Great Yarmouth Third River Crossing

OUTLINE BUSINESS CASE

MARCH 2017

Supporting Document 4 – Local Model Validation Report (Paramics)

Great Yarmouth Third River Crossing

Local Model Validation Report

Paramics Discovery Model

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Produced for
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1 Introduction

1.1 Project Background

Norfolk County Council (NCC) has appointed Mouchel to prepare an Outline Business Case (OBC) relating to a proposed Third River Crossing in Great Yarmouth.

To support the OBC, extensive transport modelling and appraisal work will be undertaken in order to select a preferred option, forecast the likely scheme impact and quantify its benefits.

This will include the development of a tiered modelling approach, including both a SATURN model (used for strategic analysis and to feed into the economic appraisal) and a Paramics Discovery model (used to assist in the option selection process and to accurately forecast operational performance).

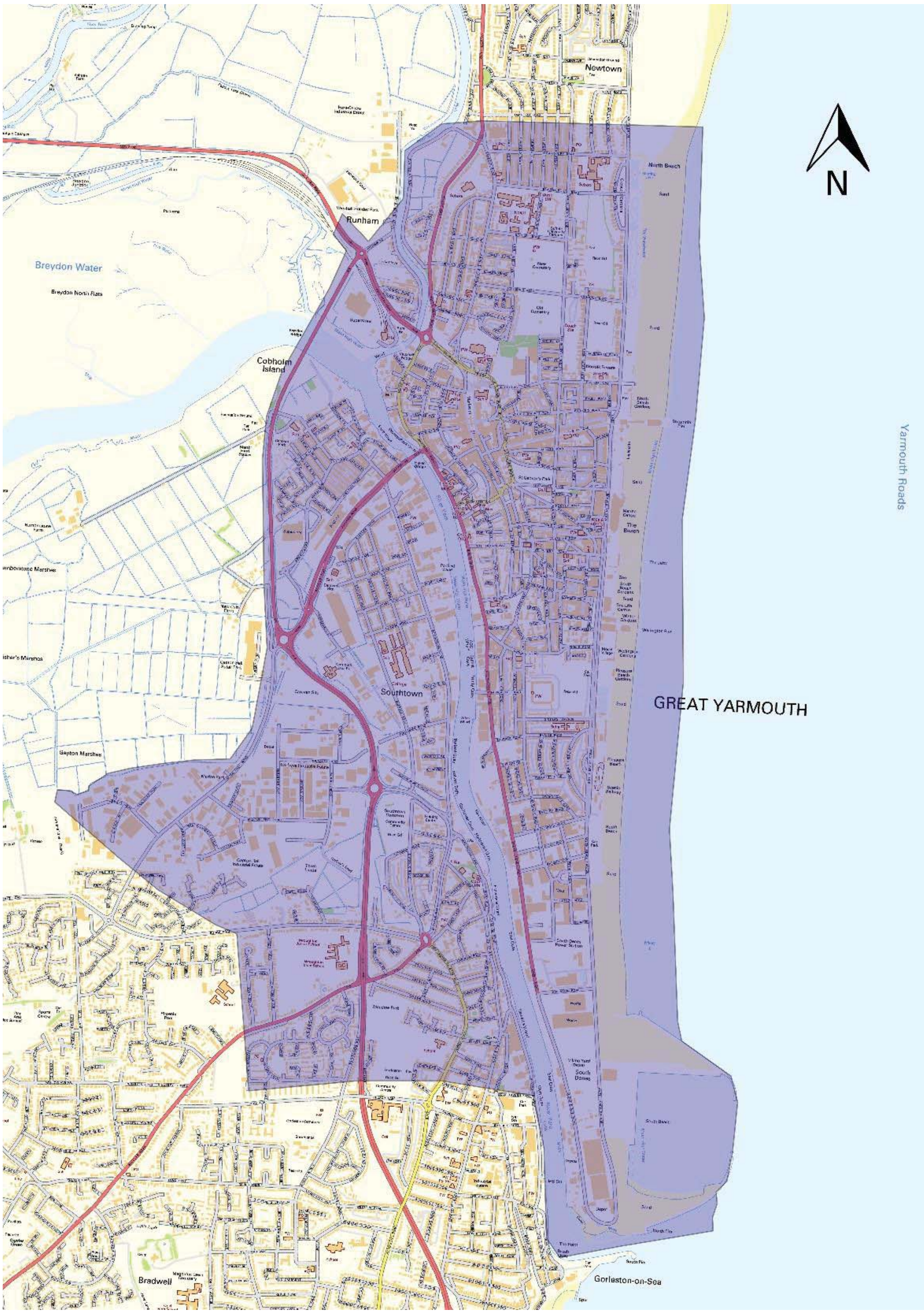
This report describes the development and validation of the Paramics Discovery microsimulation model.

1.2 Paramics Model Background

The development of the model for the Third River Crossing builds on previous work undertaken by Mouchel, who were appointed by NCC to develop a Paramics Discovery model of Great Yarmouth Town Centre. The aim of the initial model was to test various local congestion relief schemes in the town centre.

In order to provide a model fit for the purpose of assessing the Third River Crossing scheme, the initial town centre model has been enlarged to include the whole area shown in Figure 1 below:

Figure 1 Proposed Scope for the Paramics Discovery Model



1.3 Purpose of this Report

The aim of this report is to provide information related to the development, calibration and validation of the Paramics Discovery model and to demonstrate the fitness for the purpose of assessing the Third River Crossing scheme. The report includes details regarding the development of the model, available traffic surveys for matrix development, the cordoned matrices from SATURN and the prior matrices obtained through them as well as the matrix estimation process.

2 Model Data Sources

2.1 Traffic Surveys

Existing traffic survey information was provided by NCC and AECOM. Additional traffic surveys were carried out by Mouchel specifically for this study.

- **NCC Surveys**. These surveys were provided by NCC in order to carry out the calibration and validation of the previous model of the town centre. The surveys were conducted on Thursday 15th October 2015 at nine sites around Great Yarmouth Town Centre. Junction turning counts, pedestrian crossing counts and queue length observations were collected.
- **AECOM surveys**. Traffic counts were gathered in different years and months, between June 2015 and April/May 2016. Queues were measured only in 2015.
- **Mouchel Surveys**. New traffic surveys were conducted at key locations within the new study area on Tuesday 4th October 2016. The data contains information regarding traffic counts and queue lengths.

In addition to this, there are two permanent traffic count stations within the study area and one close to the model's boundaries. This information was taken from WebTRIS, which provides information from permanent count sites on the strategic road network and is an official website of Highways England.

The data was summarised into three vehicle classes: cars, Light Goods Vehicles (LGV) and Heavy Goods Vehicles (HGV). This is in line with common practice and matches the vehicle classifications used in the SATURN models and provides a desired level of detail for the Paramics Discovery model.

The traffic survey sites are shown in Figure 2:

Figure 2 Available Traffic Data Surveys

Once the available information was received, the traffic data was collated and analysed in order to verify the reliability and compatibility of the different data sets. This data has an important impact on the quality of the prior matrices, the matrix estimation process and the model calibration. Hence, after a careful analysis of the traffic surveys, some of the traffic counts were eliminated in order to preserve the consistency of the data.

Figure 3 shows the final set of traffic surveys.

Figure 3 Final set of traffic counts for modelling and matrix manipulation purposes

Counts for vehicle type were summarised for each turn and modelled peak hours. Further information regarding the traffic counts is shown in Appendix A.

The location of the points where queue surveys were conducted is shown in Figure 4:

Figure 4 Queue Survey Available Data

The observed queue data was collected using two different methods. These were:

- The red light & green light method: which was carried out at junctions where queues were recorded at the start of red and start of green. This should provide the maximum and minimum queue length during each cycle; and
- The snap & maximum method. This method was used at the priority controlled intersections. A snap queue is the queue at five minute intervals, while the maximum is the longest observed within that five minutes.

Some surveys recorded in the queue data are in metres whereas others are in vehicles. Also, the measured interval is not the same for all the surveys; the majority of them were measured in 5 minutes intervals while others were measured in intervals of 15 minutes.

Further details regarding queue data are included in Appendix B.

2.2 Journey Time Data

Information relating to travel times was collected from Highways England Open Data website. The data source provided information of journey times along the A12, specifically at the locations below:

- Between Harfreys Roundabout and Gapton Hall Roundabout.
- Between Gapton Hall Roundabout and Vauxhall Roundabout.
- Both A12 slip roads at the A143 Beccles Road.

The travel time on the slip roads was ignored due to the variability of travel times caused by the traffic signal timings at the Beccles Road junction.

Journey time data was available for the period between January and October 2016. Therefore, an average of the travel times was calculated. The average was calculated for a typical weekday (Monday to Friday).

The average Journey Time data is shown in Appendix C.

2.3 Peak Periods

A peak hour was determined by adding the flows from the whole set of surveys in order to calculate the peak periods. As a result of the data analysis, three peak hours were identified as shown below:

- Morning peak - 08:00 – 09:00;
- Interpeak – 13:00 – 14:00;
- Evening peak- 16:30 – 17:30.

For each period, one hour peak models were developed, plus one hour warm-up and cool-down periods. The warm-up periods allow vehicles to load onto the network before calculations can begin, and the cool-down allows vehicles released during the peak hour to complete their journeys in order for them to feed their data into the assessment process.

2.4 Traffic Release Profiles

Since a three hour period is being modelled for each peak, it is important to replicate how traffic demand changes within this period. Paramics Discovery allows replication of the proportion of vehicles released onto the network at 5 minute intervals. This makes it possible to reproduce the demand variation during the simulation, the ‘peak within the peak’ as well as the build-up and dissipation of queues. At other times, the demand is assumed constant throughout the modelled period and the vehicles are released uniformly.

In addition, depending on the land use, the peak demand at each zone may be reached at different hours, for instance, a school zone will be busiest in the 20 minutes before lessons commence. Therefore, where diverse land uses are expected, different release profiles must be built in order to replicate the behaviour of traffic.

The available surveys were used to calculate the release profiles of certain zones located near the junction or roads where the counts were carried out. Nonetheless, it is impossible to create as many profiles as zones are modelled due to the amount of data required to do so, and accordingly, some assumptions must be considered. Thus, the zones without enough traffic data to estimate their profile use one of the 34 existing profiles. These profiles were allocated depending on the land use of the zone and their proximity to the reference zone.

2.5 Normalisation of the traffic counts

Because the surveys were carried out in different months and years, it was necessary to adjust the traffic data in order to represent a neutral month in 2016.

As a consequence, normalisation factors have been calculated in order to convert the traffic data to a neutral weekday. These factors were calculated using trustworthy, long-term traffic data within, or as near as possible to the study area. Highway England WebTRIS provided the necessary information to carry out the calculation of these factors by means of three permanent traffic counts locations. The factors were calculated for the day of the week, month and year allowing to change the traffic counts from different traffic surveys into an average weekday of April 2016.

The location of the permanent traffic counts used for the calculation of the factors are shown in Figure 5 below:

Figure 5 Location of Highways England permanent traffic counts

Tables 1-3 show the normalisation factors used for this process.

Table 1 Normalisation Factors. Day of the week factor.

Day of the Week	Daily Normalisation Factor
Monday	1.040
Tuesday	1.016
Wednesday	0.994
Thursday	0.990
Friday	0.985
Saturday	1.173
Sunday	1.402

Table 2 Normalisation Factors. Monthly factor.

Month	Monthly Normalisation Factor
Jan	1.092
Feb	1.026
Mar	1.008
Apr	1.000
May	0.990
Jun	0.971
Jul	0.952
Aug	0.960
Sep	0.972
Oct	0.982
Nov	1.013
Dec	1.061

Table 3 Normalisation Factors. Annual factor.

Year	Annual Normalisation Factor
2016	1.000
2015	1.006
2014	1.026
2013	1.046
2012	1.034
2011	1.035
2010	1.038
2009	1.025
2008	1.026
2007	1.038
2006	1.040

2.6 Normalisation of queue surveys

Since Paramics Discovery collects queue data in metres, the queue surveys must be normalised to this standard. As previously mentioned, some of the surveys include the queue data in metres while others provide the number of vehicles in the queue, without vehicle classification.

In order to convert all data to a common unit of measurement, some assumptions were required. These assumptions are listed below:

- Vehicle lengths: The queue surveys measured in vehicles provided a table of equivalences between vehicle types and metres.

Table 4 Vehicle Length Assumptions to Normalise Queue Data

Vehicle	Metres
PC, MC	2.50
LV	5.00
OGV1	10.00
OGV2	15.00
Bus	15.00

- Vehicle classification: The queue surveys were conducted in the same location as the traffic counts. Thus, it was possible to obtain the vehicle type proportions relating to the queue surveys.

- Survey intervals: Some data was gathered in 5 minute intervals, while others were gathered in 15 minutes intervals. Therefore, the data was grouped into 15 minutes intervals.

3 Network Development

3.1 Road Network

The development of the microsimulation network was focused on expanding the previous microsimulation model to include the new study area. The model was extended using the Ordnance Survey AutoCAD mapping and as-built drawings provided by NCC. Both sources provide information regarding the physical features of Great Yarmouth highways, and the junction layouts allow accurate replication of stop line positions, signal staging phasing and timing.

Additional information such as speed limits, give-way priorities, banned movements, lane configuration, bus stop locations and vehicle behaviour were gathered from the CAD drawings, satellite and street images.

Paramics Discovery allows different road categories to be modelled which improves the accuracy of route choice. The main link categories are 'Major' and 'Minor' roads. These link types determine the road importance and likely utilisation depending on whether the drivers are familiar or not with the network.

Driver behaviour is controlled by a vehicle type parameter known as "Familiarity" and it defines the percentage of familiar drivers for each vehicle type. Therefore, depending on the percentage of familiar drivers, the perception of cost derived from using minor road routes instead of major ones may differ. For instance, unfamiliar drivers perceive the cost of using secondary routes as more than double that of a familiar driver. Hence, if a road is extremely congested a familiar driver is more likely to change their route using secondary roads to avoid the delays whereas the unfamiliar driver is less likely to divert.

These perceived costs, plus actually modelled costs due to congestion, tolls and distances feed into the Generalised Cost Equation (GCE) which determines the route choice of drivers. The Network calibration section of this document provides further information regarding the model parameters and their utilisation for calibration purposes.

Figure 6 shows the proposed road hierarchy for Great Yarmouth model. The links in red represent the major road whereas the minor ones are coloured in blue.

Figure 6 Proposed Roadway Hierarchy for Great Yarmouth Model

3.2 Traffic Signal Information

NCC provided traffic signal controller specifications and as-built drawings where the data was available, for twenty-five signal controlled junctions and pedestrian crossings within the study area network as indicated in Figure 7 below:

Figure 7 Traffic Signal Controller Information Available

Signal timings for junctions and pedestrian crossings during the modelled periods were calculated using the controller specifications provided. NCC confirmed that most of the junctions run under SCOOT control and timing logs were provided for most junctions.

It was considered appropriate that all traffic signals in the model could be replicated using Fixed Time Plans (FTP). Thus, average stage green times and cycle times were obtained using the timing logs as the base for the calculation of the morning, evening and interpeak periods. Where timing logs were not available, signal specification reports and local knowledge were used to calculate signal timings.

For example, the log of the junction of Pasteur Road / Southtown Road suggested no green time was allocated to stage 2, which provides the right turn from Pasteur Road to Southtown Road and some pedestrian phases. The survey indicated around 60/70 vehicles per hour make this movement. It was noted that a very long inter-green was recorded in the log file and it was therefore assumed that Stage 2 was running minimum traffic green of 7 seconds with the remainder of the long intergreen shown in the log providing the preceding and following intergreen for stage 2.

No signal timing log file was available for the Acle New Road / Station Access junction. Initial timings were therefore derived from phase maximums within the controller spec and adjusted during model runs to serve traffic demands efficiently.

Figure 8 shows the complete set of modelled signalised junctions and pedestrian crossings. These are listed in Table 5 which includes the reference code, name and crossing type.

Figure 8 Modelled signalised junctions and pedestrian crossings

Table 5 Pedestrian and vehicle crossings include in the model

Reference Code	Name	Type
P61133	Alexandra Rd	Pedestrian Crossing
P61313	S Quay (Nottingham Way)	Pedestrian Crossing
P61413	Yarmouth Way (Kings St)	Pedestrian Crossing
P62133	Southtown Rd (Anson Rd)	Pedestrian Crossing
P64123	Regent Rd / Nelson Rd	Pedestrian Crossing
Y96253	The Conge	Pedestrian Crossing
Y96211	Regent Rd / Marine Parade	Pedestrian Crossing
Y96233	A12 / Pasteur Rd Roundabout	Pedestrian Crossing
Y96333	Beccles Rd (nr Manby Rd)	Pedestrian Crossing
Y96213	S Beach Parade (nr Shadingfield Cl)	Pedestrian Crossing
Y96223	S Beach Parade (nr Trafalgar D)	Pedestrian Crossing
J61111	Fullers Hill / Northgate St	Vehicle Junction
J61121	Fullers Hill / Priory Plain	Vehicle Junction
J61131	Temple Rd / S Market Rd	Vehicle Junction
J61141	Priory Plain / St Nicholas Rd	Vehicle Junction
J61211	Alexandra Rd / Trafalgar Rd	Vehicle Junction
J61221	Yarmouth Way / S Quay	Vehicle Junction
J61231	Hall Quay / Regent St	Vehicle Junction
J61241	Heaven Bridge	Vehicle Junction
J62111	Pasteur Rd / Southtown Rd	Vehicle Junction
J62121	Southtown Rd / Station Rd	Vehicle Junction
J62141	Southtown Rd / Gordon Rd	Vehicle Junction
J62211	Southtown Rd / Tollgate Rd	Vehicle Junction
J62221	Southtown Rd / Boundary Rd	Vehicle Junction
J62231	Southtown Rd / Beccles Rd	Vehicle Junction
J62241	Beccles Rd / High Rd	Vehicle Junction
J64111	St Nicholas Rd / Nelson Rd N	Vehicle Junction
J64131	Nelson Rd / Trafalgar Rd	Vehicle Junction
J64231	Caister Rd / Lawn Ave	Vehicle Junction
Y96231	Acle New Rd / Station	Vehicle Junction
Y96221	Admiralty Rd / Queens Rd	Vehicle Junction

Where demand dependent pedestrian phases were present, their frequency was estimated from the pedestrian crossing counts.

3.3 Haven Bridge lifts

The River Yare runs through the Town and there are two bascule bridges that connect either side. The bridge lifts to allow boats to access the port of Great Yarmouth and the inland waterways, and is closed to vehicular traffic during the lift. NCC has provided historical data from 2014/15/16 for the number of Haven Bridge lifts per month.

A more detailed log from June 16 provides the precise times when the bridge was opened and closed to traffic. It was closed to traffic for durations of between 5 to 10 minutes. The timings in the log file indicate that bridge lifts appear to be concentrated outside the peak hour period, and is likely to be dominated by tidal times.

Table 6 shows the frequency of bridge lifts varies significantly from one month to another. During summer 2015 the frequency was over 40 times per month with a peak of 61 in May. During the winter it was less than 20 times per month.

Table 6 Monthly Haven Bridge lifts in 2015

Month	Total Lifts	Weekday	Weekend
Jan-15	**13**	12	1
Feb-15	**17**	15	2
Mar-15	**26**	21	5
Apr-15	**41**	30	11
May-15	**61**	42	19
Jun-15	**49**	32	17
Jul-15	**49**	27	13
Aug-15	**39**	26	13
Sep-15	**28**	19	9
Oct-15	**20**	11	9
Nov-15	**14**	13	1
Dec-15	**9**	8	1

Due to the limited number of bridge openings, and the fact that the port authority generally avoid bridge openings during peak times, bridge opening was not included in the base year model for the Haven Bridge.

3.4 Zone Plan

The zone system represents specific areas within the model from which trips start and end. Each individual zone has access and egress points where vehicles are 'released' into the network or leave the model. Vehicles make their trip choice through the network based on the driver's perception of cost and then leave the network at their destination zone.

In order to optimise working flows and reduce the differences between the macroscopic and microscopic model, the SATURN model zone plan has been adapted to fulfil the microsimulation level of detail requirements.

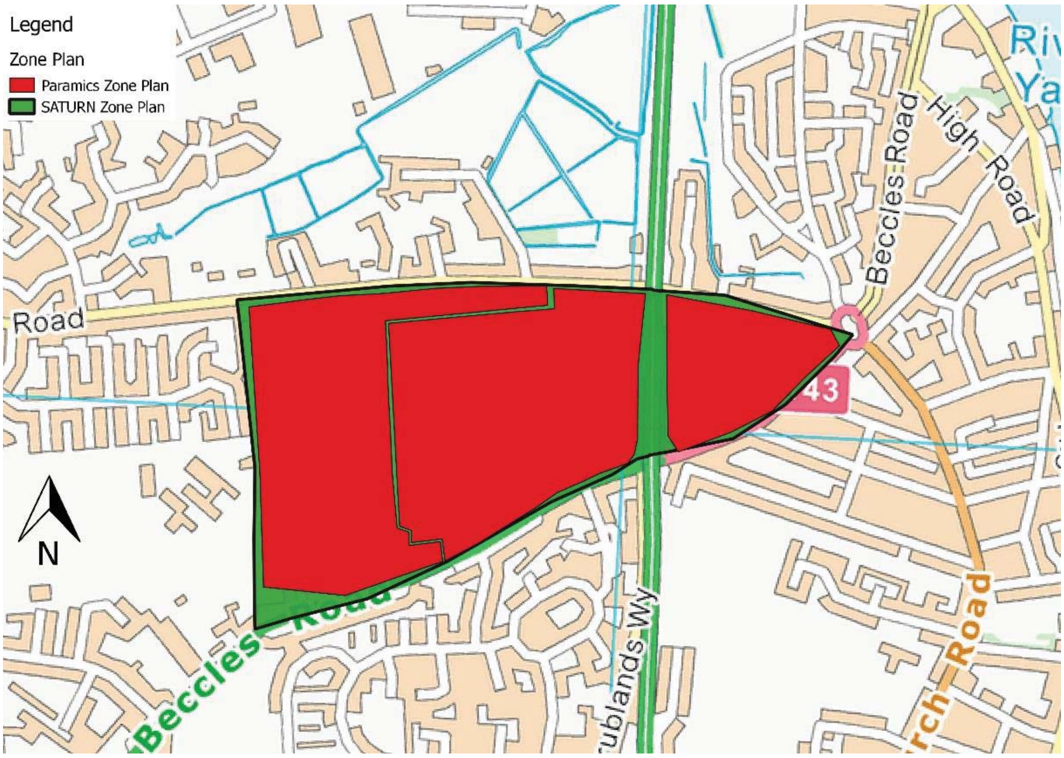
Thus, to reach the desired level of detail at this stage of the study, several SATURN zones were split considering the following methodology:

- Land use of the SATURN zone. When different land uses categories were contained in the same zone, the aim was to split it into as many zones as land uses the main zone contained. The zone analysis was carried out according to TRICS categories.
- Most likely access/egress routes. When different access and egress points could be reached using different although, not complementary routes, the zone was split in order to avoid reproducing unlikely route choices.

- The proximity of the zone to the future bridge location. The closer to the proposed location of the bridge, the more detailed the zones are. Thus, it is possible to replicate in a more realistic and appropriate manner the impacts of the new infrastructure in local movements.

Figure 9 helps to clarify the methodology described above.

Figure 9 Example of the methodology followed to perform the Zone Plan for Paramics Discovery



The diagram shows a SATURN zone (coloured in green) which has been disaggregated into three different zones in the Paramics Discovery model (in red). The SATURN zone was split in three because the central zone has an educational land use whereas the other two are residential.

In total, the Paramics Discovery model has 119 zones, whereas the SATURN model contains 60 zones.

A network zone plan and the correspondence between SATURN and Paramics Discovery zones are shown in Figure 10 and Table 7 below:

Figure 10 Paramics Zone Plan

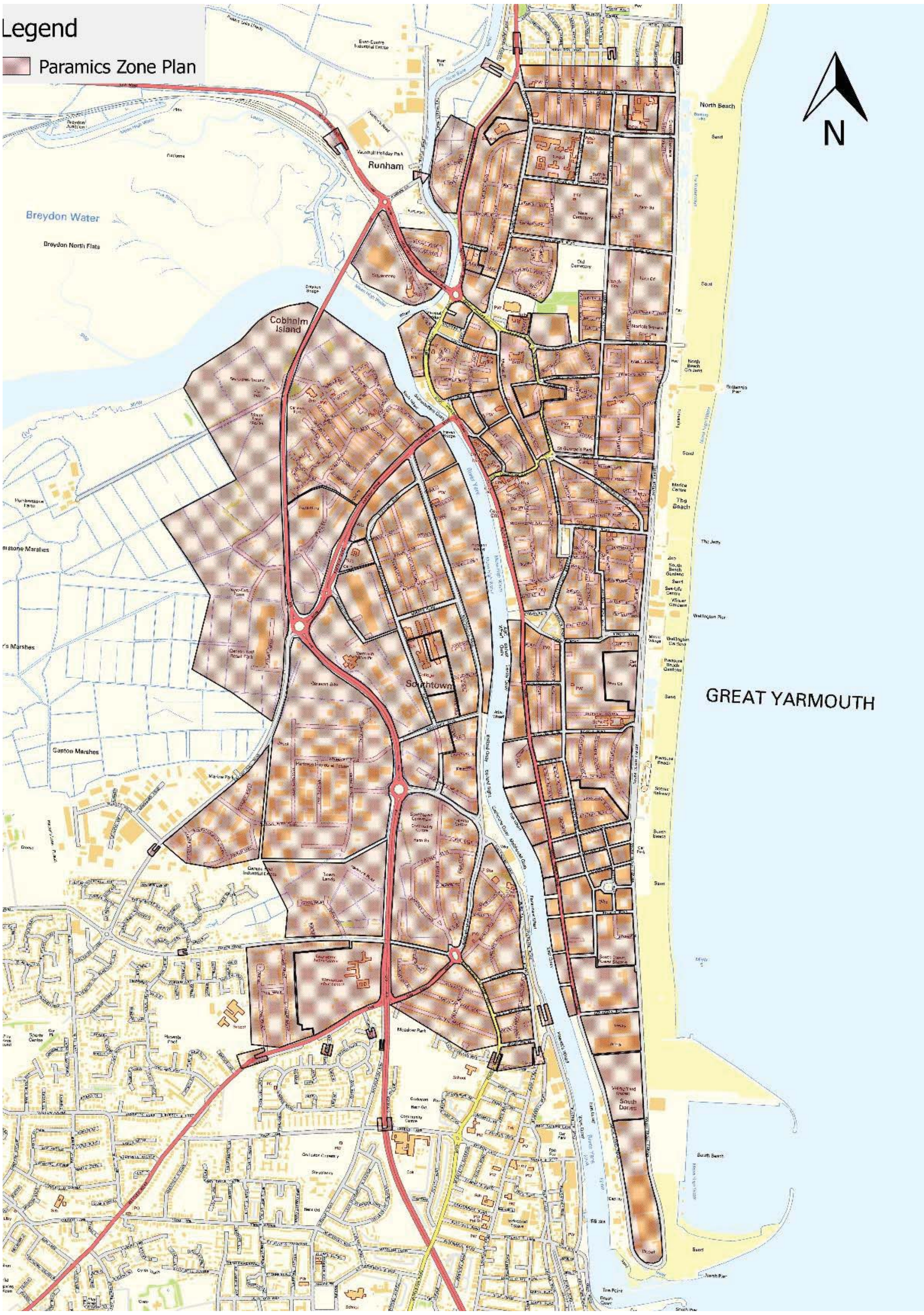


Table 7 Connection between SATURN and Paramics Discovery Zone Plan

ID Saturn Zone	ID Paramics Zone	Type
1	19	Inner
2	4	Inner
2	71	Inner
2	5	Inner
2	72	Inner
3	24	Inner
3	66	Inner
3	67	Inner
4	22	Inner
5	18	Inner
5	31	Inner
6	37	Inner
7	2	Inner
7	68	Inner
7	69	Inner
7	70	Inner
8	26	Inner
8	64	Inner
8	27	Inner
9	29	Inner
10	30	Inner
11	32	Inner
12	33	Inner
13	34	Inner
14	36	Inner
15	35	Inner
16	39	Inner
16	75	Inner
17	38	Inner
17	73	Inner
17	74	Inner
18	40	Inner
18	76	Inner
18	77	Inner
18	78	Inner
18	79	Inner
18	80	Inner
18	81	Inner
18	82	Inner
18	83	Inner
19	25	Inner
20	28	Inner
20	65	Inner
21	15	Inner
22	15	Inner
25	63	Inner

ID Saturn Zone	ID Paramics Zone	Type
25	119	Inner
26	58	Inner
27	56	Inner
28	44	Inner
29	49	Inner
29	108	Inner
29	109	Inner
30	52	Inner
30	110	Inner
30	111	Inner
30	112	Inner
31	46	Inner
31	47	Inner
32	48	Inner
33	51	Inner
33	113	Inner
33	114	Inner
34	53	Inner
35	11	Inner
35	115	Inner
35	116	Inner
37	41	Inner
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37	86	Inner
37	87	Inner
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37	89	Inner
37	90	Inner
37	91	Inner
37	92	Inner
37	93	Inner
37	94	Inner
37	95	Inner
37	96	Inner
37	97	Inner
37	98	Inner
37	99	Inner
37	100	Inner
37	101	Inner
37	102	Inner
38	42	Inner
38	103	Inner
38	104	Inner
39	9	Inner
39	12	Inner
41	59	Inner

ID Saturn Zone	ID Paramics Zone	Type
42	60	Inner
42	117	Inner
42	118	Inner
43	61	Inner
58	55	Inner
62	57	Inner
64	45	Inner
75	54	Inner
84	3	Inner
85	50	Inner
86	43	Inner
86	105	Inner
86	106	Inner
86	107	Inner
87	58	Inner
88	21	Inner
22101	17	Boundary
22102	16	Boundary
22103	20	Boundary
22104	7	Boundary
22105	8	Boundary
22106	10	Boundary
22107	13	Boundary
22108	14	Boundary
22109	1	Boundary
22110	23	Boundary
22111	62	Boundary
22112	6	Boundary

3.5 Public Transport

The main bus routes in Great Yarmouth have been included in the model. Information regarding the timetables and routes followed by the different services was obtained from the official sites of public transport operators in Norfolk such as FIRST and Anglian Bus. The location of the bus stop and public transport vehicle types was collected by visual inspection of both Google street view and maps.

After careful examination of the available information, 12 public transport services were modelled along with their complete timetables and bus stops within the study area. The modelled PT routes are shown in Table 8 below:

Table 8 Modelled Public Transport Lines and allocated vehicle types

Bus Line	Vehicle Type
2	Single Decker Bus
4	Double Decker Bus
5	Single Decker Bus
6	Double Decker Bus
7	Double Decker Bus
8	Double Decker Bus
9	Double Decker Bus
X1	Double Decker Bus
X11	Double Decker Bus
1	Double Decker Bus
1A	Double Decker Bus

The route followed by the PT as well as the modelled bus stops are shown in Figures 11 and 12 below.

Figure 11 Modelled Public Transport Services

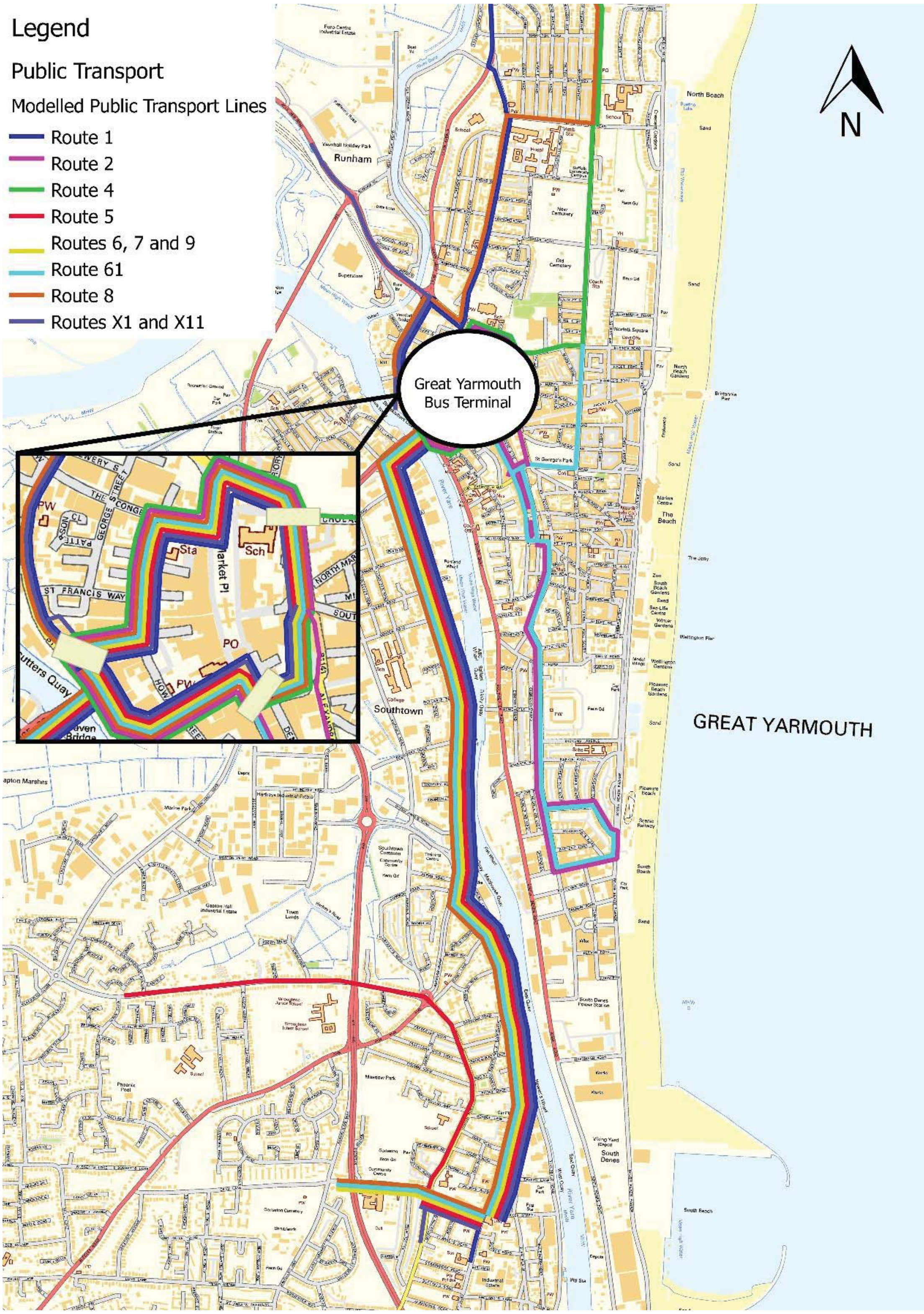


Figure 12 Modelled Public Transport Services

4 Demand Matrix Development

4.1 Prior Matrix Development

A 2008 base SATURN model of Great Yarmouth was previously developed by Mott MacDonald and a copy of the 2015 Do Minimum model was provided by NCC. The SATURN model covers a larger model area than the Paramics Discovery model and so the SATURN model was cordoned around the boundaries of the Paramics Discovery model network. Once the model was cordoned, the morning and evening peaks, as well as the interpeak matrices, were extracted for all of the user types included in the SATURN model.

The SATURN zone plan was adapted to the requirements of the Paramics Discovery model as described in Chapter 3. It was necessary to estimate the proportion of trips that the split zones represent from the main SATURN zone. This estimation considered the land use of the microsimulation zones and made reference to trip rates derived from the input parameters from the TRICS database (Gross floor area, dwellings, parking lots, etc.).

- For industrial zones, gross floor area in each sub-zone was used to calculate the proportion of trips assigned to that zone.
- For residential zones, number of dwellings in each sub-zones was used to calculate the proportion of trips assigned to that zone.
- For commercial zones, number of parking spaces was used to calculate the proportion of trips assigned to each new zone.
- When mixed land uses were observed the measured feature for each land use (dwellings, parking spaces, etc) was normalised and the trip proportion between the sub-zones was calculated.

The SATURN model has 5 user classes. The first three correspond to different purpose car trips. These three matrices were aggregated into one car matrix in order to keep the calibration and validation as simple as possible. The other two SATURN matrices correspond to LGV and HGV traffic.

Where traffic counts were available on boundary links of the microsimulation network, the O-D demand at the zone was factored up to the observed count. The cordoned SATURN matrices were only for one hour, so it was necessary to extend them in order to include the warm-up and cool-down periods. To do so, the traffic surveys are used to estimate the proportion of traffic between the peak hour and the previous and next hour. Next, the warm-up and cool-down matrices were added to the cordon matrix, thus creating the prior matrices for the full three hour period.

Further details of the prior matrices are shown in Appendix D.

The prior matrix was run on the base network to check and adjust network coding. An initial test of validation with the prior matrix indicated:

Table 9 Prior Matrix Validation

Matrix	Vehicle type	Count Percentage within 5 GEH	Count Percentage within 10 GEH
AM Prior	CAR	73%	95%
	LGV	94%	100%
	HGV	97%	100%
IP Prior	CAR	68%	92%
	LGV	94%	100%
	HGV	99%	100%
PM Prior	CAR	64%	89%
	LGV	96%	100%
	HGV	100%	100%

This was considered a good result for a prior matrix, nonetheless, in order to improve the accuracy of the model, it was considered necessary to use matrix estimation.

