LOCAL MODEL VALIDATION REPORT

SYSTRA

MID SUSSEX STRATEGIC HIGHWAY MODEL

LOCAL MODEL VALIDATION REPORT

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1. INTRODUCTION

1.1 Commission

1.1.1 Mid Sussex District Council (MSDC) commissioned SYSTRA to:

- i. Build a strategic highway model to underpin the Mid Sussex Transport Study (MSTS);
- ii. Update the Mid Sussex Transport Study to test the impact of proposed development on the strategic and local transport network and upon significant routes in Ashdown Forest (adjacent to but outside of Mid Sussex District).

1.1.2 The work is further divided into the following stages:

- 2017 Base Year Highway Model Production and Validation (subject of this report);
- 2031 Reference Case Scenario;
- 2031 Development Scenarios including MSDC local plan developments;
- 2031 Development Scenarios including potential mitigation schemes with particular emphasis on demonstrating the impacts on the county and strategic road network including the impact on key junctions;
- Provision of detailed junction models for key junctions:

1.2 Background to the Study

1.2.1 The District Plan was submitted to the Secretary of State in August 2016 and adopted on 28th March 2018.

1.2.2 The Inspector is satisfied that it is appropriate for the Plan to contain a stepped housing trajectory, taking place after year 2023/24,at 876 dpa for the period up to 2023/24, and subsequently 1,090 dpa to 2031. Effectively this means MSDC have an agreed Plan at 876 dpa for the period to 2023/24 - with any subsequent increase primarily subject to the findings of Habitats Regulation Assessment at the higher level of development to assess the transport impact of the Plan on the Ashdown Forest.

1.2.3 The Mid Sussex Transport Study has been published in stages to support the District Plan through to adoption, the last being the Stage 3 Report (December 2016) with subsequent updates (see examination documents MSDC18 and MSDC244). Stage 3 reported on the impact of 800 dpa on the transport network. Agreement has been reached with Highways England (HE) and West Sussex County Council (WSCC) that the proposed District Plan housing requirement at 876 dpa is adequately considered by the Stage 3 Study as it is possible that virtually all the required significant interventions set out in the MSTS to mitigate the impact of development of 800 dpa per annum to 2031 (to support a total of 13,600 dwellings), will be delivered in the period up to 2023/24 (supporting a total of 6,132 dwellings at 876 dpa); and that the MSTS provides sufficient evidence to demonstrate that the additional units would also not cause harm to the highway network, subject to the implementation of required remedial intervention. This is on the

understanding that further transport modelling work will be completed to test the impact of 1,090dpa on the highway network.

1.3 Highway Model Production

1.3.1 The Mid Sussex Strategic Highway Model (MSSHM) was produced in accordance with standard good practice as set out in the DfT's WebTAG guidelines, in particular TAG unit M3-1 Highway Assignment Modelling, (January 2014). As such, the approaches to data processing, matrices and network production, along with model calibration are consistent with those of similar strategic highways models.

1.3.2 The model production made significant and appropriate use of existing data and existing models in the area. A very small programme of surveys was undertaken to fill in some gaps in data.

1.4 Transport Study

1.4.1 The impact on the highway network of the agreed Development Scenarios are assessed based on the National Planning Policy Framework (NPPF). The assessment of impacts is based on criteria agreed by MSDC and WSCC. These are derived using WSCC's position statement in relation to the NPPF which sets out their interpretation of terms defining traffic impacts.

1.4.2 Where junctions are assessed to be adversely impacted by the developments, a set of appropriate mitigation schemes are devised and tested. These mitigations aim to remove all 'severe' impacts. The proportion of the additional junction use attributable to each development site is also calculated.

1.4.3 Further work is also undertaken to:

- Undertake environmental impact and road safety impact analysis to comply with National Planning Practice Guidance on transport evidence bases in plan making. This work is expected to be undertaken for the 'preferred' development option as part of the Mid Sussex Transport Study to inform the proposed submission (Regulation 19) Site Allocations Development Plan Documents (DPD).
- Undertake air quality modelling and ecological interpretation for Habitats Regulations Assessment to test the impact of traffic, as a result of proposed development, on the Ashdown Forest Special Area of Conservation. This will be based on the outputs of the Mid Sussex Transport Study.

1.5 This Report

1.5.1 This report describes the production of the MSSHM and is structured as follows:

- Chapter 2: Key Features of the Model;
- Chapter 3: Model Standards;
- Chapter 4: Model Data;
- Chapter 5: Road Network;
- Chapter 6: Trip Matrices;
- Chapter 7: Calibration and Validation; and
- Chapter 8: Summary of Model Fitness for purpose.

2. KEY FEATURES OF THE MODEL

2.1 Software

2.1.1 The model uses SATURN software developed by Atkins and University of Leeds. The deterministic user equilibrium assignment method is used, which assumes users have perfect knowledge of journey times on the network from their origin to destination.

Geographic Coverage

2.1.2 In accordance with WebTAG Unit M3.1 Highway Assignment Modelling, the coverage of the model is organised into model areas of varying detail:

- Fully Modelled Area (FMA) as shown in **Figure 1:**
  - SATURN simulation (includes junction modelling)
  - Mid Sussex District and the Ashdown Forest plus a suitable area beyond
- External Area
  - SATURN buffer (does not include junction modelling)
  - Suitable area to accommodate all reasonable route choices for trips travelling within FMA in any part of its journey
  - Mainly motorways and A roads only

Figure 1. Fully Modelled Area

2.2 Base Year and Month

2.2.1 The base year and month is defined by the most predominant data used in matrix calibration. As in most models featuring a major trunk road or motorway this is likely to be the Highways England traffic count data, along with other permanent sites on major roads. The chosen base year and month should be the latest neutral month that can be practicably used in the model. According to DMRB (Design Manual for Roads and Bridges) guidance neutral months include:

- Late March and April -excluding the weeks before and after Easter
- May – excluding the weeks before and after bank holidays
- Most of June
- Late September
- All of October
- All of November

2.2.2 For Highways England and other permanent counts it is convenient to choose months where four full weeks of data can be used. Therefore it is considered that March, April, May and September are not suitable. The poor weather in March 2018 would also make this unsuitable. It was decided that **June 2017** would be used as the base year and month, in preference to October and November when poor weather can have an impact.

2.3 Time Periods

2.3.1 The model has the following assignment periods:

- AM peak hour (0800-0900)
- IP interpeak average hour (1000-1600)
- PM peak hour (1700-1800)

2.4 User Classes

2.4.1 The MSSHM has the following assignment user classes:

- Car;
- Light goods vehicles (LGVs); and
- Heavy goods vehicles (HGVs).

2.4.2 Additionally cars are split into three purposes:

- Car – commute / home based work
- Car – employer's business / in work
- Car – other (includes education and leisure)

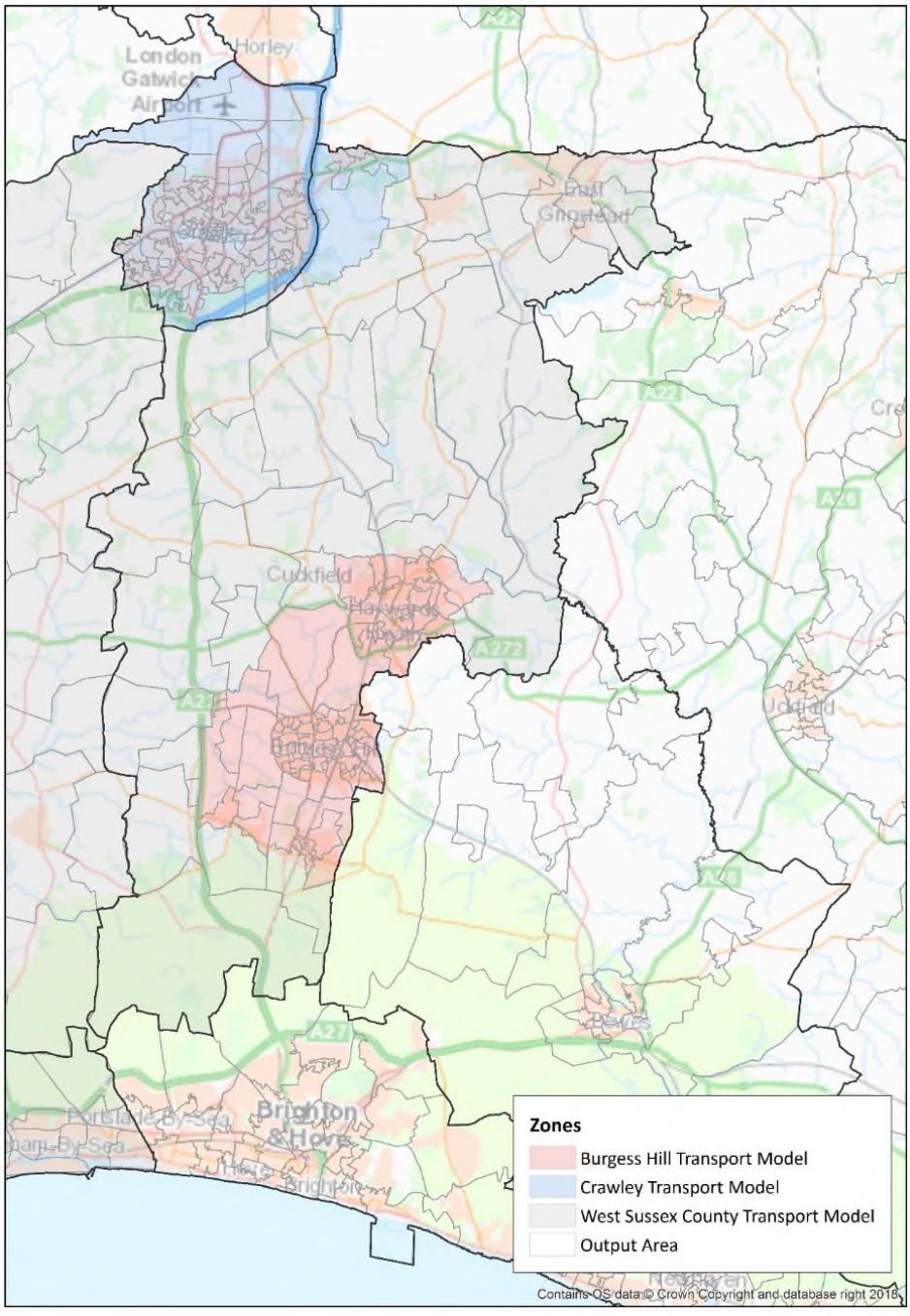
2.5 Zones

2.5.1 **Figure 2** shows the MSSHM zones system. The model has 825 zones. Several existing zone systems are combined for the MSSHM zone system:

- West Sussex County Transport Model (WSCTM) zones **(385 zones)**
- Burgess Hill Transport Model (BHTM) zones **(138 zones)**
- Crawley Transport Model (CTM) zones **(292 zones)**

2.5.2 Additionally, Middle and Lower Super Output Areas (MSOAs/LSOAs) are used for zones in neighbouring authorities. In Mid Sussex district the approach is to use the finest level of detail available from the existing systems. TEMPro areas (Middle Super Output Areas) are compatible with the zone system.

Figure 2. Zones



3. MODEL STANDARDS

3.1 Introduction

3.1.1 This chapter describes the criteria and acceptability guidelines against which the base year model is assessed in Chapter 6 (Calibration and Validation). The model should achieve the validation criteria and acceptability guidelines set out in WebTAG Unit M3-1 https://www.gov.uk/government/publications/webtag-tag-unit-m3-1-highway-assignment-modelling

3.2 Validation Criteria and Acceptability Guidelines

3.2.1 Validation involves comparing modelled and observed data. Any adjustments to the model intended to reduce the differences between the modelled and observed data are regarded as calibration.

3.2.2 The differences between modelled and observed data are quantified and assessed using the criteria described in this Chapter. The acceptability of the proportion of instances where the criteria are met is then assessed.

3.2.3 The validation of a highway assignment model includes comparisons of the following:

- assigned flows and counts totalled for each screenline or cordon, as a check of the quality of the trip matrices;
- assigned flows and counts of individual links as a check of the quality of the assignment; and
- modelled and observed journey times along routes, as a check of the quality of the network and the assignment.

3.2.4 For trip matrix validation, the measure used is the percentage difference between modelled flows and counts.

3.2.5 For link flow validation, the measures used are:

- the absolute differences between modelled flows and counts; and
- the GEH statistic which is a form of the Chi-squared statistic that incorporates both relative and absolute errors, and is defined as follows:

$$GEH = \sqrt{\frac{(M-C)^2}{(0.5\times(M+C))}}$$

where:
M is the modelled flow; and
C is the observed flow.

3.2.6 For journey time validation, the measure used is the percentage difference between modelled and observed journey times.

3.2.7 The validation criteria and acceptability guidelines for each of these measures are described as follows.

Trip Matrix Validation

3.2.8 Comparisons at screenline level provide information on the quality of the trip matrices. The validation criterion and acceptability guideline for screenline flows are defined in **Table 1** from WebTAG Unit M3-1 which is reproduced below.

Table 1. Screenline Flow Validation Criterion and Acceptability Guideline

CRITERIA	DMRB ACCEPTABILITY GUIDELINE
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines

3.2.9 With regard to screenline validation, the following should be noted:

- screenlines should normally be made up of more than 5 links;
- the comparisons for screenlines containing high flow routes such as motorways should be presented both including and excluding such routes;
- the comparisons should be presented separately for (a) roadside interview screenlines; (b) the other screenlines used as constraints in matrix estimation (excluding the roadside interview screenlines even though they have been used as constraints in matrix estimation); and (c) screenlines used for independent validation;
- the comparisons should be presented by vehicle type (preferably cars, light goods vehicles and other goods vehicles); and
- the comparisons should be presented separately for each modelled period.

Link Flow Validation

3.2.10 The validation criteria and acceptability guidelines for link flows are defined in **Table 2** from WebTAG Unit M3-1 which is reproduced below.

Table 2. Link Flow Validation Criteria and Acceptability Guidelines

CRITERIA	DMRB GUIDELINES
Individual flows within 15% of counts for flows from 700-2700 veh/h	> 85% of cases
Individual flows within 100 veh/h of counts for flows less than 700veh/h	> 85% of cases
Individual flows within 400 veh/h of counts for flows more than 2700 veh/h	> 85% of cases
GEH < 5 for individual flows	> 85% of cases

3.2.11 With regard to flow validation, the following should be noted:

- the comparisons should be presented for cars and all vehicles but not for light and other goods vehicles unless sufficiently accurate link counts have been obtained; and
- the comparisons should be presented separately for each modelled period.

Journey Time Validation

3.2.12 The validation criterion and acceptability guideline for journey times are defined in **Table 3** from WebTAG Unit M3-1 which is reproduced below.

Table 3. Journey Time Validation Criteria and Acceptability Guideline

CRITERIA	DMRB ACCEPTABILITY GUIDELINE
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher)	> 85% of routes

3.2.13 With regard to the journey time validation, the comparisons should be presented separately for each modelled period.

3.3 Convergence Criteria and Standards

3.3.1 WebTAG Unit M3-1 states that before the results of any traffic assignment are used to influence decisions, the stability (or degree of convergence) of the assignment must be confirmed at the appropriate level. The importance of achieving convergence is related to the need to provide stable, consistent and robust model results. When the model outputs are being used to compare development or infrastructure options, it is important to be able to distinguish differences due to the scheme from those associated with different degrees of convergence, i.e. model 'noise'.

3.3.2 As recommended in WebTAG Unit M3-1 SATURN provides the ability to monitor and control stopping criteria using the '%GAP' statistic which is controlled in SATURN by the parameter 'STPGAP'. This is the difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs. **Section 7.6** provides more detail on the parameters used to control and monitor convergence.

3.3.3 **Table 4** summarises the most appropriate convergence measures and the values generally considered acceptable for use in establishing a base model. Tighter levels of convergence may be required for option testing. To ensure that, during the development of the base year model, reasonable levels of assignment convergence are achieved, WebTAG Unit M3-1 states a target %GAP value of 0.1% is used – that is, sufficient iterations are carried out to achieve a %GAP of 0.1% or less on four consecutive assignment loops.

