East Midlands Gateway Transport Model

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HIGHWAY LOCAL MODEL VALIDATION REPORT



SYSTRA

EAST MIDLANDS GATEWAY TRANSPORT MODEL

HIGHWAY LOCAL MODEL VALIDATION REPORT

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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.

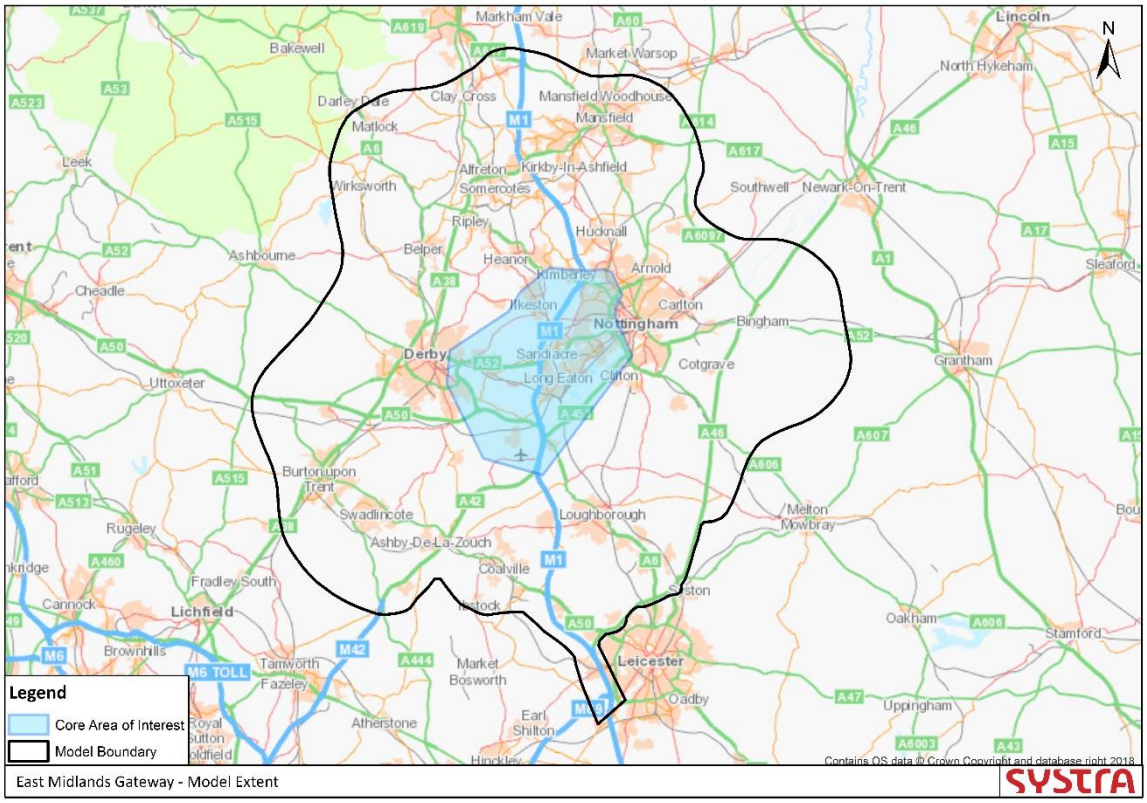
1.1.4 This report provides information on the highway model development and the highway calibration and validation performance.

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



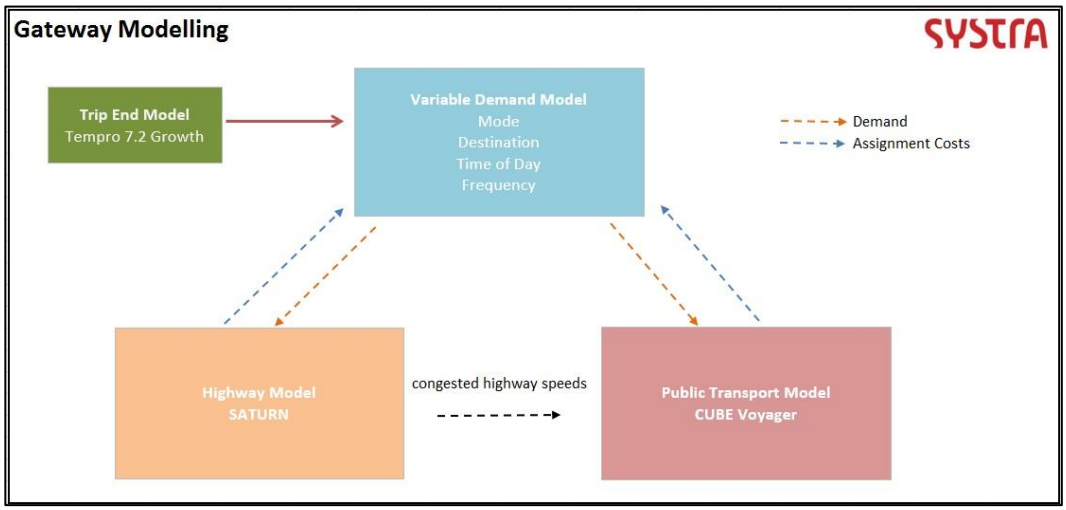
1.3 Structure of the Gateway Model

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.

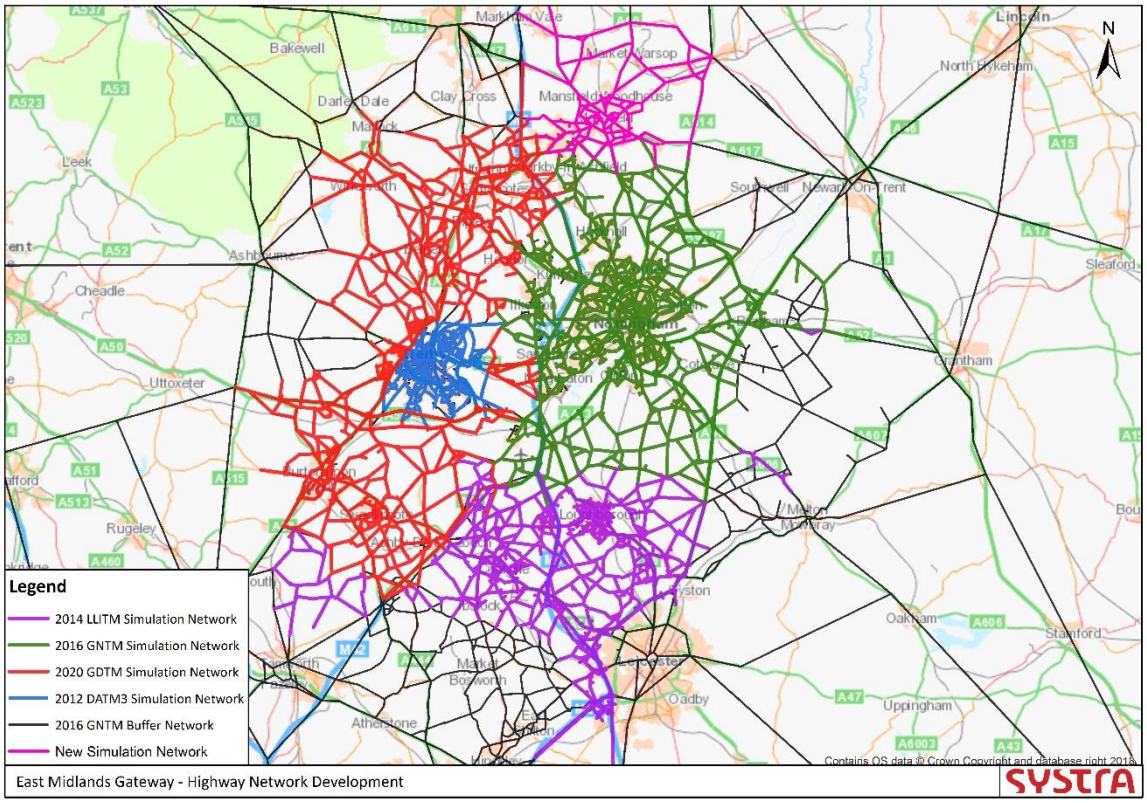
2.2 Creation of initial network

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

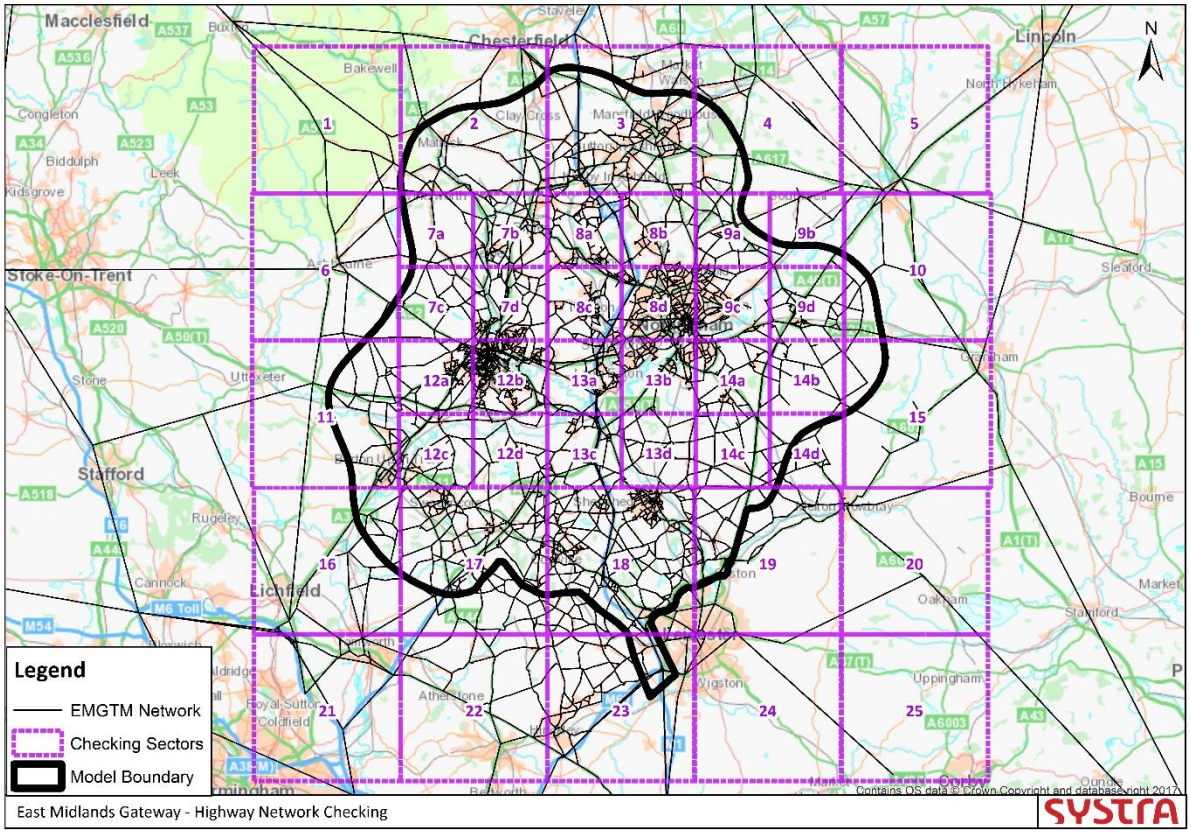
along the Strategic Road Network was updated in line with the HE Regional Transport Models assumptions. The coding manual is included in Appendix A.

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

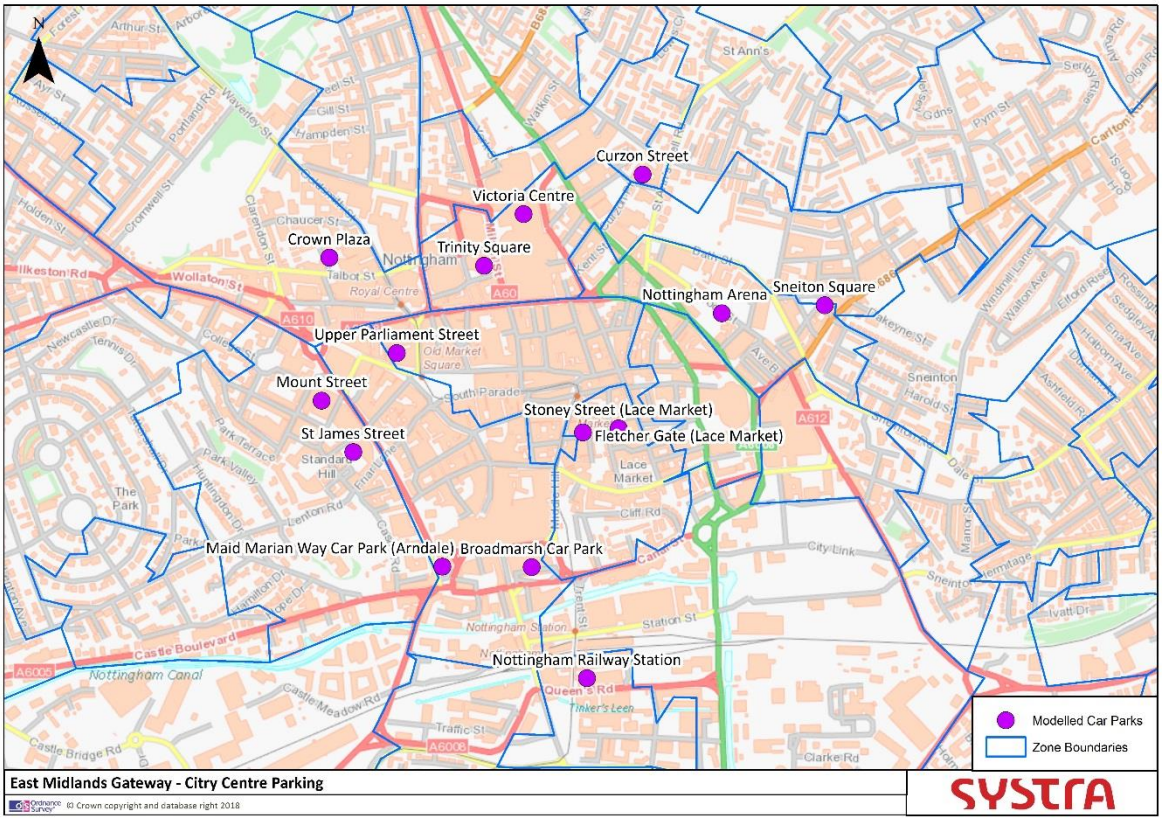
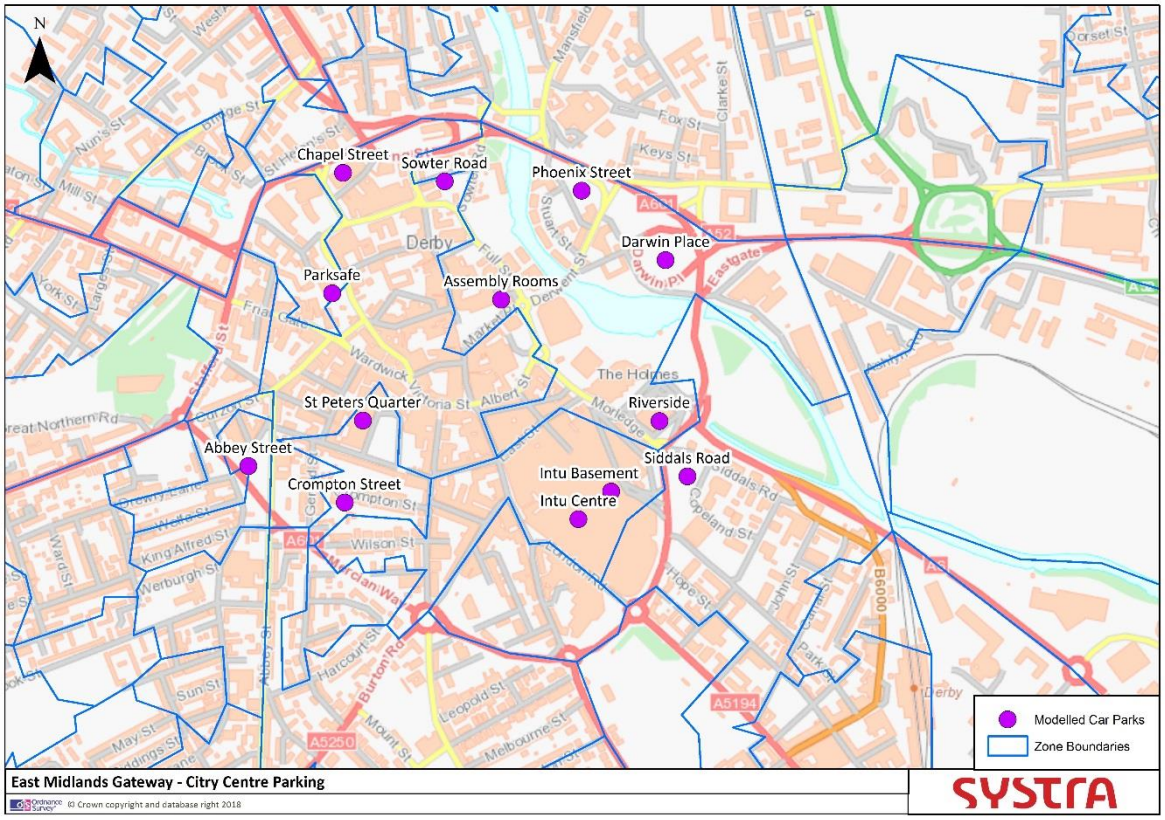


Figure 6. Derby City Centre Car Parking



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

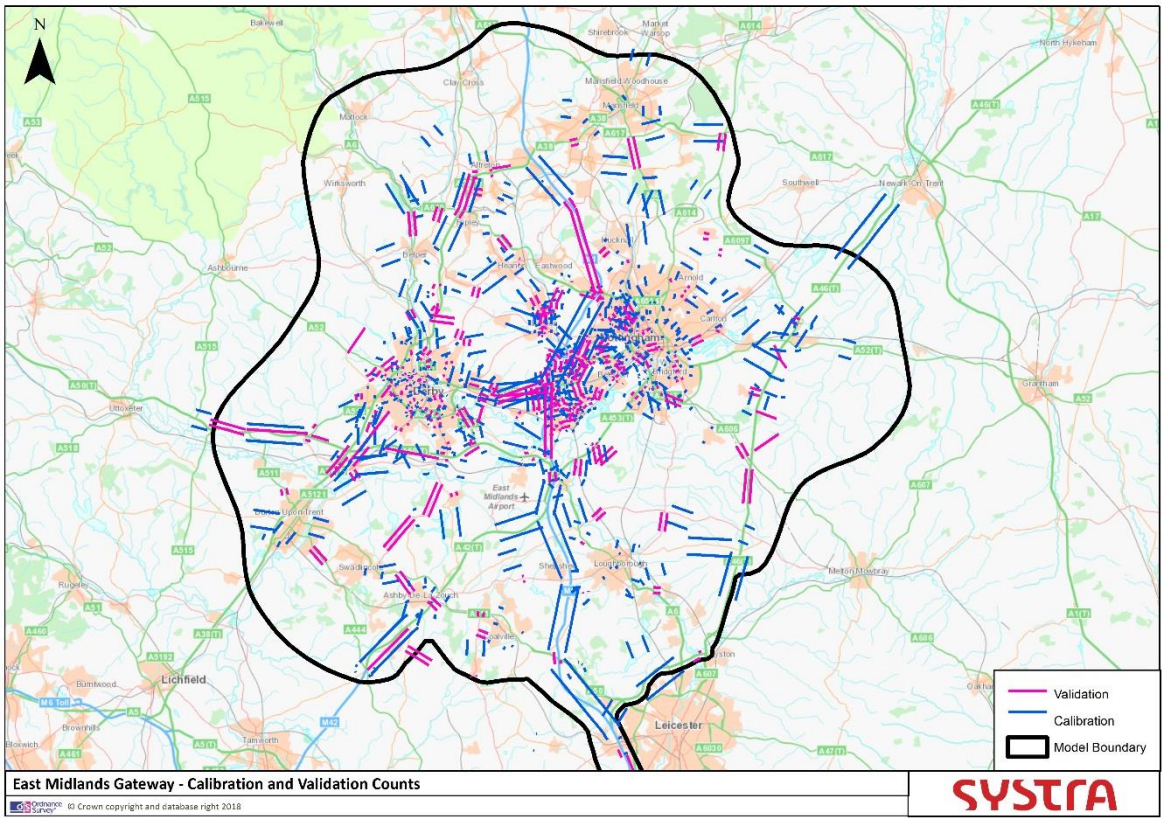
4.3 Count Checks

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

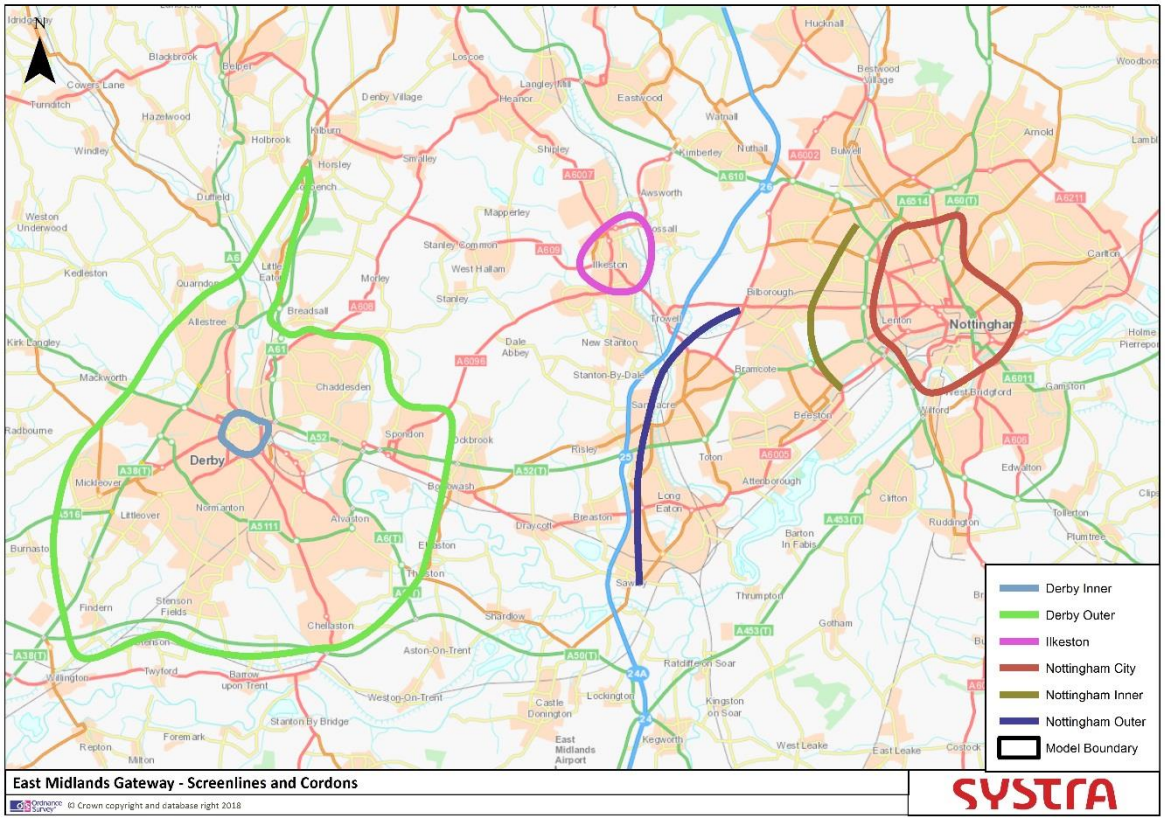


4.4 Cordons and Screenlines

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

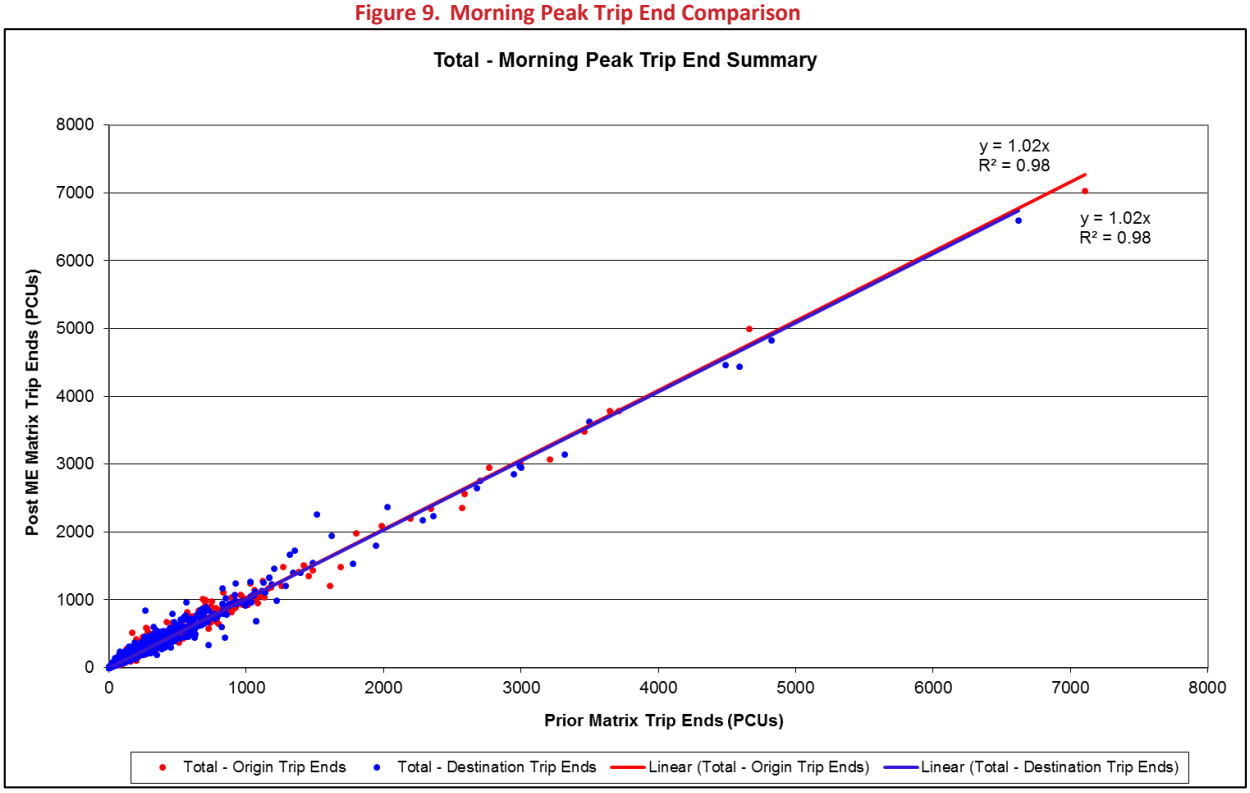


Figure 10. Inter Peak Trip End Comparison

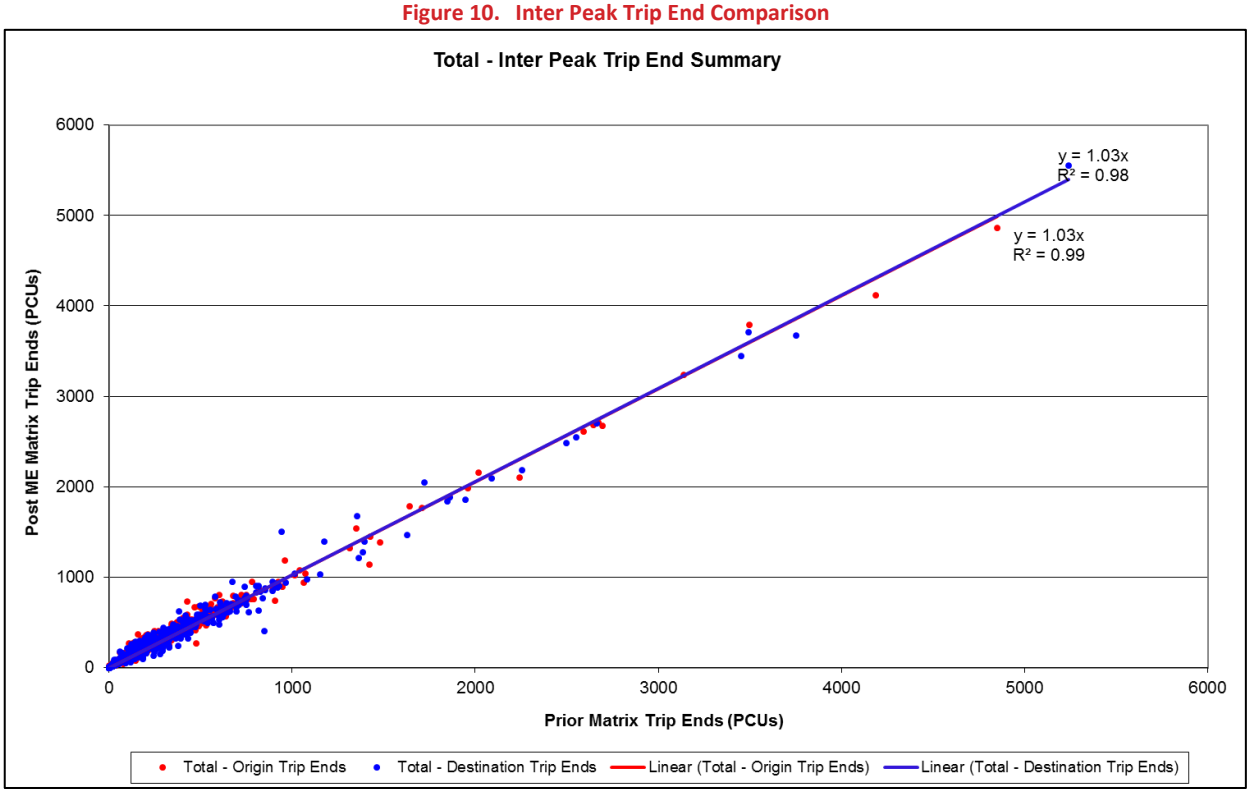
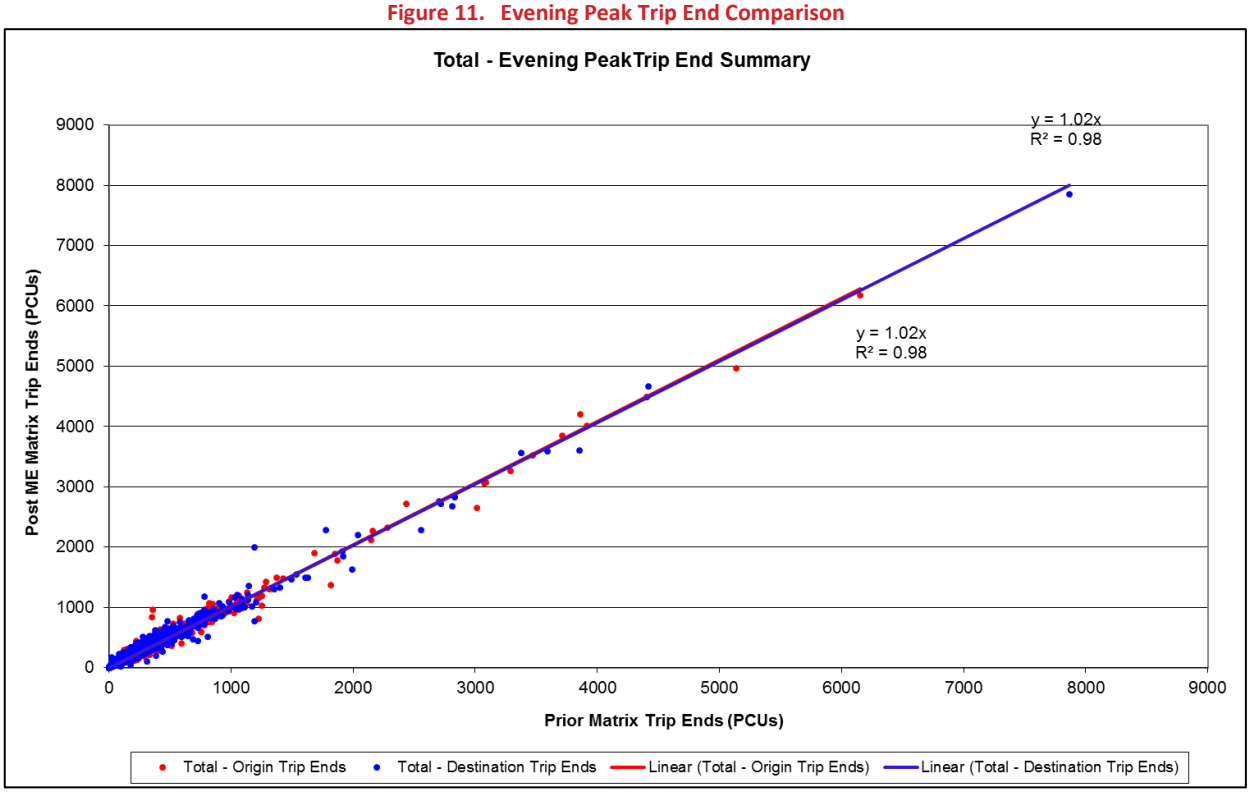


Figure 11. Evening Peak Trip End Comparison



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

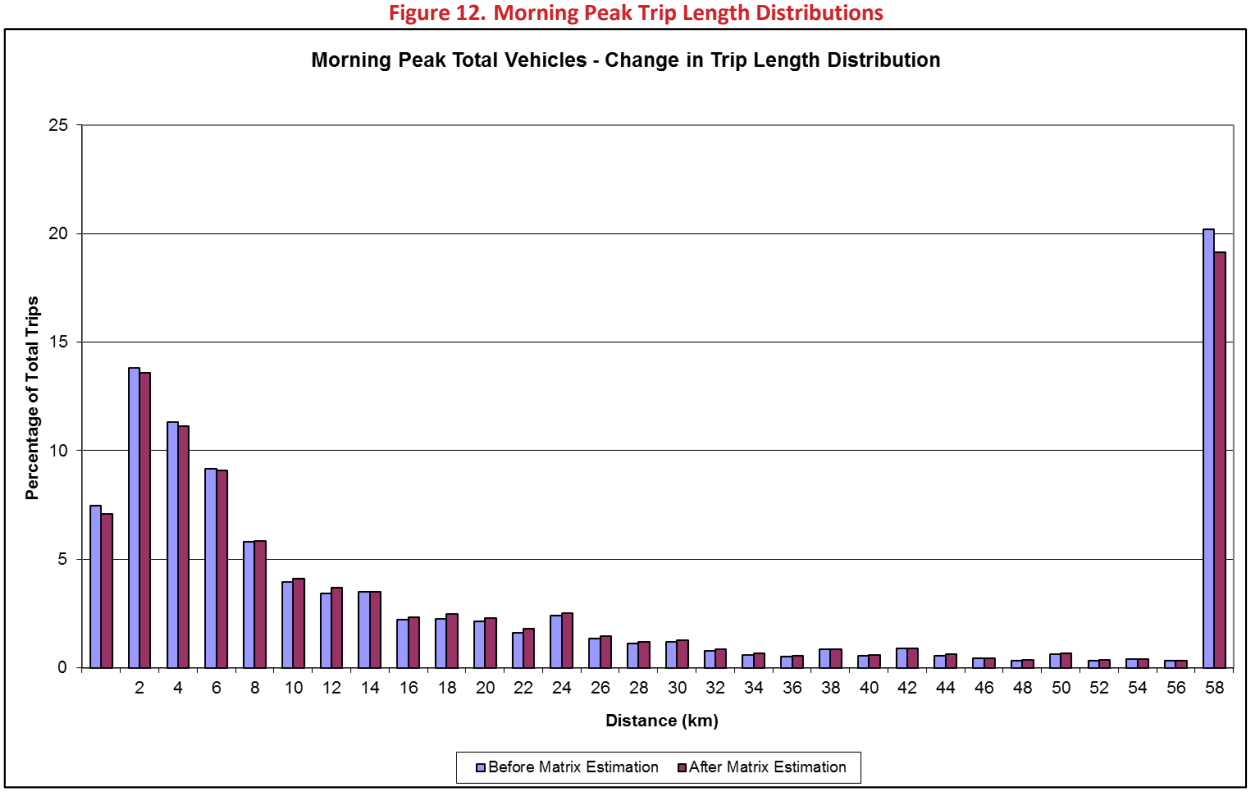


Figure 13. Inter Peak Trip Length Distributions

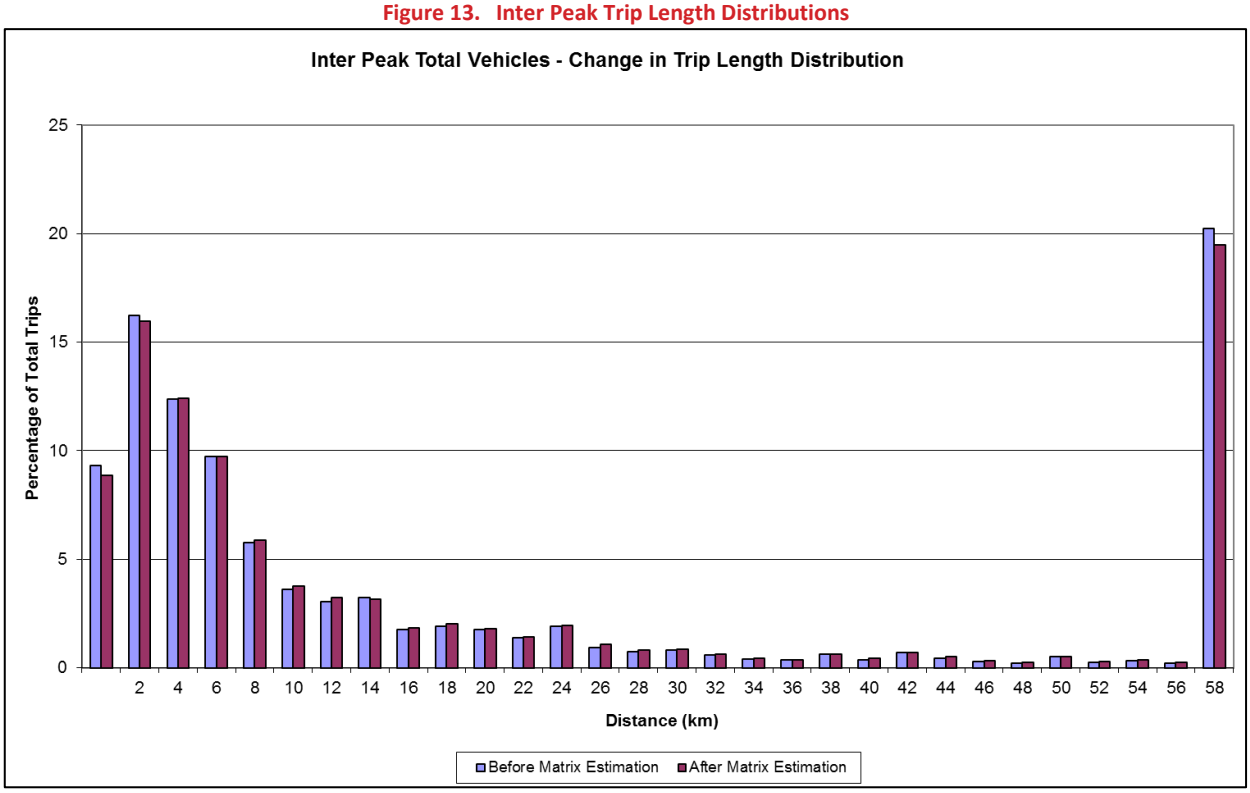
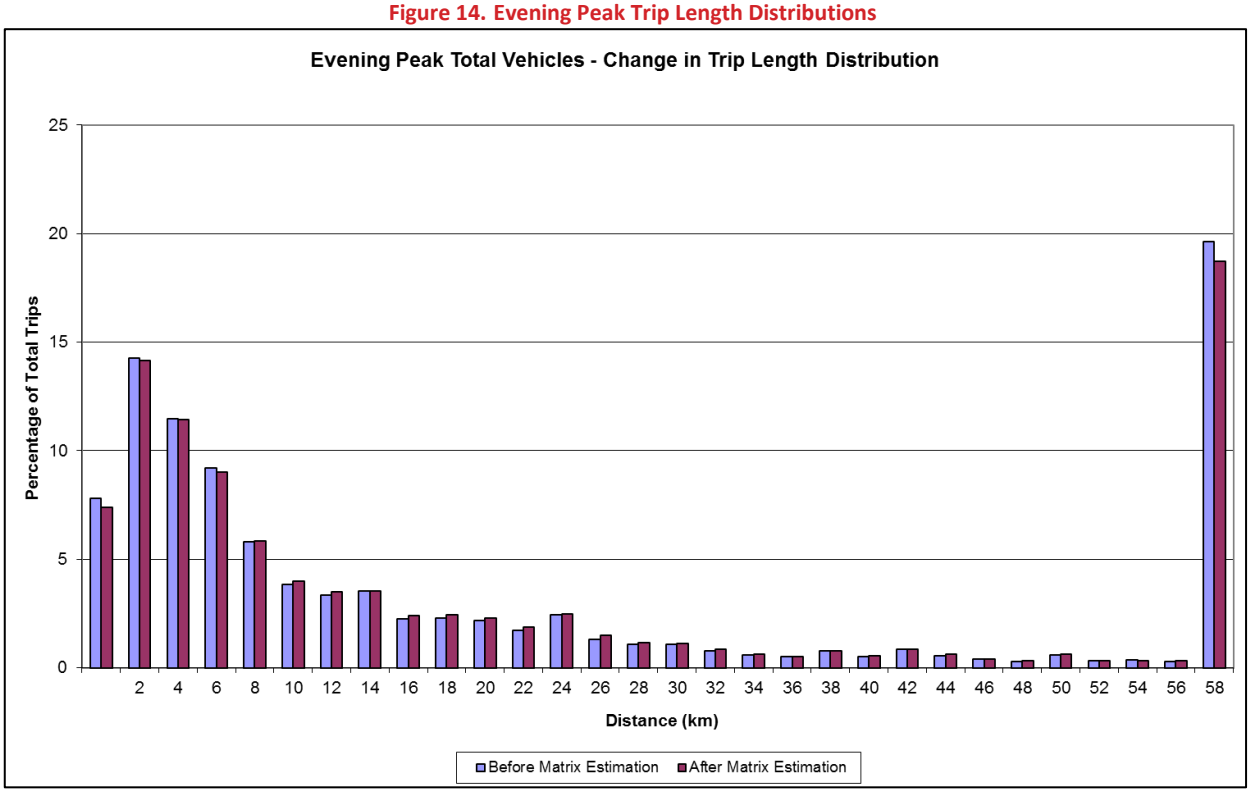