4.2 Matrix Estimation

The Matrix Estimation (ME) tool has been used to complete the calibration and validation of the microsimulation model. The traffic surveys have been normalised and the included in this process in order to enhance the estimation results.

The simulation of the prior matrices produced good results in terms of GEH. Nevertheless, the network experienced significant congestion which caused drivers to start using less desirable secondary routes or take long detours instead of the obvious routes along the main roads. An analysis of the prior matrices was undertaken and it was deemed that the demand was too large. The usual practice to produce better matrices in large and/or congested networks is to reduce the prior matrix demand by a percentage and use these matrices in the matrix estimation process. A reduction of 20% was applied to the prior matrices and then, the model was run again in order to generate routeing information which was fed into the matrix estimation process. This method reduces the likelihood of the prior matrix causing unrealistic delays which could then skew the matrix estimation process.

In order to prevent the ME process from changing the prior matrix too much, a set of constraints were applied. These constraints define the maximum and minimum number of vehicles entering and exiting a zone and so prevent the ME process from changing the prior matrix in an unrealistic way. Although this additional constraint may reduce the overall level of validation, it means the whole model is generally more robust and reliable.

Changes made by matrix estimation to OD zone totals were reviewed after every round of ME in order to check the trips were reasonable for the zones land use and size. The final trip matrices were obtained through the matrix estimation tool of Paramics Discovery using a maximum of one hundred iterations per round of ME.

The ME settings such as the number of iterations, traffic surveys, network delay and constraints were adjusted in order to achieve the optimum balance between changing the prior matrix and matching the traffic counts.

The changes made by ME to the prior matrix as well as the estimated matrices are shown in detail in Appendix E and Appendix F.

After carrying out the matrix estimation an analysis of the results was conducted through the Data Analysis Tool (DAT), comparing the traffic flows within the network and checking inconsistencies in flow distributions. In addition, the trip length distributions were calculated in order to better understand the variation between the prior and the estimated matrices of the short and long trips. Figure 13, 14 and 15 show the difference between the trip length distributions.

Figure 13 AM Trip Length Distribution

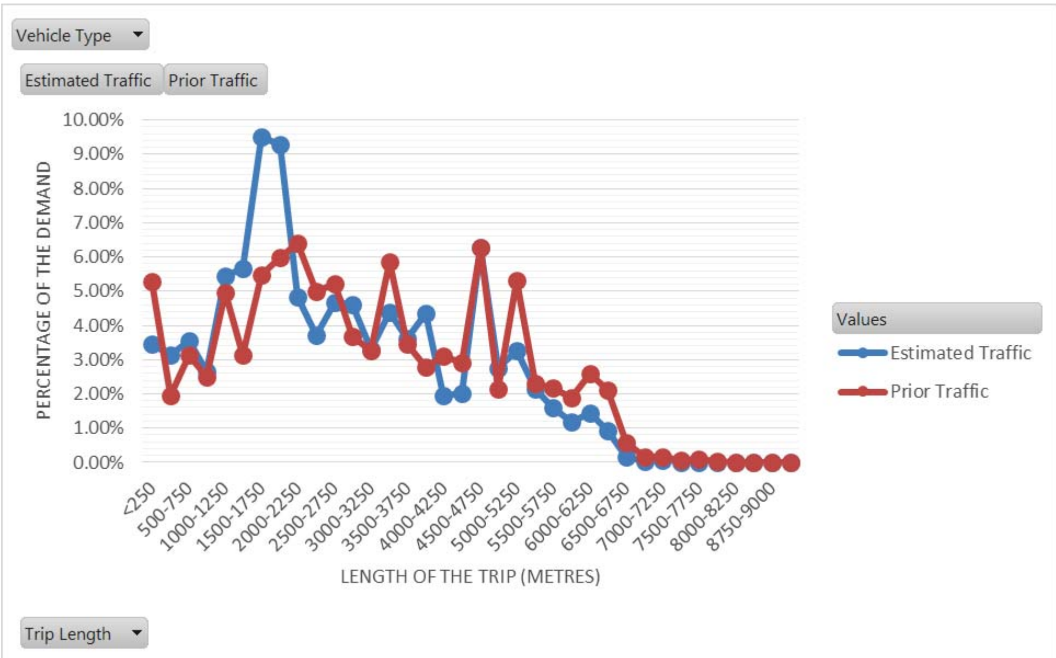


Figure 14 IP Trip Length Distribution

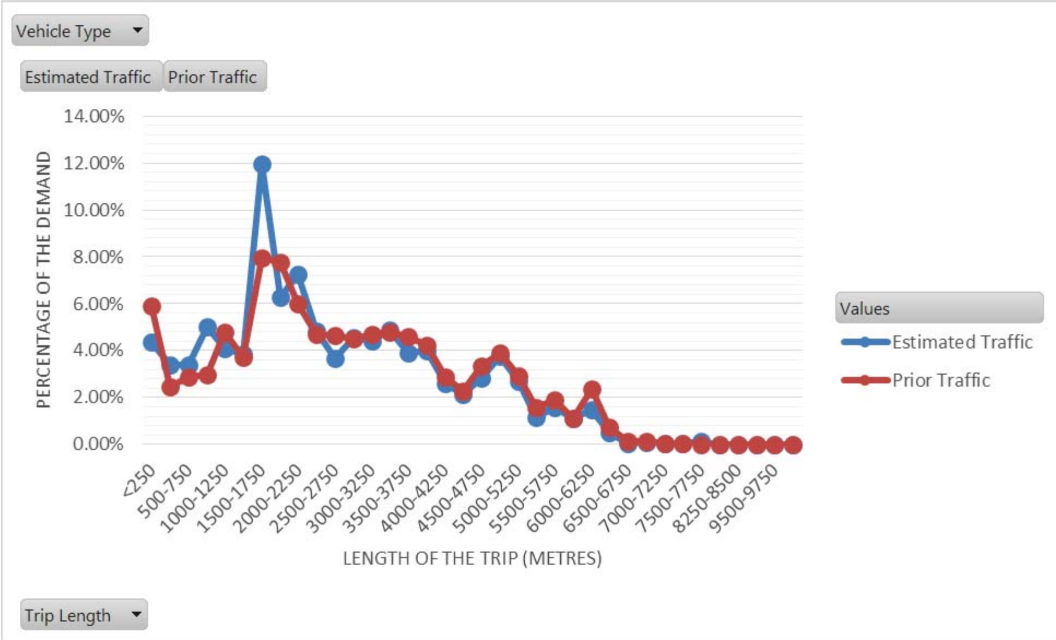
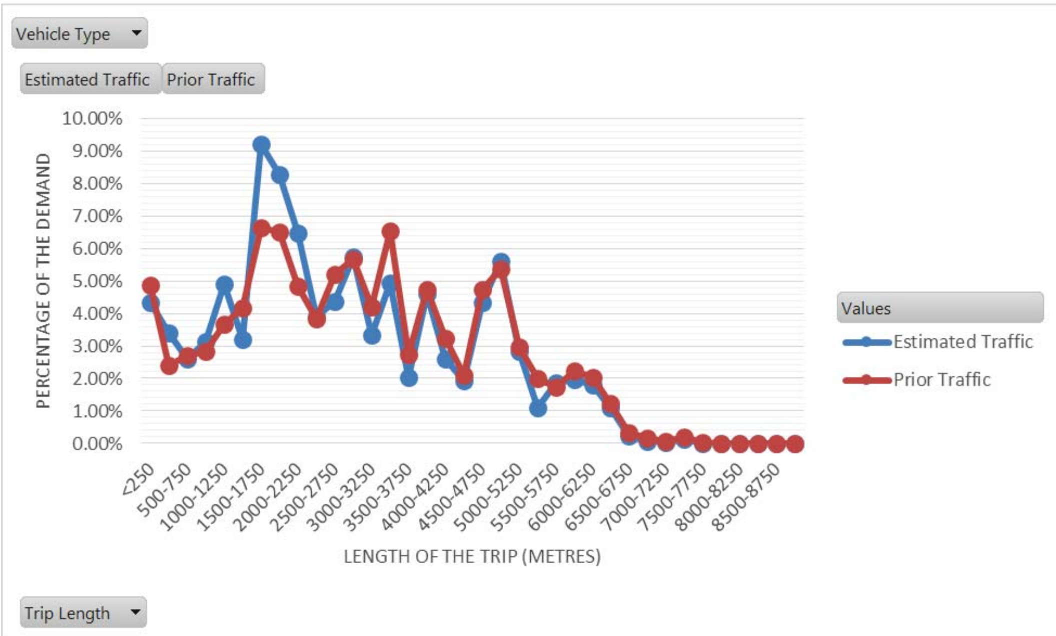


Figure 15 PM Trip Length Distribution



The graphs show a good fit of trip lengths between the prior matrix and the final matrix. Figures 13, 14 and 15 show large increases in the number of trips of approximately 2000m in length for the final matrix. This is typical for a matrix which has undergone the Matrix Estimation process as ME tends to add shorter trips to the prior matrix in order to satisfy other validation criteria. In conclusion, the matrix estimation has been carried out successfully in terms of trip length distribution for the three periods.

The net changes made to the total three-hour matrices by ME are summarised in Table 10 below:

Table 10 ME Changes Summary Table

Matrix	Vehicle type	Prior Matrix Total	Estimated Matrix Total	Difference	% Difference
AM	CAR	26740	27876	1136	4.25%
	LGV	3550	3944	394	11.10%
	HGV	720	846	126	17.52%
IP	CAR	34311	31052	-3259	-9.50%
	LGV	3985	4013	28	0.70%
	HGV	784	827	43	5.50%
PM	CAR	33313	31525	-1788	-5.37%
	LGV	3821	3588	-233	-6.10%
	HGV	565	494	-71	-12.59%

Table 10 compares the prior matrix %) and the estimated matrix, and shows trips have been added and subtracted as part of the ME process. The prior matrix had been reduced by 20% before the ME process had started and the table shows the further adjustments that the ME process has made to the matrix totals.

The IP period estimated matrix shows a closer match to the adjusted prior matrix, but it suggests that the 20% reduction was insufficient for the car matrix.

The PM period may have benefitted from a 25-30% reduction in the original prior matrix in order to reduce the computation required by the ME process in order to satisfy the validation criteria.

5 Validation Criteria

5.1 Model Stability

Paramics Discovery simulates the random daily variation that occurs in reality by using a random starting point (seed) for each individual model run. As such, no individual run result is the same as another. To reduce the impact of this simulated 'daily variation', average results from a minimum of five randomly seeded model runs have been used to provide aggregate results and reporting from the model that reduce the daily variation simulated by Paramics Discovery. This is to effectively create an 'average day' result.

As in the real world, microsimulation models do not have a 'convergence' value which defines if a network is stable or not. Instead, a review of variation in journey times is used to define how many model runs are required in order to provide stable results.

The test for stability for the model was conducted in accordance with the methodology recommended by SIAS, calculating the confidence interval to estimate the number of runs required. To calculate the confidence interval from a number (N) of randomly seeded runs the t statistic, as well as the Standard Error will be required.

In addition, a confidence level is needed to undertake the calculation; a typical value is 95% which means a significant level of 0.05 (p). Therefore, 95% of the time, the interval constructed would contain the true underlying population mean.

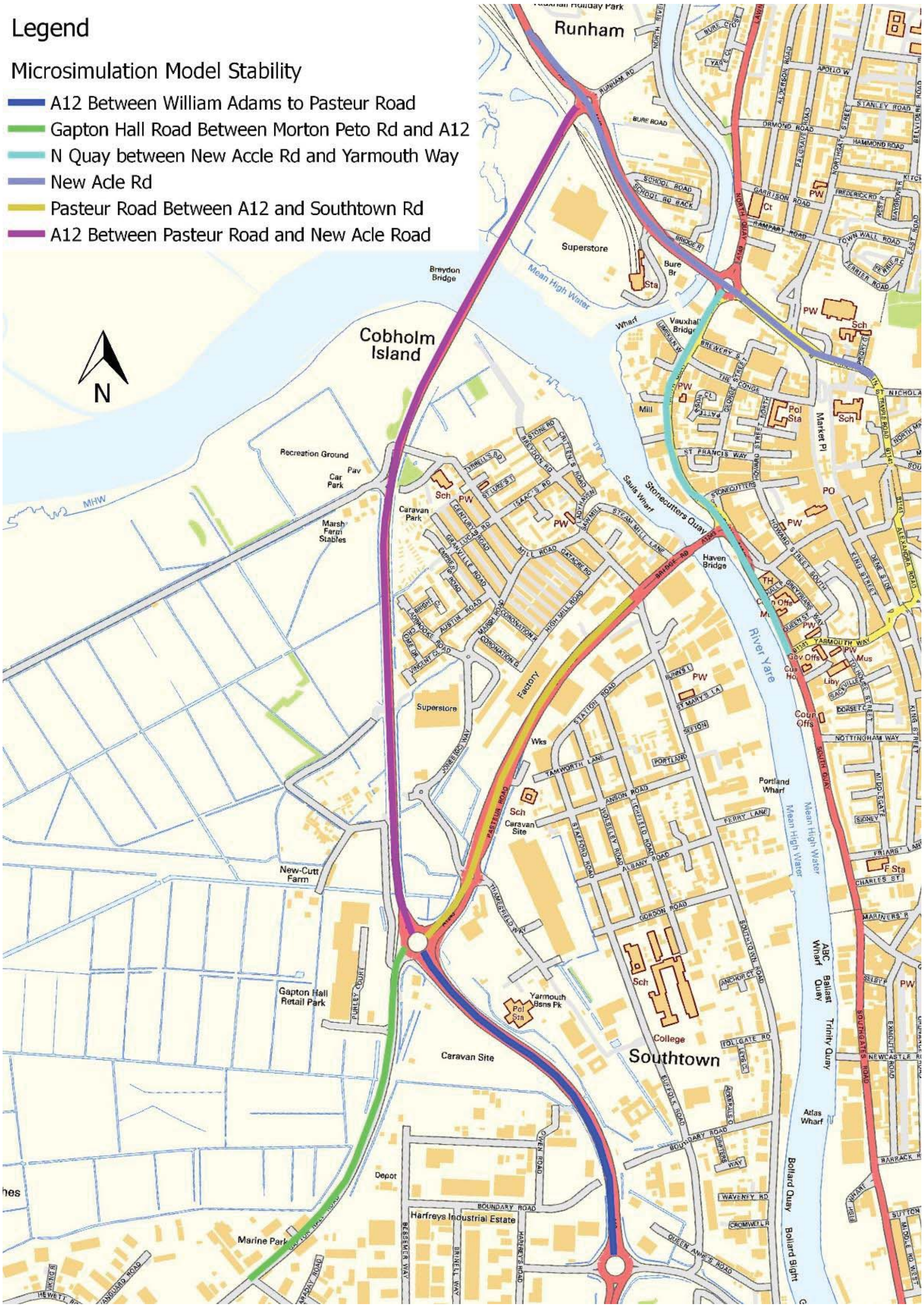
In summary, to demonstrate the stability of the model, the maximum and the minimum of the averages of journey times of each path and run must be included between the upper and lower limits of journey time values of the confidence interval.

The analysis was performed using a confidence level of 95% and 5 model runs. The stability of the model was carried out for AM, PM and IP periods.

Based on the log of 5 model runs, the journey time (JT) statistics along 14 routes were gathered. The average, maximum, minimum and the standard deviation of the journey times were calculated for each route and period.

The Figure 16 below shows the routes where journey times were analysed.

Figure 16 Journey time routes analysed



The results of the stability analysis are shown in Tables 11-13.

Table 11 AM Base Model Journey Times- 5 Runs

Period	Path Name	Average Journey Time (min)	StdDev (min)	Standard Error	T statistic	Lower Limit (p=0.05)	Min Journey Time (min)	Upper Limit (p=0.05)	Max Journey Time (min)	Stability Criteria fulfilled?
AM	NB Pasteur Road Roundabout to Accle New Road	1.7	0.02	0.01	2.78	1.7	1.7	1.8	1.8	Yes
AM	SB Pasteur Road Roundabout to Accle New Road	2.1	0.01	0.01	2.78	2.0	2.0	2.1	2.1	Yes
AM	NB Adams Roundabout to Pasteur Roundabout	1.2	0.05	0.02	2.78	1.2	1.2	1.3	1.3	Yes
AM	SB Adams Roundabout to Pasteur Roundabout	0.7	0.01	0.00	2.78	0.7	0.7	0.7	0.7	Yes
AM	NB Gapton Hall Road	1.4	0.09	0.04	2.78	1.3	1.3	1.6	1.6	Yes
AM	SB Gapton Hall Road	1.0	0.00	0.00	2.78	1.0	1.0	1.0	1.0	Yes
AM	NB Southtown Road	4.3	0.07	0.03	2.78	4.2	4.2	4.4	4.4	Yes
AM	SB Southtown Road	3.2	0.06	0.03	2.78	3.2	3.2	3.3	3.3	Yes
AM	NB Pasteur Road	2.0	0.08	0.04	2.78	1.9	1.8	2.1	2.1	No
AM	SB Pasteur Road	1.1	0.01	0.00	2.78	1.1	1.1	1.2	1.2	Yes
AM	NB Yarmouth Way to New Accle Road through S Quay Rd	1.9	0.08	0.04	2.78	1.8	1.8	2.0	2.0	Yes
AM	SB Yarmouth Way to New Accle Road through S Quay Rd	1.9	0.03	0.01	2.78	1.8	1.8	1.9	1.9	Yes
AM	NB Accle New Road	2.2	0.03	0.01	2.78	2.1	2.1	2.2	2.2	Yes
AM	SB Accle New Road	2.5	0.04	0.02	2.78	2.4	2.4	2.5	2.5	Yes

Table 12 IP Base Model Journey Times - 5 Runs

Period	Path Name	Average Journey Time (min)	StdDev (min)	Standard Error	T statistic	Lower Limit (p=0.05)	Min Journey Time (min)	Upper Limit (p=0.05)	Max Journey Time (min)	Stability Criteria fulfilled?
IP	NB Pasteur Road Roundabout to Accle New Road	1.8	0.03	0.01	2.78	1.8	1.8	1.8	1.8	Yes
IP	SB Pasteur Road Roundabout to Accle New Road	2.0	0.02	0.01	2.78	1.9	1.9	2.0	2.0	Yes
IP	NB Adams Roundabout to Pasteur Roundabout	1.1	0.08	0.03	2.78	1.1	1.1	1.2	1.3	No
IP	SB Adams Roundabout to Pasteur Roundabout	0.7	0.00	0.00	2.78	0.7	0.7	0.7	0.7	Yes
IP	NB Gapton Hall Road	1.3	0.04	0.02	2.78	1.2	1.2	1.3	1.3	Yes
IP	SB Gapton Hall Road	1.0	0.00	0.00	2.78	1.0	1.0	1.0	1.0	Yes
IP	NB Southtown Road	4.3	0.11	0.05	2.78	4.2	4.2	4.4	4.5	No
IP	SB Southtown Road	3.5	0.09	0.04	2.78	3.3	3.3	3.6	3.6	Yes
IP	NB Pasteur Road	2.1	0.10	0.04	2.78	2.0	2.0	2.2	2.3	No
IP	SB Pasteur Road	1.2	0.01	0.00	2.78	1.2	1.2	1.2	1.2	Yes
IP	NB Yarmouth Way to New Accle Road through S Quay Rd	2.0	0.03	0.01	2.78	2.0	2.0	2.1	2.1	Yes
IP	SB Yarmouth Way to New Accle Road through S Quay Rd	1.9	0.03	0.01	2.78	1.9	1.9	2.0	2.0	Yes
IP	NB Accle New Road	2.3	0.03	0.01	2.78	2.2	2.2	2.3	2.3	Yes
IP	SB Accle New Road	3.0	0.04	0.02	2.78	3.0	2.9	3.0	3.0	No

Table 13 PM Base Model Journey Times - 5 Runs

Period	Path Name	Average Journey Time (min)	StdDev (min)	Standard Error (min)	T statistic	Lower Limit (p=0.05)	Min Journey Time (min)	Upper Limit (p=0.05)	Max Journey Time (min)	Stability Criteria fulfilled?
PM	NB Pasteur Road Roundabout to Accle New Road	1.9	0.04	0.02	2.78	1.8	1.8	1.9	1.9	Yes
PM	SB Pasteur Road Roundabout to Accle New Road	2.0	0.04	0.02	2.78	1.9	1.9	2.0	2.0	Yes
PM	NB Adams Roundabout to Pasteur Roundabout	2.0	0.09	0.04	2.78	1.9	1.9	2.1	2.1	Yes
PM	SB Adams Roundabout to Pasteur Roundabout	0.7	0.03	0.01	2.78	0.7	0.7	0.8	0.8	Yes
PM	NB Gapton Hall Road	1.8	0.07	0.03	2.78	1.7	1.7	1.9	1.9	Yes
PM	SB Gapton Hall Road	1.0	0.00	0.00	2.78	0.9	1.0	1.0	1.0	Yes
PM	NB Southtown Road	5.0	0.15	0.07	2.78	4.8	4.8	5.1	5.2	No
PM	SB Southtown Road	3.8	0.09	0.04	2.78	3.7	3.7	3.9	3.9	Yes
PM	NB Pasteur Road	2.0	0.02	0.01	2.78	2.0	2.0	2.0	2.0	Yes
PM	SB Pasteur Road	1.2	0.01	0.00	2.78	1.2	1.2	1.2	1.2	Yes
PM	NB Yarmouth Way to New Accle Road through S Quay Rd	2.6	0.16	0.07	2.78	2.4	2.3	2.8	2.7	No
PM	SB Yarmouth Way to New Accle Road through S Quay Rd	1.9	0.04	0.02	2.78	1.9	1.9	2.0	2.0	Yes
PM	NB Accle New Road	2.9	0.18	0.08	2.78	2.7	2.6	3.1	3.1	No
PM	SB Accle New Road	2.8	0.04	0.02	2.78	2.7	2.7	2.8	2.8	Yes

81% (34 of 42) of the journey time samples are within their corresponding confidence interval. For the samples which are not within the limits, the differences are all within 0.1 min which means maximum differences of 6 seconds.

In conclusion, 5 is the minimum number of runs required to gather stable data from the model.

5.2 Model Features

Within a Paramics Discovery network, there are a series of parameters that provide the overall configuration for each model. These parameters are part of the calibration and validation process, such as controlling the aggressiveness of the drivers or their network knowledge. These parameters include:

- Link Categories
- Configuration
- Vehicles
- Public Transport Stop Times
- Acceleration profiles

Where parameters vary from standard inputs these are summarised in the section below:

5.2.1 Link Categories

The default categories were adopted to model the highway network in Great Yarmouth with some exceptions in secondary routes. The exceptions are described below:

- William Adams Industrial Estate. The road which connects William Adams Roundabout and Gapton Hall Road was a rat-run used by many familiar drivers when the cost of using the A12 increased slightly due to the queues at the Pasteur Road Roundabout. Furthermore, drivers continued to use the industrial estate route even when the queues on the A12 had dissipated. In order to reproduce the queues at the Pasteur Road Roundabout, it was necessary to reduce the attractiveness of the minor road. The solution recommended by SIAS involved increasing the cost of the access and egress links of the industrial estate until reaching a balance between the numbers of drivers using each route. Eventually, an increase of 20% over the cost of each access/egress link was set.

- Some secondary roads were used by familiar drivers to either avoid congestion in main and minor roads or reduce the length of their trips. After careful analysis of the highway conditions and routeing decisions, it was deemed that several of these roads would be rarely used by drivers due to on-street activities such as parking, which in many cases effectively closed a lane. In addition to this, traffic calming measures such as carriageway narrowing would have a negative impact on drivers choosing these routes in the real world. Two solutions were applied in these areas: the first of them involved increasing the cost of the links by 50 percent and reducing the travelling speed down to 10 miles per hour. The second one involved modelling the narrowing in the carriageway as if it were an intersection with give-way priorities where vehicles are forced to stop before the crossing.
- Vehicle restrictions were found on some town centre roads and these were added to the model. They include stretches of bus lanes (Fuller's Hill and Market Gates Bus Terminal) and one road for which access is allowed only for loading and unloading goods (King Street).

5.2.2 *Configuration*

Input parameters were retained as default wherever possible. Those that have been changed are listed below:

- Start time was changed from 00:00 and 07:00, 12:00 and 15:30, to reproduce the morning, interpeak and evening peak periods, the duration was amended from one hour to three hours in order to include the warm-up, peak and cold-down hours.
- In order to reproduce in an accurate manner the route choices of the diverse users, different coefficients have been established for cost calculation. The Generalised Cost Equation used by Paramics Discovery is as follows:

$$GC = aT + biD + cjP$$

Where,
"a" is the time coefficient in pence per second.
"T" is the travel time.
"b" is the distance coefficient in pence per mile.
"D" is the distance in miles.
"i" is a constant which value is 60.
"c" is the toll coefficient.
"j" is the toll unit conversion factor.
"P" is the toll price.

The toll features are not applicable as there aren't any toll roads within the study area. The coefficients for carrying out the GC calculation were obtained from SATURN model and are shown in Table 14 below:

Table 14 Generalised Cost Coefficients

Vehicle Type	a	b
Cars	0.379	0.233
Light Goods Vehicle	0.360	0.236
Medium Goods Vehicle	0.278	0.733
Heavy Goods Vehicle	0.278	0.733
Coach	0.278	0.733

- Delay feedback was enabled, as the network extent is large enough and thus there is real route choice and then the possibility of Dynamic Routeing for familiar drivers. The interval at which familiar drivers will re-calculate their routes has been slightly amended from 2 minutes to 1 minute, while the smoothing factor default value of 0.5 was retained.

5.2.3 *Vehicles*

Standard Paramics Discovery vehicles have been used, and include Car, Light Goods Vehicle, Medium Goods Vehicle, Heavy Goods Vehicles, Coach, Single Decker Bus and Double Decker Bus.

The Single and Double Decker Buses categories were used for modelling the public transport routes in Great Yarmouth. Cars and LGVs were modelled separately with separate demand matrices. MGV, Coaches and HGVs were aggregated into a single matrix and are referred to as HGVs from hereon in. The following table shows the proportion of vehicle types in the HGV group for each modelled period:

Table 15 Proportion of Heavy Vehicles

	Proportions		
Vehicle Type	AM	IP	PM
Medium Goods Vehicles	65	66	68
Heavy Goods Vehicles	30	29	27
Coaches	5	5	5

5.2.4 *Public Transport Stop times*

The default value of 0 was considered unrealistic so it was increased to 40 seconds.

5.2.5 *Acceleration Profiles*

Default acceleration profiles were applied to all models.

5.3 Calibration of Junctions

During the model calibration process, it was necessary to adjust the coding of the Fullers Hill roundabout to include three circulatory lanes on some sections. This is in accordance with calibration guidance from SIAS (the software manufacturer for Paramics Discovery). This improves vehicle give-way behaviour where there are multi-lane entries and exits and is unlikely to overestimate capacity. On the North Quay approaches, gap acceptance parameters which control the space vehicles leave when pulling out into opposing traffic streams, have been reduced. This was necessary to achieve the level of throughput recorded in the survey.

Moreover, some parameters such as visibility, headway factor, gap acceptance and look through have been amended to replicate the observed behaviour of some network elements and validation purposes of queue lengths and traffic flows. The following describes the changes to the parameters mentioned above:

- Headway factor. It was necessary to reduce the headway factor at the signalised junction between Pasteur Rd and Southtown Rd to adjust throughput and queue lengths. The same modification was carried out in Acle New Roundabout with North Quay and seeking the same results.
- Gap Acceptance. In order to replicate the real behaviour of drivers waiting in very congested links, the gap acceptance parameter was reduced in several junctions such as Acle Road Roundabouts, A12 Roundabouts and two minor intersections: James Watt Close and Morton Peto Rd with Gapton Hall Road.
- Look Through. The feature is deactivated by default. Nevertheless, it is necessary to activate the “look through” in approaching roads of roundabouts when the access/egress road are modelled in two different links. Once the feature is activated, vehicles approaching the junction take into account the vehicles driving through the roundabout in their gap acceptance calculations.
- Visibility. This feature applies to vehicles about to use a medium or minor priority movement across a junction. It defines the distance from the junction node where vehicles begin to anticipate available gaps in the major priority flow. A value less than the waitline distance from the node forces vehicles to stop at the waitline before looking for gaps” (2014 S-Paramics Reference Manual 4-54). The default value is 0 and it leads to unrealistic driving behaviours forcing vehicles to stop when they reach the intersection. The visibility value has been increased in all the roundabouts and Gapton Hall Road intersection with James Watt Close and Morton Peto Roads.

Table 16 shows the difference between the default values and those included in the model.

Table 16 Junction Calibration

Paramics Discovery Feature	Default Value	Set Value	Site
Number of lanes	2	3	Fullers Roundabout - Some inner sections
Gap Acceptance Lane Merge	4	0.75	Fullers Roundabout - North Approach
		1.5	Fullers Roundabout - South Approach
		2	Fullers Roundabout - Inner Section
		2	Vauxhall Roundabout - West Approach
		2	William Adams Roundabout - North Approach
		1.5	Gapton Hall Roundabout - South Approach
		3	James Watt Close with Gapton Hall - James Watt Close
		3	Morton Peto Road with Gapton Hall - Morton Peto Road
Gap Acceptance Lane Cross	4	0	Fullers Roundabout - North Approach
		1	Fullers Roundabout - South Approach
		2	Fullers Roundabout - Inner Section
		2	Vauxhall Roundabout - West Approach
		2	William Adams Roundabout - North Approach
		1	Gapton Hall Roundabout - South Approach
		3	James Watt Close with Gapton Hall - James Watt Close
		3	Morton Peto Road with Gapton Hall - Morton Peto Road
Gap Acceptance Path Cross	3	1	Fullers Roundabout - North Approach
		3	Vauxhall Roundabout - West Approach
		3	William Adams Roundabout - North Approach
		3	Gapton Hall Roundabout - South Approach
		2	James Watt Close with Gapton Hall - James Watt Close
		1	James Watt Close with Gapton Hall - Gapton Hall
		2	Morton Peto Road with Gapton Hall - Morton Peto Road
		1	Morton Peto Road with Gapton Hall - Gapton Hall
Headway Factor	1	0.25	Pasteur Road with Southtown Junction - East and West (3 lanes) approaches
		0.50	Pasteur Road with Southtown Junction - North and South approaches
		0.5	Pasteur Road with Southtown Junction - West (2 lanes) approach
		0.5	Station Road with Southtown Junction - West and South approaches
		0.5	Fuller Hills Roundabout - North approach and some inner sections
Look Through	Inactive	Active	Fullers Roundabout
			Vauxhall Roundabout
			William Adams Roundabout
			Gapton Hall Roundabout
			Pasteur Road Roundabout (A1243)
			Burgh Road Roundabout
Visibility	0	15	Fullers Roundabout - East and North approaches
		20	Fullers Roundabout - South approach
		20	Vauxhall Roundabout - All approaches
		20	William Adams Roundabout - West and East approaches
		30	William Adams Roundabout - South and North approaches
		20	Gapton Hall Roundabout - West and East approaches
		25	Gapton Hall Roundabout - South and North approaches
		15	Pasteur Road Roundabout (A1243) - West and East approaches
		20	Pasteur Road Roundabout (A1243) - South and North approaches
		5	James Watt Close with Gapton Hall
		5	Morton Peto Road with Gapton Hall
		15	Burgh Road Roundabout - All approaches

5.4 Count Comparison

The model has been calibrated in accordance with the Department for Transport (DfT) Transport Appraisal Guidance (TAG) unit M3.1. GEH is used as a method of comparing modelled flows with observed traffic count data. TAG gives a guideline criteria of 85% of modelled counts within a GEH value of 5. Table 17 presents the GEH statistics for the post matrix estimation flows. Appendix G includes the GEH for all the turns. All periods show more than 85% of modelled flows within a GEH of 5, exceeding the TAG Link Flow and Turning Movement Validation and Acceptability Guidelines (TAG 3.2.8).

Table 17 Count Validation Results

Matrix	Vehicle type	Count Percentage within 5 GEH	Count Percentage within 10 GEH
AM Prior	CAR	89%	100%
	LGV	98%	100%
	HGV	96%	100%
IP Prior	CAR	94%	100%
	LGV	99%	100%
	HGV	100%	100%
PM Prior	CAR	88%	99%
	LGV	100%	100%
	HGV	100%	100%

5.5 Queue length comparison

There is no threshold for the acceptability of modelled versus observed queue lengths in DMRB. Precise validation of queue lengths can be difficult because of the volatility of the observed data (DMRB Volume 12).

Furthermore, in some situations, the length of the queues is not easily appreciable, for instance, extremely long queues or queues measured in locations where obstacles complicate the queue recordings.

Once the survey data was normalised as described in Section 0, a total of 122 queue measurements were included in the queue validation process.

In order to assess the fitness of the model to reproduce the queues in the network, a comparison between the observed and modelled queues has been performed. The following table shows the percentage of queues in the model with a difference of below 5 or 10 PCUs when compared with the observed queues.

Table 18 Queue Validation

Time Period	Difference <= 5 PCUs	Difference <= 10 PCUs
AM	70%	85%
IP	74%	89%
PM	66%	83%

Further details regarding queue validation are shown in Appendix H.

5.6 Travel Time comparison

The travel time validation was carried out in accordance with the Transport Analysis Guidance (TAG). An analysis of the difference between the modelled and the observed journey times (JT) was conducted following the criteria shown below:

Table 19 Journey Time Validation Criteria in accordance with TAG

Journey Time Validation Criteria and Acceptability Guideline	
Criteria	**Acceptability Guideline**
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher than 15%)	>85% Routes

The journey time validation results are as follows:

Table 20 AM Period Journey Time Validation

Routes	Average 07:00-08:00		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	109	98	*-11*	*-10%*	*125*	*93*	*169*	*49*	✔
SB Pasteur Road Roundabout to Accle New Road	116	124	*8*	*7%*	*134*	*99*	*176*	*56*	✔
NB Adams Roundabout to Pasteur Roundabout	62	66	*4*	*7%*	*71*	*52*	*122*	*2*	✔
SB Adams Roundabout to Pasteur Roundabout	48	41	*-7*	*-14%*	*55*	*40*	*108*	*-12*	✔

Routes	Average 08:00-09:00		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	119	102	*-18*	*-15%*	*137*	*101*	*179*	*59*	✔
SB Pasteur Road Roundabout to Accle New Road	125	126	*1*	*1%*	*144*	*106*	*185*	*65*	✔
NB Adams Roundabout to Pasteur Roundabout	104	100	*-4*	*-4%*	*120*	*89*	*164*	*44*	✔
SB Adams Roundabout to Pasteur Roundabout	53	42	*-11*	*-21%*	*61*	*45*	*113*	*-7*	✔

Routes	Average 09:00-10:00		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	123	100	*-23*	*-19%*	*142*	*105*	*183*	*63*	✔
SB Pasteur Road Roundabout to Accle New Road	123	124	*1*	*0%*	*142*	*105*	*183*	*63*	✔
NB Adams Roundabout to Pasteur Roundabout	67	61	*-6*	*-8%*	*76*	*57*	*127*	*7*	✔
SB Adams Roundabout to Pasteur Roundabout	49	41	*-8*	*-17%*	*57*	*42*	*109*	*-11*	✔

Table 21 IP Period Journey Time Validation

Routes	Average 12:00-13:00		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	130	102	*-28*	*-22%*	*150*	*111*	*190*	*70*	✔
SB Pasteur Road Roundabout to Accle New Road	125	118	*-7*	*-6%*	*144*	*106*	*185*	*65*	✔
NB Adams Roundabout to Pasteur Roundabout	109	78	*-31*	*-29%*	*125*	*93*	*169*	*49*	✔
SB Adams Roundabout to Pasteur Roundabout	52	41	*-11*	*-21%*	*60*	*44*	*112*	*-8*	✔

Routes	Average 13:00-14:00		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	133	100	*-33*	*-25%*	*153*	*113*	*193*	*73*	✔
SB Pasteur Road Roundabout to Accle New Road	125	117	*-9*	*-7%*	*144*	*107*	*185*	*65*	✔
NB Adams Roundabout to Pasteur Roundabout	98	60	*-39*	*-39%*	*113*	*83*	*158*	*38*	✔
SB Adams Roundabout to Pasteur Roundabout	52	40	*-12*	*-22%*	*60*	*44*	*112*	*-8*	✔

Routes	Average 14:00-15:00		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	145	102	*-44*	*-30%*	*167*	*124*	*205*	*85*	✔
SB Pasteur Road Roundabout to Accle New Road	127	118	*-9*	*-7%*	*146*	*108*	*187*	*67*	✔
NB Adams Roundabout to Pasteur Roundabout	82	64	*-17*	*-21%*	*94*	*69*	*142*	*22*	✔
SB Adams Roundabout to Pasteur Roundabout	51	40	*-11*	*-21%*	*59*	*43*	*111*	*-9*	✔

Table 22 PM Period Journey Time Validation

Routes	Average 15:30-16:30		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	156	105	*-51*	*-33%*	*180*	*133*	*216*	*96*	✔
SB Pasteur Road Roundabout to Accle New Road	128	116	*-12*	*-10%*	*147*	*109*	*188*	*68*	✔
NB Adams Roundabout to Pasteur Roundabout	126	76	*-50*	*-39%*	*145*	*107*	*186*	*66*	✔
SB Adams Roundabout to Pasteur Roundabout	55	42	*-13*	*-24%*	*64*	*47*	*115*	*-5*	✔

Routes	Average 16:30-17:30		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	172	106	*-66*	*-38%*	*198*	*147*	*232*	*112*	!
SB Pasteur Road Roundabout to Accle New Road	129	122	*-7*	*-5%*	*149*	*110*	*189*	*69*	✔
NB Adams Roundabout to Pasteur Roundabout	205	101	*-104*	*-51%*	*236*	*175*	*265*	*145*	!
SB Adams Roundabout to Pasteur Roundabout	71	44	*-27*	*-38%*	*82*	*61*	*131*	*11*	✔

Routes	Average 17:30-18:30		Difference	% Difference	Range +/- 15%		Range +/- 60secs		Check
	Observed (Secs)	Modelled (Secs)							
NB Pasteur Road Roundabout to Accle New Road	147	107	*-41*	*-28%*	*169*	*125*	*207*	*87*	✔
SB Pasteur Road Roundabout to Accle New Road	129	164	*35*	*27%*	*149*	*110*	*189*	*69*	✔
NB Adams Roundabout to Pasteur Roundabout	92	238	*146*	*158%*	*106*	*78*	*152*	*32*	!
SB Adams Roundabout to Pasteur Roundabout	52	51	*-1*	*-1%*	*60*	*44*	*112*	*-8*	✔

In conclusion, JT validation criteria have been successfully fulfilled during the three periods. During the PM period, three routes do not achieve the acceptability guidelines in accordance with TAG along the A12 between William Adams Roundabout and Pasteur Roundabout. However, considering the 36 JT measurements collected for validation purposes, the guideline was achieved in the 91% of the routes. Therefore, the model is considered suitable to replicate the real JT between different points of the network.

