East Midlands Gateway Transport Model

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HIGHWAY LOCAL MODEL VALIDATION REPORT

EAST MIDLANDS GATEWAY TRANSPORT MODEL

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1. INTRODUCTION

1.1 Model Background and Application

1.1.1 SYSTRA has been commissioned by Nottingham City Council to develop the East Midlands Gateway Model (EMGM) to appraise a multi-modal access strategy to connect the East Midlands to the proposed HS2 station at Toton between Derby and Nottingham.

1.1.2 EMGM has been developed as a multimodal transport model built following the guidance in WebTAG. The structure of the model is based on the Greater Nottingham Transport Model (GNTM) however it has been developed using information from the existing Greater Nottingham Transport Model, Greater Derby Transport Model (GDTM) and the Leicester and Leicestershire Integrated Transport Model (LLITM). The model has been fully recalibrated and validated in line with WebTAG guidance.

1.1.3 In addition to being used to assess the HS2 access strategy, the model is likely to be used in the future to assess a wide range of development and highway and public transport scheme applications across the study area.

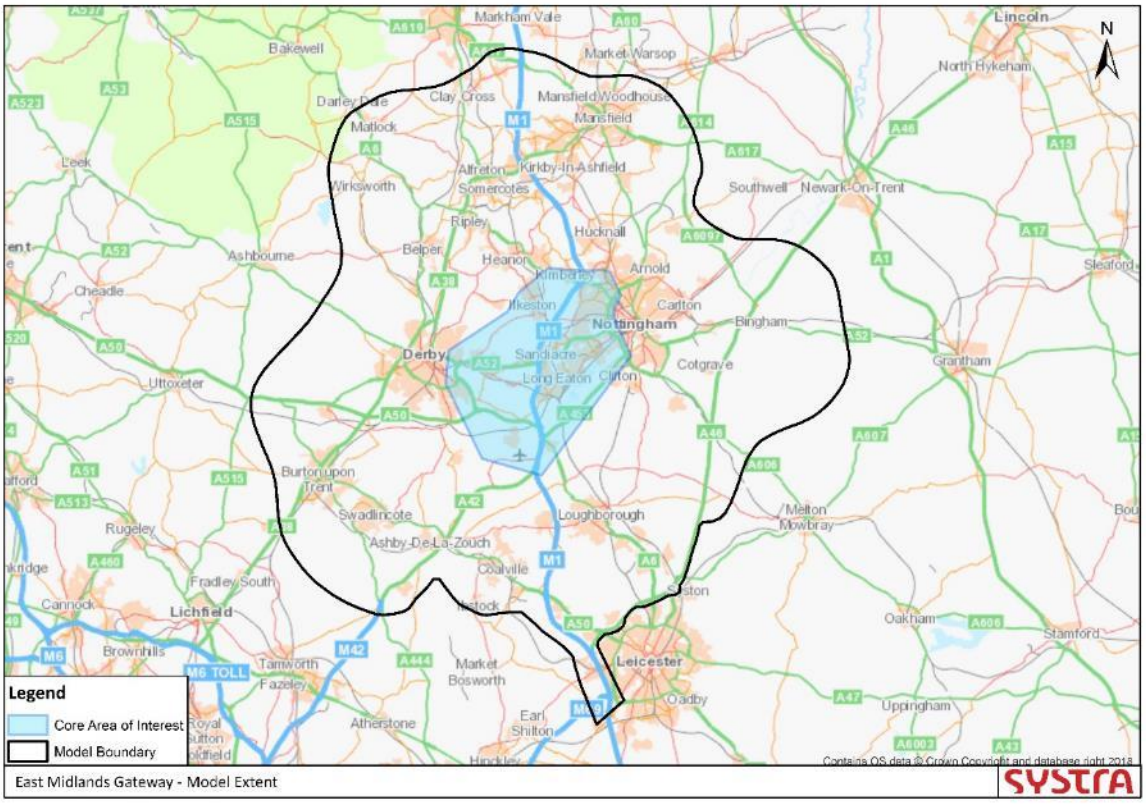
1.1.4 This report provides information on the highway model development and the highway calibration and validation performance.

1.2 Model Extent

1.2.1 The geographical extent of the model is shown in Figure 1. The model boundary is shown in black and represents the area of detailed simulation modelling. This includes the authorities of Nottingham City, Ashfield, Broxtowe, Erewash, Gedling, Rushcliffe, Derby City, Amber Valley, South Derbyshire, Charnwood and North-West Leicestershire. Areas outside of this simulation area are modelled as a skeleton buffer network, this includes Leicester City and areas to the south of the A46.

1.2.2 Figure 1 also shows the Area of Interest boundary which has been specified for the purposes of assessing the impacts of the HS2 station at Toton.

Figure 1. Model Area



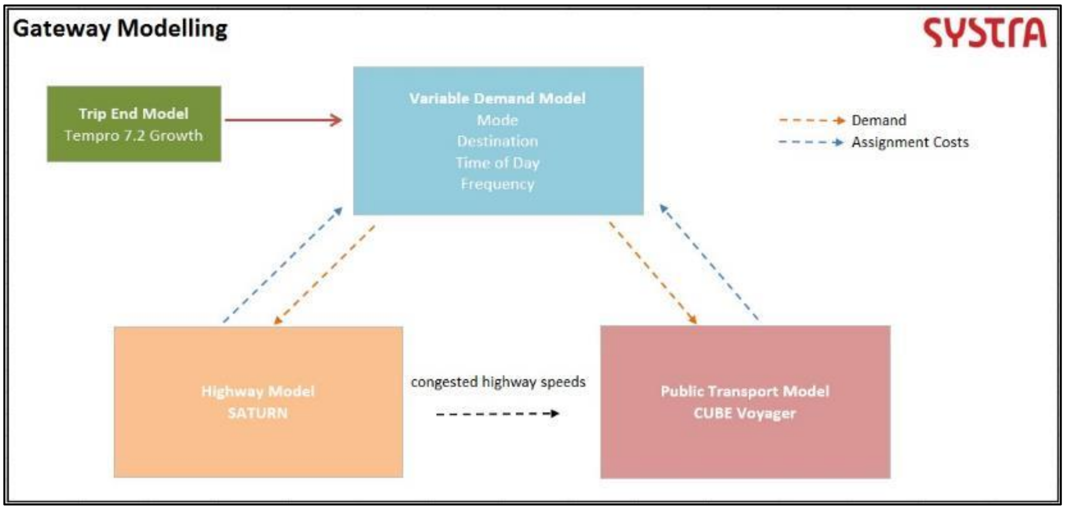
1.3 Structure of the Gateway Model

1.3.1 EMGM has been developed as a multimodal transport model built following the guidance in WebTAG Unit M2. EMGM has all the expected responses (time of day, main mode, destination, frequency, route/submode) arranged in the standard hierarchy order.

1.3.2 An overview of the structure of the East Midlands Gateway model is shown in Figure 2. The Gateway modelling suite is comprised of the following elements:

- SATURN Highway Model;
- CUBE Voyager Public Transport Model;
- Cube Variable Demand Model including destination, mode choice, trip frequency and time of day responses; and,
- TRICs based Trip End Model.

Figure 2. EMGTM Overview



1.4 SATURN Highway Model Overview

Time Periods

1.4.1 The following time periods have been modelled:

- Morning Peak: 0800-0900
- Inter Peak: 1100-1400 average hour
- Evening Peak: 1700-1800

User Classes

1.4.2 Current WebTAG guidance in Unit 3.1 suggests that transport models should be disaggregated by journey purpose to reflect individual user group behaviour where feasible. For the EMGM, the model has been developed in such a way as to allow it to be run with or without Clean Air Zone (CAZ) functionality. The advantage of this approach is that there may be circumstances where CAZ modelling is not required and the ability to 'switch off' the functionality will result in substantial model run time benefits.

1.4.3 With CAZ functionality switched off the model possess seven user classes (UC1 – UC7) where private car is comprised of four purpose constituents and LGV, HGV and Taxi account for the remaining three user classes.

1.4.4 When CAZ functionality is switched on, the seven user classes are sub-divided into 14 CAZ compliant and non-compliant Euro-class emissions groups as described in Table 1. The sub division of user classes has been informed by 2016 ANPR data obtained for the purpose of the CAZ testing which contains compliant and non-compliant splits by geographical area.

1.4.5 The calibration and validation process has been undertaken on the 7 user class model.

Table 1. Gateway Userclasses

USER CLASS	PURPOSE	7 USER CLASS	CAZ COMPLIANCY
UC1	Commute (No WPL)	✓	Compliant
UC2	Commute (WPL)	✓	Compliant
UC3	Work	✓	Compliant
UC4	Other	✓	Compliant
UC5	LGV	✓	Compliant
UC6	HGV	✓	Compliant
UC7	Taxi	✓	Compliant
UC8	Commute (No WPL)	-	Non-Compliant
UC9	Commute (WPL)	-	Non-Compliant
UC10	Work	-	Non-Compliant
UC11	Other	-	Non-Compliant
UC12	LGV	-	Non-Compliant
UC13	HGV	-	Non-Compliant
UC14	Taxi	-	Non-Compliant

SATURN Version

1.4.6 The highway model has been built in SATURN version 11.3.12W. The base year model has the following network dimensions:

- 1,056 zones;
- 41,444 nodes; and,
- 58,944 links.

2. NETWORK DEVELOPMENT

2.1 Overview

2.1.1 The EMGM highway network was created using information from the Greater Nottingham Transport Model, Greater Derby Transport Model, Derby Area Transport Model and the Leicester and Leicestershire Integrated Transport Model.

2.1.2 The network build occurred in a number of steps:

- Creation of initial network from existing individual models
- Model expansion to cover Mansfield, Sutton in Ashfield and Kirby in Ashfield
- Comprehensive coding review of entire network
- Zone connectors
- Global application of new network speeds
- Application of speed flow curves
- Review of banned links and turns
- Update of bus lines and frequencies
- Values of Time and Vehicle Operating Costs
- Network checks

2.1.3 The remainder of this chapter discusses each of these steps in more detail.

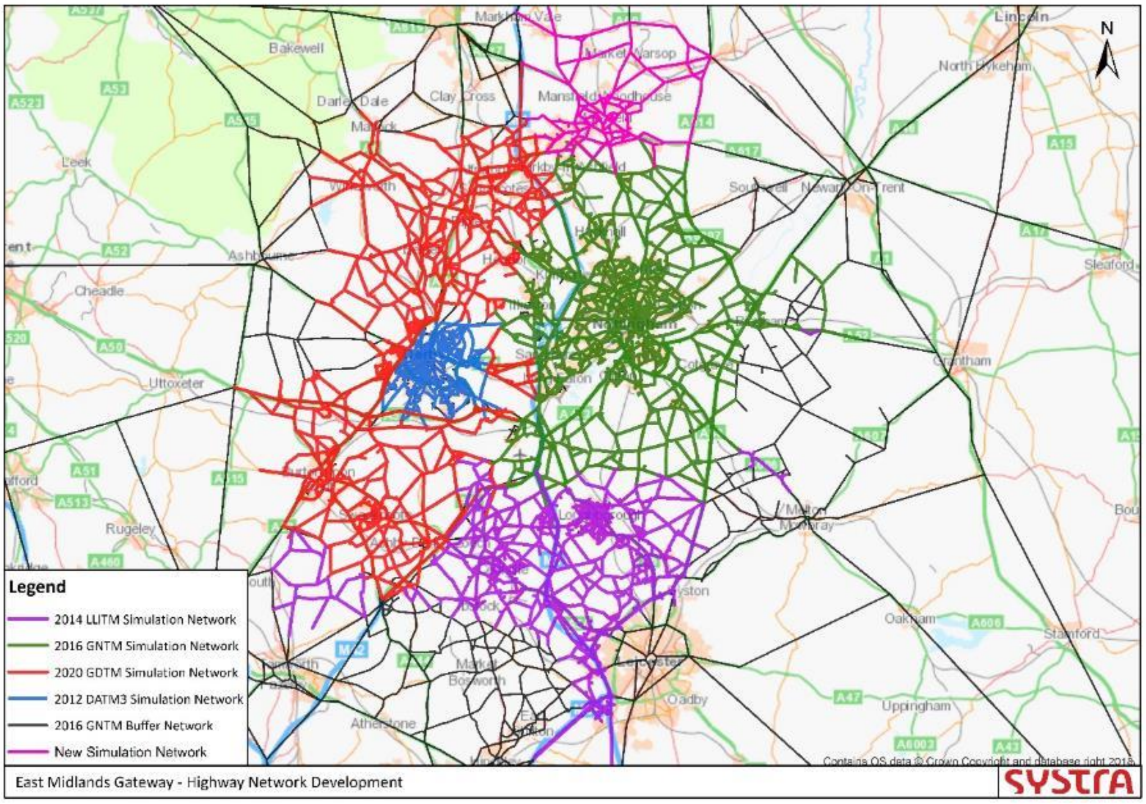
2.2 Creation of initial network

2.2.1 Table 2 below outlines the source of the coding for each local authority within the model. This is also shown graphically in Figure 3. The coding for each area was taken from the most representative local model and from an existing 2016 base year or forecast year scenario where possible.

Table 2. Network Coding Sources

AREA	SOURCE
Derby City	Greater Derby Transport Model
Amber Valley and South Derbyshire	Greater Derby Transport Model
Nottingham City	Greater Nottingham Transport Model
Nottinghamshire and Erewash	Greater Nottingham Transport Model
Leicestershire	Leicester and Leicestershire Integrated Transport Model
Buffer	Greater Nottingham Transport Model

Figure 3. Network Coding Sources



2.2.2 Each individual model was cordoned within P1X to extract the relevant coding information. This coding was then renumbered to avoid duplication of node numbers and manually combined into one network by stitching together connecting links from adjacent areas. During this process the majority of serious errors and warnings were identified and rectified within the coding.

2.3 Model Expansion

2.3.1 A requirement of the new model was to extend the simulation coding to cover Mansfield, Sutton in Ashfield and Kirby in Ashfield. The extent of the new simulation coding is shown in pink in Figure 3.