Figure 14. Evening Peak Trip Length Distributions



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

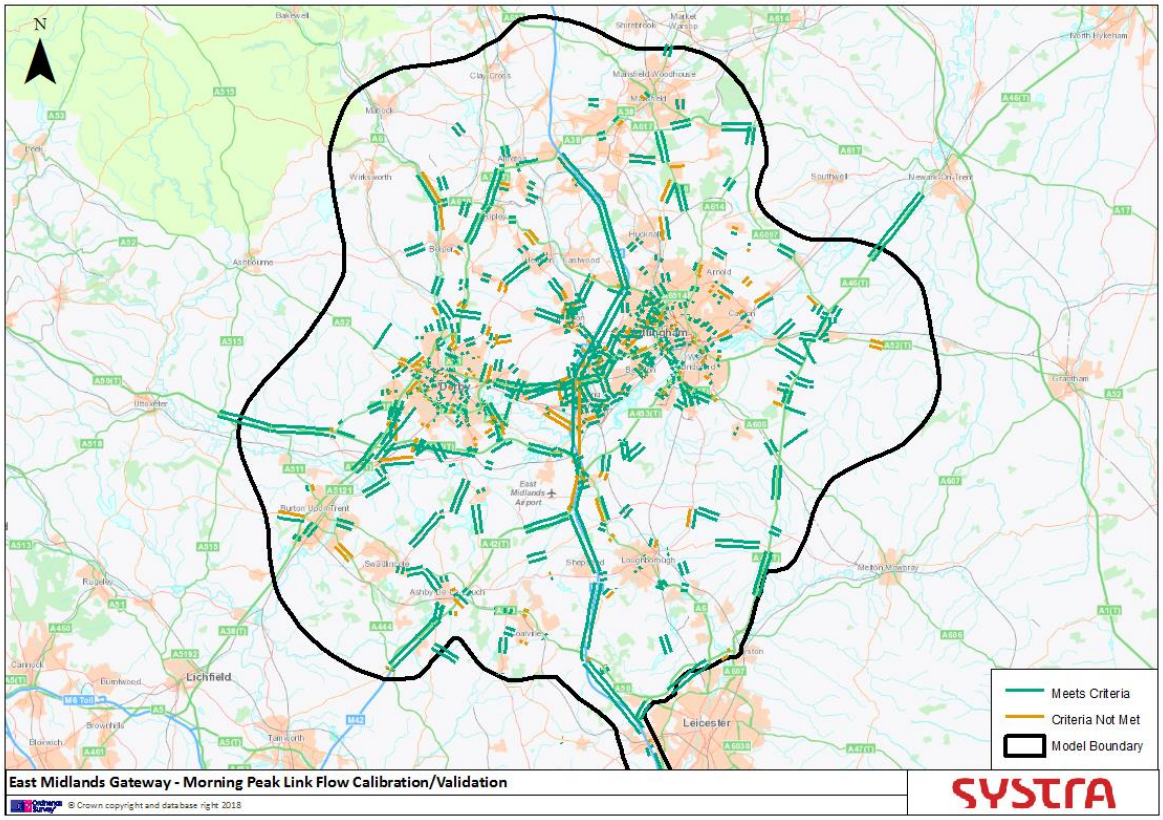


Figure 16. Morning Peak Count Performance – Core Area of Influence

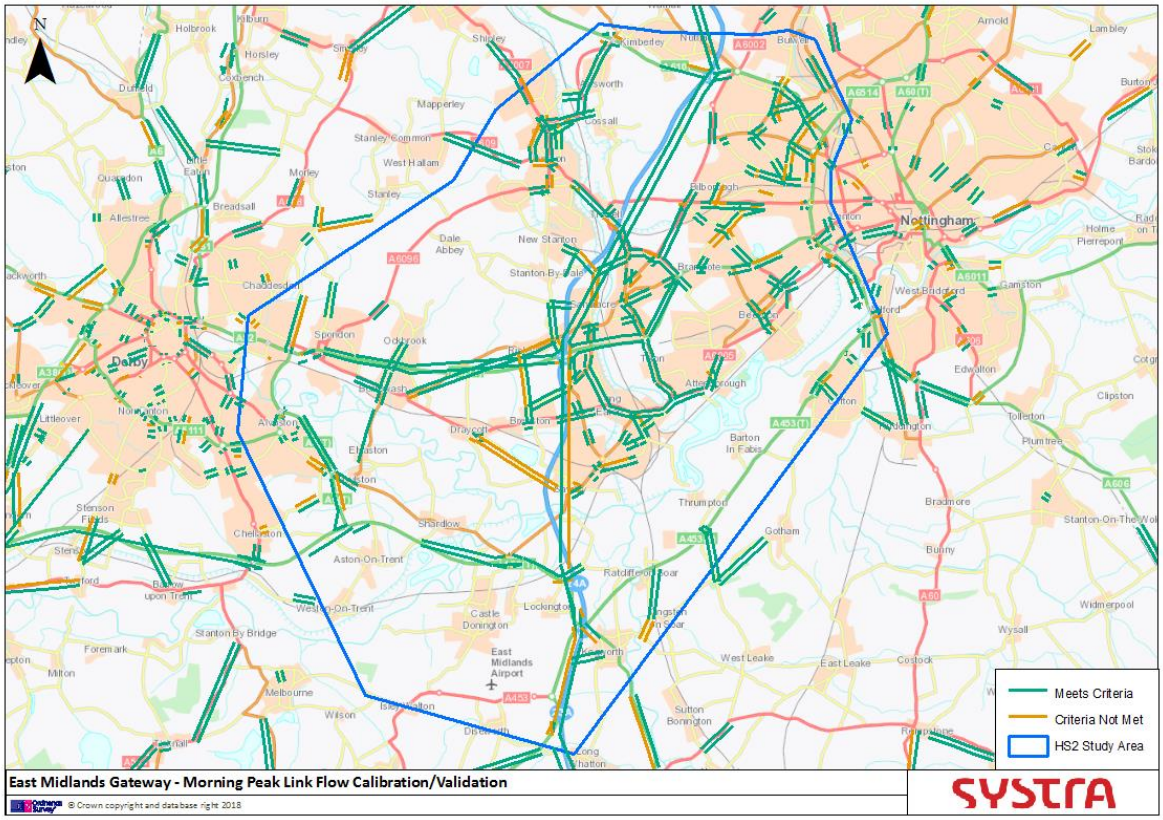


Figure 17. Inter Peak Count Performance – Full Model

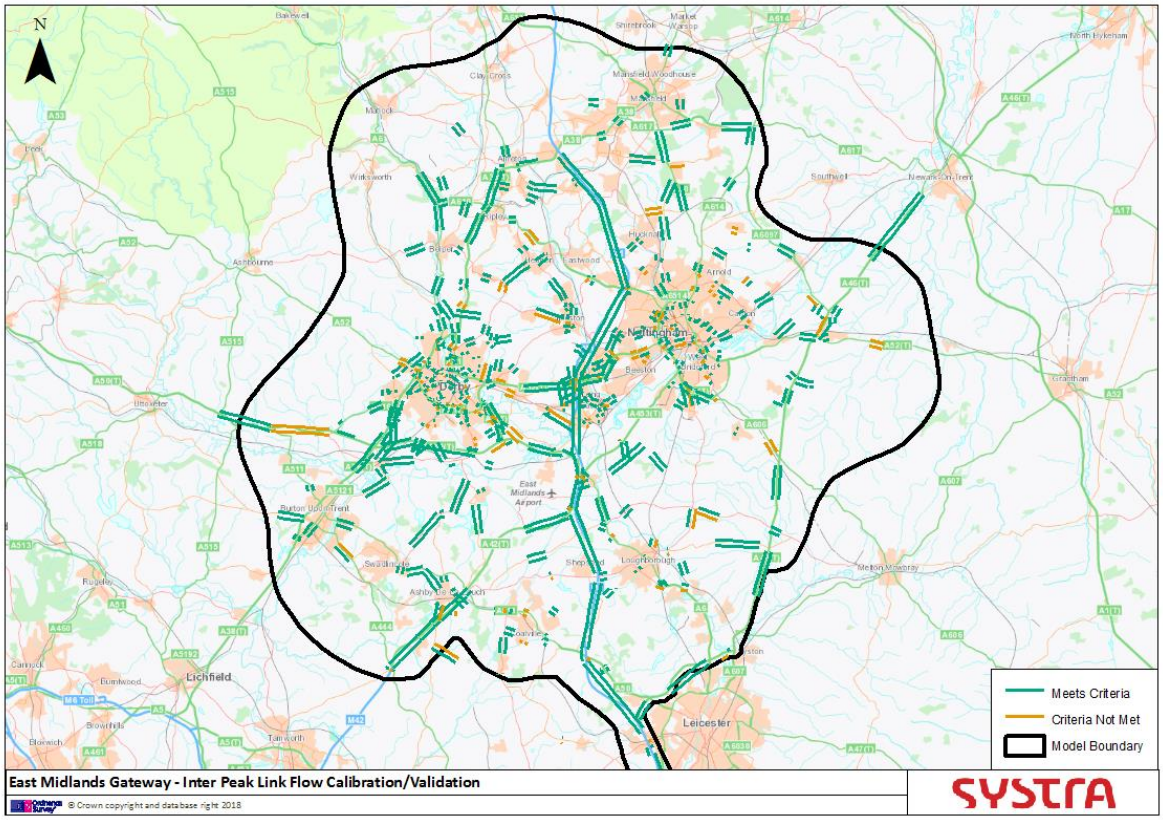


Figure 18. Inter Peak Count Performance – Core Area of Influence

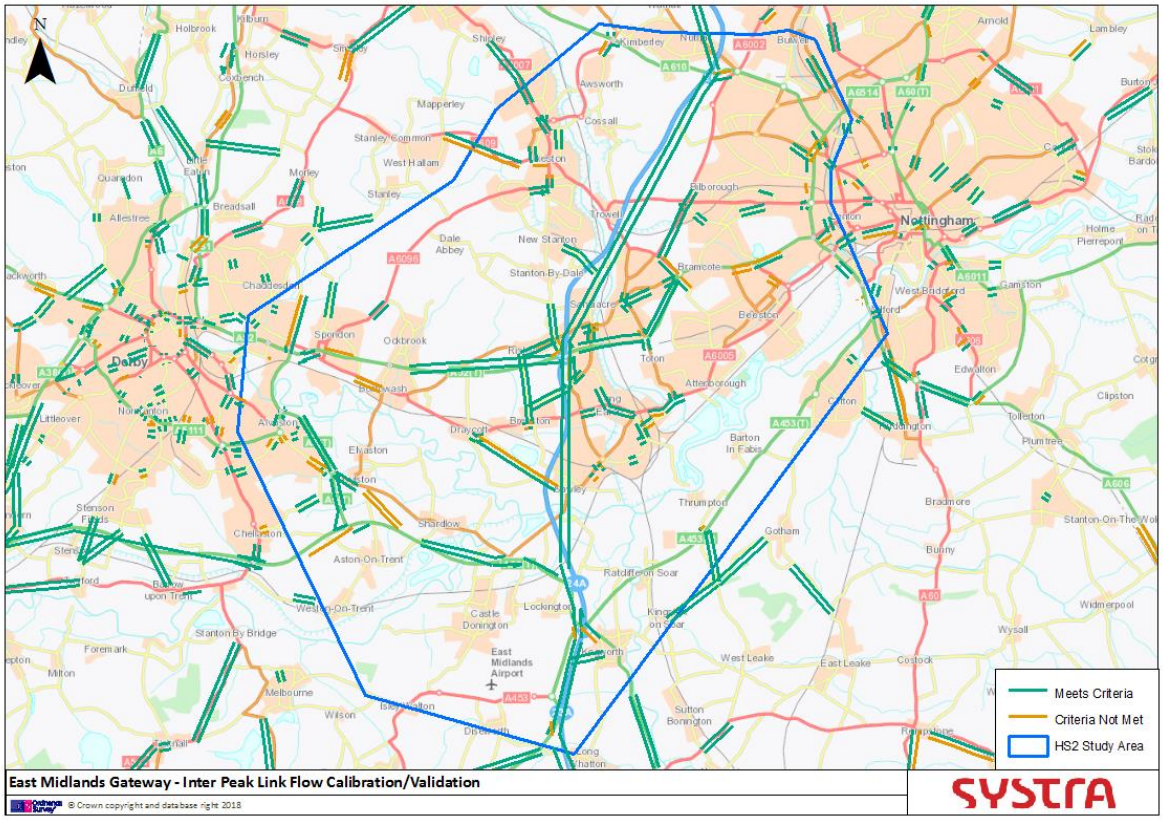


Figure 19. Evening Peak Count Performance – Full Model

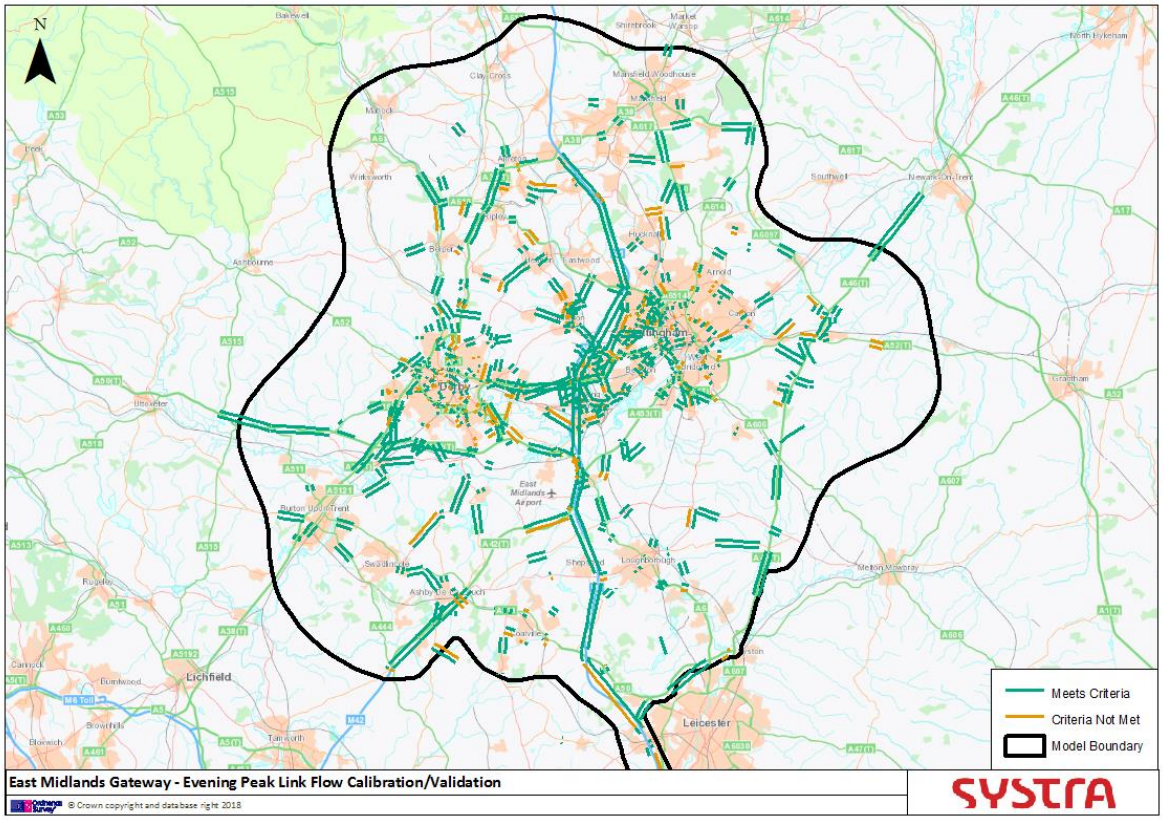
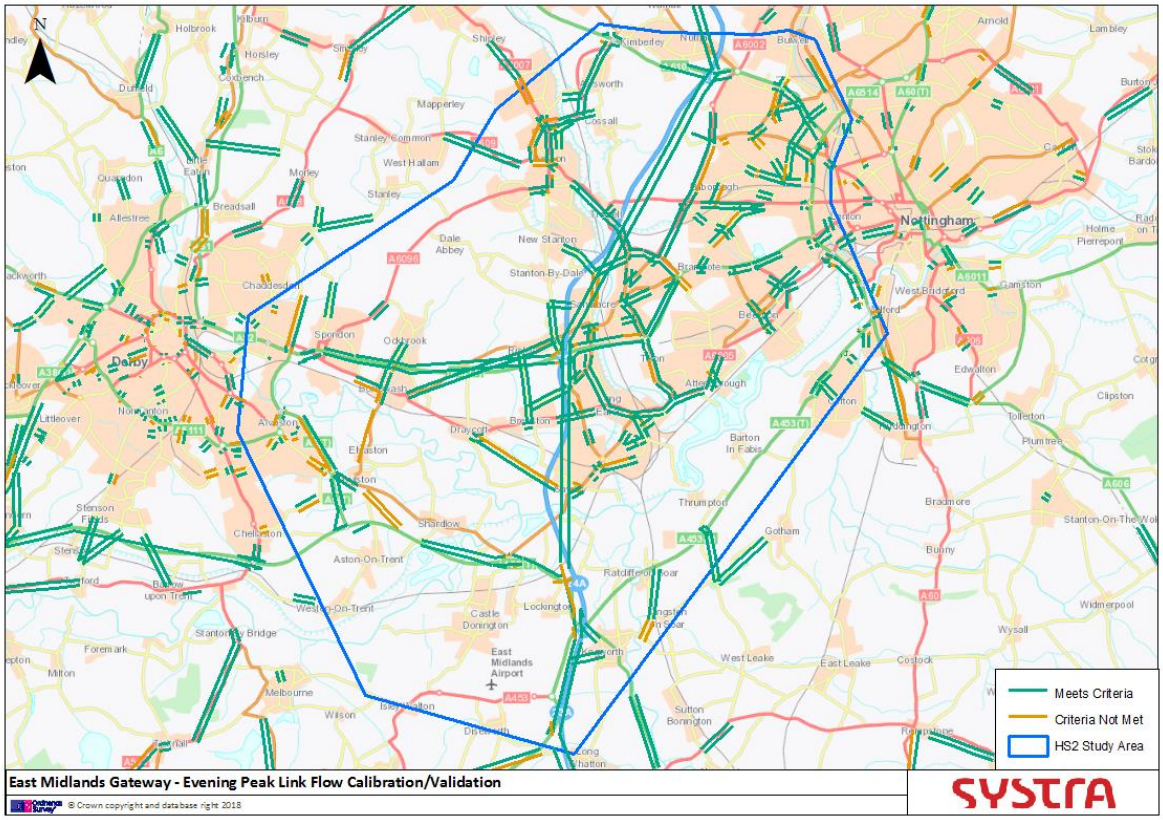


Figure 20. Evening Peak Count Performance – Core Area of Influence



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

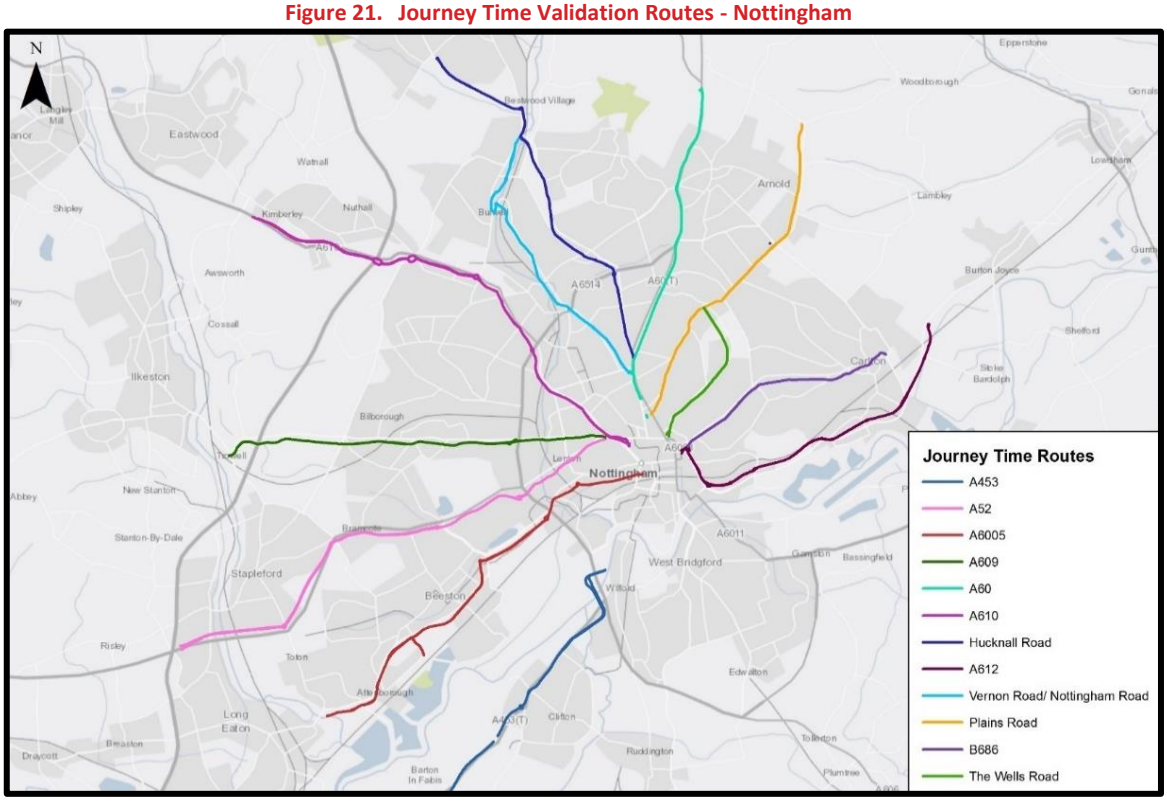


Figure 22. Journey Time Validation Routes - Derby

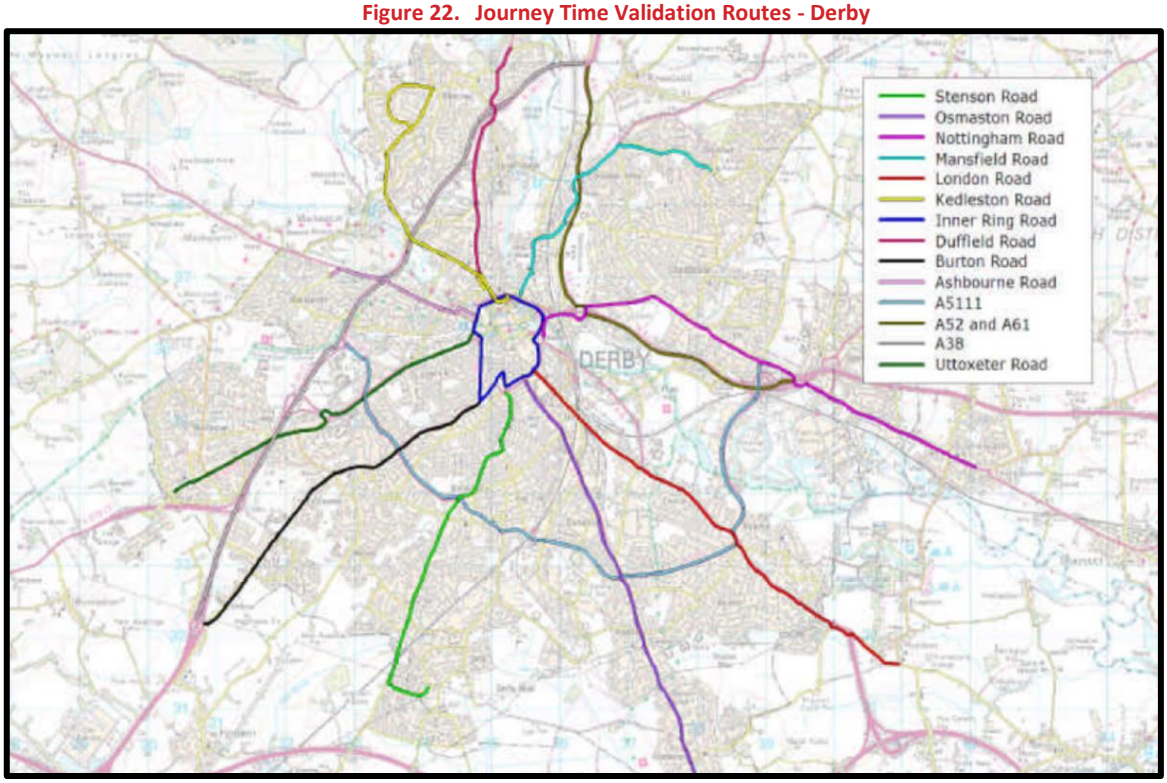


Table 21. Nottingham Journey Time Validation – Morning Peak

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.

Appendix A

TECHNICAL NOTE

EAST MIDLANDS GATEWAY STUDY

HIGHWAY CODING MANUAL

IDENTIFICATION TABLE	
Client/Project owner	Nottingham City Council
Project	East Midlands Gateway Study
Title of Document	Highway Coding Manual
Type of Document	Technical Note
Reference number	106770
Number of pages	15

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4. CITY CENTRE PARKING 12

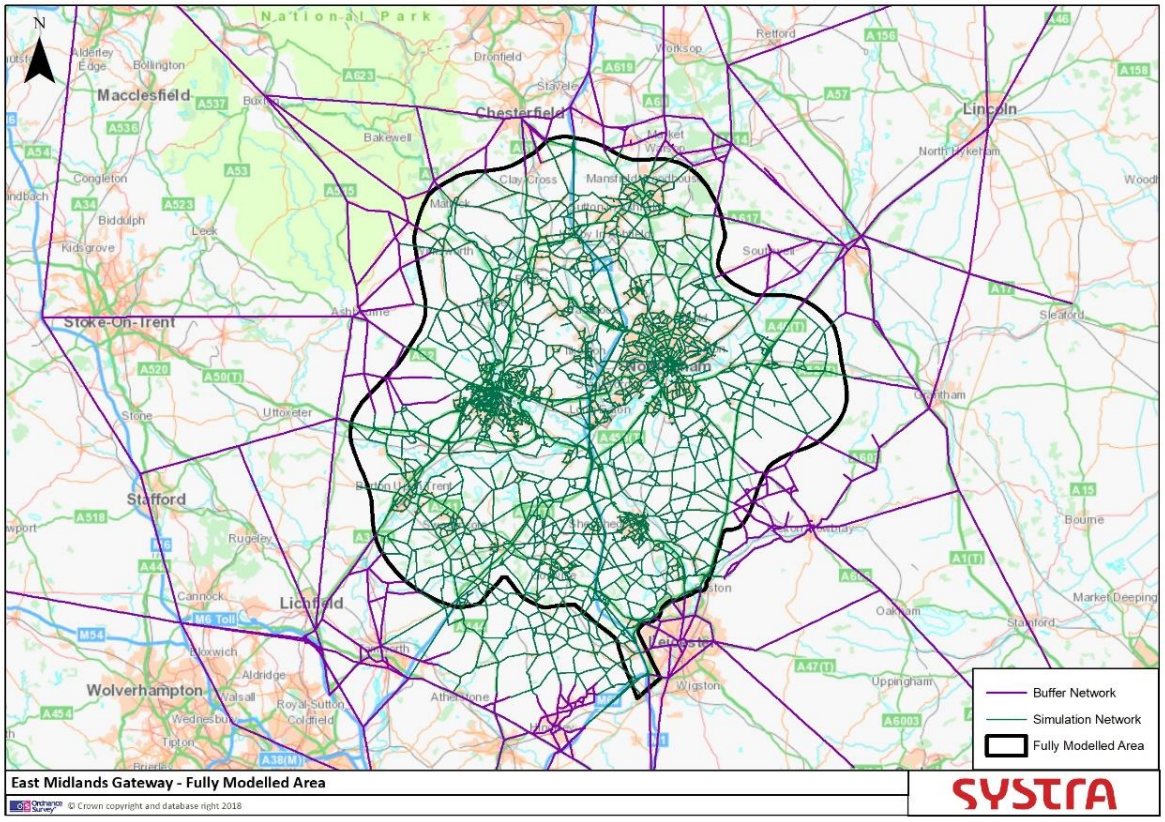
5. BUS ROUTES 15

1. MODEL OVERVIEW

1.1 Modelled Area

1.1.1 The Fully Modelled Area, shown in Figure 1, extends to the A46 to the east, the A38 west of Derby and Burton-Upon-Trent, the Sutton In Ashfield to the north and the A46 Leicester Western Bypass to the south. It contains Nottingham City and Derby City and a number of boroughs in Derbyshire and Nottinghamshire, including South Derbyshire, Amber Valley, Erewash, Broxtowe, Ashfield, Rushcliffe, Gedling, North West Leicestershire and Charnwood.

Figure 1. EMG Network



1.1.2 The fully modelled area includes simulation coding for all roads which are represented in GDTM for areas of Derbyshire and Derby City, and GNTM for Nottinghamshire and Nottingham City. For Northern Leicestershire the model is fully simulated in the areas of Charnwood and North West Leicestershire and the M1 as far as the M69 junction.

1.1.3 Outside of the fully modelled area, the network is skeletal and characterised by buffer coding. This buffer coding includes Leicester and areas to the south of the A46 where only the main 'A' roads will be included in the network.

1.2 Time Periods

1.2.1 The Gateway model will have the following time periods:

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

1.3 User Classes

1.3.1 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 EMGTM, the model will be 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.

1.3.2 With CAZ functionality switched off the model possesses just 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.

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

Table 1. EM Gateway Highway User Classes

USERCLASSID	PURPOSE	CAZ STATUS
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

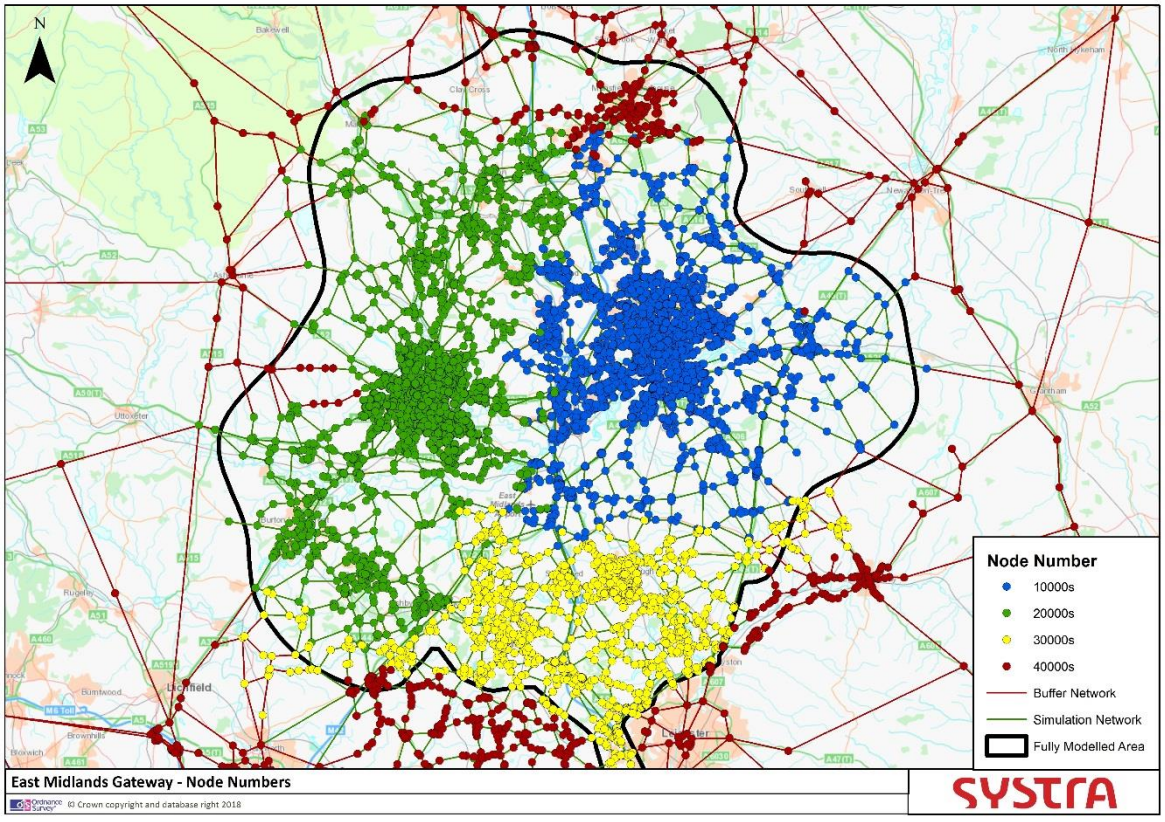
1.4 Node and Zone Numbering Convention

1.4.1 The node numbering convention to be adopted in the EM Gateway model is documented in Table 2 and illustrated in Figure 2.

Table 2. Node Numbering Convention

	NODE RANGE	
	Minimum	Maximum
Nottingham City	10000	19999
Nottinghamshire (excluding Ashfield)	10000	19999
Derby City	20000	29999
Derbyshire	20000	29999
Leicestershire	30000	39999
Edge of Model and Buffer	40000	49999
Forecast Year Coding	50000	59999

Figure 2. Node Numbering Convention



2. SATURN SIMULATION NETWORK CODING

2.1 Introduction

2.2 Saturation Flows

2.2.1 Turn saturation flows refer to the maximum number of pcus per hour which could make a particular turning movement provided that there were no constraints (eg no other vehicles on the road, no red lights). Thus, the only restrictions to be taken in to account when specifying the turn saturation flow are the physical characteristics of the junction.

2.2.2 The GNTM and GDTM models have consistent saturation flows assumptions. It is therefore proposed to use these saturation flows as a basis for the EM Gateway Model. The saturation flows in Leicester vary slightly to GNTM and GDTM - an initial task of the network development will be to update these to reflect GNTM/GDTM assumptions.

Signalised Junctions

2.2.3 For traffic signal junctions the following saturation flows per lane will be used;

- Left turn = 1725 pcu/hr
- Straight on = 1940 pcu/hr
- Right turn = 1680 pcu/hr

Priority Junctions

2.2.4 Table 1 shows the saturation flows per lane for priority junctions within the model.

Table 3. Priority Junction Saturation Flows

	LEFT	STRAIGHT ON	RIGHT
From minor arm	745	1000	627
From major arm	1725	2000	745

Roundabouts

2.2.5 In SATURN, turning movements at roundabouts are not considered as individual turns but are rather simulated as a single flow. All saturation flows must therefore equal the saturation flow for the arm as a whole.

2.2.6 Only small roundabouts will be coded as roundabouts in the model. Large roundabouts on key roads will be coded as an exploded roundabout and use saturation flows akin to priority junctions.

2.2.7 For small roundabouts a saturation flow of 1200 pcus/hr per lane will be used.

2.2.8 For roundabouts with a 1 lane approach the circulating time will be set to 10 seconds. In instances where unexploded roundabouts have a 2 lane approach the circulating time will be 15 seconds.

Gyratories and 'Exploded' Roundabouts

2.2.9 Roundabouts situated along key routes or those of sufficient size (> 60m diameter) will be coded as a series of priority junctions or traffic signal nodes around the perimeter of the roundabout.

2.2.10 The following saturation flows will apply to 'exploded' roundabouts with priority junctions:

- Joining the roundabout = 1200 pcu/hr per lane
- Circulating the roundabout = 2000 pcu/hr per lane
- Leaving the roundabout = 2000 pcu/hr per lane

2.2.11 The following saturation flows will apply to 'exploded' roundabouts with traffic signalised junctions:

- Joining the roundabout = 1725 pcu/hr per lane
- Circulating the roundabout = 1940 pcu/hr per lane
- Leaving the roundabout = 1940 pcu/hr per lane

2.3 Flare Lanes

2.3.1 Taking account of flares at a junction is important within a SATURN network in order to represent the likely capacity of any given junction. There is an inconsistent approach to the use of flares within the three models. Flares reviewed during the network development, and the following principles will be adopted.

2.3.2 If a flare length is less than 10 pcus (60 metres) the model will utilise the FLAREF (nearside lane) and FLAREX (offside lane) markers within SATURN. The saturation flow for the flared approaches will be based on the saturation flow of the midpoint of the link. For example, a single lane flared to 2 lanes will be coded as one lane with a single lane capacity with a marker F1 (in the case of a nearside flare) with the number of pcus accommodated in the flare added as an extra line of data FF1 for example. An offside flare will be coded as 1F and the extra data as FX1 for example. The use of FLAREF and FLAREX removes the need to update the stack capacity manually.

2.3.3 If a flare length is longer than 10 pcus (approximate 60m assuming a standard pcu axle length of 5.75m) a full separate lane will be modelled. In this case, by default there will be a tendency of overestimating link stack capacity as SATURN will assume the total number of lanes at the downstream stop line is applied to the whole link. As such, it may be necessary to update the stack capacity by adding the extra pcus which can be accommodated by the flare lane (now treated as a separate lane) to the standard stack capacity calculated from the equation above, especially where blocking back at a junction is to be modelled in detail.

2.3.4 Only in exceptional cases will an extra node be coded to represent a flare as in a network as large as EMGM this approach would result in a significant increase in the number of nodes in a network, and subsequently increased assignment run times.

2.4 SRN Main Carriageway and Slip Roads

2.4.1 SRN saturation flows will adopt similar assumptions to the Regional Transport Models. The saturation flows are summarised in the Table 3 below.

Table 4. SRN Saturation Flows – pcus/hr

ROAD TYPE	LANES	SATURATION FLOW
Main Carriageway	2 Lanes	4660
	3 Lanes	6990
	4 Lanes	9320
	5 Lanes	11650
Motorway Slip Road	1 Lane	1930
	2 lanes	3990
A Road Slip Road	1 lane	1730
	2 lanes	3460

2.4.2 Irrespective of how many lanes there are on the slip road, in the absence of a "Ghost Island" with 2 separate merge points, the turn saturation flow will be calculated based upon a one lane approach. This is because traffic is effectively forced into one lane at the merge point.

2.4.3 Single lane merges onto a motorway or dual carriageway will be coded using the M priority marker. A Y junction will be coded where two streams of traffic with equal priority merge ie two "equal" motorways merge together. In this instance both affected turns will be assigned priority markers M and both turns would suffer a reduction to their capacity and an increase in their delay dependent upon the alternative flows.

2.5 Speed Flow Curves

2.5.1 Speed-flow curves represent delay on links that result from the volume of traffic travelling along a given link, and are independent of the delays that result from individual junctions. Speed-flow curves should not be used to represent 'junction' delay, and therefore should only be used on longer links.

2.5.2 A speed-flow curve will only be applied where the majority of the delay along a link can be attributed to the link itself rather than the junction at the downstream end of the link. Speed flow curves will therefore be applied to the Strategic Road Network and rural links. The links which speed flow curves are applied are indicated on Figure 3.

2.5.3 In urban areas where the delay is attributable to the junction at the end of the link, delays will be controlled by the fixed speed coding at the node. Fixed speeds will not necessarily directly relate to the speed limit on a given road but consider other characteristics of the links in addition to their relationship with alternative routes.

2.5.4 Default speed flow curves used in the EM Gateway modelling will be based on those used in Regional Transport Models which were originally derived by the TAME.