6 Conclusions

A 2016 morning, interpeak and evening peak period base model of Great Yarmouth has been produced using Paramics Discovery microsimulation software extending the existing ‘Town Centre’ model.

The model has been produced using 2016 average traffic, calculated from existing and new survey data as well as the cordoned demand matrix from the 2008 DM SATURN model provided by NCC.

Model stability has been checked based on journey time variance between individual model runs. The model exceeds TAG validation criteria for comparison of observed and modelled traffic counts. Modelled and observed queue lengths have been compared and found to be consistent with the majority of junction approaches. The journey time has been checked and TAG acceptability guidelines have been successfully fulfilled. Model simulations have been observed to check for realistic and reasonable vehicle behaviour.

In conclusion, the model is deemed to provide a valid representation of real world network conditions in Great Yarmouth. The model is therefore considered fit for the purpose of testing the impact that the proposed Third River Crossing has on the local highway network.

APPENDIX A. Traffic Counts

Figure 1 Traffic counts peak hour – Pasteur Road Roundabout


HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

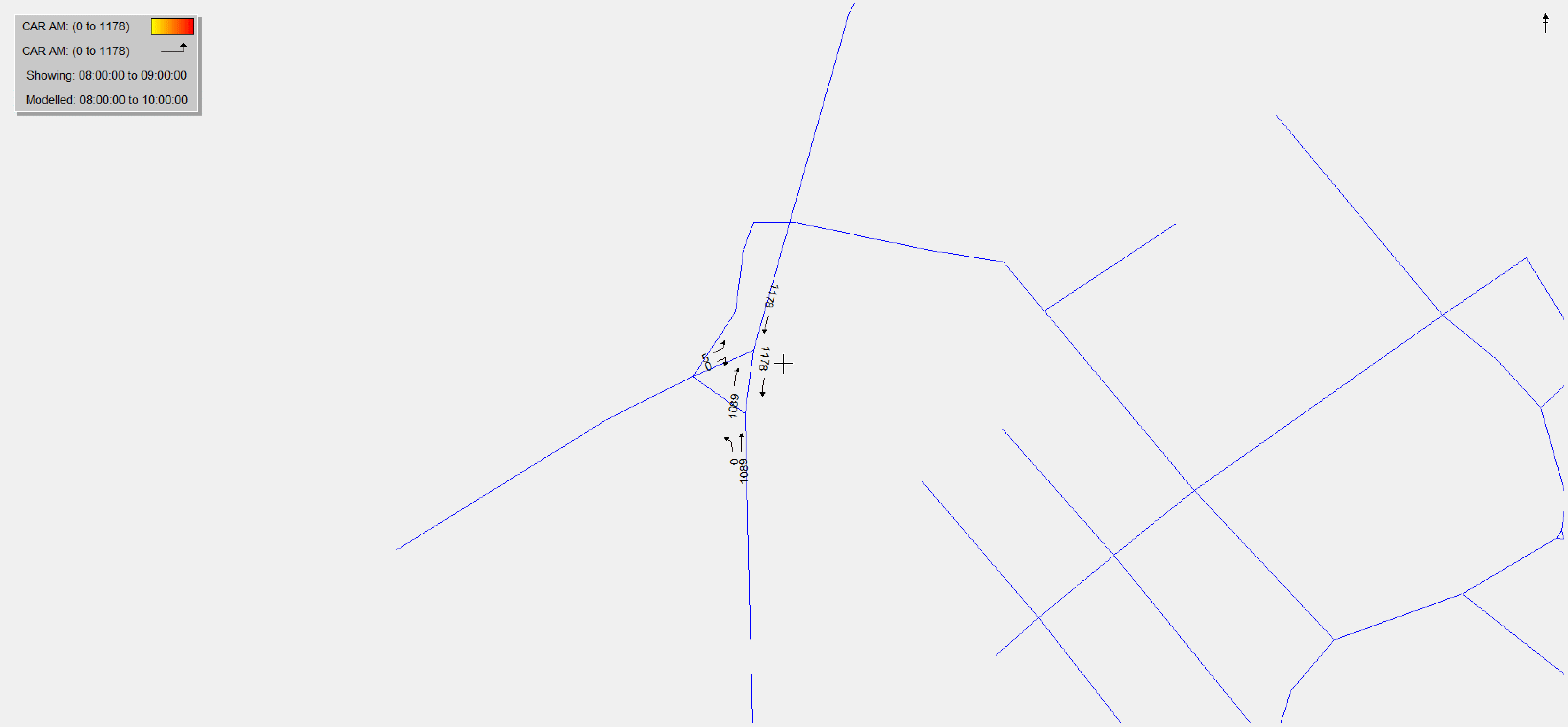
LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

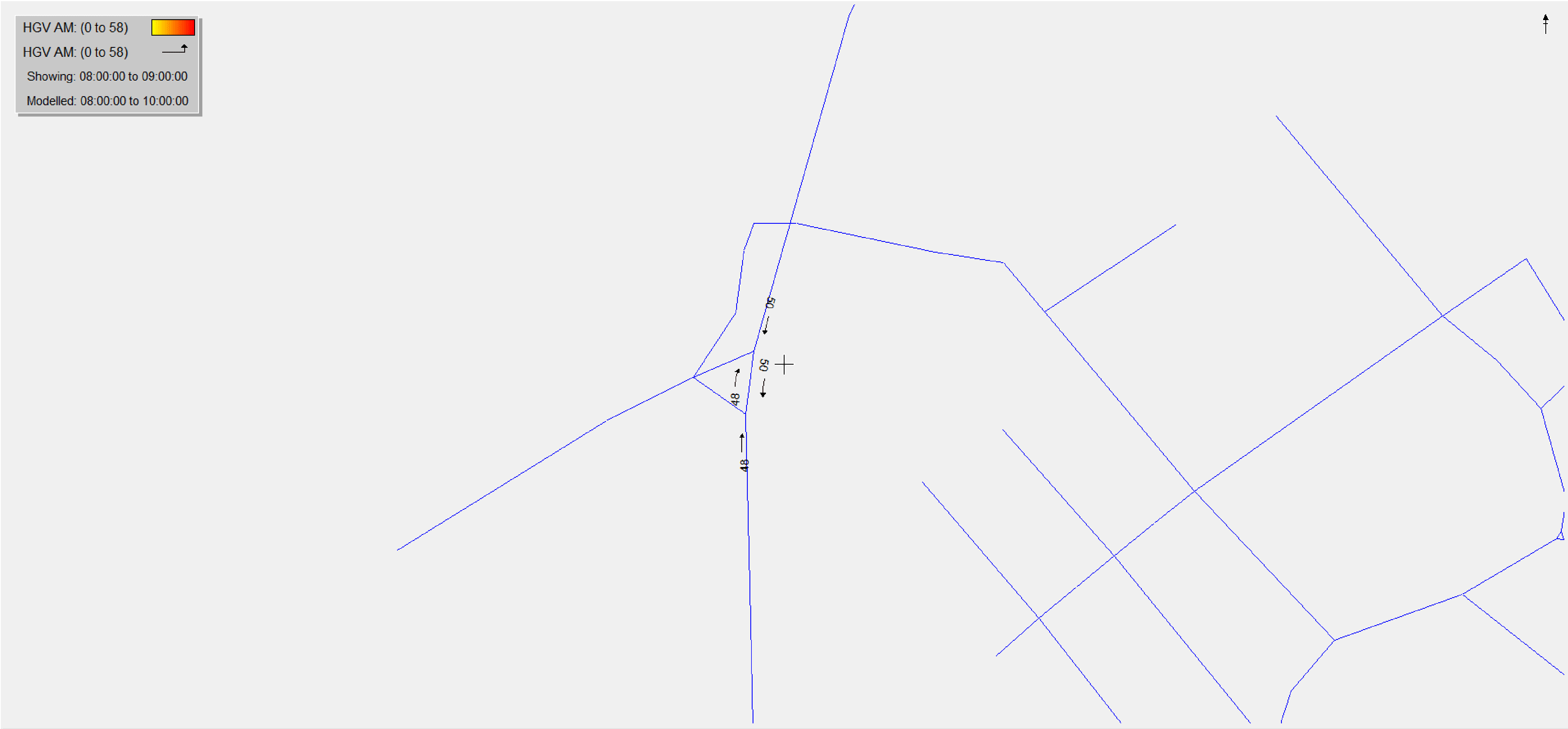

CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

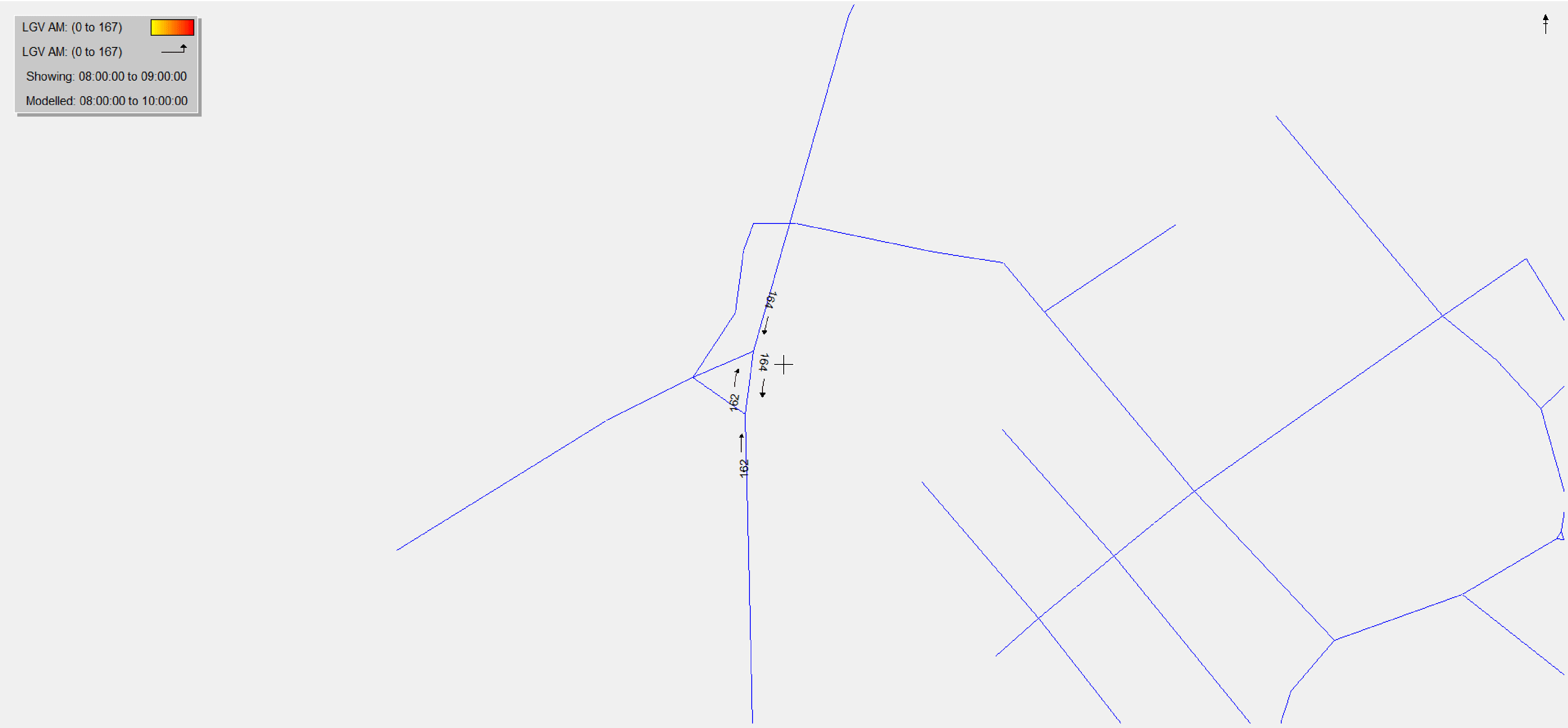

HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

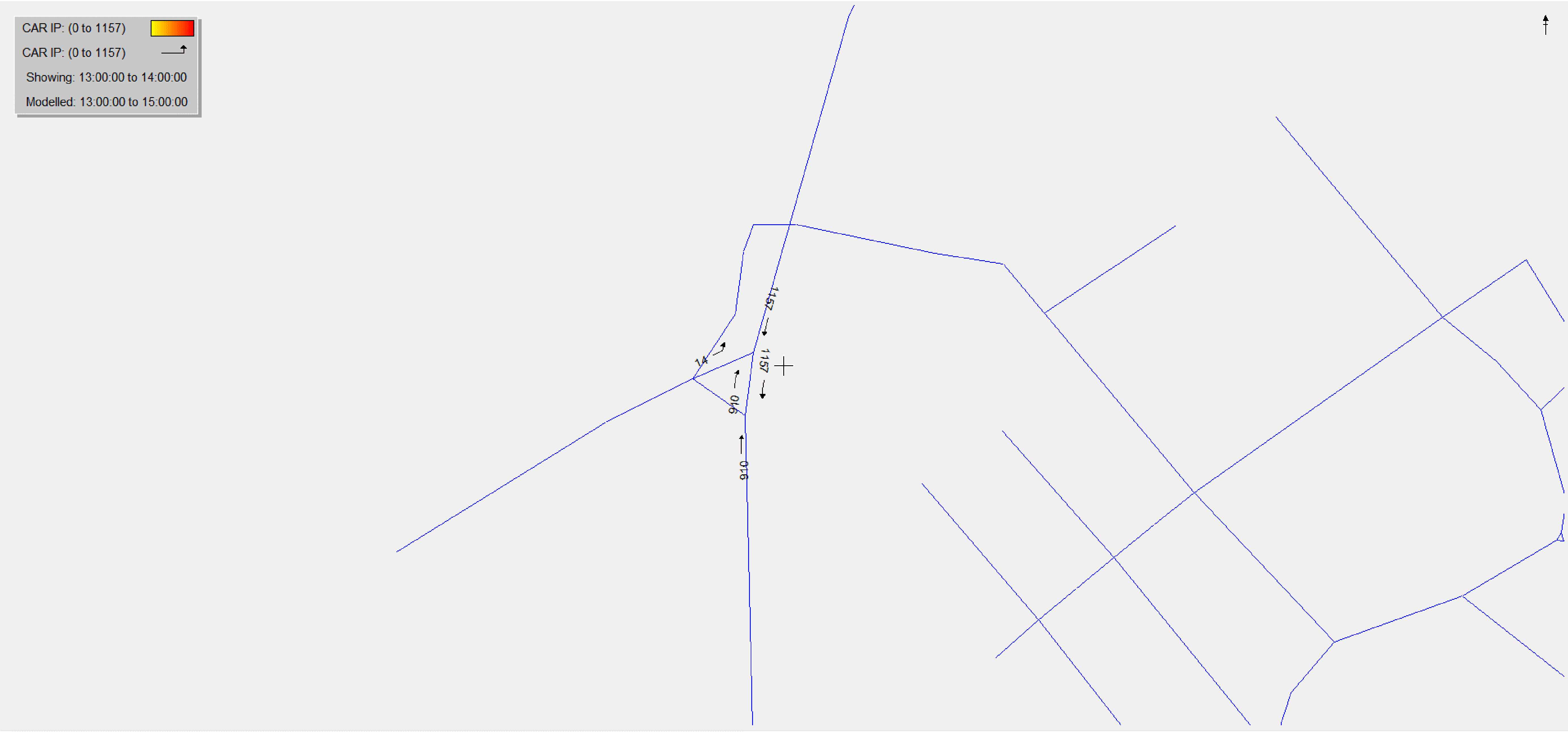
LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

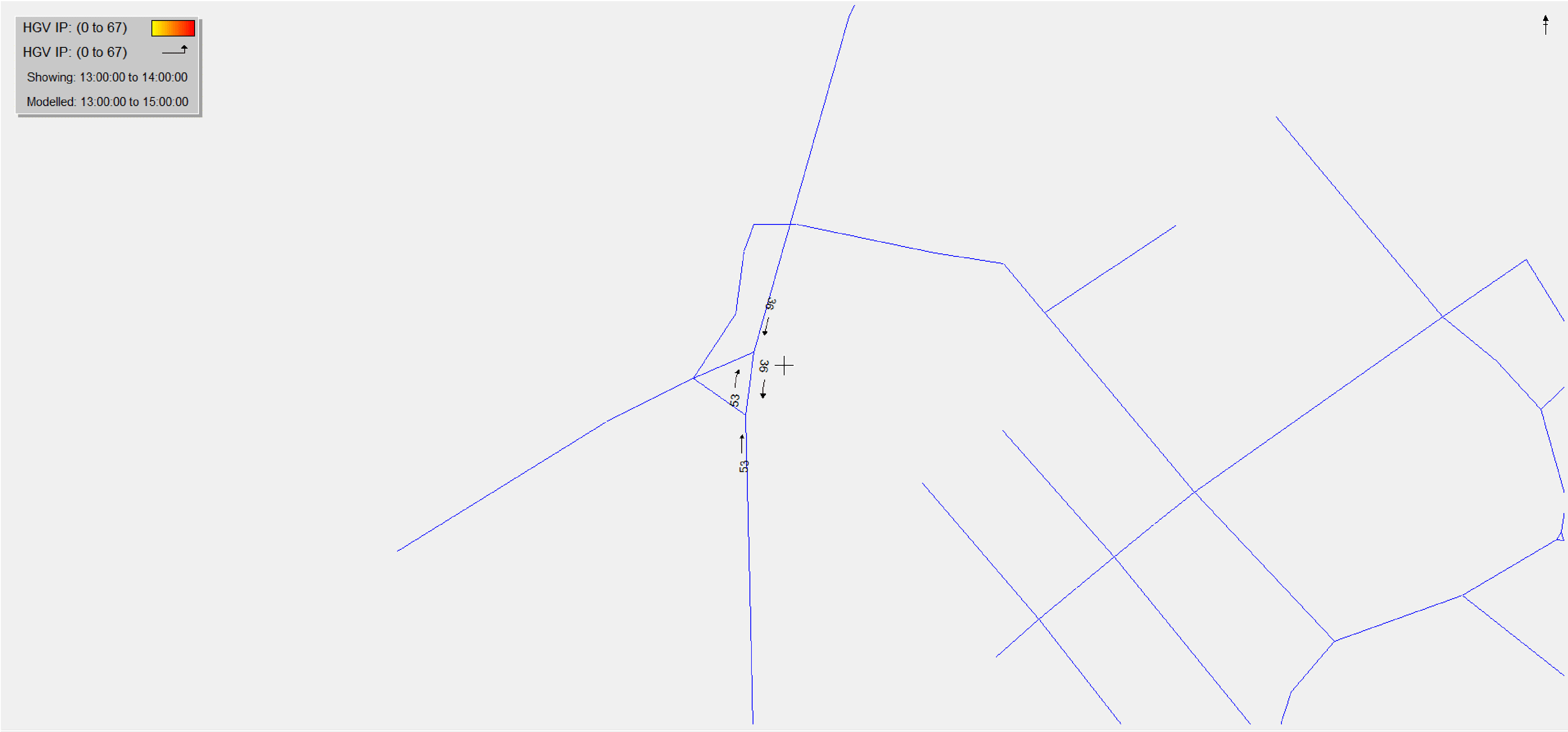
Figure 2 Traffic counts peak hour – A12 Rugby Club