2.4 Coding Checks and Standardisation

Coding Principles

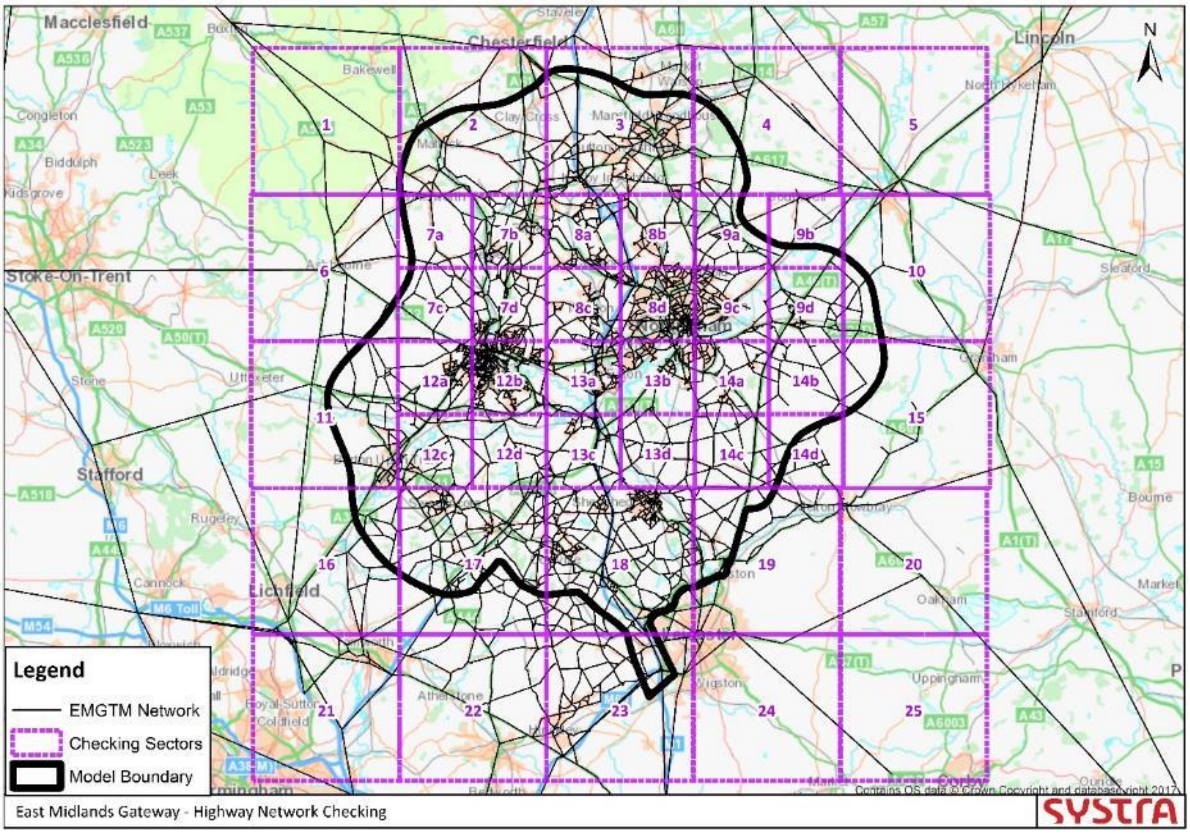
2.4.1 The Nottingham and Derby models were developed by SYSTRA and possess largely similar network coding approaches, especially in terms of saturation flows. The Leicestershire model was developed externally and has different set of coding assumptions. Due to the differences in how some aspects of the individual models are coded and a requirement for consistent coding across the full model area a coding manual was developed for the new model. This is consistent with current best practice and draws largely from the current coding adopted in GNTM to ensure consistency for the combined model throughout the modelled area. Coding along the Strategic Road Network was updated in line with the HE Regional Transport Models assumptions. The coding manual is included in Appendix A.

2.4.2 Once the network structure had been finalised a comprehensive review of the network coding commenced. The purpose of this review was to identify major coding issues and standardise the coding of the network. The network was subdivided into 25 separate sectors (Figure 4) and the coding contained within each sector was reviewed against the assumptions specified within the coding manual. The review focussed on the following key aspects:

- Link distances (compared to google maps);
- Link speeds;
- Speed flow curves;
- Junction type and saturation flows;
- Bus lanes;
- Banned turns and links; and,
- Signal timings.

2.4.3 When network coding issues were identified changes were incorporated into the main network.

Figure 4. Network Checking Sectors



2.5 Zone Connectors

2.5.1 The base year model has 1,056 zones. The structure of the zoning system is shown in Figure 5. Within the model simulation boundary there are 993 zones. These are based on Output

Areas and LSOAs in the urban areas and MSOAs in rural areas. Outside of the model boundary, the model has 63 zones which are either amalgamations of MSOAs or regions.

2.5.2 Zone connectors were initially taken from the corresponding zone in the appropriate individual models. These were reviewed in detail and updated where appropriate. New connections were also added where necessary to provide sensible access to the wider highway network.

2.6 City Centre Parking

2.6.1 Zones in Nottingham and Derby city centres are connected to a series of spigots which represent car parks. The rationale for this approach is that the driving portion of a trip into the city centre will typically end at a carpark, regardless of the traveller's final destination in the city centre.

2.6.2 Each city centre zone has a connection of an appropriate length to every car park so that any car park can be used to any zone, regardless of where the car park is within the city centre.

2.6.3 Each car park has a parking charge applied to it. This charge is an average of car parking charges across all car parks within the city, excluding 24 hour charges. The charge applied to Nottingham car parks is £6.60. The charge in Derby City is £4.70. Plans of the car parks and city centre zones are shown in Figure 5 and Figure 6.

Figure 5. Nottingham City Centre Car Parking

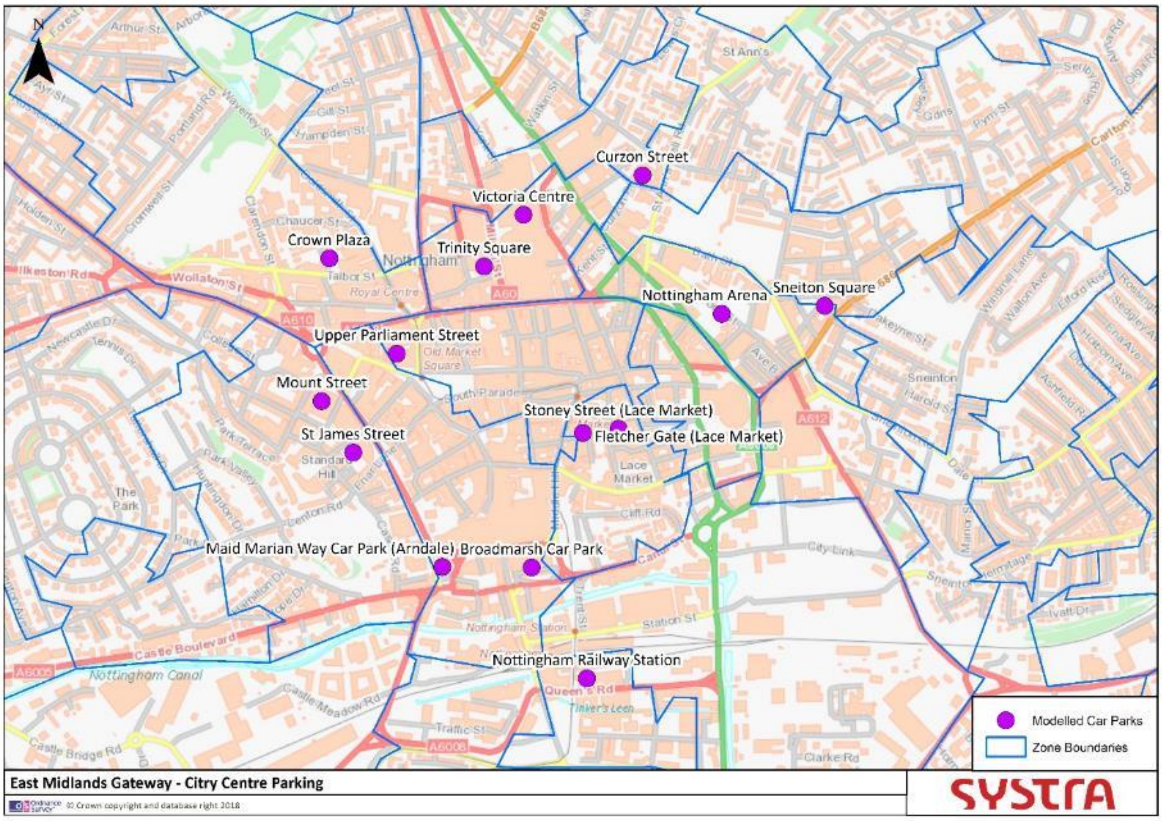
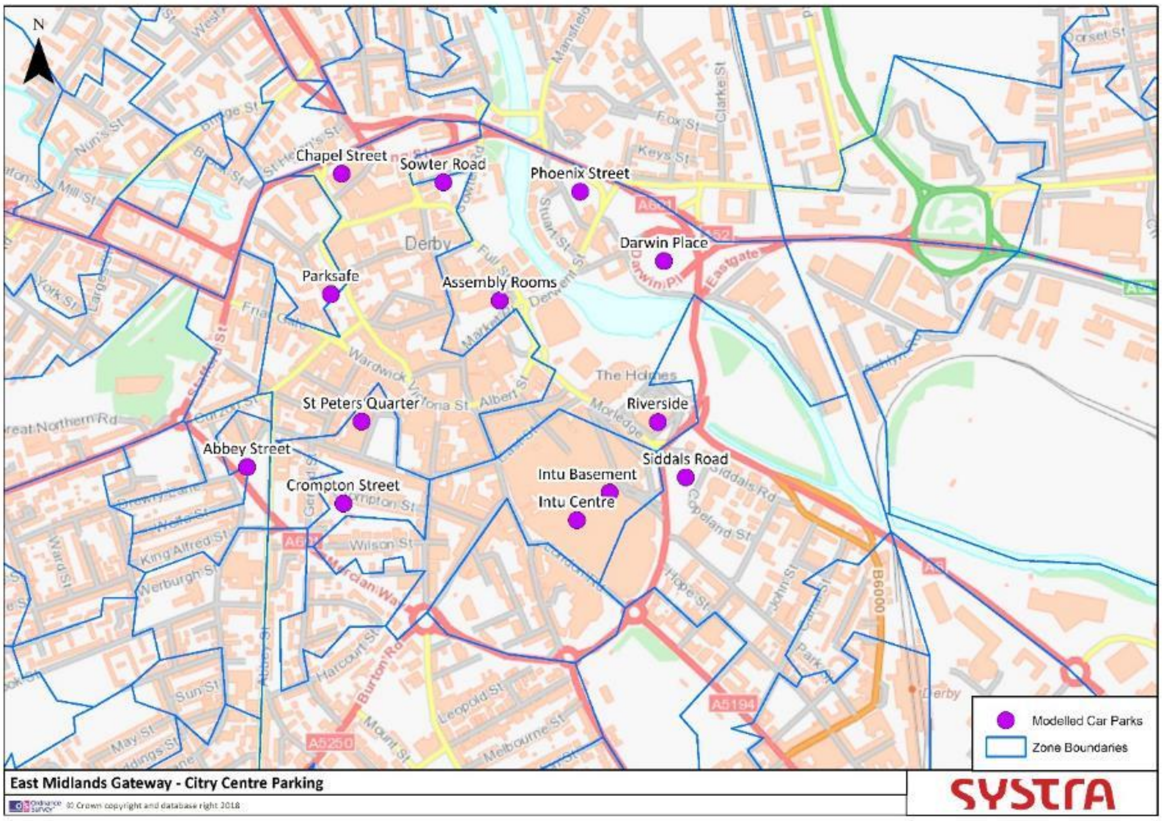


Figure 6. Derby City Centre Car Parking



2.7 Network Speeds

2.7.1 New network link speeds were derived from survey data commissioned for the highway validation exercise. An average speed was calculated across all authorities for each road type and speeds were updated globally within each peak hour network.

2.7.2 During the calibration process, and with knowledge of road conditions across the study area, network speeds were adjusted on a global level to bring the modelled speeds more in line with observed journey time information (network speeds on all journey time routes were consistently too fast). A global reduction in network speeds was applied rather than speed flow curves as speed-flow curves should not be used to represent 'junction' delay, and therefore should only be used on longer links. Table 3 summarises the network speeds used within the model.

Table 3. Network Speeds

MPH (LIMIT)	KPH (LIMIT)	KPH (SURVEY)	KPH ADJUSTED
20	32	32	25
30	48	38	31
40	64	49	42
50	80	66	59

MPH (LIMIT)	KPH (LIMIT)	KPH (SURVEY)	KPH ADJUSTED
60	96	74	67
70	112	112	105

2.7.3 Individual localised changes to speeds were made to a small number of roads within the model where journey times did not calibrate against observations and the specific circumstances of that section of route merited localise speed adjustments.

2.8 Speed Flow Curves

2.8.1 The speed flow curves used in the EM Gateway modelling are described in the coding manual (Appendix A). These speed flow curves are based on those used in Regional Transport Models (which were originally derived by the TAME) and have been modified to suit local conditions during the calibration and validation process.

2.8.2 Appropriate speed flow curves were applied to the entire extent of the Strategic Road Network falling within the model boundary. In addition to this, speed flow curves were applied to several key urban roads.

2.9 Review of Banned Links and Turns

2.9.1 Banned turn and link information brought across from the existing models has been reviewed visually and updated where necessary. Particular attention was made to HGV bans in Derbyshire and Leicestershire as many rural routes are unsuitable for HGV vehicles.

2.9.2 The model cannot restrict HGV access on all rural routes as it need to provide local access to towns and villages, however, by using a combination of link speeds and HGV bans longer distance HGV trips route via either the strategic road network or suitable trunk roads.

2.10 Bus Routes and Frequencies

2.10.1 Bus lines were included as a pre-load file in the Gateway SATURN network. The information on bus routes and frequencies have been taken from the updated 2016 public transport model and converted from a CUBE Voyager format into a SATURN format.

2.11 Traffic Signal Data

2.11.1 Broxtowe Council provided signal data for Mansfield, Hucknall and at the following key junctions in the vicinity of Toton:

- A52 Bardhills
- A52 Sherwin Arms
- A6005 Nottingham Road/Attemborough Lane
- A6005 Nottingham Road/Barton Lane
- A6005 Nottingham Road/Eldon Road
- B6003 Toton Lane/A6005
- B6003 Toton lane/NET Junction

- B6003 toton Lane/Swiney Way
- B6003/B5910 The Roach Crossroads

2.11.2 In cases where it was possible to use council provided information the data has been applied however these were reviewed and adjusted to fit the strategic model purpose, especially in cases where there were alternative signal patterns being applied for certain traffic situations or at different times of the day.

2.11.3 In the absence of any further traffic signal data from local authorities signal settings were taken from the individual models.

2.11.4 Signal optimisation was undertaken once at an early stage of the network build, in order to move the signal timings to common 2016 base year and provide a more realistic starting point. The rationale for this approach was driven by many of the the signals across the study area being controlled by scoot or mova which are subject to change based on traffic volumes. Signals were subsequently fixed and only updated on a case by case basis during the calibration/validation process.