2.5.5 Some speed flow curves have been modified as a result of the calibration and validation process. Tables 4 and 5 summarise the resultant speed flow curves applied within the model.

Table 5. Speed Flow Curves – Rural and Motorway

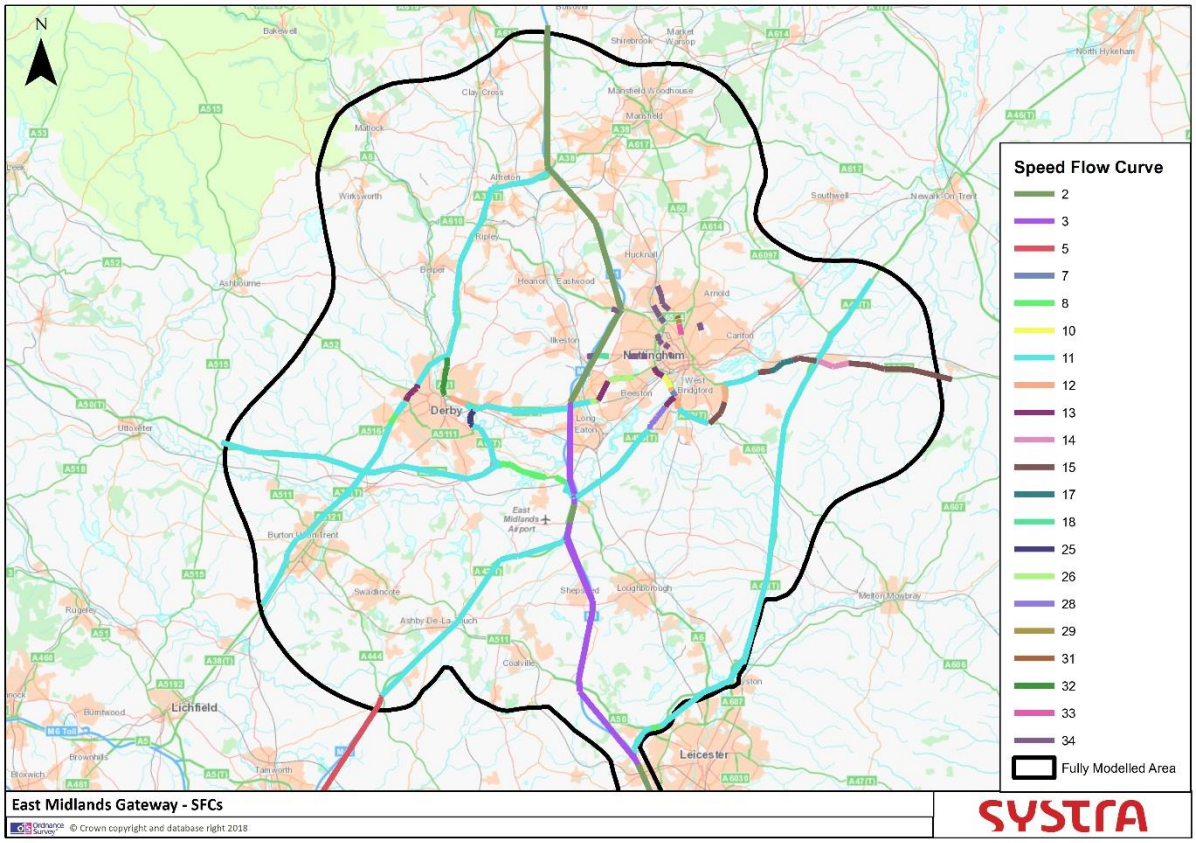
INDEX	DESCRIPTION	S0	S2	CAPACITY	N
1	Rural Motorway D5	105	73	11650	2.8
2	Rural Motorway D4	105	73	9320	2.8
3	Rural Motorway D3	105	73	6990	2.8
4	Rural Motorway D3 + Dynamic Hard Shoulder 60mph	67	42	9320	4.7
5	Rural Motorway D2	105	66	4659	2.8
6	Rural All-Purpose D4 (60mph)	67	45	8397	2.75
7	Rural All-Purpose D4 50mph	67	49	8397	2.2
8	Rural All-Purpose D3 (70mph)	105	73	6298	2.75
9	Rural All-Purpose D3 60mph	67	45	6298	2.75
10	Rural All-Purpose D3 50mph	59	49	6298	2.2
11	Rural All-Purpose D2 (70 mph)	105	66	4199	2.75
12	Rural All-Purpose D2 50mph	59	42	4199	2.2
13	Rural All-Purpose D2 40mph	42	30	4199	1.6
14	Rural WS2 10.0m A Road	67	29	1686	2.15
15	Rural S2 7.3m A Road (TD9/81)	67	38	1328	1.99
16	Rural S2 7.3m A Road (Older)	67	38	1328	2.04
17	Rural S2 A Road 40mph	42	30	1328	2.39
18	Rural S2 6.5m Poor	59	37	1010	1.79
19	Rural S2 Other Road (slow)	42	23	1328	1.53
20	Rural S2 Other Road (narrow carriageway)	67	38	950	2.11
21	Rural S2 Other Road (slow, narrow carriageway)	42	23	950	1.53
44	Rural Motorway D3 + Roadworks	67	51	5580	2.6
45	Rural All-Purpose D5 (70mph)	105	73	10497	2.75
46	Rural All-Purpose D5 (60mph)	67	45	10497	2.75
47	Rural All-Purpose D4 (70 mph)	105	73	8397	2.75
48	Rural Motorway D6	105	73	13980	2.8

Table 6. Speed Flow Curves - Suburban

INDEX	DESCRIPTION	S0	S2	CAPACITY	N
22	Suburban D4	67	27	7080	1.42
23	Suburban D3	67	27	5310	1.42
24	Suburban D2 (slight development)	67	27	3540	2.56
25	Suburban D2 (typical development)	67	27	3540	1.42
26	Suburban D2 (heavy development)1	42	27	3540	0.93
27	Suburban D2 (30mph)	31	20	3540	1.28
28	Suburban S4 (slight development)	42	23	3400	2
29	Suburban S4 (typical development)	42	23	2500	2
30	Suburban S2 (50mph)	67	31	1680	1.52
31	Suburban S2 (light development)	59	19	1680	2.63
32	Suburban S2 (typical development)	42	23	1680	1.58
33	Suburban S2 (heavy development)	42	9	1680	1.03
34	Suburban S2 (30mph)	31	19	1680	1.28

2.5.6 Figure 3 illustrates the locations of speed flow curves within the model.

Figure 3. Speed Flow Curves



2.6 Free Flow Speeds

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

2.6.2 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 applied within the model.

Table 7. 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
60	96	74	67

MPH (LIMIT)	KPH (LIMIT)	KPH (SURVEY)	KPH ADJUSTED
70	112	112	105

2.7 GAP Parameters

2.7.1 The following default GAP values will be applied:

- GAP - 3 seconds
- GAPM - 2 seconds
- GAPR - 2.5 seconds

2.7.2 The GAP values are subject to change during the calibration and validation stages based on local road conditions.

3. ZONE CONNECTORS

3.1.1 There are a total of 1,056 zones in the model. These zones are broken down as follows:

- Inside fully modelled area – 993 zones
- Outside fully modelled area – 63 zones

3.1.2 Within the Fully Modelled Area connectors are modelled as spigots and connected within the 22222 card within the SATURN .dat file. Outside of the fully modelled area and external zones are coded as buffer connectors within the 33333 card.

3.2 Work Place Parking Levy

3.2.1 Workplace parking functionality will be coded into Nottingham City and Derby City. Only the Nottingham City workplace parking is currently operational however the functionality will be included in Derby City for futureproofing reasons. Trips classed as workplace parking trips will be identified as a separate user class and each zone coded with two spigot connectors. One of these connectors will be a designated workplace parking connector permitting only workplace parking trips. The second spigot will be used by all other traffic. This approach will allow a charge to be applied to the workplace parking trips.

4. CITY CENTRE PARKING

4.1.1 Zones in Nottingham and Derby city centres will be connected via a series of centroid connector 'walk' links to 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.

4.1.2 Each connection between a zone and city centre car park will be an appropriate length so that any car park can be used to any zone, regardless of where the car park is within the city centre. The selection of a city centre car park will be determined by the attractiveness of the car park in relation to the walking distance to the zone .

4.1.3 Each car park will have 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 average charge

applied to Nottingham car parks will be £6.60. The average charge in Derby City will be £4.70. Plans of the car parks and city centre zones are shown in Figure 4 and Figure 5.

4.1.4 The centroid connectors for these zones will be coded as part of the buffer network and capacities will be different to the standard saturation values used elsewhere in the model in order to reflect the number of available parking spaces.

Figure 4. Nottingham City Centre Car Parking

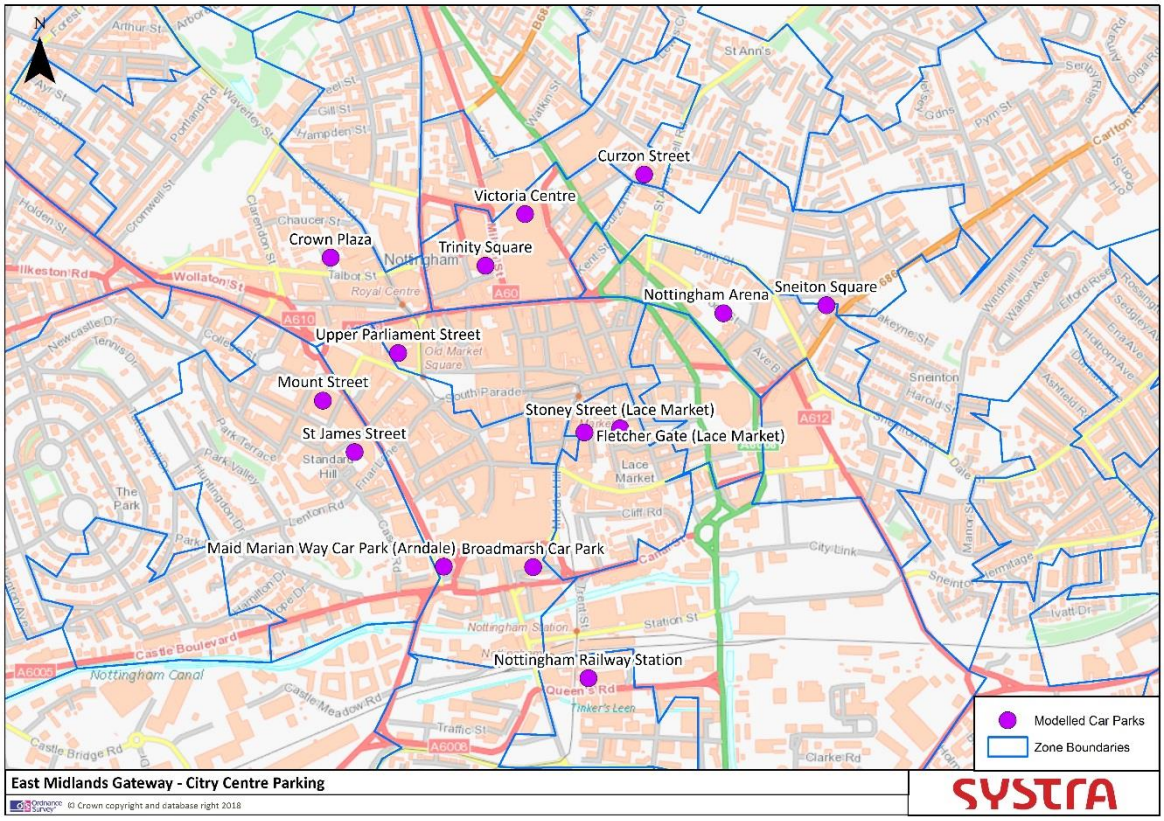
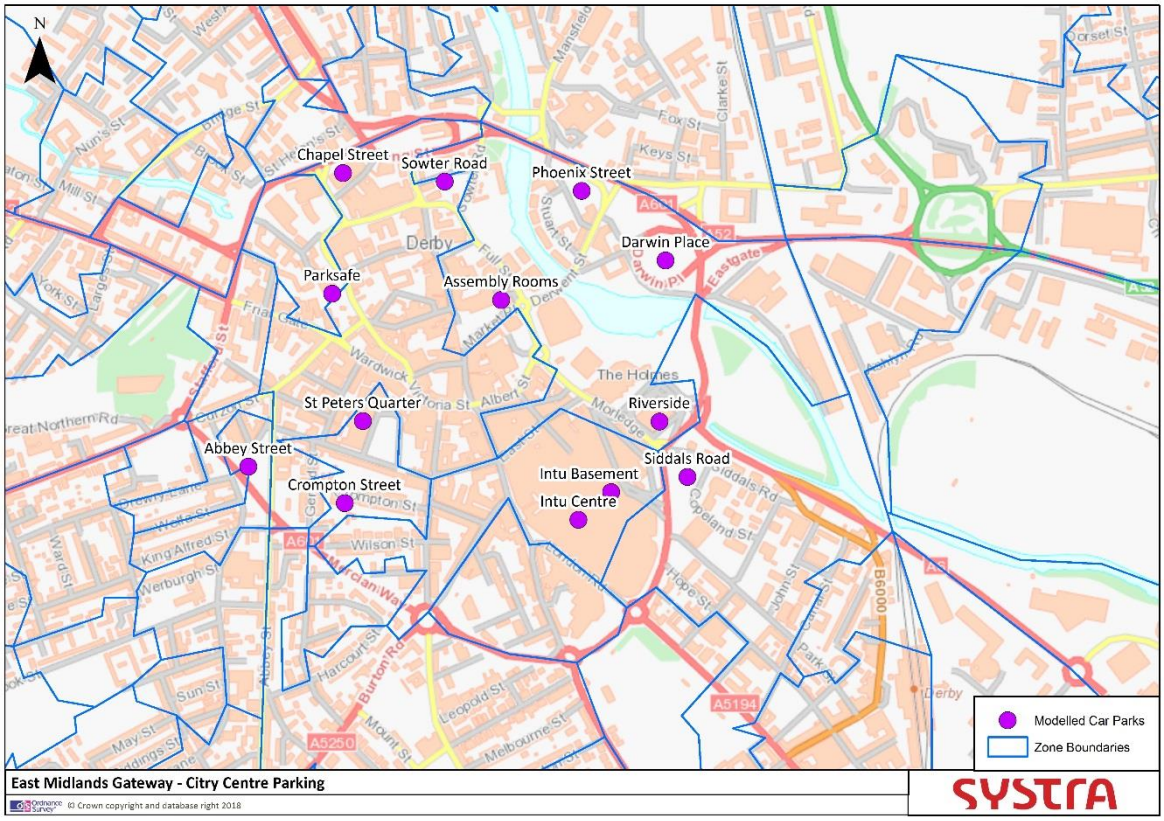


Figure 5. Derby City Centre Car Parking



5. BUS ROUTES

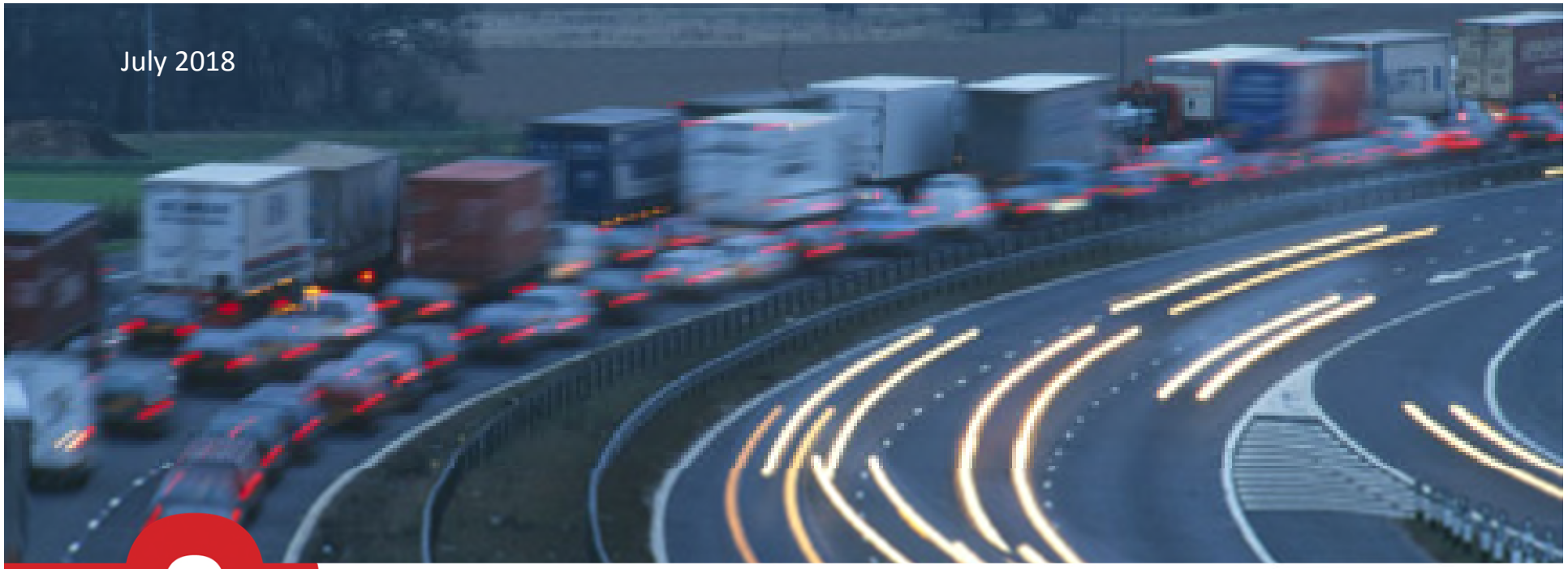
5.1.1 The bus routes in the highways model will be obtained by converting the updated bus routes in the updated Public Transport model into SATURN fixed flows. The public transport model includes buses that run at least once within the given peak hour and will exclude infrequent shopper services and weekend or holiday services.

APPROVAL

Version	Name		Position	Date	Modifications
1	Author	Rhian Turgoose	Associate	DD/MM/YY	Version 1
	Approved by	Duncan Irons	Director	DD/MM/YY	
2	Author	Rhian Turgoose	Associate	12/10/2018	Version 2
	Approved by	Duncan Irons	Director	12/10/2018	

Appendix B

July 2018



Appendix B: Origin Destination Trees

Base Model

SYSTRA

Summary

- Saturn Tree outputs are displayed for the following nine Origins/Destinations:

1. Derby - Nottingham
2. Nottingham - Leicester
3. Derby - Leicester
4. Mansfield - Nottingham
5. Mansfield - Derby
6. North - South
7. East - West
8. West Midlands - Nottingham
9. West Midlands - Derby

- The central Zones utilised for each location are as follows:
  - Derby - Zone 451
  - Nottingham - Zone 1
  - Leicester – Zone 968
  - Mansfield – Zone 441
  - West Midlands – Zone 1032
  - North – Zone 1045
  - South – Zone 1026
  - East – Zone 349
  - West – Zone 975



