumption, and to active and public modes of transportation. Tallied with this is a growth in public and 3rd sector service activity, and a series of targeted regeneration programmes in currently deprived areas within the region. Here we see high levels of employment maintained across all areas of the study area. The slower levels of overall productivity growth do not necessarily imply a fall in quality of life of residents.

5th scenario This scenario is a combination of inherently compatible elements of the *Our Route to Growth* and *Sustainable Future* scenarios. It focuses on sustainable growth in key urban areas while maintaining social and environmental justice. For this scenario, we boost employment growth in the following sectors for those chosen districts:

- Basingstoke and Deane: Manufacturing and Industry, Media and Technology
- Brighton and Hove: Media and Technology, Law, Finance and Management
- Hart: Manufacturing and Industry, Media and Technology
- Medway: Business Services
- Hastings and Ashford: Business Services
- Portsmouth: Science and Health
- Reading: Media and Technology, Law, Finance and Management
- Southampton: Science and Health

In order to reduce the environmental impact of these changes, we assumed that population and employment growth would be spatially co-located in dense urban areas, in order to increase the mode share of public and active transport modes.

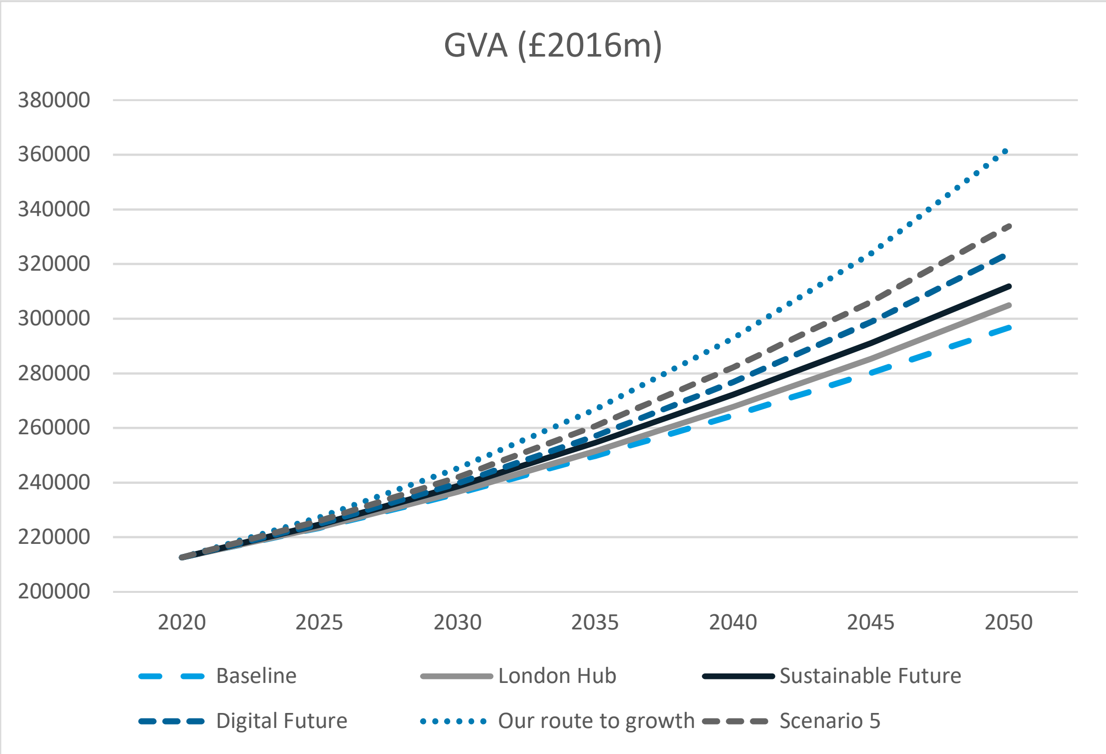
Separate to this, we implement a series of sectoral shifts corresponding to a transition to a low-carbon and climate-resilient economy[1]. These imply a reallocation of energy generation to renewable sources, and a reduction in activity in heavy industry and extraction. Additional growth is seen in construction and the public and third sector.