2.12 Values of Time and Vehicle Operating Costs

2.12.1 Values of time and vehicle operating costs were calculated from the information in the WebTAG data book, issued December 2017. They are expressed in values of pence per minute (PPM) and pence per kilometre (PPK) for a passenger car unit (pcu).

Table 4. Value of time (pence per minute) and vehicle operating cost (pence per kilometre)

PURPOSE	PPM	PPK
Commute	20.26	12.34
Business	30.21	14.86
Other	13.98	12.34
LGV	21.71	14.80
HGV	18.40	39.64
Taxi	20.26	12.34

2.13 Network Checks

Queues

2.13.1 A crucial part of the network build was to ensure that the delays simulated within the model had a close correlation with reality in order to be able to replicate the highway conditions and provide robust forecast year modelling. If queuing in the base year is unrepresentative then forecasts into the future may result in dubious results.

2.13.2 SYSTRA have a good knowledge of the roads and junctions within the Gateway model and used this knowledge along with Google traffic information and site visits to conduct logic checks to ensure that queues are represented in the correct places. This is, however, a strategic model and whilst we have undertaken some visual checks to ensure congestion is generally in the right places, detailed quantitative checks of this type are not required for this type of model.

Routing

2.13.3 Modelled routes were checked using Select link Analysis and Tree Analysis to ensure integrity. These checks show that the model assigns traffic along logical and expected routes in order for traffic to reach its destination. Appendix B presents a set of modelled routes between a representative sample of origin and destination pairs.

GAP Values

2.13.4 GAP values were set uniformly at the network build stage however during the calibration process a number of these values were amended to more robustly reflect road conditions. Changes commonly occurred along:

- the strategic Road Network to make allowances for variances in the type of merge at each junction
  - GAPM of 1 used for lane gains
  - GAPM of 2 used for typical merges
  - GAPM of 3 used for short slip lanes
- at specific junctions to encourage more flow or reduce flow through a junction. In some instances the GAP values have been changed to be more consistent with those used in the individual GDTM, GNTM and LLITM models.

Core Area of Influence

2.13.5 Network coding in the vicinity Toton was independently checked against Google Earth to ensure roads had appropriate distances, speeds and lanes. Junctions were checked to ensure they were coded with sensible lane allocations, saturation flows and GAP values.

Strategic Road Network Checks

2.13.6 The strategic network was closely checked against mapping tools to ensure that distances, lanes and lane allocation and speeds were correct. Merge GAP values were reviewed and amended where necessary. Particular attention was paid to the M1 and A52, especially around the HS2 site.

SATNET Errors and Warnings

2.13.7 The SATURN network-building program SATNET produces error and warning messages that were dealt with individually. All fatal and semi-fatal errors introduced into the model were corrected, and warning messages were inspected and faults corrected where necessary. Not all warnings have been rectified as some relate to legitimate coding decisions made within the model build and calibration and validation process.

2.13.8 A number of zone loading checks were also performed to ensure that zones loaded onto the correct parts of the network and all trips associated with the zone were able to get onto the highway network.

3. DEVELOPMENT OF PRIOR MATRICES

3.1 Introduction

3.1.1 This section provides information on the development of the prior matrix, including an overview of the data sources used and the methodology.

3.2 MRTM assignment matrices

3.2.1 The initial highway matrices were taken from the Midlands Regional Traffic Model (MRTM). These were largely derived from mobile phone data and infilled with synthetic data.

3.2.2 The MRTM demand represents the entire country, though with more spatial detail in the Midlands region. However, it should be noted that the MRTM was developed to model inter-city movements on the strategic road network and so the zoning system is relatively coarse within urban areas compared to the EMGM zoning system.

3.2.3 These matrices were rezoned to the EMGM zoning system using postcode data to derive splitting factors between the two zoning systems. The MRTM assignment demand is based on MSOAs or amalgamations of MSOAs. These matrices were rezoned to the EMGM zoning system using postcode data to disaggregate the MRTM demand into OA and LSOA areas required for the EMG zoning system.

3.3 Taxi demand

3.3.1 The MRTM matrices neither include a separate user class for taxis or include the demand within the car matrices. Therefore the taxi matrix that has been generated represents additional demand to that in the MRTM.

3.3.2 The taxi user class was derived from the MRTM car matrices assuming a percentage of trips in the matrices are taxi trips. The percentages used were 5% within Derby, 3% within Nottingham and 1% elsewhere. These percentages were taken from 2016 ANPR data collected for the Derby and Nottingham Clean Air Zone projects. The ANPR data was collected at 3 sites in Nottingham (A60/County Road junction, Mansfield Road/Edwards Lane, A6514/Wollaton Road) on a neutral day in May and 6 sites in Derby (Eastgate, Moorledge, Traffic Street, King Street, Jury Street, Abbey Street) on a neutral weekday in October. The ANPR data was combined with VRN data to generate the proportion of taxis at a postcode level. This was mapped to the EMG zoning system to give the proportion of compliant/non-compliant demand at a production/origin level.

3.4 Mask trips

3.4.1 The MRTM matrices cover the entire country and therefore contain a large amount of demand that doesn't travel through the EMGTM model area (e.g. intra-South East trips). A mask was developed to remove these movements, whilst retaining any movements that could possibly travel through the study area (e.g. Northamptonshire to Yorkshire).

3.5 Work place parking levy (WPL)

3.5.1 Trips in the commute user class were split into 2 user classes, reflecting demand that pays the WPL and demand that doesn't. The factor for splitting the commute user class was taken from the GNTM and were based on surveys undertaken by NCC which identified the levels of private workplace parking within the city that are required to pay the charge. This information has also been used as the basis for the application of the WPL charging regime and is therefore confidential.

3.6 Adjust demand

3.6.1 Trips to/from large industrial and employment zones including Boots, Pride Park and Rolls Royce were adjusted to match generations in the constituent models. These have been sense checked against count data where possible.

3.6.2 Trips to/from all Park and Ride sites were replaced with trips for these sites from the existing Derby and Nottingham models. This approach also provided an indicative distribution of trips generated by the respective Park and Ride models.

3.7 Factoring of the Prior Matrices

3.7.1 The matrix was derived from Highways England regional model matrices which represent an average hour rather than a peak hour. Furthermore, an initial review of sectored demand indicated that there was little demand within and to/from key urban areas and therefore an initial matrix factoring was undertaken using just screenline and cordon counts to get the demand entering and exiting urban areas closer to observed peak hour count data. A set of peak hour counts around each of the key cities were identified and used in an initial matrix estimation run to adjust the traffic levels so that they met the overall levels of demand to and from each city. These counts were **not** used as validation counts in the cal/val process, but do form part of the overall screenline performance statistics reported in section 5.6. This produced a new 'prior' matrix which was taken forward in subsequent matrix estimation runs. The counts used as in this process are marked as 'CAL' in Appendix D.

4. MATRIX ESTIMATION

4.1 Introduction

4.1.1 This section looks at the enhancements that have been undertaken to the prior matrices before the application of matrix estimation and the process and impact upon the matrices of matrix estimation.

4.2 Traffic Count Data

4.2.1 The data specification report (Appendix C) details the availability of observed data from each constituent model and sets out data collection exercise required for the purposes of the highway (and public transport) model validation.

4.2.2 Data was collected from the following sources:

- Derby and Nottingham City Councils
- Derbyshire, Nottinghamshire and Leicestershire County Councils
- HE TRADS system
- AECOM Capita Ineco JV (data collected on behalf of HS2 Ltd)
- AECOM (data collected on behalf of Highways England)
- Newly commissioned count data from NCC

4.2.3 A large amount of count data was received for this study, some of which was part or fully processed by external companies. Upon receipt of the counts they were reviewed for quality. If there was a known problem with the collection of the count data (such as an accident or roadworks) these counts were immediately disregarded and not processed. Valid counts were then processed to select data from only neutral weekdays, relevant peak hours and vehicle type classifications. Further detail on each of these elements is provided below.

4.2.4 The majority of count data was classified by vehicle type (Car, LGV and HGV) and available for morning peak (08:00 – 09:00), inter peak (average of 11:00 – 14:00) and evening peak (17:00 – 18:00).

4.2.5 The counts provided by HS2 in the vicinity of the Toton site were available for morning peak and evening peak hours however not all locations had inter peak data readily available and consequently the inter peak model calibration/validation only uses a subset of the HS2 count data.

4.2.6 All count data used within the model calibration and validation have been taken from a neutral week in a neutral month. At sites where data for more than one day was collected/available the model has used the average traffic flows between Tuesday and Thursday.

4.2.7 All counts were factored to a 2016 base year using an average factor from all authorities within the model boundary within TEMPRO 7.2. The factors applied to the counts are shown in Table 5 below.

Table 5. TEMPRO Factors

YEAR	MORNING PEAK	INTER PEAK	EVENING PEAK
2015	1.015	1.017	1.016
2016	1.000	1.000	1.000
2017	0.985	0.983	0.985

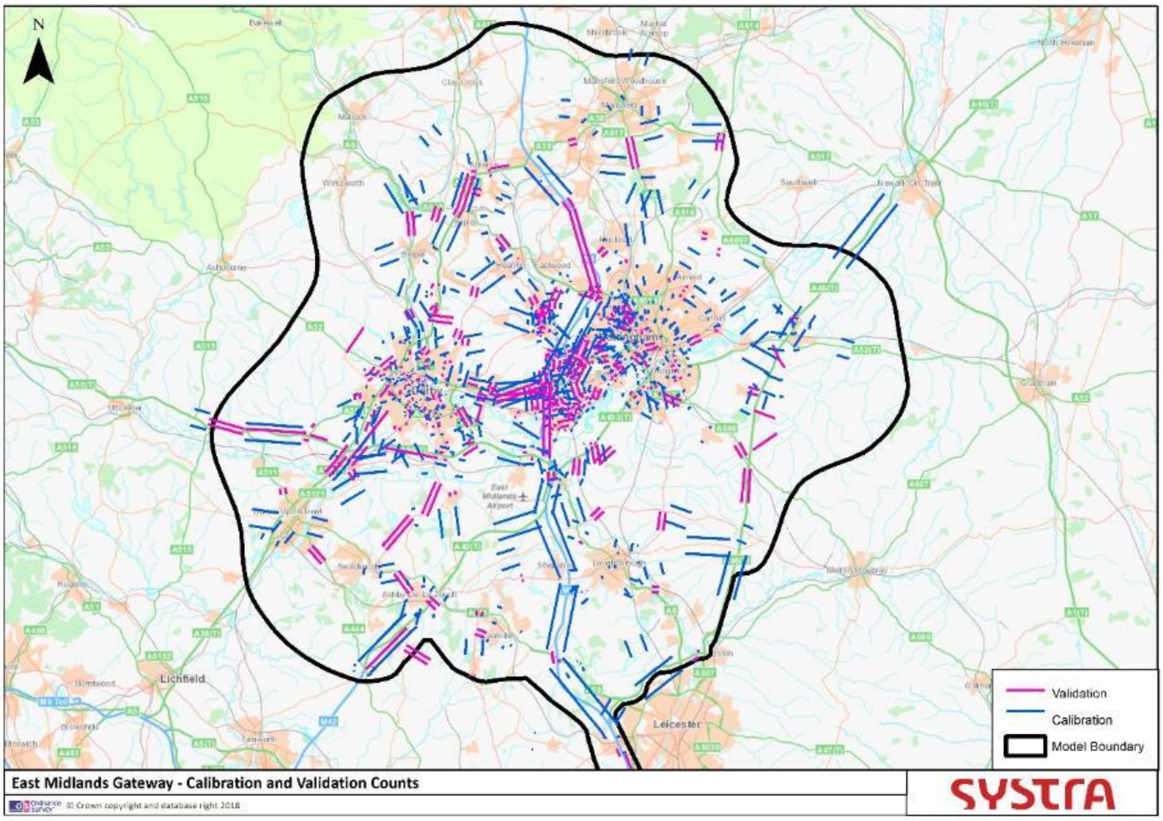
4.3 Count Checks

4.3.1 Each count was assigned to a saturn link at an early stage and in parallel to the network build so checks were carried out to make sure that the cal/val process had mapped the counts to the correct link. Counts were also reviewed on ArcGIS to make sure that the observed flow on adjacent counts were similar or defendable and in cases where the counts differed they were removed from the cal/val process.

4.3.2 Counts were reviewed prior to the calibration process to identify inconsistencies between flows on adjacent counts and issues with counts being assigned to the wrong link. In the case of the latter the links were updated accordingly however where inconsistencies in flows were identified the counts were removed and not used in calibration or validation process.

4.3.3 Figure 7 shows the locations of the counts used in the calibration/validation process.

Figure 7. Calibration and Validation Counts

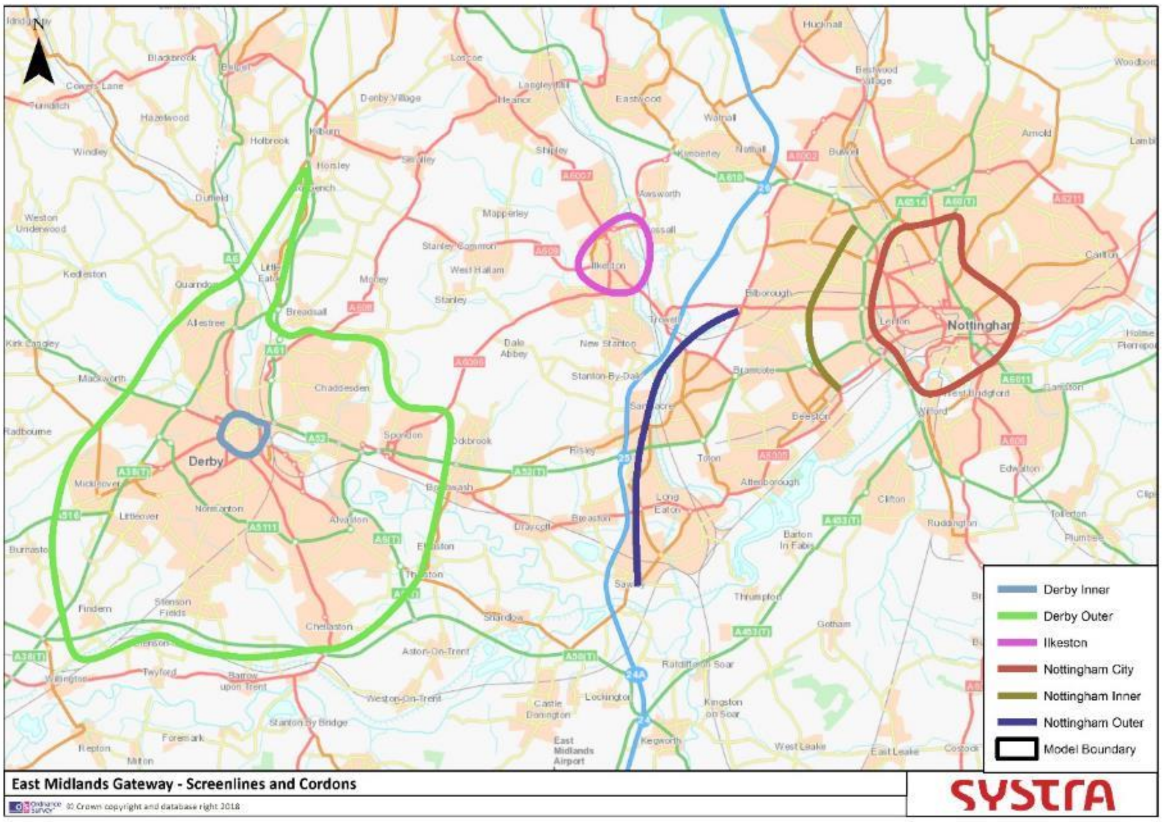


4.4 Cordons and Screenlines

4.4.1 A series of cordons and screenlines were established prior to the calibration process to monitor traffic flows into/out of towns and cities. Figure 8 illustrates the cordons and screenlines which have been used. These include the following:

- Nottingham City Cordon
- Derby City Centre Cordon
- Derby City Outer Cordon
- Ilkeston Cordon
- Nottingham Outer Screenline
- Nottingham Inner Screenline

Figure 8. Location of Screenlines and Cordons



4.5 Matrix Estimation

4.5.1 Matrix estimation was run for 7 loops, focussing on each vehicle type in turn. The prior matrix was used as an input to the process on each loop. The calibration and validation process has been undertaken on the 7 user class model.