Route: 1

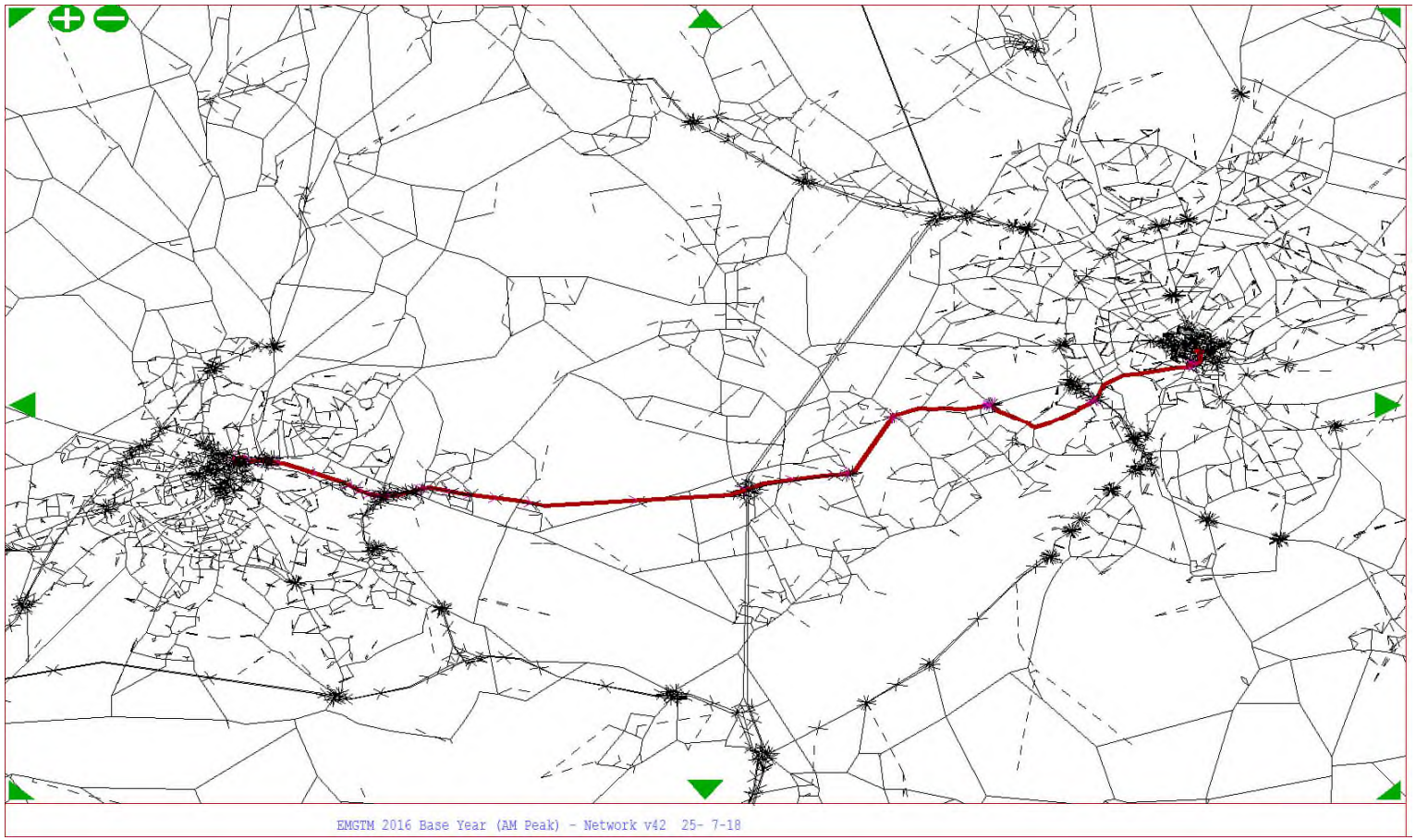
Derby - Nottingham

Trees

SYSTRA

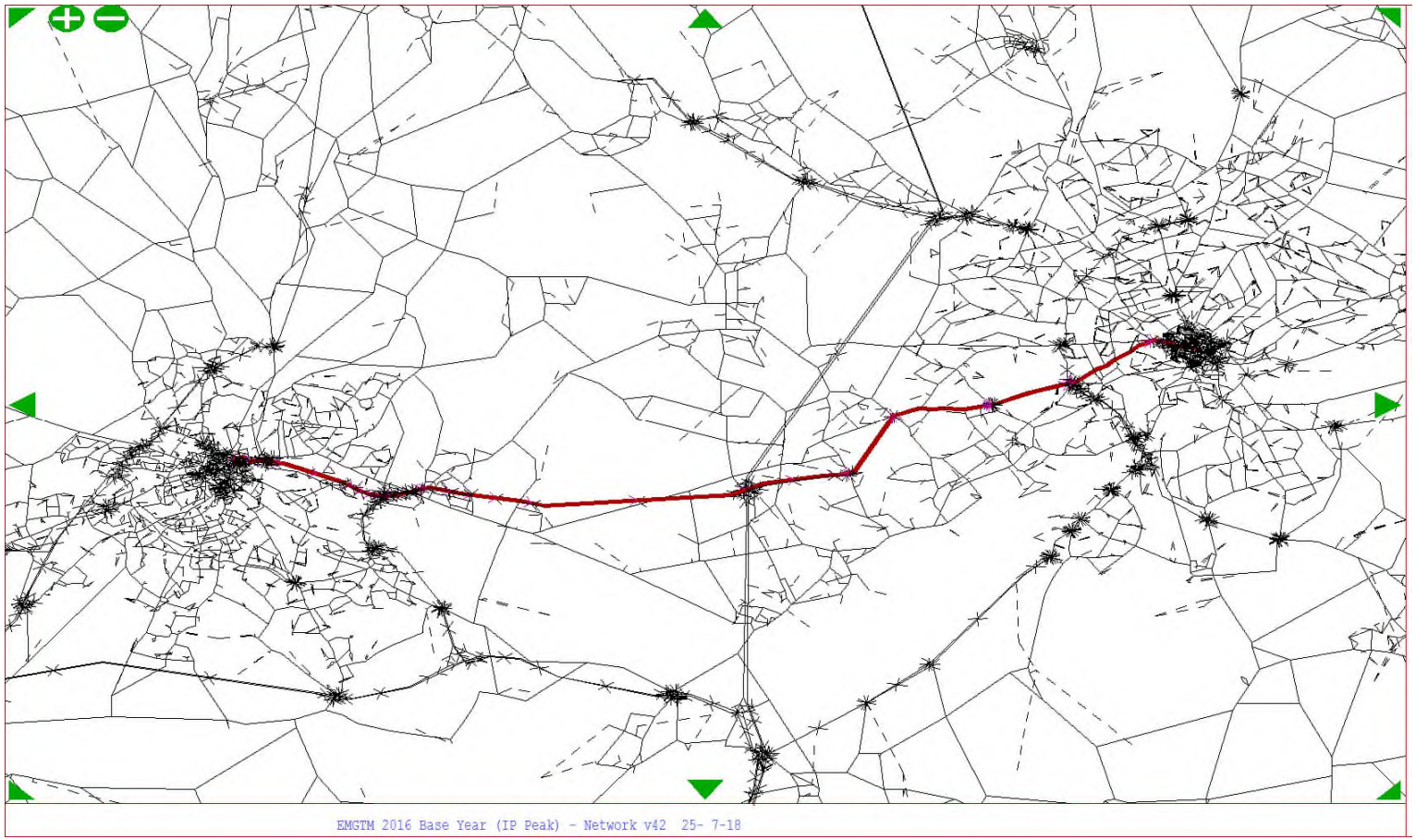
AM Tree

Base Year



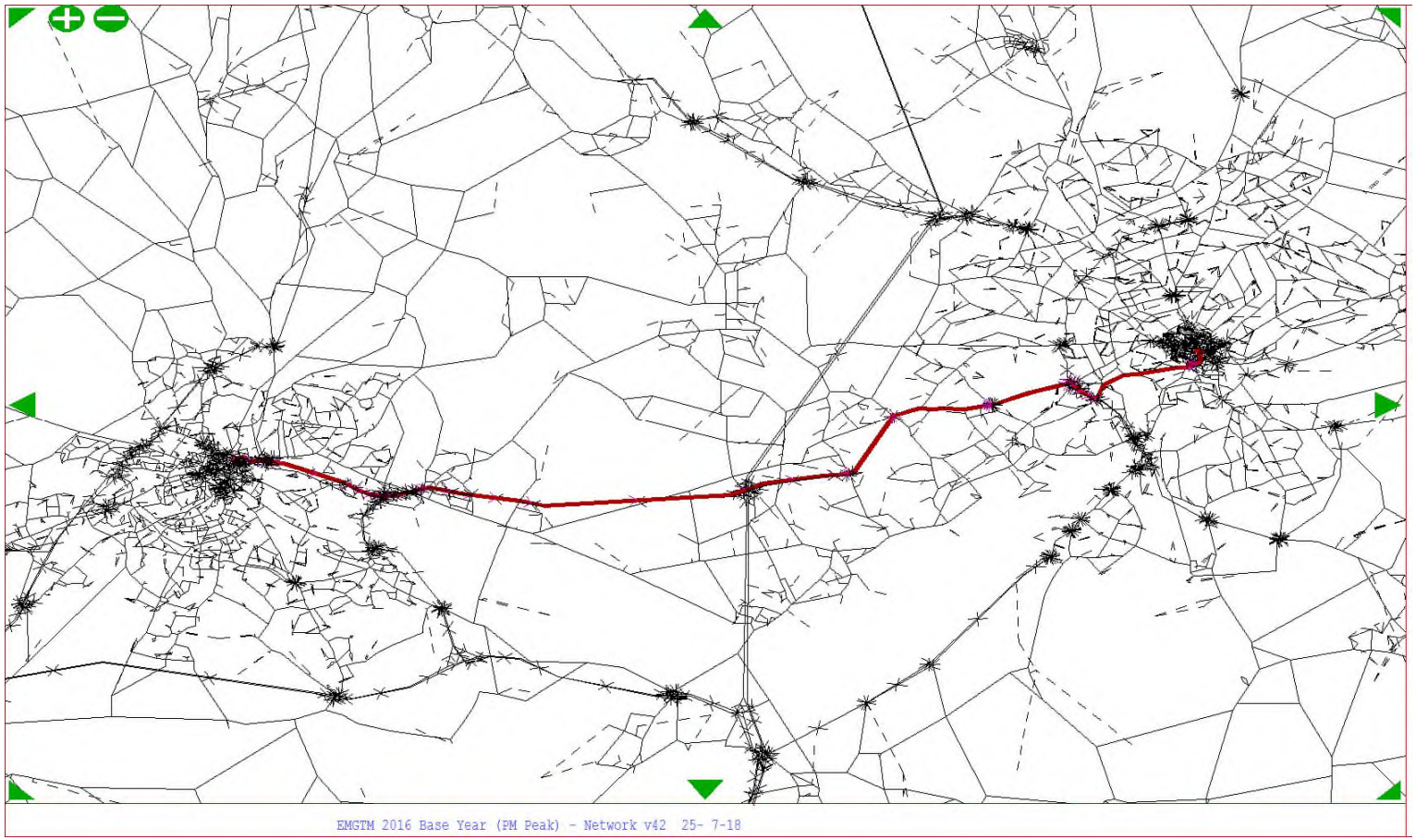
IP Tree

Base Year



PM Tree

Base Year





Route: 2

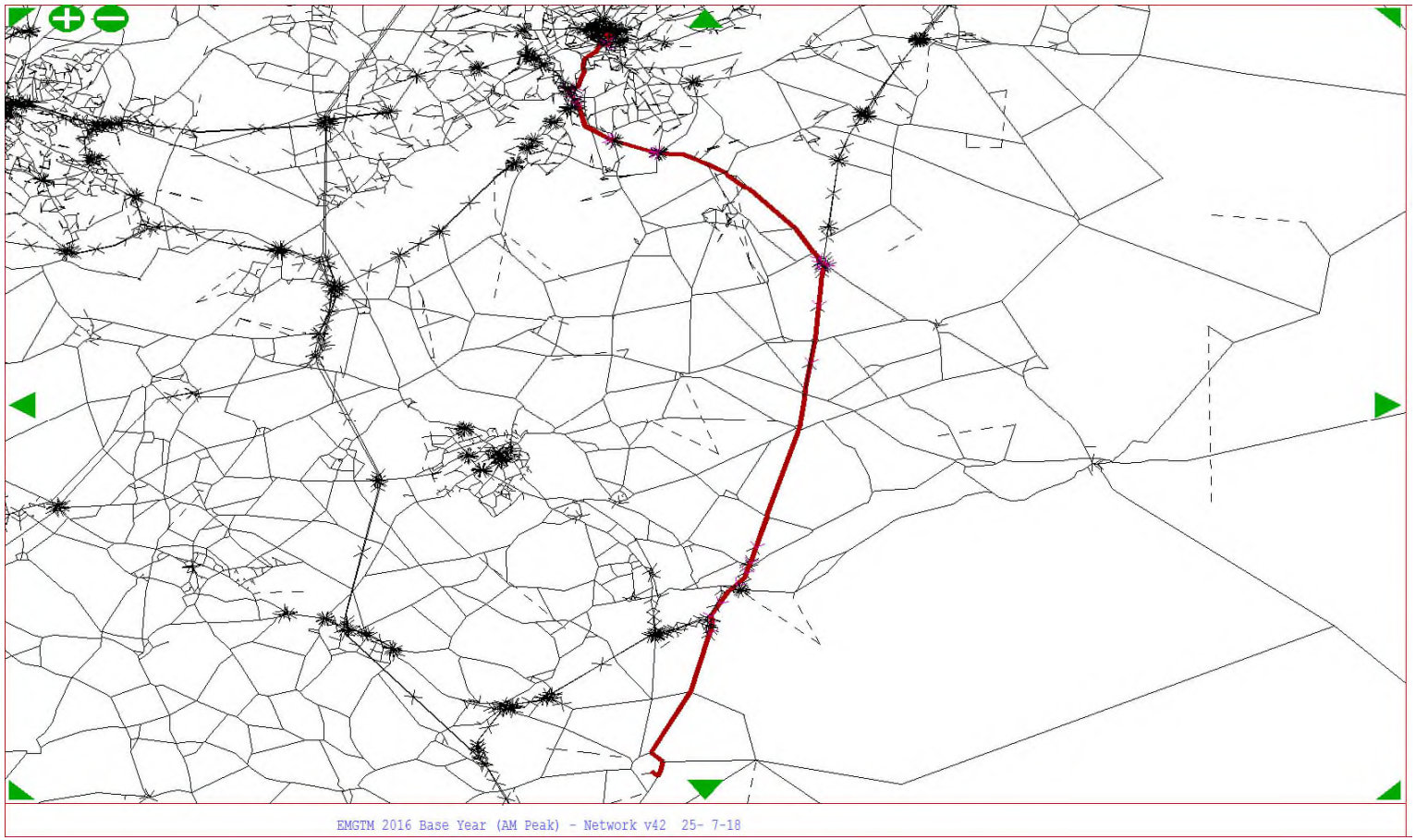
Nottingham – Leicester

Trees

SYSTRA

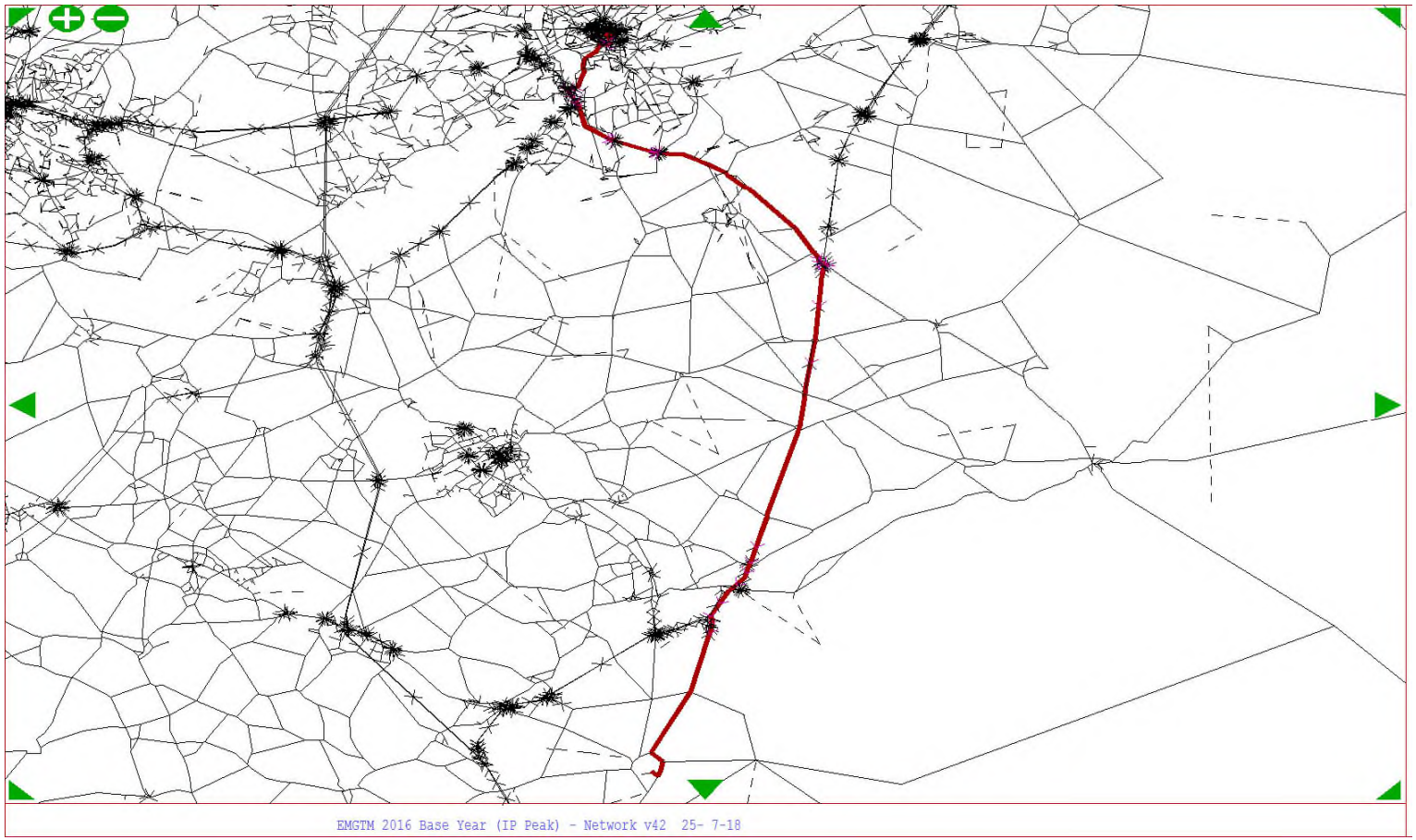
AM Tree

Base Year



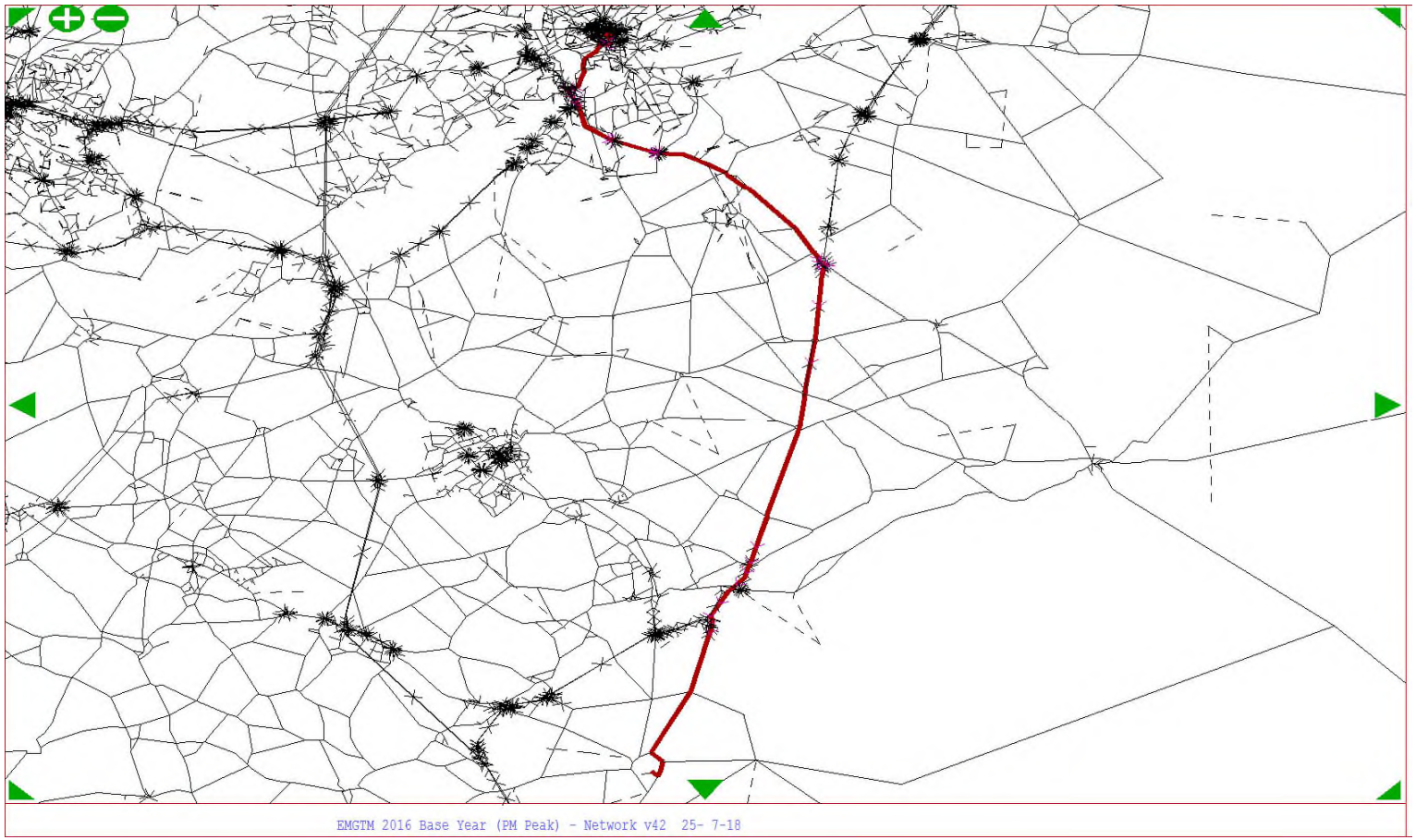
IP Tree

Base Year



PM Tree

Base Year





Route: 3

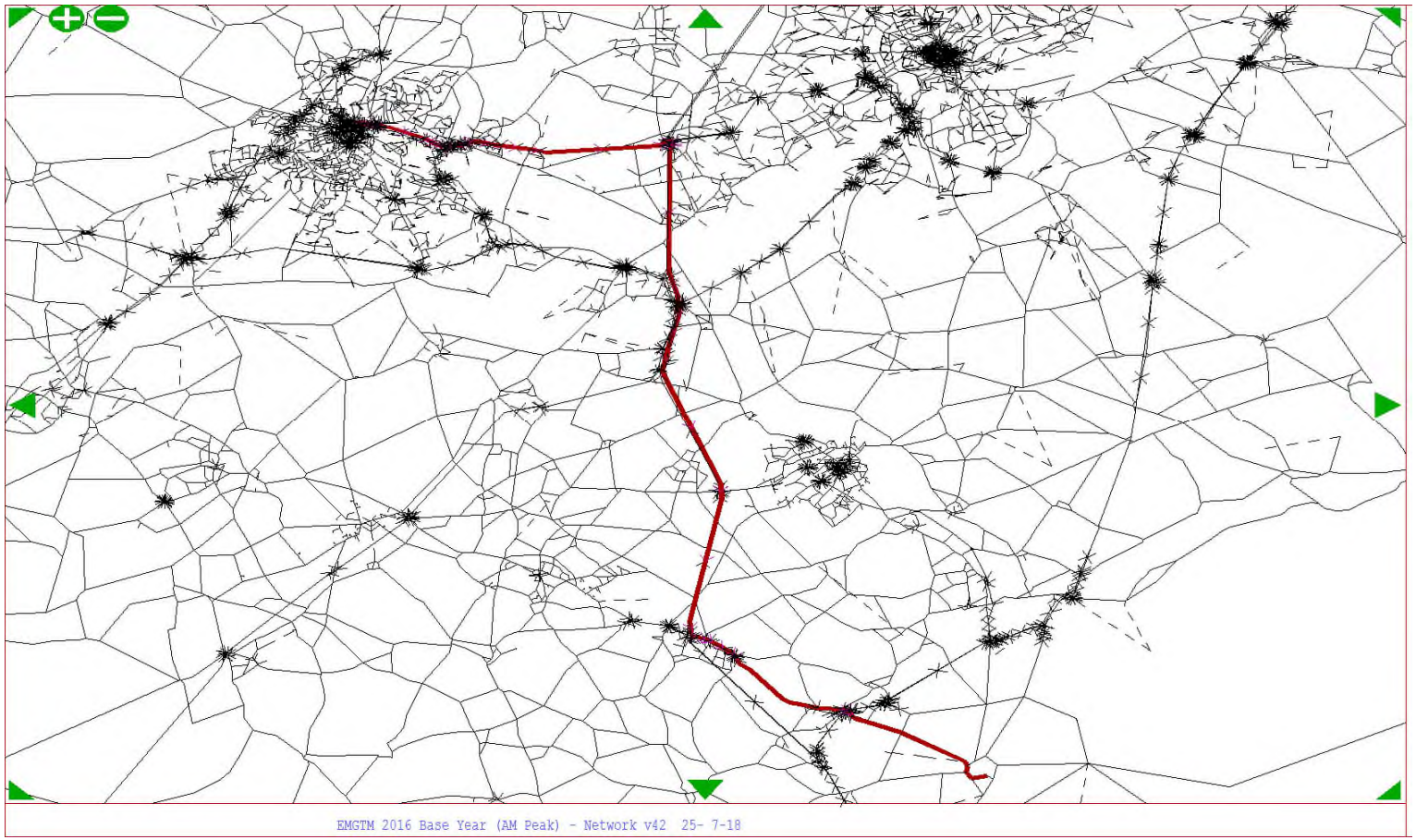
Derby - Leicester

Trees

SYSTRA

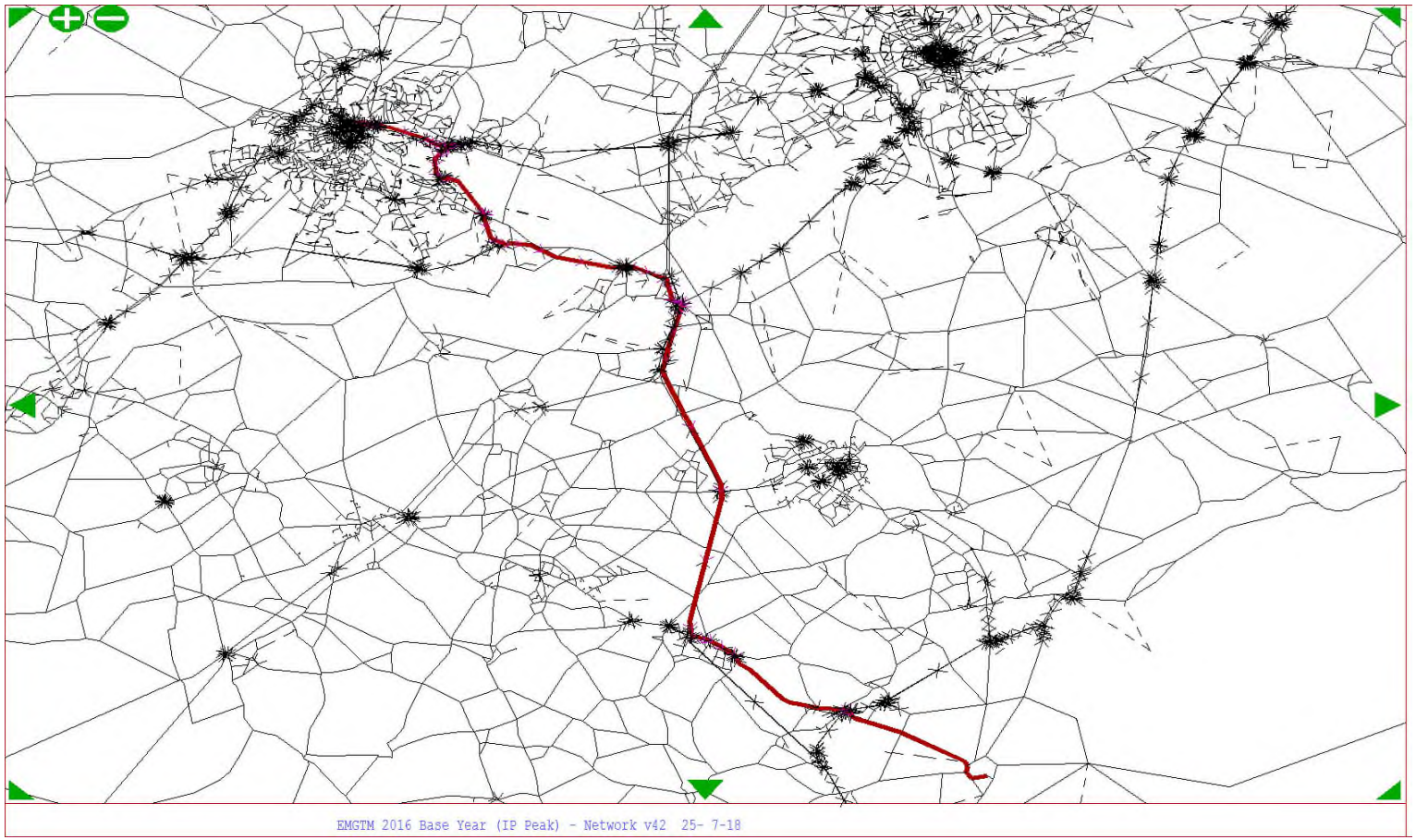
AM Tree

Base Year



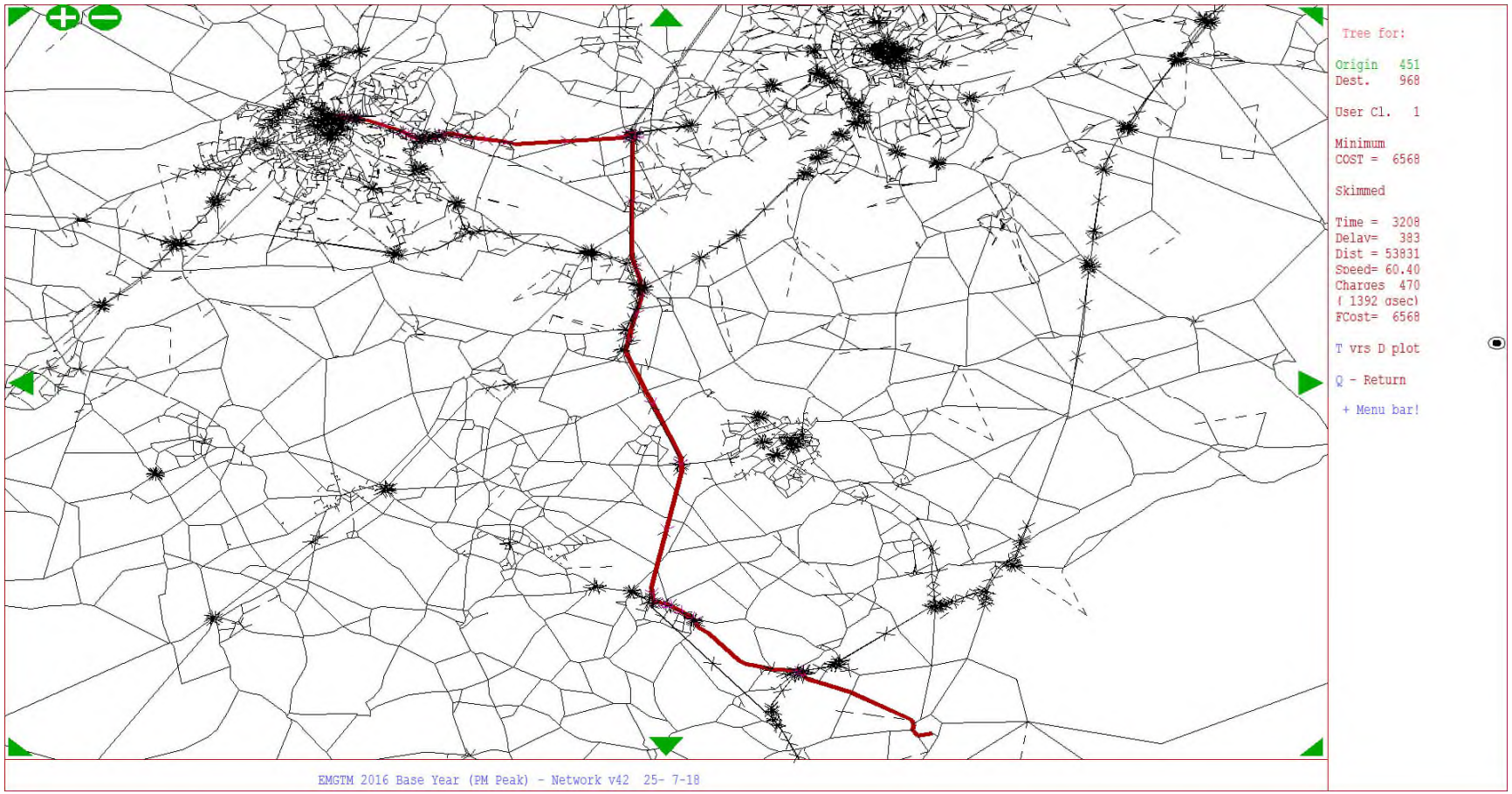
IP Tree

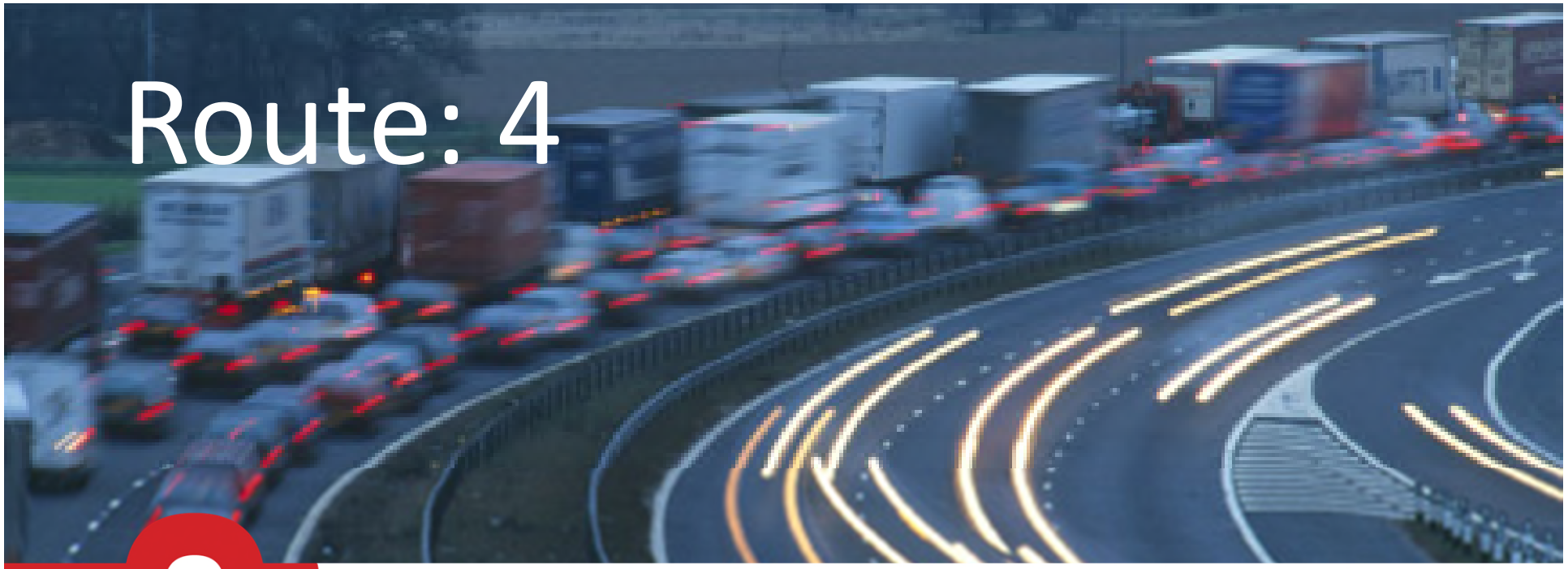
Base Year



PM Tree

Base Year





Route: 4

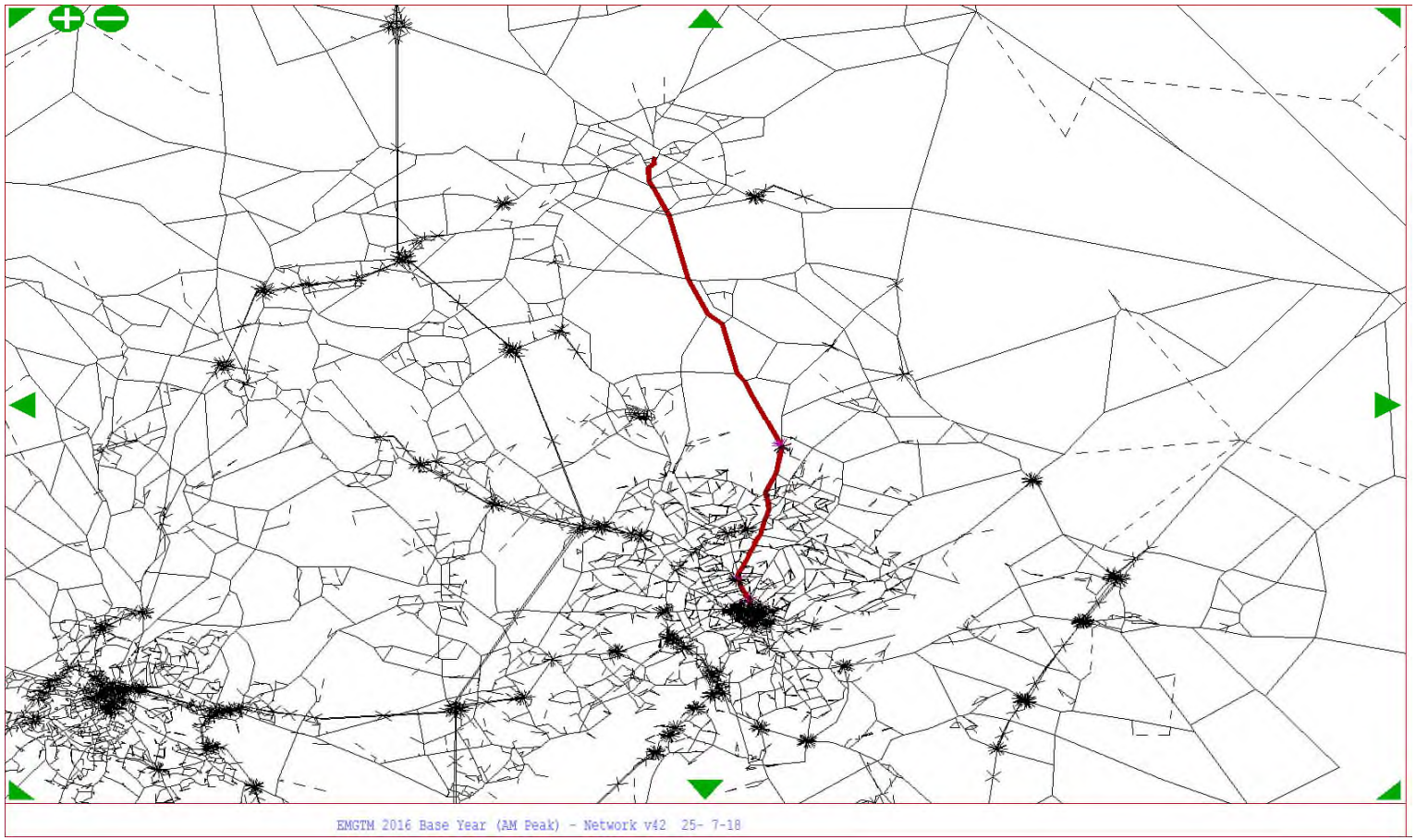
Mansfield - Nottingham

Trees

SYSTRA

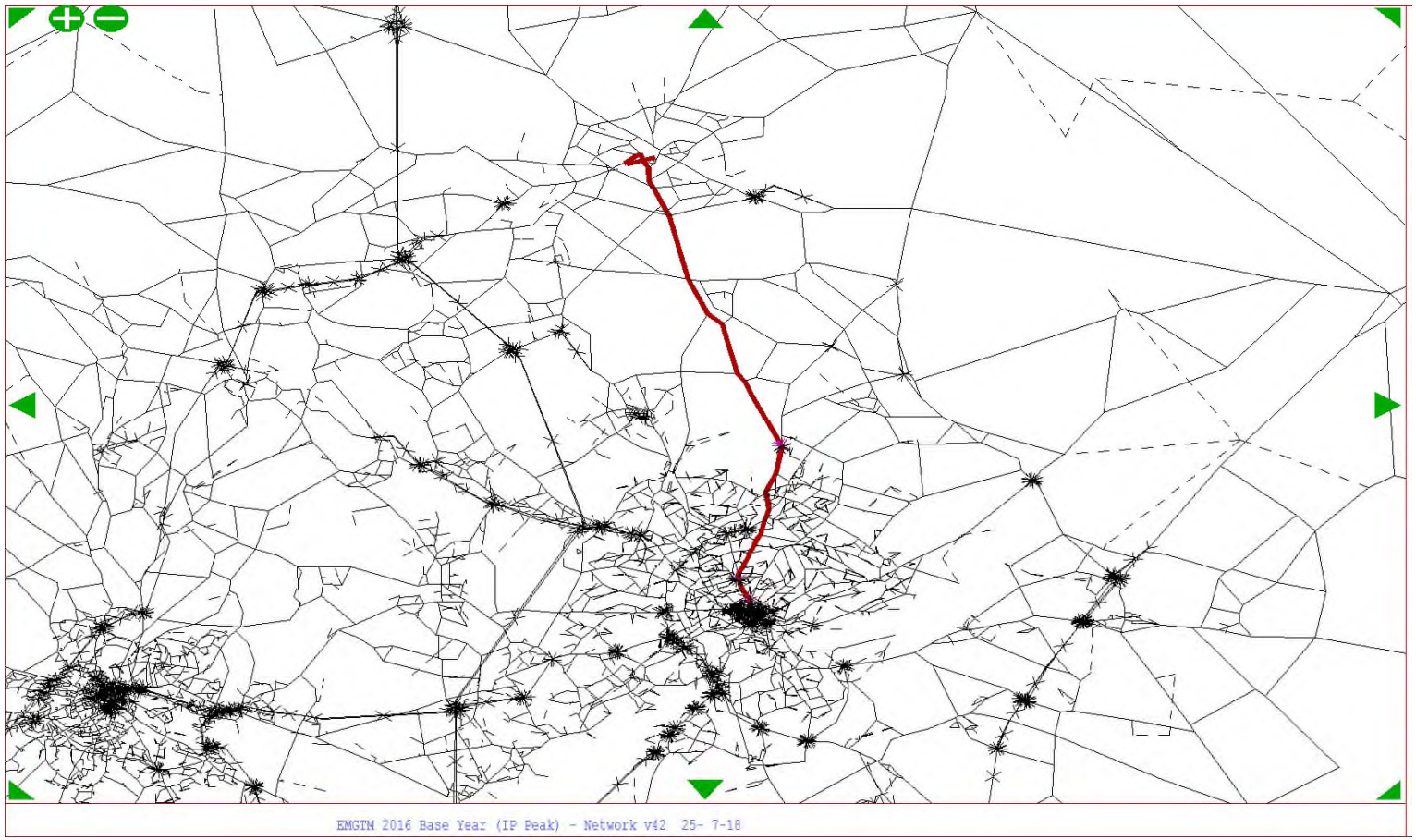
AM Tree

Base Year



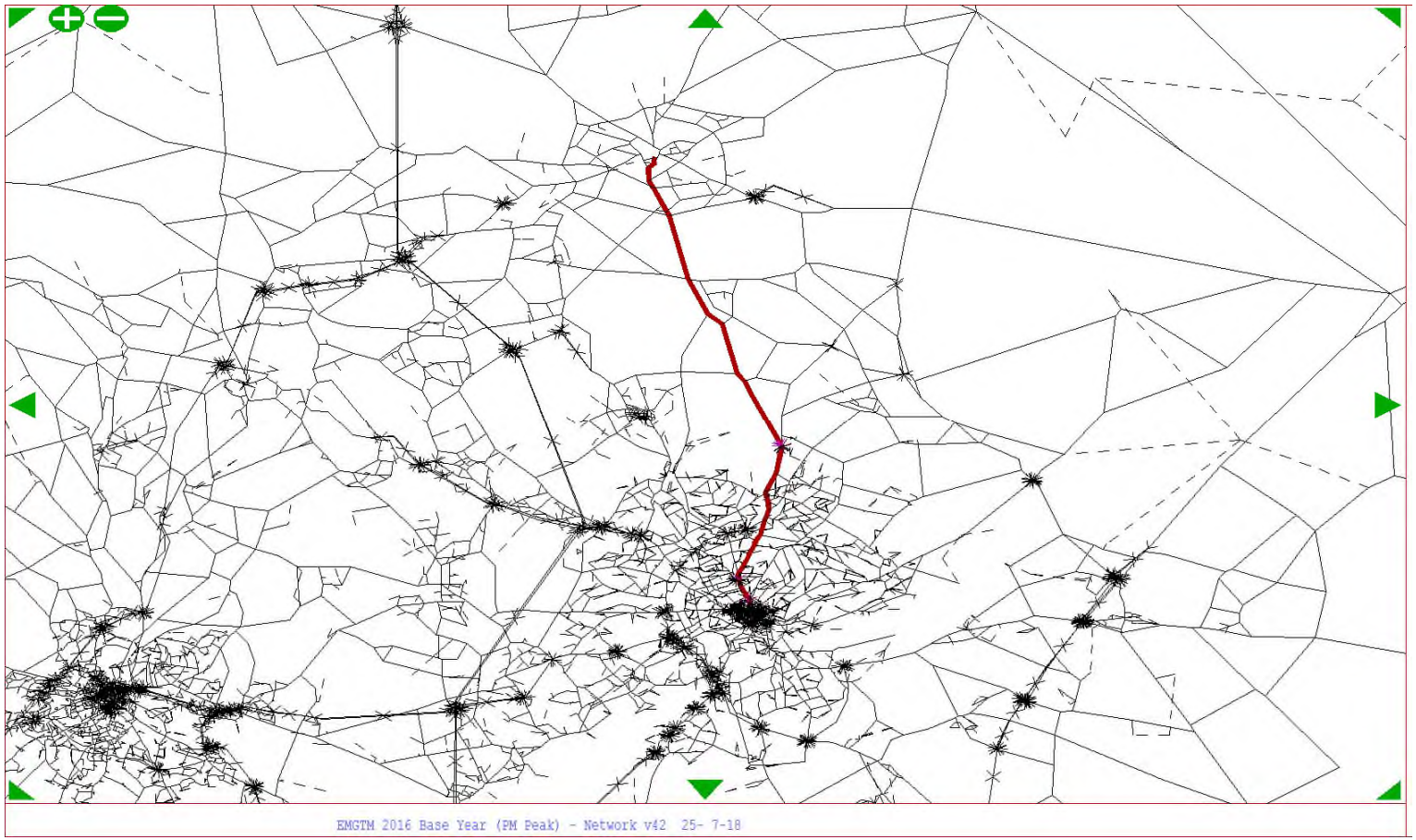
IP Tree

Base Year



PM Tree

Base Year





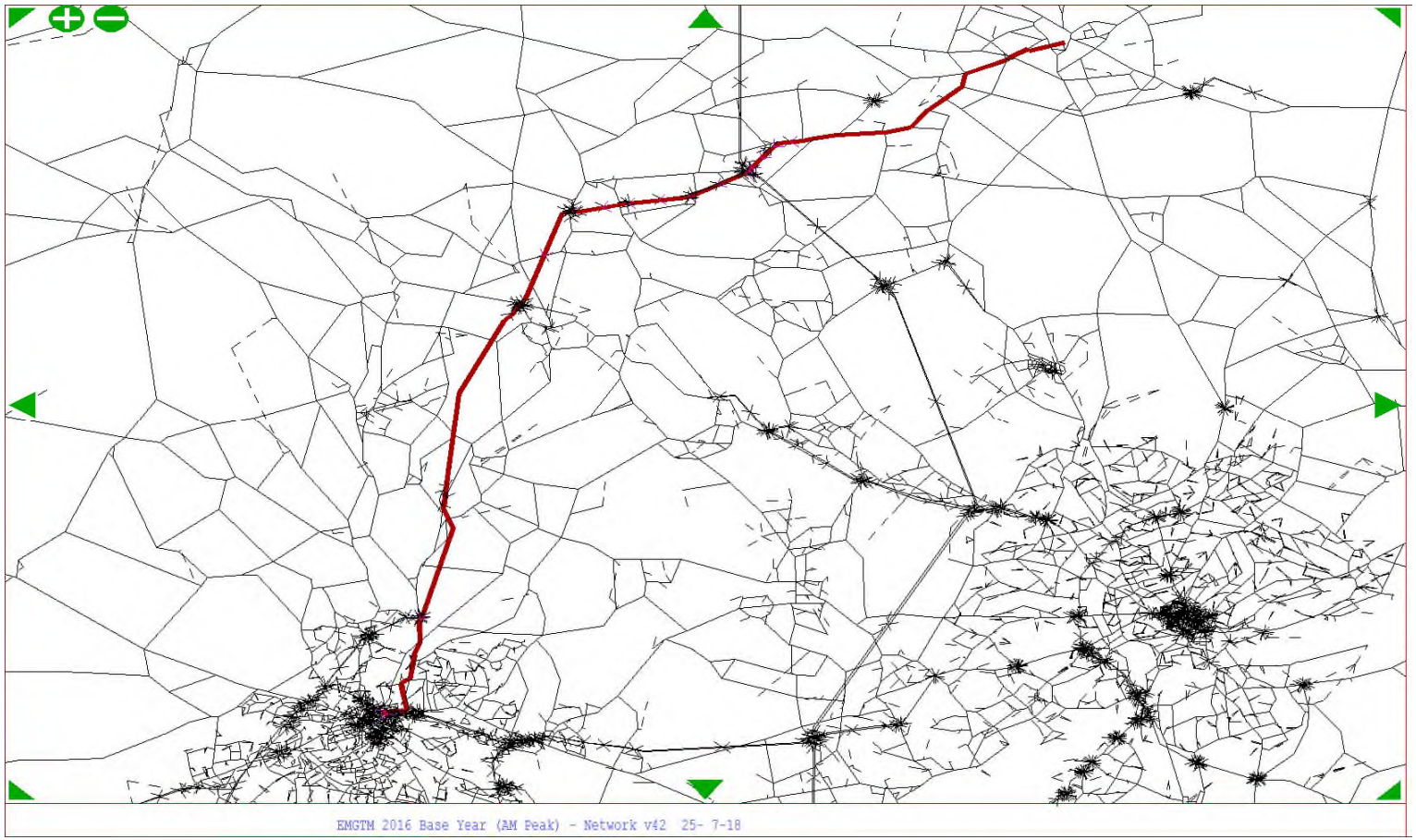
Route: 5

Mansfield - Derby

Trees

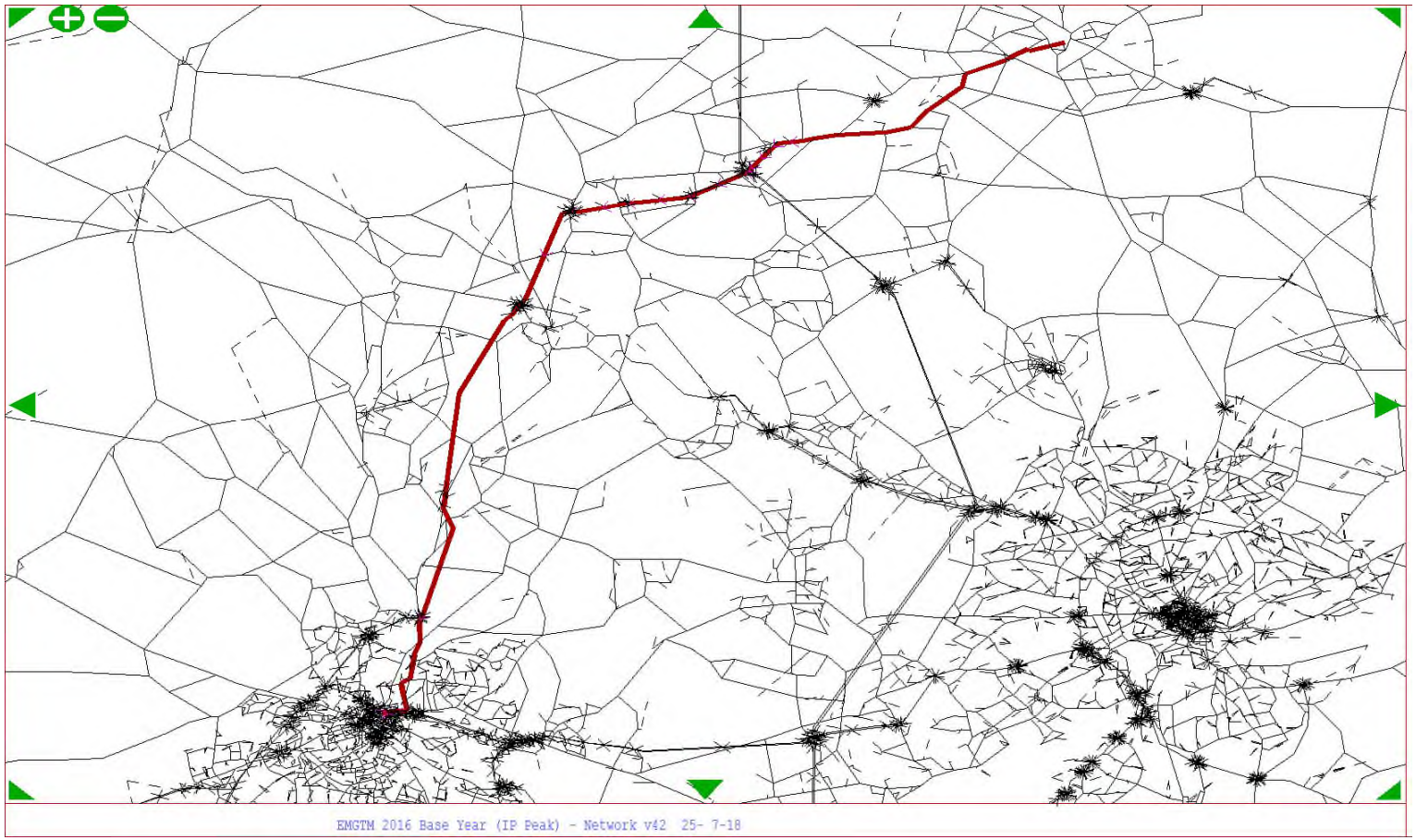
AM Tree

Base Year



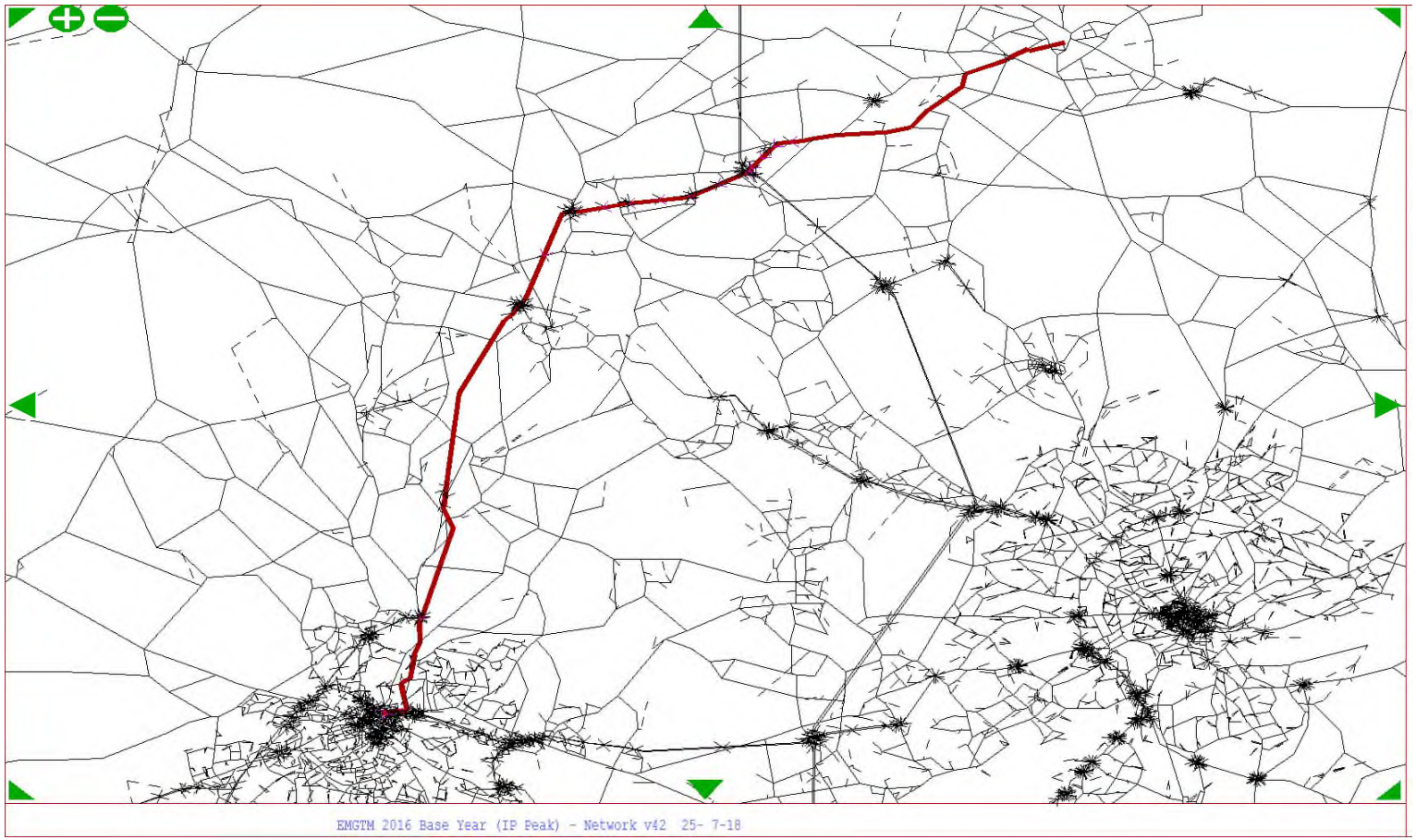
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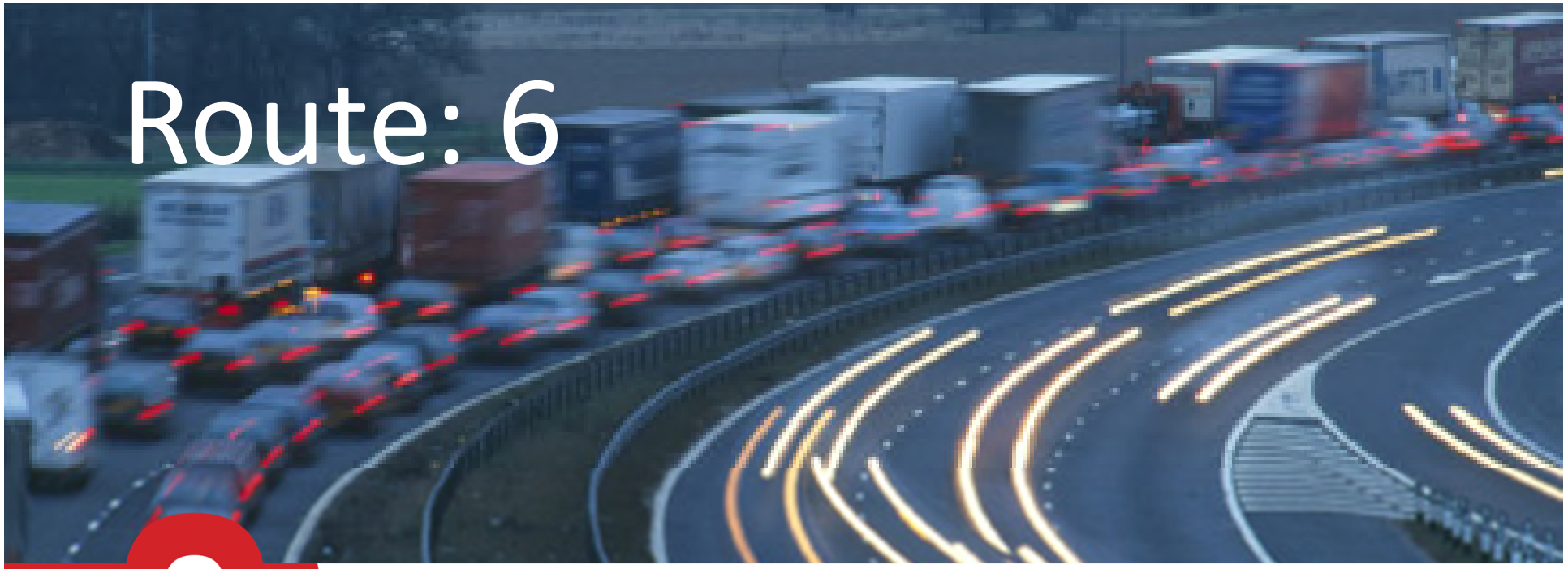
Base Year