Table 4. Summary of Convergence Measures and Base Model Acceptable Values

MEASURE OF CONVERGENCE	BASE MODEL ACCEPTABLE VALUES
Delta and %GAP	less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P)<1%	four consecutive iterations greater than 98%
Percentage of links with cost change (P2)<1%	four consecutive iterations greater than 98%

4. MODEL DATA

4.1 Introduction

4.1.1 In order to undertake calibration and validation of the highway model a set of up to date traffic count data is required. The data collected are from the following sources:

- Highways England counts (Webtris)
- West Sussex County Council permanent and ad-hoc counts
- Department for Transport traffic counts
- Counts from the BHTM
- Surrey County Council
- East Sussex County Council
- Wealden District Council

4.1.2 The traffic count data is prepared for use in the model using the following Stages:

- Collation of Existing Traffic Counts
- Design of Screen Lines and Cordons
- New Traffic Counts
- Processing of Traffic Counts
- Preparation of Traffic Count Database

4.1.3 In addition journey time data is collected from TrafficMaster and Google.

4.2 Collation of Existing Traffic Counts

4.2.1 The traffic count data are collated and an inventory for each set is prepared. This is loaded into GIS (Graphical Information System) mapping using the Easting and Northing coordinates provided for each site. The count locations are shown **Figure 3.**

4.3 Design of Screen Lines and Cordons

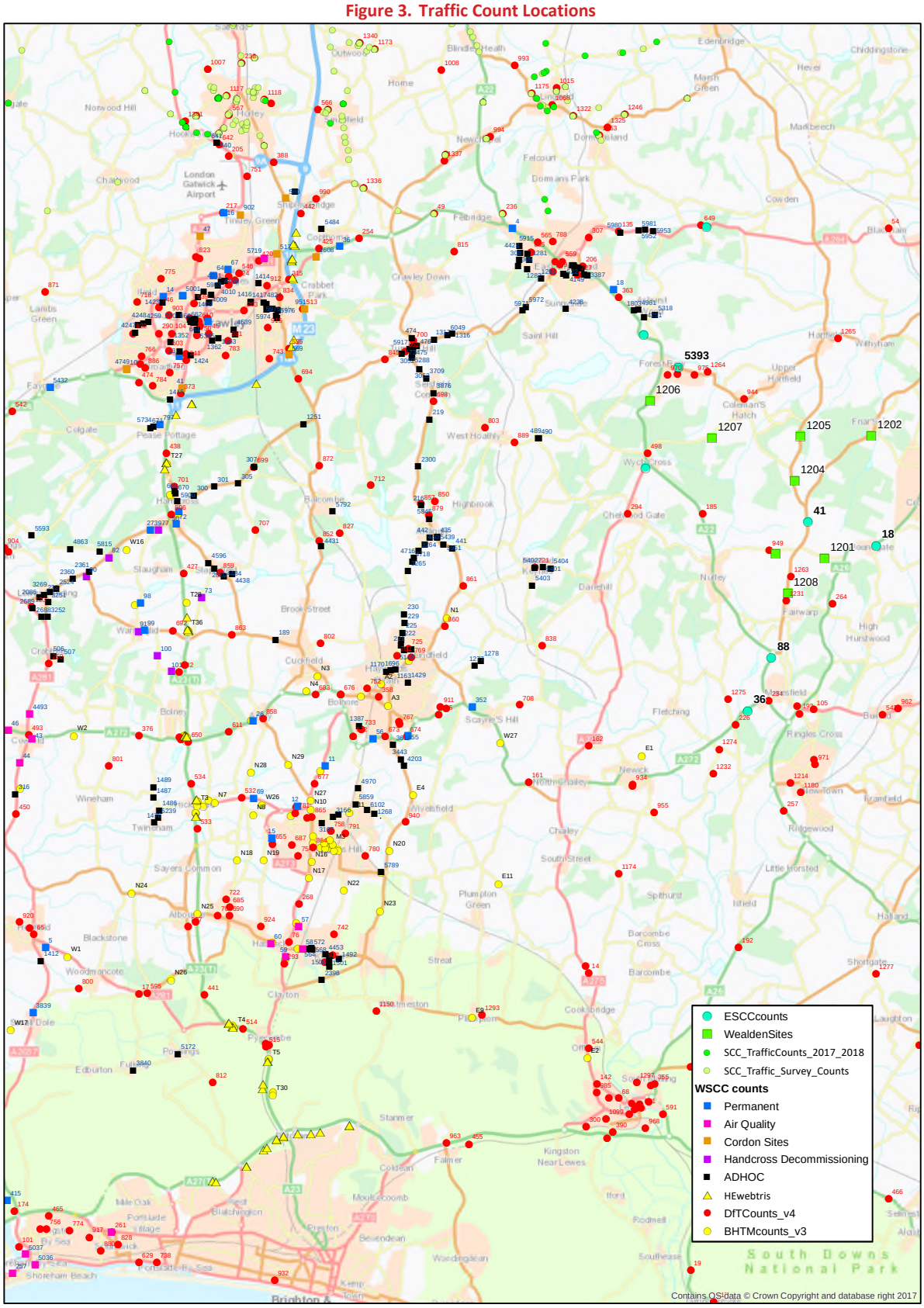
4.3.1 Screenlines and Cordons are groups of traffic count locations that are used to provide an organised structure for the use of counts in model production and to monitor and report broad movement of traffic. They are used in matrices construction, in model calibration and in validating the quality of the model.

4.3.2 The broad location of screenlines and cordons is dictated by suitable coverage and detail in accordance with good practice. However, the roads they pass through is additionally dictated by count data availability and making the best use of existing data.

4.3.3 *Cordons* are best for monitoring movements to, from and through key areas and towns. In the MSSHM cordons include:

- A large cordon broadly following the district boundary
- Cordons for the key towns, Burgess Hill, Haywards Heath and East Grinstead
- A cordon for the Ashdown Forest

Figure 3. Traffic Count Locations



4.3.4 *Screenlines* are for the purpose of monitoring broad movements across the district. Ideally they are long and cross each other to form a grid. They include:

- Long screenlines running north to south to the east and west of the A23
- East-west screenline south of the A272
- Smaller 'town' screenlines crossing Burgess Hill and Haywards Heath.

4.3.5 **Figure 4** shows the MSSHM cordons and screenlines and the locations of traffic counts used in the model production.

4.3.6 Although best use of existing data is made in designing the screenlines and cordons, some gaps or 'holes' are inevitable as shown in by the crosses on the figure. New traffic surveys are considered at these locations to ensure the screenlines and cordons are as watertight as possible, as described in the next section.

4.4 New Traffic Count Surveys

4.4.1 Locations identified as minor holes (blue crosses) are usually single track roads where surveys were not considered appropriate or good value due to the likely low flow. Some major holes on key roads were identified and new traffic surveys were undertaken at these locations as detailed in **Table 5** and shown on **Figure 4.**

Table 5. New Traffic Survey Locations

LOCATION	DESCRIPTION	DISTRICT
Monteswood Lane	Between Freshfield Lane and Treemans Road	Mid Sussex
Valebridge Road	Between Theobolds Road and Rocky Lane	Mid Sussex
Lower Church Road	Between Civic Way and St. John's Road	Mid Sussex
A2300 Northbound Slip	Between A23 and A2300 / Hickstead Lane roundabout	Mid Sussex
B2026 Edenbridge Road	Between Butcherfield Lane and B2110 Castlefields	Wealden
Chelwood Gate Road / Beaconsfield Road	Between A22 Chelwood Gate Road and Stone Quarry Road	Wealden

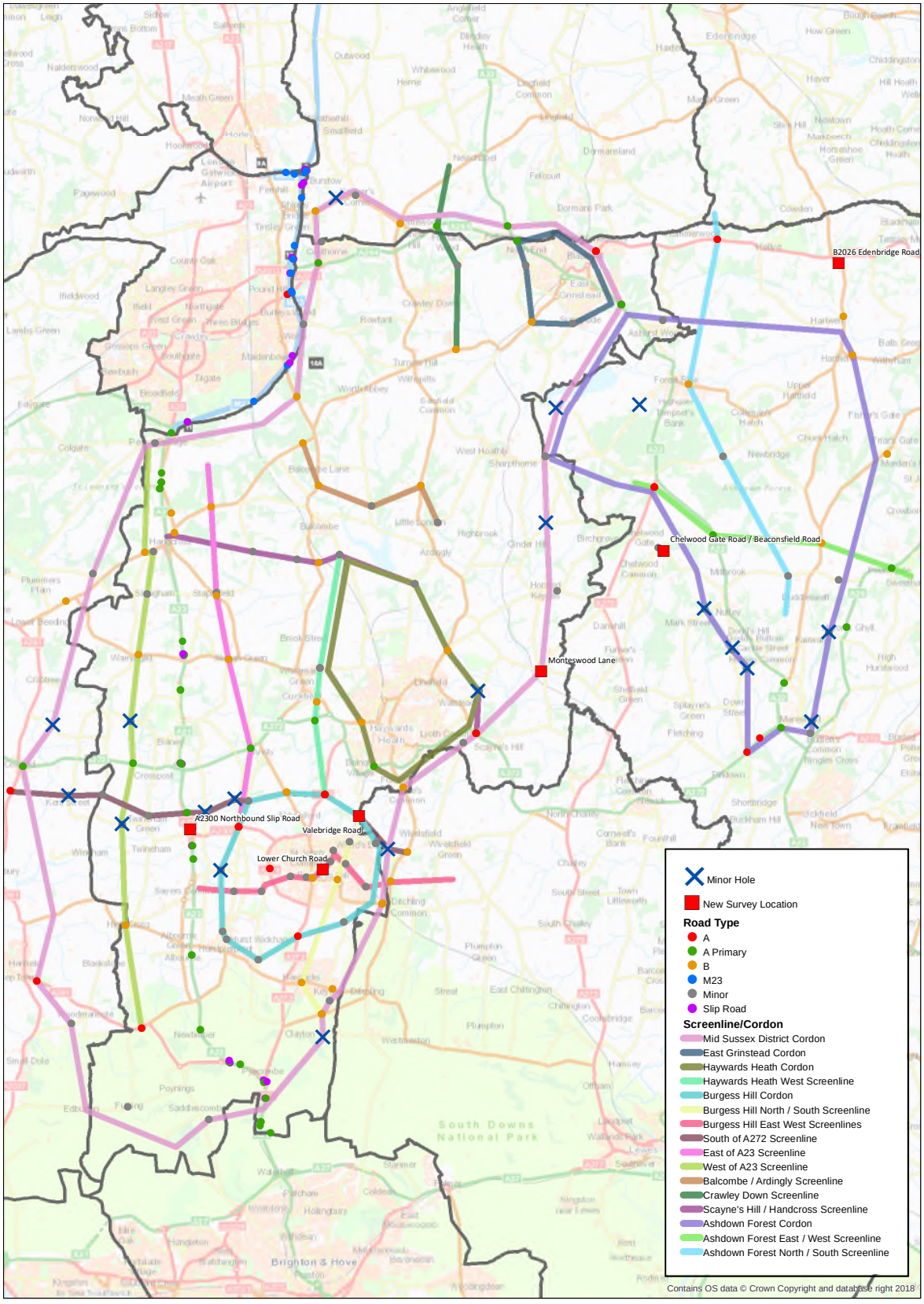
4.5 Processing of Traffic Counts

4.5.1 Traffic counts were collated from the follow datasets:

- **Highways England counts (Webtris)**
  Monday 5 June to Friday 30 June (weekdays only) is used where available

- **West Sussex County Council permanent and ad-hoc counts**
  These are extracted as required from the online system
  For permanent sites Monday 5 June to Friday 30 June (weekdays only) is used where available.
  For 'ad-hoc' sites data is used as available, usually only when less than 5 years old

Figure 4. Cordons and Screenlines with New Survey Locations



- **Department for Transport traffic counts**
  All counts for West Sussex, East Sussex and Surrey were extracted. As they were already processed the provenance is not fully understood. However, the accompanying guidance note states:

  "Raw manual counts dataset is the actual data collected by trained enumerators to feed into road traffic estimates….
  ….A raw count represents the number of vehicles of each type that flowed past a given point on that day broken by direction and hour. Major roads include Motorway and A-class roads."

  Theses counts are considered suitable for use where other data is not available.

- **Counts from the BHTM**
  Traffic count data used in the production of the BHTM was provided. This was predominantly dated 2015.

- **Surrey County Council (SCC)**
  SCC provided locations of all their available traffic count data. A selection of sites were requested in the Tandridge District to the north of Mid Sussex.

- **East Sussex County Council (ESCC)**
  ESCC provided existing and newly collected automatic traffic count data.

- **Wealden District Council (WDC)**
  WDC provided a set of existing counts located in the area of the Ashdown Forest.

Data Cleaning

4.5.2 A cleaning process was undertaken to remove anomalous data, resulting from incidents, equipment faults or other problems. For permanent counters the four weeks of June 2017 (Monday 5 June to Friday 30 June – weekdays only) are processed where available.

4.5.3 The processing is a part automated, part manual process and ensures consistency of approach. The steps are as follows:

Step A Raw data entry: The data is passed from the raw datasets to the analysis spreadsheet. At this point all recorded data is included.

Step B Initial analysis: The average (mean), maximum and minimum values are calculated for each location The analysis is undertaken for every row, i.e., by site, direction and hour for across all of the days on which data was collated (up to 20 weekdays for each direction).

Step C Remove anomalous counts: The maximum and minimum daily count for each direction are analysed to identify anomalies. Outlying days are removed manually until the maximum and minimum count are within approximately 20% of the average.

Step D: Finalise for Count Database: Final checks are undertaken before the average counts are passed to the count database for use in the model.

4.6 Traffic Count Database

4.6.1 Once processed the traffic counts are presented in a common format using MS Excel spreadsheets. This makes the data accessible for analysis and use across all the data sets. It also means it can be conveniently accessed and used for other non-modelling purposes if desired. The database is directly linked to GIS allowing easy navigation of data.

4.6.2 The count database includes an output sheet which presents all count sites by direction, with classified counts (Car, LGV, HGV) for the model periods (AM 0800-0900, average inter-peak 1000-1600 and PM 1700-1800). This output is then used as the main input for use of traffic counts in the model, i.e. for matrix updates, calibration and validation.

4.6.3 **Table 6** shows a summary of the analysis undertaken to provide vehicle class proportions to disaggregate counts into Car, LGV and HGV. The table shows proportions for traffic counts where full vehicle classification is available. These proportions are then used to 'infill' traffic counts where only a total vehicle count is available. Observation of the range proportions for each road type showed that they are broadly consistent for road type and period, with no particular geographical trends for the Mid Sussex area. Therefore it is considered appropriate to apply the factors globally by road type and period.

Table 6. Traffic Counts (Vehicles) by Road Type and Vehicle Class

ROAD TYPE	AM			INTER-PEAK			PM		
	Car	LGV	HGV	Car	LGV	HGV	Car	LGV	HGV
Motorway	77.5%	14.9%	7.7%	72.6%	17.6%	9.8%	82.8%	12.6%	4.6%
A	83.2%	13.3%	3.5%	79.7%	15.7%	4.6%	87.8%	11.0%	1.3%
B	86.2%	12.0%	1.8%	82.3%	14.9%	2.8%	88.6%	10.8%	0.6%
C	87.6%	11.0%	1.4%	84.1%	13.9%	2.0%	89.0%	10.6%	0.4%
unclassified	88.3%	10.5%	1.2%	84.2%	14.0%	1.9%	89.8%	9.7%	0.5%
Overall	83.2%	13.1%	3.7%	79.2%	15.8%	5.0%	87.3%	11.1%	1.6%

4.7 Journey Times

4.7.1 The journey time routes are summarised in **Table 7** and mapped in **Appendix A**.

Table 7. Journey Time Routes

ID	Journey Time Route	Distance (km)	ID	Journey Time Route	Distance (km)
1	Cowfold - Burgess Hill	13.6	9	Hurstpierpoint - Cowfold	12.5
2	Burgess Hill - Crawley	22.9	10	Crawley - East Grinstead	13.5
3	Burgess Hill - East Grinstead	23.2	11	Haywards Heath - Crawley	19.3
4	Burgess Hill - Haywards Heath	6.1	12	Hurstpierpoint - Crawley	23.2
5	Hurstpierpoint - Burgess Hill	8.6	13	Haywards Heath - East Grinstead	18.1
6	Cowfold - Crawley	21.3	14	Hurstpierpoint - East Grinstead	36.1
7	Cowfold - East Grinstead	26.5	15	Hurstpierpoint - Haywards Heath	12.1
8	Cowfold - Haywards Heath	13.0			

5. ROAD NETWORK

5.1 Introduction

5.1.1 The road network is represented by two levels of network detail, the fully modelled area (FMA) and external area. **Table 8** outlines the different regions.

Table 8. Network Structure by Model Area

NETWORK TYPE	MODEL AREA	MODELLING DESCRIPTION
Simulation network	Fully Modelled Area	Junction capacity restraints are explicitly modelled for priority junctions, roundabouts, and signalised junctions considering the interaction of different movements. As shown in Figure 1.
Speed / flow network	External Area	Capacity restraint is based on speed versus flow curves, where increased flows on a particular link result in increased travel times along that link

5.1.2 The core fully modelled area includes all motorways, A roads, B roads and minor roads and other roads considered to carry high volumes of traffic. Professional judgment of the project team was used to assess which minor roads have sufficiently high volumes of traffic to warrant inclusion. Furthermore, the client, and related consultants have been consulted with to ensure all appropriate roads have been included.