4.5.2 A series of constraints have been applied to matrix estimation to minimise the ability of the program to make significant changes to demand to meet individual counts. Zones with very little land use, and therefore trips, were identified and their origins and destinations trips 'frozen'. Furthermore, the XAMAX setting was set to 1.5 to avoid significant, and potentially erroneous, demand changes.

4.6 Changes to Matrix Totals

4.6.1 Tables 6, 7 and 8 below provide the highway matrix totals for pre and post matrix estimation for the morning peak, inter peak and evening peak. The overall trip levels have changed by 7.49% in the morning peak, by 7.32% in the inter peak and by 7.22% in the evening peak. These changes are narrowly outside the less than 5% recommendation set in the WebTAG guidance, however, the changes are considered reasonable given the prior matrix is concentrated around the movements along the SRN rather than urban travel movements whilst the Gateway model is focused on intra-urban movements and movements between Derby, Nottingham and Leicester.

Table 6. Impact on Morning Peak matrix totals (vehicles)

	BEFORE MATRIX ESTIMATION	AFTER MATRIX ESTIMATION	PERCENTAGE DIFFERENCE
Cars	442,688	479,044	8.21%
LGV	58,569	59,771	2.05%
OGV	27,190	29,192	7.36%
Total	528,448	568,008	7.49%

Table 7. Impact on Inter Peak matrix totals (vehicles)

	BEFORE MATRIX ESTIMATION	AFTER MATRIX ESTIMATION	PERCENTAGE DIFFERENCE
Cars	348,785	375,785	7.74%
LGV	53,752	55,743	3.70%
OGV	26,420	28,848	9.19%
Total	428,958	460,376	7.32%

Table 8. Impact on Evening Peak matrix totals (vehicles)

	BEFORE MATRIX ESTIMATION	AFTER MATRIX ESTIMATION	PERCENTAGE DIFFERENCE
Cars	488,124	525,782	7.71%
LGV	47,578	48,890	2.76%
OGV	17,312	18,257	5.46%
Total	553,013	592,929	7.22%

4.7 Changes to Zonal Trip Ends

4.7.1 A regression analysis has been conducted to ascertain the degree of fit between the prior trips ends and those following the ME process. Figures 9, 10 and 11 graphically represent this data for each peak, focussing on a total trip end basis (all user classes combined).

4.7.2 Table 9 conveys the correlation between prior and post matrix estimation trip ends at Origin and Destination levels. The correlation coefficient R^2 provides indication of the 'goodness of fit' whilst the slope of the best fit regression line through the origin indicates the range by which the modelled values are under or over estimated.

4.7.3 WebTAG Unit M3 advises that acceptable values are deemed to be above 0.98 for R^2 and a slope of between 0.99 and 1.01 with a value of 1.00 for each being a perfect fit. Where trip numbers are large it may be difficult to obtain a perfect slope and values of R^2. A linear model with the following formula has been used:

Post ME2 Trips = a * prior

Table 9. Correlation between trip end totals between before and after matrix estimation

	ORIGIN TRIP ENDS		DESTINATION TRIP ENDS	
	R^2	slope	R^2	slope
Morning Peak	0.98	1.02	0.98	1.02
Inter Peak	0.99	1.03	0.98	1.03
Evening Peak	0.98	1.02	0.98	1.02

4.7.4 The correlation is reasonable between the trip ends before and after matrix estimation. For each peak the R^2 value, an indicator of goodness of fit between the two datasets, is greater than 0.98. The slope is marginally outside the guidance, however, it is considered reasonable given the size of the model and the use of the MRTM matrix which was developed to model inter-city movements on the strategic road network rather than urban movements.

Figure 9. Morning Peak Trip End Comparison

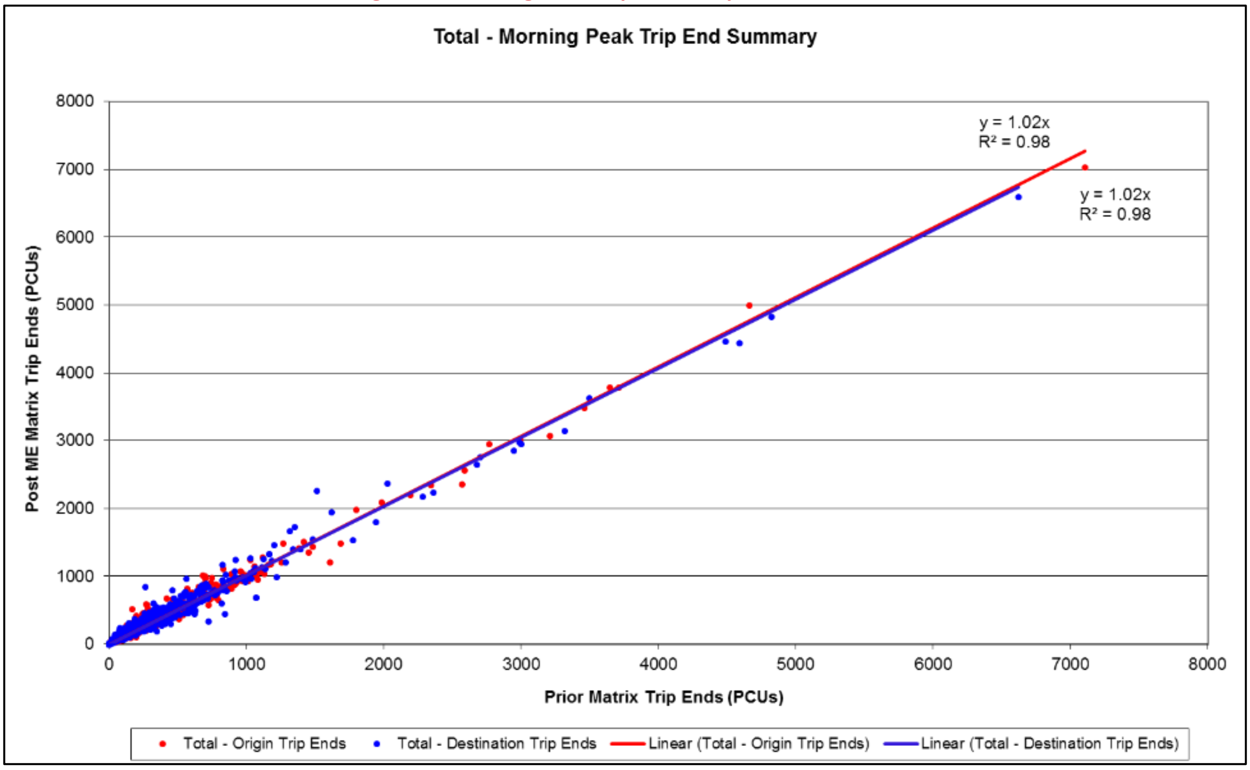


Figure 10. Inter Peak Trip End Comparison

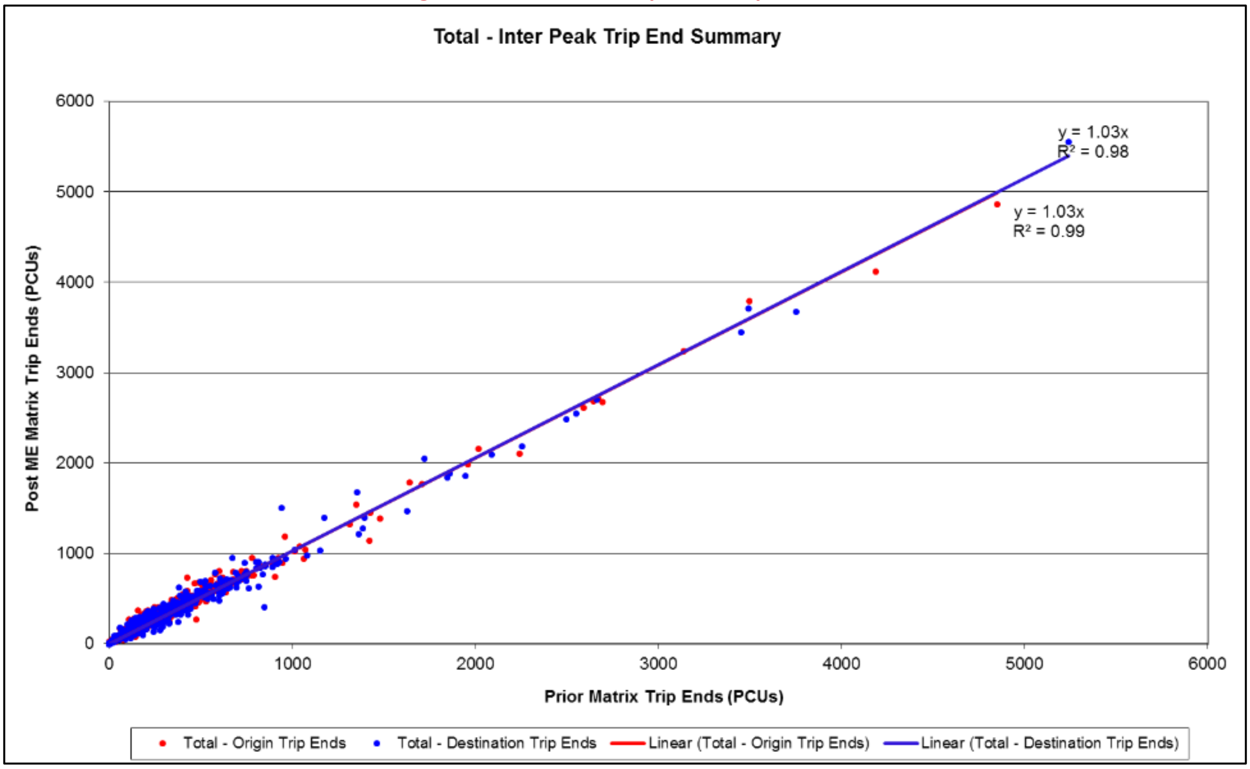
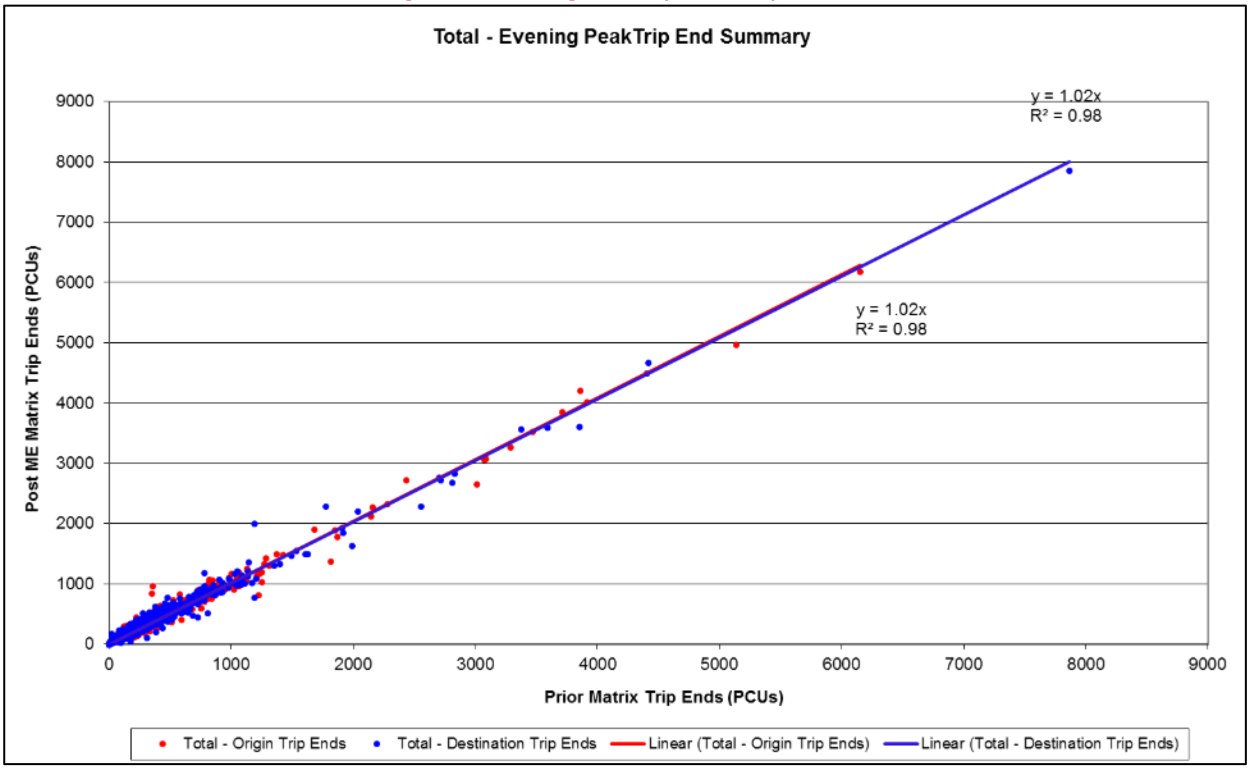


Figure 11. Evening Peak Trip End Comparison



4.8 Changes to Trip Length Distributions

4.8.1 The distributions of trip lengths within the model are shown in Figures 12, 13 and 14 for all vehicles combined by time period. The blue bars represent trips for the prior matrix, whilst the purple bars represent the post matrix estimation trips.