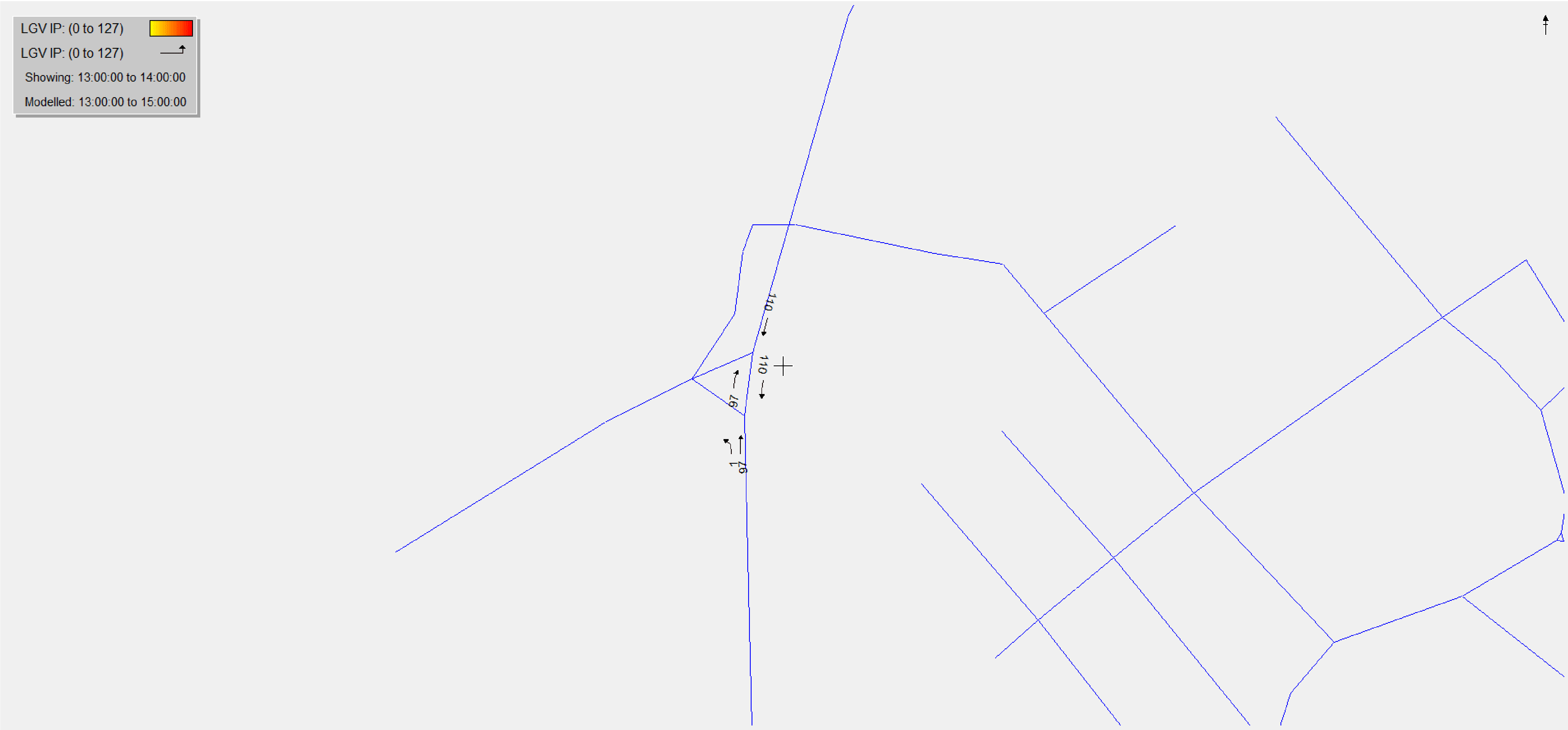


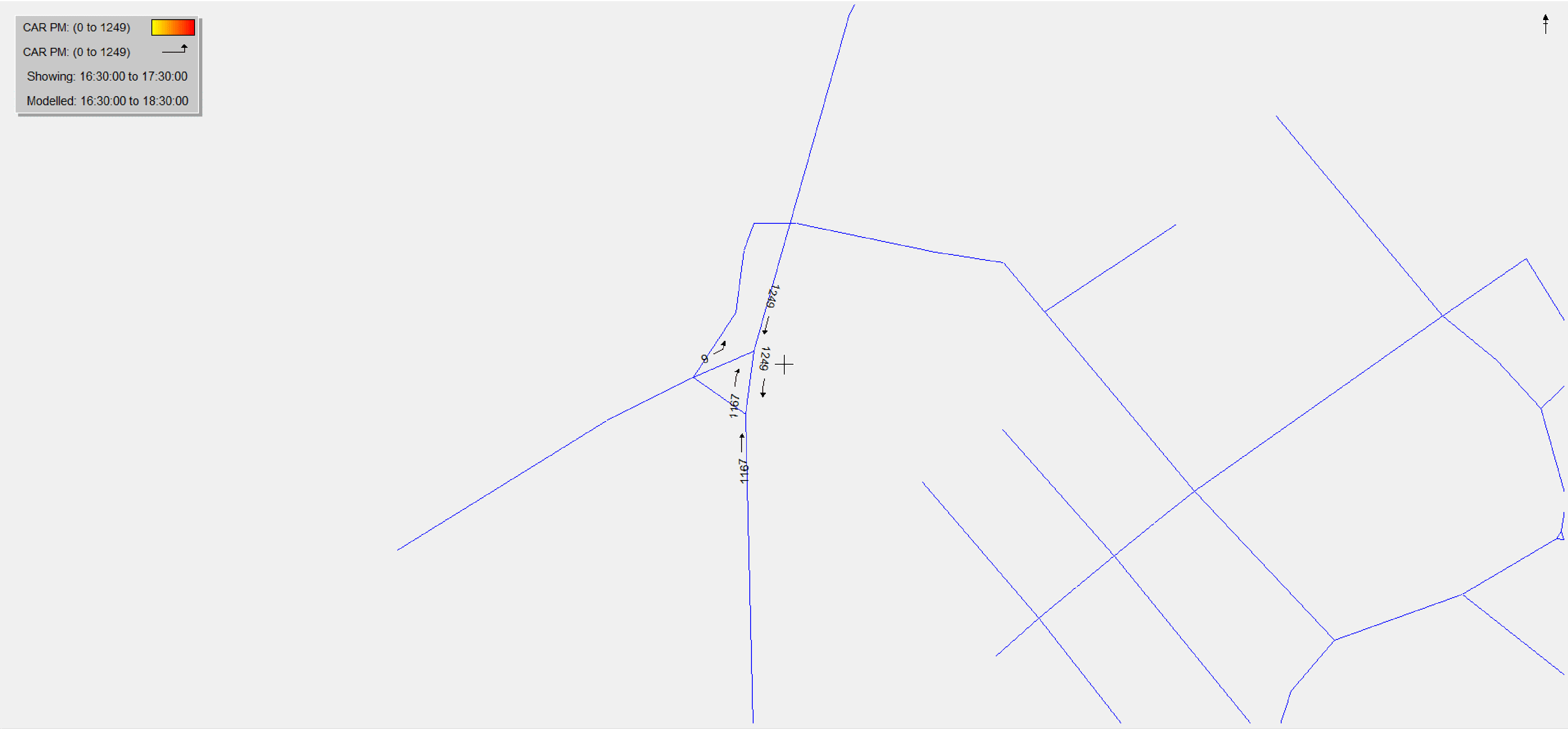

HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00
50
50
48
48

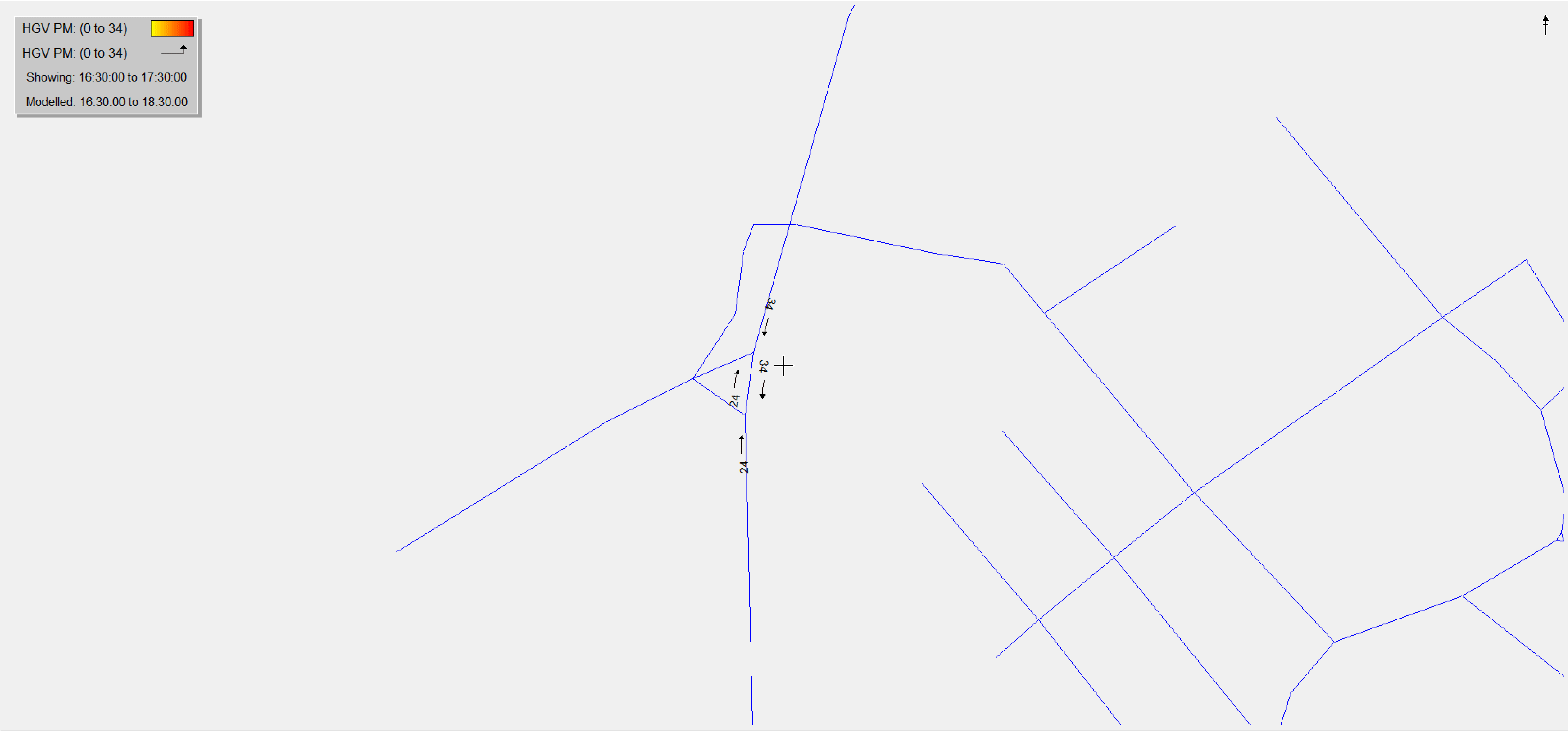

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00
164
164
162
162


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
1157
1157
14
916
916


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
36
36
53
53


LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
110
110
97
97
1


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00
1249
1249
9
1167
1167


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00
34
34
24
24

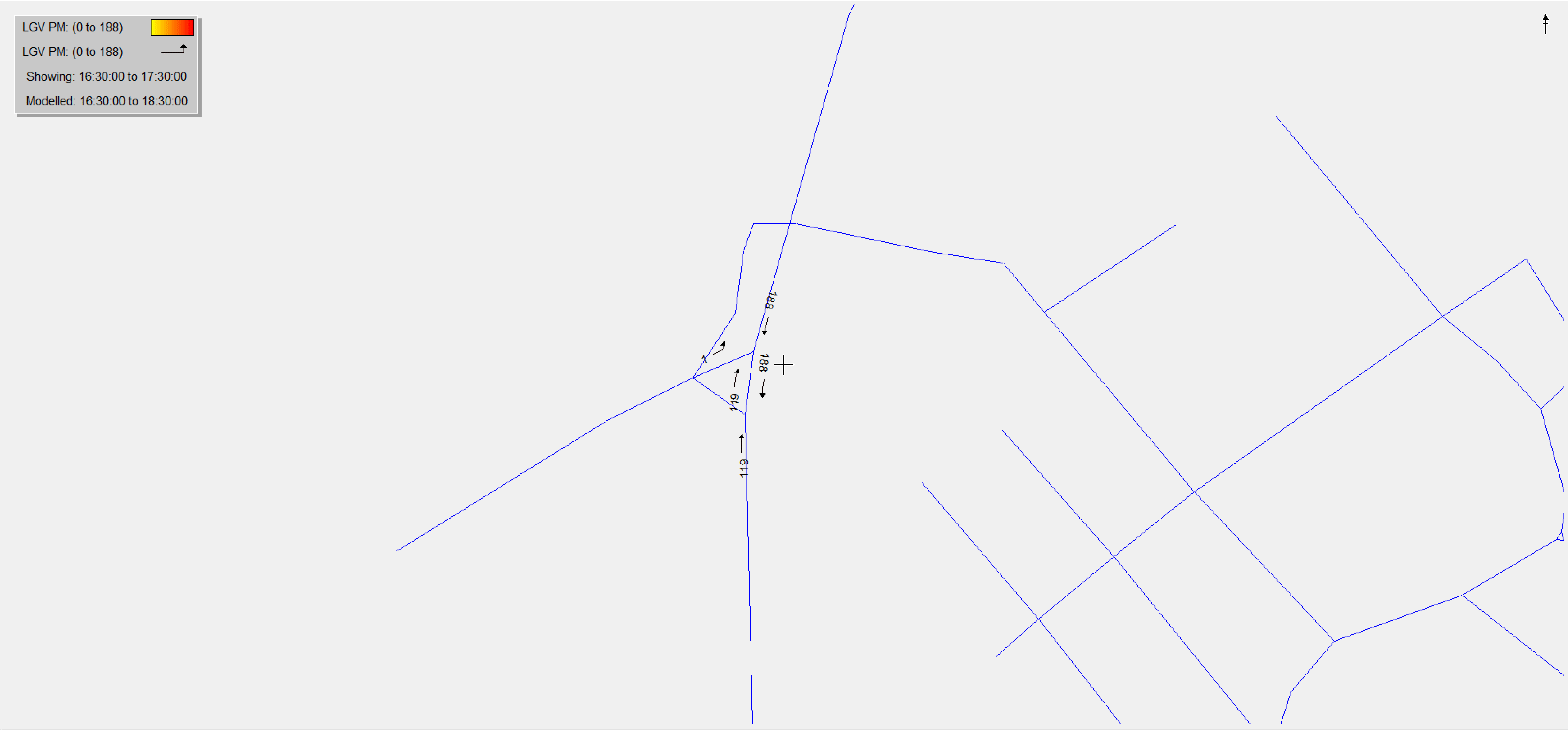
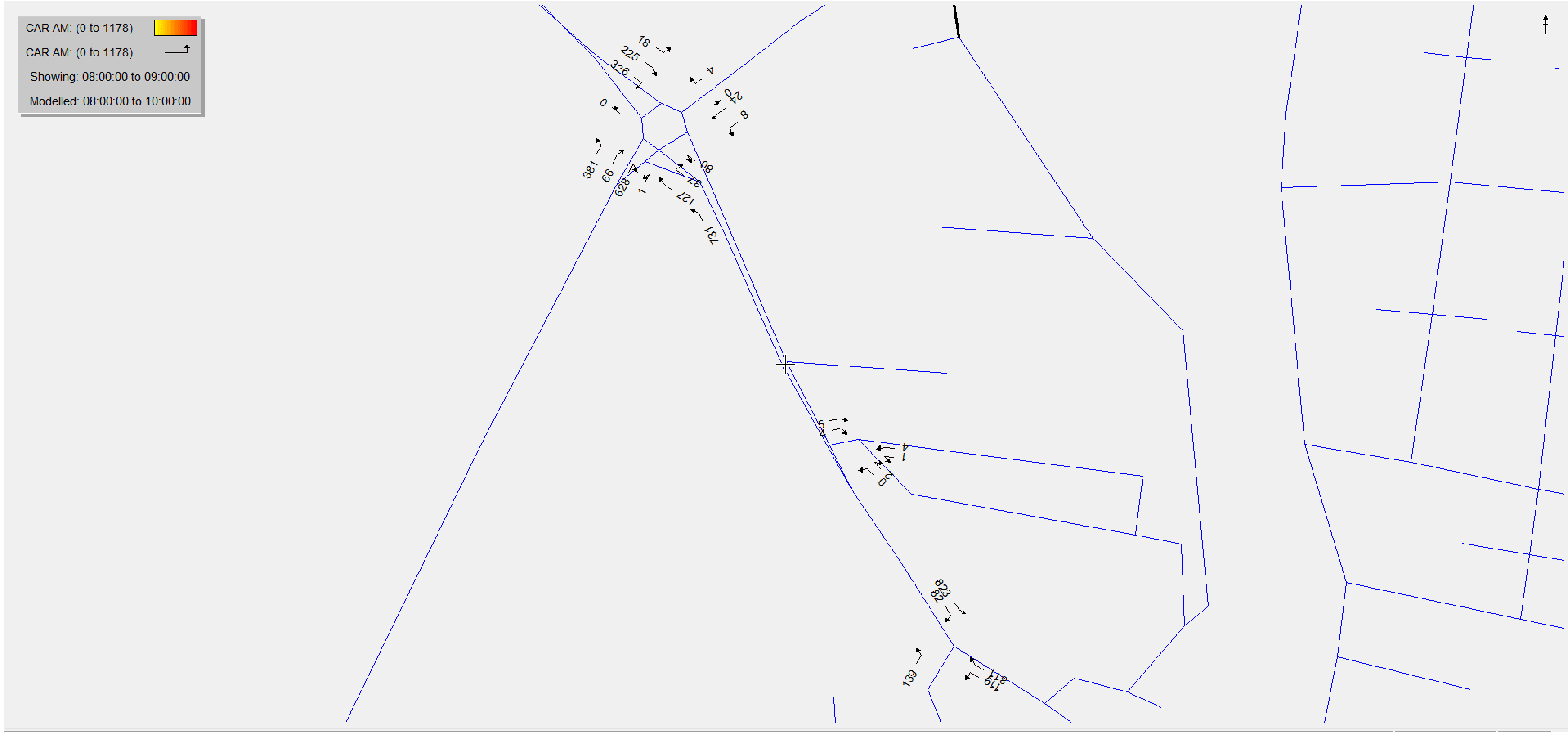
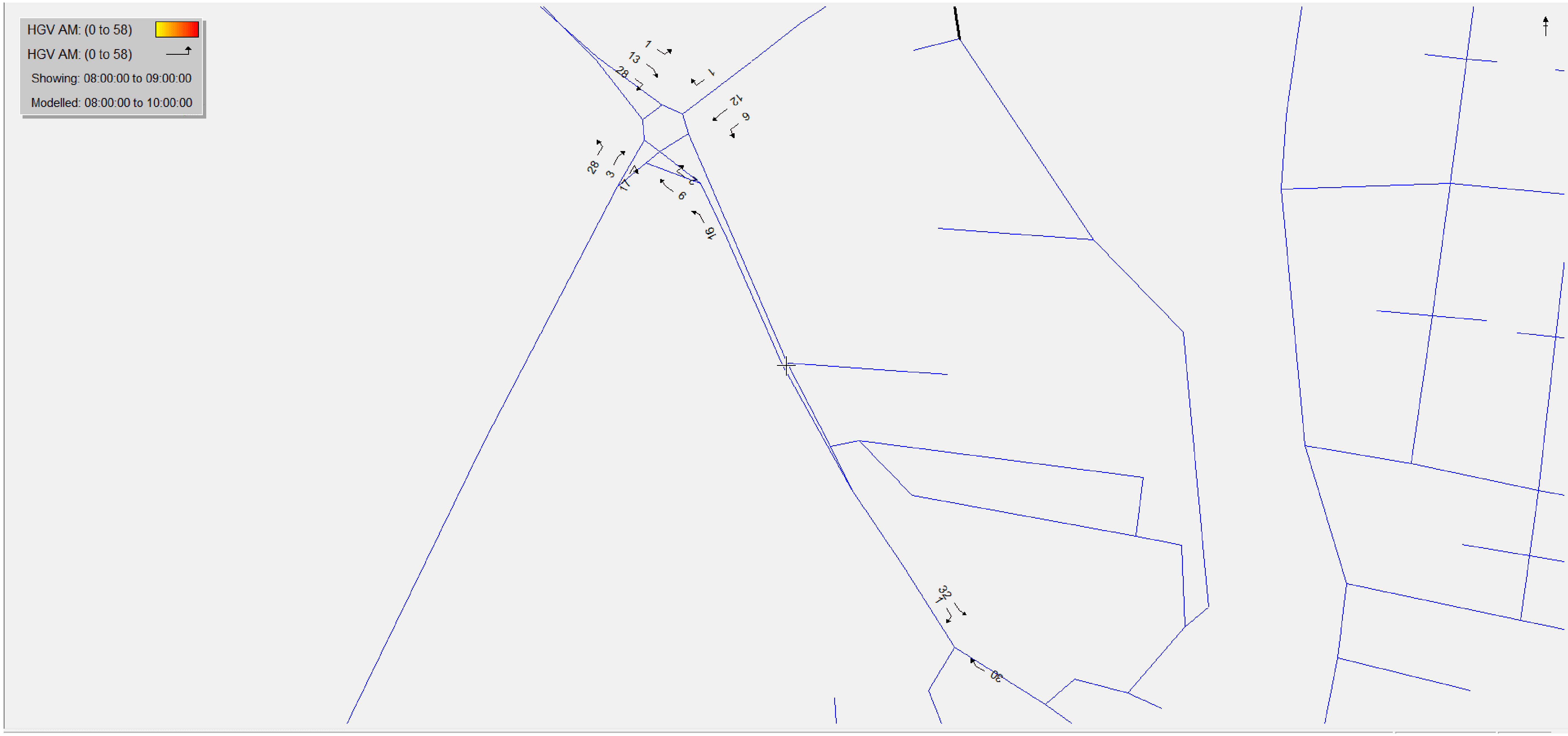
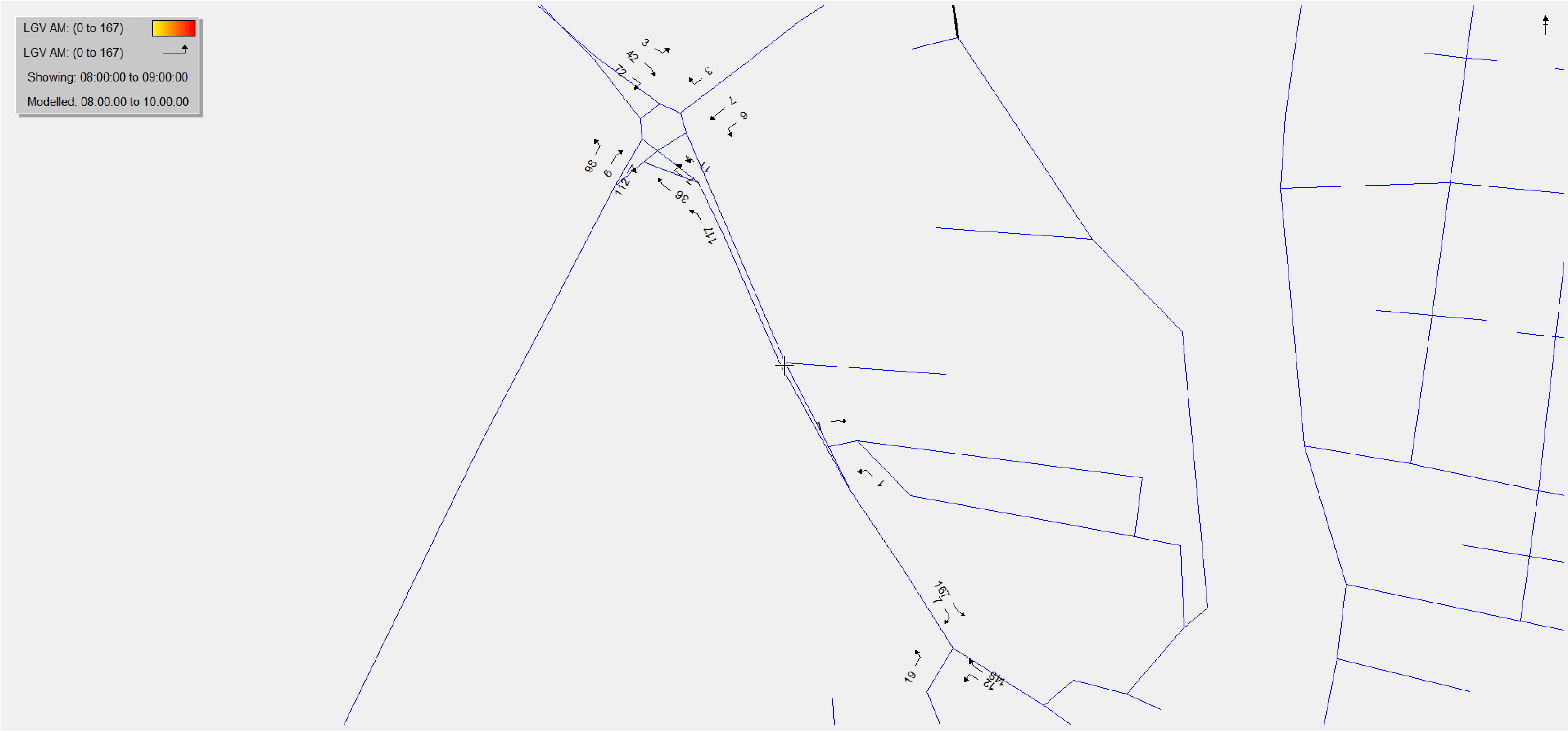

LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00
188
188
119
119

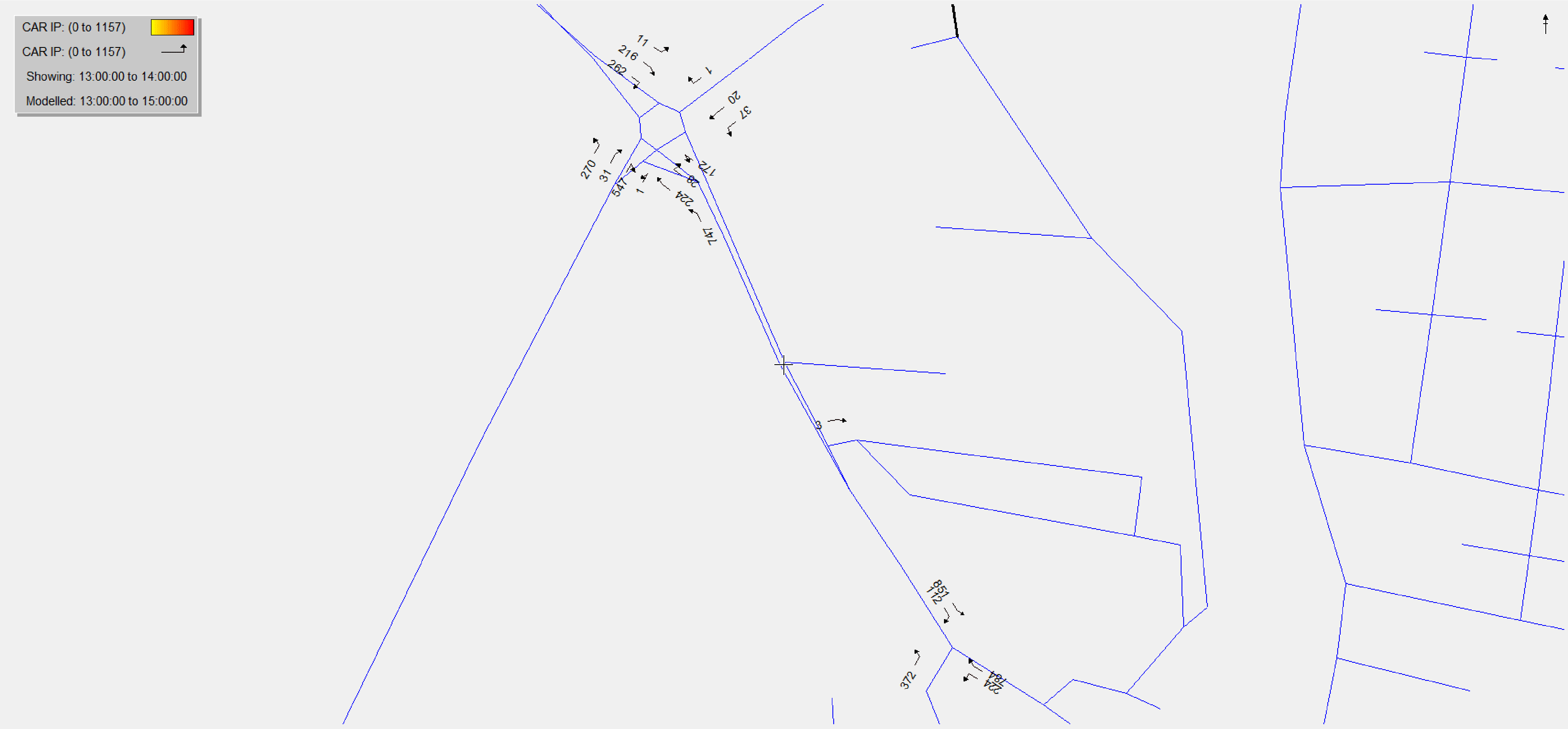
Figure 3 Traffic counts peak hour – Acle New Road



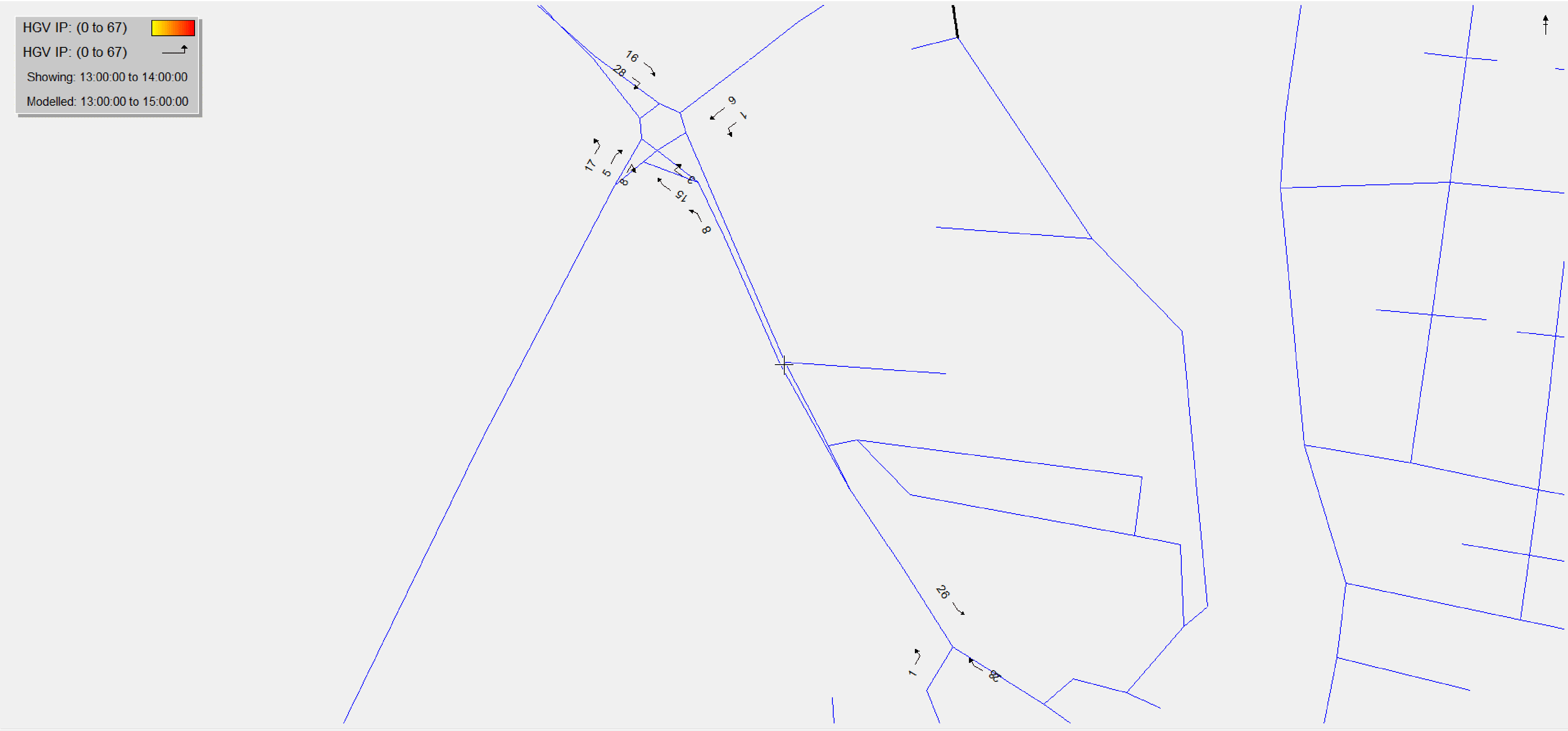

HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

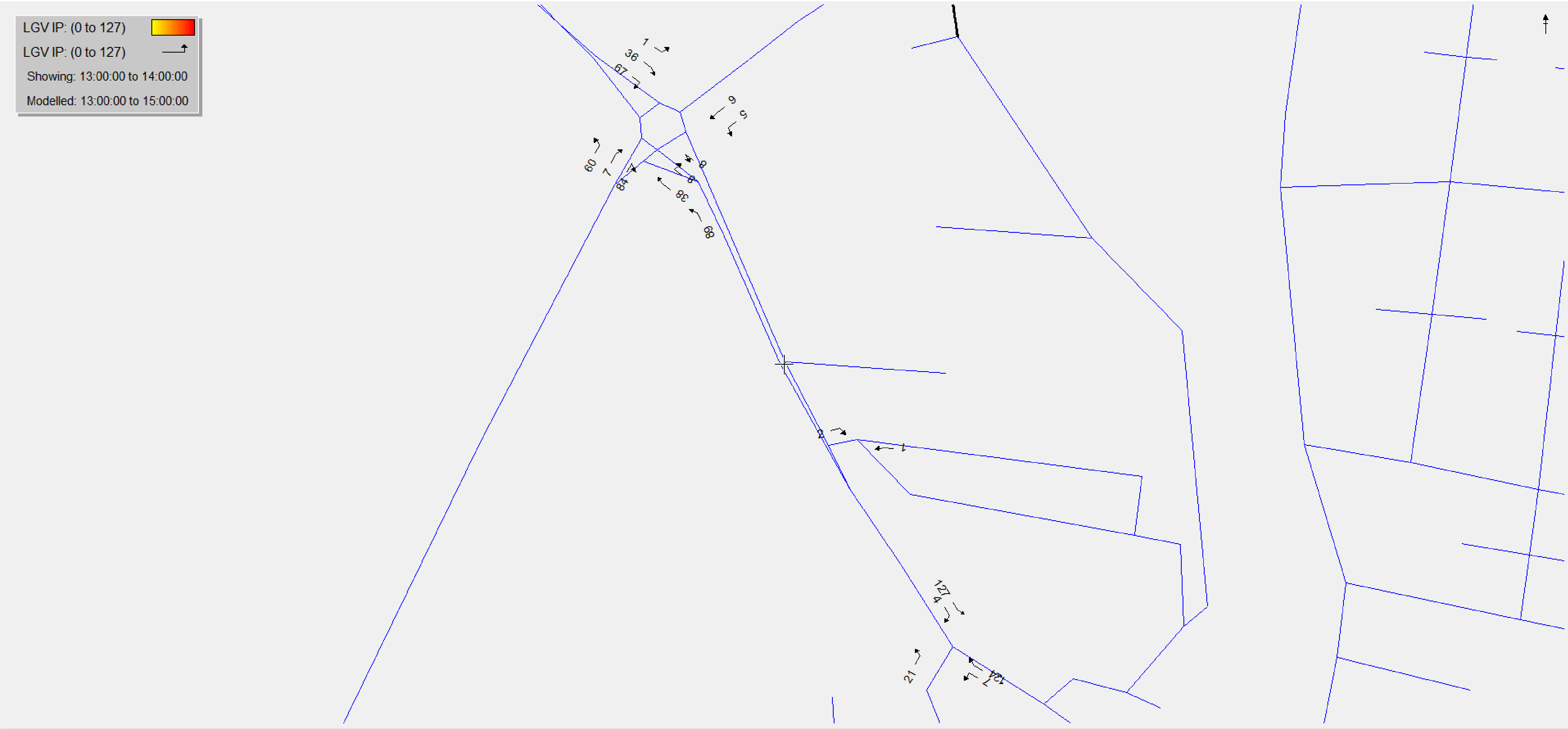


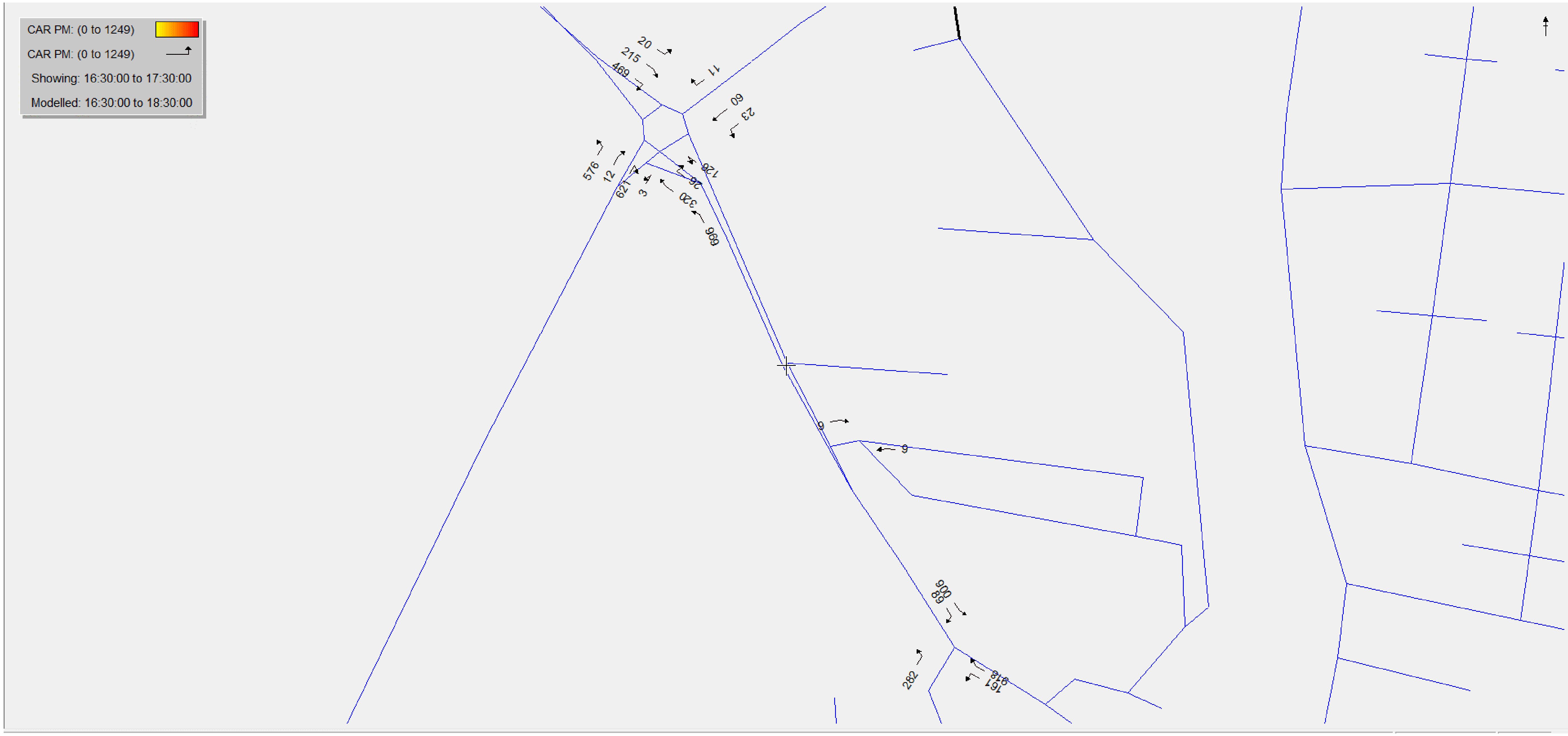
LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

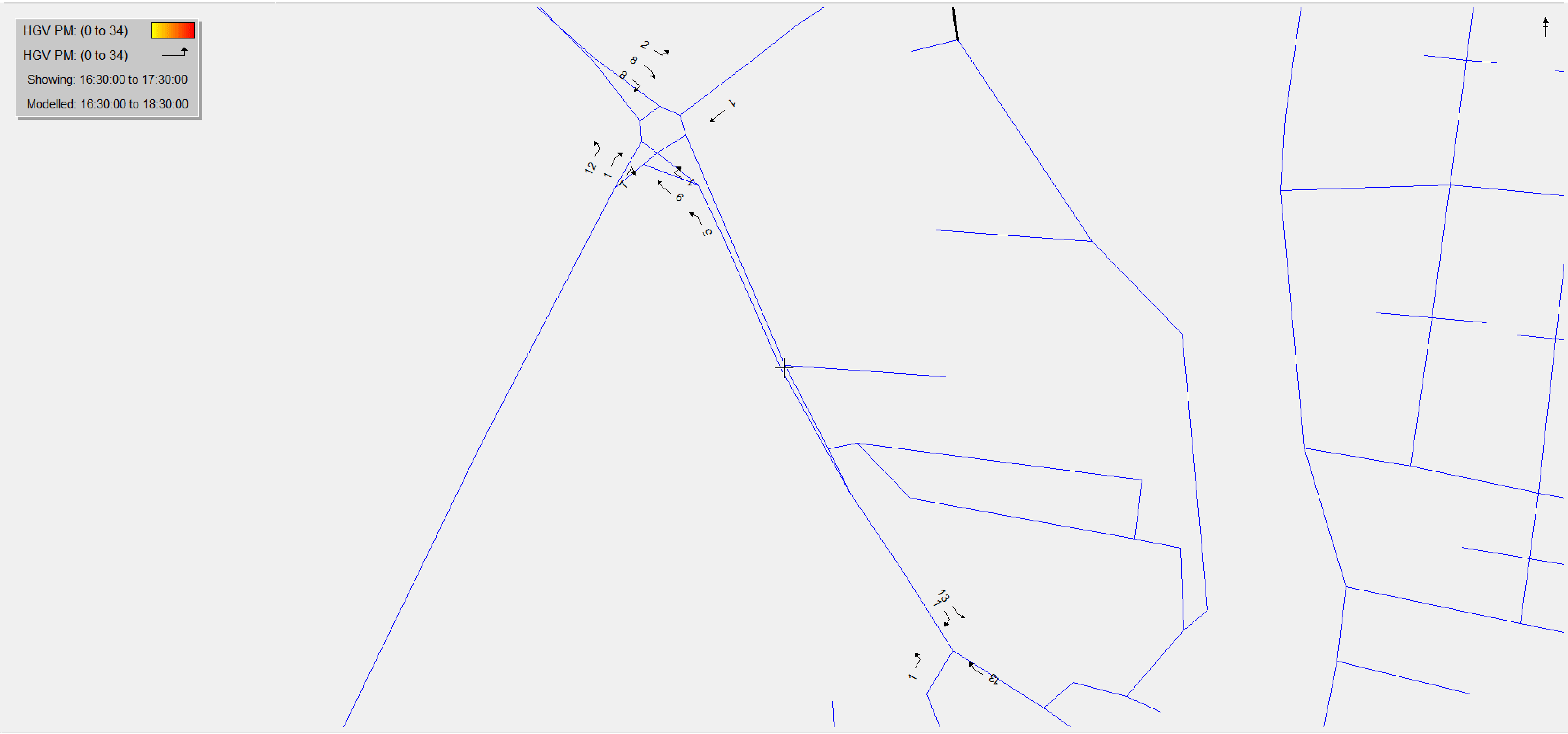


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00



HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

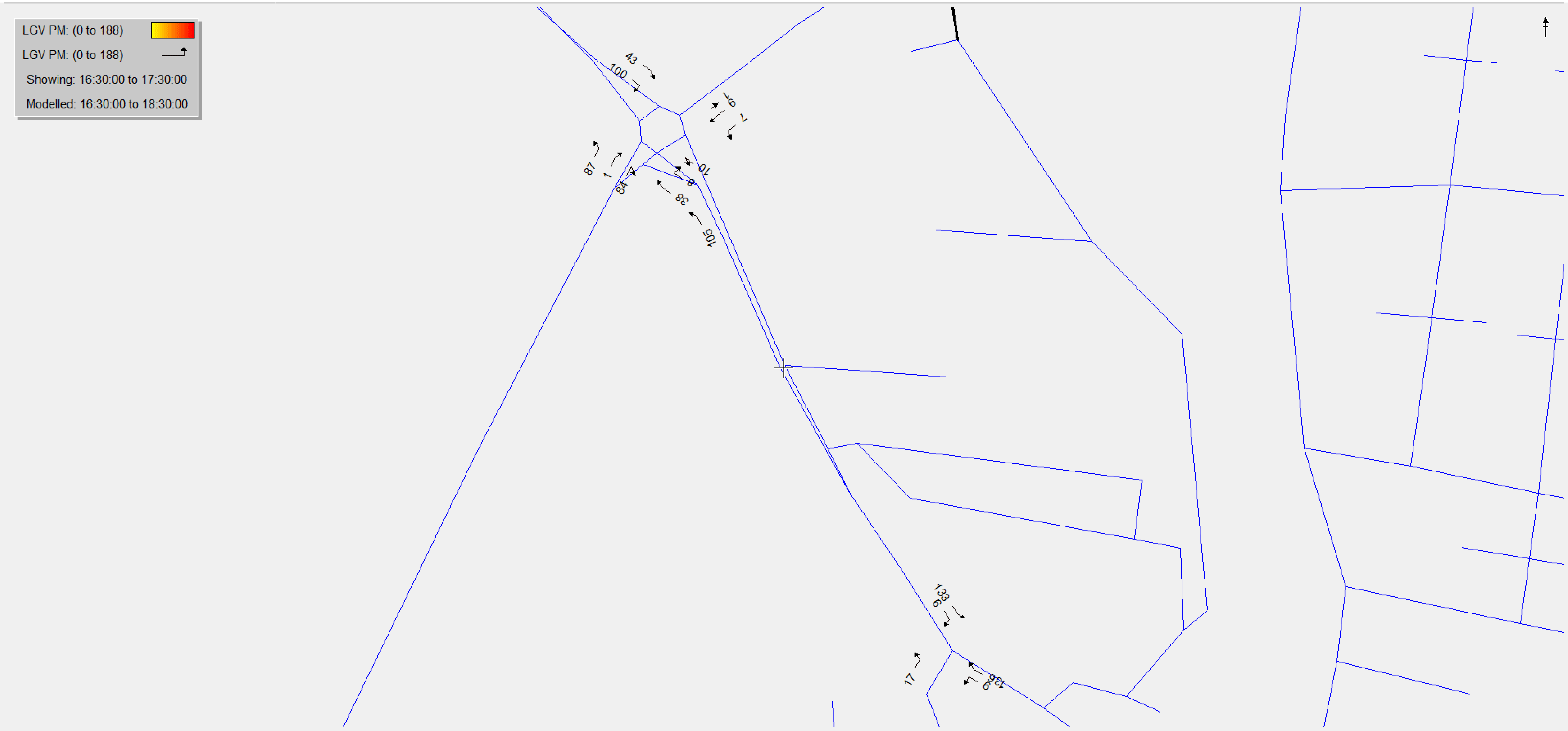
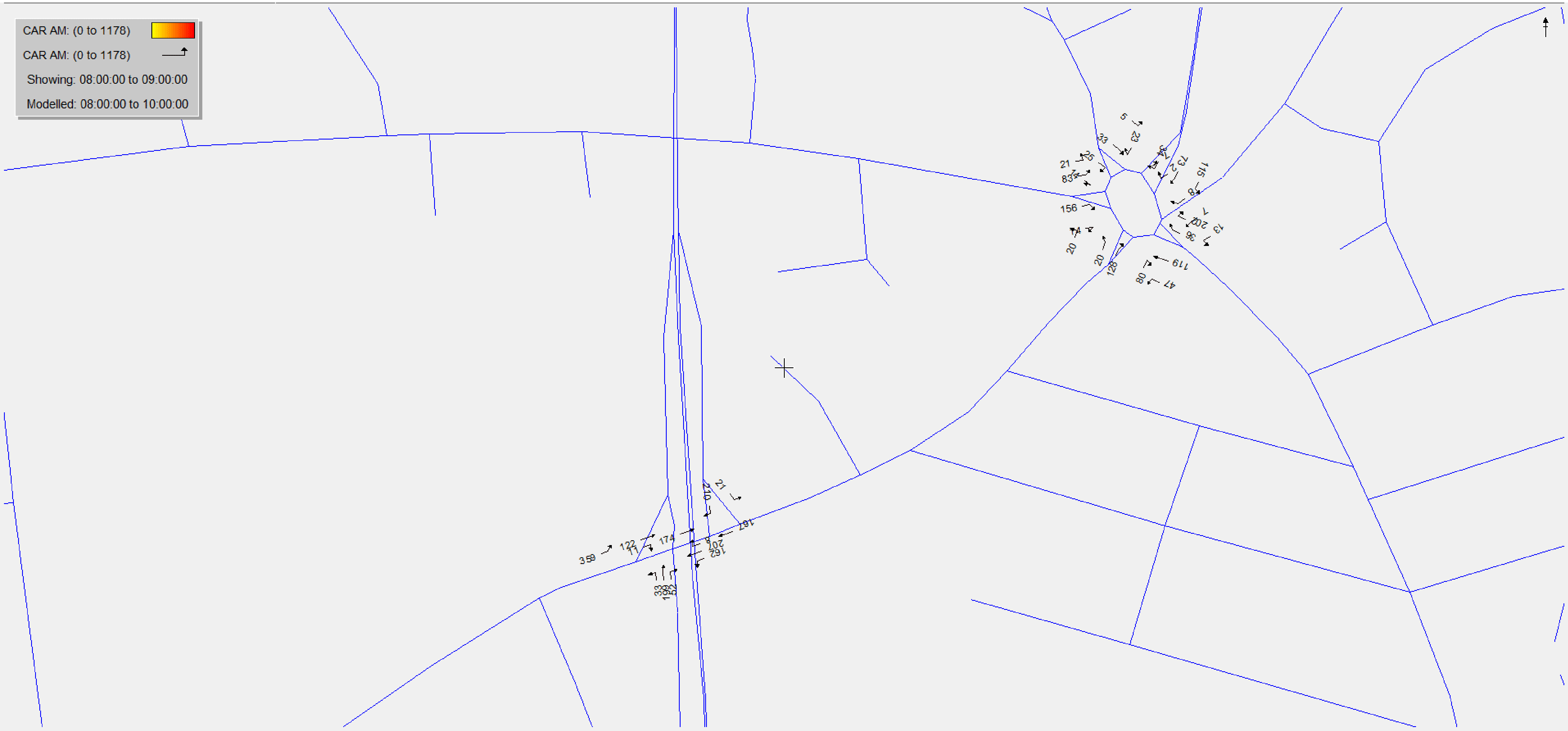
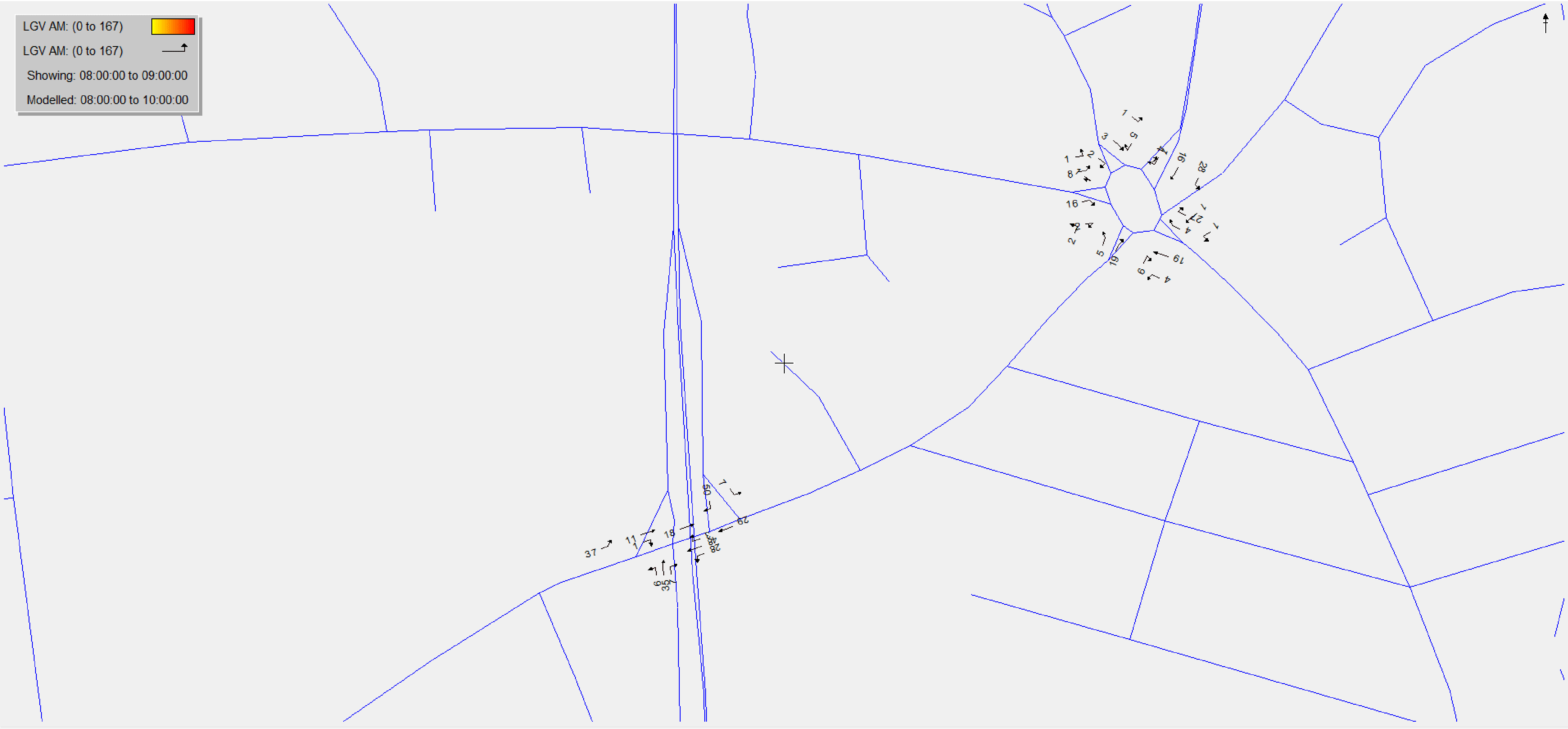
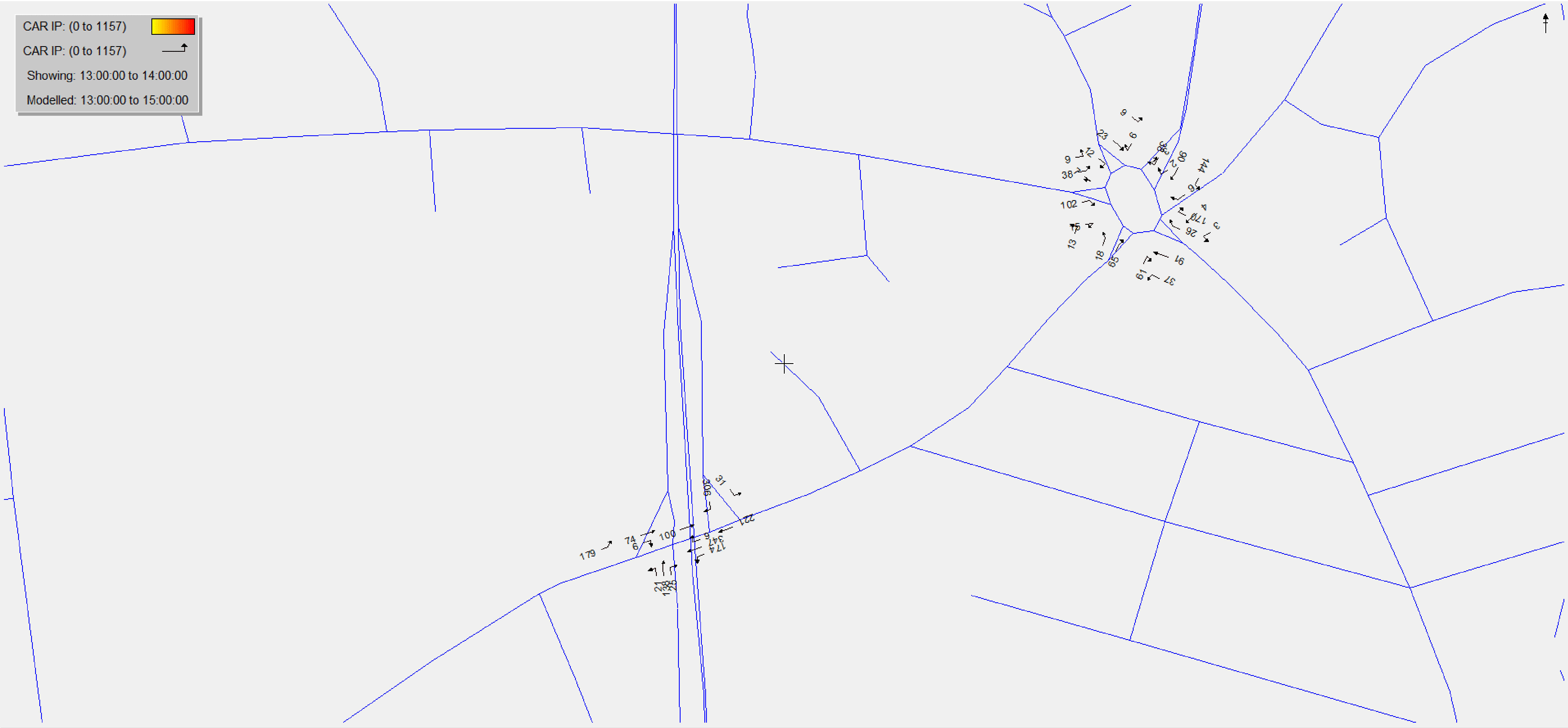

LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00
43
100
87
1
84
38
105
17

Figure 4 Traffic counts peak hour – A12 and Beccles Road Junction

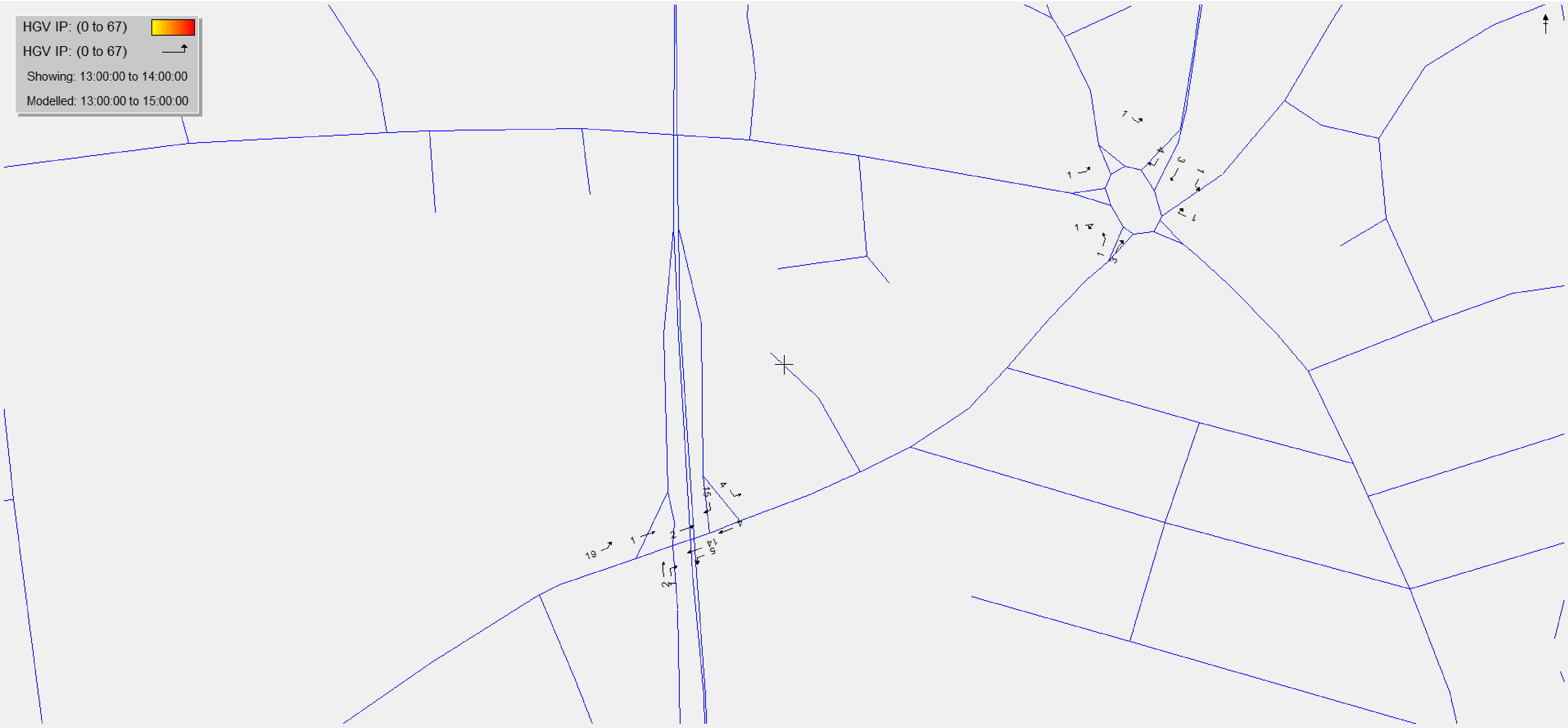


HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

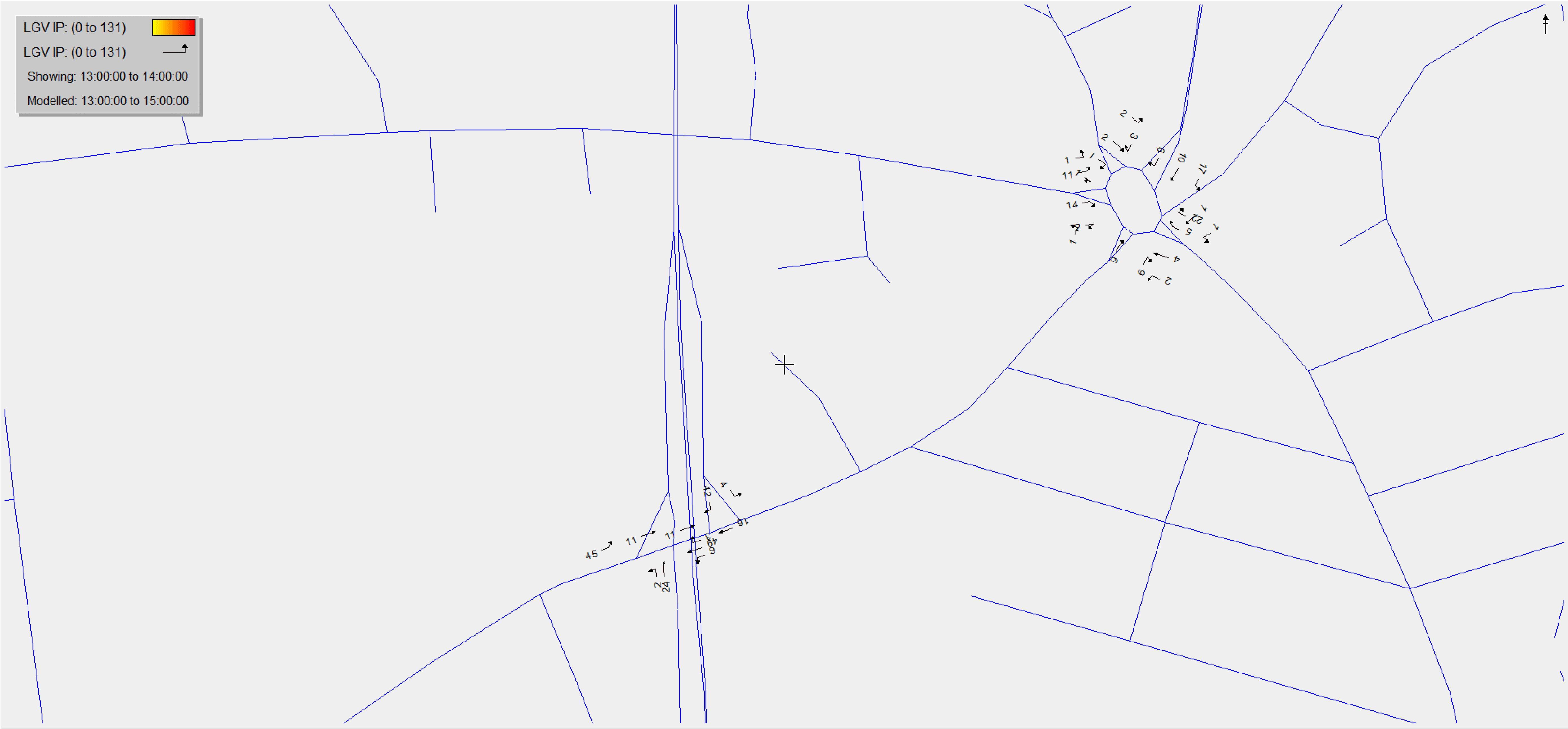

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

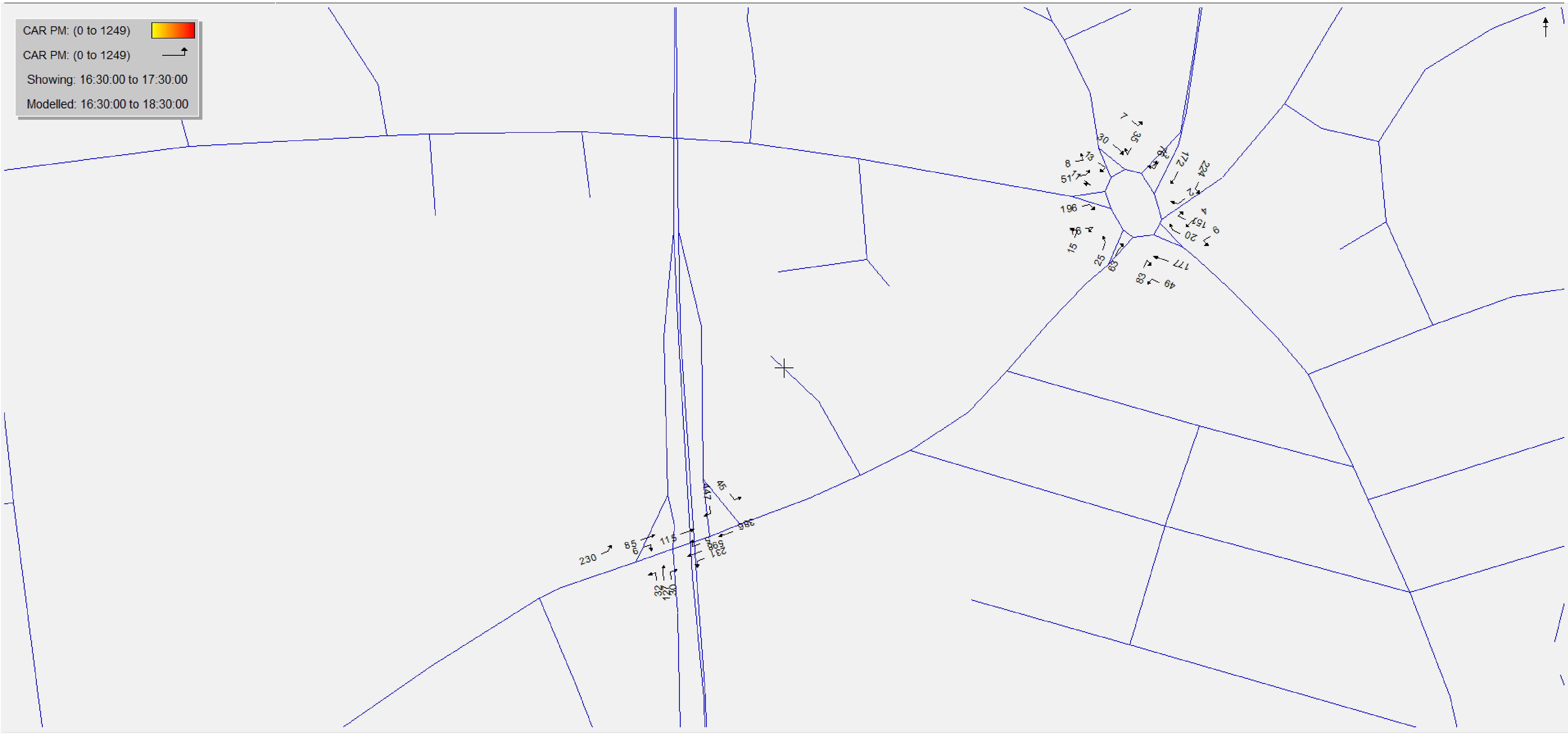


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



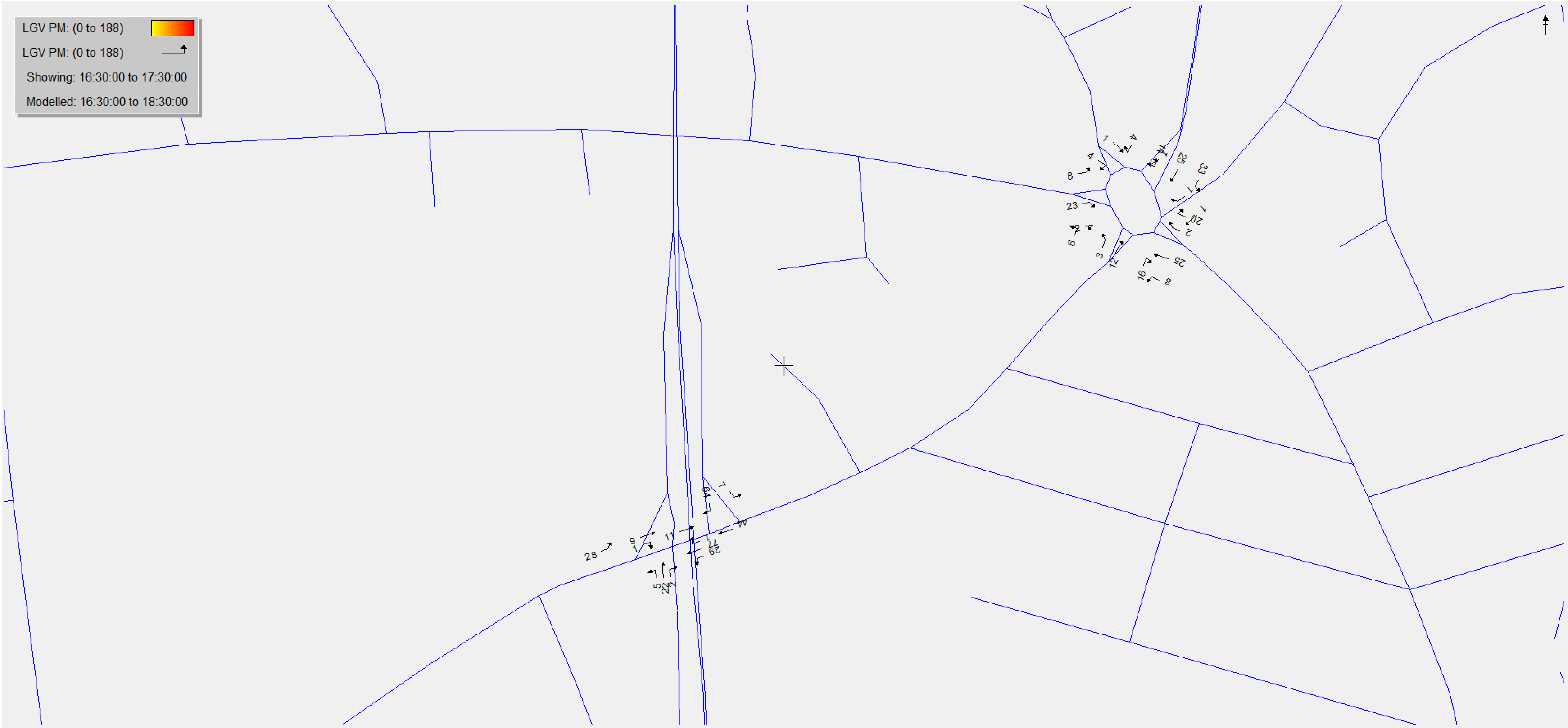
HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP: (0 to 131)
LGV IP: (0 to 131)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



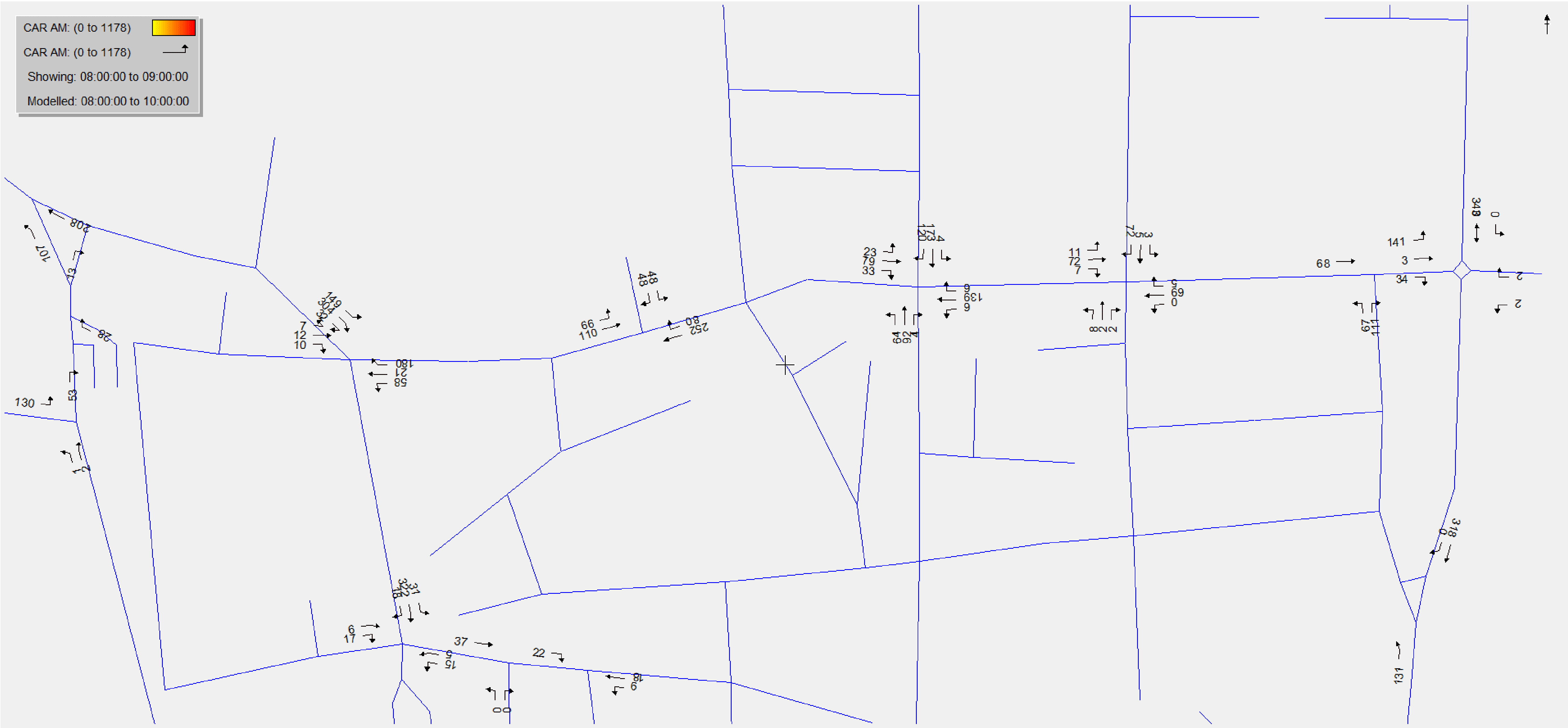
CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

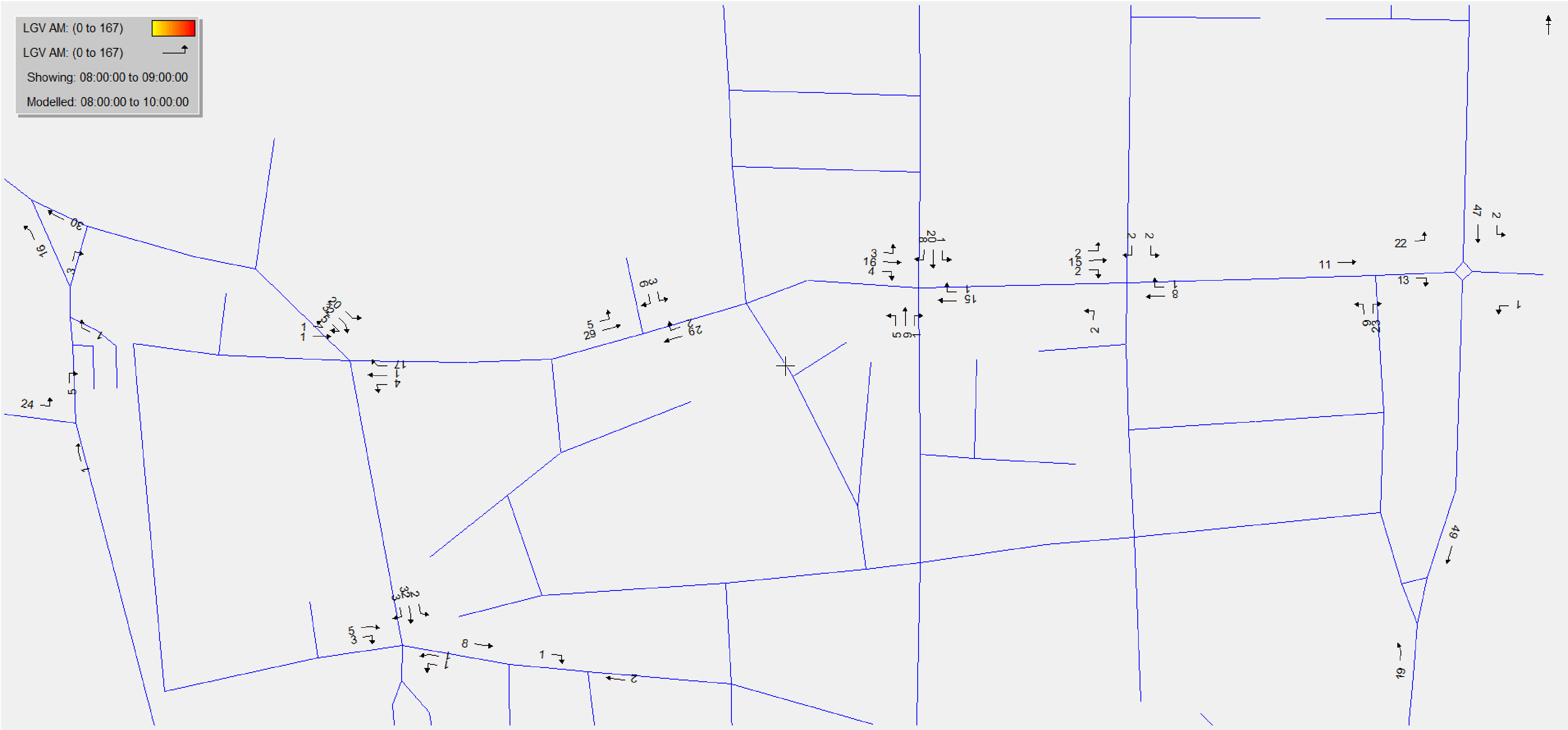


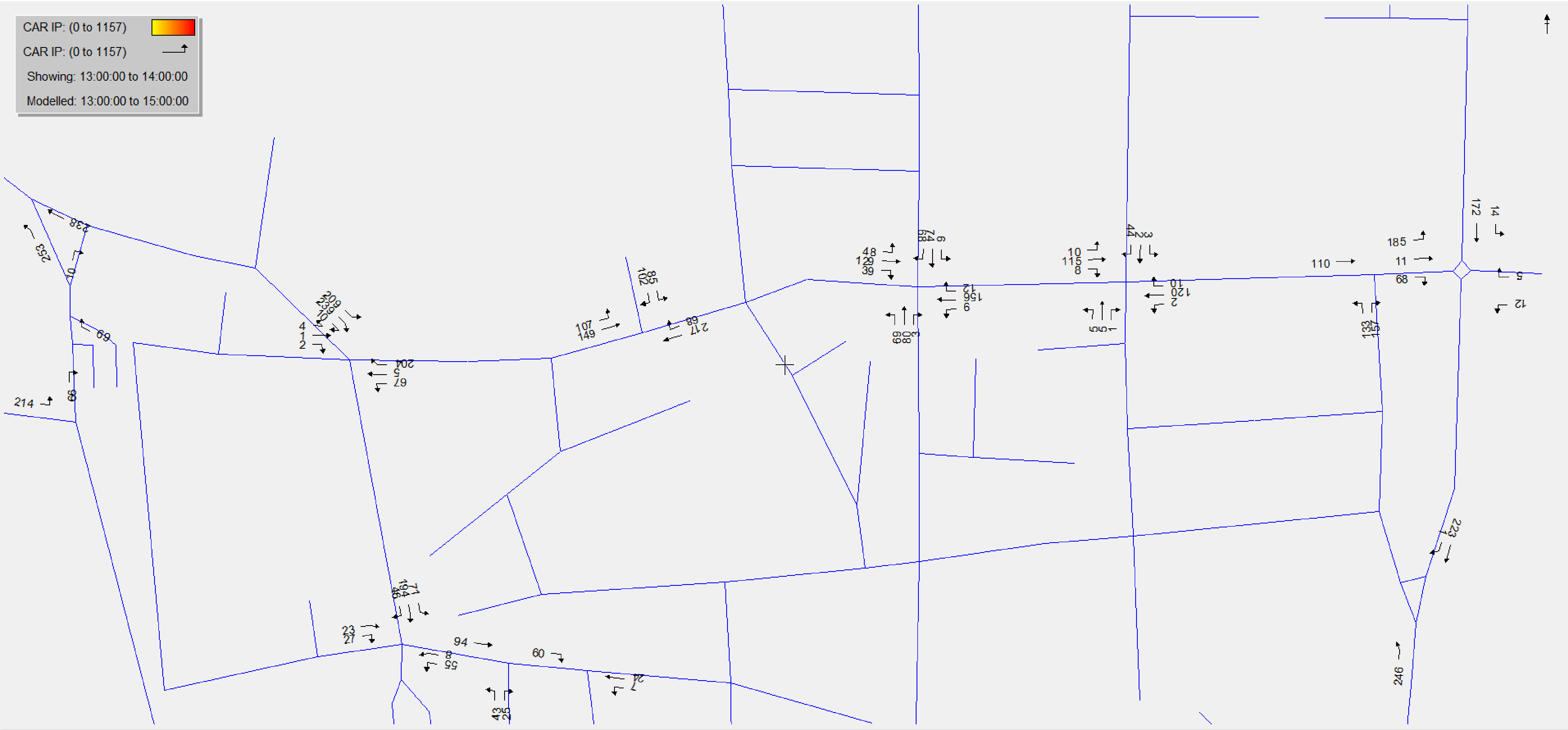
LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