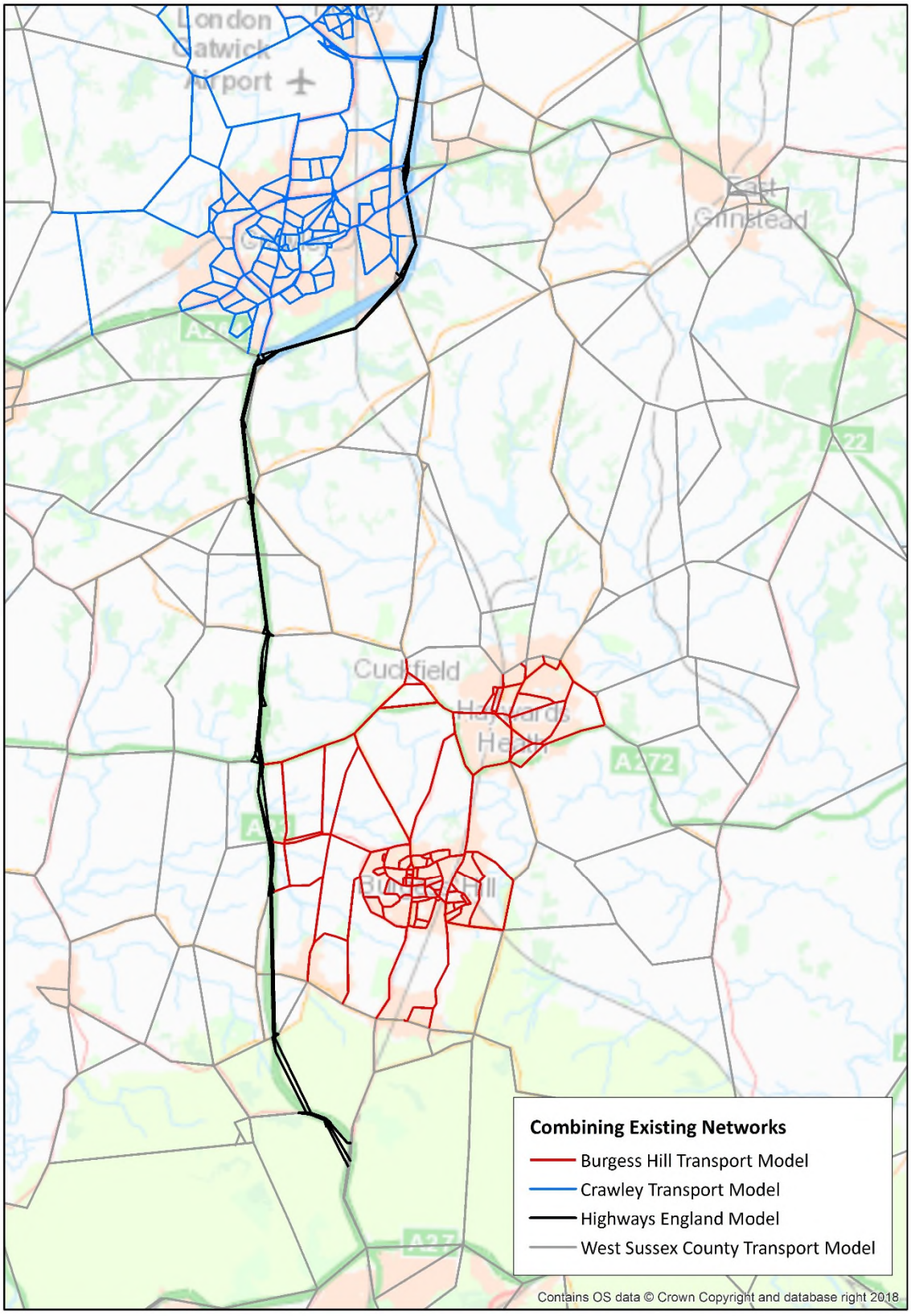
5.1.3 The road network represented in the external area reduces in density with distance from the core fully modelled area. This mirrors the zone system used in the MSSHM. In the districts surrounding Mid Sussex, all motorways, A roads and key strategic routes are included. At a regional level however, a skeletal network is used, covering only main routes into the area.

5.2 Method

5.2.1 The MSSHM uses several existing models to produce a road network with an appropriate level of detail for the model purpose. The existing models have different purposes and therefore cover different areas in and around Mid Sussex. The WSCTM for example, provides sufficient detail for the entire West Sussex area, whereas the BHTM and CTM models have greater detail of the road networks in Burgess Hill and Crawley respectively. To establish a detailed road network of Mid Sussex, the most detailed areas of each model have been combined to form the MSSHM. The models are listed below, with the road used from each model being represented in **Figure 5.**

- The West Sussex County Model (WSCTM)
- Burgess Hill Transport Model (BHTM)
- Crawley Transport model (CTM)
- Highways England M23 Junction 8-10 Model

Figure 5. Existing networks combined for the MSSHM



5.3 Network Review

5.3.1 The models used to establish the road network have different base years, and therefore have be audited against the road network in 2017, the base year of the MSSHM.

5.3.2 By using web-based portals, such as road maps, aerial photography, and ITN networks, an audit has been conducted to ensure all strategic roads are included in the network. A GIS shapefile, including all roads in the West Sussex County was also used. The shapefile contains supplementary information, including the following:

- Road class
- Road length
- Speed limit

5.3.3 The modelled speed of the roads within the network should not be solely based on the speed limit. This would assume that vehicles travel at the speed limit for the full length of the road. In reality, it takes time for vehicles to accelerate after entering a road, and decelerate when approaching a junction, and on some minor, rural roads, traffic may never travel at the speed limit due to the road conditions. To represent this behaviour accurately, and to ensure speeds are modelled consistently throughout the MSSHM, standards have been developed. The standards use a factored speed limit, established by the attributes in **Table 9**, to determine the cruise speed of roads in the model.

Table 9. Attributes used to determine modelled cruise speed

ATTRIBUTE	DESCRIPTION
Speed limit	Sign-posted speed limit As shown in **Figure 6**.
Road classification	Motorway Slip Road A Road B Road C Road Other. As shown in **Figure** 7.
Area type	Whether the geographical area is classified as urban or rural. Urban settlements are defined as having a resident population greater than 10,000, whereas rural settlements have less than 10,000. As determined in the Rural Urban Classification, published as an official statistic as part of the 2011 Census. As shown in **Figure 8**.
Lanes	The number of lanes on the road, by direction.

Figure 6. Speed Limits

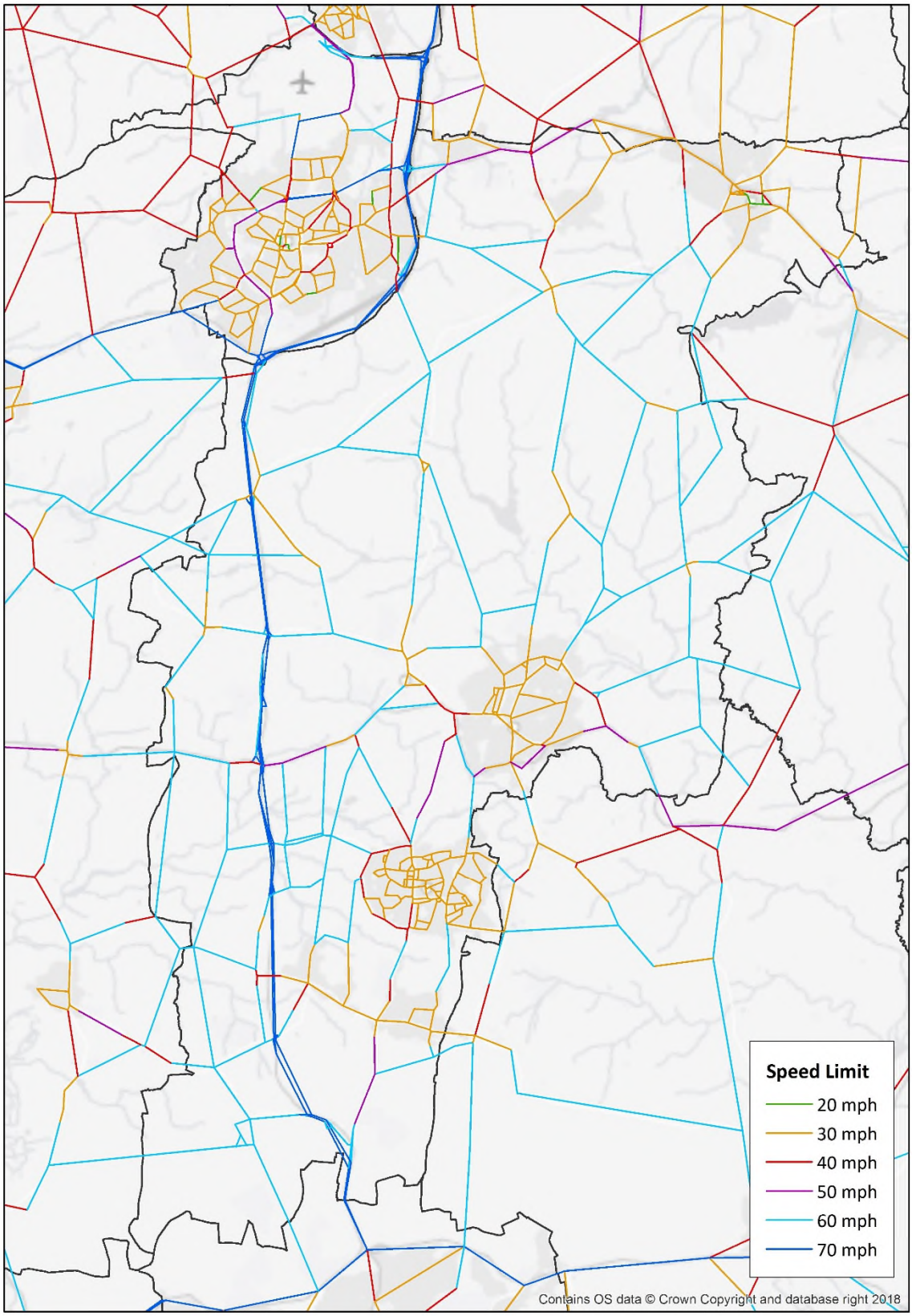


Figure 7. Road classification

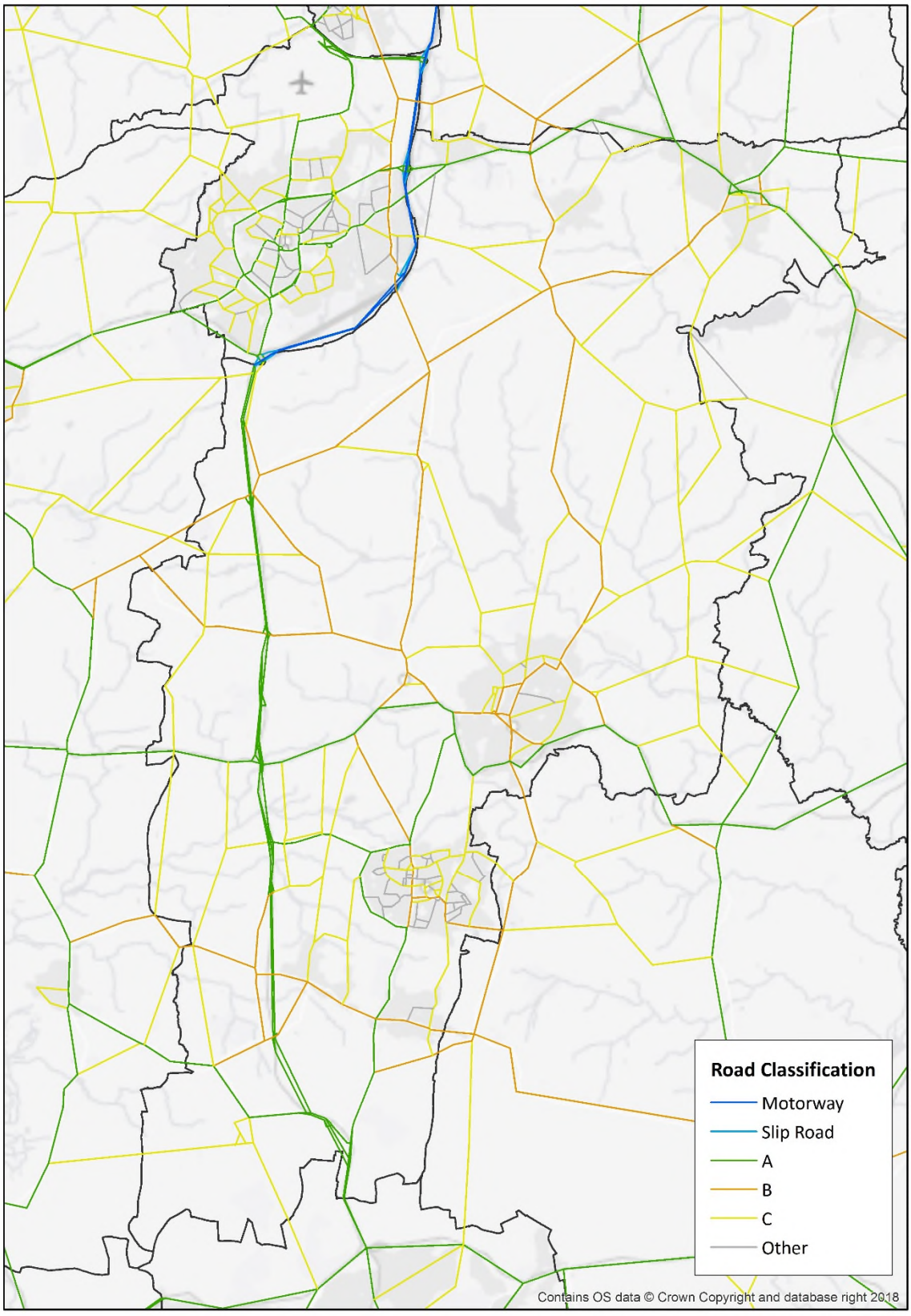
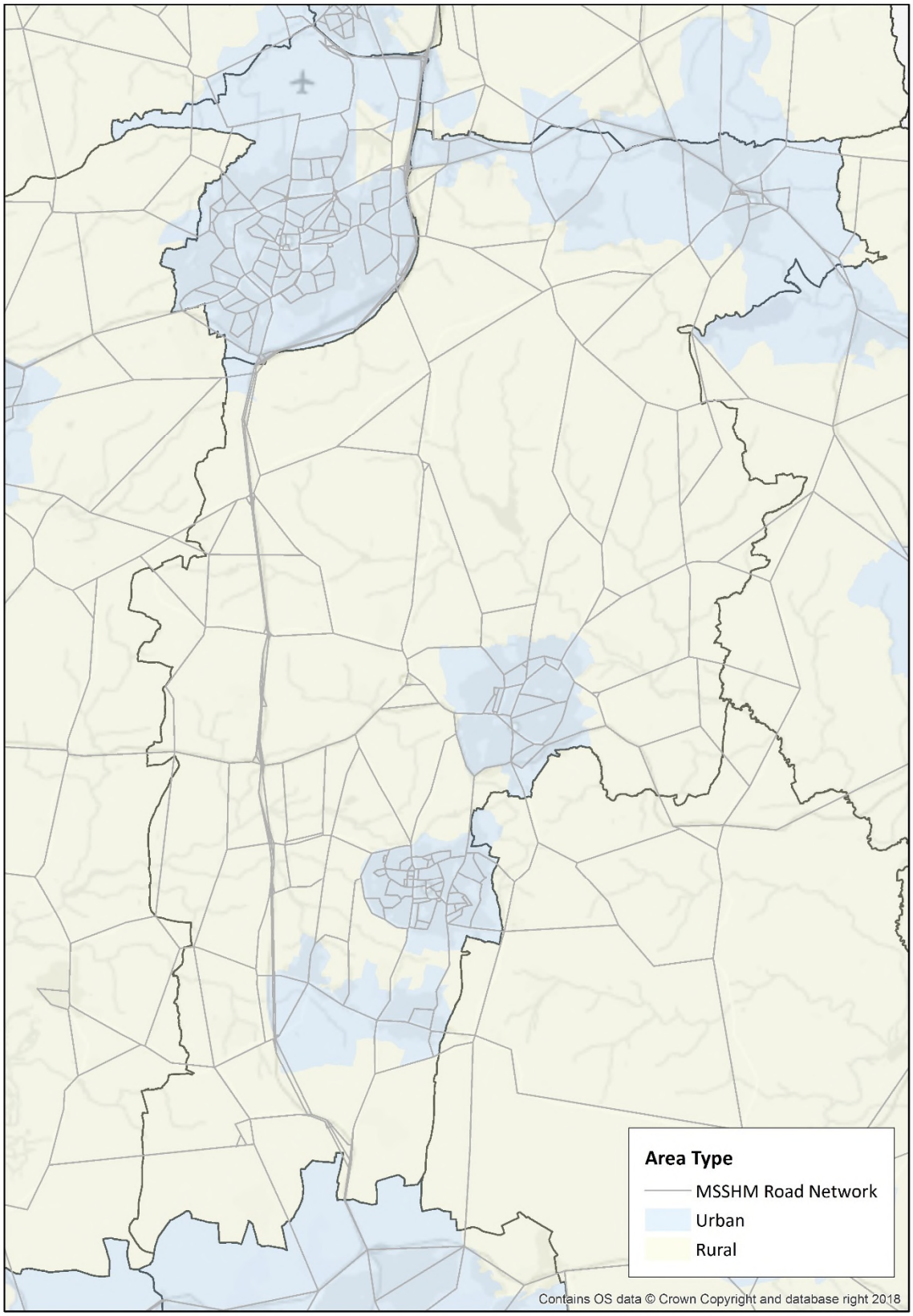


Figure 8. Area type



5.4 Junction Modelling

5.4.1 The design of a junction determines the capacity, in terms of the volume of traffic able to pass through the junction in a defined period of time. Saturation flow represents this measure, describing the number of passenger car units able to pass through the junction on a particular turning movement during one hour of unopposed flow i.e. assuming that no traffic is making another conflicting movement through the junction during this time.