PM Tree

Base Year





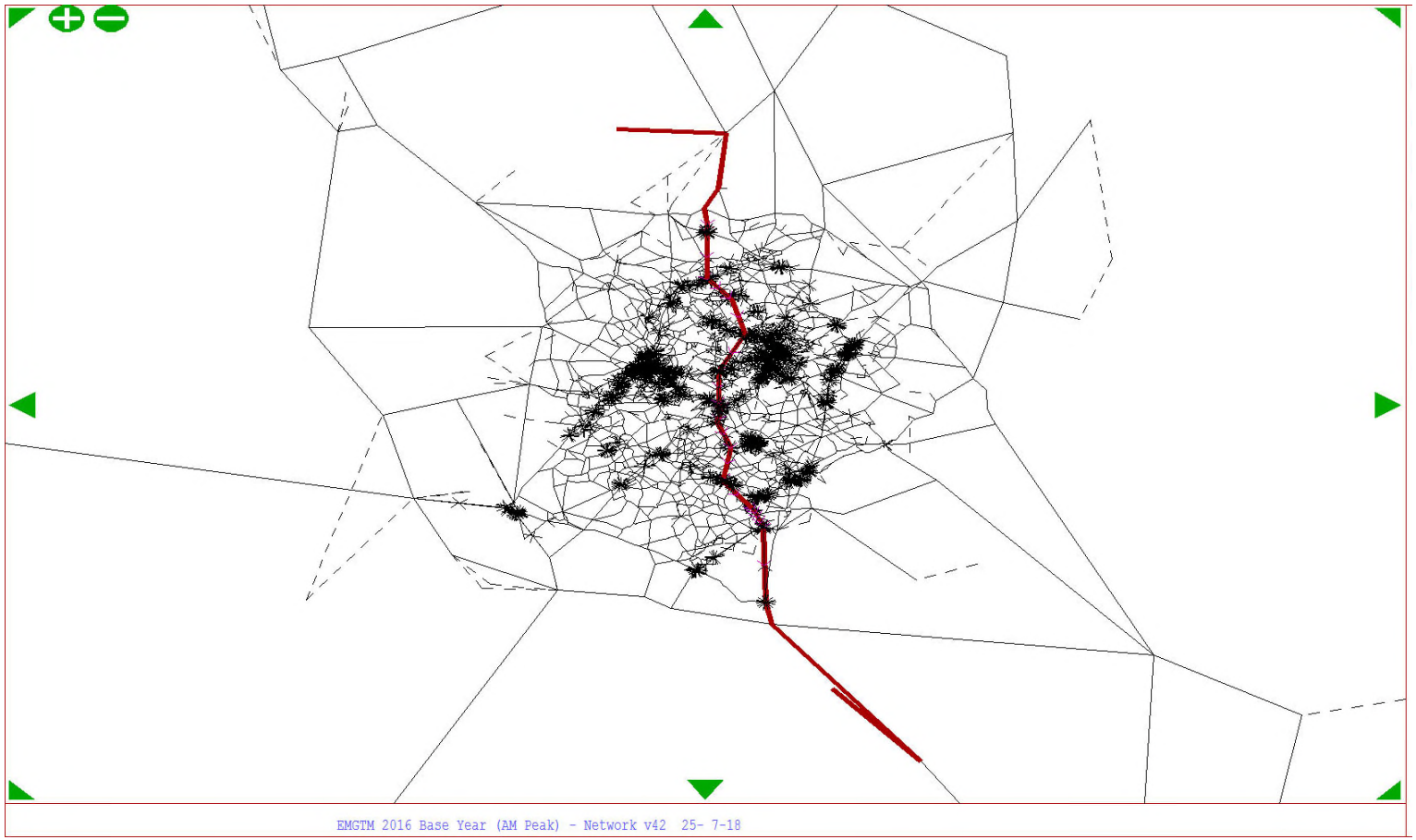
Route: 6

North - South

Trees

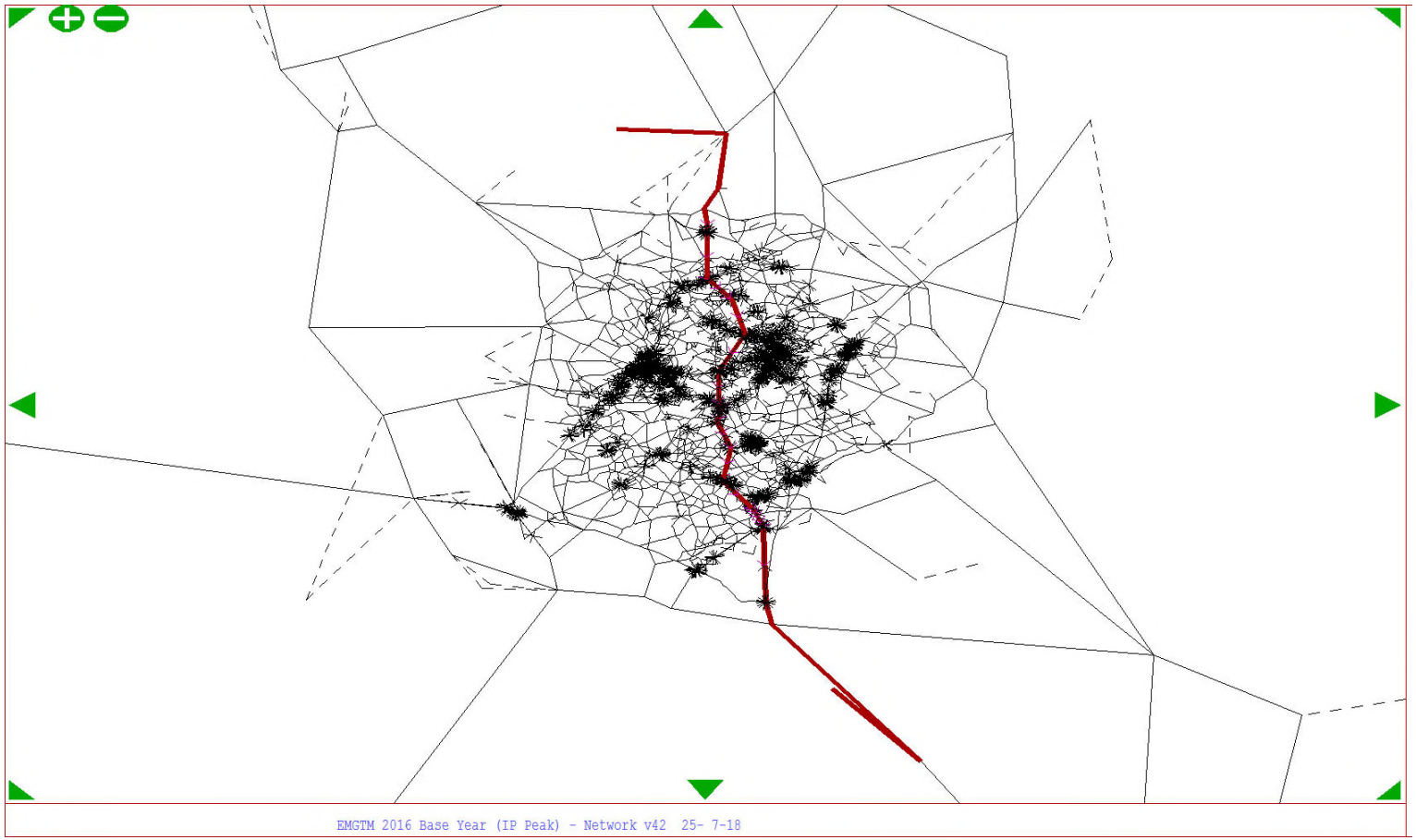
AM Tree

Base Year



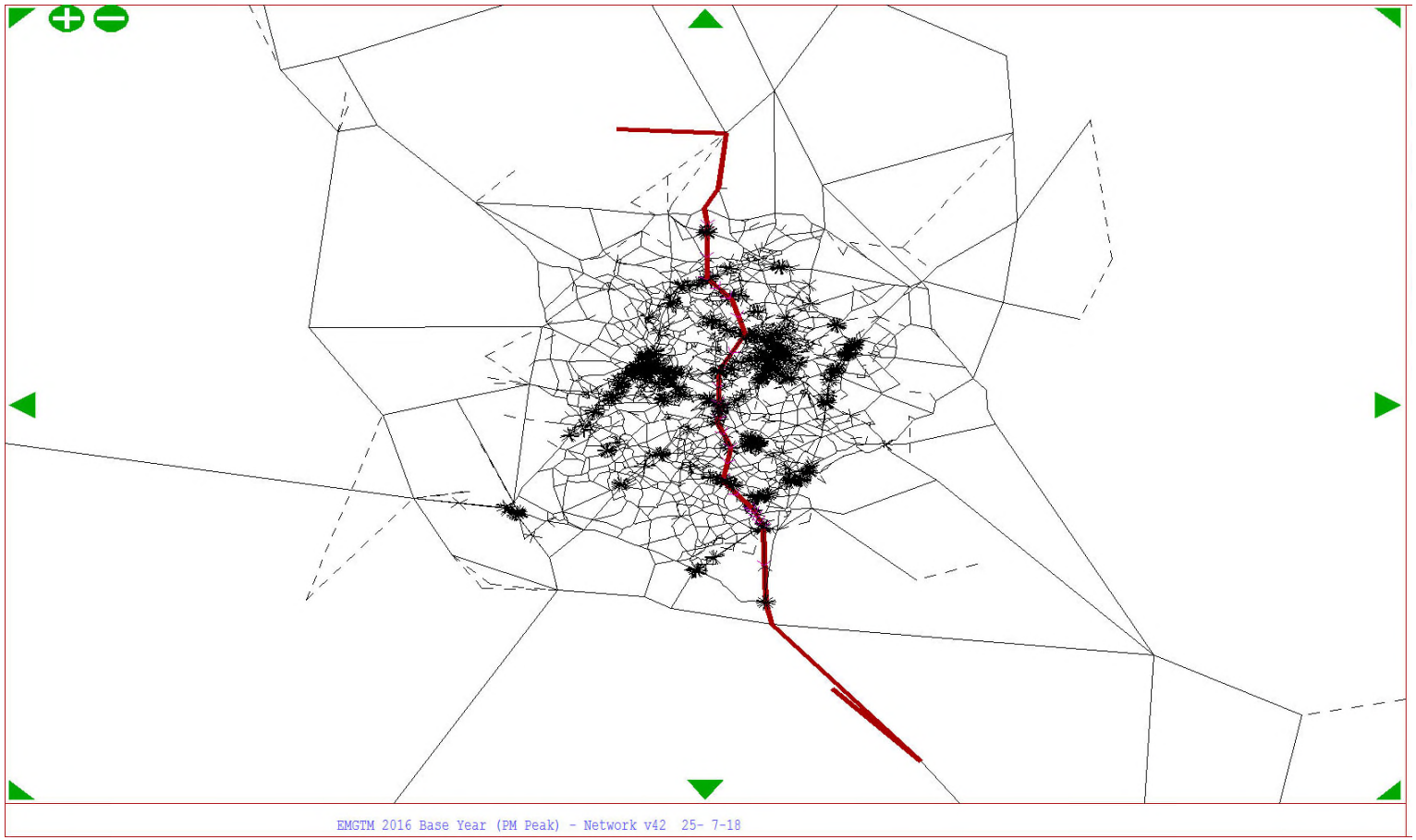
IP Tree

Base Year



PM Tree

Base Year





Route: 7

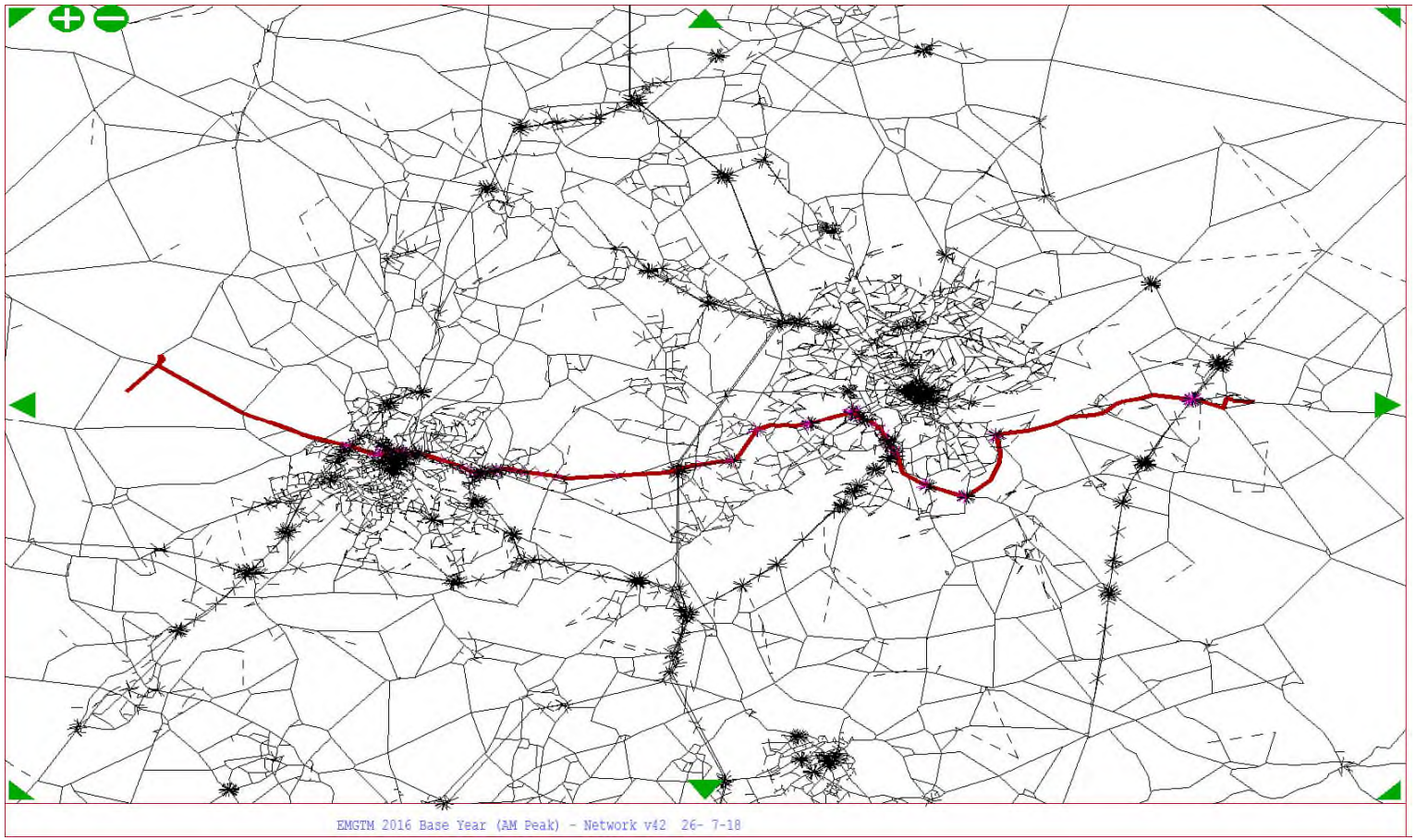
East - West

Trees

SYSTRA

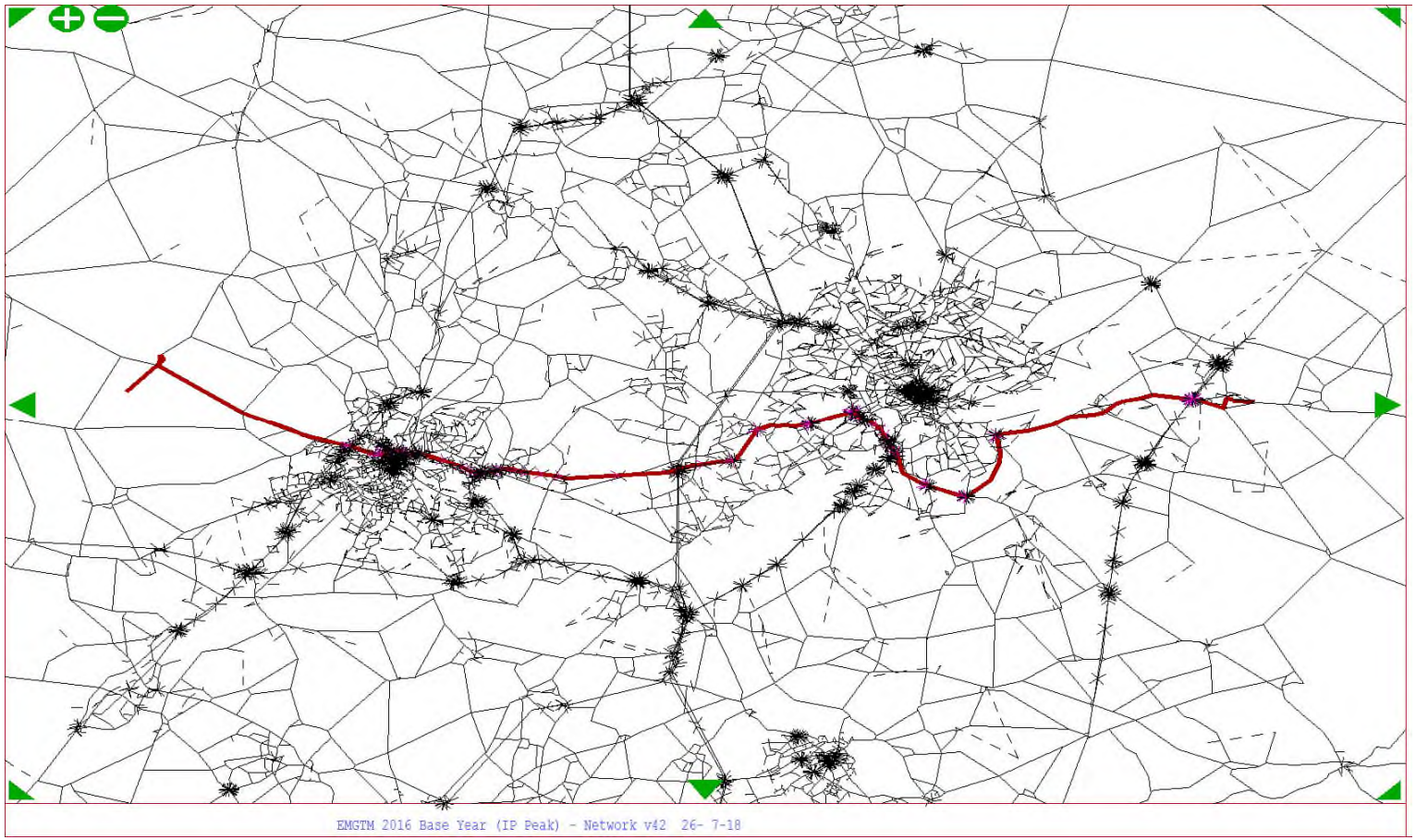
AM Tree

Base Year



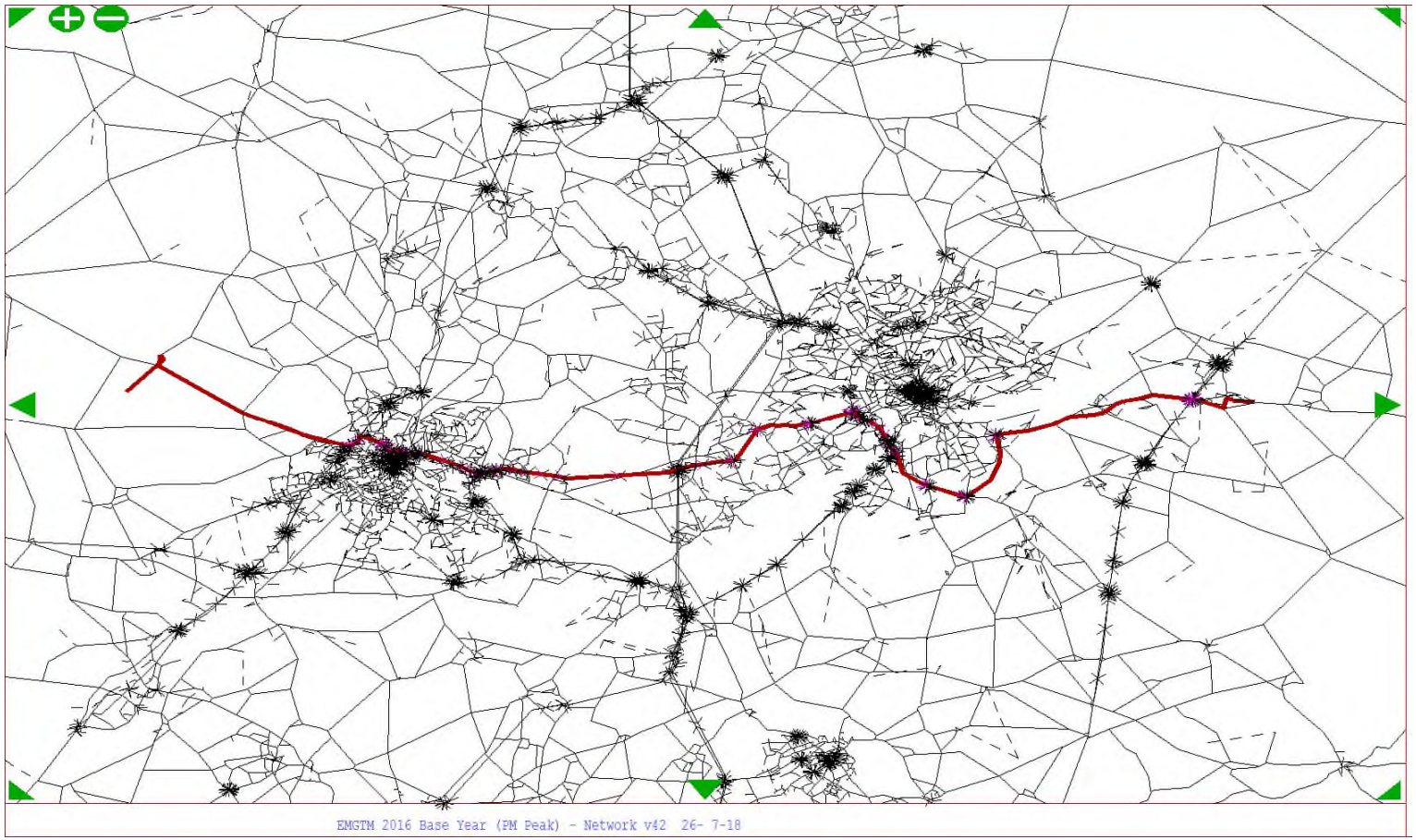
IP Tree

Base Year



PM Tree

Base Year





Route: 8

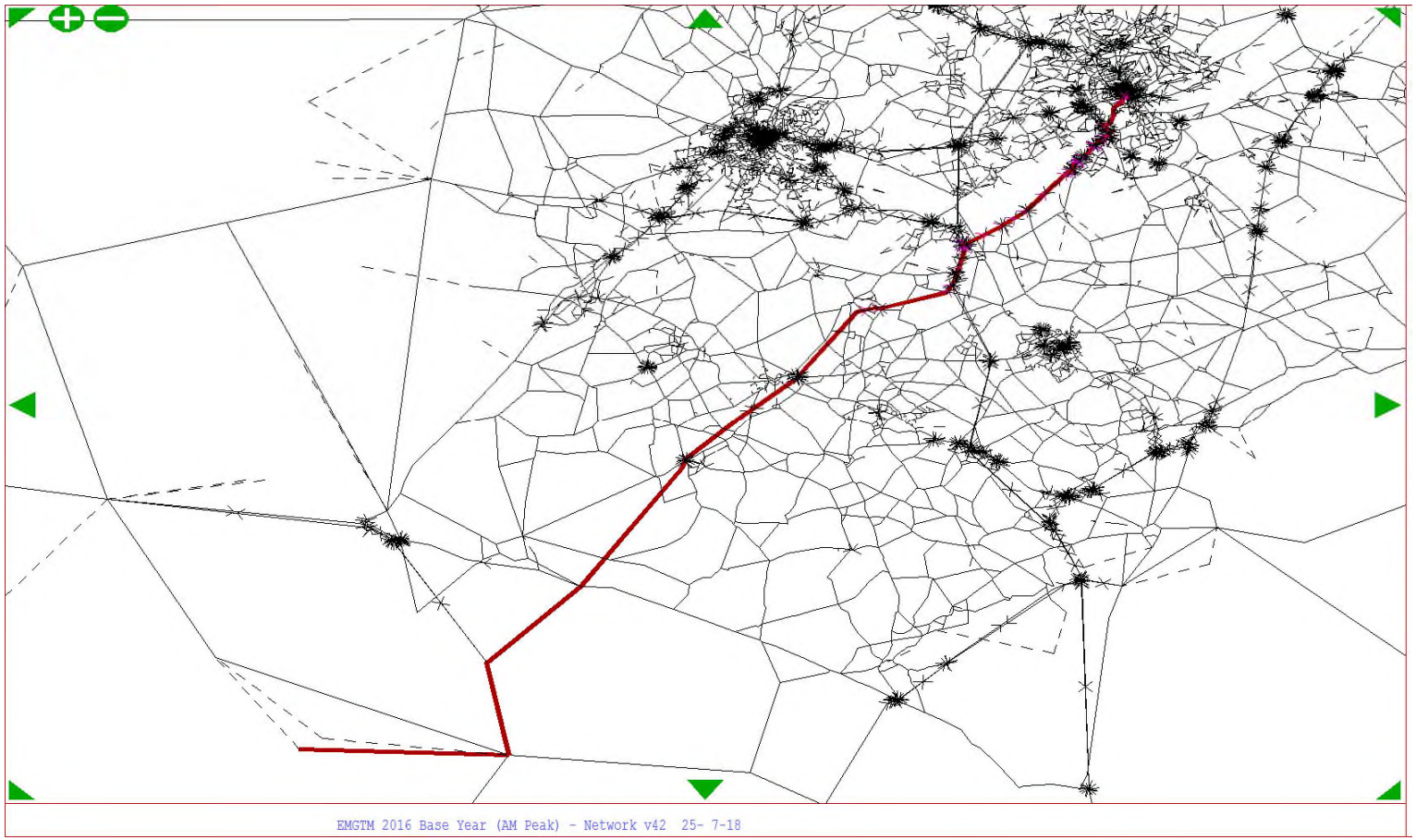
West Midlands - Nottingham

Trees

SYSTRA

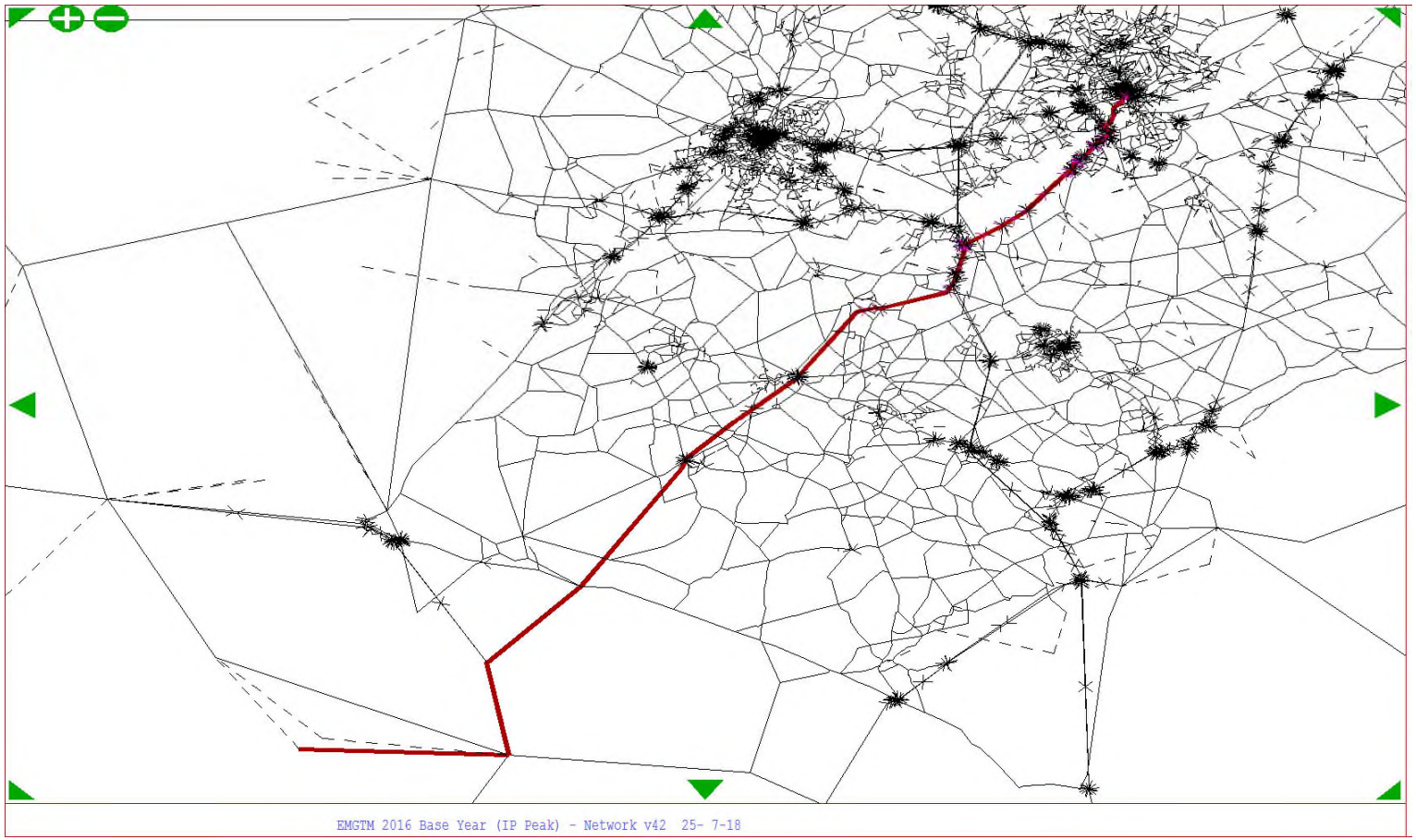
AM Tree

Base Year



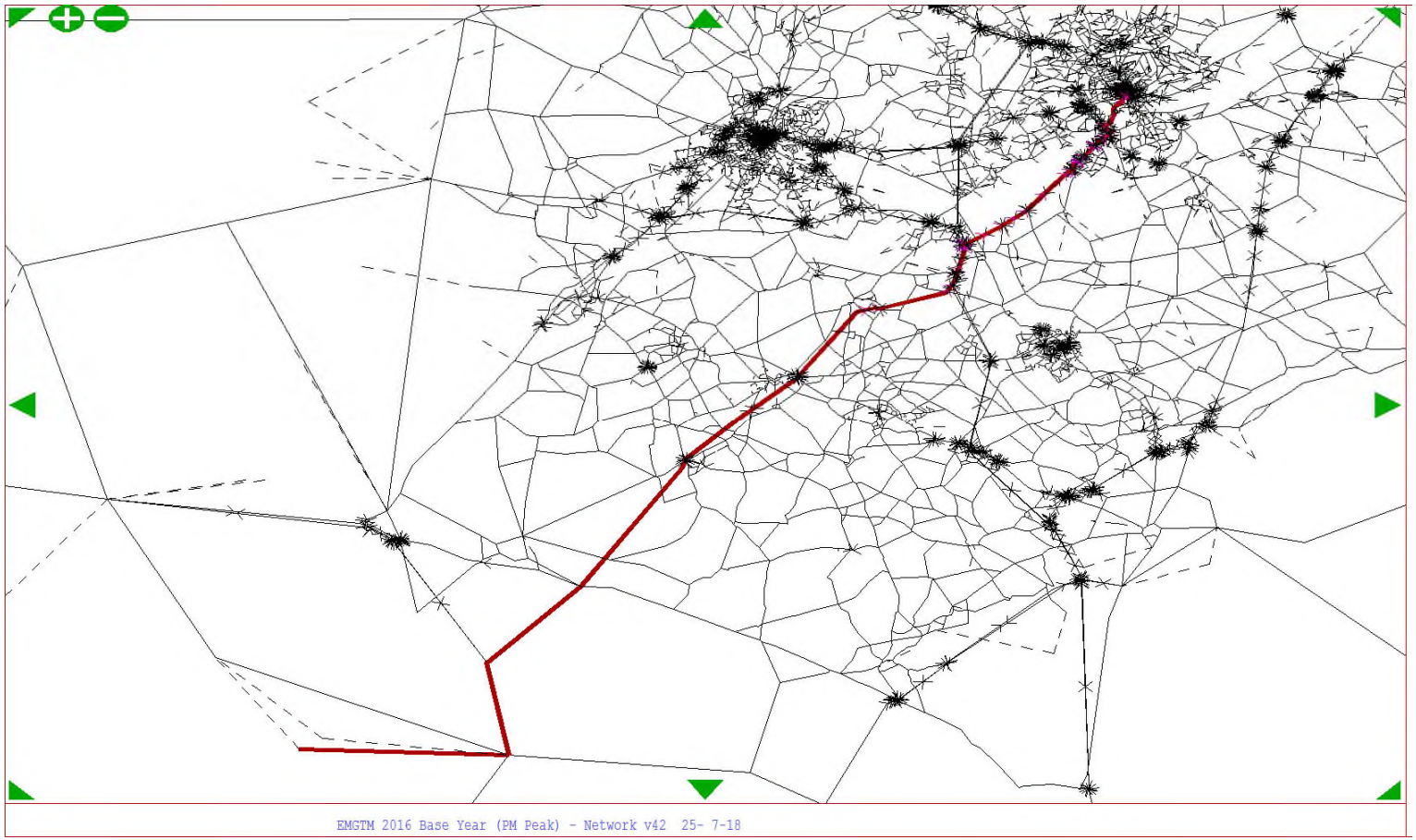
IP Tree

Base Year



PM Tree

Base Year





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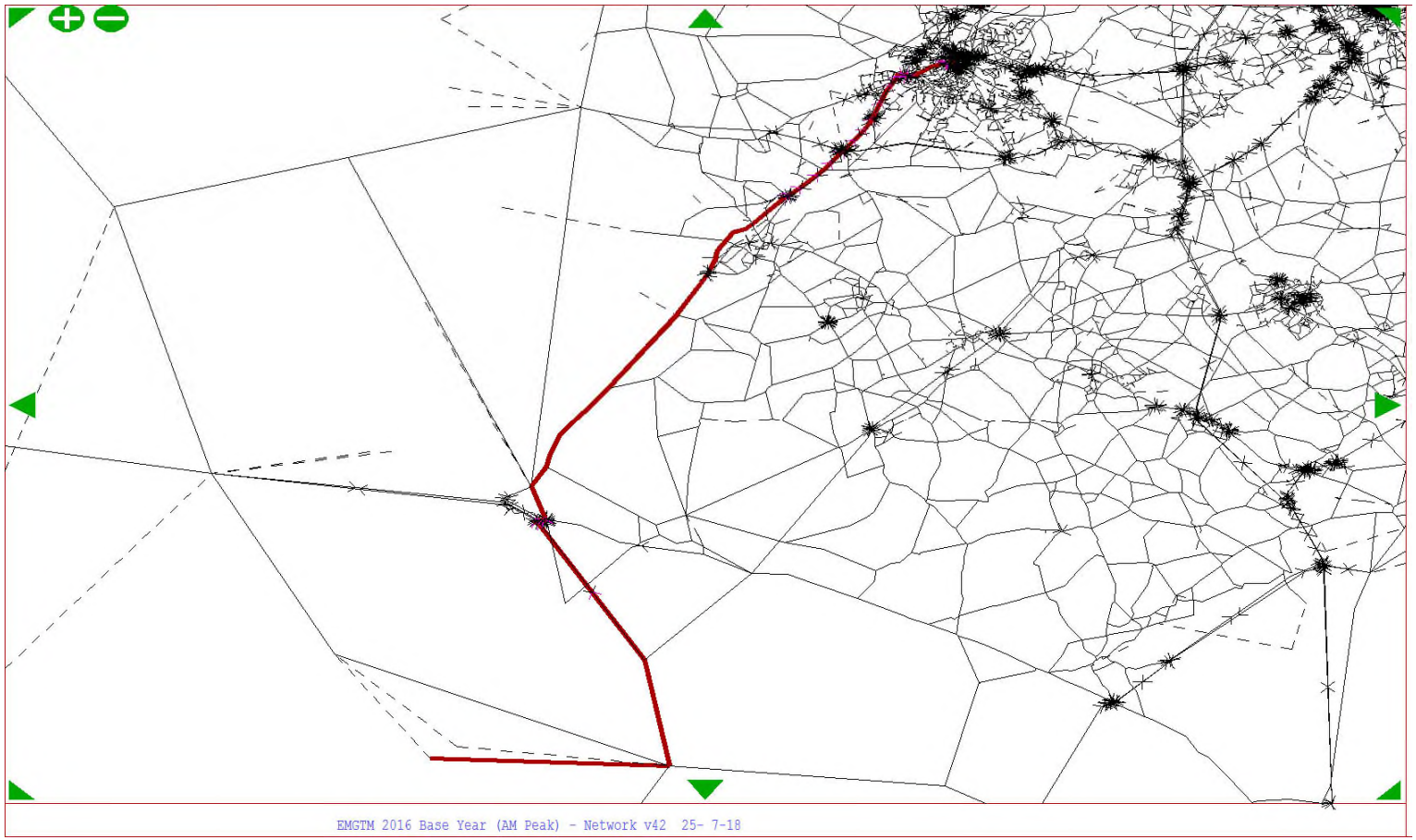
West Midlands - Derby

Trees

SYSTRA

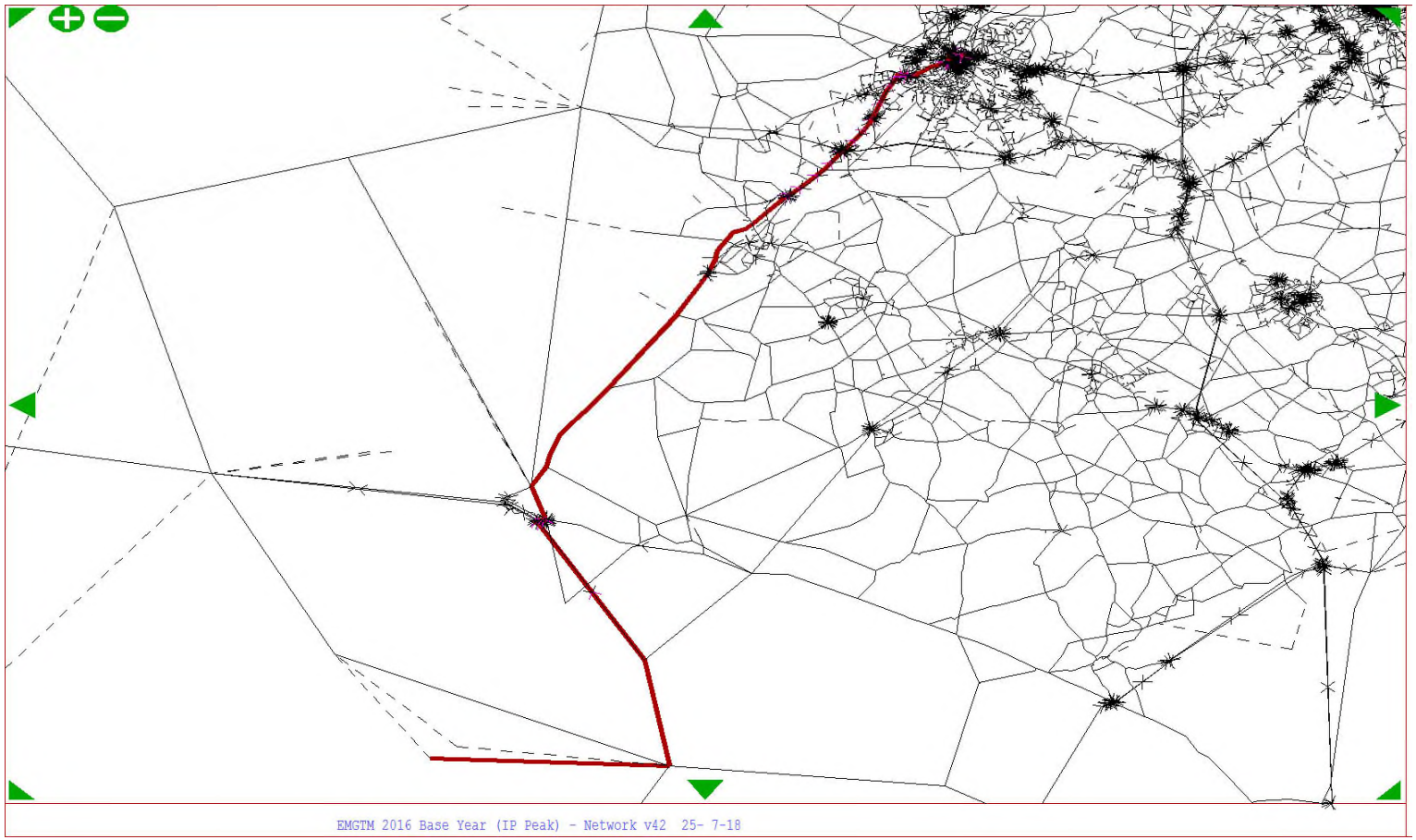
AM Tree

Base Year



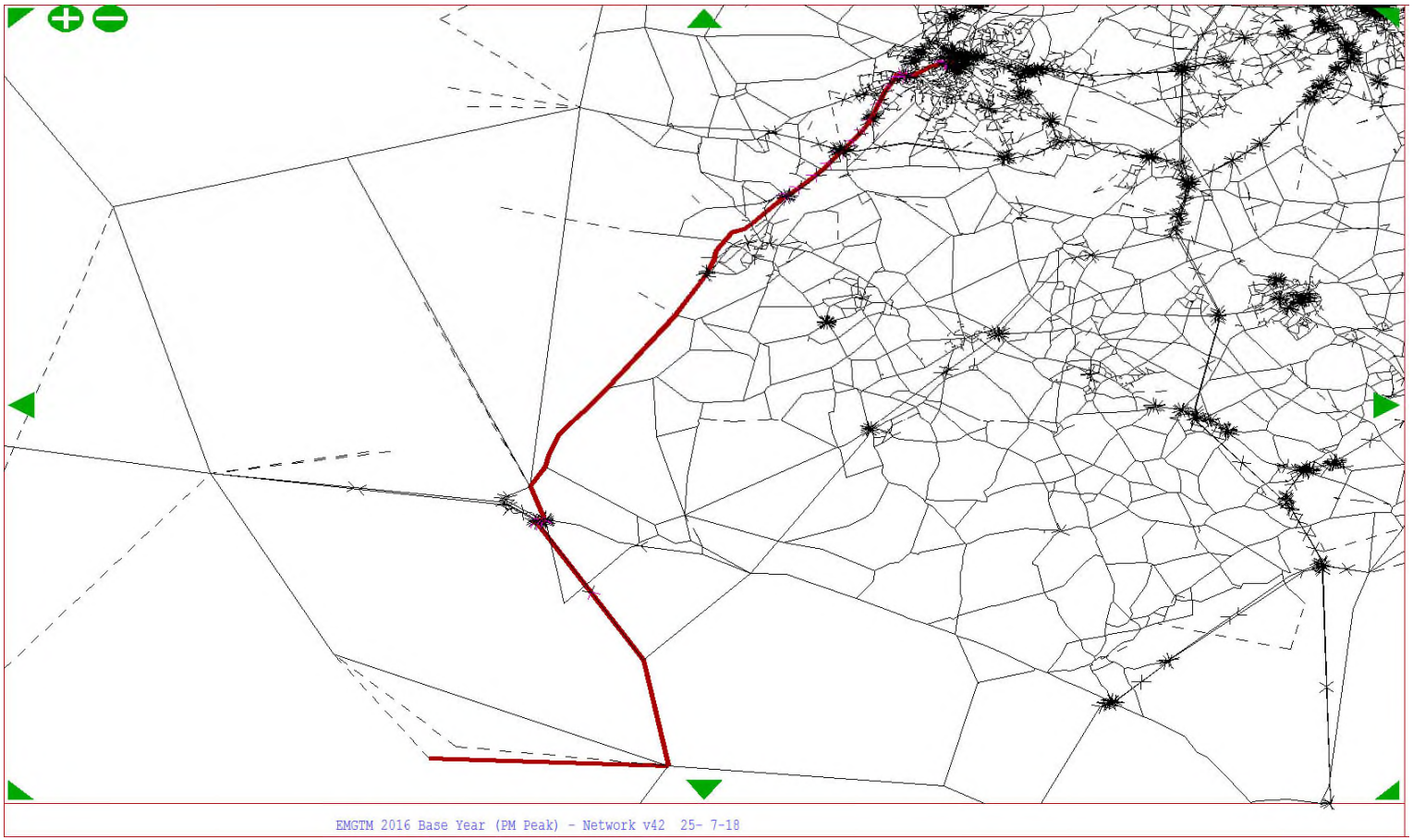
IP Tree

Base Year



PM Tree

Base Year



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Appendix C

TECHNICAL NOTE

EAST MIDLANDS GATEWAY MODEL

DATA SPECIFICATION

IDENTIFICATION TABLE	
Client/Project owner	Nottingham City Council
Project	East Midlands Gateway Model
Title of Document	Data Specification
Type of Document	Technical Note
Date	12/10/2018
Reference number	106770
Number of pages	33