Figure 5 Traffic counts peak hour – Euston Road

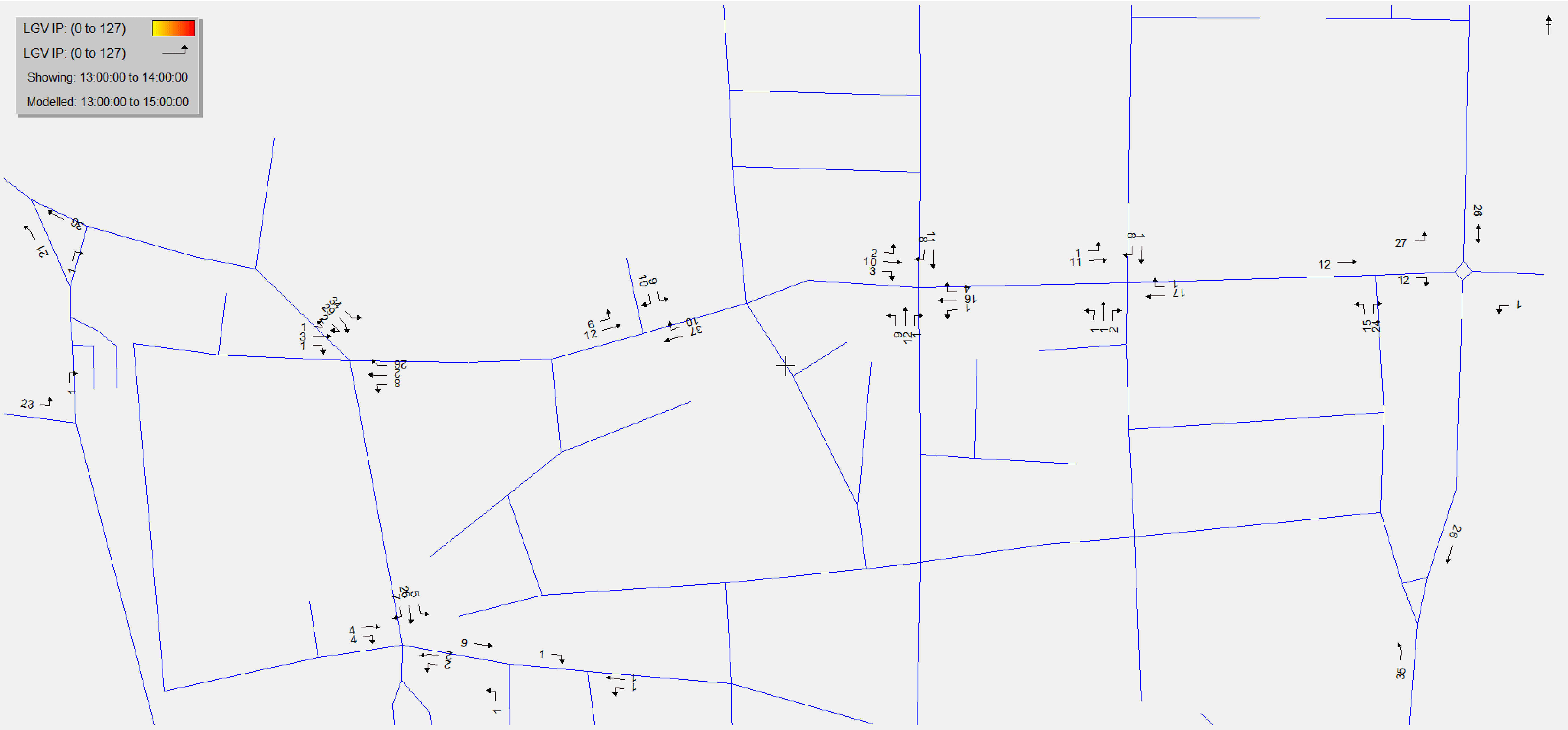


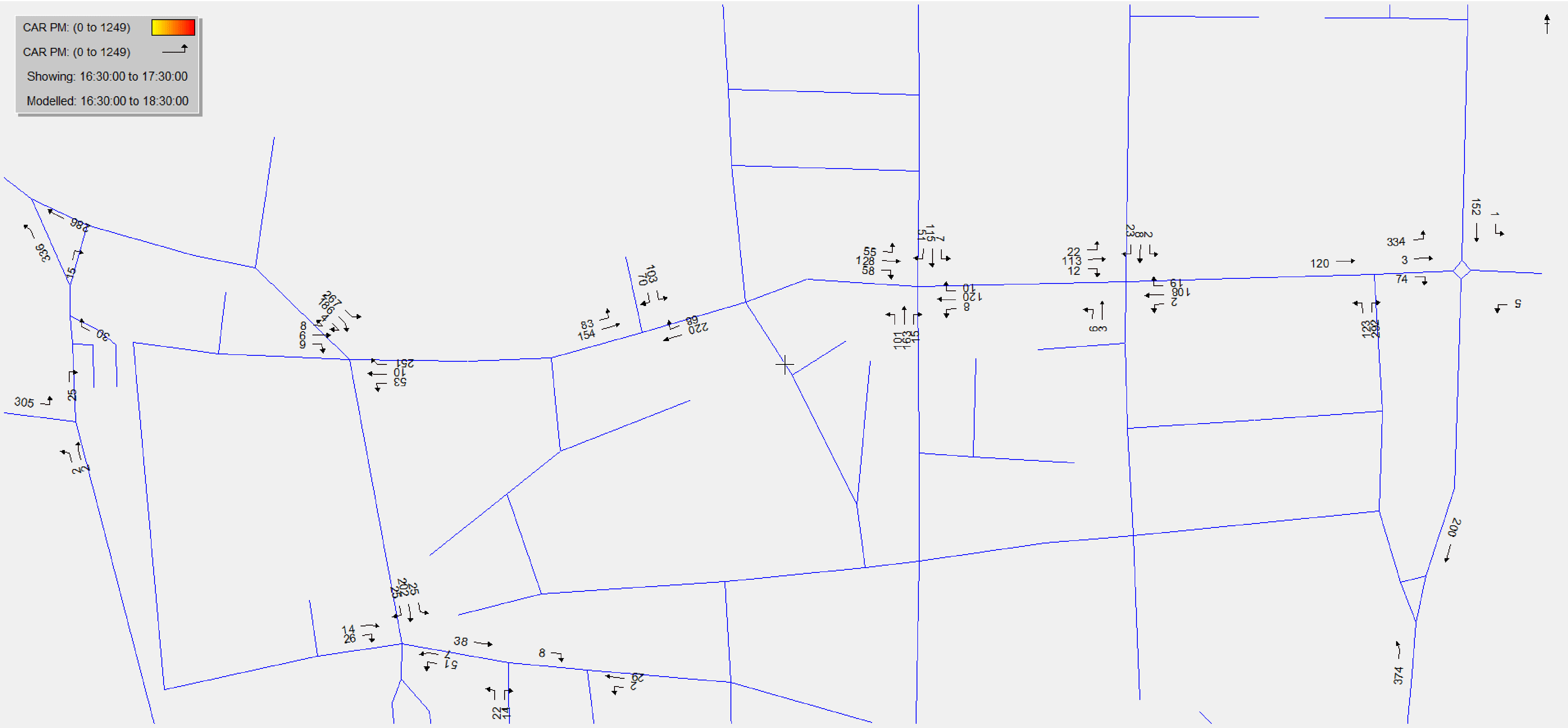

HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

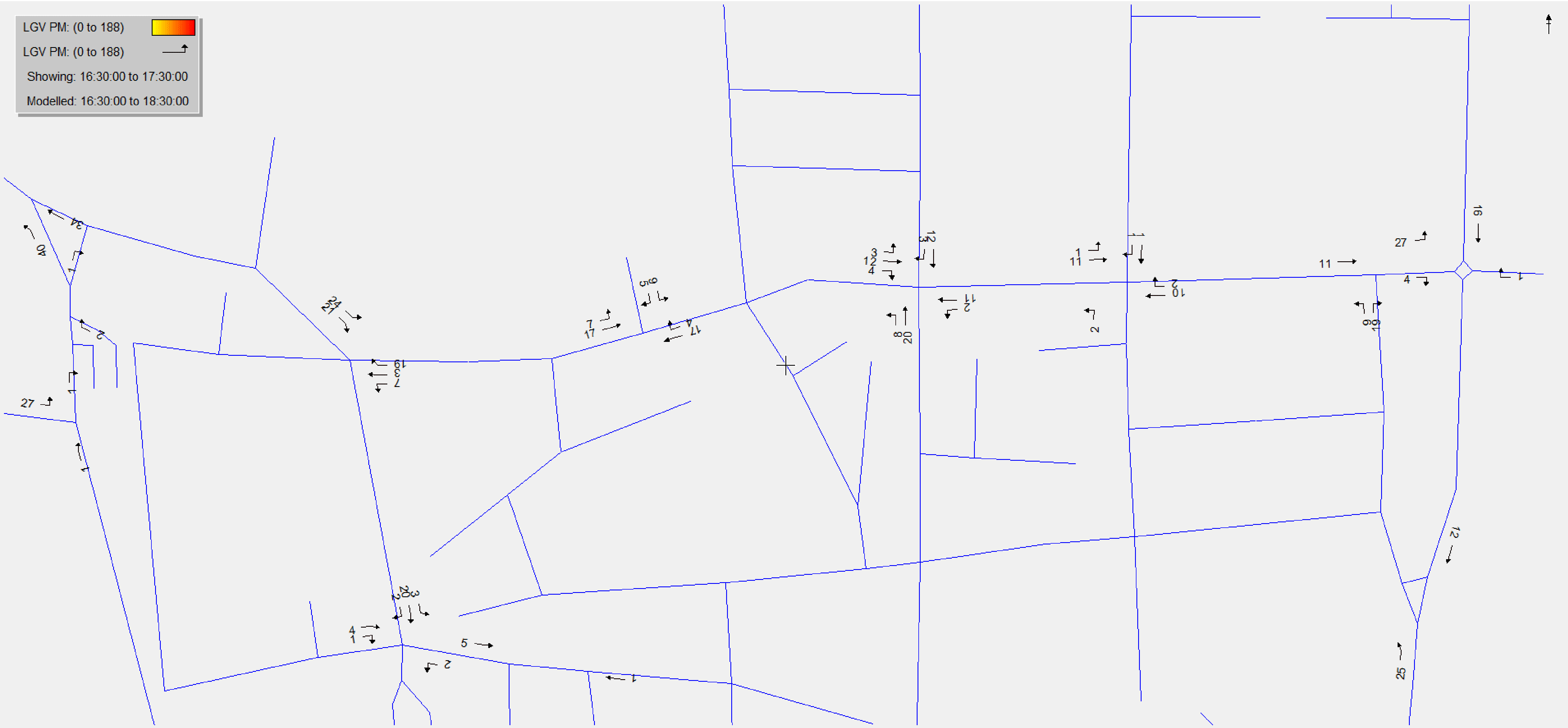
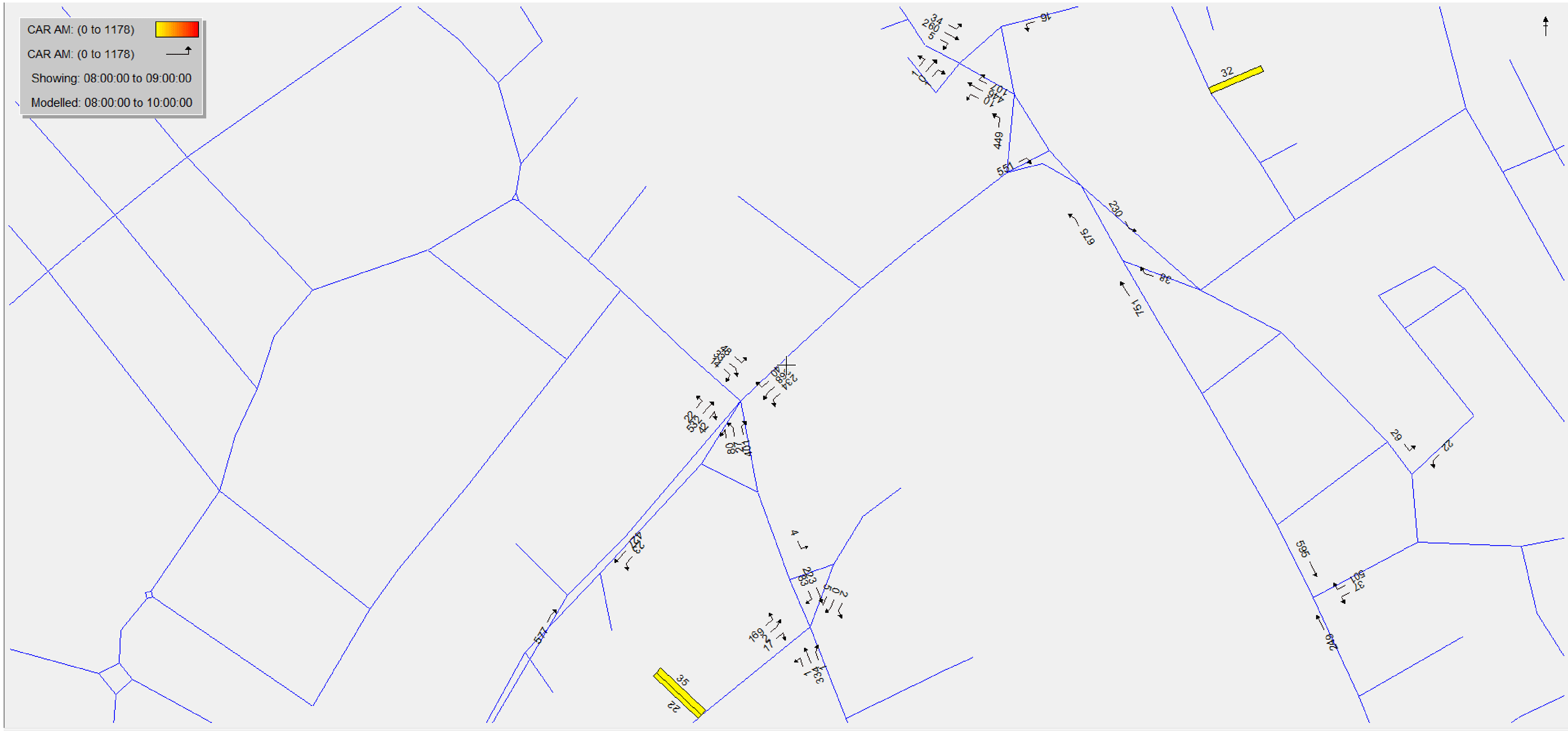
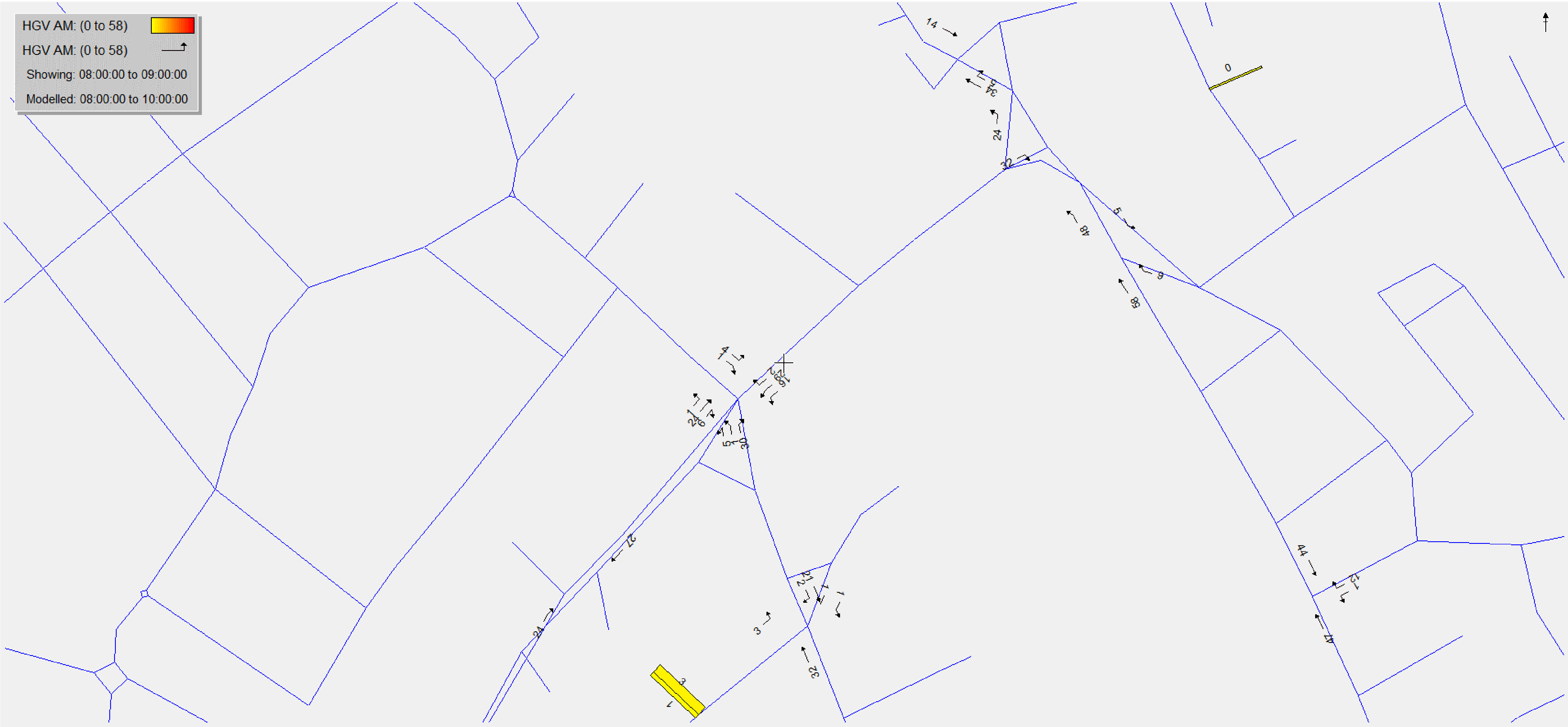

LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

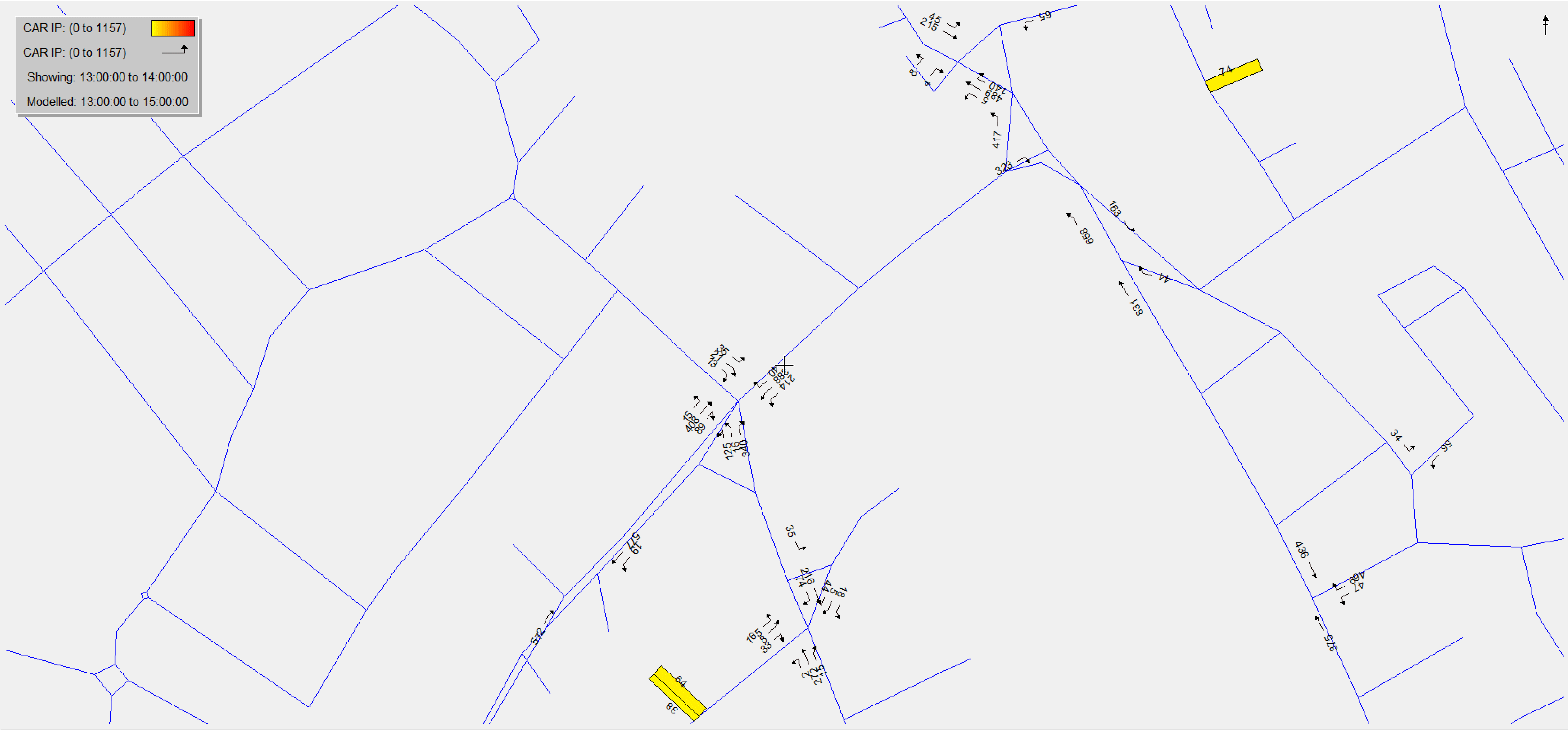
Figure 6 Traffic counts peak hour – Haven Bridge

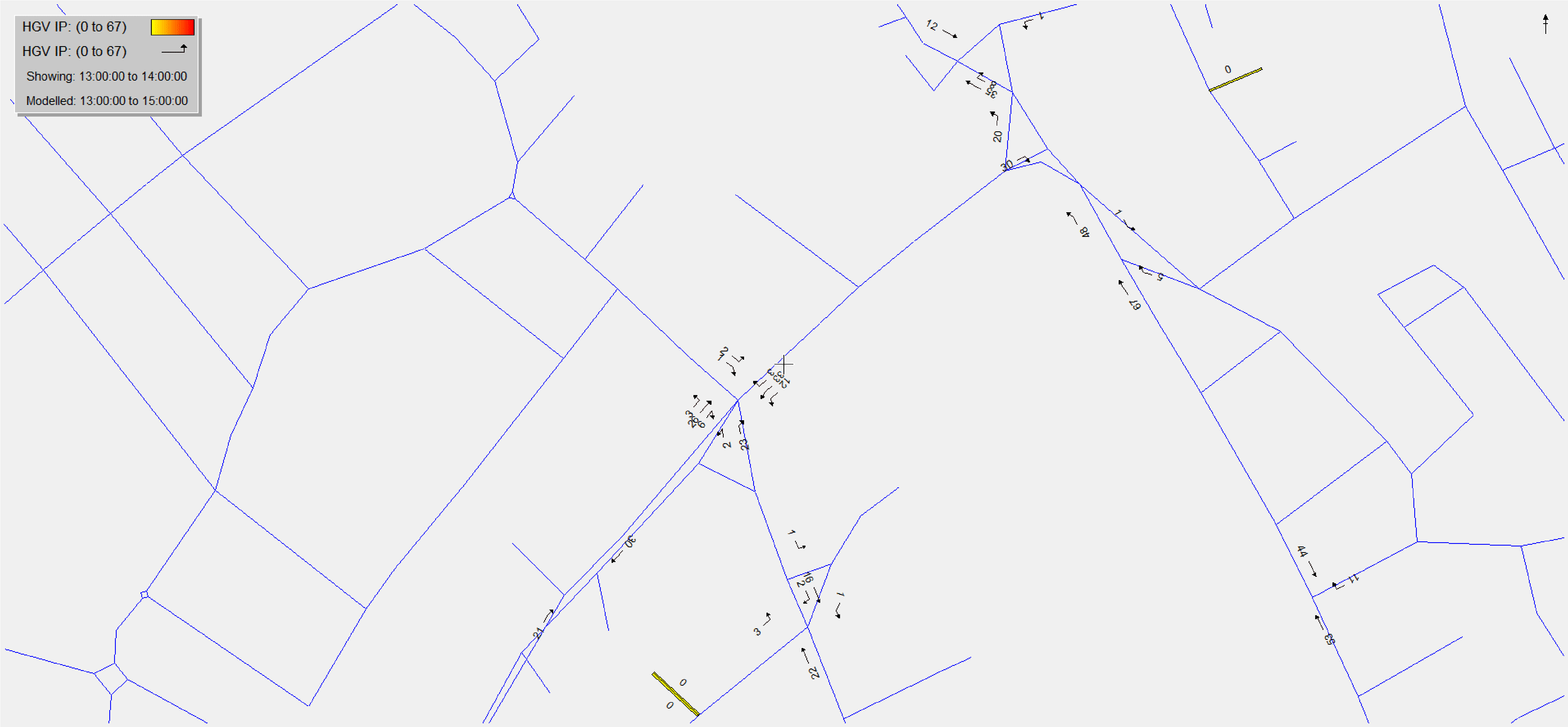


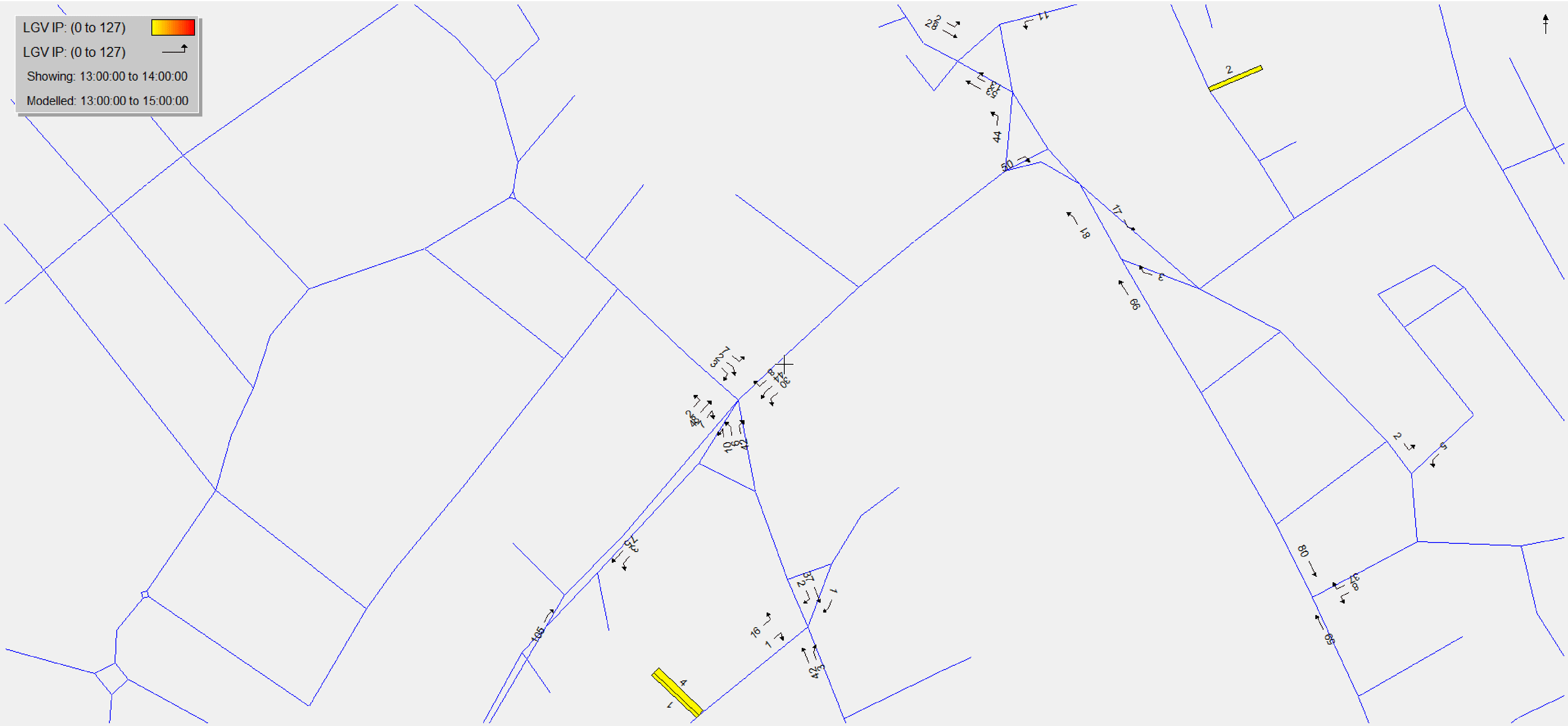


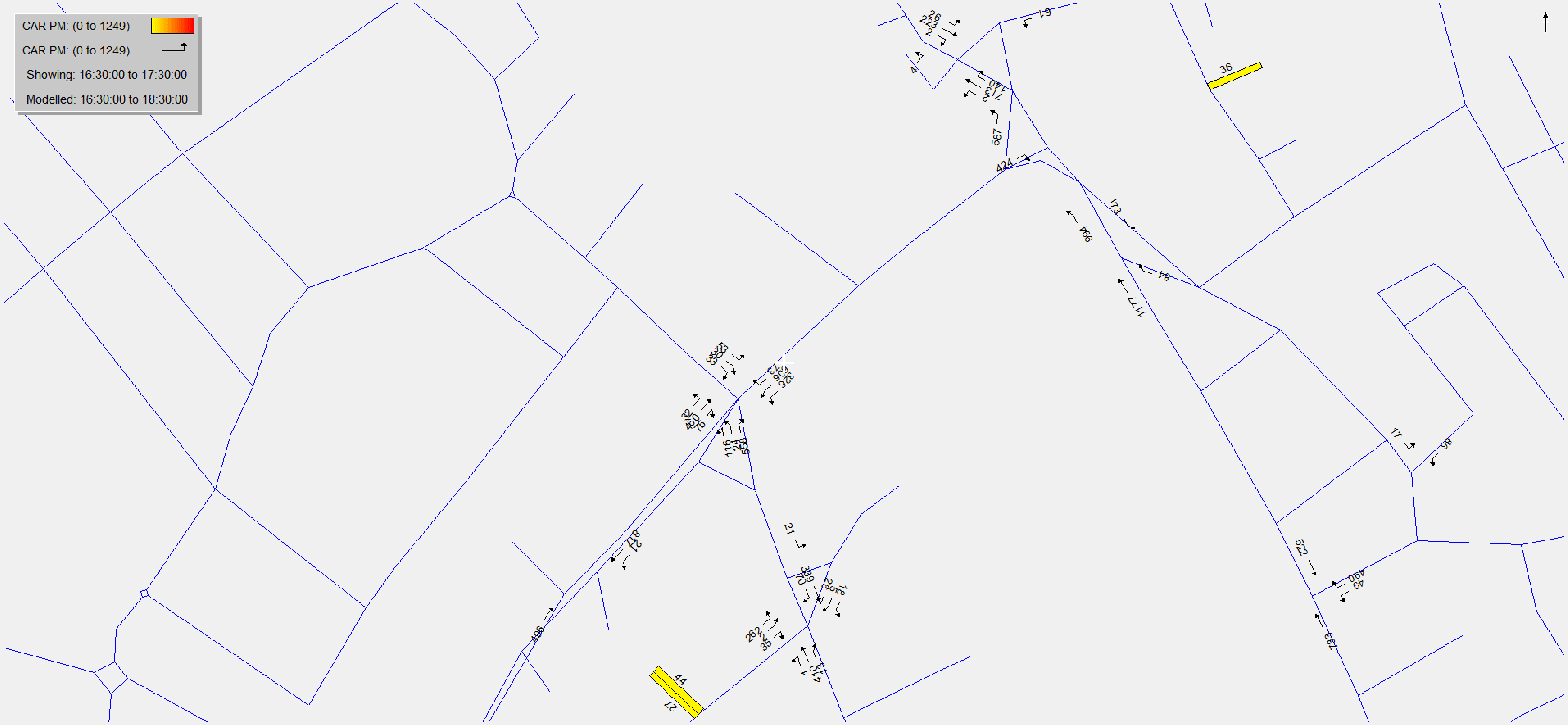
HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