Figure 12. Morning Peak Trip Length Distributions

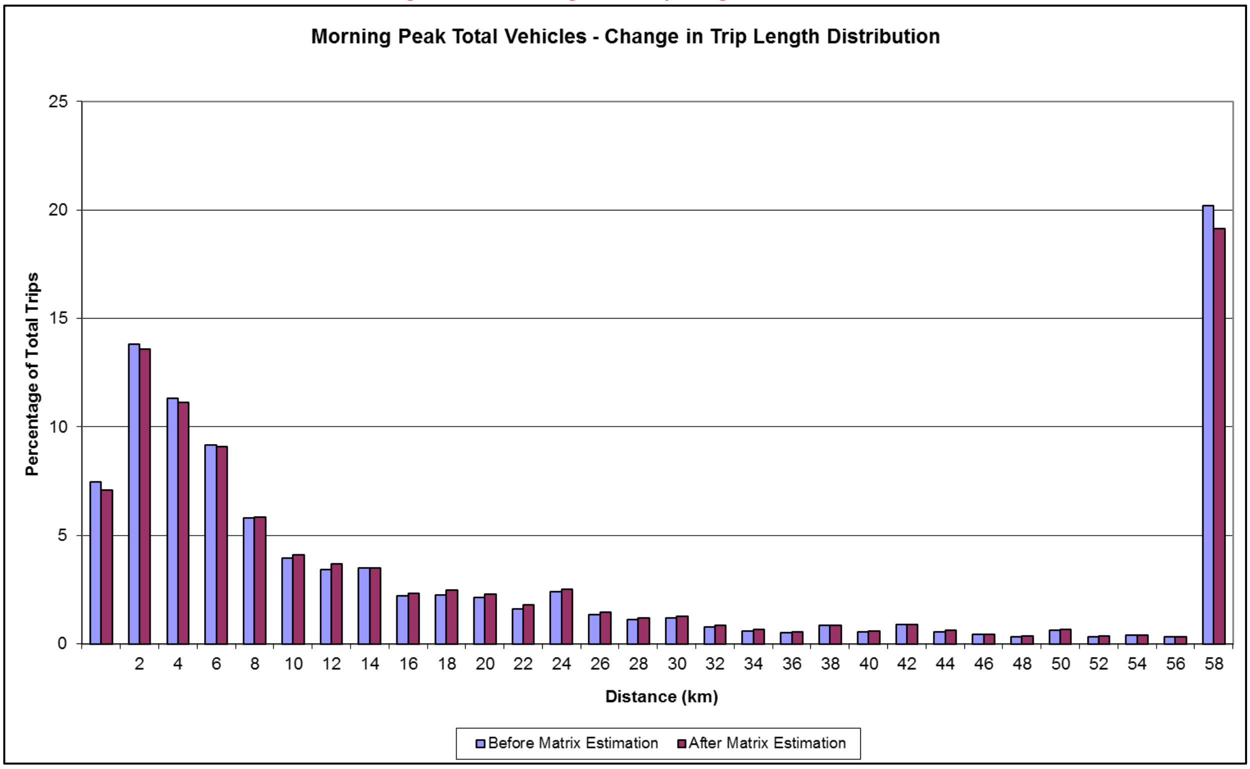


Figure 13. Inter Peak Trip Length Distributions

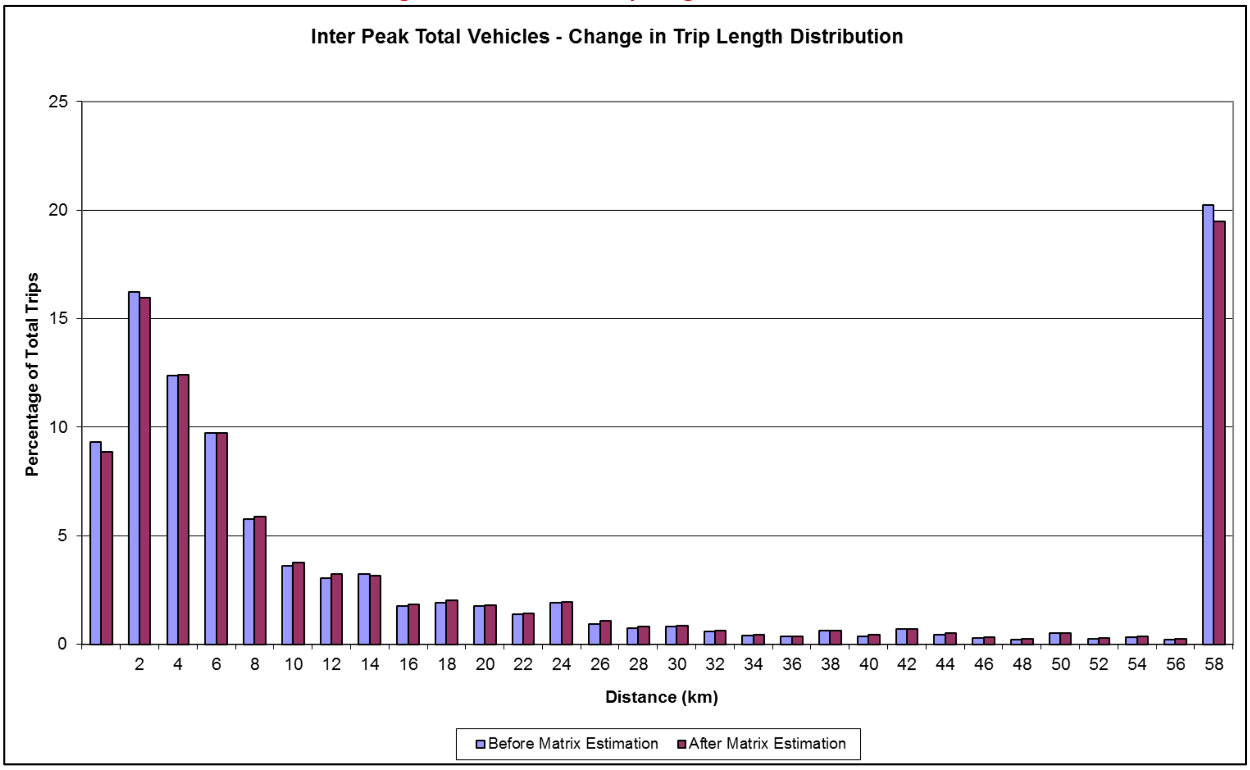
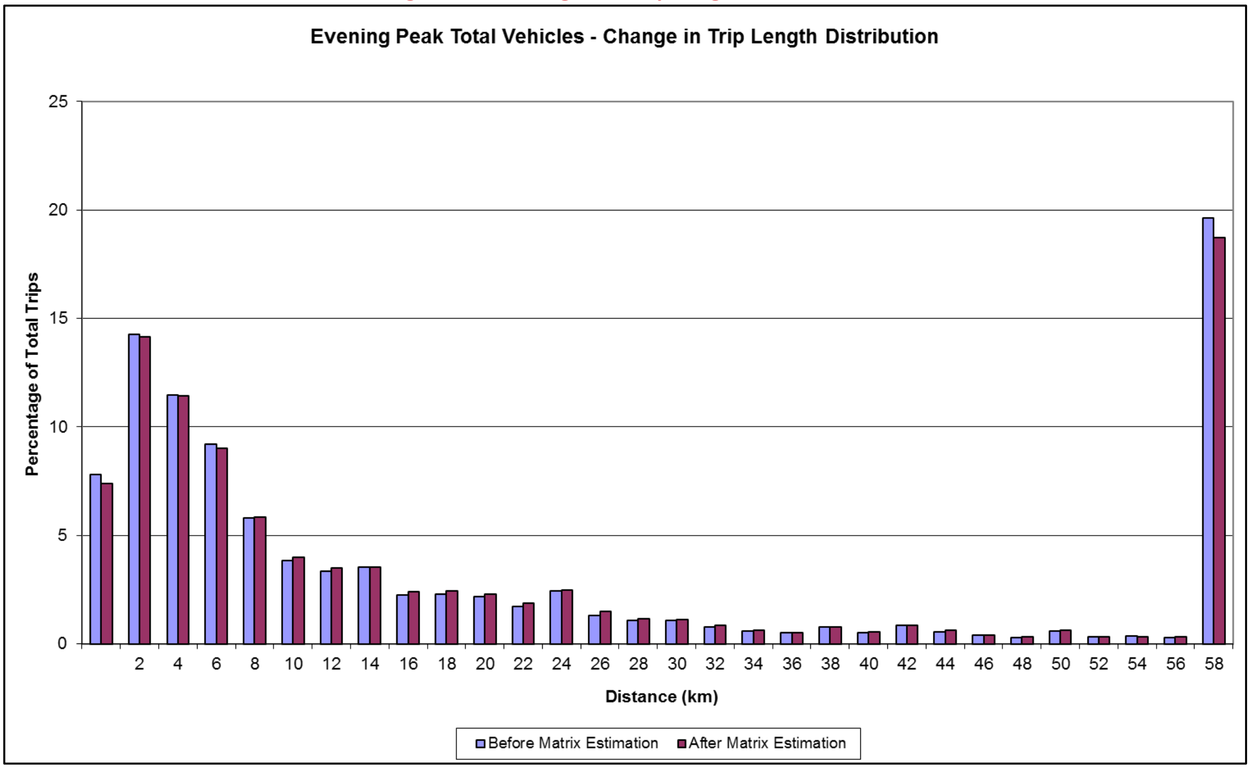


Figure 14. Evening Peak Trip Length Distributions



4.8.2 Table 10 shows the change in mean car trip lengths for the prior and post matrix estimation matrices for the morning and evening peaks respectively. This includes all trips within the network, including exogenous trips that travel through the study area.

4.8.3 These show that matrix estimation changes the mean car trip lengths by 1% in the inter peak, -1% in the evening peak and no change in the morning peak. WebTAG advises that changes to mean trip length by matrix estimation should be no more than 5%.

Table 10. Average Car Trip Lengths Before and After Matrix Estimation

	BEFORE ME	AFTER ME	% DIFFERENCE
Morning	20.0	20.0	0%
Inter	17.9	18.0	1%
Evening	21.4	21.3	-1%

4.8.4 Overall, the average trip length has changed by a very small amount in all time periods and therefore indicates that matrix estimation has not significantly altered the trip lengths within the model.

5. ASSIGNMENT CALIBRATION AND VALIDATION

5.1 Introduction

5.1.1 This section discusses the assignment model convergence before presenting the aggregate performance of the highway model against individual counts, screenlines and observed journey times for Nottingham and Derby.

5.2 Network Convergence

5.2.1 WebTAG M3 discusses the importance of achieving highway assignment convergence. The following convergence monitoring indicators (and their acceptable values) have been specified in WebTAG by:

- DELTA is reported from the assignment iterations. It is the difference between the times along the actual routes and the minimum cost routes, summed across the whole network and expressed as a percentage of the minimum cost times. DELTA is expected to be below 1% shows that the model convergence is well within this target range with values less than 0.05 in all time periods;

- % GAP is a measure of the stability of the model. It is a generalisation of the Delta function to include the interaction effects within the simulation. The recommended value by WebTAG is less than 0.1% over four consecutive iterations;

- Epsilon is reported from the simulation iterations. It is a measure of the degree to which the area under the speed/flow curves is minimised and is expected to be below 1%. Table 5.1 shows that the model convergence is well within the target range; and

- % Flows is a measure of the stability of the model and shows the percentage of links where flow differs by < 1%. WebTAG guidance states that 98% links should not vary by more than 1% in successive iterations.

5.2.2 Table 11 provide the convergence statistics for the base year model. In all three peaks the model is well below the %GAP target of < 0.1%. With 97% percent of links flows changing by less than 1%, the model narrowly misses the % flow target of 98%. However, the model covers an extensive geographical area and there is a desire to keep run times at an acceptable level resulting in a trade-off between model run time and accuracy.

5.2.3 Despite narrowly missing the % flow criteria the model is still considered stable since the given that the %GAP value is well within the target, and the % change in flows between the final four loops is minimal.

Table 11. Network Convergence Statistics

CRITERION	TARGET	AM PEAK	IP PEAK	PM PEAK
Delta	< 0.1%	0.0022	0.0009	0.0018
%GAP	< 0.1%	0.0027	0.00074	0.0024
% of links with < 1% flow change on final iteration	98%	96.8	96.8	96.6
Final iteration -1		96.8	96.7	96.6
Final iteration -2		96.7	96.6	96.7
Final iteration -3		96.8	96.6	96.6

5.3 Validation Guidance

5.3.1 TAG Unit M3.1 Table 2 sets out validation acceptability guidelines for comparing modelled and observed traffic flows based on the level of flow in vehicles per hour (vph). These are:

- **For observed flows less than 700 vph,** at least 85% of model flows should be within 100 vph of observations
- **For observed flows of between 700 and 2,700 vph,** at least 85% of model flows should be within 15% of observations
- **For observed flows greater than 2,700 vph,** at least 85% of model flows should be within 400 vph of observations

5.3.2 These guidelines are referred to as the WebTAG flow criteria in the text, and as '% Flow Criteria' in the tables.

5.3.3 In addition to the flow criteria described above, WebTAG also refers to the GEH statistic, where;

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

5.3.4 and, M is the modelled flow
C is the counted (observed) flow.

5.3.5 The GEH statistic is a form of Chi squared statistic, incorporating both relative and absolute errors. WebTAG recommends that greater than 85% of counted links should have a GEH value of less than 5.0.

5.3.6 WebTAG advice on counts meeting flow criteria and GEH criteria is as follows that:

"These two measures are broadly consistent and link flows that meet either criterion should be regarded as satisfactory."

5.3.7 The guidance also requires that for any cordons and screenlines, that the difference between the modelled flows and counts should be less than 5% of the counts in nearly all cases.

5.4 Link Flow Calibration and Validation

5.4.1 This section presents the link flow calibration and validation for the full model area, core area of interest and the Highways England network.

Full Modelled Area

5.4.2 Table 12 provides the headline calibration statistics for the full model area. Table 13 provides the validation statistics for the same area.

5.4.3 In all three peak hours at least 85% of the model calibration counts meet either the GEH or flow criteria with particular strong performance of LGV and HGV counts.