5.4.2 To ensure further consistency across the model, saturation flows have been standardised alongside model speeds. The factors listed in **Table 10** have been used to identify, and implement standards in the MSSHM.

Table 10. Attributes used to determine modelled saturation flows

ATTRIBUTE	DESCRIPTION
Junction type	i.e. Priority junction, roundabout, mini-roundabout, signalised junction, zone access
Approach lanes	The number of lanes at the junction stop line
Volume of traffic	The volume of traffic passing through the junction
Opposing traffic flows	Including give way, merging traffic, and opposed right turns

5.4.3 Each node and link is run through the SATURN network build module, SATNET to ensure no serious errors or warnings exist in the model.

5.4.4 The gap acceptance has been adopted based on practical experience of calibrating and validating SATURN based models, and existing models. The following values have been used in the simulation road network:

- 1.5 seconds for priority junctions or traffic signals;
- 0.75 seconds for merging turns; and
- 1.25 seconds for roundabouts.

5.5 Zone Loading Locations

5.5.1 The location of zone loading points ensures the loading of traffic onto the network is realistic. By using aerial photography and technical experience, patterns of traffic movements and feeding points of local traffic onto strategic roads have been identified.

5.6 Assignment Parameters

5.6.1 Generalised cost parameters are used in the model to determine the minimum cost route by which traffic is assigned onto the network. The parameters required are pence per minute (PPM), and pence per kilometre (PPK). These are calculated by using value of time (VOT), vehicle operating costs (VOC), and vehicle occupancies from the WebTAG Databook - March 2018 Release v1.7. PPM and PPK figures are read into SATURN by user class and time period.

6. TRIP MATRICES

6.1 Introduction

6.1.1 This Chapter summarises the methodology for production of the base year trip matrices. These matrices were later calibrated using matrix estimation; the trip matrix validation results are reported in Chapter 7. The matrices described in this section are referred to as 'prior' matrices.

6.1.2 The 2017 base year highway trip matrices are produced for the periods and user classes/purposes described in Chapter 2. Several sets of existing matrices and data were available for use in matrices production, including:

- West Sussex Mobile Network Data (MND) matrices
- West Sussex County Transport Model (WSCTM) matrices
- Burgess Hill Transport Model (BHTM) matrices
- Crawley Transport Model (CTM) matrices
- Census Travel to Work 2011

6.1.3 The approach used for the MSSHM matrices was to make the best use of these existing matrices and data in combination. The MSSHM zone system and matrices have been developed to be compatible with the systems listed above, along with Middle Super Output Areas (MSOAs) .

6.2 Data Analysis

Suitability of Existing Data

6.2.1 The existing datasets were analysed to assess suitability for use in the MSSHM. The BHTM and CTM matrices have base years of 2015 and were constructed using the MND matrices. The WSCTM is a well-established model and has a base year of 2010. The following key analysis was undertaken:

- Analysis of year to year trends (this was required to ascertain whether adjustment factors need to be applied to data used)
- Census Travel to Work 2011 (to confirm suitability for commuting trip patterns)
- West Sussex Mobile Network Data (MND), to confirm its suitability for use as applied in the BHTM and CTM matrices, here using a direct comparison to Census Travel to Work 2011

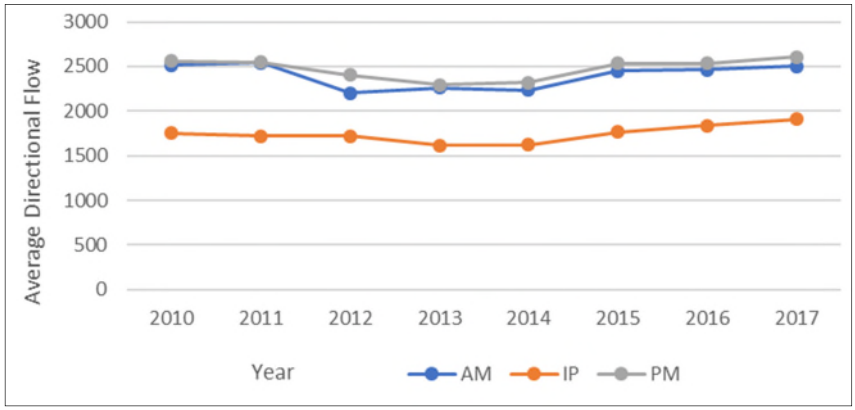
Analysis of Year to Year Trends

6.2.2 The existing data and models used in the MSSHM matrices have varied base years. Therefore it is appropriate to investigate whether adjustments should be made to ensure existing data reflects 2017 volumes of traffic before they are used for the MSSHM.

6.2.3 An analysis of year to year trends in traffic flows was undertaken using Highway England permanent traffic counts. Ten sites were identified on the M23 and A23 for which data

was available for the month of June for every year from 2010 to 2017. **Figure 9** shows the year to year variation of the average traffic flow across these sites, for the three model periods, AM, IP and PM.

Figure 9. Year to Year Traffic Flow Trends: 2010-2017



6.2.4 The key years which require consideration are 2010 (WSCTM), 2011 (Census Travel to Work), 2015 (BHTM and CTM), and 2017 (MSSHM). The analysis shows that for these years, for AM and PM in particular the trend is reasonably consistent, with similar volumes across the four years being considered. All periods show a dip from 2012 to 2014, before returning to 2010/2011 volumes by 2015. This dip was likely to be due to the A23 Handcross to Warninglid works and also possibly Smart Motorway works on the M25.

6.2.5 It was concluded that year to year adjustment factors do not need to be applied to the existing data.

Census Travel to Work 2011

6.2.6 It is considered that although now several years old this data still provides a realistic distribution for home to work trips, due mainly to its very high sample rate and full geographic coverage. However, to confirm this and familiarise with the local commuting patterns an analysis of this data was undertaken for a suitable MSOA based sector system which is shown in **Figure 10.**

6.2.7 **Table 11** shows the matrix of car driver home to work trips for the colour coded sector system.

West Sussex Mobile Network Data (MND)

6.2.8 Similarly to the Census data the MND data was analysed to confirm its suitability for use. The home to work AM peak MND matrices were converted to the same sector system so that a direct comparison could be made to the Census Travel to Work data. This resulting matrix is shown in **Table 12.**

6.2.9 In terms of the overall pattern of trips, it is considered that, where comparable, the correlation between the Census and MND matrices is reasonable, confirming the MND matrices suitability for use in the MSSHM.

Figure 10. Mid Sussex MSOAs

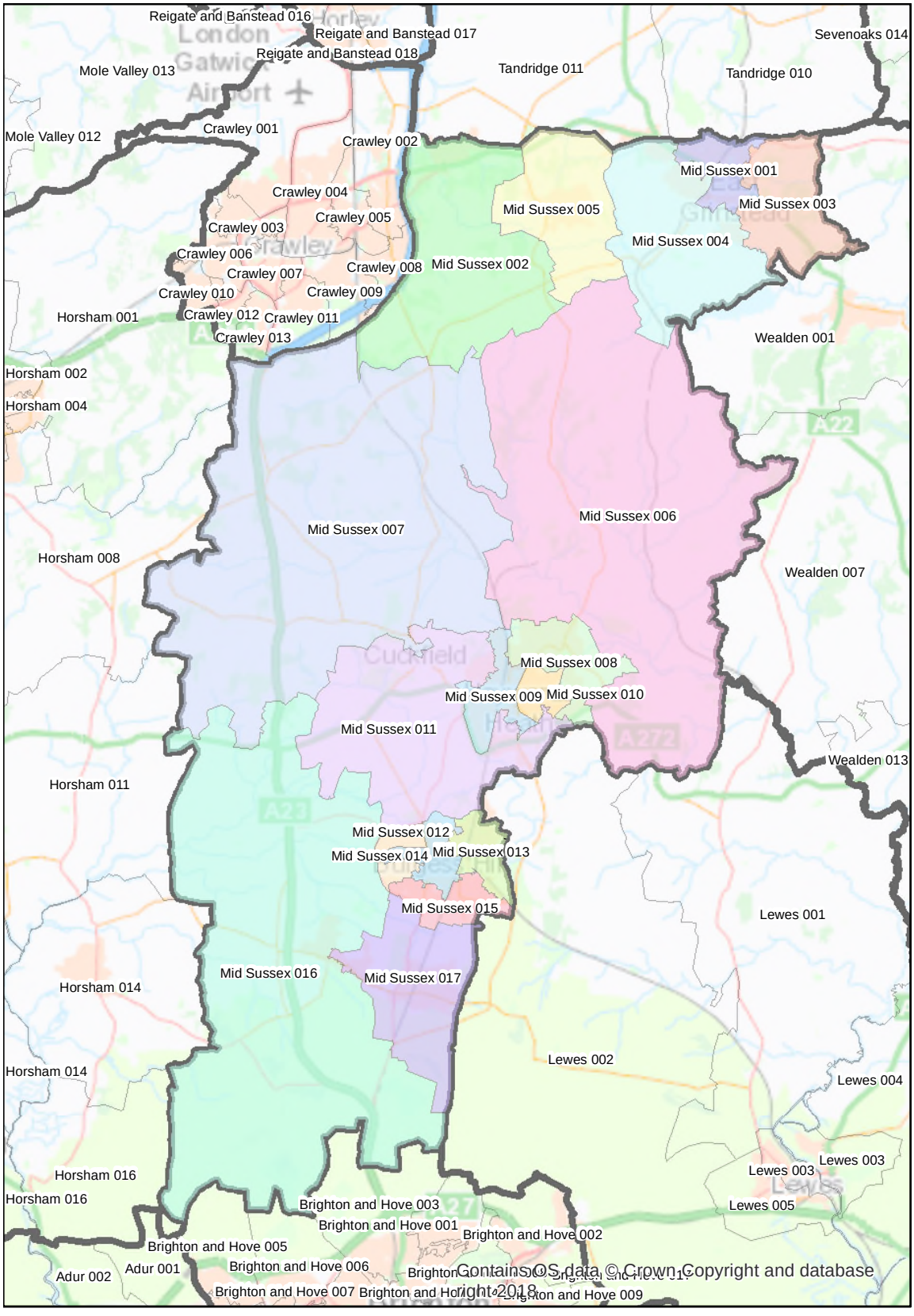


Table 11. Census Travel to Work 2011 (Car Driver)

		East Grinstead Central/North	Copthorne	East Grinstead East, Ashurst Wood	East Grinstead West, Saint Hill	Crawley Down	Horsted Keynes, Scaynes Hill	Staplefield, Balcombe	Haywards Heath - Lindfield	Haywards Heath - West	Haywards Heath Central	Ansty, Cuckfield	Burgess Hill - West	Burgess Hill - East	Burgess Hill - Central	Burgess Hill - South	Hickstead, Albourne	Hassocks	West Sussex (rest)	Brighton and Hove	East Sussex	Surrey	South East (rest)	Rest of UK	
001	East Grinstead Central/North	514	28	74	227	39	48	14	13	34	3	8	7	1	7	5	11	3	624	32	196	742	195	267	3,092
002	Copthorne	86	104	12	33	34	23	20	6	30	1	6	9	3	15	12	9	0	784	22	37	463	57	202	1,968
003	East Grinstead East, Ashurst Wood	492	28	106	178	21	41	10	10	25	3	14	3	0	7	9	11	1	448	25	211	489	151	179	2,462
004	East Grinstead West, Saint Hill	376	22	51	126	14	33	9	10	25	2	10	2	0	6	5	4	1	434	17	132	404	130	184	1,997
005	Crawley Down	157	59	21	41	76	32	13	7	18	0	11	7	1	15	8	5	3	663	30	52	430	71	173	1,893
006	Horsted Keynes, Scaynes Hill	79	26	15	25	6	169	23	73	156	21	67	15	7	30	26	24	6	342	55	216	161	57	130	1,729
007	Staplefield, Balcombe	25	23	6	11	6	29	153	34	102	12	80	27	3	34	21	46	11	630	74	78	224	64	150	1,843
008	Haywards Heath - Lindfield	40	16	5	16	4	95	46	146	292	56	146	26	3	66	55	46	15	428	128	194	133	69	114	2,139
009	Haywards Heath - West	28	11	4	15	5	90	48	58	297	33	154	57	8	94	59	60	12	624	154	217	158	64	130	2,380
010	Haywards Heath Central	28	8	1	10	9	88	50	108	253	53	108	18	7	69	46	44	8	350	92	148	106	42	76	1,722
011	Ansty, Cuckfield	39	14	9	13	4	89	57	99	308	65	167	25	10	99	51	58	17	495	149	191	150	53	149	2,311
012	Burgess Hill - West	17	6	1	6	6	25	38	32	243	19	112	86	20	251	126	86	39	535	186	160	116	46	105	2,261
013	Burgess Hill - East	19	3	1	2	9	17	36	42	228	19	128	99	38	242	144	101	50	402	202	215	103	42	88	2,230
014	Burgess Hill - Central	14	8	1	11	7	40	46	31	207	13	113	96	33	222	130	113	66	446	197	226	102	50	96	2,268
015	Burgess Hill - South	23	8	1	6	5	12	17	25	158	13	87	60	11	165	116	61	38	339	171	166	82	39	69	1,672
016	Hickstead, Albourne	8	1	3	5	3	21	36	24	96	15	75	35	12	130	60	226	81	509	396	156	93	46	121	2,152
017	Hassocks	17	1	4	8	4	20	15	35	138	16	69	39	12	172	104	133	121	424	384	239	66	37	77	2,135
	West Sussex (rest)	556	448	43	315	172	161	519	140	797	59	342	380	26	526	341	567	79	119,089	8,529	2,112	14,191	9,376	7,879	166,647
	Brighton and Hove	84	35	21	60	25	61	79	55	382	54	284	245	28	486	259	461	150	8,530	21,713	4,305	1,205	869	2,253	41,644
	East Sussex	666	73	108	244	41	348	84	163	781	77	376	197	24	416	280	359	90	4,133	7,212	85,076	1,770	10,296	4,517	117,331
	Surrey	557	139	58	279	88	44	94	30	129	9	40	49	1	40	52	45	3	9,210	290	358	173,193	34,191	66,206	285,105
	South East (rest)	334	37	28	124	19	32	31	17	81	9	17	52	3	31	42	35	2	11,419	381	4,102	49,092	1,285,464	178,128	1,529,480
	Rest of UK	166	75	11	132	16	45	49	18	107	9	22	228	6	47	140	86	2	7,891	707	1,386	52,507	180,732	10,574,760	10,819,142
		4,325	1,173	584	1,887	613	1,563	1,487	1,176	4,887	561	2,436	1,762	257	3,170	2,091	2,591	798	168,749	41,146	100,173	295,980	1,522,141	10,836,053	12,995,603

Table 12. MND Home to Work (AM)