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1. INTRODUCTION

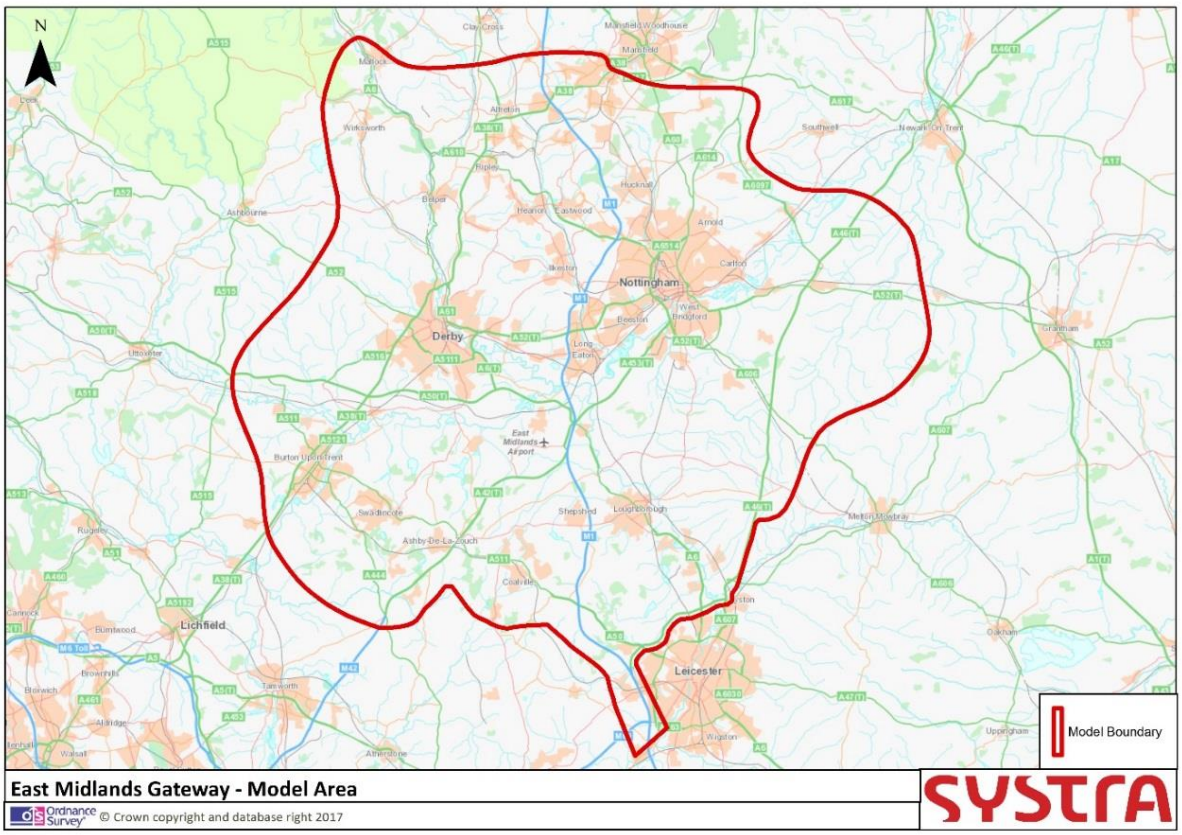
1.1 Purpose of Note

1.1.1 This note details the data that is required to proceed with the calibration and validation of the highway and public transport models for the East Midlands Gateway commission. The proposed simulation area of the East Midlands Gateway model is shown in Figure 1. This model is to be developed to primarily access strategic multi-modal access options to the proposed HS2 station at Toton, however, the local councils also wish to utilise the model for other purposes throughout this area and therefore it has to be validated for the majority of the main highway and public transport routes within this area.

1.1.2 This note reviews the existing data that is currently available and identifies locations where further surveys will be commissioned by SYSTRA to provide a comprehensive data set for the calibration and validation of this model.

1.1.3 This note excludes the data required for the creation of the base prior matrices which will be the subject of a separate note.

Figure 1. Study Area of the Model



2. PUBLIC TRANSPORT DATA

2.1 Network Data

2.1.1 In order to create a network covering the Derby, Nottingham and Leicester areas existing coding from the three separate models will be used. Network coding from the three current models will be reviewed and a common method of coding applied to all.

2.1.2 All other data included in the model will need to be updated to represent a 2016 model year.

2.1.3 Current bus routes and timetables need to be obtained from each local authority. Only services that operate at a frequency of one hour or greater will be included however attention should be paid to services which operate between each of the centres regardless of frequency.

2.1.4 Distance based fares tables will be created for each operator which will require data being provided by each operator.

2.1.5 Public transport ticketing data will need to be obtained from each of the relevant operators.

2.1.6 A review of Park and Ride sites will need to be undertaken. For this P&R usage data will be required.

2.1.7 Rail services will require review and update using 2016 LENNON data.

2.2 Required Data

2.2.1 The calibration and validation of the model will require extensive counts being collected. The majority of the data in the current models is pre 2008 and would not be acceptable.

2.2.2 The following information is required:

- **Public transport surveys** are required for the areas around the cities of Derby, Nottingham and Leicester, Nottinghamshire and Derbyshire.
- **Journey times** for key routes for each of the main urban centres.

2.2.3 2016 data is available for a number of bus and NET counts for an outer cordon of Nottingham. Further counts would be required to create an inner cordon.

2.2.4 There is no current public transport information available for the remainder of the area and therefore public transport surveys would be need to carried out for both Derby and Leicester inner and outer cordons.

2.2.5 Journey time routes and data are required for key routes for each of the main urban centres.

2.3 Public Transport Survey Specification

2.3.1 Passenger counts will be required for locations across Derby, Derbyshire, Nottinghamshire Leicester, Loughborough and Coalville. The maps below show the location of the counts that are required and the accompanying tables give further detail. The closest pair of stops to the location shown should be surveyed. Stops in both directions should be surveyed separately.

2.3.2 Passenger surveys will be required during:

- morning peak (7am – 10am)
- inter-peak (11am – 2pm)
- evening peak (3pm – 6pm)

2.3.3 Surveys will need to record the following:

- number of people boarding and alighting each service;
- the number of passengers on board each service at the locations specified;
- the service number and direction.
- the operator;
- the time of the service.

2.4 Public Transport Surveys – Derby/Derbyshire

2.4.1 Figures 2 and 3 show the locations where passenger counts are required for Derby. Table 1 details the corresponding locations.

2.4.2 Upon request of Derby City Council and Derbyshire County Council, all of these counts will be undertaken by a survey company during November.

Figure 2. Derby Inner Count Locations

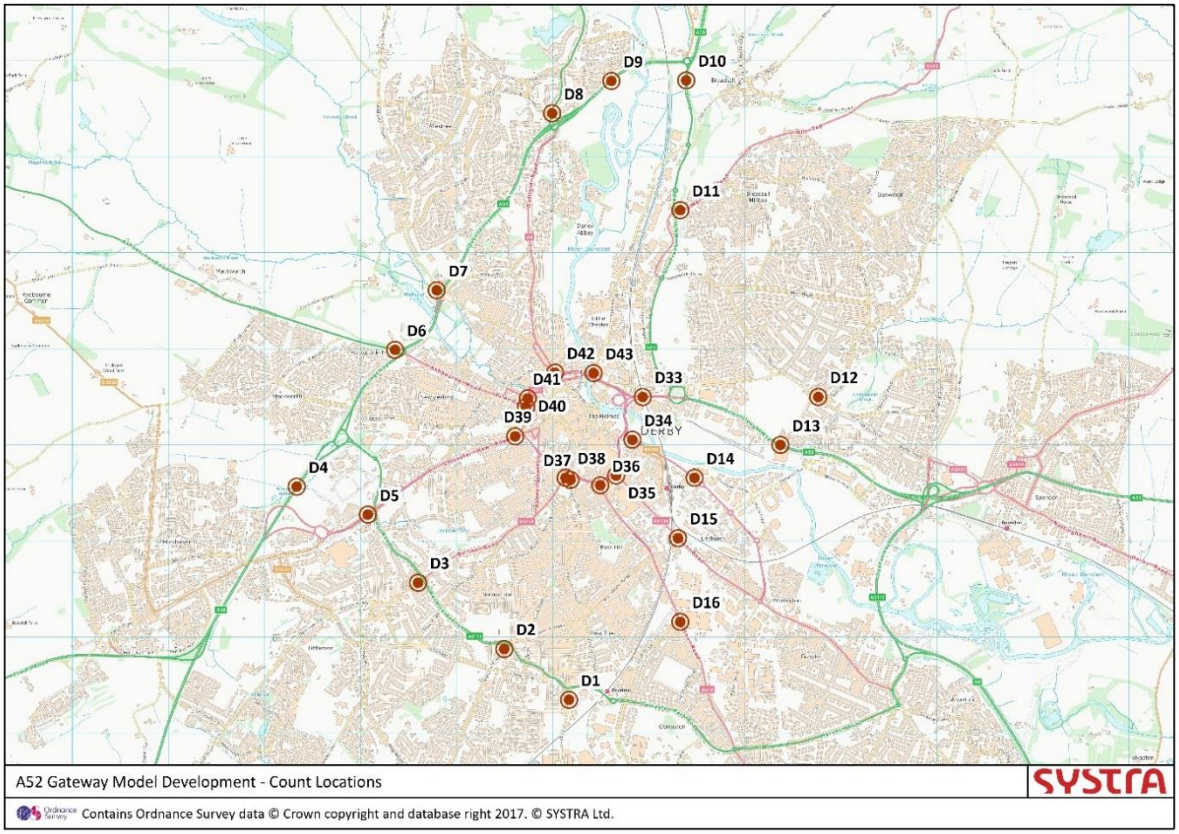


Figure 3. Derby Outer Count Locations

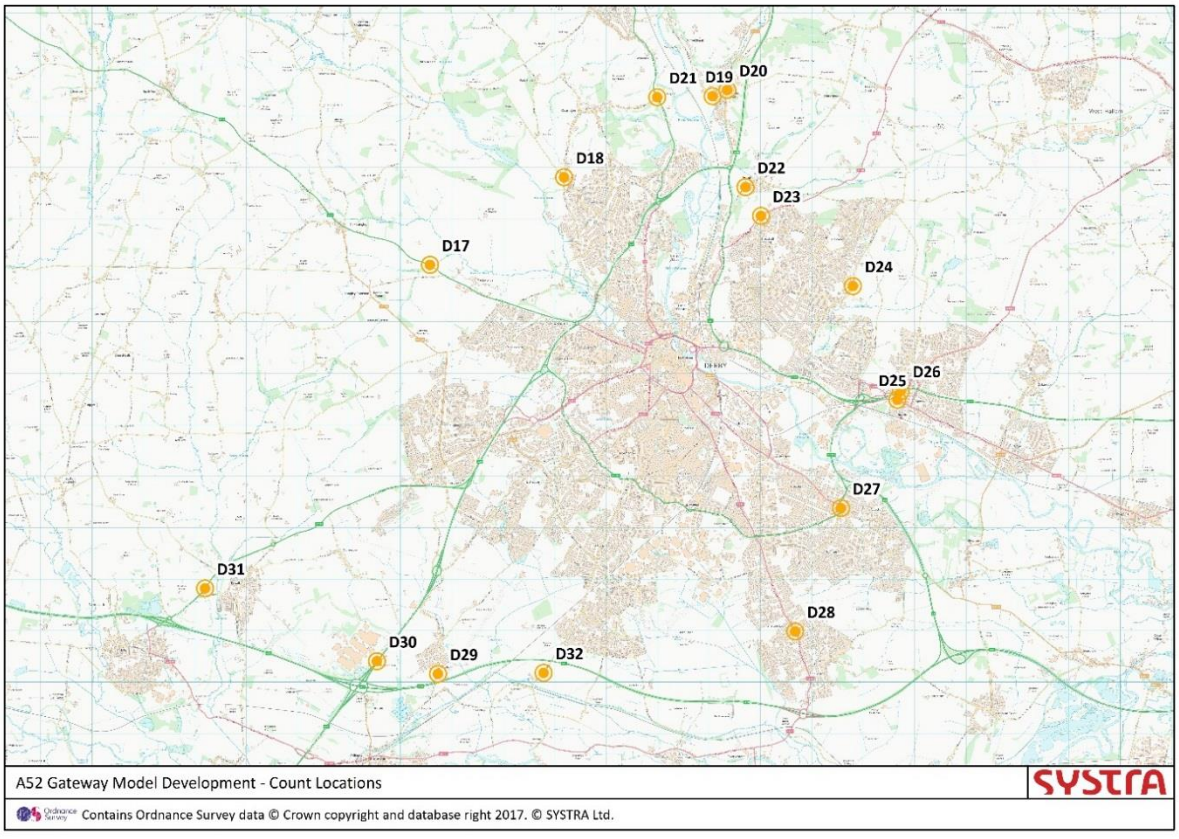


Table 1. Location of Derby Passenger Counts

COUNT NUMBER	TYPE	COUNT LOCATION
D1	Inner	Sinfin Lane
D2	Inner	Stenson Road
D3	Inner	Burton Road
D4	Inner	Mickleover Bypass
D5	Inner	Uttoxeter Road
D6	Inner	Ashbourne Road
D7	Inner	Kedleston Road
D8	Inner	Duffield Road
D9	Inner	Abbey Hill
D10	Inner	Alfreton Road (above Whittle Road Jct)
D11	Inner	Mansfield Road
D12	Inner	Nottingham Road
D13	Inner	Brian Clough Way
D14	Inner	Pride Parkway
D15	Inner	London Road
D16	Inner	Osmaston Road
D17	Outer	Ashbourne Road
D18	Outer	Kedleston Road/Burley Lane (Church Road)
D19	Outer	Duffield Road/Queensway
D20	Outer	Alfreton Road
D21	Outer	Derby Road/ Burley Lane
D22	Outer	Croft Lane
D23	Outer	Mansfield Road/Hill Top
D24	Outer	Morley Road

COUNT NUMBER	TYPE	COUNT LOCATION
D25	Outer	Nottingham Road/Derby Road
D26	Outer	A52
D27	Outer	Shardlow Road/A6
D28	Outer	Derby Road/Bypass
D29	Outer	Heath Lane/Willington Road
D30	Outer	Burton Road/Bypass
D31	Outer	A516 Etwall Road
D33	Inner	Eastgate
D34	Inner	A6 – Pride Parkway
D35	Inner	London Road
D36	Inner	Osmaston Road
D37	Inner	Normanton Road
D38	Inner	Burton Road
D39	Inner	Uttoxter New Road
D40	Inner	Friar Gate
D41	Inner	Agard St
D42	Inner	King Street
D43	Inner	Mansfield Road

2.5 Public Transport Surveys – Nottinghamshire

2.5.1 Figures 4 show the locations where passenger counts are required for Nottinghamshire and around the M1. Table 2 details the corresponding locations.

2.5.2 Upon request of Nottinghamshire County Council, all of these counts will be undertaken by an external survey company during November.

Figure 4. Nottinghamshire Count Locations

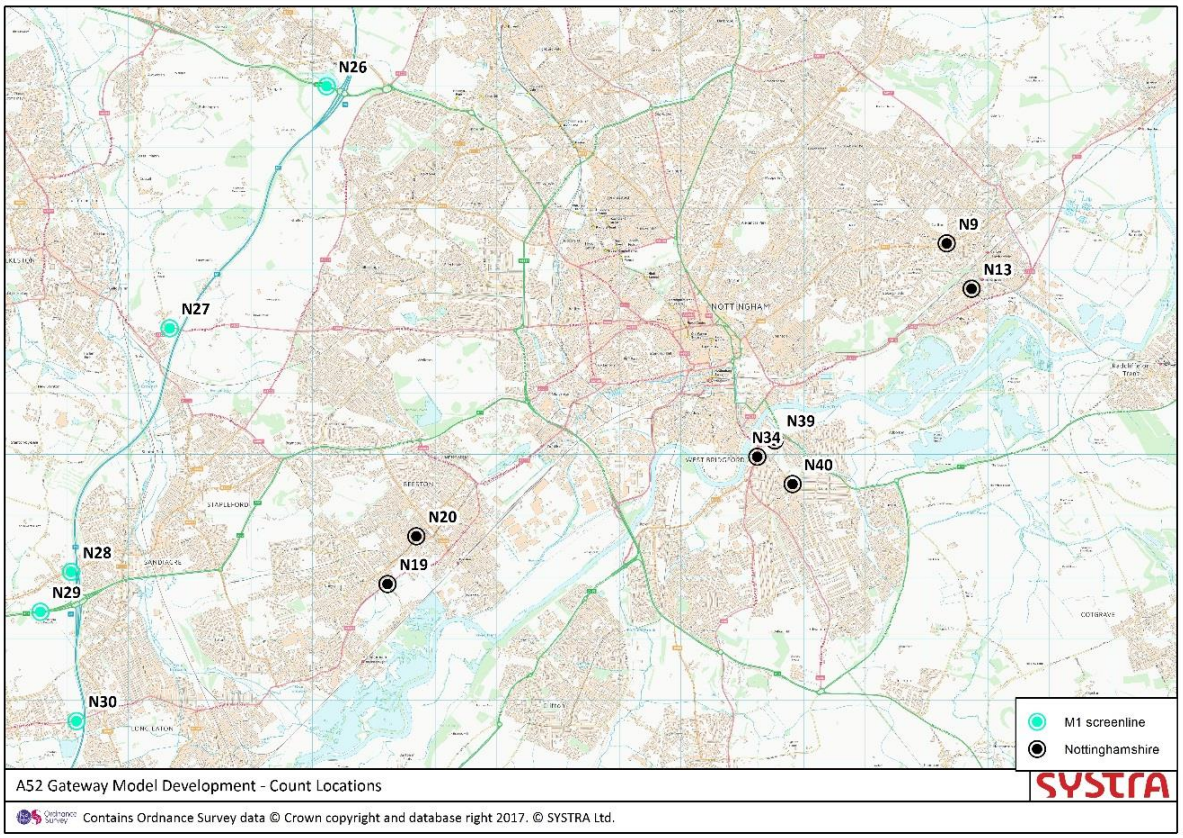


Table 2. Location of Nottingham Passenger Counts

COUNT NUMBER	TYPE	COUNT LOCATION
N9	Outer	B686 Carlton Road, west of junction with Cavendish Road
N13	Outer	Vale Road, Netherfield , south west of junction with Chaworth Road
N19	Outer	A6005 Queens Road West, east of junction with Meadow Lane
N20	Outer	Beeston Public Transport interchange.
N26	M1	B600 West of Nuthall Roundabout
N27	M1	A609 Nottingham Road Trowell (w of M1 outside Festival Inn)
N28	M1	Derby Road (W. of M1)

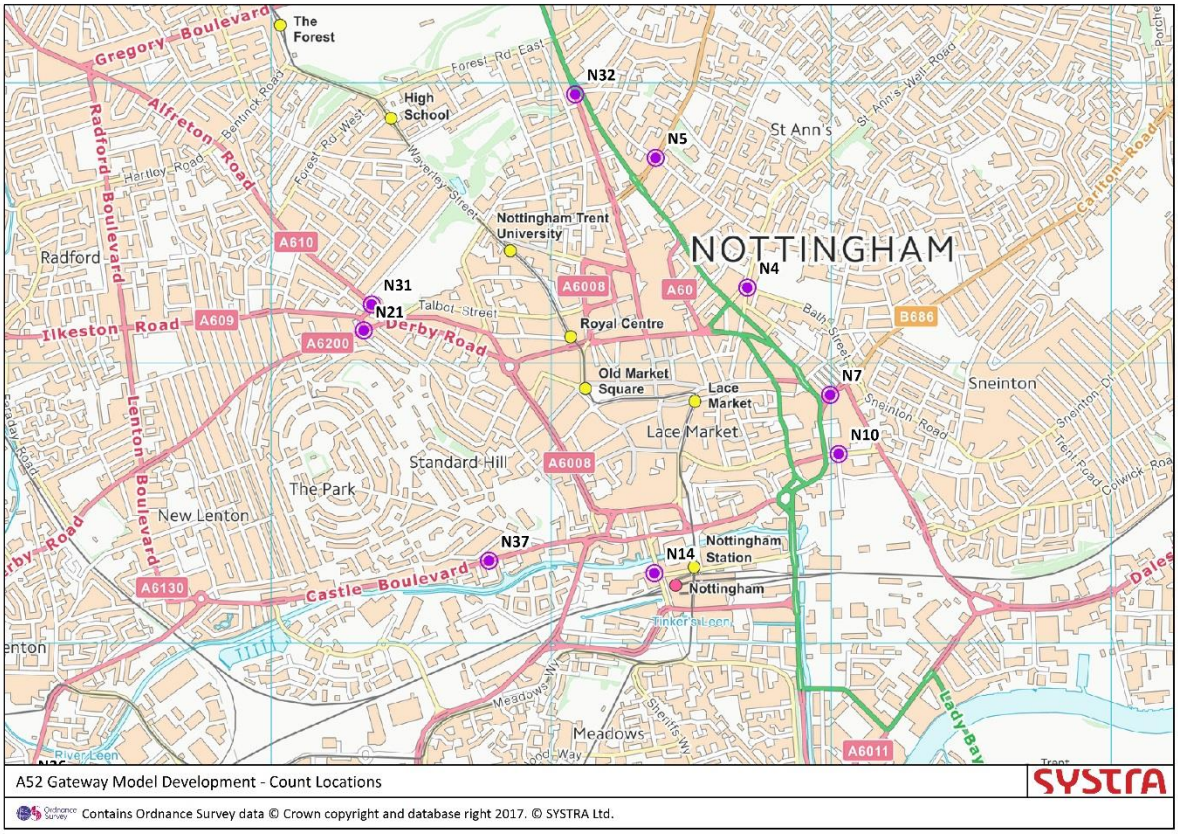
COUNT NUMBER	TYPE	COUNT LOCATION
N29	M1	A52 (W. of M1)
N30	M1	A6005 (W. of M1)
N34	Outer	A60 Loughborough Road south of Bridgford Road.
N39	Outer	A6520 Radcliffe Road east of A60.
N40	Outer	Central Avenue West Bridgford i.e. the restricted access link (bus +selected others) through the middle of the town centre.

2.6 Public Transport Surveys – Nottingham

2.6.1 Figures 5 and 6 show the locations where passenger counts should be undertaken for both the Nottingham inner and outer cordons. Table 3 details the corresponding locations.

2.6.2 Nottingham City Council are to collect all public transport survey data within Nottingham City during November.

Figure 5. Nottingham Inner Cordon Count Locations

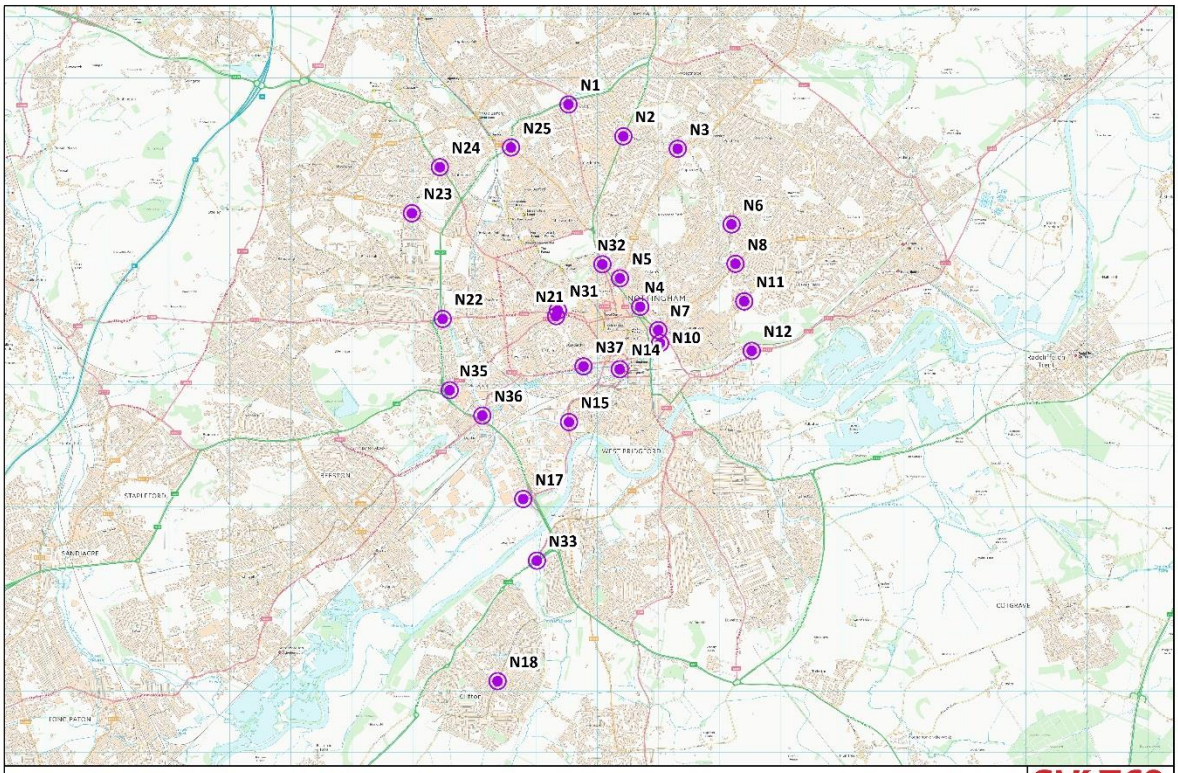


A52 Gateway Model Development - Count Locations

SYSTRA

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Figure 6. Nottingham Outer Cordon Count Locations



A52 Gateway Model Development - Count Locations

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Table 3. Nottingham City Bus Count Locations

COUNT	TYPE	COUNT LOCATION	DATA AVAILABLE
N1	Outer	Hucknall Road (S. of Valley Road)	Partial
N2	Outer	Mansfield Road (S. of Winchester St)	Partial
N3	Outer	Woodborough Road (S. of Winchester St)	No
N4	Inner	St Ann's Well Road (Bath St)	No
N5	Inner	Woodborough Road (Shelton St)	No
N6	Outer	Thorneywood Mount	No
N7	Inner	Southwell Road (Nelson St)	No
N8	Outer	Carlton Road (Swains Ave)	No
N10	Inner	Pennyfoot Street	No
N11	Outer	Sneiton Dale (Greenwood Ave)	No
N12	Outer	Colwick Road (Bendigo Lane)	No
N14	Inner	Carrington Street	Yes
N15	Outer	Queens Drive (Crossgate Drive)	Partial
N17	Outer	Thane Road	Yes
N18	Outer	Southchurch Lane (Green Lane)	No
N21	Inner	Derby Road (St Helen's Road)	Yes
N22	Outer	Ilkeston Road (E. of Western Boulevard)	No
N23	Outer	Aspley Lane (S. of Melbourne Road)	Partial
N24	Outer	Nuthall Road (S. of Melbourne Road)	Partial
N25	Outer	Nottingham Road (S. of Valley Road)	Partial
N31	Outer	Alfreton Road (Canning Circus)	Yes
N32	Outer	Mansfield Rd (S. of Huntingdon St)	Yes
N33	Outer	Clifton Lane	Yes
N35	Outer	Derby Road (QMC)	Yes
N36	Outer	Abbey Bridge	No
N37	Inner	Castle Boulevard	No

2.7 Public Transport Surveys - Leicester, Loughborough and Coalville

2.7.1 Figures 7, 8 and 9 show the locations where passenger counts should be undertaken for Leicester, Loughborough and Coalville cordons. Table 4 details the corresponding locations.

2.7.2 All counts within Leicestershire will be undertaken by an external survey company during November.

Figure 7. Leicester Cordon Count Locations

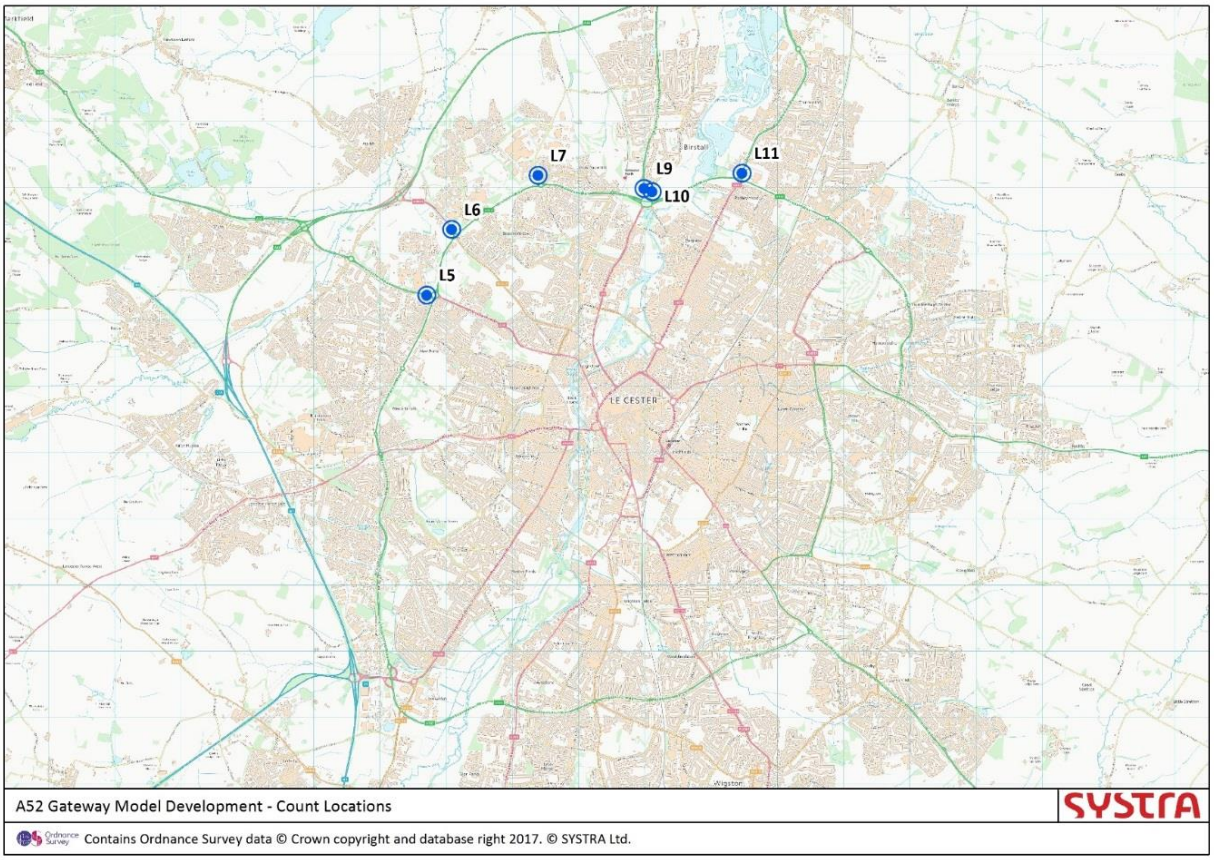


Figure 8. Loughborough Cordon Count Locations

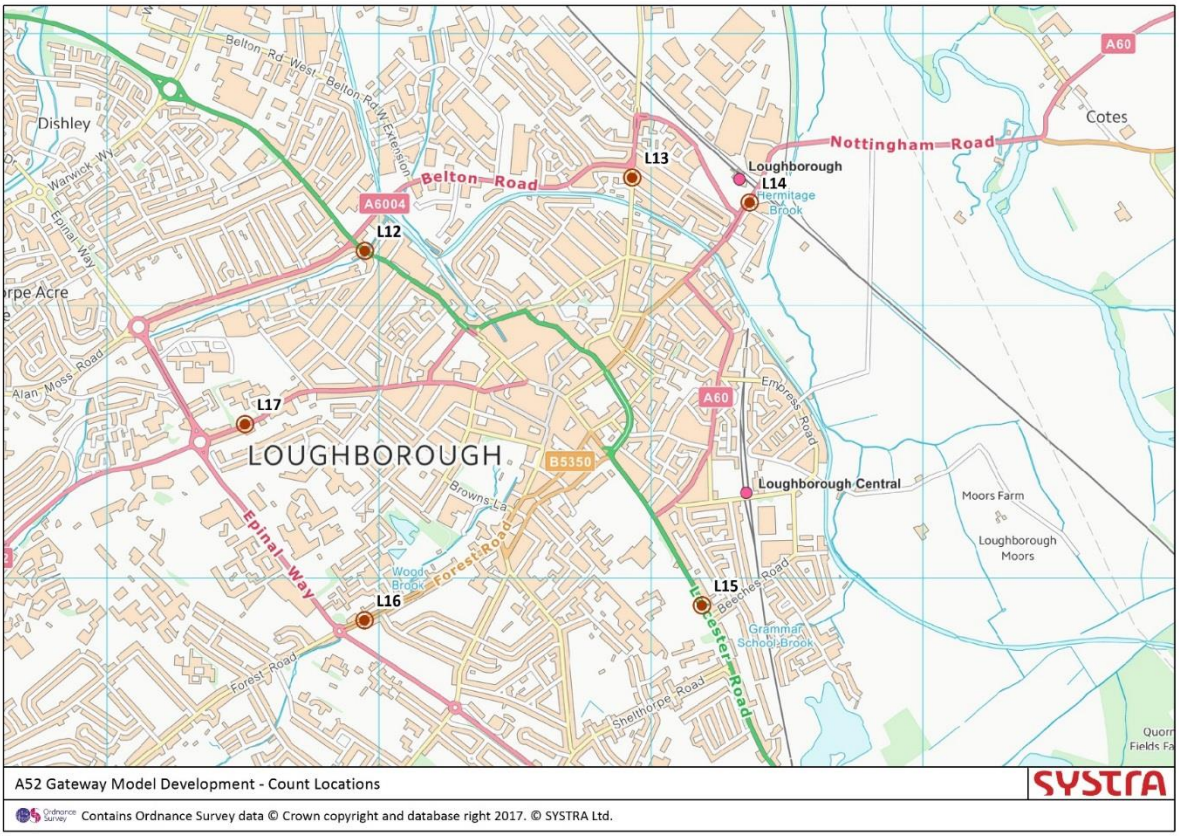


Figure 9. Coalville Cordon Count Locations

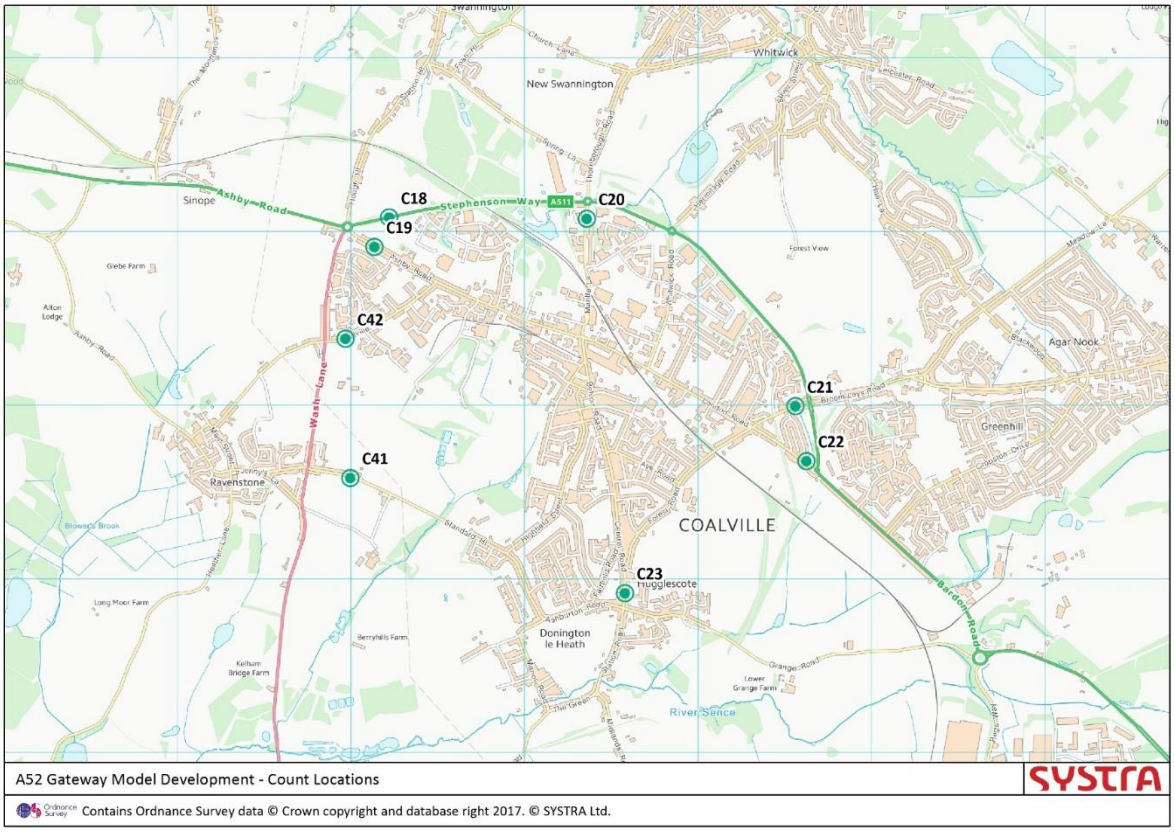


Table 4. Location of Leicester, Loughborough and Coalville Passenger Counts

COUNT NUMBER	COUNT TYPE	COUNT LOCATION
L5	Leicester	Groby Road
L6	Leicester	Anstey Lane
L7	Leicester	Beaumont Leys Lane
L9	Leicester	Loughborough Road
L10	Leicester	Birstall Road
L11	Leicester	Melton Road
L12	Loughborough	Derby Road
L13	Loughborough	Meadow Lane
L14	Loughborough	Nottingham Road
L15	Loughborough	A6
L16	Loughborough	Forest Road
L17	Loughborough	Ashby Road
C18	Coalville	A511
C19	Coalville	Ashby Road
C20	Coalville	Thornborough Road
C21	Coalville	Broom Leys Lane
C22	Coalville	Bardon Road
C23	Coalville	Central Road (S. of Forest Road)
C41	Coalville	Standard Hill
C42	Coalville	Coalville Lane

2.8 Public Transport Journey Time Routes

2.8.1 Bus services have been selected to provide journey time data for both Nottingham and Derby to give a comprehensive picture of journey times for travel on public transport into each commercial centre. Upon request of the local authorities, a survey company will be commissioned to collect journey time information in November.