3.2 Scenarios outputs

GVA projections for the baseline and four scenarios are shown in figure 3.2.1. All four scenarios see GVA growth above the baseline, with *Our Route to Growth* experiencing the strongest GVA benefit, due to the additional investment and employment seen in key sectors in target cities. This spatially concentrated form of investment in urban areas is most likely to produce high levels of productivity and GVA growth though agglomeration mechanisms.

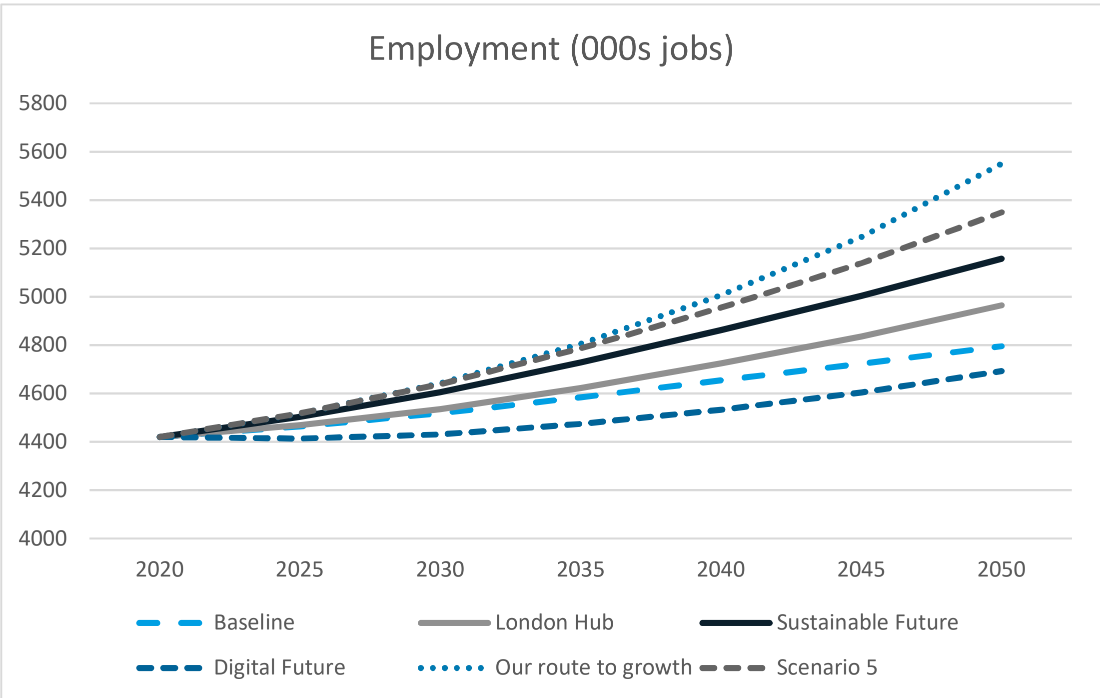
[1] DG CLIMA, ICF: *Employment effects of a transition towards a low-carbon and climate-resilient economy* final report, 2019

Figure 3.2.1 Comparison of Scenarios: Total GVA growth 2020-2050.