		East Grinstead Central/North	Copthorne	East Grinstead East, Ashurst Wood	East Grinstead West, Saint Hill	Crawley Down	Horsted Keynes, Scaynes Hill	Staplefield, Balcombe	Haywards Heath - Lindfield	Haywards Heath - West	Haywards Heath Central	Ansty, Cuckfield	Burgess Hill - West	Burgess Hill - East	Burgess Hill - Central	Burgess Hill - South	Hickstead, Albourne	Hassocks	West Sussex (rest)	Brighton and Hove	East Sussex	Surrey	South East (rest)	Rest of UK	
001	East Grinstead Central/North	186	47	71	105	74	22	8	1	17	8	8	1	1	10	2	3	0	581	20	247	560	201	118	2,291
002	Copthorne	184	5	8	78	119	3	17	1	10	7	65	7	0	5	0	26	0	875	15	32	278	33	51	1,819
003	East Grinstead East, Ashurst Wood	185	19	11	183	115	20	5	4	19	4	17	3	0	0	2	3	0	286	9	133	448	181	89	1,736
004	East Grinstead West, Saint Hill	219	31	31	55	91	18	17	14	16	8	4	1	2	2	4	1	0	369	5	122	252	125	77	1,464
005	Crawley Down	130	4	55	27	21	13	17	4	8	1	8	1	0	3	0	4	0	420	7	65	205	49	55	1,097
006	Horsted Keynes, Scaynes Hill	107	16	7	83	9	20	12	8	65	8	85	13	13	60	1	18	5	352	20	181	201	74	32	1,390
007	Staplefield, Balcombe	28	21	6	18	7	2	6	10	52	0	42	14	6	30	13	4	4	712	35	47	134	28	53	1,272
008	Haywards Heath - Lindfield	34	12	11	7	7	23	20	16	84	28	211	96	11	164	46	38	13	373	61	190	60	29	12	1,546
009	Haywards Heath - West	44	4	3	11	3	35	52	55	117	13	672	83	15	149	26	20	13	453	131	187	50	28	19	2,183
010	Haywards Heath Central	26	9	3	6	0	17	8	14	59	4	209	38	22	129	31	10	2	208	49	161	23	21	11	1,060
011	Ansty, Cuckfield	33	0	7	4	7	15	70	24	58	62	91	62	18	135	42	23	27	421	97	168	52	29	27	1,472
012	Burgess Hill - West	28	10	2	2	0	31	38	49	142	33	213	2	0	10	42	45	75	331	179	138	75	17	24	1,486
013	Burgess Hill - East	17	3	0	5	8	30	71	50	95	59	128	34	9	99	29	46	19	268	130	198	38	22	6	1,364
014	Burgess Hill - Central	18	7	2	4	2	39	41	29	204	35	182	1	0	52	56	39	33	441	342	168	73	21	24	1,813
015	Burgess Hill - South	6	1	0	3	0	17	11	15	64	13	39	11	0	113	42	84	1	238	365	166	31	15	7	1,242
016	Hickstead, Albourne	24	4	0	0	3	7	38	16	55	5	140	13	2	22	42	17	99	542	347	88	74	22	21	1,581
017	Hassocks	14	8	1	4	5	24	27	26	124	15	47	12	45	82	24	132	40	339	591	186	49	17	21	1,833
	West Sussex (rest)	588	473	85	238	239	163	313	122	390	51	364	540	54	446	141	438	136	120,341	11,711	1,871	12,248	5,704	3,659	160,315
	Brighton and Hove	65	34	8	37	17	33	64	46	193	18	125	284	55	429	207	358	232	7,862	64,066	9,433	463	577	294	84,900
	East Sussex	804	60	129	227	108	171	193	181	717	119	392	158	17	442	158	239	108	2,983	10,126	21,724	1,246	8,923	853	50,078
	Surrey	672	119	236	300	100	13	37	28	34	0	9	47	3	42	9	35	1	8,966	187	495	101,658	5,540	18,372	136,903
	South East (rest)	316	24	98	108	34	22	25	26	52	5	20	29	5	23	16	38	14	8,298	1,138	8,082	10,700	46,722	11,927	87,722
	Rest of UK	107	19	13	76	15	7	14	10	15	6	2	16	5	10	9	21	4	3,822	216	321	25,000	9,569	4,861	44,138
		3,835	930	787	1,581	984	745	1,104	749	2,590	502	3,073	1,466	283	2,457	942	1,642	826	159,481	89,847	44,403	153,918	77,947	40,613	590,705

6.3 Prior Matrices Production

6.3.1 Following the analysis of the existing matrices and data, a method to combine these to create the MSSHM prior matrices was specified. As previously stated the approach for the MSSHM matrices was to make the best use of these existing matrices and data in combination, within the confines of the geographic coverage and matrix dimensions (e.g. time periods, vehicle/user classes) that are available for each existing data source.

6.3.2 Matrices are required for each of the three periods (Section 2.3) and five vehicle/users classes, resulting in fifteen matrices in total.

6.3.3 Before data could be used it also had to be converted to the MSSHM zone system. This was done using GIS based analysis and use of postcode points to accurately split zonal trip ends.

Matrices combination

6.3.4 For each period and user class, the suitable data source was specified based on the data analysis. This was undertaken separately for the following features of the matrices:

- Zonal trip ends, i.e. the volume of trips going to and from the zones
- Distribution i.e. the pattern of trips or where the trips go to or come from

6.3.5 The availability of this information differs by existing data source for each period and vehicle/user classes, for example the WSCTM is AM peak hour only, with one user class. The existing data also varies in geographical coverage in terms of the fullness of the trip data it provides; while the Census and WSCTM provide wide coverage, the BHTM and CTM are smaller models and have more limited coverage.

6.3.6 For these reasons the data source selected varies for trip ends and distribution, by vehicle/use class and geographical area. **Table 13** shows the main source data for geographical and user class components of the matrices.

Table 13. Prior Matrix Sources

Class	Burgess Hill / Haywards Heath		Rest of Mid Sussex		Crawley Area		Rest of West Sussex		Rest of UK	
	Trip Ends	Distribution	Trip Ends	Distribution	Trip Ends	Distribution	Trip Ends	Distribution	Trip Ends	Distribution
Car Commute	BHTM / MND	**Census Journey to Work**	WSCTM (Split by Class)	**Census Journey to Work**	CTM / MND	**Census Journey to Work**	WSCTM (Split by Class)	**Census Journey to Work**	WSCTM/ TEMPro	**Census Journey to Work**
All Others	BHTM / MND	WSCTM	WSCTM (Split by Class)	WSCTM	CTM / MND	WSCTM	WSCTM (Split by Class)	WSCTM	WSCTM/ TEMPro	WSCTM

Trip Ends

6.3.7 Trips ends are largely provided by WSCTM, BHTM and CTM models for the MSSHM area. Although WSCTM coverage is good within West Sussex and the immediate surrounds, for locations near to Mid Sussex in Surrey and East Sussex, TEMPro was used to ensure the demand to and from these areas is complete for journeys in the MSSHM area.

6.3.8 Where WSCTM is used this required the single user class to be split using appropriate factors. These were derived from models with more segregation of user classes, as shown in **Table 14**.

Trip Distribution

6.3.9 Census Travel to Work 2011 data is used for the distribution of commuting destinations. This data is regarded as being the best for providing accurate representation of home to work trips due to its very high sample size. This is of critical importance for the development sites being tested in the transport study. The WSCTM is considered suitable for providing a realistic trip distribution for non-commuting trips.

6.3.10 Due to the timing of the Census the 2011 data is six years older than the model base year. This data is used for trip distribution purposes only and is not used for any volumetric totals in the matrices. It is therefore considered that this data is suitable for use as long as there have not been any large changes to the proportional distribution of employment compared to housing in the district and surrounding area. Following discussion with Mid Sussex District Council it was concluded that there have not been any significant such changes that would require any adjustment to the Census data.

Matrix Sizes and Proportions

6.3.11 **Table 14** shows the MSSHM matrices sizes and proportions by user classes with comparison to the BHTM and CTM. The proportions are consistent across the models.

Table 14. Matrix Sizes

		BHTM		CTM		MSSHM	
AM							
Car	Commute	13,258	39%	18,055	31%	59,807	38%
Car	Business	5,547	16%	6,318	11%	24,070	15%
Car	Other	9,436	28%	23,068	40%	46,401	30%
LGV	LGV	3,252	10%	5,013	9%	14,652	9%
HGV		1,229	7%	2,732	9%	5,454	7%
Car Total		**28,241**	**83%**	**47,441**	**82%**	**130,278**	**84%**
Grand Total		**33,952**	**100%**	**57,918**	**100%**	**155,838**	**100%**
IP							
Car	Commute	2,364	10%	2,815	7%	9,356	10%
Car	Business	3,116	13%	4,233	10%	12,489	13%
Car	Other	12,742	54%	23,282	58%	52,592	54%
LGV	LGV	2,889	12%	4,940	12%	13,276	14%
HGV		1,204	10%	2,554	13%	5,255	11%
Car Total		**18,223**	**77%**	**30,330**	**75%**	**74,437**	**76%**
Grand Total		**23,519**	**100%**	**40,379**	**100%**	**98,223**	**100%**
PM							
Car	Commute	11,684	36%	16,991	30%	50,768	35%
Car	Business	3,120	10%	4,012	7%	14,309	10%
Car	Other	13,818	43%	26,981	48%	62,989	43%
LGV	LGV	2,356	7%	4,302	8%	11,669	8%
HGV		585	4%	1,747	6%	2,824	4%
Car Total		**28,621**	**89%**	**47,984**	**86%**	**128,066**	**88%**
Grand Total		**32,147**	**100%**	**55,780**	**100%**	**145,383**	**100%**

Calibration and Validation of Prior Matrices

6.3.12 Following production of the initial 'prior' matrices, calibration is undertaken using matrix estimation. This process results in a better match between the model traffic flows and observed traffic counts. The SATURN program SATME2 is used for this. This process is described in the next Chapter.

7. CALIBRATION AND VALIDATION

7.1 Introduction

7.1.1 This Chapter describes the calibration and validation of the model, using the traffic counts grouped into cordons and screenlines as shown in **Figure 4**. The process uses the SATURN software to undertake adjustments to the trip matrices to achieve a better match between observed and assigned traffic flows.

7.2 Trip Matrix Estimation Process

7.2.1 The matrix estimation process uses the SATURN program SATME2 in conjunction with the supplementary program SATPIJA. It is based on the theoretical procedure generally referred to as ME2 - Matrix Estimation from Maximum Entropy. SATME2 tries to improve the fit between modelled and observed flows by selectively factoring individual cells of the input trip matrix. SATPIJA creates a file used by SATME2 which represents the proportion of trips between origin-destination pairs which uses the counted link (from SATURN Manual Section 13).

7.2.2 The process is undertaken using six loops between the assignment and matrix estimation. The Matrix Estimation process is constrained using the XAMAX = 5 to restrict individual cell value changes to a factor of 5 to prevent excessive distortion of the matrix.

7.2.3 The inputs to the process are:

- highway networks, AM, IP and PM;
- highway prior matrices AM, IP and PM by user class and vehicle class; and
- SATME2 inputs – calibration counts divided into mini-screenlines.

7.2.4 As described in Chapter 4, the traffic count database provides an output sheet of traffic count information to be used in the matrix calibration and validation. Matrix estimation is applied separately to each user and vehicle classes.

7.3 Changes Resulting from Matrix Estimation

7.3.1 In accordance with best practice the changes resulting from the matrix estimation are monitored and assessed to ensure that the prior matrix is not being excessively distorted. This section describes the trip matrices before and after matrix estimation using the following analyses:

- matrix size by user/vehicle class;
- statistical analysis of change in trip ends; and
- statistical analysis of change in trip length distributions.

Matrix size

7.3.2 **Table 15** show matrix sizes by user class before and after matrix estimation.

Table 15. Prior and Estimated Matrix Sizes

	Vehicle Class	User Class	AM			IP			PM		
			Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
1	Car	Commute	59,807	60,950	1.9%	9,356	9,725	3.9%	50,768	53,749	5.9%
2	Car	Business	24,070	24,091	0.1%	12,489	12,965	3.8%	14,309	14,922	4.3%
3	Car	Other	46,401	46,445	0.1%	52,592	54,647	3.9%	62,989	65,942	4.7%
	Car Total		**130,278**	**131,485**	**0.9%**	**74,437**	**77,337**	**3.9%**	**128,066**	**134,613**	**5.1%**
4	Light Goods		14,652	15,487	5.7%	13,276	13,881	4.6%	11,669	12,480	7.0%
5	Heavy Goods		10,908	11,535	5.7%	10,510	11,205	6.6%	5,648	5,808	2.8%
	Grand Total		**155,838**	**158,508**	**1.7%**	**98,223**	**102,424**	**4.3%**	**145,382**	**152,901**	**5.2%**

HGV PCU factor = 2

7.3.3 The overall changes in matrix size are considered satisfactory for the MSSHM. The bigger changes in the PM for car commute and light goods in particular could be attributable to the prior matrices approach. In a traditional matrix building using roadside interview (RSI) data the matrices are expanded using traffic count data and for this reason traffic count volumes are already an integral part of the prior matrix and therefore less volumetric adjustment is required in the matrix estimation. The MSSHM prior matrices were constructed from existing matrices data and did not include any new RSIs or traffic counts (other than in the analysis of year to year trends as shown in Figure 9. For this reason the changes resulting from matrix estimation are considered acceptable.

Sectoral Trip End Changes

7.3.4 **Table 16** shows changes resulting from matrix estimation at a trip end level for a suitable sector system. WebTAG guidance recommends the percentage changes are within 5%.

Table 16. Sector Trip End Changes Resulting from Matrix Estimation

SECTOR / AREA	AM		IP		PM	
	Origins	Dests.	Origins	Dests.	Origins	Dests.
East Grinstead	-3.6%	19.9%	5.0%	-7.2%	4.4%	0.1%
Haywards Heath	7.1%	7.8%	4.9%	-3.0%	2.6%	6.4%
Burgess Hill	-4.5%	10.0%	6.3%	15.2%	11.2%	5.3%
West Sussex	-1.0%	-3.4%	2.1%	-1.2%	0.1%	2.4%
Rest of UK	9.9%	5.8%	8.1%	29.6%	14.8%	12.3%
Overall	**1.7%**	**1.7%**	**4.3%**	**4.3%**	**5.2%**	**5.2%**

7.3.5 Although many of results are not within 5% the majority are within 10% which is considered a reasonable result, given the reasons already explained in paragraph 7.3.3 .

7.3.6 The high changes in AM destinations for East Grinstead indicate that the prior matrix was underestimating trips into this area when compared to the traffic counts used in matrix estimation. The adjustment that the matrix estimation has made is appropriate to ensure a realistic volume of trips. The same conclusion is made for the Burgess Hill inter-peak destinations and PM origins. The highest change is the 'Rest of UK' sector for inter-peak

destinations and is not considered critical for the transport study which is using the AM and PM peaks only.

Zonal Trip End Changes

7.3.7 **Figure 11** to **Figure 13** show scatter plots of the pre and post ME matrix origin and destination totals by period. **Table 17** shows a summary of the overall changes for zonal trip ends with WebTAG guidelines for comparison.

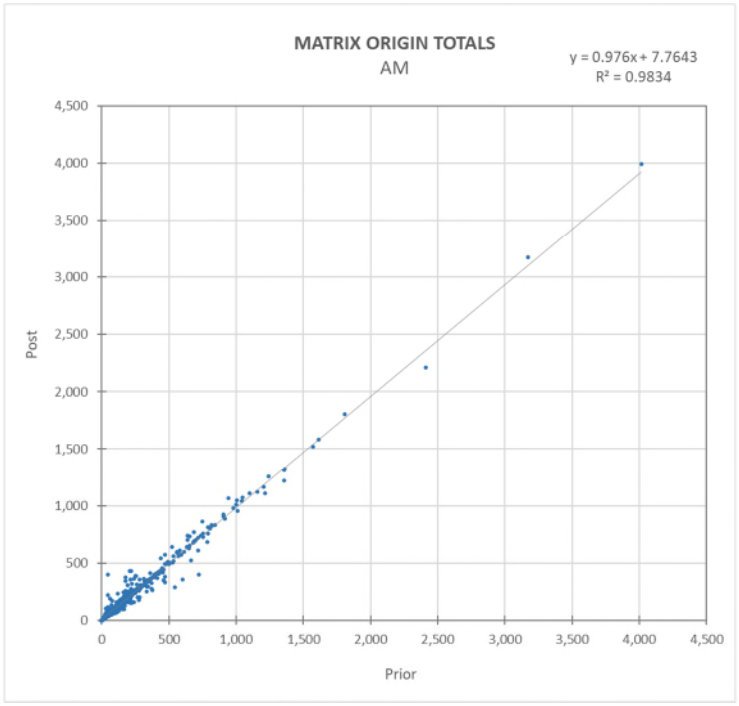
Table 17. Significance of Matrix Estimation Changes

		Origins			Destinations		
Measure	WebTAG Criteria	AM	IP	PM	AM	IP	PM
Slope	within 0.99 and 1.01	0.98	1.00	1.02	0.96	0.99	0.99
R-squared	in excess of 0.98	0.98	0.98	0.98	0.97	0.94	0.96

7.3.8 The table shows that for origins the guidelines are largely met and the two slope criteria that are not met can be considered a 'near miss'. The scatter charts for origins also show good correlation across the three periods, with no significant outliers.