5.4.4 In terms of validation, over 96% of the LGV counts meet either the GEH or flow criteria in each peak and over 90% of the HGV counts meet either the GEH or flow criteria. These statistics far exceed the recommended target of 85% stated in WebTAG guidance.

5.4.5 Over 77% of the car counts match either the GEH or flow criteria. Whilst this is lower than the recommended 85% target specified by WebTAG it still demonstrates a strong level of model validation given the size of the model, the number of counts within the data set and the complexities of route choice available within the model.

Table 12. Link Flow Calibration – Full Modelled Area

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Morning Peak				
Cars	947	83%	86%	88%
LGV	947	89%	98%	99%
HGV	947	79%	94%	95%
Total	954	81%	84%	85%
Inter Peak				
Cars	718	85%	90%	91%
LGV	718	91%	99%	100%
HGV	718	89%	99%	99%
Total	723	85%	89%	90%
Evening Peak				

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Cars	944	82%	87%	88%
LGV	944	91%	99%	99%
HGV	944	89%	99%	99%
Total	949	81%	85%	86%

Table 13. Link Flow Validation – Full Modelled Area

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Morning Peak				
Cars	564	68%	74%	77%
LGV	564	86%	97%	97%
HGV	574	70%	89%	90%
Total	574	70%	75%	78%
Inter Peak				
Cars	386	66%	76%	77%
LGV	386	83%	96%	96%
HGV	399	80%	95%	95%
Total	399	68%	74%	76%
Evening Peak				
Cars	576	69%	77%	78%
LGV	576	86%	99%	98%
HGV	587	82%	96%	97%
Total	587	68%	75%	77%

Core Area of Interest

5.4.6 Table 14 provides the headline calibration statistics for the Core Area of Interest. Table 15 provides the validation statistics for the same area.

5.4.7 In the morning and evening peaks over 85% of the model calibration counts meet, or are close to meeting, either the GEH or flow criteria. There is a strong performance of LGV and HGV counts.

5.4.8 In terms of validation, over 94% of the LGV counts meet either the GEH or flow criteria and over 86% of the HGV counts meet either the GEH or flow criteria. These statistics exceed the recommended target of 85% stated in WebTAG guidance.

5.4.9 The level of car validation is strong in the morning peak (80%) and evening peak (78%). The validation is slightly lower in the inter peak, primarily due to reduced levels of count data during this peak. Whilst the car statistics are lower than the 85% recommendation specified by WebTAG the model still demonstrates a good level of validation given the size of the model and the complexities of route choice available within the model.

Table 14. Link Flow Calibration – Core Area of Interest

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Morning Peak				
Cars	333	85%	86%	88%
LGV	333	90%	98%	99%
HGV	334	63%	85%	86%
Total	334	81%	82%	84%
Inter Peak				
Cars	151	81%	88%	89%
LGV	151	89%	99%	99%
HGV	152	78%	95%	95%
Total	152	79%	88%	88%
Evening Peak				
Cars	333	83%	87%	88%
LGV	333	95%	99%	99%
HGV	334	82%	96%	96%

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Total	334	83%	86%	87%

Table 15. Link Flow Validation – Core Area of Interest

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Morning Peak				
Cars	284	74%	79%	80%
LGV	284	86%	99%	99%
HGV	284	63%	85%	86%
Total	284	74%	77%	80%
Inter Peak				
Cars	117	64%	74%	74%
LGV	117	80%	94%	94%
HGV	117	75%	91%	91%
Total	117	68%	72%	74%
Evening Peak				
Cars	295	73%	77%	78%
LGV	295	91%	98%	98%
HGV	295	77%	94%	95%
Total	295	73%	77%	78%

Highways England

5.4.10 Table 16 provides the headline calibration statistics for the strategic road network. Table 17 provides the validation statistics for the same area.

5.4.11 Table 16 shows that over 85% of the model calibration counts meet either the GEH or flow criteria In all three peak hours.

5.4.12 In all three peaks over 82% of the LGV validation counts meet either the GEH or flow criteria and over 86% of the HGV validation counts meet either the GEH or flow criteria. These statistics are close to the target of 85% recommended by WebTAG guidance.

5.4.13 Over 71% of the car validation counts match either the GEH or flow criteria. Whilst this is slightly lower than the 85% target specified by WebTAG it still demonstrates a good level of model validation given the number of available counts and the complexities of route choice along the SRN within the model.

Table 16. Link Flow Calibration– Highways England

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Morning Peak				
Cars	100	84%	90%	92%
LGV	100	85%	94%	94%
HGV	100	89%	98%	98%
Total	100	84%	91%	92%
Inter Peak				
Cars	101	88%	90%	90%
LGV	101	89%	97%	97%
HGV	101	90%	96%	96%
Total	101	89%	90%	92%
Evening Peak				
Cars	100	88%	89%	90%
LGV	100	79%	90%	90%
HGV	100	92%	99%	99%
Total	100	83%	84%	85%

Table 17. Link Flow Validation – Highways England

	COUNTS	GEH < 5	% FLOW	GEH < 5 OR FLOW
Morning Peak				
Cars	56	63%	71%	71%
LGV	56	73%	82%	82%
HGV	56	70%	86%	86%
Total	56	73%	80%	82%
Inter Peak				
Cars	60	82%	82%	85%
LGV	60	80%	88%	88%
HGV	60	75%	92%	92%
Total	60	88%	90%	90%
Evening Peak				
Cars	56	75%	82%	82%
LGV	56	66%	89%	89%
HGV	56	86%	100%	100%
Total	56	71%	82%	82%

5.5 Link Flow Calibration and Validation (Spatial Analysis)

5.5.1 Figures 15 and 16 display the performance of all calibration and validation counts for the morning peak. Figures 17 and 18 display this information for the inter peak and Figures 19 and 20 provide this information for the evening peak. These figures show that there is no bias in the model as the locations that do not meet the GEH or % flow criteria are spread throughout the model area.