2.8.2 Each service will need to be surveyed for the full length of the journey (unless stated otherwise in the table below) in both directions. Every bus within the times specified would need to be surveyed.

2.8.3 Details of every bus stop and major junction likely to incur a delay will need to be recorded as part of the survey. It is up to the surveying company to specify the precise timing points and submit these to SYSTRA for verification.

2.8.4 Derby bus route maps and timetables can be found at http://www.derbysbus.info/times/

2.8.5 Nottingham bus route maps and timetables can be found at the following address https://www.nctx.co.uk/timetables-tickets-maps/buses-lines/

2.8.6 Table 5 details the services required for Derby and Table 6 for Nottingham.

Table 5. Required Derby Journey Time Services

SERVICE NUMBER	OPERATOR	FROM - TO
SWI	Trent Barton	Derby - Uttoxeter
114	YourBus	Derby - Ashbourne
TP	High Peak	Derby – Manchester (Belper)
AMB	Trent Barton	Derby - Hucknall
H1	Trent Barton	Derby - Alfreton
BC	Trent Barton	Derby - Mansfield
V3	Trent Barton	Derby - Burton
X38	Trent Barton/Arriva Midlands	Derby - Burton
Y5	YourBus	Derby - Nottingham
Pride P&R	Arriva	Derby – P&R site
Meteor P&R – D1	Notts & Derby	Derby – P&R site
Y3	YourBus	Derby -Cotmanhey
SKY	Kinchbus	Derby - Leicester

SERVICE NUMBER	OPERATOR	FROM - TO
2	Arriva Midlands	Derby - Swadlincote
38	Arriva Derby	Derby - Sinfin
7	Trent Barton	Derby - Belper
V1	Trent Barton	Derby - Burton

Table 6. Required Nottingham Journey Time Services

SERVICE	OPERATOR	FROM - TO
17 – Brown Line	Nottingham City Transport	Nottingham - Bulwell
89 - Purple Line	Nottingham City Transport	Nottingham – Rise Park
58 - Lime Line	Nottingham City Transport	Nottingham - Killisick
45 - SkyBlue Line	Nottingham City Transport	Nottingham - Gedling
41 - Blue Line	Nottingham City Transport	Nottingham – St Ann's
39 - Blue Line	Nottingham City Transport	Nottingham – Carlton Valley
25 - Lilac Line	Nottingham City Transport	Nottingham - Arnold
44 - Red Line	Nottingham City Transport	Nottingham - Gedling
77 - Turquoise Line	Nottingham City Transport	Nottingham - Strelley
43 - Red Line	Nottingham City Transport	Nottingham - Bakersfield
7 - Green Line	Nottingham City Transport	Nottingham - Gamston
9 - Green Line	Nottingham City Transport	Nottingham – Wilford Hill
1 - Navy Line	Nottingham City Transport	Nottingham - Loughborough
48 - Navy Line	Nottingham City Transport	Nottingham - Clifton
35 - Orange Line	Nottingham City Transport	Nottingham - Bulwell
36 - Orange Line	Nottingham City Transport	Nottingham - Chilwell
28 - Pink Line	Nottingham City Transport	Nottingham - Bilborough

SERVICE	OPERATOR	FROM - TO
68 - Yellow Line	Nottingham City Transport	Nottingham – Snape Wood
53 – Grey Line	Nottingham City Transport	Arnold - Clifton
100 - Pathfinder	Nottingham City Transport	Nottingham - Southwell

3. HIGHWAY NETWORK

3.1.1 In order for the network to be calibrated and validated to a WebTAG standard there are number of data sources that need to collected.

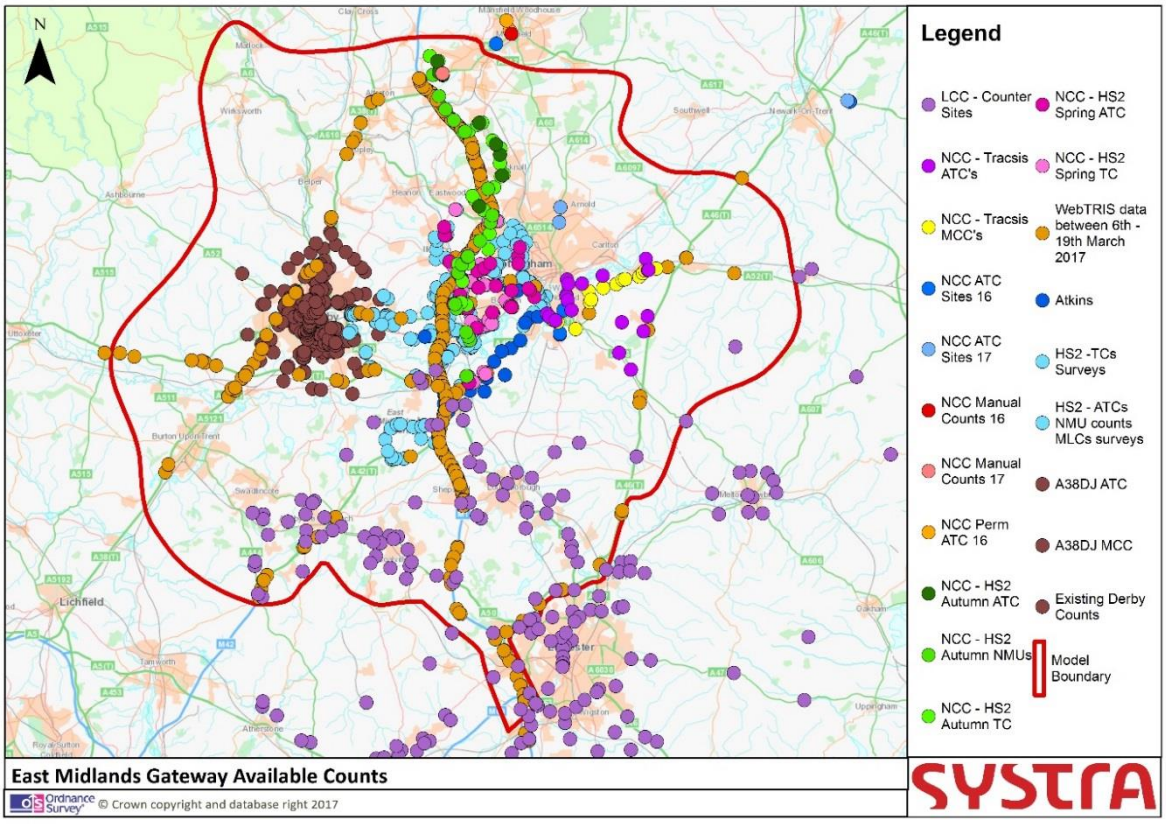
3.2 Existing Highway Count Data

3.2.1 There is a large quantity of highway count data which is available for use that covers the period from 2016 onwards. Figure 10 shows the available highway count data along with the various sources of this data. This plot shows data which is readily available from:

- 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)

3.2.2 Data is also potentially available from the post A453 widening appraisal undertaken by our partners Atkins (shown in dark blue), however, further approval for this data to be used is required. AECOM Capita Ineco JV are also undertaking further surveys on behalf of HS2 over the next few weeks (shown in light blue), however the results of these may not be available until early in 2018.

Figure 10. Available Counts



3.2.3 Since the original circulation of Figure 10 in our Technical Note dated 12/10/17, additional count data has been made available to SYSTRA from Derby and Nottingham City Councils and Nottinghamshire County Council. This additional data is not shown in Figure 7, but has been reviewed prior to counts being commissioned.

3.2.4 The counts available from HS2 only cover AM and PM peaks. However, we understand that inter-peak data is available at these sites and can be obtained from the survey company. We will therefore identify a set of critical counts required for the IP calibration and validation and will request that this information is extracted by the survey company for use in the Gateway model development.

3.3 Required Count Data

3.3.1 Although the existing data covers a significant part of the core simulation area of the proposed model, in particular the SRN, there are a number of locations where data is not currently available.

3.3.2 The calibration and validation of the East Midlands Gateway model will require the following information:

- ATCs across Derby, Derbyshire, Burton-on-Trent, Nottinghamshire, Nottingham City and Leicestershire.
- MCCs at two major junctions near Derby

3.3.3 Traffic count data required within Derby, Derbyshire, Nottinghamshire, Leicestershire and Burton-on-Trent will be collected during November by a survey company. Any required count data within Nottingham City will be provided by Nottingham City Council.

3.4 Highway Count Specification

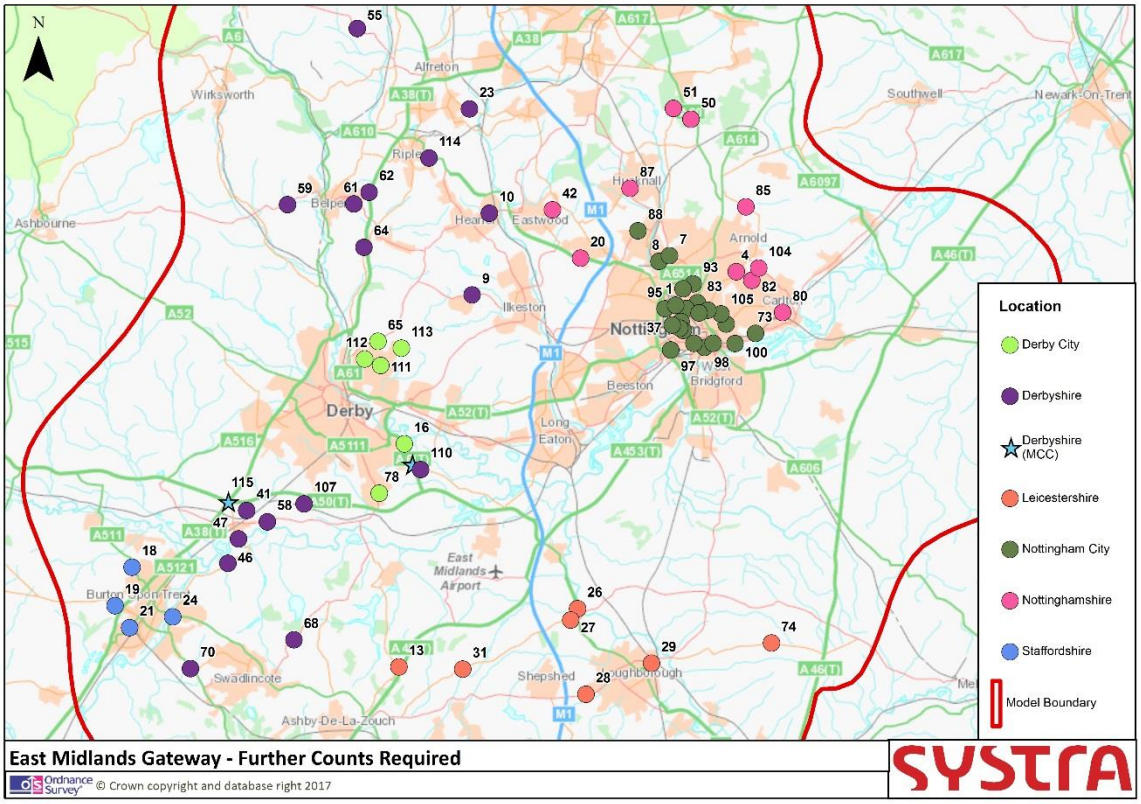
3.4.1 SYSTRA have chosen a number of specific locations which are required to validate the model. These are plotted below in Figure 11.

3.4.2 Directional link count data will be required during:

- morning peak (7am – 10am)
- inter-peak (11am – 2pm)
- evening peak (3pm – 6pm)

3.4.3 Count data should include individual vehicle classes (Car, LGV and HGV).

Figure 11. All Highways Count Locations



3.4.4 Sections 3.5 to 3.7 provide further plots to show the location of individual counts more clearly and accompanying tables to give further detail.

3.5 Required Count Data – Derby City, Derbyshire and Staffordshire

3.5.1 Figures 12, 13 and 14 show the locations where counts should be undertaken In Derby, Derbyshire and Staffordshire. Table 7, 8 and 9 detail the corresponding locations.

3.5.2 All traffic counts within Derby, Derbyshire and Staffordshire will be undertaken by a survey company during November.

Figure 12. Counts required to the north of Derby

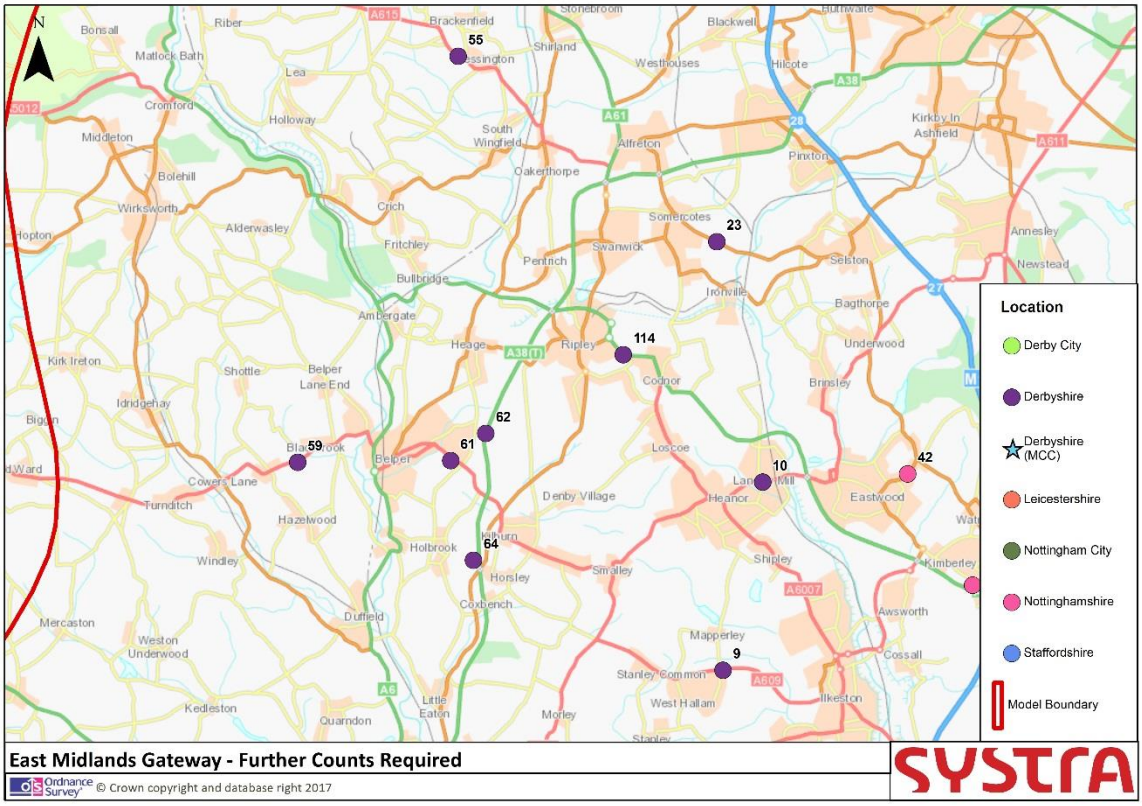


Table 7. Counts required to the north of Derby

LOCATION ID	ROAD DESCRIPTION	TYPE
9	A609 High Lane East	ATC
10	A608 Mansfield Road	ATC
23	B600 Lower Somercotes	ATC
55	A615 Matlock Road	ATC
59	A517 Ashbourne Road	ATC
61	A609 Belper Road	ATC
62	A38	ATC
64	A38	ATC
114	A610 Nottingham Road, Codnor Gate	ATC

Figure 13. Counts required in Derby City

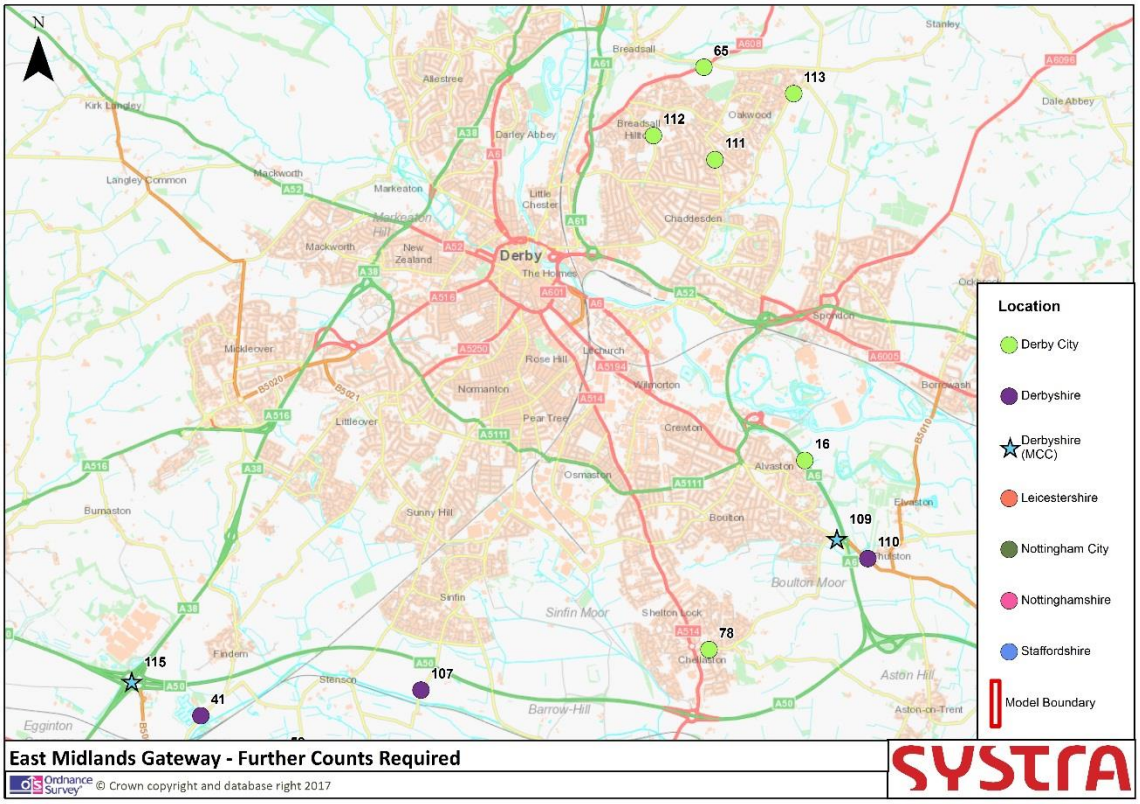


Table 8. Counts required in Derby City

LOCATION ID	ROAD DESCRIPTION	TYPE
16	A6 Alvaston Bypass	ATC
41	Willington Road	ATC
65	A608 Hill Top	ATC
78	High Street	ATC
107	Arleston Lane	ATC
109	Thulston Roundabout	MCC
110	Shardlow Road, East of Thurlston Road	ATC
111	Wood Road, North of Copes Way	ATC
112	St Andrews View	ATC
113	Morley Road, South West of Locko Road	ATC
115	A38/A50 Toyota Roundabout	MCC

Figure 14. Counts required to the south of Derby, including Staffordshire

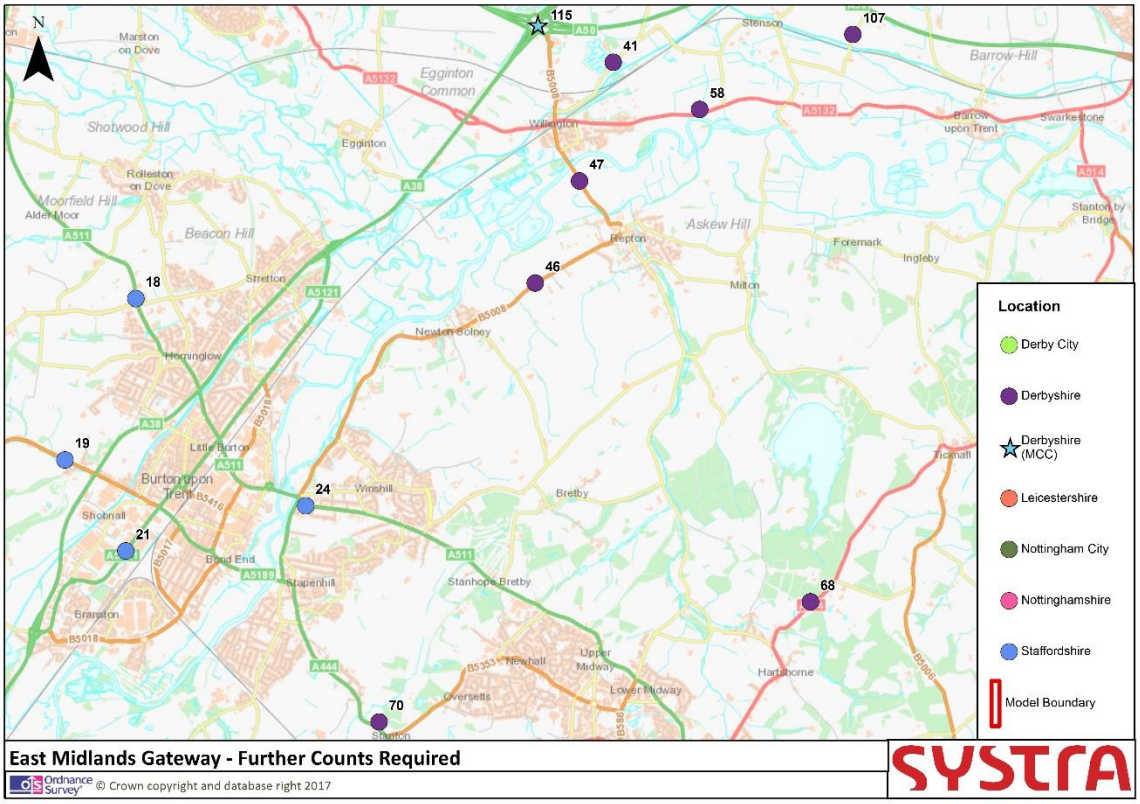


Table 9. Counts required to the south of Derby, including Staffordshire

LOCATION ID	ROAD DESCRIPTION	TYPE
18	A511 Tutbury Road	ATC
19	B5017 Forest Road	ATC
21	A5121 Wellington Road	ATC
24	A511 Ashby Road	ATC
46	Repton Road	ATC
47	Repton Road	ATC
58	A5132 Twyford Road	ATC
68	A514 Ticknall Road	ATC
70	A444 Woodland Road	ATC

3.6 Required Count Data – Nottinghamshire

3.6.1 Figure 15 shows the locations where passenger counts are required for Nottinghamshire. Table 10 details the corresponding locations.

3.6.2 Upon request from Nottinghamshire County Council, all traffic counts within Nottinghamshire will be undertaken by a survey company during November.

Figure 15. Counts Required in Nottinghamshire

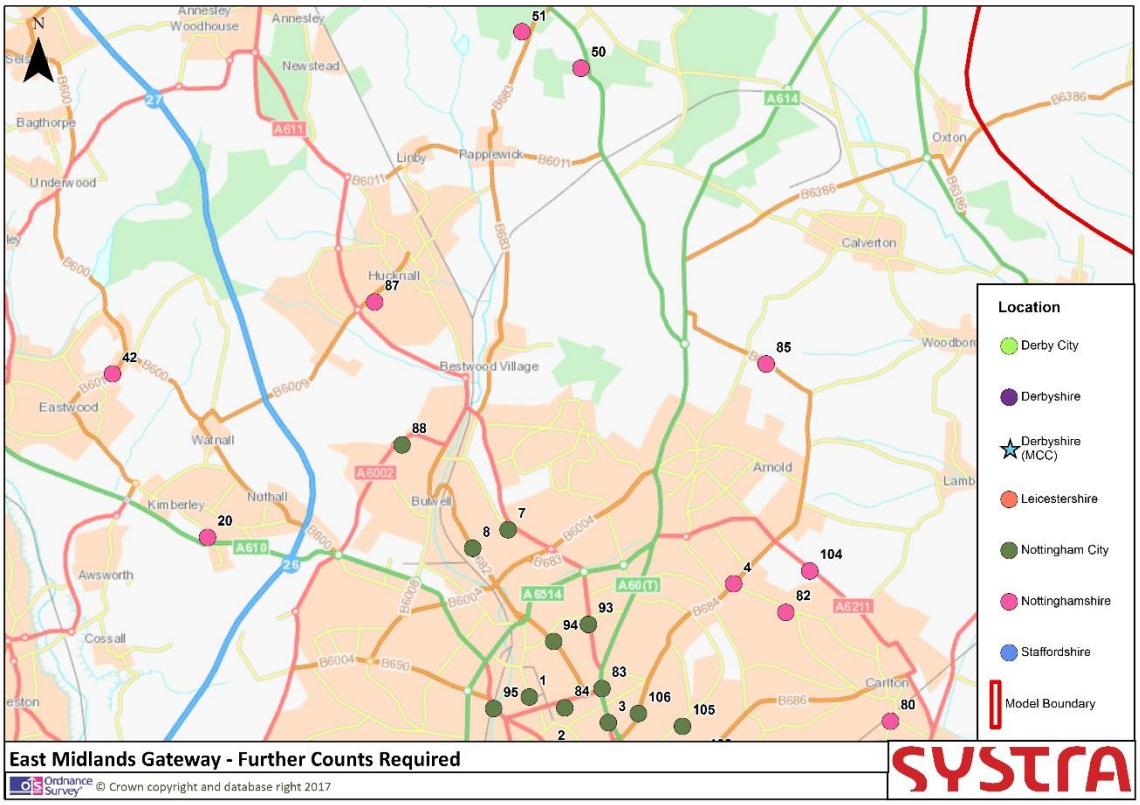


Table 10. Counts Required in Nottinghamshire

LOCATION ID	ROAD DESCRIPTION	TYPE
4	B684 Woodborough Road	ATC
20	A610	ATC
42	B6010 Moorgreen	ATC
50	A60 Mansfield Road	ATC
51	B683 Blidworth Waye	ATC
80	Victoria Road	ATC
82	Westdale Lane West	ATC
85	Woodborough Lane	ATC

LOCATION ID	ROAD DESCRIPTION	TYPE
87	B6009 Watnall Road	ATC
104	Arnold Lane, North of Linsdale Gardens	ATC

3.7 Required Count Data – Nottingham City

3.7.1 Figure 16 shows the locations where passenger counts are required for Nottinghamshire. Table 11 details the corresponding locations.

3.7.2 All traffic counts in Nottingham City will be undertaken by Nottingham City Council during November and provided to SYSTRA for use in the model development.

Figure 16. Counts Required in Nottingham City

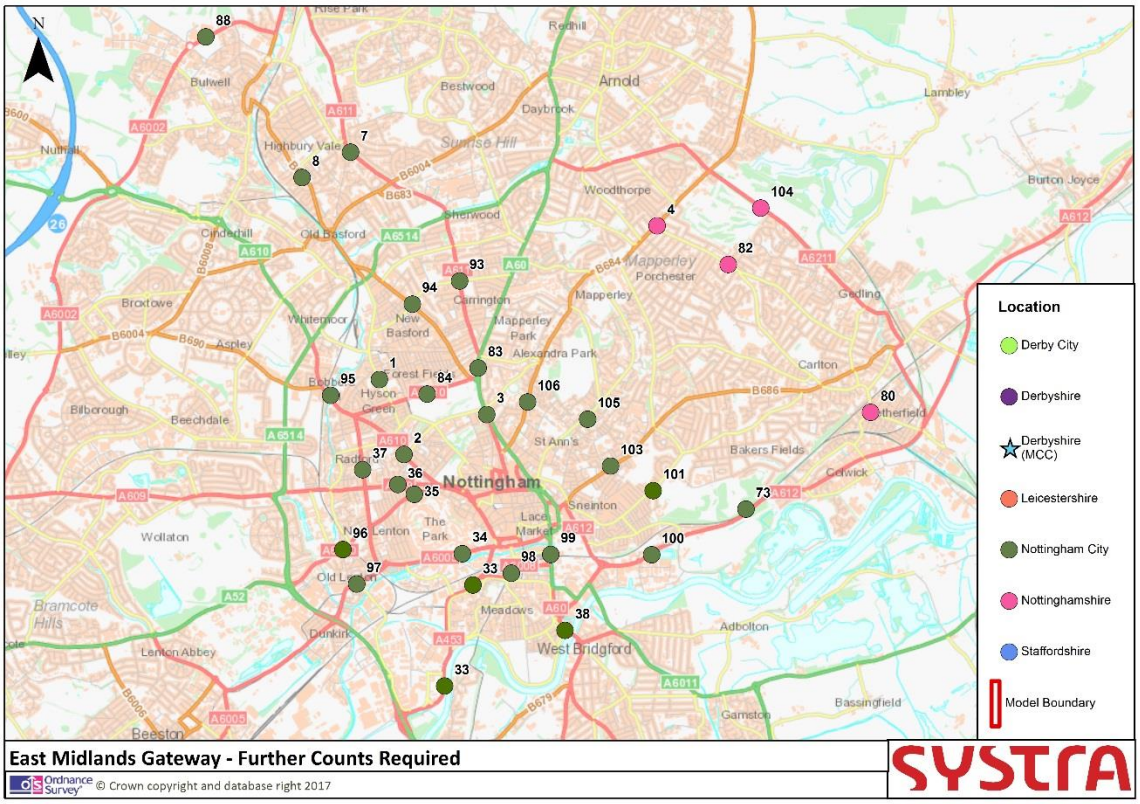


Table 11. Counts Required in Nottingham City

LOCATION ID	ROAD DESCRIPTION	TYPE
1	Radford Road	ATC
2	A610 Alfreton Road S of Bentinck Road	ATC
3	A60 Mansfield Road N of Haydn Road	ATC
7	A611 Hucknall Road N of Kersall Drive	ATC
8	B682 Highbury Road	ATC

LOCATION ID	ROAD DESCRIPTION	TYPE
33	A453 Queens Drive S of Tottle Road	ATC
34	A6005 Castle Boulevard E of Castle Bridge Road	ATC
35	A6200 Derby Road NE of Lenton Boulevard	ATC
36	A609 Ilkeston Road E of Lenton Boulevard	ATC
37	A6130 Radford Boulevard N of Hartley Road	ATC
38	A60 London Road (Trent Bridge)	ATC
73	A612 Daleside Road East W of Vale Road	ATC
83	A60 Mansfield Road S of Magdala Road	ATC
84	A6130 Gregory Boulevard E of Noel Street	ATC
88	A6002 Camberley Road W of Ravensworth Road	ATC
93	A611 Hucknall Road S of Haydn Road	ATC
94	B682 Nottingham Road S of Haydn Road	ATC
95	A610 Bobbers Mill Bridge SE of Aspley Lane	ATC
96	A6200 Derby Road E of Ring Road	ATC
97	A6005 Abbey Bridge E of Gregory Street	ATC
98	A6008 Queens Road E of Carrington Street	ATC
99	A60 London Road N of Station Street	ATC
100	A612 Daleside Road W of Racecourse Road	ATC
101	Sneinton Dale W of Highcliffe Road	ATC
103	B686 Carlton Road E of St Mathias Rd	ATC
105	St Anns Well Road N of Southampton Street	ATC
106	B684 Woodborough Road N of Cranmer Street	ATC

3.8 Required Count Data – Leicestershire

3.8.1 Figure 17 shows the locations where traffic counts are required for Leicestershire. Table 12 details the corresponding locations.

3.8.2 All traffic counts within Leicestershire will be undertaken by a survey company during November.

Figure 17. Counts required in Leicestershire

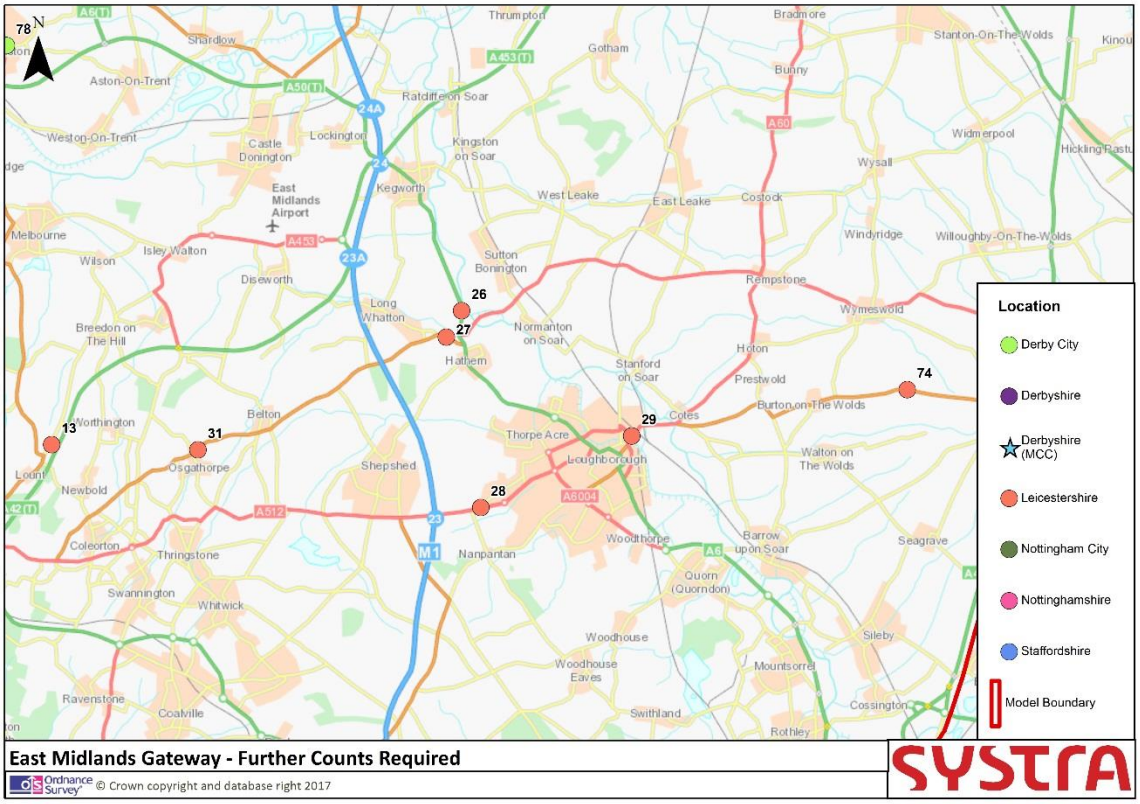


Table 12. Counts required in Leicestershire

LOCATION ID	ROAD DESCRIPTION	TYPE
13	A42	ATC
26	A6 Derby Road	ATC
27	B5324 Whatton Road	ATC
28	A512 Ashby Road	ATC
29	A60 Nottingham Road / A6004 Station Boulevard	MCC
31	B5324 Ashby Road	ATC
74	B676 Melton Road	ATC

3.9 Highway Journey Time Routes

3.9.1 SYSTRA have limited access to journey time data available from 2016 onwards. Figure 18 shows the routes where journey time data is required. These are also detailed in Table 13 with more specific details as to where each route starts and ends.

3.9.2 SYSYRA understands that 2016 Trafficmaster data is available from the Local Authorities and we propose to use this data in a processed form for journey time validation.