7.3.9 The correlations for destinations are generally not as good as for origins. However, observation of the scatter chart for the AM peak destinations shows a reasonable correlation with no significant outliers, which also results in an R-squared value that is very close to meeting the criterion. The scatter charts and R-squared values for inter-peak and PM show some outliers. The locations that these relate to are predominantly outside the core model areas and are not considered to be of concern with respect to model quality and fitness for purpose.

Figure 11. Scatter Plot of Prior and Post ME AM Peak Matrix Origins and Destinations



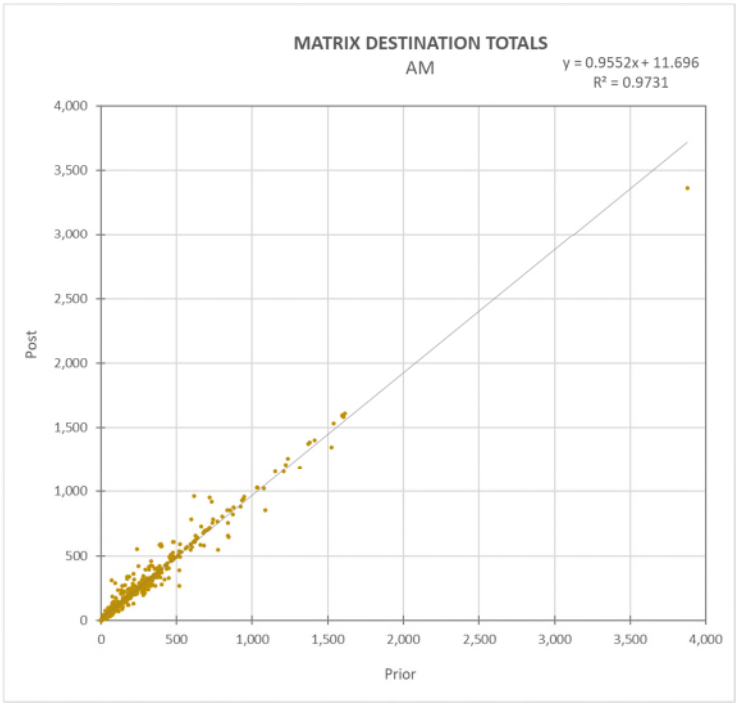
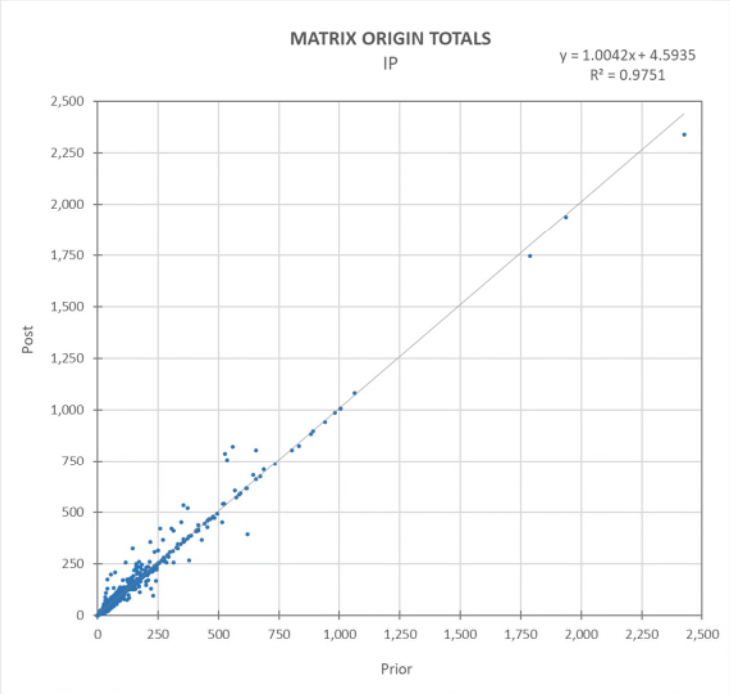


Figure 12. Scatter Plot of Pre and Post ME Inter-Peak Matrix Origins and Destinations



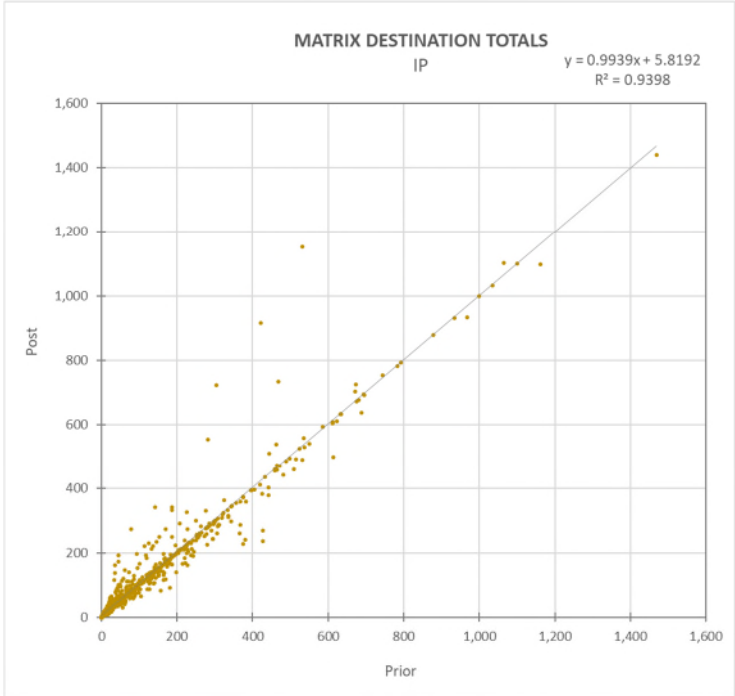
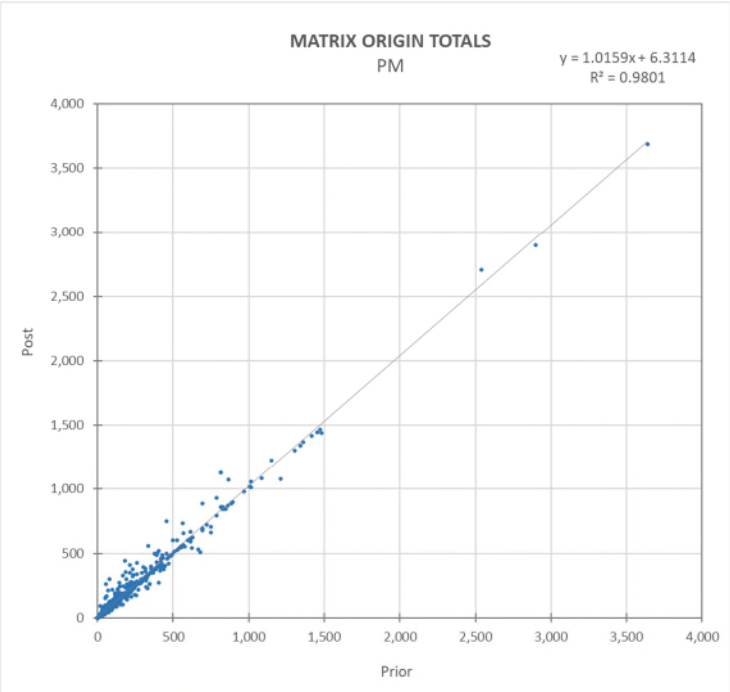
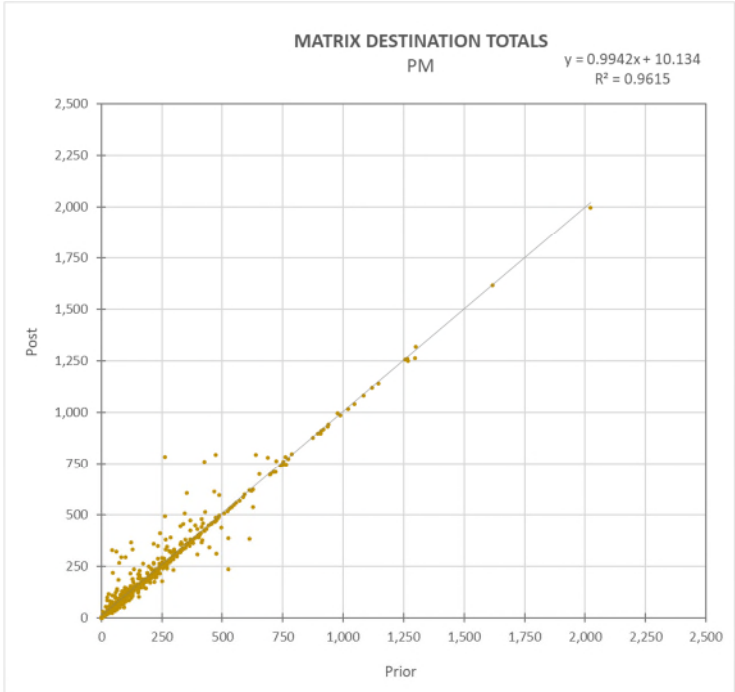


Figure 13. Scatter Plot of Pre and Post ME PM Peak Matrix Origins and Destinations





Trip Length Distributions

7.3.10 **Figure 14** to **Figure 16** show trip length frequency distributions, showing the number of trips lying within each distance band pre and post matrix estimation, by period. **Table 18**

shows the mean trip length for the prior and post estimation matrices. The WebTAG guidance recommends that the means and standard deviations should be within 5%.

Table 18. Mean and Standard Deviation Trip Length (km)

MODEL PERIOD	MEAN			STANDARD DEVIATION		
	PRIOR	POST	%	PRIOR	POST	%
AM Peak Hour	24.2	24.7	2.2%	26.2	27.0	2.9%
Inter-Peak Hour	25.8	27.9	8.1%	28.2	30.5	8.1%
PM Peak Hour	25.1	26.6	6.0%	33.4	34.4	3.1%

7.3.11 The mean and standard deviation for the AM peak are both within WebTAG guidelines.

7.3.12 For inter-peak, both mean and standard deviation are outside the guidelines. **Figure 15** shows, however, that the distribution has not been significantly distorted. This is also less of a concern at this stage because the inter-peak is not being using in the transport study.

7.3.13 The PM peak hour mean falls just outside, but the standard deviation is within. **Figure 16** shows that the distribution has not been distorted.

7.3.14 The shape of the curves in **Figure 14** to **Figure 16** is in line with expectations for a model representing both urban and interurban trips, with short trips dominating the distribution, but a significant number of longer distance trips forming the tail of the distribution.

Figure 14. Trip Frequency Distribution Pre/Post ME AM Peak Hour

Figure 15. Trip Frequency Distribution Pre/Post ME Inter-Peak Hour

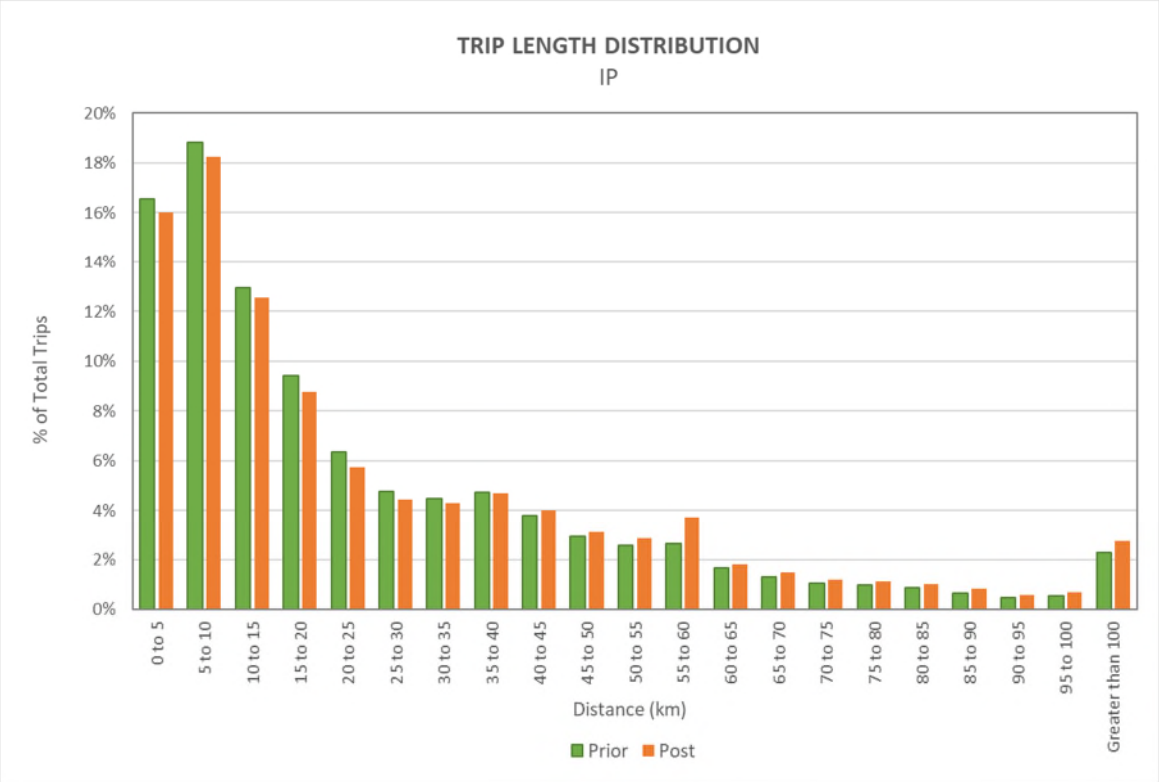
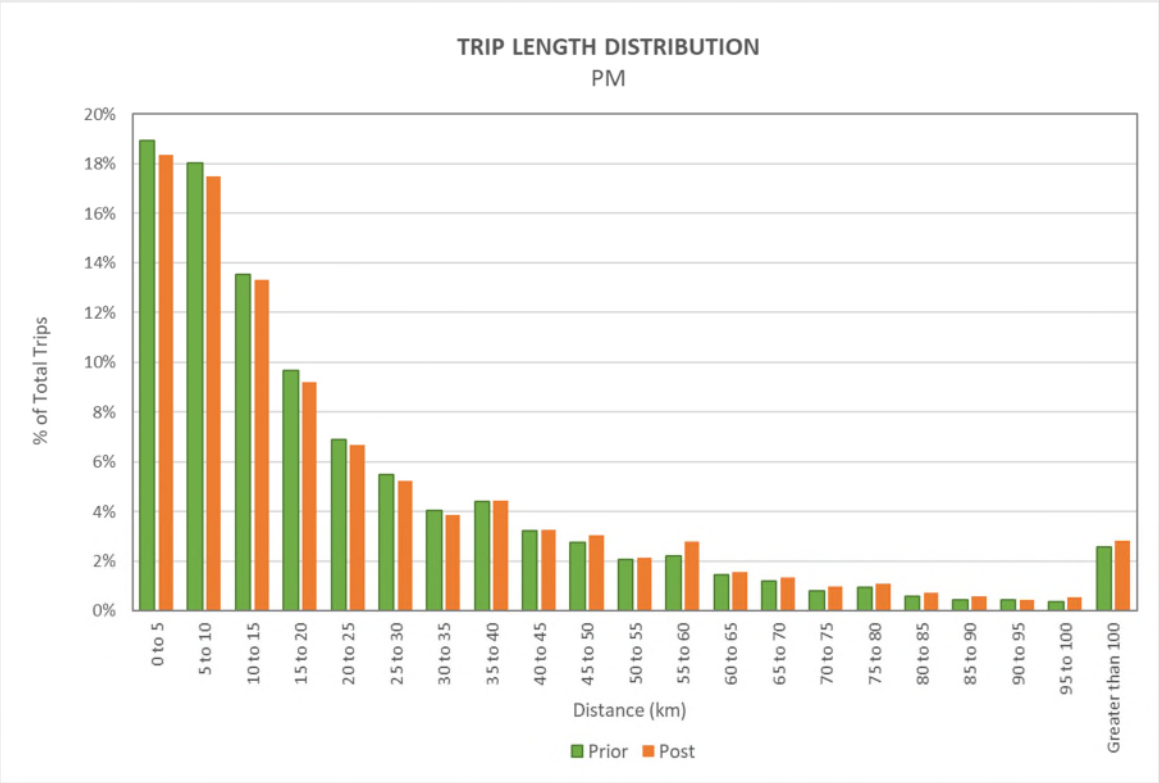


Figure 16. Trip Frequency Distribution Pre/Post ME PM Peak Hour



7.4 Trip Matrix Validation

7.4.1 The trip matrices are assessed using totals of the grouped screenlines and cordon traffic flows as described in Chapter 2. The WebTAG screenline flow criteria and acceptability guidelines are in **Table 19**.

Table 19. Screenline Flow Validation Criterion and Acceptability Guideline

CRITERIA	ACCEPTABILITY GUIDELINE
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines

7.4.2 The results of the cordon and screenline validation for each period are shown in **Table 20.** In addition to WebTAG performance the results are shown for two additional criteria. There are 16 screenlines and cordons in total, therefore 32 by direction.