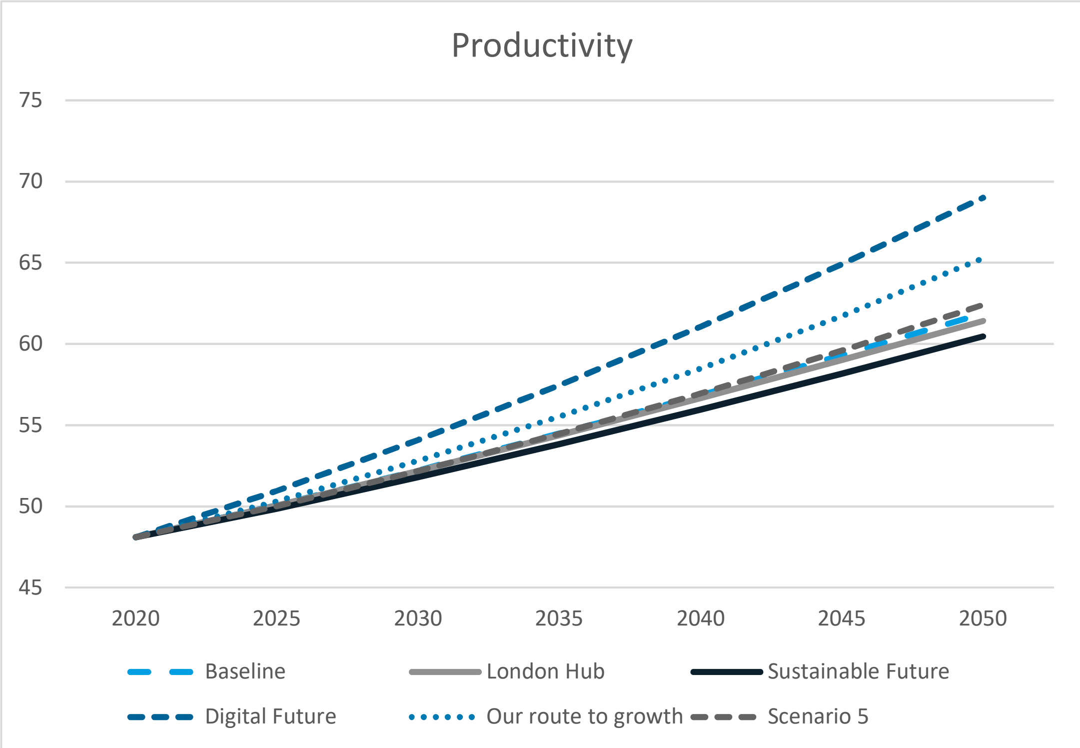
Employment projections are shown in figure 3.2.2. *Our Route to Growth, Scenario 5*, *London Hub* and *Sustainable Future* scenarios all see employment growth above the baseline projection. *Digital Future* has lower rates of employment growth, due to our explicit assumption of labour-substitutionary effects of some aspects of new technology innovations.

Figure 3.2.2 Comparison of Scenarios: Total Employment growth 2020-2050



The *Digital Future* scenario does however see the highest rate productivity growth, with *Our Route to Growth* also exhibiting productivity growth above baseline. In this case, the two mechanisms of productivity growth are different, with the additional productivity growth in *Digital Future* arising from additional adoption and integration of new technologies, whereas additional productivity impacts in the *Our Route to Growth* scenario arises from agglomeration benefits in the targeted urban areas.