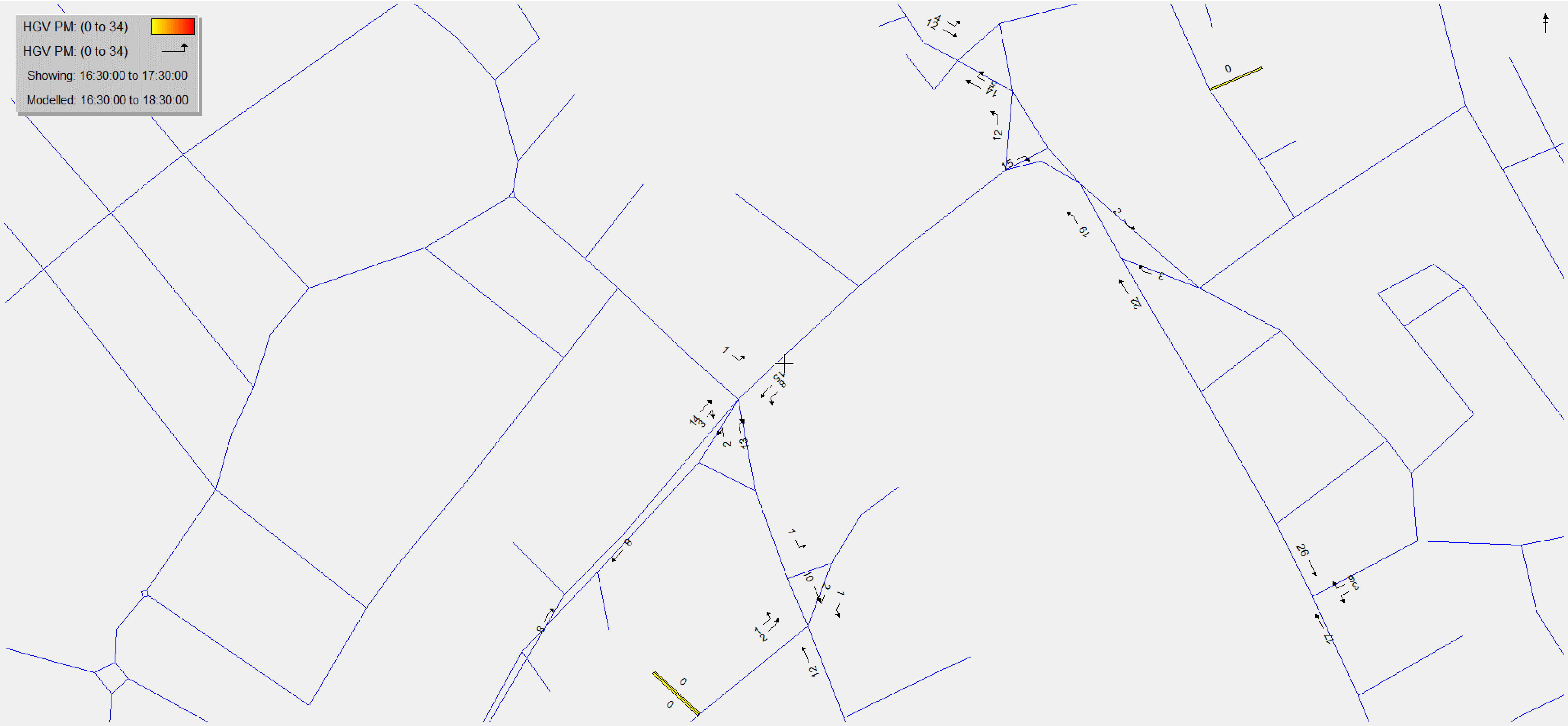

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

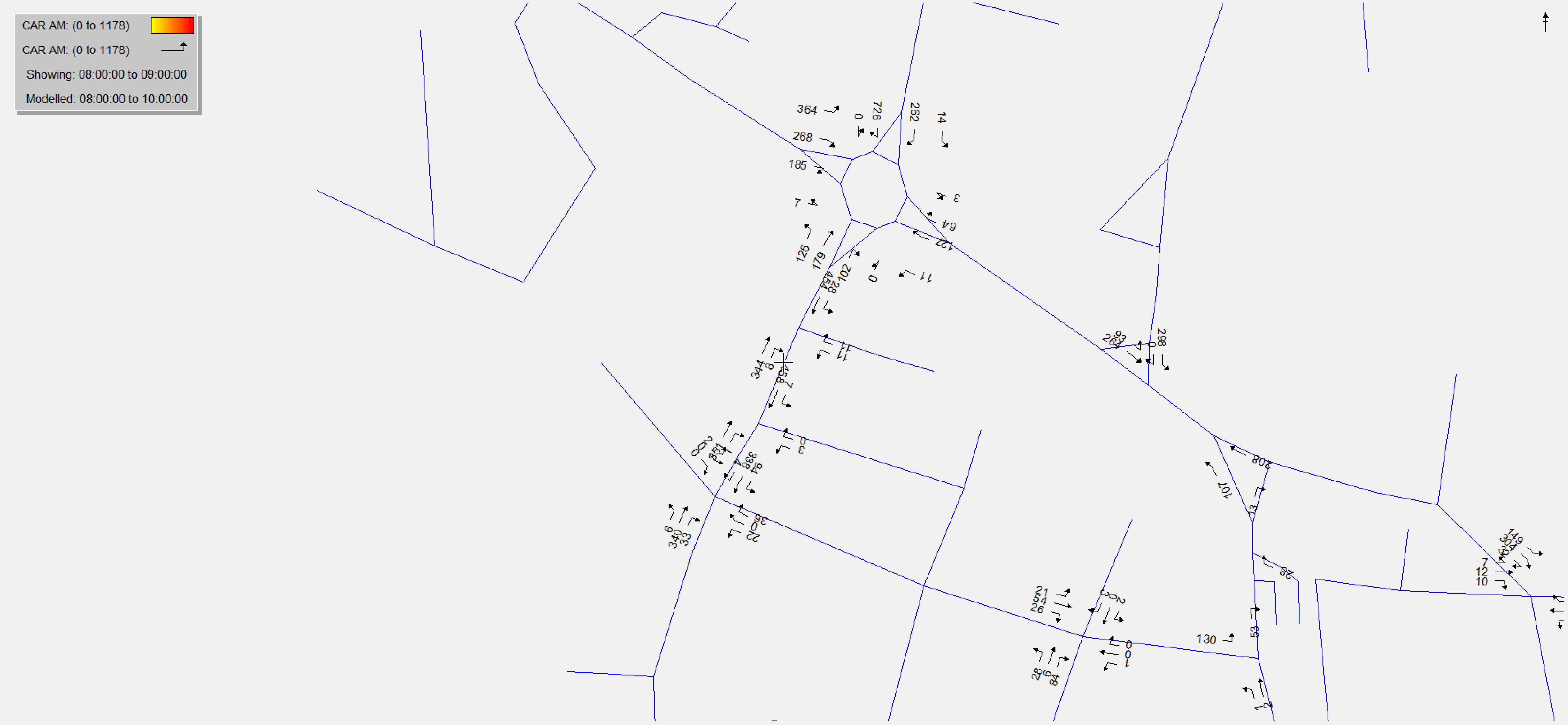

LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

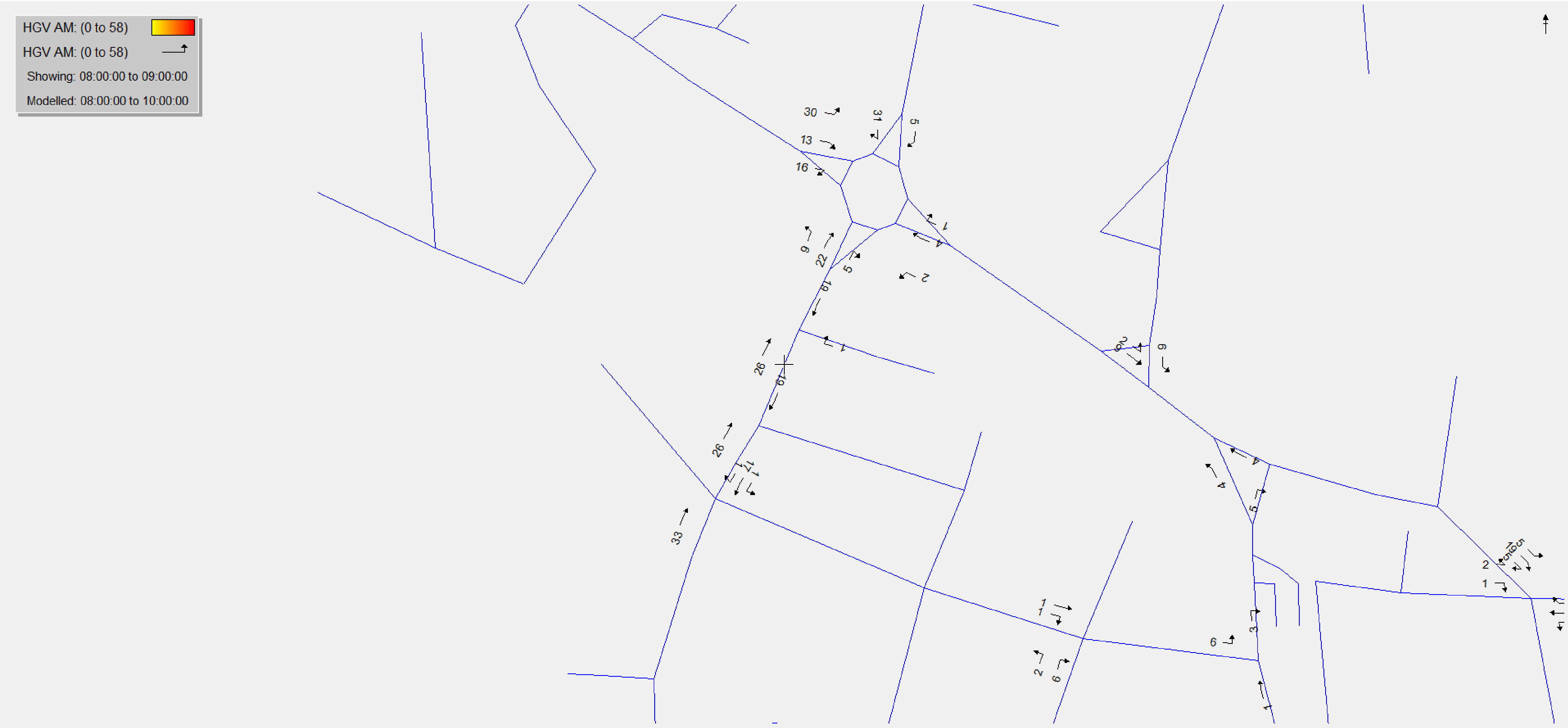

CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

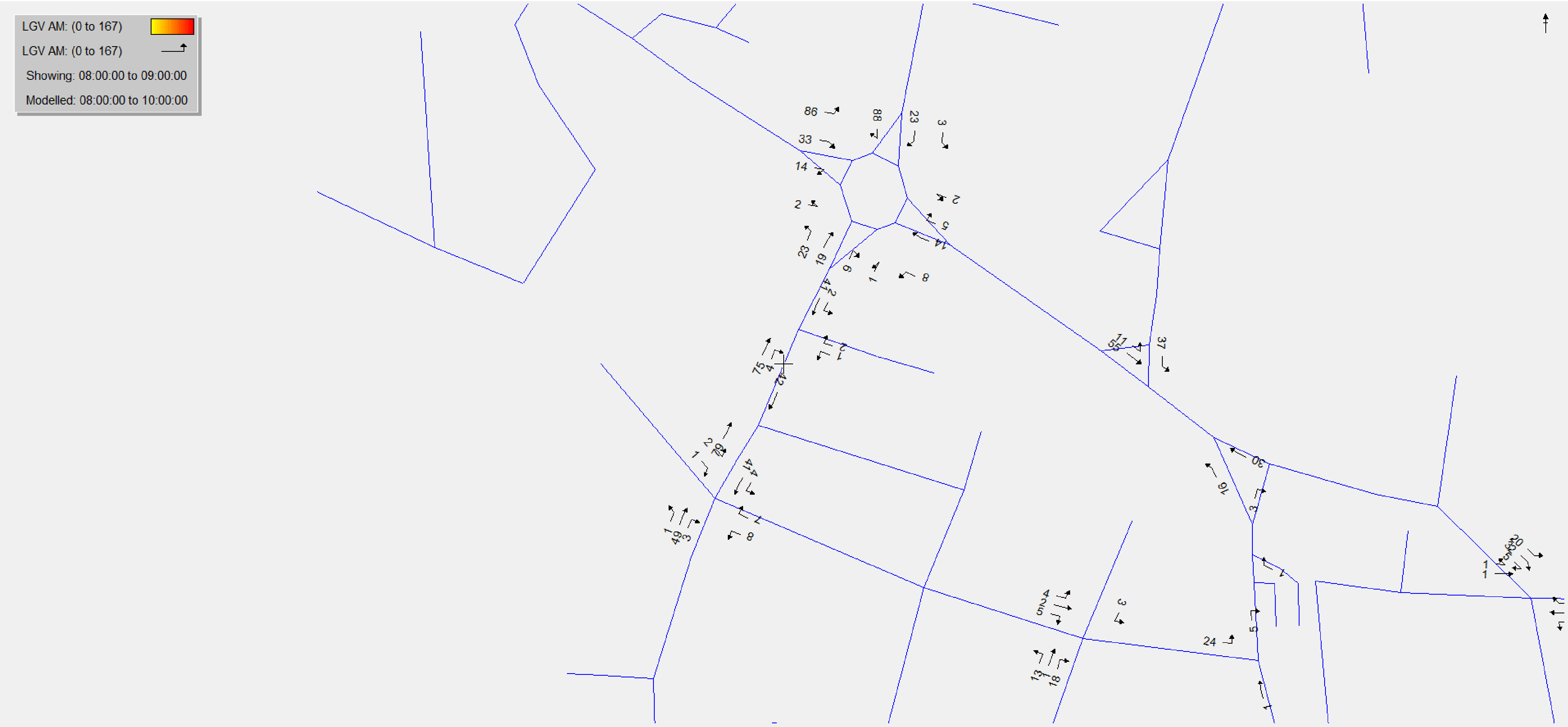

HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

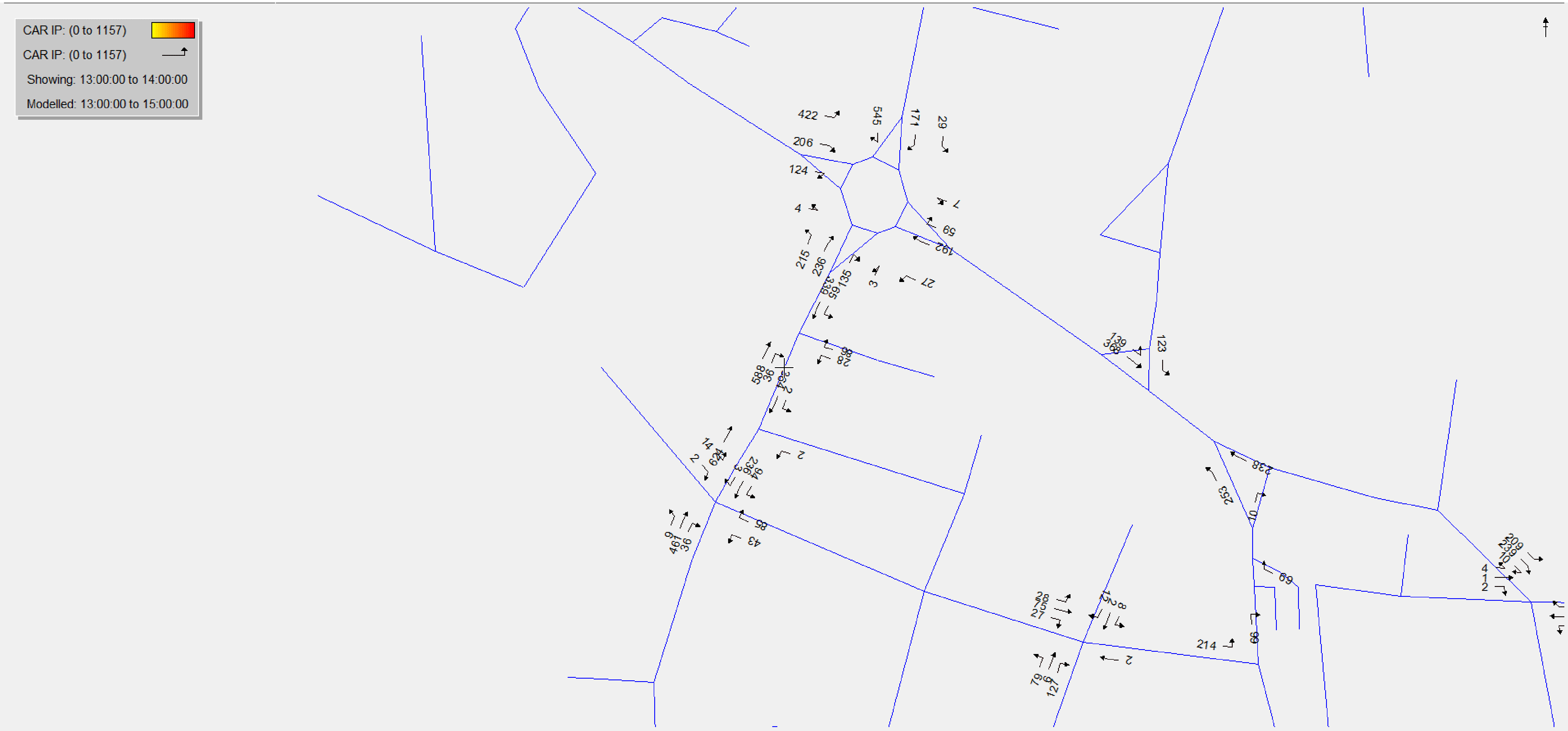
LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

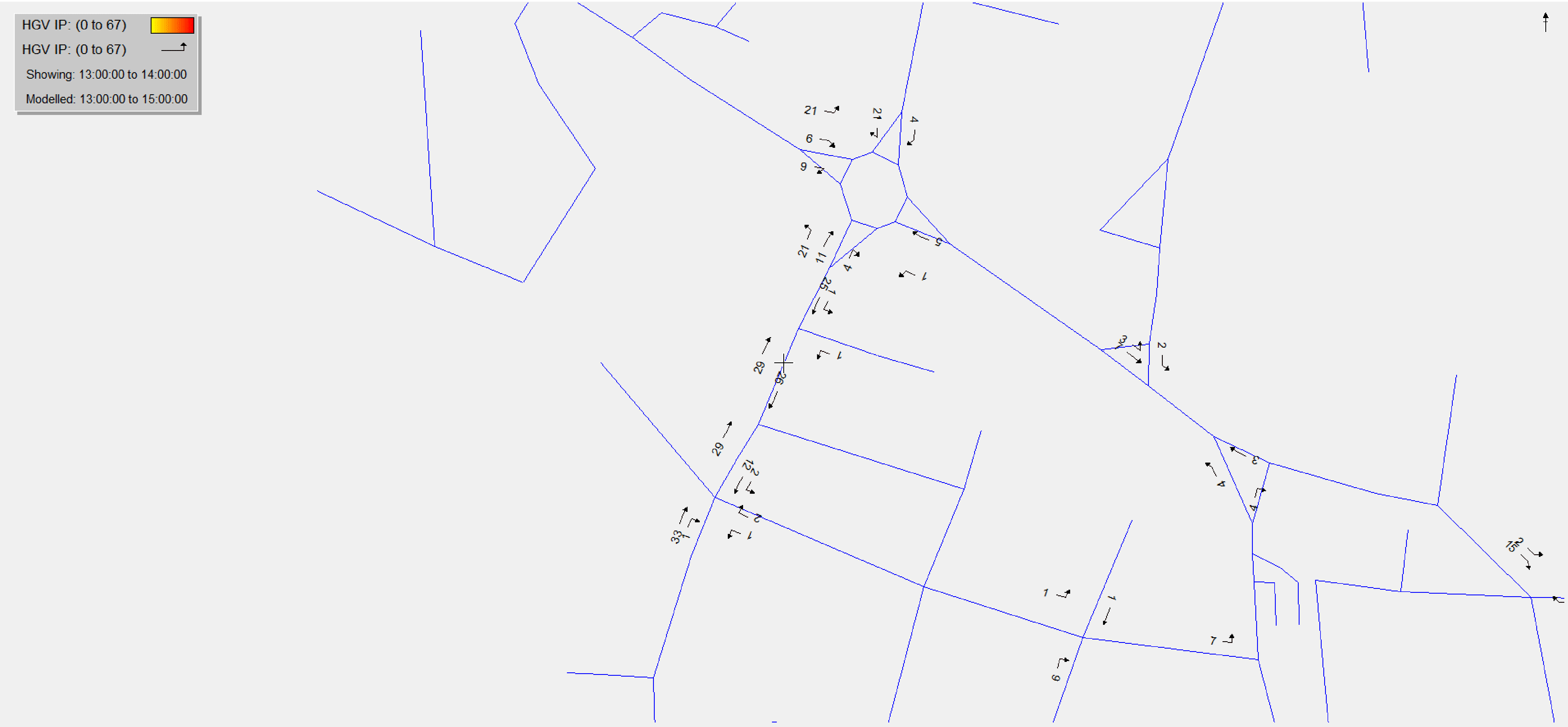
Figure 7 Traffic counts peak hour – North Quay Roundabout

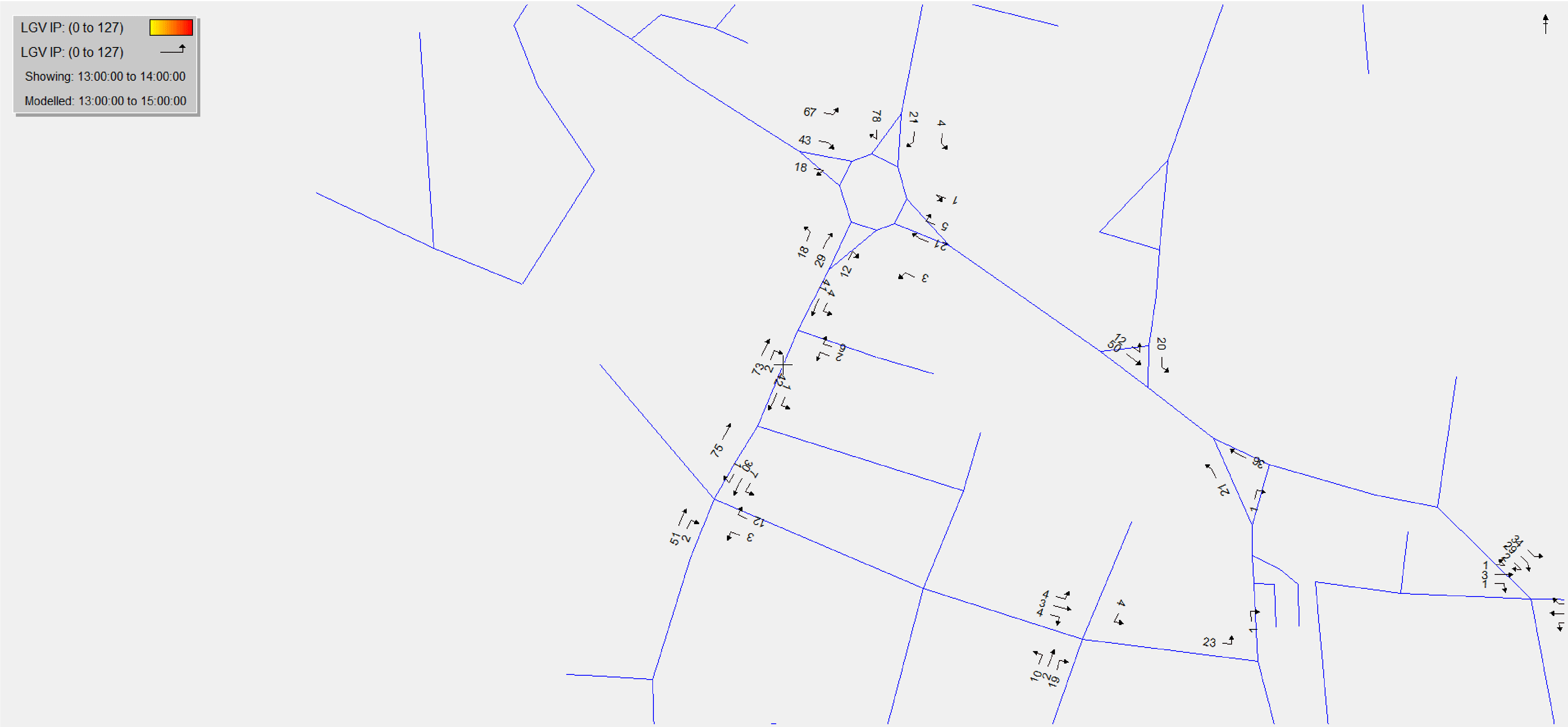


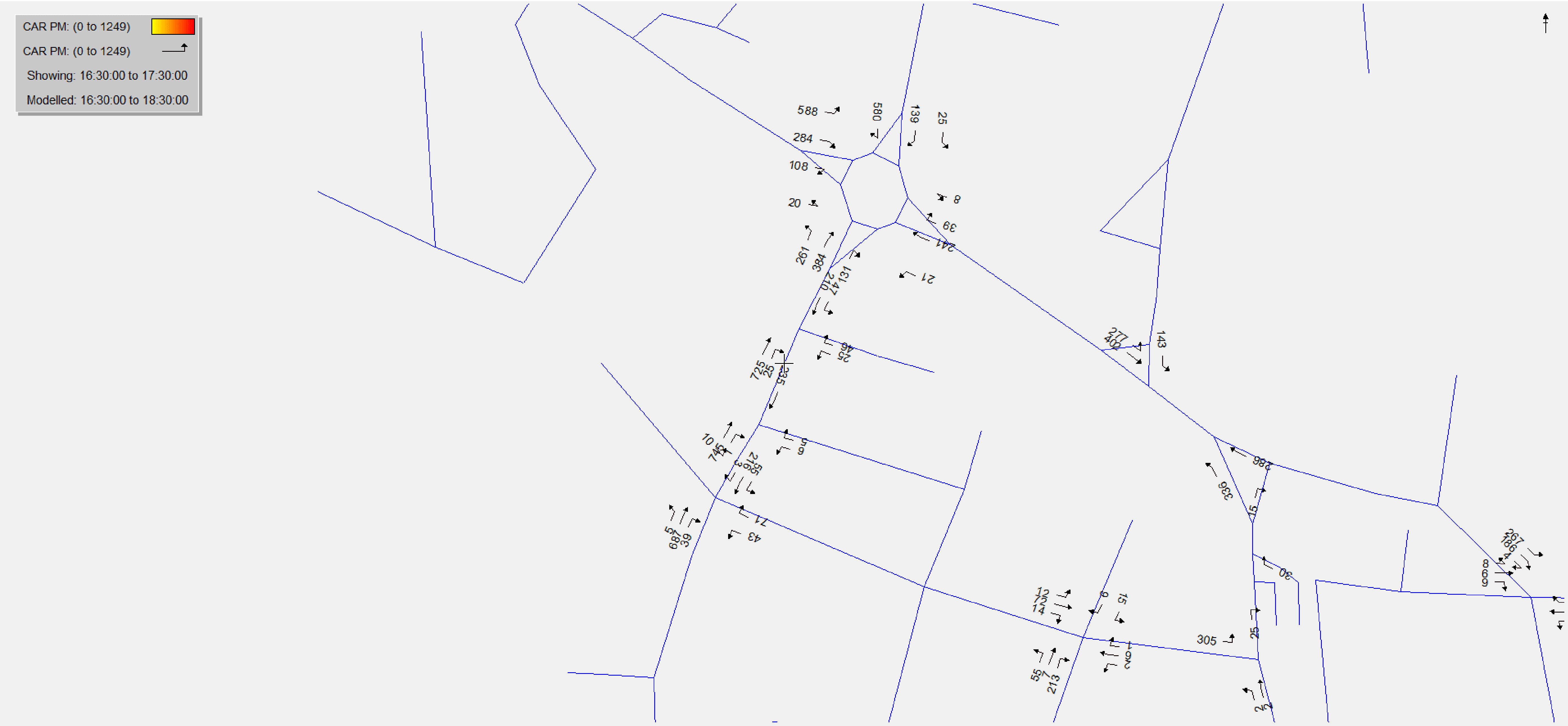

HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

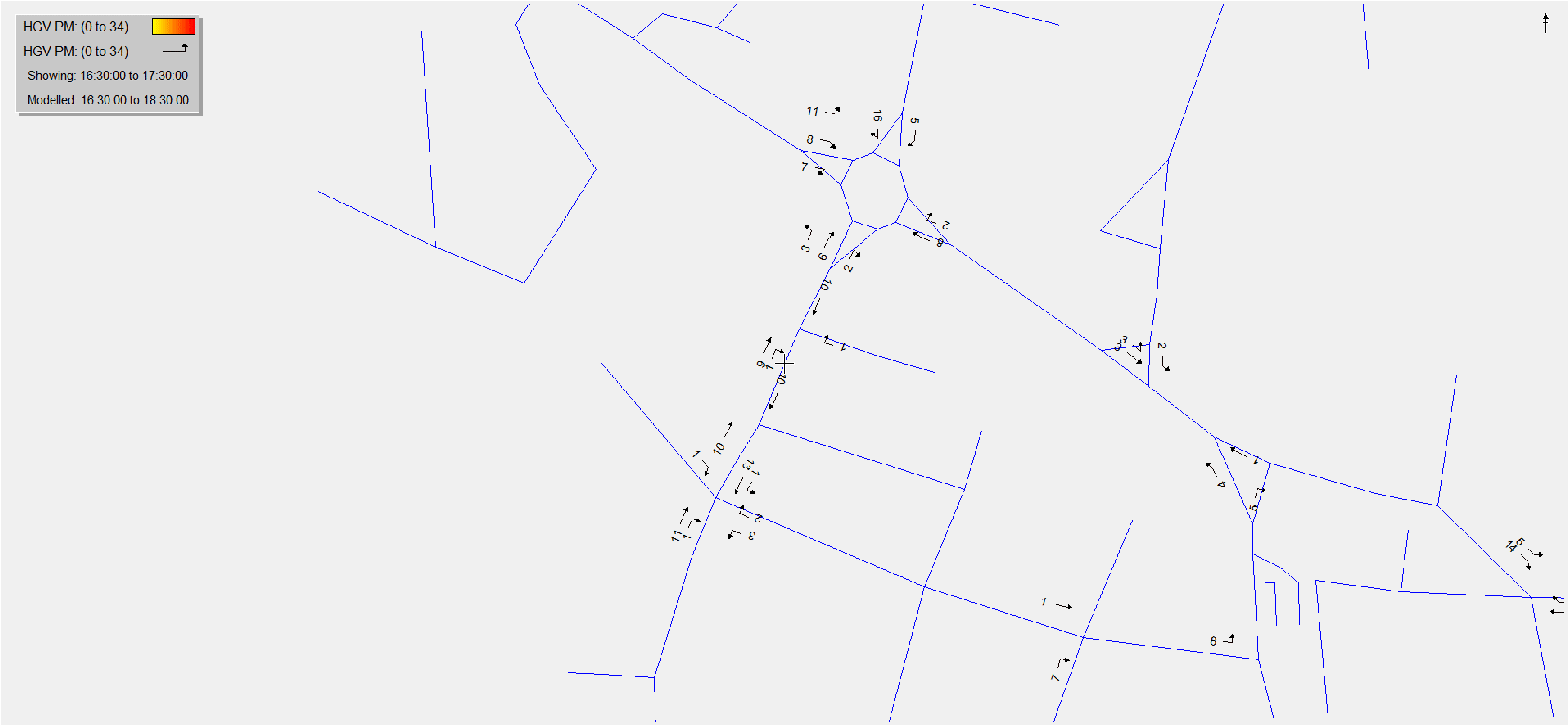

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

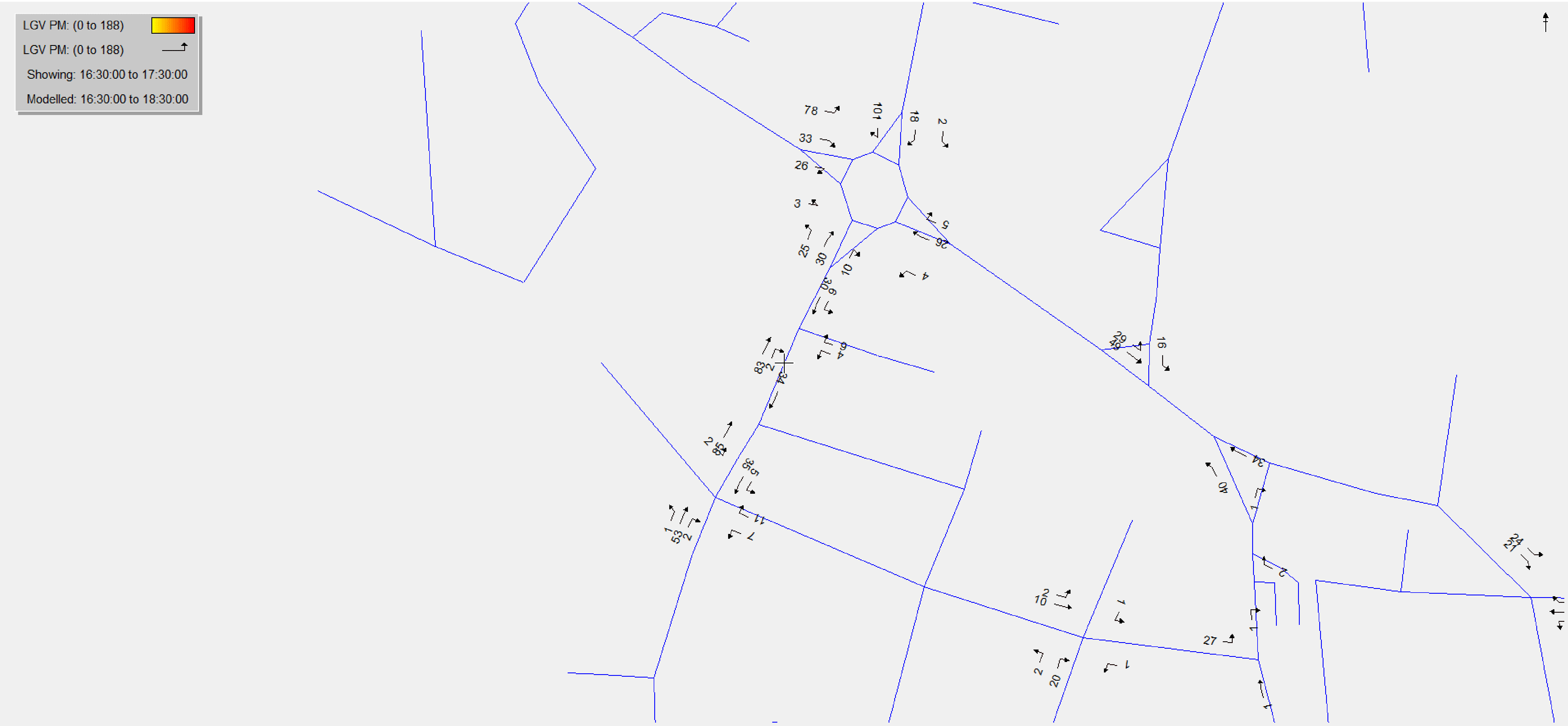
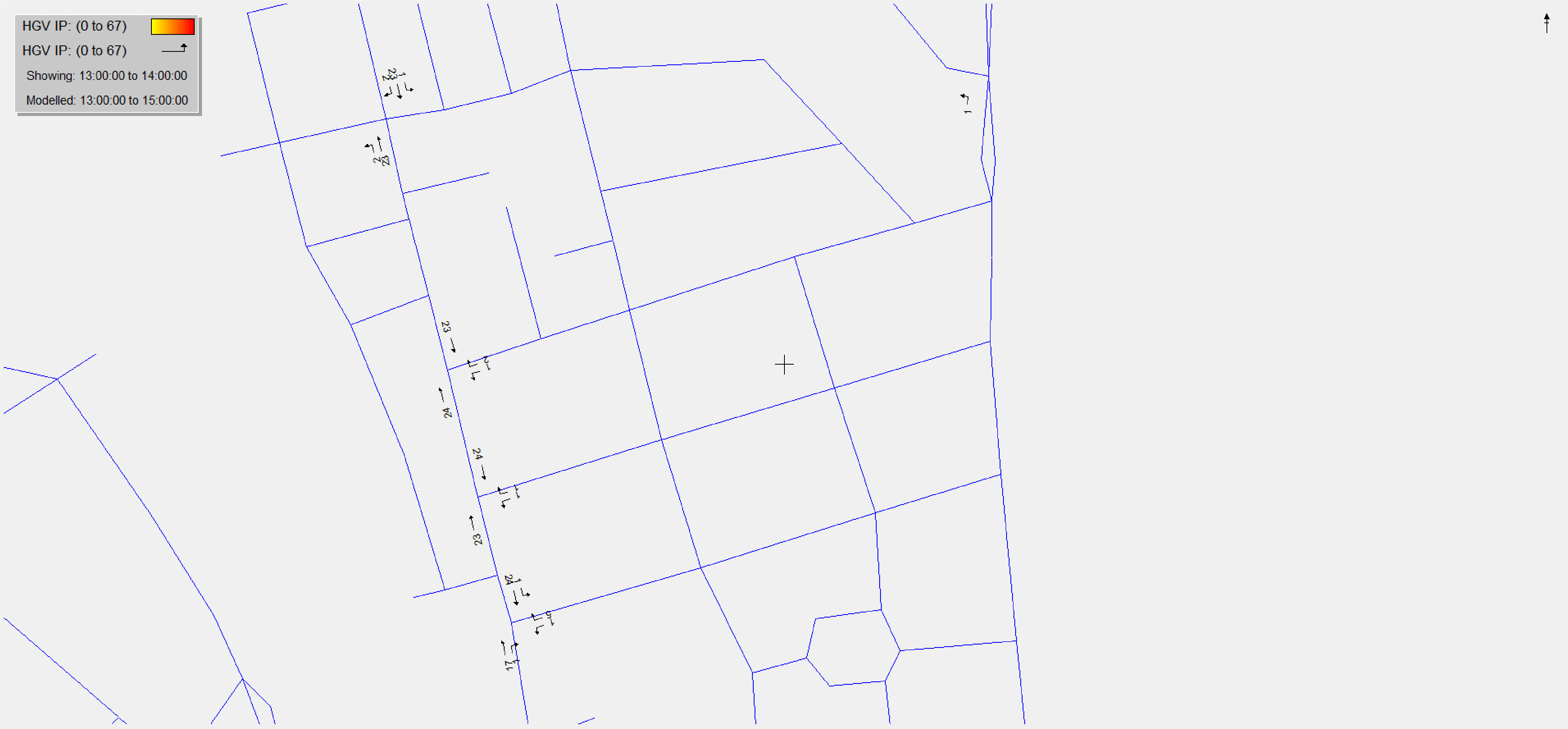

LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

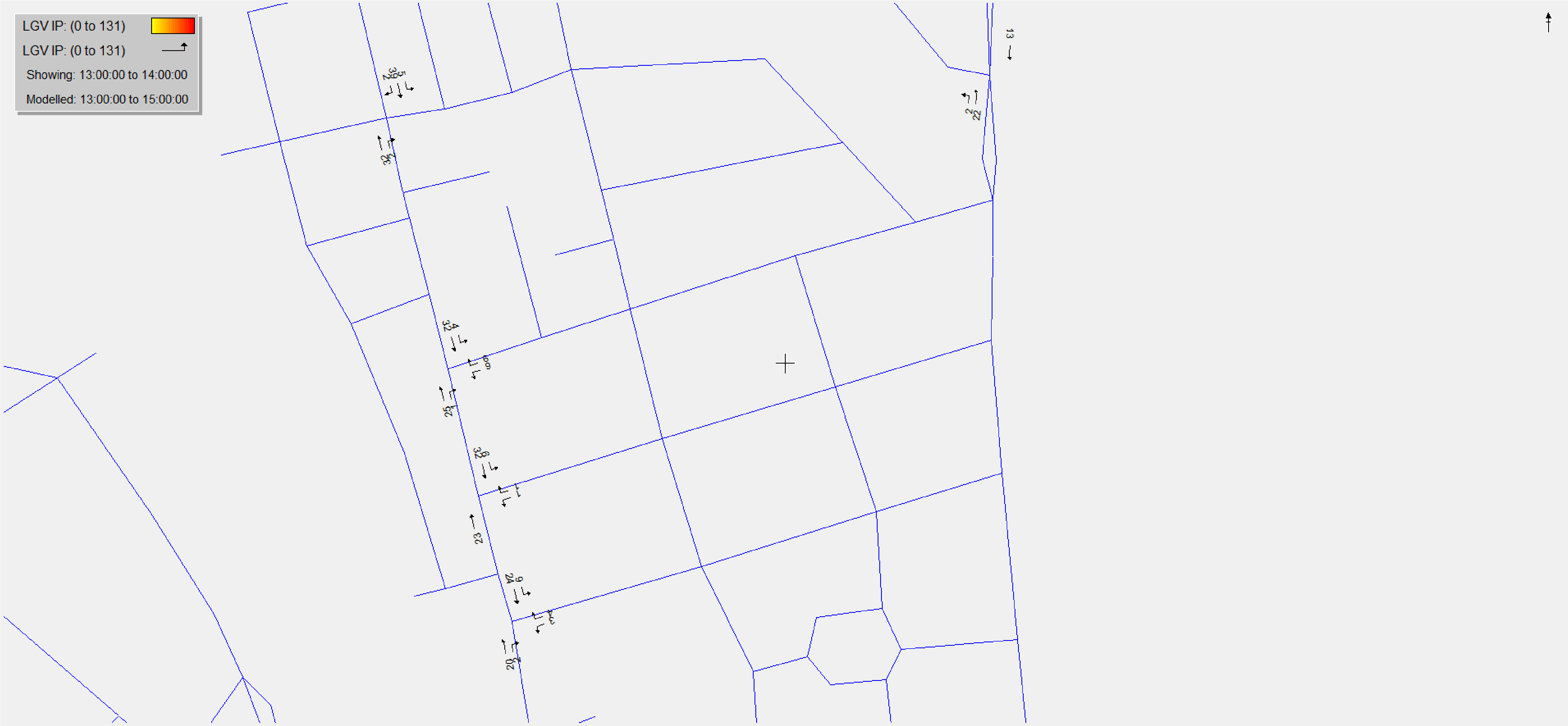
Figure 8 Traffic counts peak hour – Southgate Road


HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

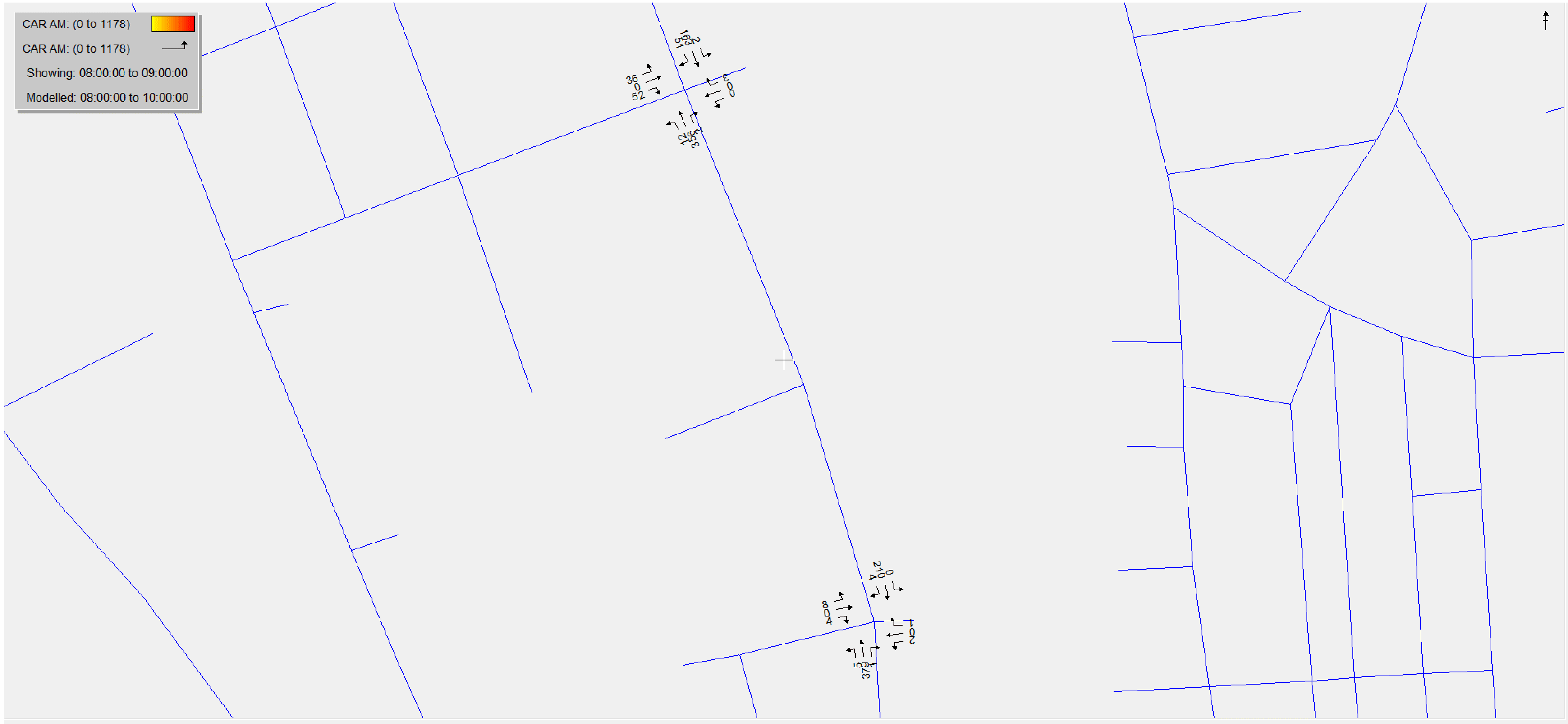

LGV IP: (0 to 131)
LGV IP: (0 to 131)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

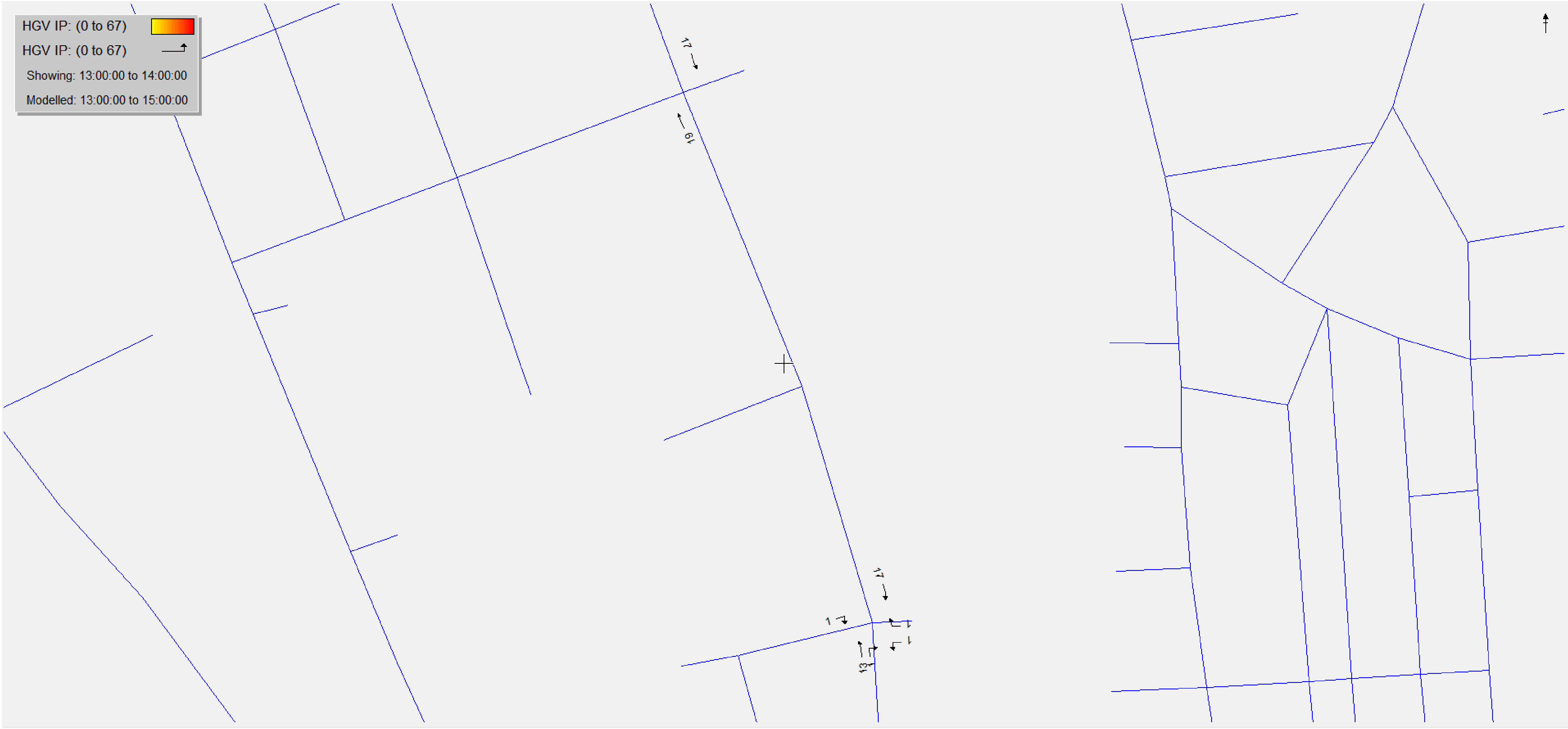
Figure 9 Traffic counts peak hour – Southtown Road