Table 20. Trip Matrix Vehicle Flow Validation

Measure	Criteria	Acceptability Guideline	AM Peak	Inter Peak	PM Peak
Matrix Validation	**Differences between modelled flows and counts should be less than 5% of the counts**	**All or nearly all screenlines (WebTAG)**	**81%**	**91%**	**88%**
	*Differences between modelled flows and counts should be within **GEH=4** of the counts*	*N/A*	*91%*	*100%*	*97%*
	*Differences between modelled flows and counts should be less than **10%** of the counts*	*N/A*	*91%*	*97%*	*100%*

7.4.3 The results show a satisfactory performance across the three periods. There are some screenlines which do not meet the 5% WebTAG criteria, however some of these are for low flow screenlines where it could be regarded that GEH is a more appropriate measure. Over 90% of screenlines are within GEH=4 for all three periods which is a good result.

7.4.4 It is therefore considered that the model quality is suitable for proceeding with the transport study. Locations where the model quality is less strong will be considered for local improvements where necessary as the study proceeds, particularly if in the vicinity of developments being tested and impacted junctions.

7.5 Network Link Calibration and Validation

7.5.1 Individual modelled road/link traffics flows are assessed using the WebTAG link flow criteria and acceptability guidelines shown in **Table 21**.

Table 21. Link Flow Validation Criteria and Acceptability Guidelines

CRITERIA	ACCEPTABILITY GUIDELINE
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases
GEH < 5 for individual flows	> 85% of cases

7.5.2 The results of the network validation for each period are shown in **Table 22.** In addition to WebTAG performance the results are shown for an additional criterion

Table 22. Link Vehicle Flow Validation

Measure	Criteria	Acceptability Guideline	AM Peak	Inter Peak	PM Peak
Link Flow Validation	**Individual flows within 15% of counts for flows from 700 to 2700 veh/h**	**>85% of cases (WebTAG)**	**82%**	**86%**	**87%**
	Individual flows within 100 veh/h of counts for flows less than 700 veh/h				
	Individual flows within 400 veh/h of counts for flows more than 2700 veh/h				
	GEH < 5 for individual flows	**> 85% of cases (WebTAG)**	**84%**	**81%**	**83%**
	*GEH < **10** for individual flows*	*N/A*	*96%*	*95%*	*97%*

7.5.3 Overall the results show good performance across the three periods. The WebTAG criteria results are all 80% or above which is considered good for a relatively large strategic model.

7.5.4 It is therefore considered that the model network quality is suitable for proceeding with the forecast modelling and transport study. As was recommended for the matrices, the locations where the model quality is less strong will be considered for local improvements where necessary as the study proceeds, particularly if in the vicinity of developments being tested and impacted junctions.

7.5.5 **Table 23** to **Table 25** show the matrix and link validation performance by cordon or screenline.

7.5.6 In the AM and PM peak models (which are the priority because these periods are being used in the transport study) the majority of screenlines have all or nearly all links meeting the WebTAG criteria, with no screenlines where the pass rate is below 50% for both WebTAG criteria.. Screenlines that have a pass rate of below 75% in either the AM or PM peak (denoted by yellow highlighting in **Table 23** to **Table 25**) will be monitored as the transport study proceeds. These are:

- Haywards Heath Cordon
- Burgess Hill North / South Screenline
- Burgess Hill East / West Screenline
- South of A272 Screenline
- Balcombe / Ardingly Screenline
- Crawley Down Screenline

7.5.7 **Appendix B** shows the results for all roads that make up the screenlines and cordons.

Table 23. Matrix and Link Vehicle Flow Validation by Cordon/Screenline: AM Peak Hour

Cordon / Screenline (SL)	Dir	Sites	Observed	Model	Diff	% Diff	GEH	GEH<=	WebTAG within			WebTAG within			
								4	5%	10%	15%	Abs / %	GEH=5	GEH=10	GEH=15
1 Mid Sussex District Cordon	Out	42	19,905	19,377	-529	-3%	4	Y	Y	Y	Y	84%	81%	100%	100%
1 Mid Sussex District Cordon	In	42	18,669	18,639	-30	0%	0	Y	Y	Y	Y	75%	78%	91%	97%
2 East Grinstead Cordon	Out	8	3,743	3,704	-39	-1%	1	Y	Y	Y	Y	71%	71%	100%	100%
2 East Grinstead Cordon	In	8	3,657	3,884	227	6%	4	Y	N	Y	Y	71%	71%	100%	100%
3 Haywards Heath Cordon	Out	10	4,502	4,650	148	3%	2	Y	Y	Y	Y	78%	78%	89%	100%
3 Haywards Heath Cordon	In	10	5,170	5,186	15	0%	0	Y	Y	Y	Y	56%	56%	89%	100%
4 Haywards Heath West SL	EB	4	1,968	1,927	-41	-2%	1	Y	Y	Y	Y	100%	100%	100%	100%
4 Haywards Heath West SL	WB	4	2,072	2,006	-67	-3%	1	Y	Y	Y	Y	100%	100%	100%	100%
5 Burgess Hill Cordon	Out	13	4,826	4,819	-7	0%	0	Y	Y	Y	Y	82%	73%	100%	100%
5 Burgess Hill Cordon	In	13	4,664	4,675	11	0%	0	Y	Y	Y	Y	82%	100%	100%	100%
6 Burgess Hill North / South SL	EB	4	2,171	2,258	86	4%	2	Y	Y	Y	Y	75%	100%	100%	100%
6 Burgess Hill North / South SL	WB	4	2,479	2,444	-35	-1%	1	Y	Y	Y	Y	50%	50%	75%	100%
7 Burgess Hill East / West SL	NB	15	4,029	3,977	-52	-1%	1	Y	Y	Y	Y	58%	67%	83%	92%
7 Burgess Hill East / West SL	SB	15	4,685	4,132	-553	-12%	8	N	N	N	Y	83%	67%	92%	92%
8 South of A272 SL	NB	13	6,419	6,072	-347	-5%	4	Y	Y	Y	Y	80%	80%	100%	100%
8 South of A272 SL	SB	13	4,694	5,081	387	8%	6	N	N	Y	Y	78%	67%	89%	100%
9 East of A23 SL	EB	6	2,444	2,433	-12	0%	0	Y	Y	Y	Y	100%	100%	100%	100%
9 East of A23 SL	WB	6	2,489	2,530	40	2%	1	Y	Y	Y	Y	100%	80%	100%	100%
10 West of A23 SL	EB	10	2,582	2,367	-215	-8%	4	Y	N	Y	Y	71%	71%	86%	100%
10 West of A23 SL	WB	10	2,268	2,185	-83	-4%	2	Y	Y	Y	Y	71%	86%	86%	100%
11 Balcombe / Ardingly SL	EB	5	1,339	1,132	-207	-15%	6	N	N	N	Y	67%	67%	100%	100%
11 Balcombe / Ardingly SL	WB	5	907	919	12	1%	0	Y	Y	Y	Y	67%	100%	100%	100%
12 Crawley Down SL	EB	3	1,110	1,160	50	4%	1	Y	Y	Y	Y	67%	100%	100%	100%
12 Crawley Down SL	WB	3	1,211	1,371	161	13%	4	Y	N	N	Y	67%	67%	100%	100%
13 Handcross SL	NB	4	4,159	4,273	113	3%	2	Y	Y	Y	Y	100%	100%	100%	100%
13 Handcross SL	SB	4	2,968	3,009	40	1%	1	Y	Y	Y	Y	100%	100%	100%	100%
14 Ashdown Forest Cordon	Out	19	4,099	4,100	1	0%	0	Y	Y	Y	Y	100%	100%	100%	100%
14 Ashdown Forest Cordon	In	19	3,926	4,087	161	4%	3	Y	Y	Y	Y	73%	73%	91%	100%
15 Ashdown Forest East / West SL	NB	4	2,060	2,047	-13	-1%	0	Y	Y	Y	Y	100%	100%	100%	100%
15 Ashdown Forest East / West SL	SB	4	1,617	1,626	10	1%	0	Y	Y	Y	Y	100%	100%	100%	100%
16 Ashdown Forest North / South SL	EB	3	481	460	-20	-4%	1	Y	Y	Y	Y	100%	100%	100%	100%
16 Ashdown Forest North / South SL	WB	3	643	662	19	3%	1	Y	Y	Y	Y	100%	100%	100%	100%
17 M23 / A23	NB	13										100%	92%	100%	100%
17 M23 / A23	SB	12										92%	83%	100%	100%
		351	**127,956**	**127,190**	**-766**	**-1%**		**91%**	**81%**	**91%**	**100%**	**82%**	**84%**	**96%**	**99%**

Table 24. Matrix and Link Vehicle Flow Validation by Cordon/Screenline: Inter-Peak Hour

Cordon / Screenline (SL)	Dir	Sites	Observed	Model	Diff	% Diff	GEH	GEH<=	WebTAG within			WebTAG within			
								4	5%	10%	15%	Abs / %	GEH=5	GEH=10	GEH=15
1 Mid Sussex District Cordon	Out	42	12,937	12,660	-278	-2%	2	Y	Y	Y	Y	84%	75%	97%	97%
1 Mid Sussex District Cordon	In	42	12,776	12,778	2	0%	0	Y	Y	Y	Y	91%	81%	94%	100%
2 East Grinstead Cordon	Out	8	2,643	2,608	-35	-1%	1	Y	Y	Y	Y	86%	86%	100%	100%
2 East Grinstead Cordon	In	8	2,615	2,767	152	6%	3	Y	N	Y	Y	100%	86%	100%	100%
3 Haywards Heath Cordon	Out	10	2,971	3,052	81	3%	1	Y	Y	Y	Y	100%	100%	100%	100%
3 Haywards Heath Cordon	In	10	2,941	3,072	131	4%	2	Y	Y	Y	Y	89%	89%	100%	100%
4 Haywards Heath West SL	EB	4	1,184	1,229	45	4%	1	Y	Y	Y	Y	100%	100%	100%	100%
4 Haywards Heath West SL	WB	4	1,217	1,232	15	1%	0	Y	Y	Y	Y	100%	100%	100%	100%
5 Burgess Hill Cordon	Out	13	3,159	3,189	30	1%	1	Y	Y	Y	Y	73%	73%	91%	100%
5 Burgess Hill Cordon	In	13	3,083	3,124	41	1%	1	Y	Y	Y	Y	64%	64%	82%	100%
6 Burgess Hill North / South SL	EB	4	1,634	1,641	7	0%	0	Y	Y	Y	Y	100%	100%	100%	100%
6 Burgess Hill North / South SL	WB	4	1,632	1,570	-62	-4%	2	Y	Y	Y	Y	25%	50%	75%	100%
7 Burgess Hill East / West SL	NB	15	2,988	2,972	-17	-1%	0	Y	Y	Y	Y	58%	50%	75%	92%
7 Burgess Hill East / West SL	SB	15	2,959	2,837	-123	-4%	2	Y	Y	Y	Y	67%	75%	83%	92%
8 South of A272 SL	NB	13	3,758	3,716	-41	-1%	1	Y	Y	Y	Y	80%	70%	80%	100%
8 South of A272 SL	SB	13	3,784	3,940	156	4%	3	Y	Y	Y	Y	78%	78%	100%	100%
9 East of A23 SL	EB	6	1,402	1,479	76	5%	2	Y	Y	Y	Y	80%	60%	80%	100%
9 East of A23 SL	WB	6	1,488	1,530	42	3%	1	Y	Y	Y	Y	80%	80%	100%	100%
10 West of A23 SL	EB	10	1,576	1,592	16	1%	0	Y	Y	Y	Y	100%	86%	100%	100%
10 West of A23 SL	WB	10	1,581	1,619	38	2%	1	Y	Y	Y	Y	100%	71%	100%	100%
11 Balcombe / Ardingly SL	EB	5	580	564	-16	-3%	1	Y	Y	Y	Y	33%	33%	67%	100%
11 Balcombe / Ardingly SL	WB	5	564	543	-21	-4%	1	Y	Y	Y	Y	100%	67%	100%	100%
12 Crawley Down SL	EB	3	829	786	-43	-5%	2	Y	Y	Y	Y	100%	100%	100%	100%
12 Crawley Down SL	WB	3	825	798	-27	-3%	1	Y	Y	Y	Y	100%	100%	100%	100%
13 Handcross SL	NB	4	2,512	2,539	27	1%	1	Y	Y	Y	Y	100%	100%	100%	100%
13 Handcross SL	SB	4	2,700	2,684	-16	-1%	0	Y	Y	Y	Y	100%	100%	100%	100%
14 Ashdown Forest Cordon	Out	19	2,807	2,749	-58	-2%	1	Y	Y	Y	Y	82%	64%	100%	100%
14 Ashdown Forest Cordon	In	19	2,704	2,728	25	1%	0	Y	Y	Y	Y	91%	82%	91%	100%
15 Ashdown Forest East / West SL	NB	4	1,237	1,231	-6	0%	0	Y	Y	Y	Y	100%	100%	100%	100%
15 Ashdown Forest East / West SL	SB	4	1,311	1,272	-38	-3%	1	Y	Y	Y	Y	50%	50%	100%	100%
16 Ashdown Forest North / South SL	EB	3	423	376	-46	-11%	2	Y	N	N	Y	100%	100%	100%	100%
16 Ashdown Forest North / South SL	WB	3	423	450	27	6%	1	Y	N	Y	Y	100%	100%	100%	100%
17 M23 / A23	NB	13										100%	100%	100%	100%
17 M23 / A23	SB	12										100%	92%	100%	100%
		351	**85,242**	**85,328**	**86**	**0%**		**100%**	**91%**	**97%**	**100%**	**86%**	**81%**	**95%**	**99%**

Table 25. Matrix and Link Vehicle Flow Validation by Cordon/Screenline: PM Peak Hour

Cordon / Screenline (SL)	Dir	Sites	Observed	Model	Diff	% Diff	GEH	GEH<=	WebTAG within			WebTAG within			
								4	5%	10%	15%	Abs / %	GEH=5	GEH=10	GEH=15
1 Mid Sussex District Cordon	Out	42	19,466	19,214	-251	-1%	2	Y	Y	Y	Y	75%	75%	88%	100%
1 Mid Sussex District Cordon	In	42	19,450	18,842	-609	-3%	4	Y	Y	Y	Y	91%	88%	97%	100%
2 East Grinstead Cordon	Out	8	3,657	3,722	65	2%	1	Y	Y	Y	Y	71%	71%	100%	100%
2 East Grinstead Cordon	In	8	3,551	3,234	-317	-9%	5	N	N	Y	Y	100%	86%	100%	100%
3 Haywards Heath Cordon	Out	10	4,688	4,731	44	1%	1	Y	Y	Y	Y	67%	67%	100%	100%
3 Haywards Heath Cordon	In	10	4,081	4,252	171	4%	3	Y	Y	Y	Y	89%	89%	89%	100%
4 Haywards Heath West SL	EB	4	1,780	1,844	64	4%	2	Y	Y	Y	Y	100%	100%	100%	100%
4 Haywards Heath West SL	WB	4	1,771	1,877	106	6%	2	Y	N	Y	Y	75%	75%	100%	100%
5 Burgess Hill Cordon	Out	13	4,432	4,515	83	2%	1	Y	Y	Y	Y	73%	64%	73%	91%
5 Burgess Hill Cordon	In	13	4,409	4,461	52	1%	1	Y	Y	Y	Y	82%	64%	100%	100%
6 Burgess Hill North / South SL	EB	4	2,489	2,521	32	1%	1	Y	Y	Y	Y	100%	100%	100%	100%
6 Burgess Hill North / South SL	WB	4	2,030	2,034	4	0%	0	Y	Y	Y	Y	100%	100%	100%	100%
7 Burgess Hill East / West SL	NB	15	4,314	4,112	-202	-5%	3	Y	Y	Y	Y	67%	50%	83%	83%
7 Burgess Hill East / West SL	SB	15	4,050	3,917	-132	-3%	2	Y	Y	Y	Y	50%	42%	67%	100%
8 South of A272 SL	NB	13	4,980	4,959	-20	0%	0	Y	Y	Y	Y	70%	70%	100%	100%
8 South of A272 SL	SB	13	6,253	6,040	-213	-3%	3	Y	Y	Y	Y	67%	67%	100%	100%
9 East of A23 SL	EB	6	2,372	2,483	111	5%	2	Y	Y	Y	Y	80%	60%	100%	100%
9 East of A23 SL	WB	6	2,138	2,231	94	4%	2	Y	Y	Y	Y	80%	80%	100%	100%
10 West of A23 SL	EB	10	2,216	2,203	-13	-1%	0	Y	Y	Y	Y	100%	86%	100%	100%
10 West of A23 SL	WB	10	2,819	2,740	-79	-3%	1	Y	Y	Y	Y	86%	86%	100%	100%
11 Balcombe / Ardingly SL	EB	5	850	859	9	1%	0	Y	Y	Y	Y	100%	100%	100%	100%
11 Balcombe / Ardingly SL	WB	5	1,307	1,210	-97	-7%	3	Y	N	Y	Y	67%	67%	100%	100%
12 Crawley Down SL	EB	3	1,043	957	-86	-8%	3	Y	N	Y	Y	100%	100%	100%	100%
12 Crawley Down SL	WB	3	1,140	1,154	14	1%	0	Y	Y	Y	Y	100%	100%	100%	100%
13 Handcross SL	NB	4	3,093	3,084	-9	0%	0	Y	Y	Y	Y	100%	100%	100%	100%
13 Handcross SL	SB	4	4,260	4,314	54	1%	1	Y	Y	Y	Y	100%	100%	100%	100%
14 Ashdown Forest Cordon	Out	19	4,145	4,003	-142	-3%	2	Y	Y	Y	Y	73%	73%	91%	100%
14 Ashdown Forest Cordon	In	19	4,020	3,929	-91	-2%	1	Y	Y	Y	Y	91%	82%	100%	100%
15 Ashdown Forest East / West SL	NB	4	1,696	1,713	16	1%	0	Y	Y	Y	Y	100%	100%	100%	100%
15 Ashdown Forest East / West SL	SB	4	2,206	2,157	-50	-2%	1	Y	Y	Y	Y	100%	100%	100%	100%
16 Ashdown Forest North / South SL	EB	3	607	612	4	1%	0	Y	Y	Y	Y	100%	100%	100%	100%
16 Ashdown Forest North / South SL	WB	3	497	472	-25	-5%	1	Y	Y	Y	Y	100%	100%	100%	100%
17 M23 / A23	NB	13										100%	100%	100%	100%
17 M23 / A23	SB	12										92%	92%	100%	100%
		351	**125,813**	**124,399**	**-1,414**	**-1%**		**97%**	**88%**	**100%**	**100%**	**87%**	**83%**	**97%**	**99%**

7.5.8 **Table 26** shows the validation of the flows on the M23 and A23, where Highways England counts are available. The validation shows satisfactory results with the majority of flows within GEH=5 as denoted by the green highlighting.