Figure 15. Morning Peak Count Performance – Full Model

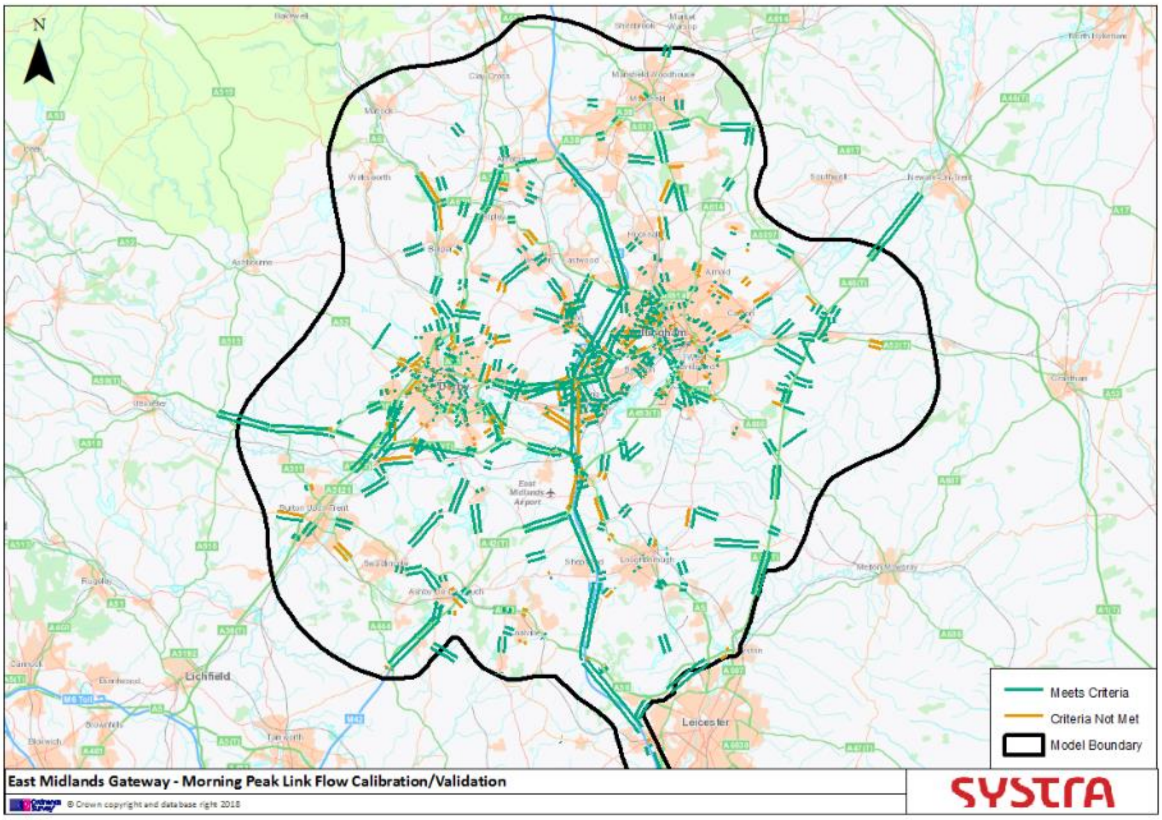


Figure 16. Morning Peak Count Performance – Core Area of Influence

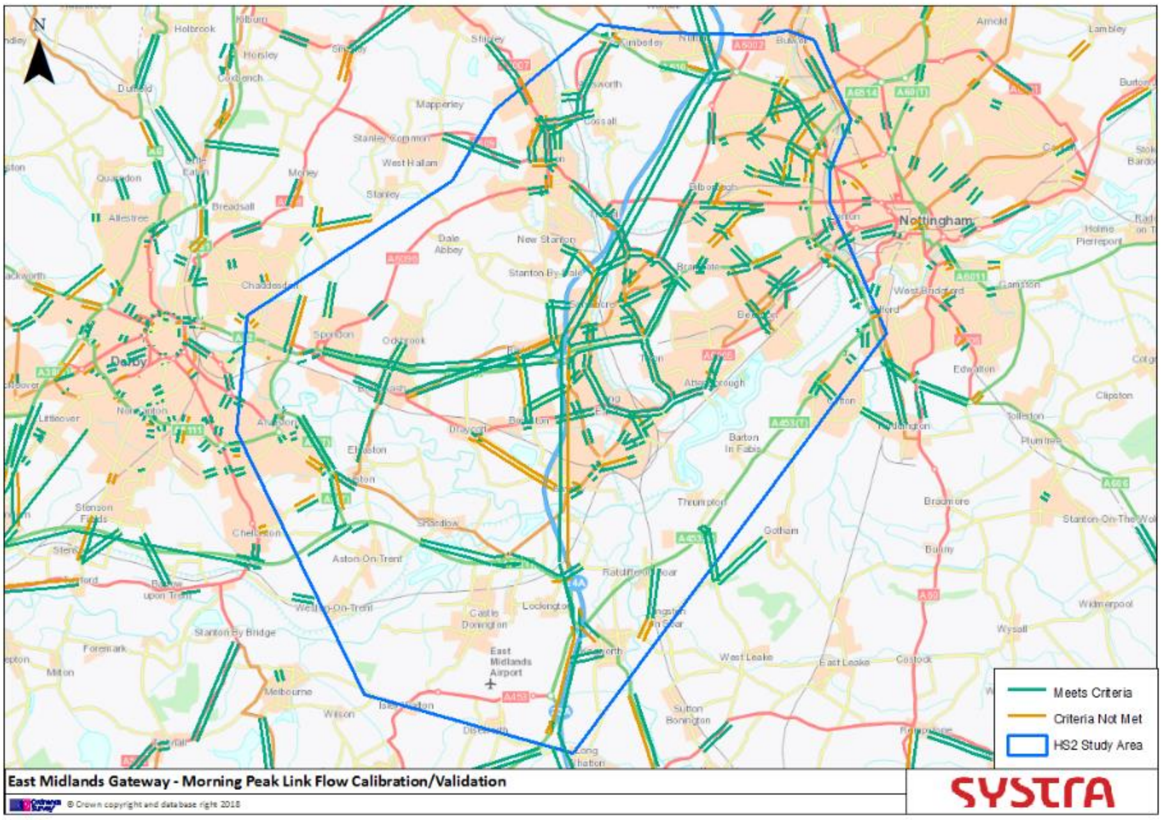


Figure 17. Inter Peak Count Performance – Full Model

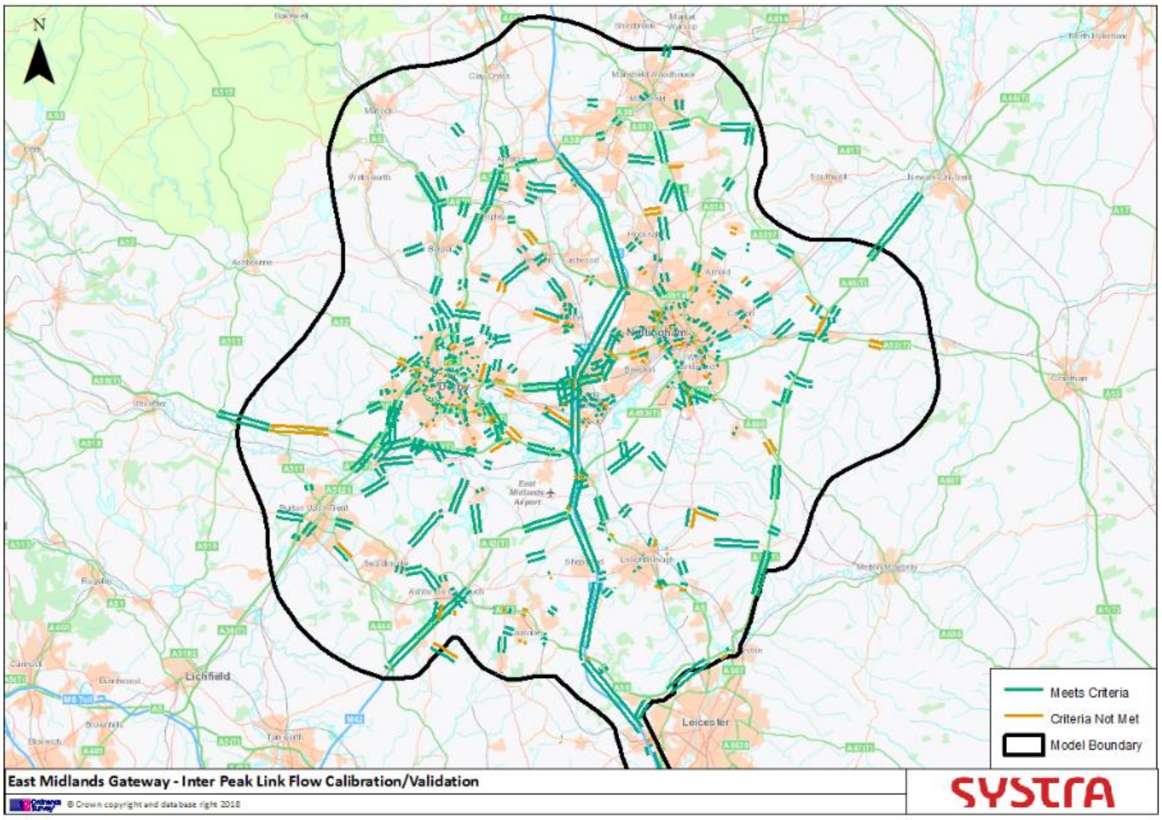


Figure 18. Inter Peak Count Performance – Core Area of Influence

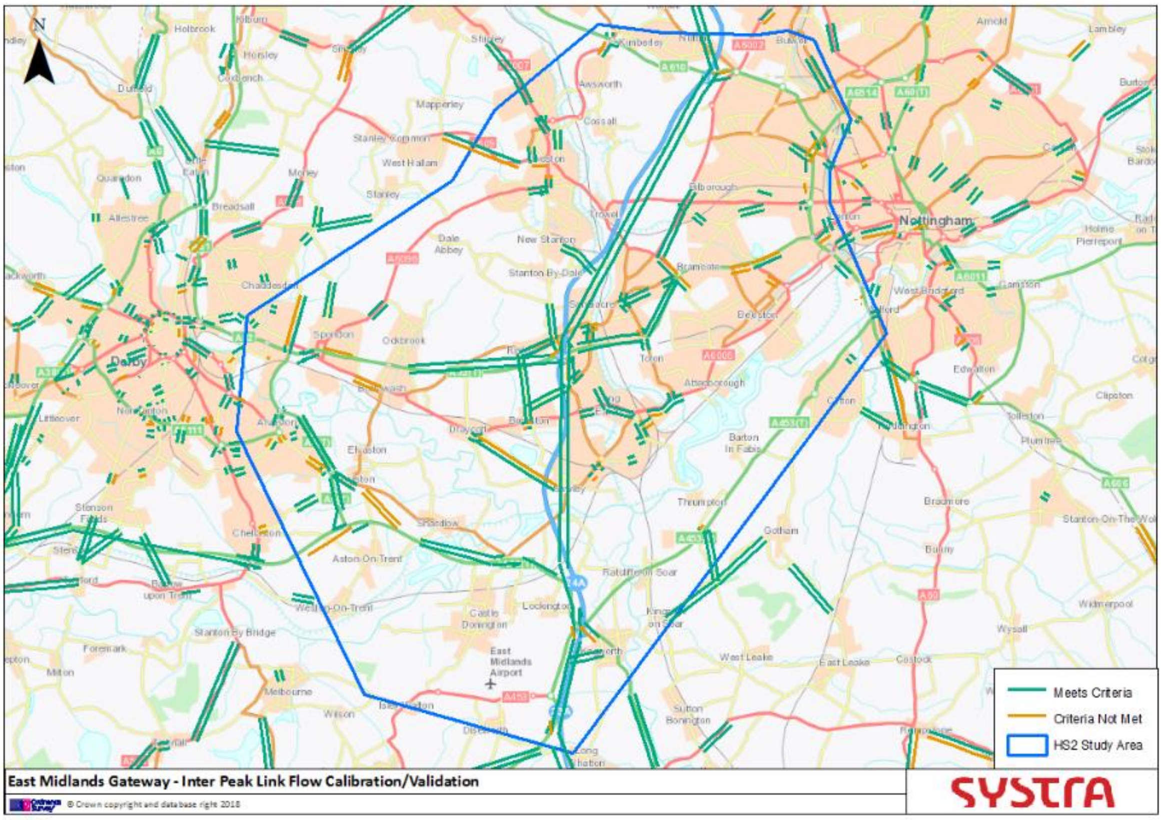


Figure 19. Evening Peak Count Performance – Full Model

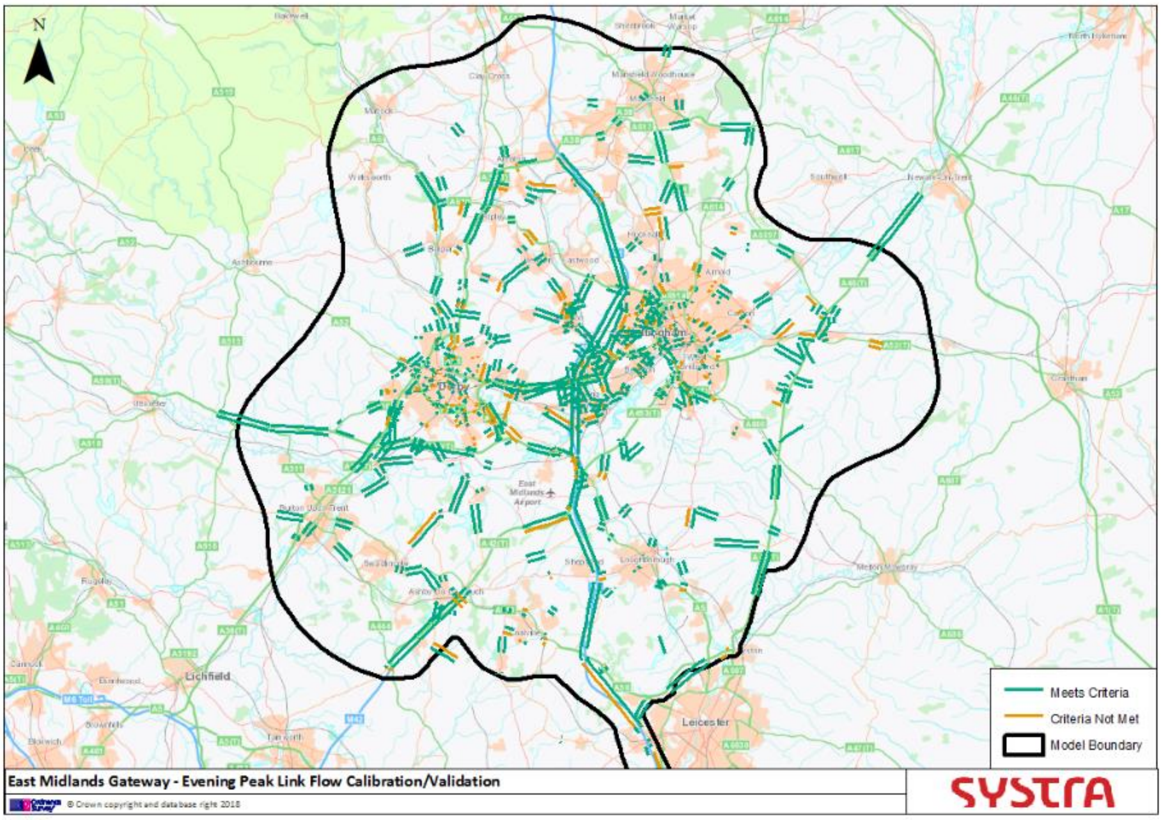
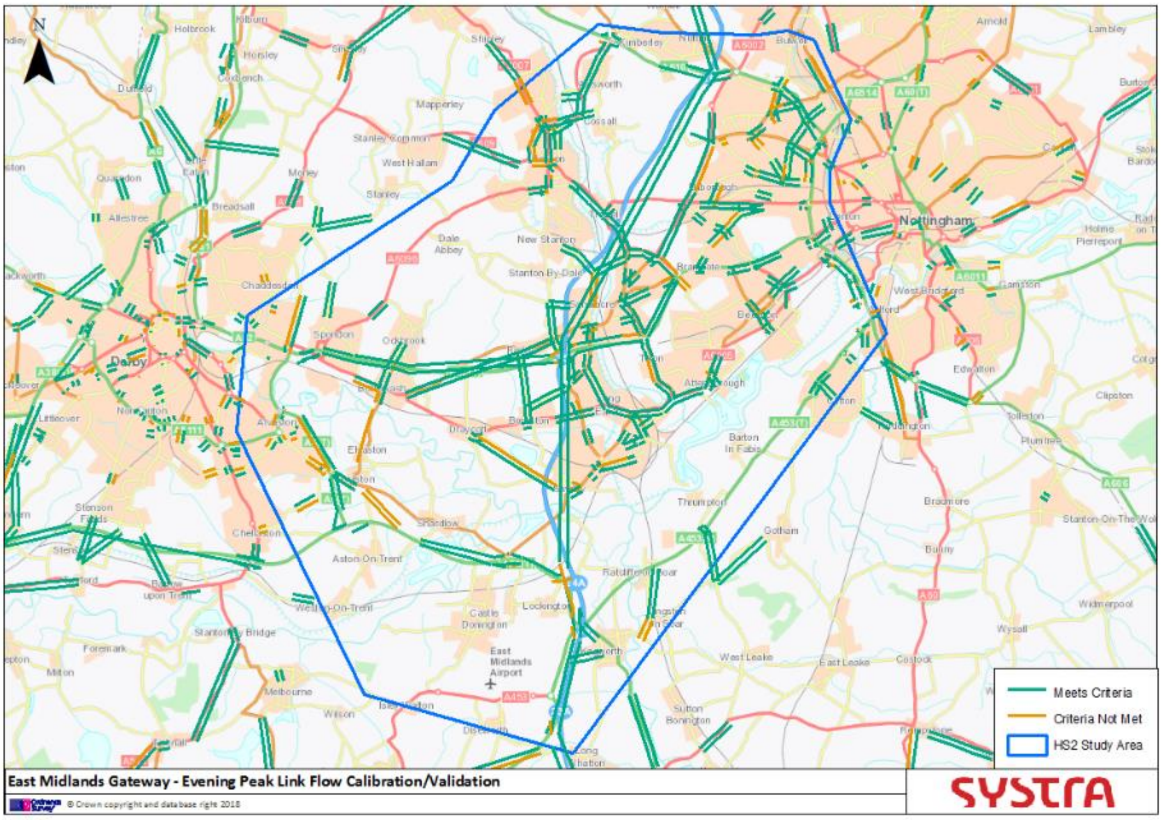


Figure 20. Evening Peak Count Performance – Core Area of Influence



5.6 Cordon and Screenline Performance

5.6.1 The performance of the cordons and screenlines are presented in the following section. WebTAG M3.1 recommends that screenlines are comprised of 5 or more counts. The screenlines presented contain a mix of calibration and validation counts since a set of peak hour counts around each of the key cities were used in an initial matrix estimation run to adjust the traffic levels so that they met the overall levels of demand to and from each city. These counts could not be subsequently used as validation counts but have been included in the statistics to ensure the screenlines were comprised of 5 or more counts.

5.6.2 In the morning peak and inter peak 10 out of 12 (or 83%) screenlines have modelled flows within 5% of the observed count. In the evening peak 100% of modelled screenline flows are within 5% of the observed count.

5.6.3 These results show a strong correlation between modelled and observed flows in all peaks and provides confidence that the model replicates flows in to and out of major urban areas.

Table 18. Morning Peak Screenline/Cordon Performance

CORDON/SCREENLINE	MODELLED	OBSERVED	DIFFERENCE	% DIFFERENCE
Derby Inner In	10927	10935	-8	0%
Derby Inner Out	7293	7134	159	2%
Derby Outer In	19252	19467	-215	-1%
Derby Outer Out	14313	13994	319	2%
Ilkeston In	4409	4678	-269	-6%
Ilkeston Out	3576	3336	240	7%
Nottingham City In	14642	14635	7	0%
Nottingham City Out	9422	9434	-12	0%
Nottingham Inner In	7521	7256	265	4%
Nottingham Inner Out	5696	5571	125	2%
Nottingham Outer EB	1884	1825	59	3%
Nottingham Outer WB	5207	5072	135	3%

Table 19. Inter Peak Screenline/Cordon Performance

CORDON/SCREENLINE	MODELLED	OBSERVED	DIFFERENCE	% DIFFERENCE
Derby Inner In	7728	7631	97	1%
Derby Inner Out	7078	7007	71	1%

CORDON/SCREENLINE	MODELLED	OBSERVED	DIFFERENCE	% DIFFERENCE
Derby Outer In	9546	9351	195	2%
Derby Outer Out	9796	9783	13	0%
Ilkeston In	2207	2157	50	2%
Ilkeston Out	2195	2096	99	5%
Nottingham City In	9640	9536	104	1%
Nottingham City Out	8696	9127	-431	-5%
Nottingham Inner In	593	410	183	45%
Nottingham Inner Out	567	466	101	22%
Nottingham Outer EB	1334	1233	101	8%
Nottingham Outer WB	2354	2289	65	3%

Table 20. Evening Peak Screenline/Cordon Performance

CORDON/SCREENLINE	MODELLED	OBSERVED	DIFFERENCE	% DIFFERENCE
Derby Inner In	8347	8113	234	3%
Derby Inner Out	9169	9629	-460	-5%
Derby Outer In	17792	17623	169	1%
Derby Outer Out	18038	18276	-238	-1%
Ilkeston In	4224	4101	123	3%
Ilkeston Out	4411	4330	81	2%
Nottingham City In	10204	10165	39	0%
Nottingham City Out	12719	12838	-119	-1%
Nottingham Inner In	5894	5925	-31	-1%
Nottingham Inner Out	7051	6940	111	2%
Nottingham Outer EB	2254	2241	13	1%
Nottingham Outer WB	5459	5353	106	2%

6. JOURNEY TIME VALIDATION

6.1 Introduction

6.1.1 Modelled and observed journey times have been compared on 12 two-way routes within the Nottingham and 12 routes within Derby. Detail on individual routes is contained in Appendix E.

6.1.2 The Nottingham journey time data used in the validation was provided by Nottingham City Council and was collected by between September 2014 and August 2015. Journey time data for the morning peak (08:00 – 09:00) and evening peak (17:00 – 18:00) was provided.

6.1.3 Two key journey time routes were excluded from this set of data as they were considered unrepresentative of 2016 conditions due to infrastructure investment in the highway network since this time. These excluded routes are:

- A52 Ring Road (Ring Road Major Improvements)
- A453 (A453 widening)

6.1.4 Journey time data for the A453 was subsequently taken from the post A453 widening evaluation study undertaken by AECOM on behalf of Highways England.

6.1.5 The Derby journey time data was provided by Derby City and was collected and processed by AECOM in 2015 for the purpose of the A38 model development. Journey time data for the morning peak (08:00 – 09:00) and evening peak (17:00 – 18:00) was provided.

6.1.6 Figure 21 illustrates the journey time routes for Nottingham and Figure 22 illustrates the journey time routes for Derby.

6.2 Journey Time Validation Guidelines

6.2.1 The WebTAG requirement (as set out in TAG Unit M3.1 Table 3) for journey time validation is that modelled times along the route should be within 15% of the observed time on more than 85% of routes.