Figure 18. Journey Time Routes

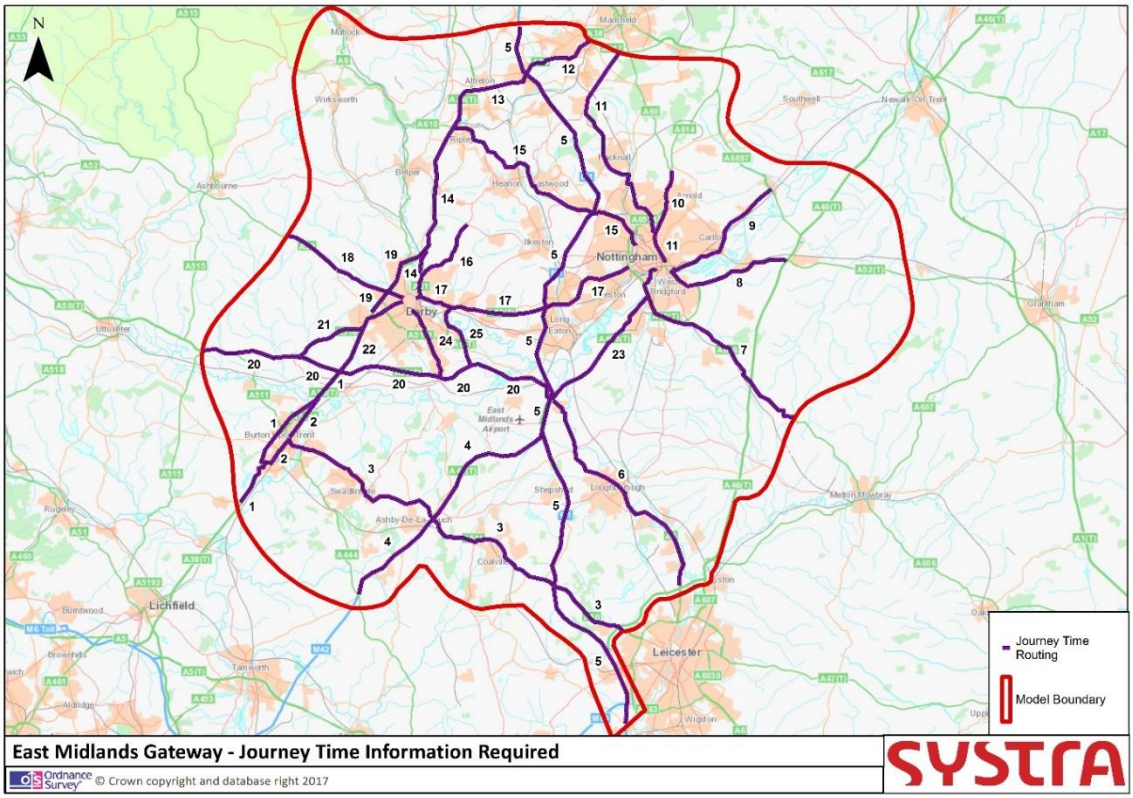


Table 13. Journey Time Routes

NUMBER	FROM AREA	FROM	TO AREA	TO
1	Barton-under-Needwood	A38 Lichfield Road	Derby & Burton Services	A50 Junction 4
2	Burton-Upon-Trent	A38 Lichfield Road	Burton-Upon-Trent	A38 Lichfield Road
3	Burton-Upon-Trent	A5121 Derby Road	Leicester	Leicester Western Bypass
4	Appleby Magna	M42 Junction 11	East Midlands Airport	M1 Junction 23A
5	Leicester	M1 Junction 21	Mansfield	M1 Junction 29
6	Leicester	Leicester Western Bypass	East Midlands Airport	M1 Junction 24
7	Nether Broughton	A606 Melton Road	Nottingham	Wilford Street
8	Saxondale	A46	Nottingham	A6011 Meadow Lane
9	Lowdham	A6097	Nottingham	A6011 Meadow Lane
10	Nottingham	A614 Ollerton Road	Nottingham	A611 Hucknall Road
11	Mansfield	A617 Sherwood Way South	Nottingham	A6008 Lower Parliament Street
12	Mansfield	A6009 Rosemary Street	Pinxton	M1 Junction 28
13	Pinxton	M1 Junction 28	Ripley	A610
14	Ripley	A610	Derby	The Pentagon
15	Ripley	A38	Nottingham	Radford Boulevard
16	Stanley Common	Ilkeston Road	Derby	A61 Sir Frank Whittle Road

NUMBER	FROM AREA	FROM	TO AREA	TO
17	Derby	The Pentagon	Nottingham	Middleton Boulevard
18	Brailsford	Luke Lane	Derby	Ford Street
19	Derby	A38	Derby	A6 Duffield Road
20	Sudbury	A515	Lockington	M1 Junction 24A
21	Hilton	A50 Junction 5	Derby	A516
22	Derby & Burton Services	A50 Junction 4	Derby	Curzon Street
23	East Midlands Airport	M1 Junction 24	Nottingham	A52 Clifton Boulevard
24	Swarkestone	A50 Junction 3	Derby	Lara Croft Way
25	Aston-on-Trent	A50 Junction 2	Derby	A52 Brian Clough Way

3.10 Highway Traffic Signal Data

3.10.1 Traffic signal data will also be required for all signalised junctions on the network where available. The following information is required:

- Traffic stages
- Cycle length
- Green and Intergreen times

4. SUMMARY OF DATA

4.1.1 Table 8 below summarises the data required for each stage of the model development.

Table 14. Summary of Data Required

DATA REQUIRED	DATA SOURCE
PT Network Building	
Current bus routes/timetables	Nottingham, Derby and Leicester authorities
Fares data	All relevant PT operators
Ticketing Data	All relevant PT operators
P&R Usage Data	Nottingham, Derby and Leicester authorities/operators
Rail timetables	2016 LENNON data
PT Calibration & Validation	
Bus Passenger Counts	Survey Company and Nottingham City Council
Tram Passenger Counts	Nottingham City Council
Journey time Route Data	Survey Company
Highway Network Building	
Traffic Signals	Nottingham, Derby and Leicester authorities
Highway Calibration and Validation	
Traffic Counts	Survey Company and Nottingham City Council
Journey Time Data	TrafficMasterData

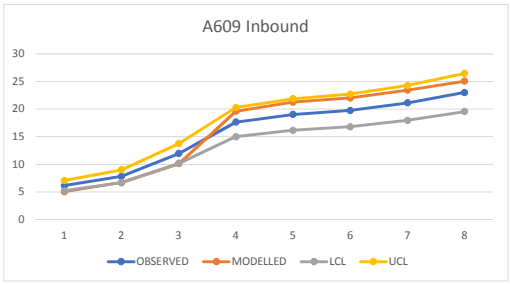
APPROVAL					
Version	**Name**		**Position**	**Date**	**Modifications**
1	Author	Helen O'Mara	Principal Consultant	12/10/2017	Version 1
	Checked by	Duncan Irons	Director	12/10/2017	
	Approved by	Rhian Turgoose	Associate	12/10/2017	
2	Author	Helen O'Mara	Principal Consultant	01/11/2017	Version 2
	Checked by	Duncan Irons	Director	01/11/2017	
	Approved by	Rhian Turgoose	Associate	01/11/2017	
3	Author	Helen O'Mara	Principal Consultant	12/10/2018	Version 3 (AECOM changed to AECOM Capita Ineco JV)
	Checked by	Duncan Irons	Director	12/10/2018	
	Approved by	Rhian Turgoose	Associate	12/10/2018	

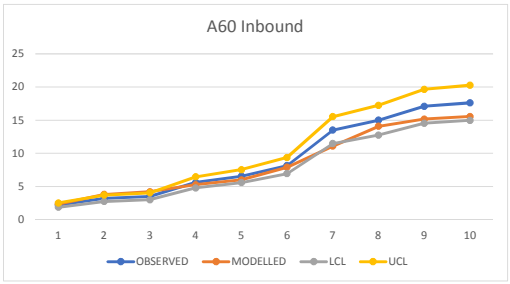
Appendix D

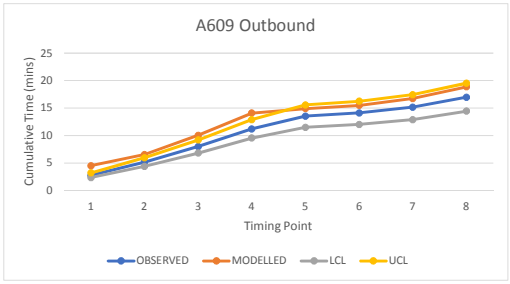
- EMGM Appendix D.xlsx

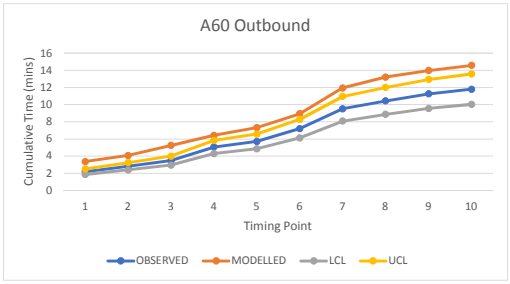
Appendix E

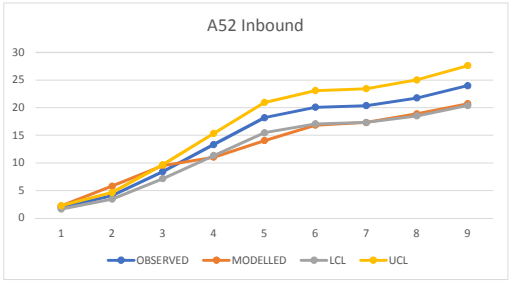
Morning Peak - Nottingham Journey Time Routes

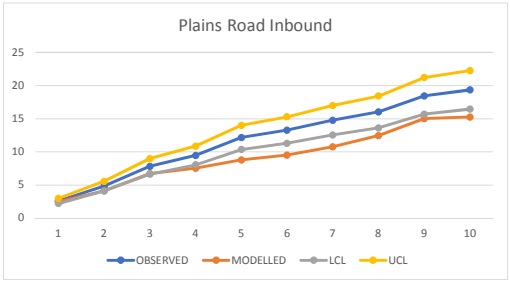


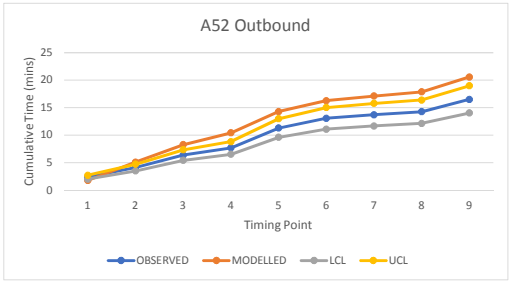


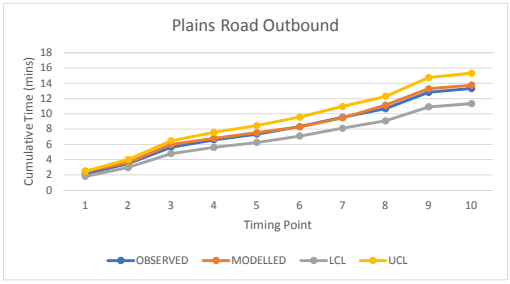


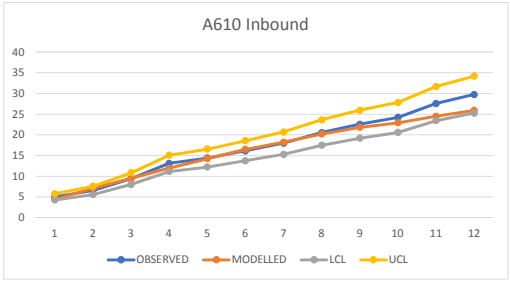


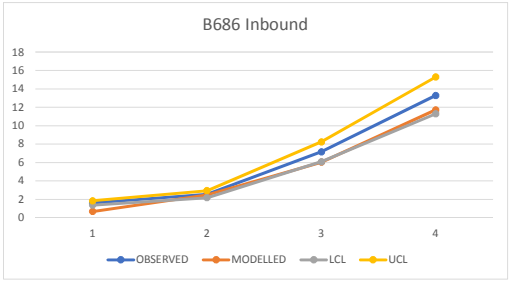


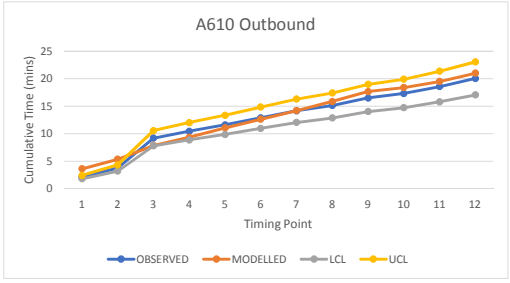


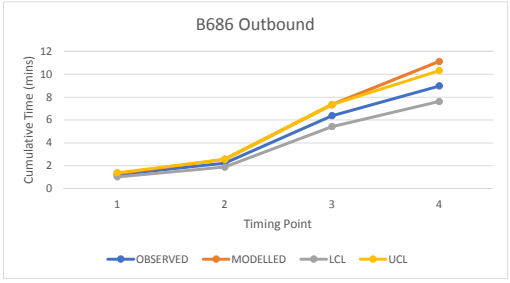


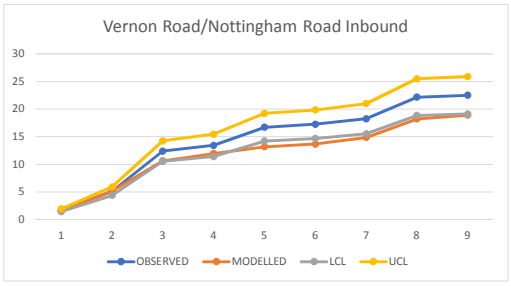


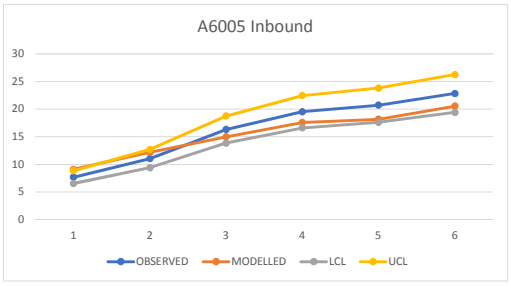


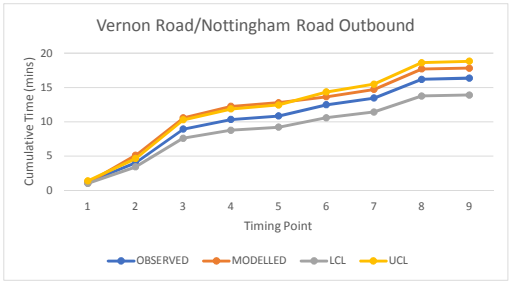


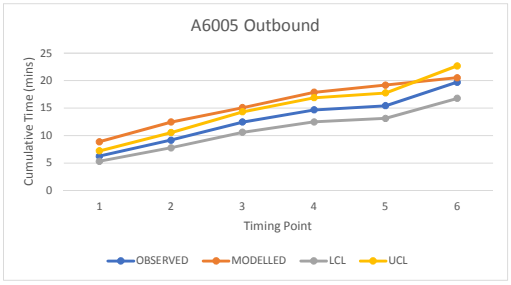


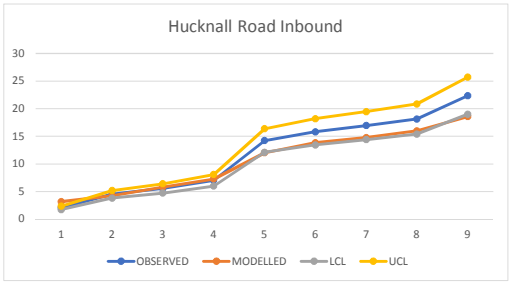


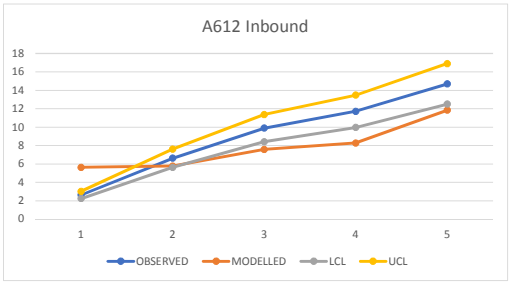

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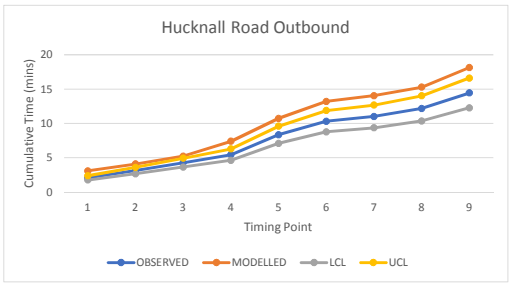

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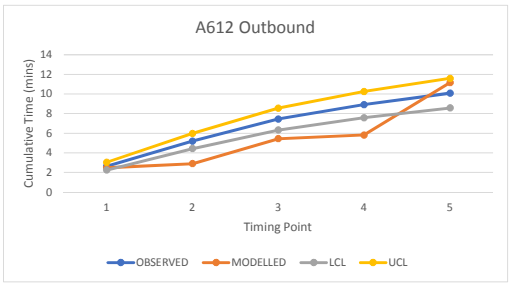

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Cumulative Time (mins)
Timing Point
OBSERVED
MODELLED
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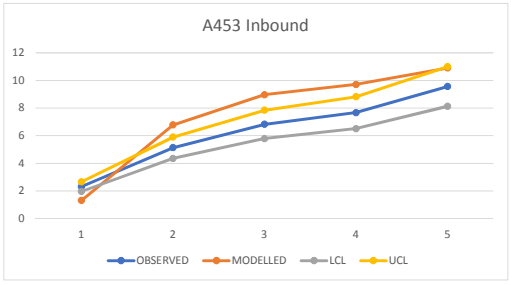

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Timing Point
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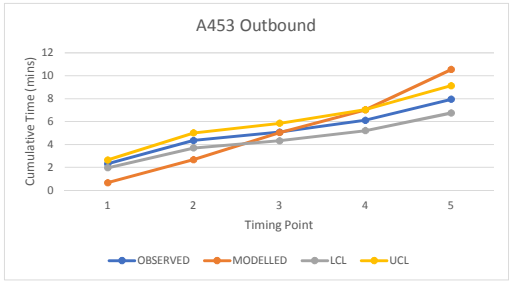

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MODELLED
LCL
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A612 Inbound
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MODELLED
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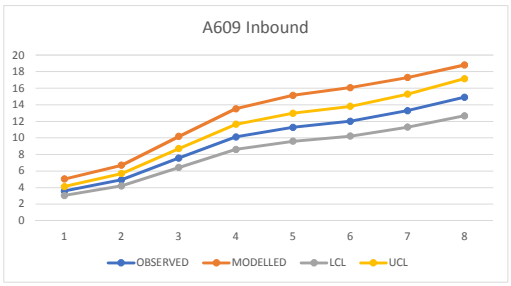

Hucknall Road Outbound
Cumulative Time (mins)
Timing Point
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MODELLED
LCL
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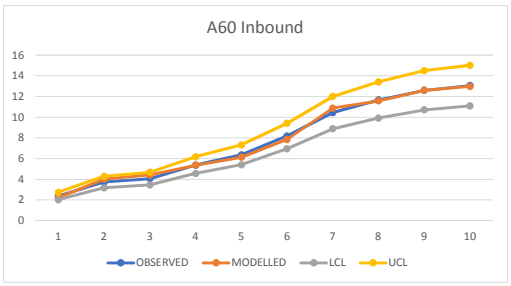

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Cumulative Time (mins)
Timing Point
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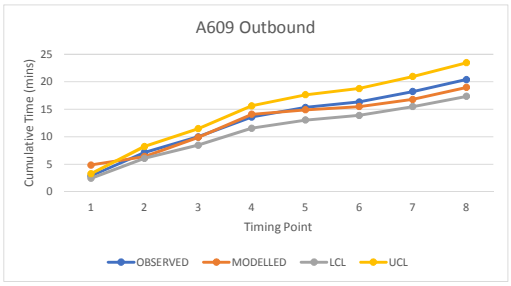

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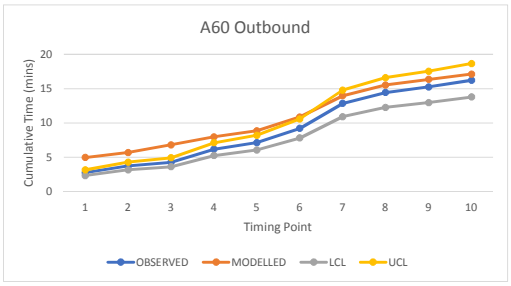

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Cumulative Time (mins)
Timing Point
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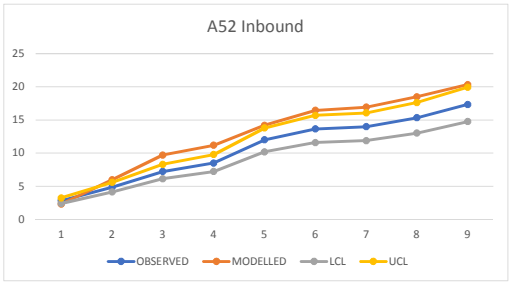
Evening Peak - Nottingham Journey Time Routes

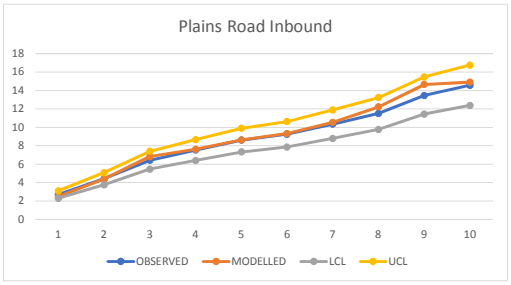


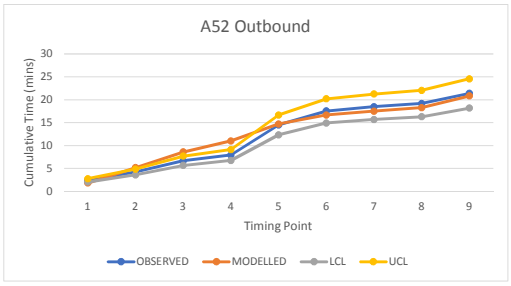


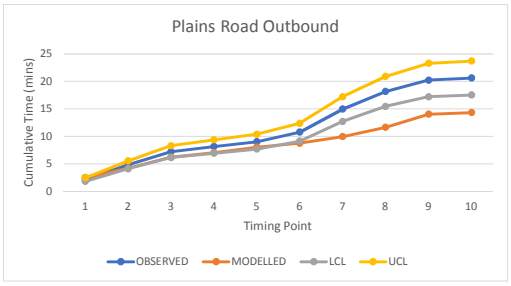


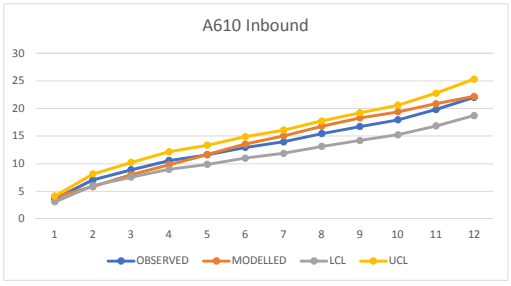


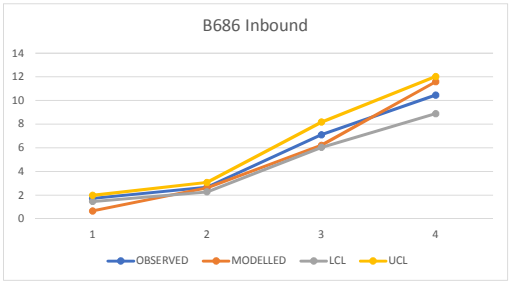


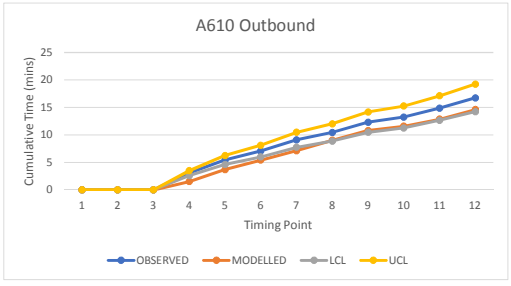


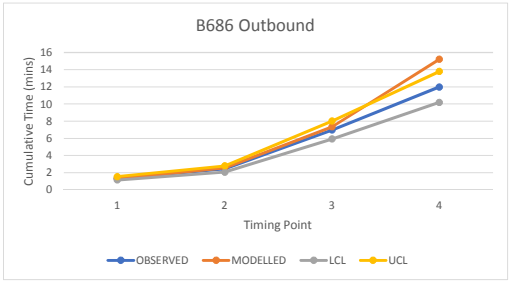


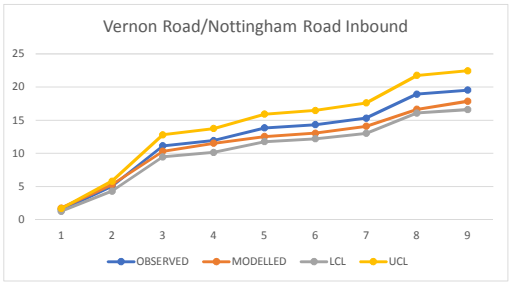


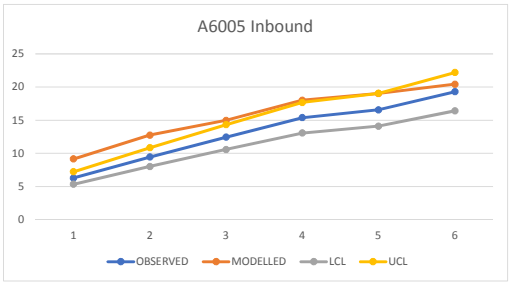


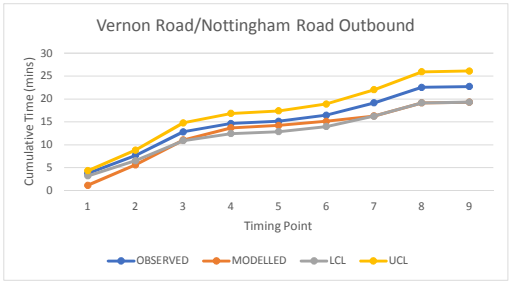


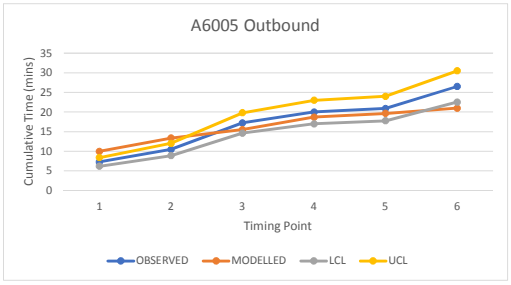


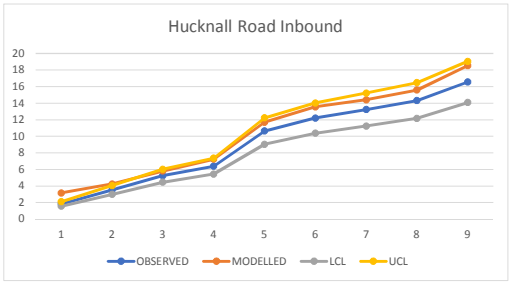


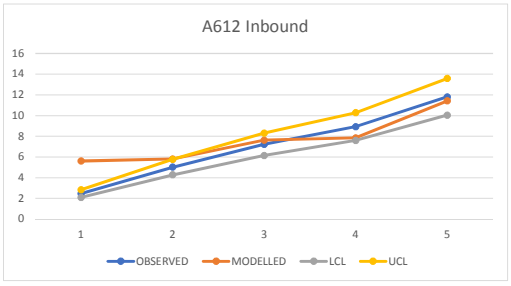

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MODELLED
LCL
UCL

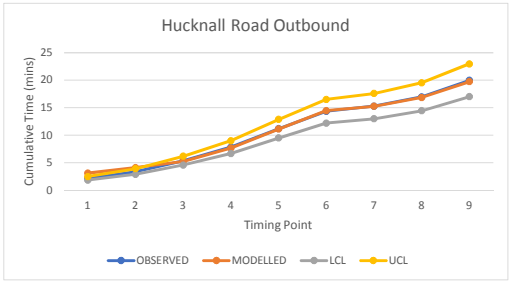

A6005 Inbound
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MODELLED
LCL
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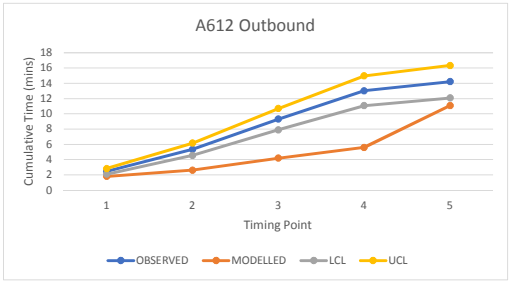

Vernon Road/Nottingham Road Outbound
Cumulative Time (mins)
Timing Point
OBSERVED
MODELLED
LCL
UCL

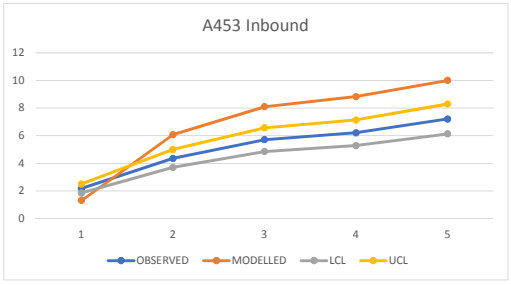

A6005 Outbound
Cumulative Time (mins)
Timing Point
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MODELLED
LCL
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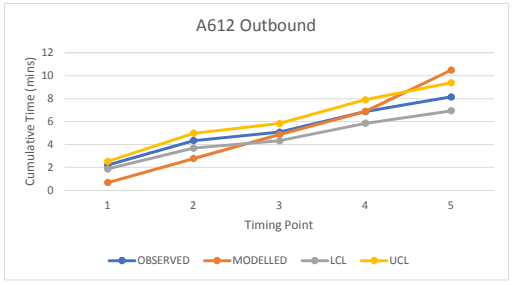

Hucknall Road Inbound
OBSERVED
MODELLED
LCL
UCL


A612 Inbound
OBSERVED
MODELLED
LCL
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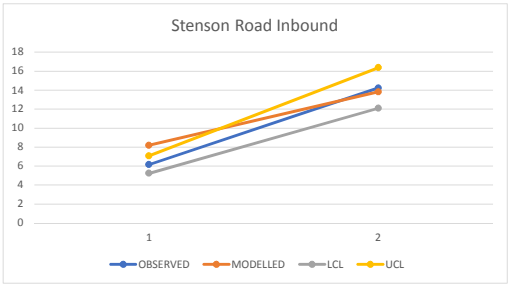

Hucknall Road Outbound
Cumulative Time (mins)
Timing Point
OBSERVED
MODELLED
LCL
UCL

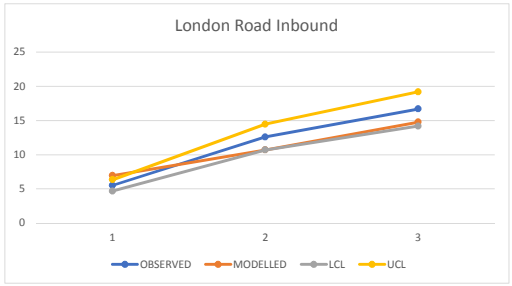

A612 Outbound
Cumulative Time (mins)
Timing Point
OBSERVED
MODELLED
LCL
UCL

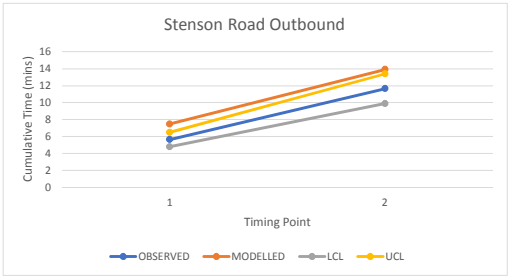

A453 Inbound
OBSERVED
MODELLED
LCL
UCL

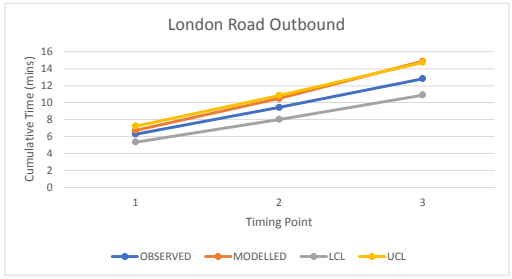

A612 Outbound
Cumulative Time (mins)
Timing Point
OBSERVED
MODELLED
LCL
UCL

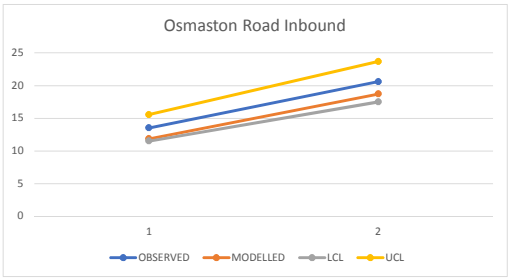
Morning Peak - Derby Journey Time Routes

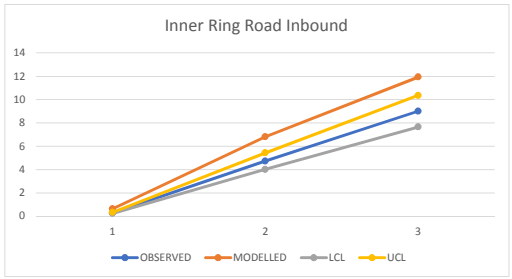


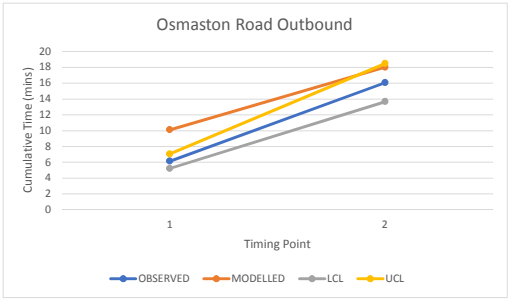


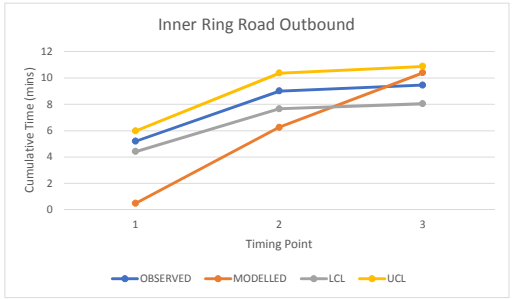


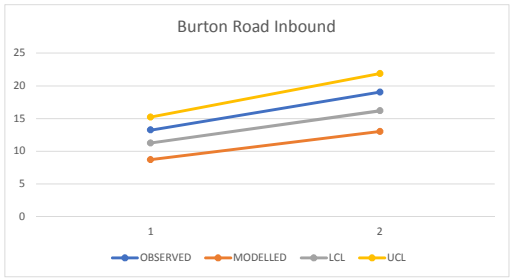


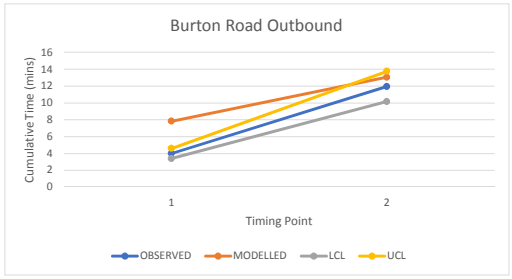


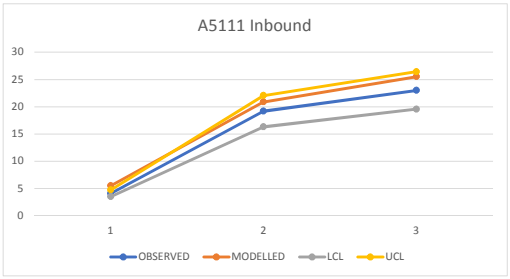


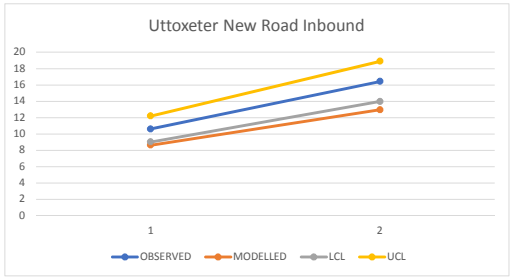


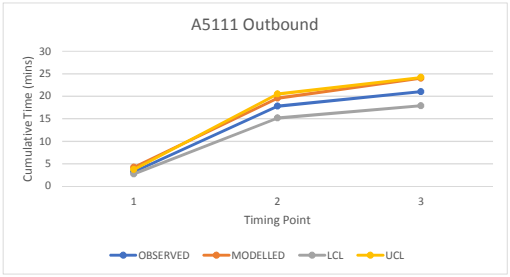


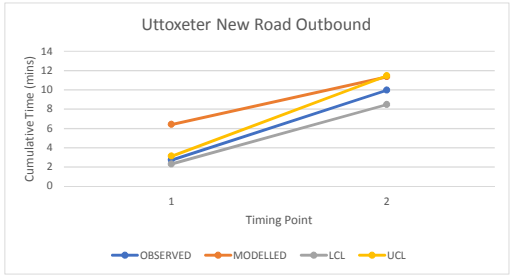




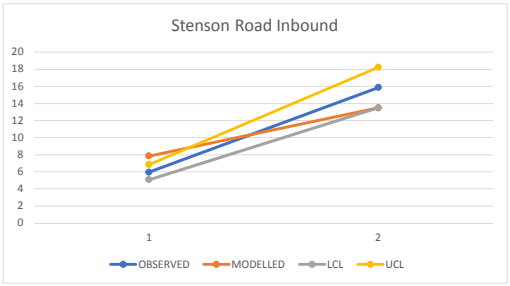

A5111 Inbound
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20
15
10
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OBSERVED
MODELLED
LCL
UCL

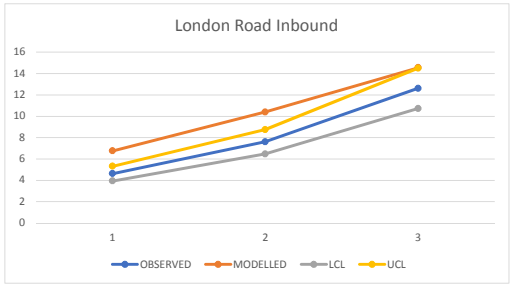

Uttoxeter New Road Inbound
20
18
16
14
12
10
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6
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2
0
1
2
OBSERVED
MODELLED
LCL
UCL

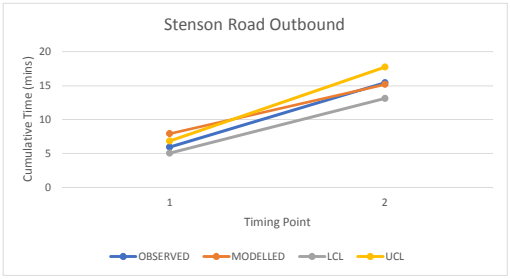

A5111 Outbound
Cumulative Time (mins)
30
25
20
15
10
5
0
1
2
3
Timing Point
OBSERVED
MODELLED
LCL
UCL

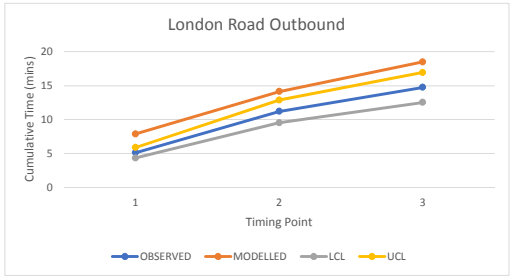

Uttoxeter New Road Outbound
Cumulative Time (mins)
14
12
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2
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2
Timing Point
OBSERVED
MODELLED
LCL
UCL

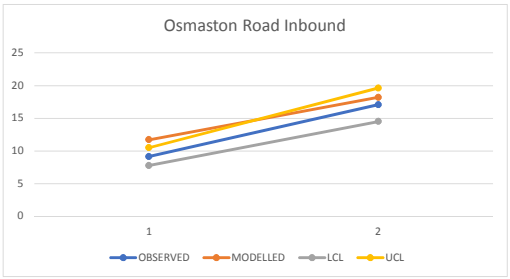
Evening Peak - Derby Journey Time Routes

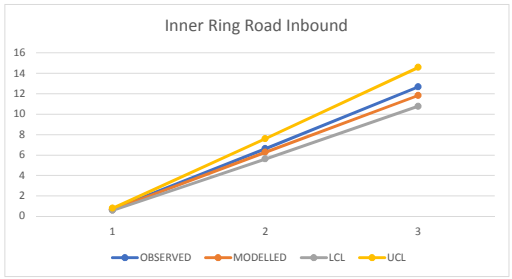


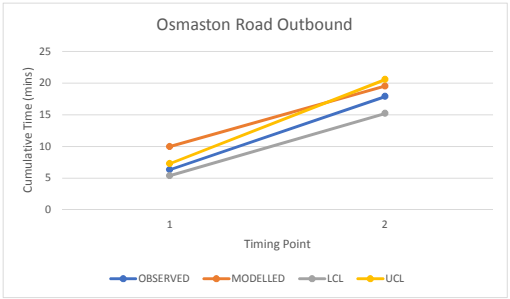


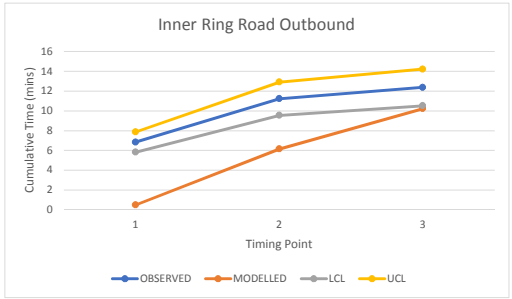


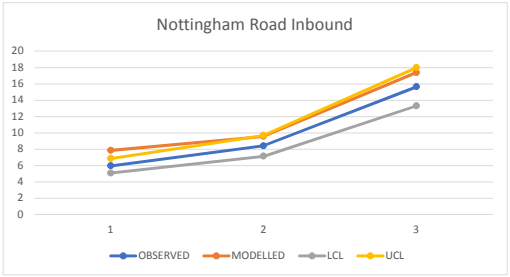


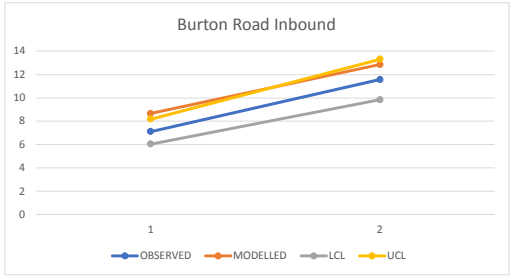


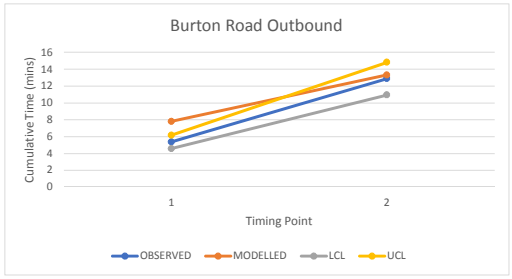


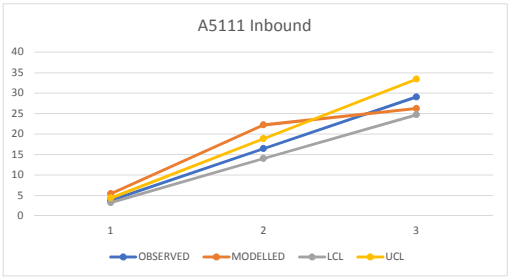


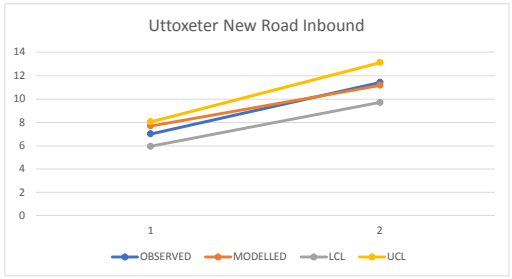


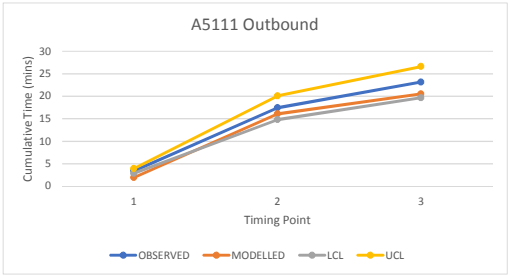


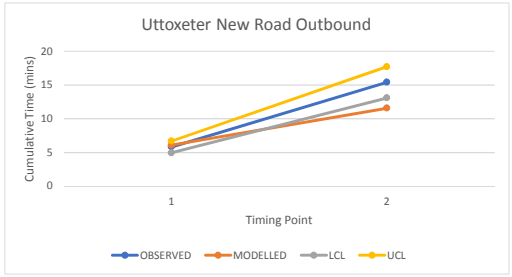





A5111 Inbound
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OBSERVED
MODELLED
LCL
UCL


Uttoxeter New Road Inbound
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OBSERVED
MODELLED
LCL
UCL


A5111 Outbound
Cumulative Time (mins)
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Timing Point
OBSERVED
MODELLED
LCL
UCL


Uttoxeter New Road Outbound
Cumulative Time (mins)
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Timing Point
OBSERVED
MODELLED
LCL
UCL

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