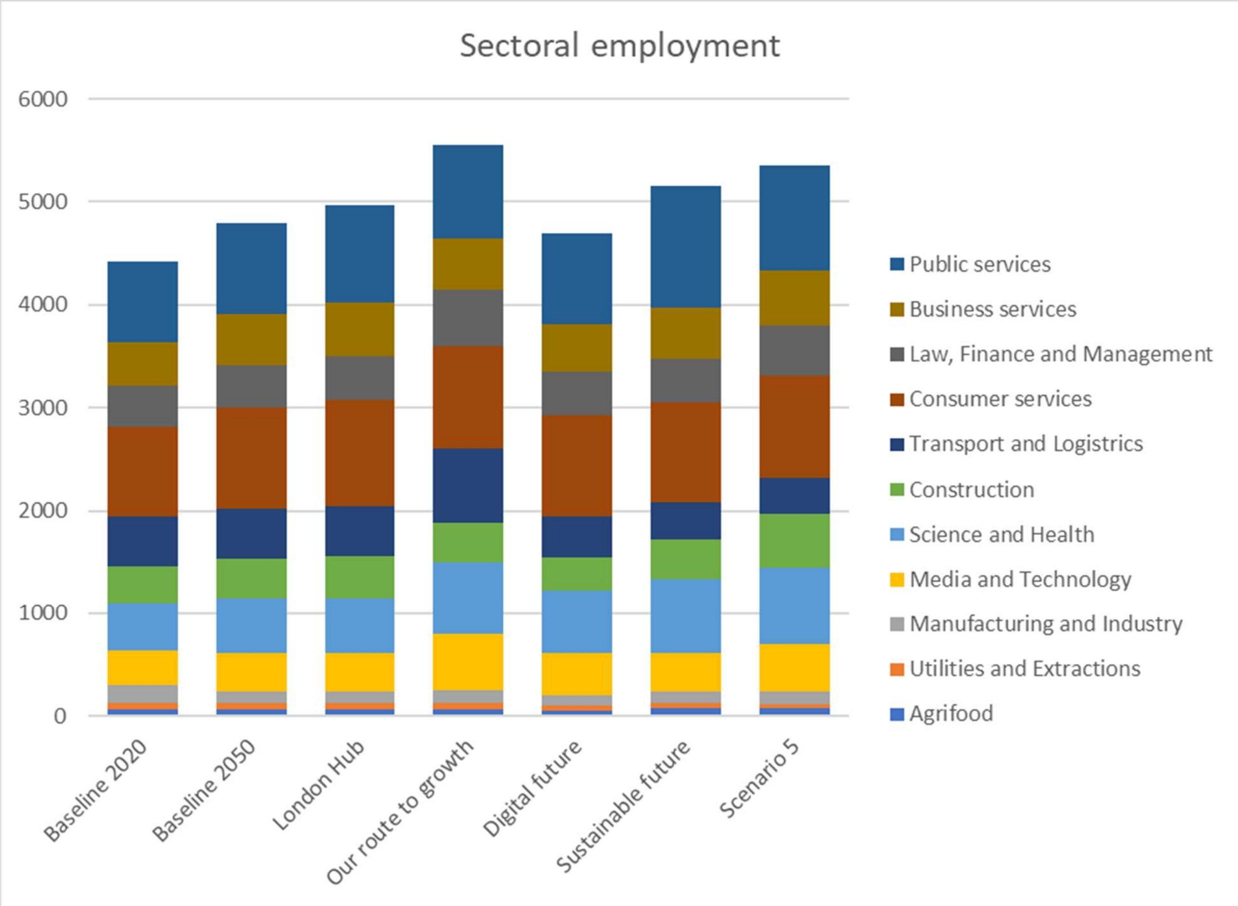
Figure 3.2.3 Comparison of Scenarios: Total Productivity growth 2020-2050



Sectoral and Occupational Outcomes

The sectoral composition of employment in 2050 is shown in figure 3.2.5, with the left-hand column showing the projected 2020 distribution for comparison. The highest overall growth in Our Route to Growth can be seen to be driven partly by growth in Media & Technology, Science & Health, and Law, Finance & Management, whereas the strong employment growth in Sustainable Futures is driven by growth in Science & Health, and Public (incl. third-sector) Services.

Figure 3.2.5 Sectoral Employment (2050 unless stated)



3.3 Spatial Implications

The spatial distribution of impacts across the TfSE area are shown in this section. Figure 3.3.1 shows 2050 total residential employment by spatial area across the five scenarios. The high levels of population growth in the *London Hub* scenario are reflected in the growth seen to the South West of London in particular, whereas *the Our Route to Growth* and the *Sustainable Route to Growth* see more growth in and around the key cities. Higher residential employment numbers are seen in Kent in the *Sustainable Future* and *London Hub* scenarios.

Figure 3.3.1 Total residential employment by spatial node in 2050 across the four scenarios