6.2.2 The modelled times that are referred to in this section represent the time taken to travel from the start of the route to the routes end point and have been calculated using the Saturn 'Joy Ride' facility. This includes the turning delays for the specific set of turns made in the course of the journey.

6.3 Journey Time Validation

6.3.1 Tables 21 and 22 summarise the journey time validation for each route in Nottingham. In the morning peak 15 out of 22 (or 68%) of the journey time routes are within +/- 15% of the observed data. In the evening peak, 16 out of 24 (or 67%) of routes are within +/- 15% of the observed data.

6.3.2 Tables 23 and 24 summarise the journey time validation for each route in Derby. In the morning peak 10 out of 18 (or 56%) of journey time routes are within +/- 15% of the observed data. In the evening peak, 13 out of 22 (or 59%) of routes are within +/- 15% of the observed data.

6.3.3 The emphasis of this model validation process has been on flow validation. To rectify some of these journey time would affect the flow validation and as a result we have prioritised the flow validation over the journey time validation.

Figure 21. Journey Time Validation Routes - Nottingham

Figure 22. Journey Time Validation Routes - Derby

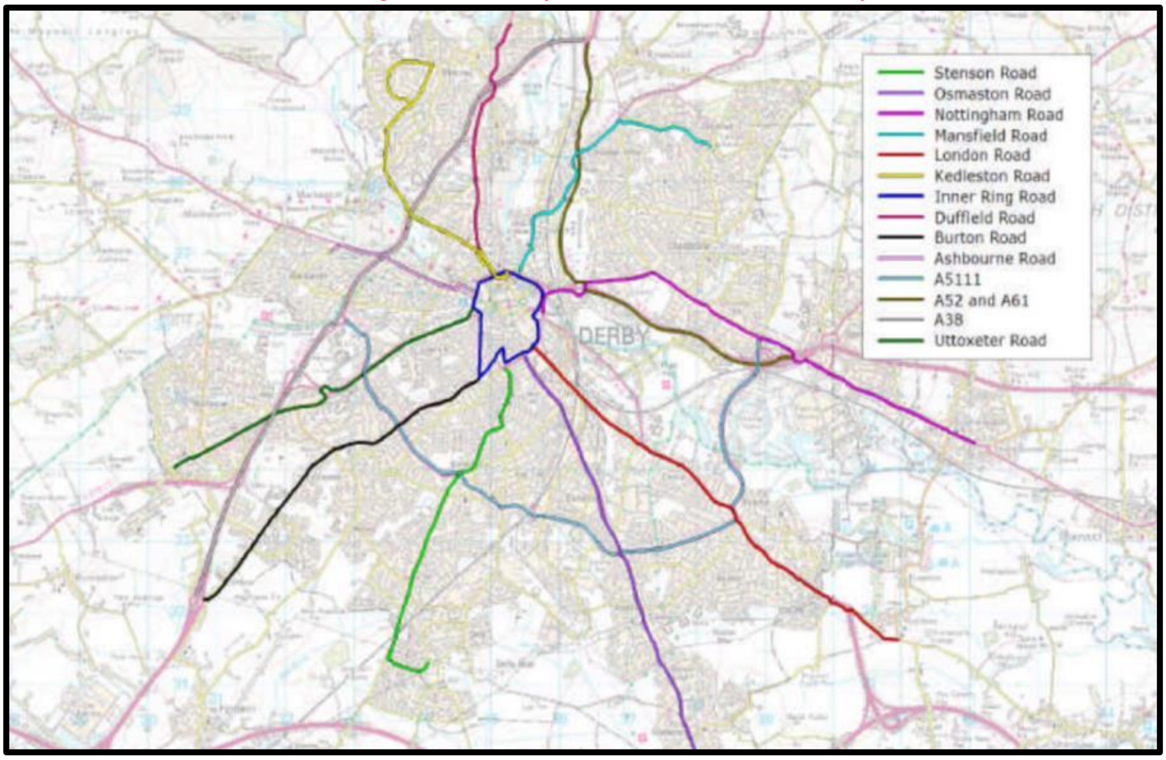


Table 21. Nottingham Journey Time Validation – Morning Peak

ROUTE	DIRECTION	OBSERVED	MODELLED	% CHANGE	WEBTAG
A609	Inbound	1380	1585	15%	Y
A609	Outbound	1019	1135	11%	Y
A52	Inbound	1440	1269	-12%	Y
A52	Outbound	990	1254	27%	N
A610	Inbound	1784	1580	-11%	Y
A610	Outbound	1204	1269	5%	Y
Vernon Road/Nottingham Road	Inbound	1350	1121	-17%	N
Vernon Road/Nottingham Road	Outbound	982	1078	10%	Y
A60	Inbound	1057	930	-12%	Y
A60	Outbound	708	880	24%	N
Plains Road	Inbound	1161	925	-20%	N
Plains Road	Outbound	799	827	3%	Y
The Wells Road	Inbound	484	512	6%	Y
The Wells Road	Outbound	492	489	-1%	Y
B686	Inbound	797	706	-11%	Y
B686	Outbound	538	671	25%	N
A6005	Inbound	1370	1235	-10%	Y
A6005	Outbound	1183	1236	4%	Y
A612	Inbound	882	712	-19%	N
A612	Outbound	605	671	11%	Y
A453	Inbound	574	657	15%	Y
A453	Outbound	476	633	33%	N

Table 22. Nottingham Journey Time Validation – Evening Peak

ROUTE	DIRECTION	OBSERVED	MODELLED	% CHANGE	WEBTAG
A609	Inbound	894	1131	26%	N
A609	Outbound	1224	1146	-6%	Y
A52	Inbound	1040	1229	18%	N
A52	Outbound	1282	1260	-2%	Y
A610	Inbound	1322	1339	1%	Y
A610	Outbound	1005	891	-11%	Y
Vernon Road/Nottingham Road	Inbound	1172	1098	-6%	Y
Vernon Road/Nottingham Road	Outbound	1362	1177	-14%	Y
Hucknall Road	Inbound	994	1119	13%	Y
Hucknall Road	Outbound	1199	1196	0%	Y
A60	Inbound	783	796	2%	Y
A60	Outbound	973	1043	7%	Y
Plains Road	Inbound	874	900	3%	Y
Plains Road	Outbound	1237	864	-30%	N
The Wells Road	Inbound	496	538	8%	Y
The Wells Road	Outbound	559	509	-9%	Y
B686	Inbound	628	698	11%	Y
B686	Outbound	719	935	30%	N
A6005	Inbound	1158	1229	6%	Y
A6005	Outbound	1591	1267	-20%	N
A612	Inbound	708	685	-3%	Y
A612	Outbound	853	666	-22%	N
A453	Inbound	432	601	39%	N
A453	Outbound	489	630	29%	N

Table 23. Derby Journey Time Validation – Morning Peak

ROUTE	DIRECTION	OBSERVED	MODELLED	% CHANGE	WEBTAG
Stenson Road	Inbound	854	830	-3%	Y
Stenson Road	Outbound	699	841	20%	N
Osmaston Road	Inbound	1235	1126	-9%	Y
Osmaston Road	Outbound	964	1082	12%	Y
London Road	Inbound	1001	889	-11%	Y
London Road	Outbound	769	895	16%	N
Inner Ring Road	Clockwise	540	698	29%	N
Inner Ring Road	Anti-Clockwise	567	626	10%	Y
Burton Road	Inbound	1142	782	-32%	N
Burton Road	Outbound	717	784	9%	Y
A5111	Clockwise	1379	1535	11%	Y
A5111	Anti-Clockwise	1263	1447	15%	Y
A52/A61	Inbound	932	770	-17%	N
A52/A61	Outbound	839	615	-27%	N
A38	Northbound	907	782	-14%	Y
A38	Southbound	1143	914	-20%	N
Uttoxeter Road	Inbound	986	780	-21%	N
Uttoxeter Road	Outbound	598	691	15%	Y

Table 24. Derby Journey Time Validation – Evening Peak

ROUTE	DIRECTION	OBSERVED	MODELLED	% CHANGE	WEBTAG
Stenson Road	Inbound	952	810	-15%	Y
Stenson Road	Outbound	926	1001	8%	Y
Osmaston Road	Inbound	1024	1095	7%	Y
Osmaston Road	Outbound	1074	1202	12%	Y
Nottingham Road	Inbound	938	1049	12%	Y
Mansfield Road	Outbound	513	563	10%	Y
London Road	Inbound	757	877	16%	N
London Road	Outbound	884	1117	26%	N
Inner Ring Road	Clockwise	760	733	-4%	Y
Inner Ring Road	Anti-Clockwise	742	618	-17%	N
Burton Road	Inbound	694	770	11%	Y
Burton Road	Outbound	772	814	5%	Y
Ashbourne Road	Inbound	349	476	36%	N
Ashbourne Road	Outbound	372	363	-2%	Y
A5111	Clockwise	1744	1593	-9%	Y
A5111	Anti-Clockwise	1390	1232	-11%	Y
A52/A61	Inbound	1020	693	-32%	N
A52/A61	Outbound	499	606	22%	N
A38	Northbound	648	797	23%	N
A38	Southbound	670	937	40%	N
Uttoxeter Road	Inbound	684	679	-1%	Y
Uttoxeter Road	Outbound	925	754	-18%	N

7. CONCLUSIONS

7.1 Use and Development of the Model

7.1.1 The East Midlands Gateway Model (EMGM) has been developed by SYSTRA to appraise a multi-modal access strategy to connect the East Midlands to the proposed HS2 station at Toton between Derby and Nottingham.

7.1.2 EMGM has been developed as a multimodal transport model built following the guidance in WebTAG. The structure of the model is based on the Greater Nottingham Transport Model however it has been developed using information from the existing Greater Nottingham Transport Model, Greater Derby Transport Model and the Leicester and Leicestershire Integrated Transport Model. The model has been fully recalibrated and validated in line with WebTAG guidance.

7.1.3 In addition to being used to assess the HS2 access strategy, the model is likely to be used in the future to assess a wide range of development and highway and public transport scheme applications across the study area.

7.1.4 The model simulation area includes the authorities of Nottingham City, Ashfield, Broxtowe, Erewash, Gedling, Rushcliffe, Derby City, Amber Valley, South Derbyshire, Charnwood and North-West. Areas outside of this simulation area are modelled as a skeleton buffer network, this includes Leicester City and areas to the south of the A46.

7.1.5 The highway networks were combined and standardised according to principles set out in the Coding Manual. A number of checks have been undertaken to ensure speeds, distances, lanes, saturation flows and route choices are representative of real world conditions.

7.1.6 The base year model has 1,056 zones. Within the simulation area there are 993 zones. These are based on Output Areas and LSOAs in the urban areas and MSOAs in rural areas. Outside of the model boundary, the model has 63 external zones which are either amalgamations of MSOAs or regions.

7.1.7 The initial highway matrices were taken from the Midlands Regional Traffic Model (MRTM). These were largely derived from mobile phone data and infilled with synthetic data. These matrices were rezoned to the EMGM zoning system using postcode data to derive splitting factors between the two zoning systems.

7.1.8 A taxi user class was derived from the MRTM car matrices assuming a percentage of trips in the matrices are taxi trips. The percentages used were taken from the 2016 ANPR data collected for the Derby and Nottingham Clean Air Zone projects.

7.2 Validation Performance

Full Model

7.2.1 Over 96% of the LGV counts meet either the GEH or flow criteria in each peak and over 90% of the HGV counts meet either the GEH or flow criteria. These statistics far exceed the recommended target of 85% stated in WebTAG guidance.

7.2.2 Over 77% of the car counts match either the GEH or flow criteria. Whilst this is lower than the recommended 85% target specified by WebTAG it still demonstrates a strong level of model validation given the size of the model, the number of counts utilised and the complexities of route choice available within the model.

Highways England Network

7.2.3 We have retained a high proportion of calibration counts on the SRN to ensure that we have the maximum levels of correlation between observed and modelled flows along these important strategic links.

7.2.4 In all three peaks over 82% of the LGV validation counts meet either the GEH or flow criteria and over 86% of the HGV validation counts meet either the GEH or flow criteria. These statistics are close to the target of 85% recommended by WebTAG guidance.

7.2.5 Over 71% of the car validation counts match either the GEH or flow criteria. Whilst this is slightly lower than the 85% target specified by WebTAG it still demonstrates a good level of model validation given the number of available counts and the complexities of route choice along the SRN within the model.

Core Area of Interest

7.2.6 Within the vicinity of the HS2 site at Toton over 94% of the LGV counts meet either the GEH or flow criteria and over 86% of the HGV counts meet either the GEH or flow criteria. These statistics exceed the recommended target of 85% stated in WebTAG guidance.

7.2.7 The level of car validation is strong in the morning peak (80%) and evening peak (78%). The validation is slightly lower in the inter peak, primarily due to the lower number of counts during this peak. Whilst the car statistics are lower than the 85% recommendation specified by WebTAG the model still demonstrates a good level of validation given the size of the model and the complexities of route choice available within the model.

Screenline Validation

7.2.8 Screenline validation shows high levels of compliance between the modelled and observed flows within the identified screenlines. In the morning peak and inter peak 10 out of 12 (or 83%) screenlines have modelled flows within 5% of the observed count. In the evening peak 100% of modelled screenline flows are within 5% of the observed count.

7.2.9 This indicates a strong correlation between modelled and observed flows in all peaks and provides confidence that the model replicates flows in to and out of major urban areas.

Journey Time Validation

7.2.10 Observed journey time data for Nottingham and Derby has been compared with modelled data. Within Nottingham 15 out of 22 (or 68%) of the journey time routes are within +/- 15% of the observed data in the morning peak. In the evening peak, 16 out of 24 (or 67%) of routes are within +/- 15% of the observed data.

7.2.11 In Derby 10 out of 18 (or 56%) morning peak journey time routes are within +/- 15% of the observed data. In the evening peak, 13 out of 22 (or 59%) of routes are within +/- 15% of the observed data.

7.2.12 The emphasis of this model validation process has been on flow validation. To rectify some of these journey time would affect the flow validation and as a result we have prioritised the flow validation over the journey time validation.

7.3 Overall Conclusion

7.3.1 The EMGM has achieved high levels of validation throughout its simulation area, with especially good correlation between modelled and observed conditions in the vicinity of the HS2 site at Toton and along the strategic highway network.

7.3.2 As a result it is recommended as 'Fit for Purpose' to assess the HS2 multi-modal access strategy and for assessing a wide range of development and scheme applications across the study area.

SYSTRA

Appendix A

Appendix B

Appendix C

Appendix D

Appendix E

SYSTRA provides advice on transport, to central, regional and local government, agencies, developers, operators and financiers.

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