Table 26. M23 and A23 Flow Validation

	AM Peak					Inter-Peak					PM Peak				
	Observed	Modelled	Diff	% Diff	GEH	Observed	Modelled	Diff	% Diff	GEH	Observed	Modelled	Diff	% Diff	GEH
NORTHBOUND															
A23 - A27 to A273 OFF	3865	3617	-248	-6%	4.1	2174	2230	56	3%	1.2	2783	2923	140	5%	2.6
A23 - A273 OFF to A273 ON	2831	2920	89	3%	1.7	1854	1900	46	3%	1.1	2241	2299	58	3%	1.2
A23 - A281 OFF to A281 ON	2792	2795	3	0%	0.1	1779	1764	-15	-1%	0.4	2138	2090	-49	-2%	1.1
A23 - A2300 OFF to A2300 ON	2592	2724	132	5%	2.6	1716	1699	-17	-1%	0.4	2069	1984	-85	-4%	1.9
A23 - A272 OFF to A272 ON	3001	3043	43	1%	0.8	1855	1860	5	0%	0.1	2359	2214	-145	-6%	3.0
A23 - B2115 OFF to B2115 ON	3094	2944	-150	-5%	2.7	2004	1850	-154	-8%	3.5	2485	2282	-203	-8%	4.2
A23 - B2110 ON to J11 OFF	3645	3837	191	5%	3.1	2219	2271	52	2%	1.1	2749	2813	65	2%	1.2
M23 - J11 OFF - J11 ON	2328	2550	222	10%	4.5	1679	1647	-32	-2%	0.8	1846	1776	-70	-4%	1.6
M23 - J10a ON to J10 OFF	4040	4161	121	3%	1.9	2700	2596	-104	-4%	2.0	3024	2929	-95	-3%	1.7
M23 - J10 OFF to J10 ON	3022	2993	-29	-1%	0.5	2210	2064	-146	-7%	3.2	2363	2268	-96	-4%	2.0
M23 - J10 ON to J9 OFF	3381	3736	355	10%	5.9	2614	2787	173	7%	3.3	3000	3268	268	9%	4.8
M23 - J9 OFF to J9 ON	2906	2975	69	2%	1.3	2384	2314	-70	-3%	1.4	2820	2859	39	1%	0.7
M23 - J9 ON to J8 OFF	3987	4054	67	2%	1.0	3956	3886	-70	-2%	1.1	4422	4426	3	0%	0.0
SOUTHBOUND															
M23 - J8 ON to J9 OFF	4656	3970	-687	-15%	10.5	4012	3798	-214	-5%	3.4	4658	4589	-69	-1%	1.0
M23 - J9 OFF to J9 ON	2906	2975	69	2%	1.3	2384	2314	-70	-3%	1.4	2820	2859	39	1%	0.7
M23 - J9 ON to J10 OFF	3617	3588	-30	-1%	0.5	3287	3245	-42	-1%	0.7	4688	4349	-339	-7%	5.0
M23 - J10 OFF to J10 ON	3022	2993	-29	-1%	0.5	2210	2064	-146	-7%	3.2	2363	2268	-96	-4%	2.0
M23 - J10 ON to J10a OFF	3069	2954	-115	-4%	2.1	2915	2965	50	2%	0.9	4796	4660	-136	-3%	2.0
M23 - J10a OFF - J11 OFF	2739	2410	-329	-12%	6.5	2612	2282	-330	-13%	6.7	4095	3672	-422	-10%	6.8
M23 - J11 OFF - J11 ON	2328	2550	222	10%	4.5	1679	1647	-32	-2%	0.8	1846	1776	-70	-4%	1.6
A23 - B2114 OFF to B2110 ON	2345	2455	110	5%	2.3	2251	2299	49	2%	1.0	3447	3565	118	3%	2.0
A23 - B2110 ON to B2115 OFF	2576	2662	86	3%	1.7	2314	2366	52	2%	1.1	3629	3726	97	3%	1.6
A23 - A272 OFF to A272 ON	3001	3043	43	1%	0.8	1855	1860	5	0%	0.1	2359	2214	-145	-6%	3.0
A23 - A2300 OFF to A2300 ON	2592	2724	132	5%	2.6	1716	1699	-17	-1%	0.4	2069	1984	-85	-4%	1.9
A23 - A273 ON to A27	3165	3190	26	1%	0.5	2588	2620	32	1%	0.6	4190	4015	-175	-4%	2.7

7.6 Journey Time Validation

7.6.1 The WebTAG acceptability guideline for journey times are in **Table 27**.

Table 27. Journey Time Validation Criteria and Acceptability Guideline

CRITERIA	ACCEPTABILITY GUIDELINE
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher)	> 85% of routes

7.6.2 The validation by route is shown in **Table 28**. This analysis uses journey times from Google. The table shows if the modelled time falls within the WebTAG criteria of 15%/1 minute and an additional 25% criterion, when compared to the Google range midpoint.

7.6.3 The table shows that 87% of AM journey times and 80% of PM journey times are within 15% of the observation and therefore meet the criteria. This satisfies the WebTAG guideline for AM but falls slightly short for PM.

7.6.4 Considering the good results for the 25% criterion it is considered that the models are satisfactory for the purpose of undertaking the transport study, however the locations of the poorer performing routes should be accounted for in this work and other applications.

7.6.5 Distance-time profiles of the journey times that do not meet the criteria were studied to identify where the differences occur. Most of these journey times begin or end in the Crawley urban area, where in some locations the model is underestimating journey times. It is considered that these locations are not critical to the transport study.

Table 28. Journey Time Route Validation

			AM				PM			
ID	Journey Time Route	Distance (km)	Observed (mm:ss)	Model (mm:ss)	Within 15%	Within 25%	Observed (mm:ss)	Model (mm:ss)	Within 15%	Within 25%
1EB	Cowfold - Burgess Hill	13.92	20:00	19:19	✓	✓	19:00	20:42	✓	✓
1WB	Burgess Hill - Cowfold	13.92	18:00	19:33	✓	✓	18:00	19:01	✓	✓
2NB	Burgess Hill - Crawley	24.00	39:00	33:45	✓	✓	35:30	24:51	✗	✗
2SB	Crawley - Burgess Hill	23.68	32:00	28:28	✓	✓	35:30	30:44	✓	✓
3NB	Burgess Hill - East Grinstead	22.72	35:00	32:23	✓	✓	32:30	32:01	✓	✓
3SB	East Grinstead - Burgess Hill	23.04	34:00	33:41	✓	✓	31:30	32:52	✓	✓
4NB	Burgess Hill - Haywards Heath	6.08	11:30	10:23	✓	✓	09:30	09:59	✓	✓
4SB	Haywards Heath - Burgess Hill	6.24	10:30	10:09	✓	✓	10:30	10:11	✓	✓
5NB	Hurstpierpoint - Burgess Hill	8.64	15:00	17:06	✓	✓	15:00	18:35	✗	✓
5SB	Burgess Hill - Hurstpierpoint	8.64	15:00	15:53	✓	✓	14:00	15:08	✓	✓
6NB	Cowfold - Crawley	22.08	27:30	25:33	✓	✓	30:00	21:10	✗	✗
6SB	Crawley - Cowfold	22.88	30:00	21:48	✗	✗	30:00	26:27	✓	✓
7NB	Cowfold - East Grinstead	27.20	35:00	33:50	✓	✓	35:00	34:06	✓	✓
7SB	East Grinstead - Cowfold	27.52	37:30	34:06	✓	✓	35:00	34:46	✓	✓
8EB	Cowfold - Haywards Heath	13.28	20:00	22:33	✓	✓	17:00	17:22	✓	✓
8WB	Haywards Heath - Cowfold	13.28	20:00	17:45	✓	✓	20:00	20:28	✓	✓
9NB	Hurstpierpoint - Cowfold	13.12	14:00	15:51	✓	✓	14:00	15:15	✓	✓
9SB	Cowfold - Hurstpierpoint	12.96	15:00	13:55	✓	✓	16:00	14:09	✓	✓
10EB	Crawley - East Grinstead	12.96	26:30	23:04	✓	✓	26:30	20:30	✗	✓
10WB	East Grinstead - Crawley	12.80	29:00	18:20	✗	✗	20:00	17:50	✓	✓
11NB	Haywards Heath - Crawley	19.36	27:30	25:42	✓	✓	22:00	22:37	✓	✓
11SB	Crawley - Haywards Heath	19.36	27:30	23:38	✓	✓	27:30	27:17	✓	✓
12NB	Hurstpierpoint - Crawley	24.32	32:00	27:54	✓	✓	31:00	21:59	✗	✗
12SB	Crawley - Hurstpierpoint	24.48	27:30	23:06	✗	✓	31:00	27:54	✓	✓
13NB	Haywards Heath - East Grinstead	17.60	25:00	24:03	✓	✓	23:00	24:04	✓	✓
13SB	East Grinstead - Haywards Heath	17.92	26:00	25:48	✓	✓	24:00	25:01	✓	✓
14NB	Hurstpierpoint - East Grinstead	35.68	40:00	40:27	✓	✓	42:30	37:04	✓	✓
14SB	East Grinstead - Hurstpierpoint	35.52	40:00	32:11	✗	✓	37:30	35:05	✓	✓
15NB	Hurstpierpoint - Haywards Heath	12.00	20:00	21:58	✓	✓	18:00	16:47	✓	✓
15SB	Haywards Heath - Hurstpierpoint	12.00	17:00	16:53	✓	✓	17:00	19:45	✗	✓
Total					**87%**	**93%**			**80%**	**90%**

7.7 Convergence and Stability

7.7.1 The acceptability guideline for model convergence are reproduced in Table 29.

Table 29. Summary of Convergence Measures and Base Model Acceptable Values

MEASURE OF CONVERGENCE	BASE MODEL ACCEPTABLE VALUES
Delta and %GAP	less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P)<1%	four consecutive iterations greater than 98%
Percentage of links with cost change (P2)<1%	four consecutive iterations greater than 98%

7.7.2 There are several important parameters in SATURN that are used to ensure convergence is acceptable. These are:

KONSTOP "KONtrol of StoPping Criteria"
This defines the type of the conditions required for the assignment to end. The stopping criteria for assignment – simulation loops are based on either: ISTOP (KONSTP = 0); %GAP value (1); CPU time (2); RSTOP and/or CPU (3); %GAP and/or CPU (4); %GAP and RSTOP (5); %GAP or (6) %ISTOP. The assignment will also end when the number of assignment loops reaches MASL (see below).
WebTAG: N/A *SATURN Default: 5* *MSSHM Base: 5*
Therefore unless MASL is reached the assignment will only stop if %GAP and RSTOP criteria are reached.

MASL
This the maximum number of assignment/simulation loops.
WebTAG: N/A *SATURN Default: 15* *MSSHM Base: 150*

NISTOP
The number of successive loops which must satisfy the RSTOP criteria in the test for convergence of the assignment/simulation loops.
WebTAG: 4 *SATURN Default: 4* *MSSHM Base: 4*

STPGAP
WebTAG: 0.1% *SATURN Default: 1.0%* *MSSHM Base: 0.02%*

PCNEAR
Percentage change in flows judged to be "near" in successive assignments.
WebTAG: 1.0% *SATURN Default: 1.0%* *MSSHM Base: 1.0%*

RSTOP
Used in the test for convergence of the assignment/simulation loops. The loops stop automatically if RSTOP % of the link flows change by less than "PCNEAR" percent (default 5%) from one assignment to the next.
WebTAG: 98% *SATURN Default: 97.5%* *MSSHM Base: 99%*

7.7.3 **Table 30** below shows the performance of the model for the key criteria. The stopping criteria set for the model are also shown and these exceed the guidelines. The results demonstrate well-converged models that comfortably meet the WebTAG guidelines.

Table 30. Convergence and Stability Model Results

MEASURE OF CONVERGENCE	SATURN PARA-METER	BASE MODEL ACCEPTABLE VALUES (WEBTAG)	MODEL STOPPING CRITERIA	AM PEAK	INTER-PEAK	PM PEAK
%GAP	**NISTOP STPGAP**	less than **0.1%** or at least stable with convergence fully documented and all other criteria met	**<0.02%** (for base model)	0.009 0.017 0.017 0.014	0.003 0.003 0.002 0.006	0.018 0.014 0.011 0.009
Percentage of links with flow change (P)<1% **(for final four iterations)**	**NISTOP PCNEAR RSTOP**	four consecutive iterations greater than **98%**	four consecutive iterations **>99%**	99.3 99.3 99.3 99.3	99.1 99.3 99.4 99.2	99.1 99.1 99.4 99.1
Percentage of links with cost change (P2)<1% **(for final four iterations)**	NONE	four consecutive iterations greater than **98%**	four consecutive iterations **>99%**	99.6 99.7 99.6 99.7	99.9 99.9 99.9 99.9	99.7 99.6 99.8 99.7

8. SUMMARY OF MODEL FITNESS FOR PURPOSE

Model Production

The Mid Sussex Strategic Highway Model (MSSHM) was produced in accordance with standard good practice as set out in the DfT's WebTAG guidelines, in particular TAG unit M3-1 Highway Assignment Modelling, (January 2014). As such, the approaches to data processing, matrices and network production, along with model calibration are consistent with those of similar strategic highways models.

The model production made significant and appropriate use of existing local data and models. A very small programme of surveys was undertaken to fill in some gaps in data.

Validation of Trip Matrices

The results show a satisfactory performance across the three periods. While some screenlines do not meet the 5% WebTAG criteria, other analyses including use of GEH-based criteria have provided confidence that the results are satisfactory for the purposes of the transport study. The areas of weaker performance will be accounted for and local improvements made as part of the transport study work if deemed necessary.

Validation of Network and Links

The results show good performance across the three periods. In all periods over 80% of links meet WebTAG guidelines which is good for a relatively large strategic model. As in the case of the matrices, areas of weaker performance will be accounted for and local improvements will be made as part of the transport study work if deemed necessary.

Validation of Journey Times

The results show a satisfactory performance across the three periods. The results satisfy the WebTAG 15% guidelines for AM while fall slightly short for PM. Considering the good results for the 25% criterion it is considered that the models are fit for the purpose of undertaking the transport study.

Model Convergence

The convergence results demonstrate well-converged models that comfortably meet the WebTAG guidelines.

Conclusion

The MSSHM was produced in accordance with good practice, making significant and appropriate use of existing data and models.

Overall, the model is considered satisfactory for the purpose of undertaking the transport study work. Locations where the model quality is less strong will be considered for local improvements where necessary as the study proceeds, particularly if in the vicinity of developments being tested and impacted junctions. This will include the roads that make up the screenlines and cordon listed in paragraph 7.5.6.

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