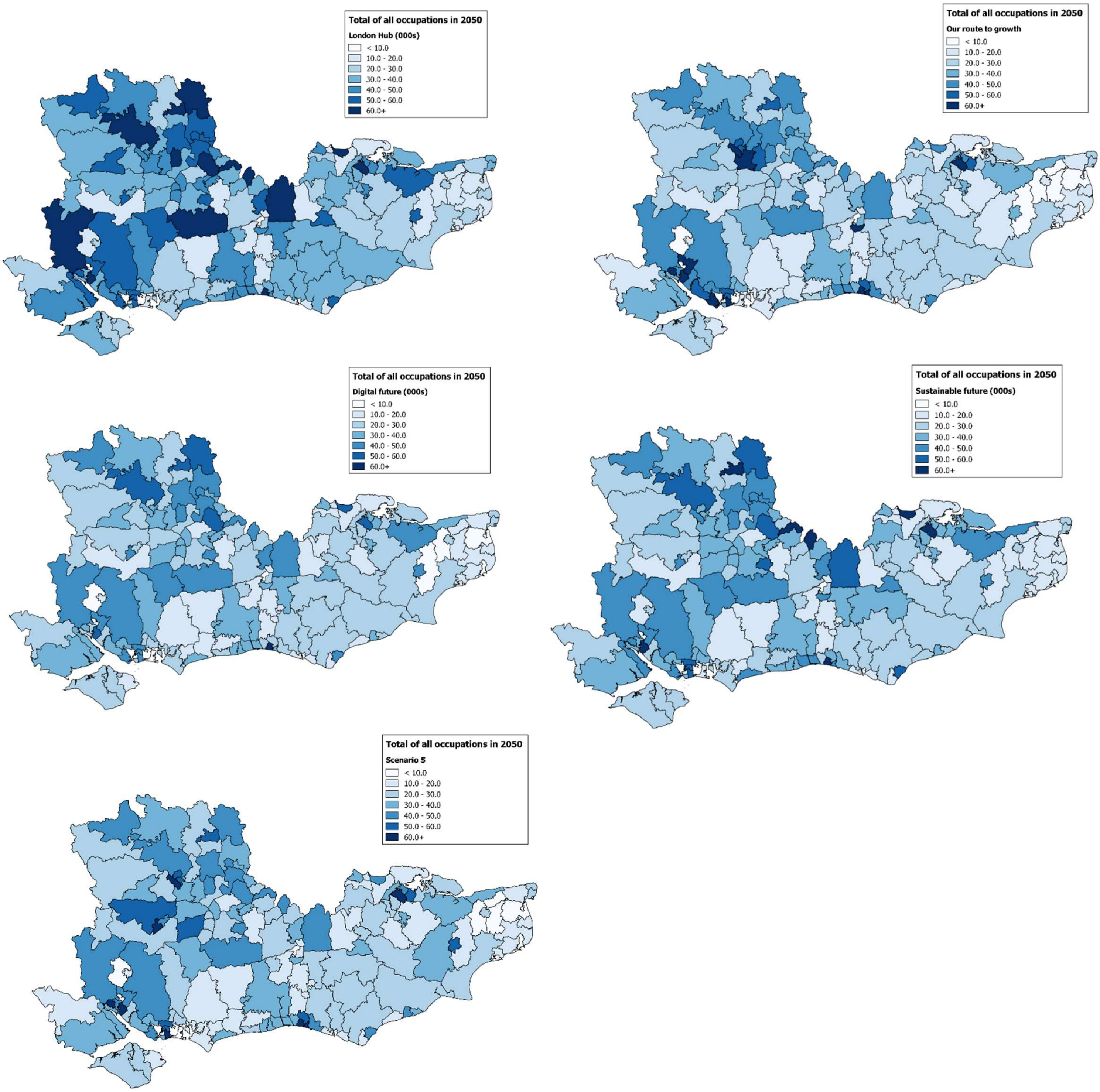
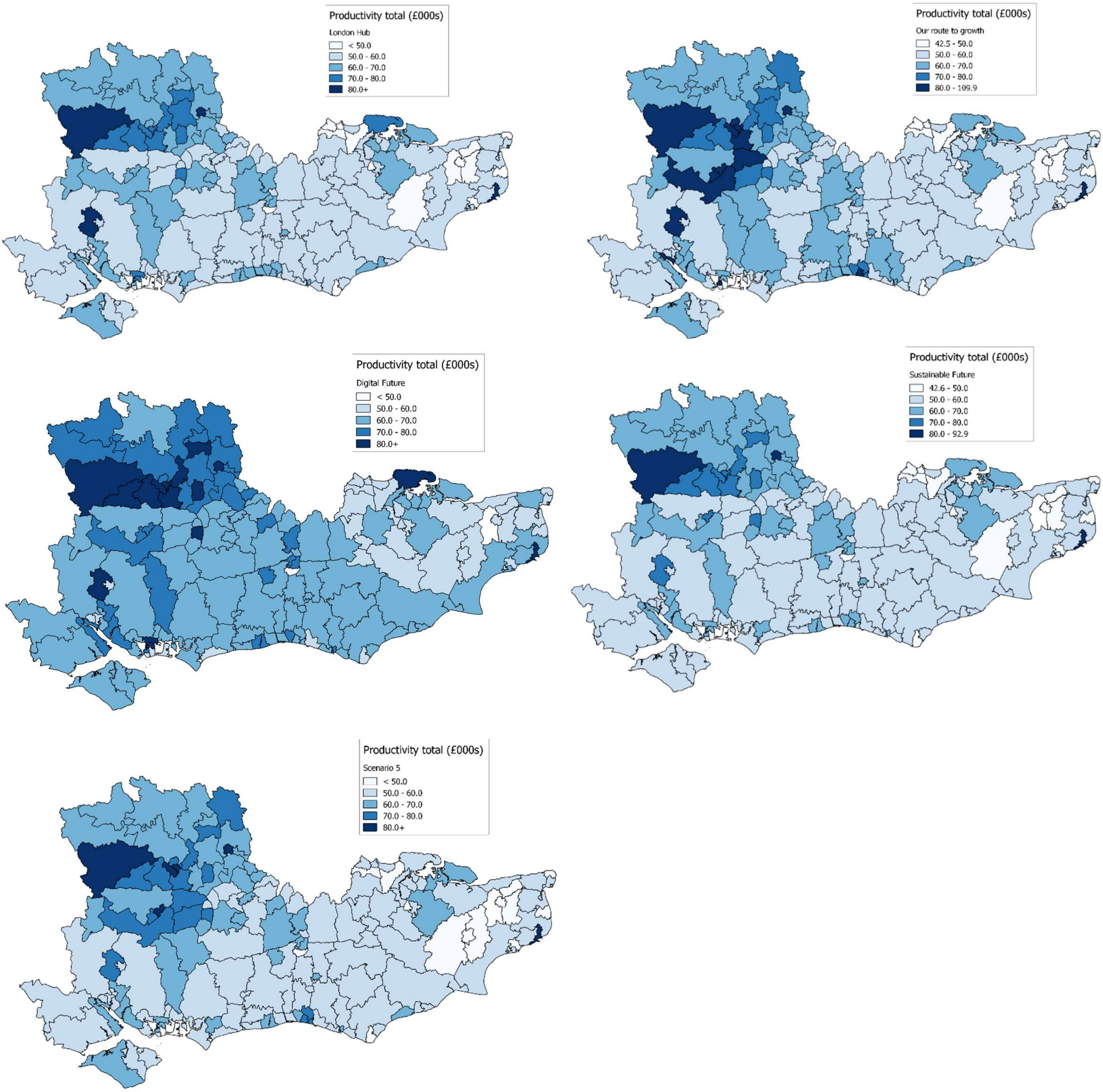


Figure 3.3.2 Total workplace employment by spatial node in 2050 across the four scenarios

Figure 3.3.2 shows total workplace employment by spatial area across the four scenarios in 2050. The patterns are broadly similar to that of residential employment, however the impact of commuting out of the region into London can be seen in the lower workplace employment figures for the *London Hub* scenario.

Figure 3.3.3 shows total workplace productivity by spatial node in 2050 across the four scenarios. Whereas the productivity growth seen in the *Our Route to Growth* scenario is closely linked to key urban areas, the *Digital Future* scenario sees significant growth right across the study area.

Figure 3.3.3 Total workplace productivity by spatial node in 2050 across the four scenarios



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Steer project/proposal number	Client contract/project number
23433704	

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Version control/issue number	Date

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