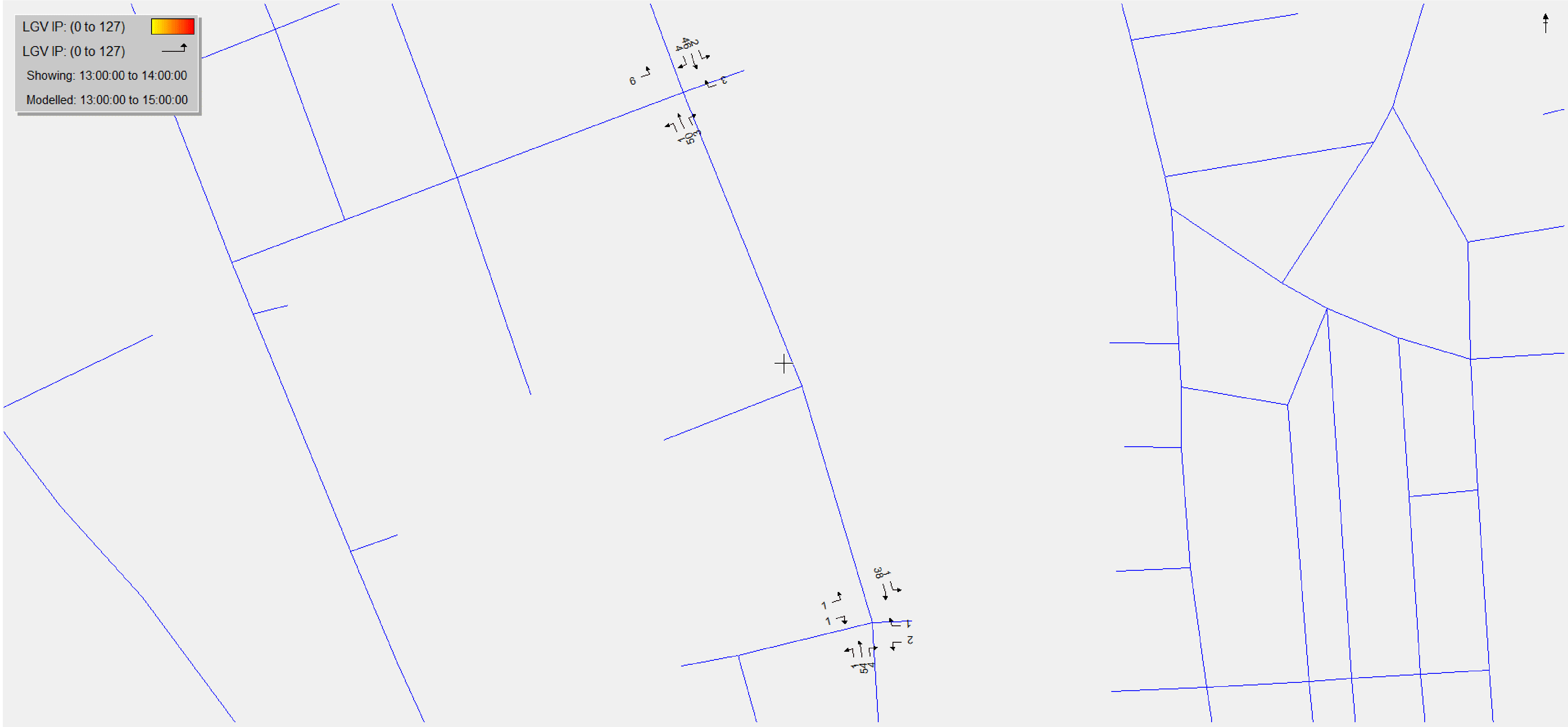


HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

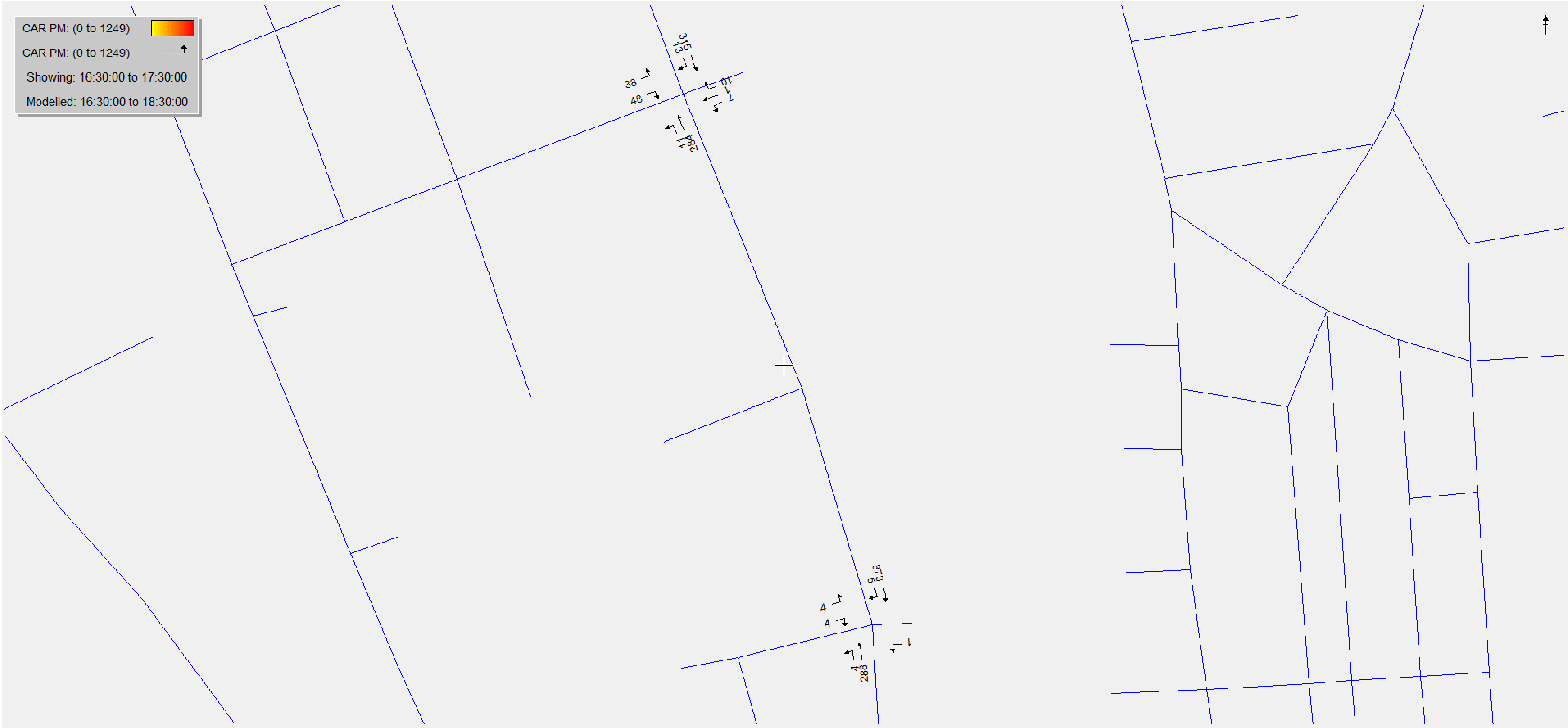

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
17
42
6
2


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
17
19
17
1
13



LGV IP: (0 to 127)
LGV IP: (0 to 127)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00
315
38
48
4
4
373
288


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

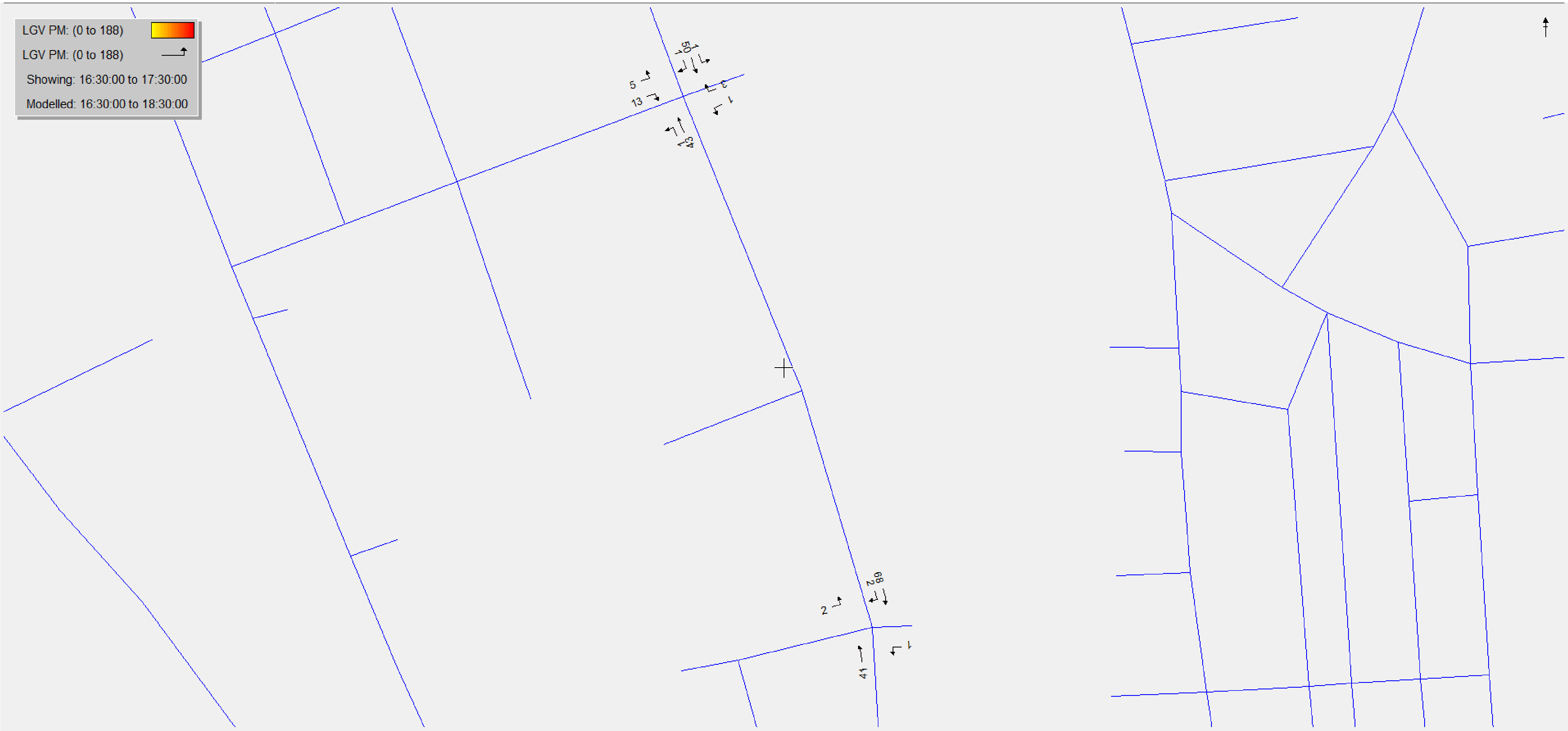
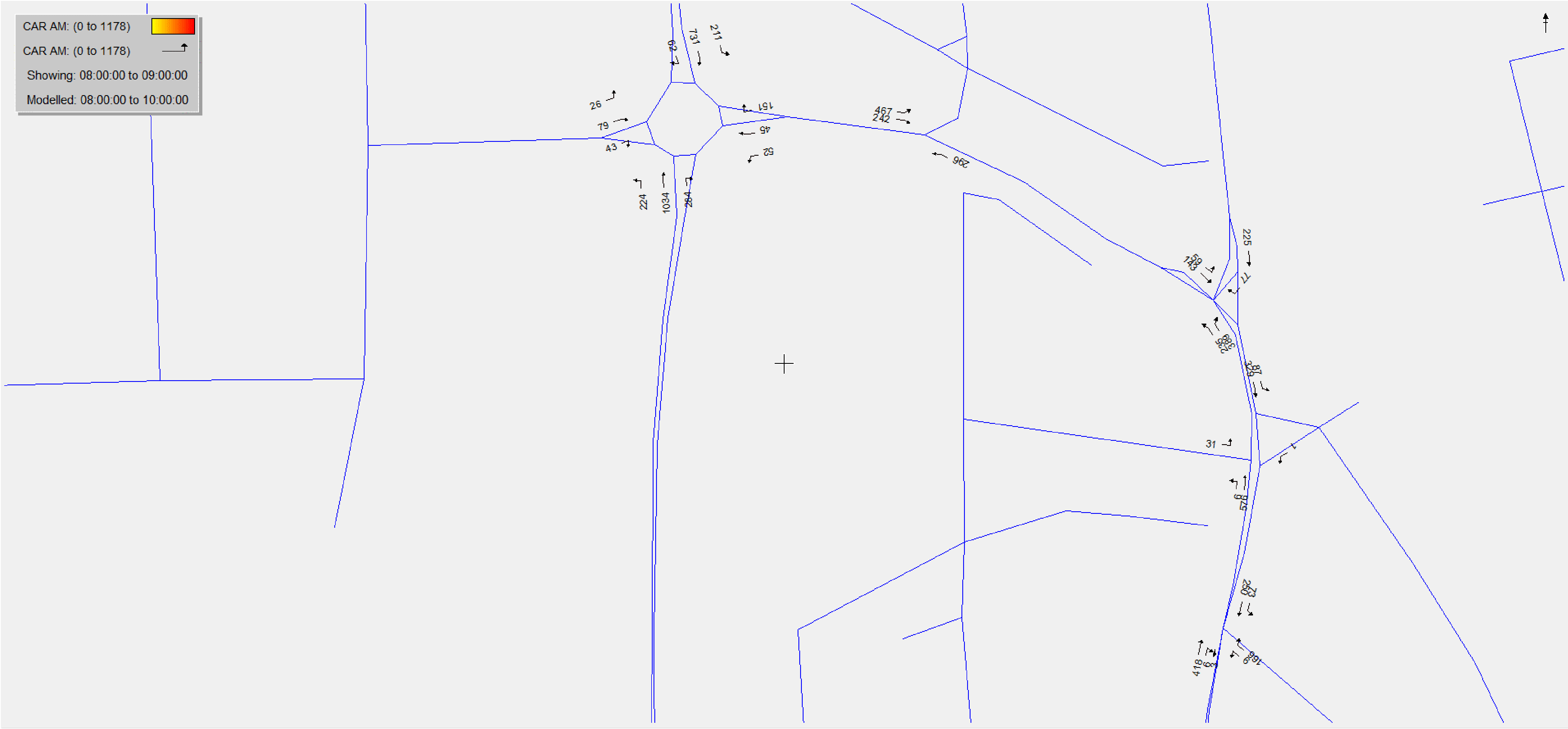
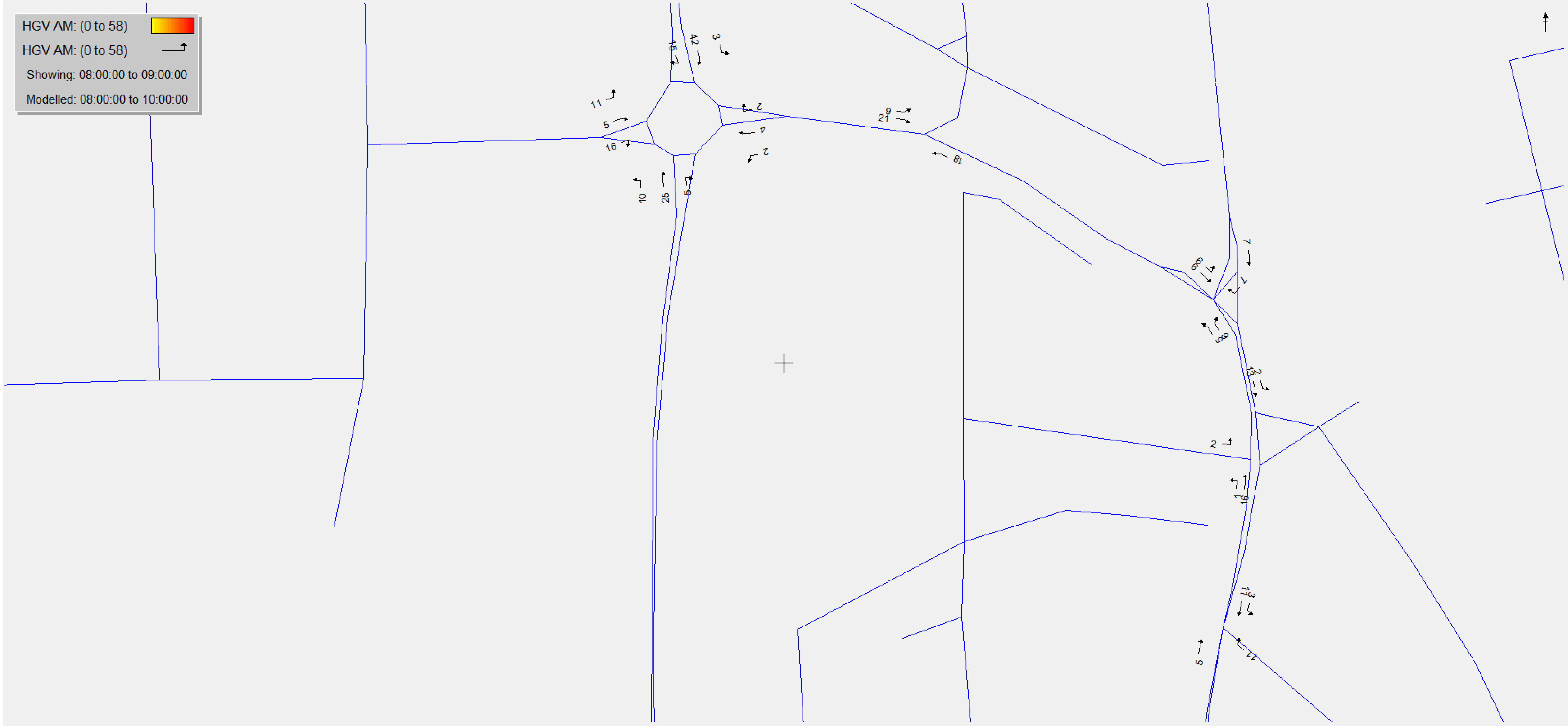
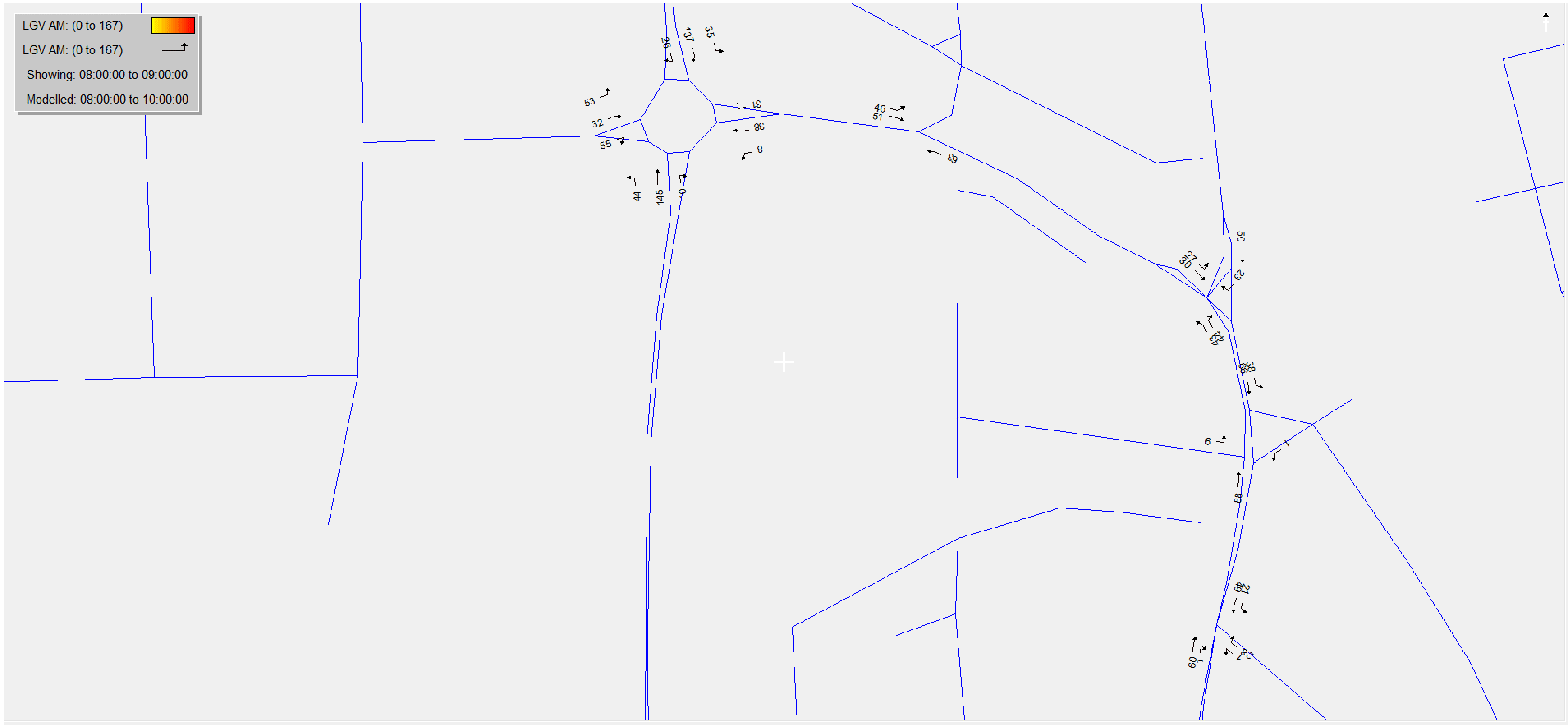

LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

Figure 10 Traffic counts peak hour – William Adams Roundabout

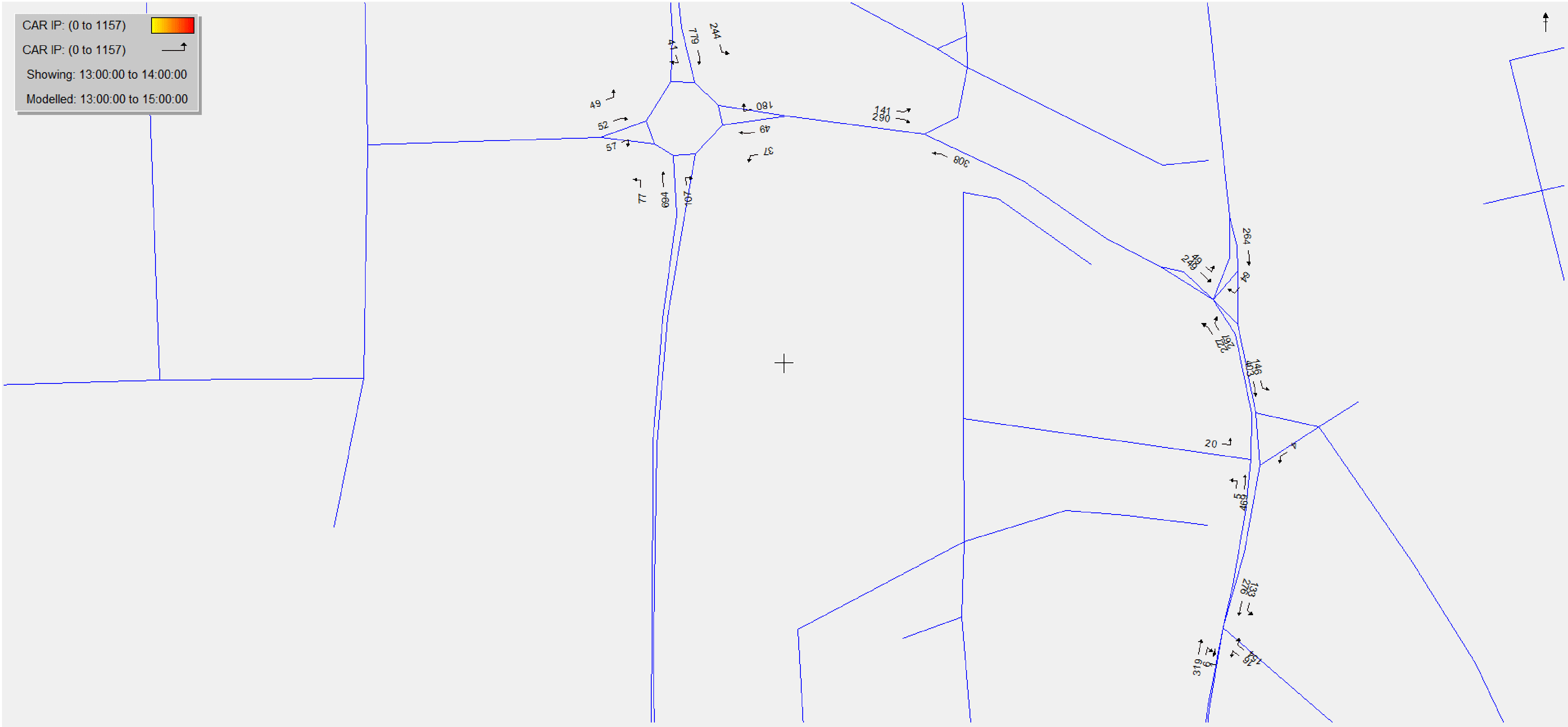


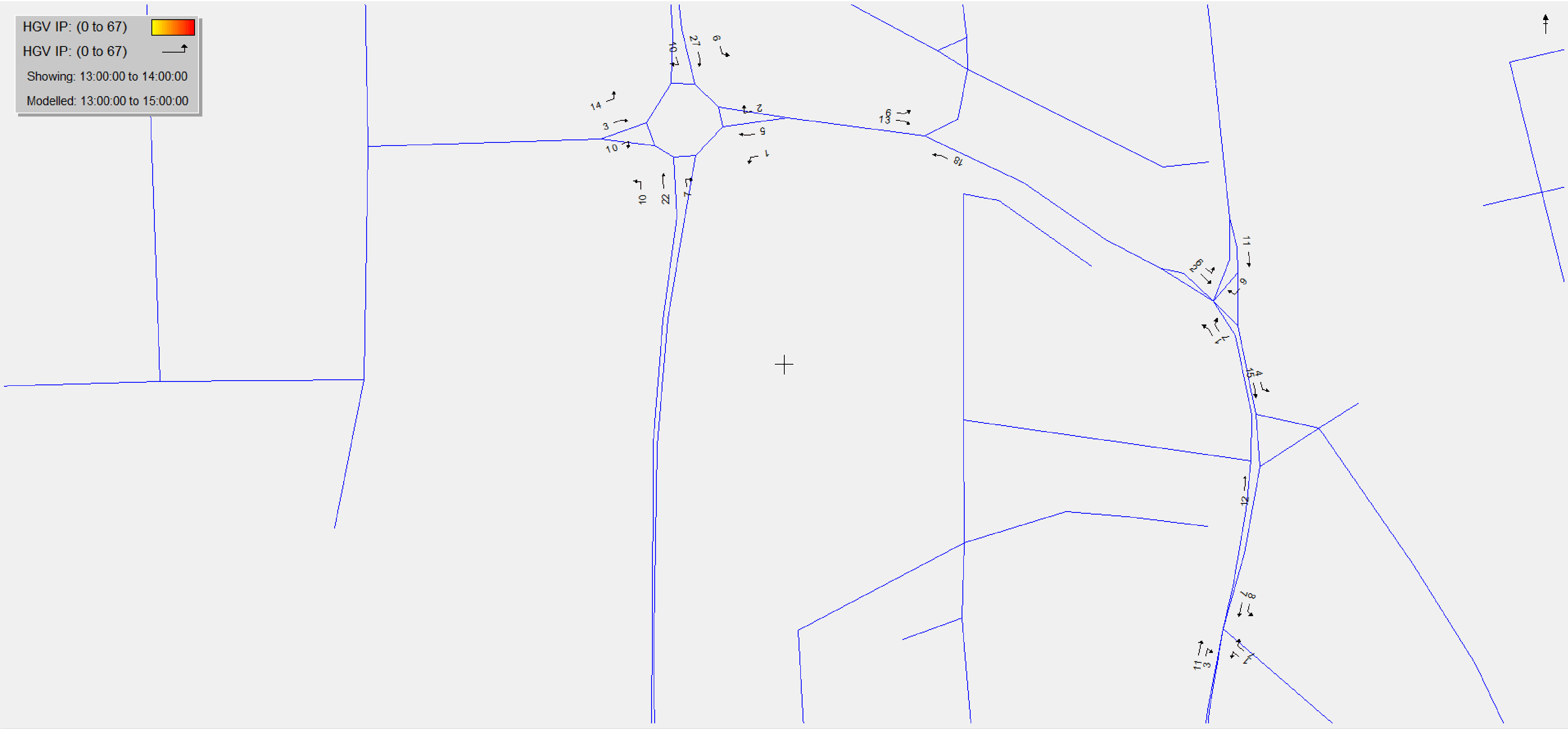


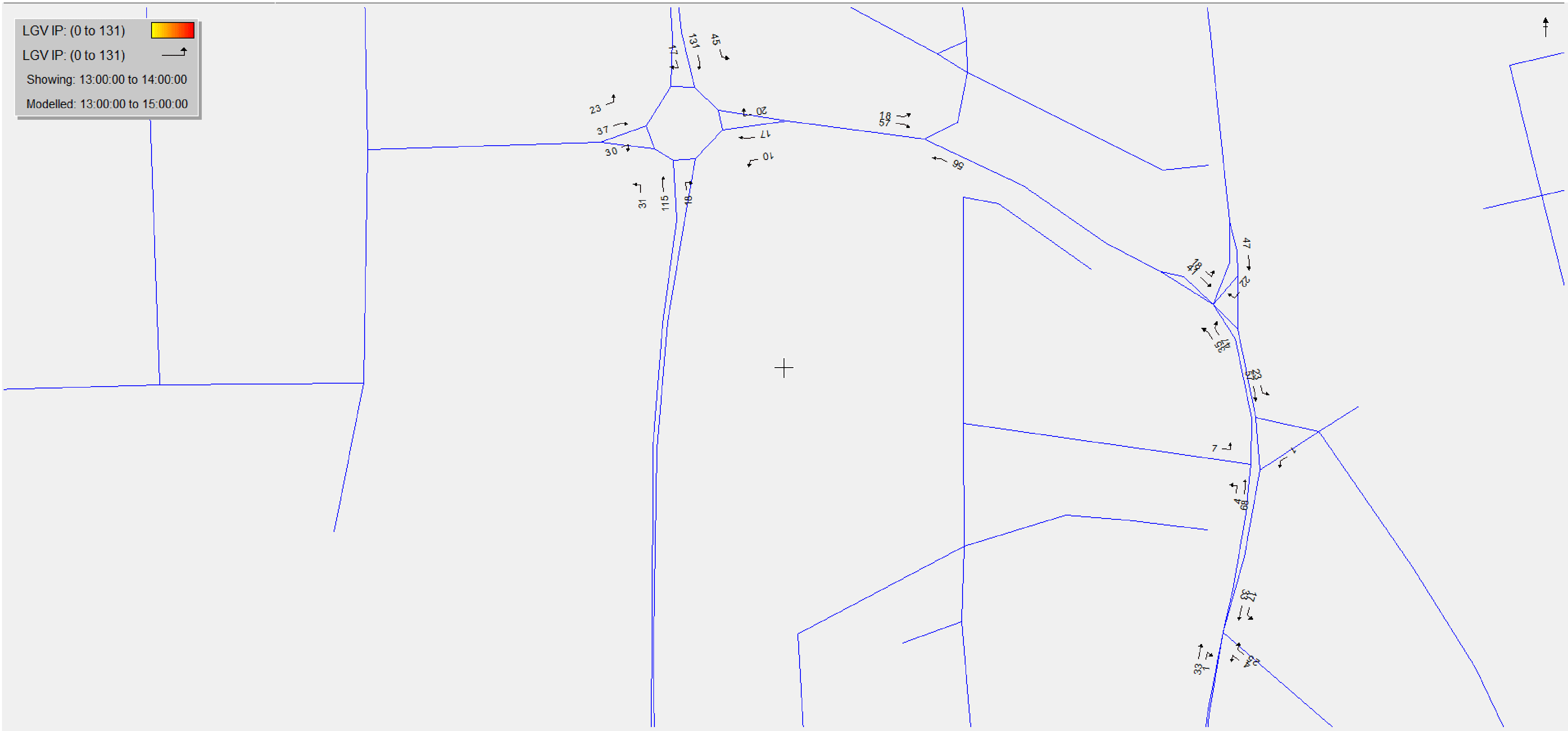
HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

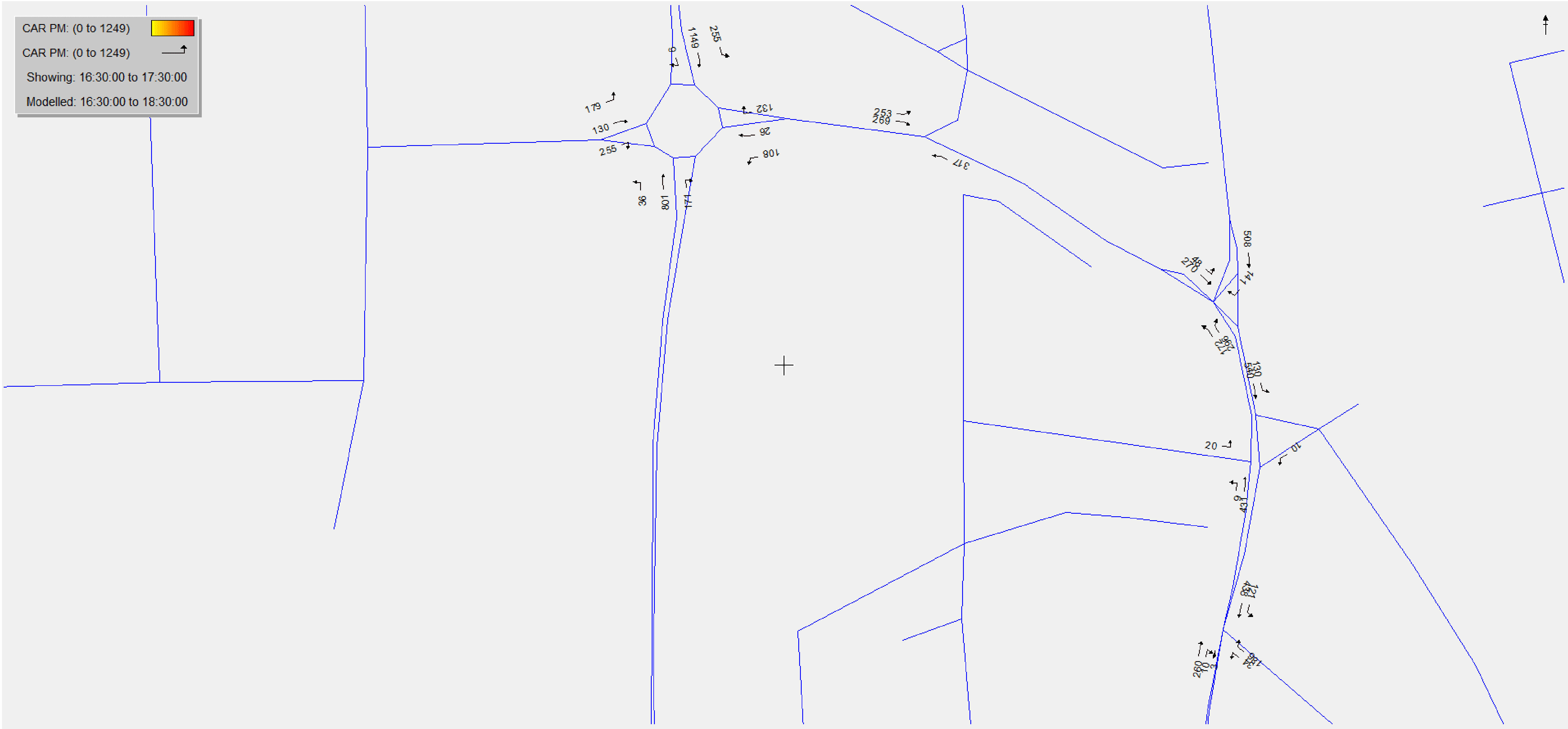


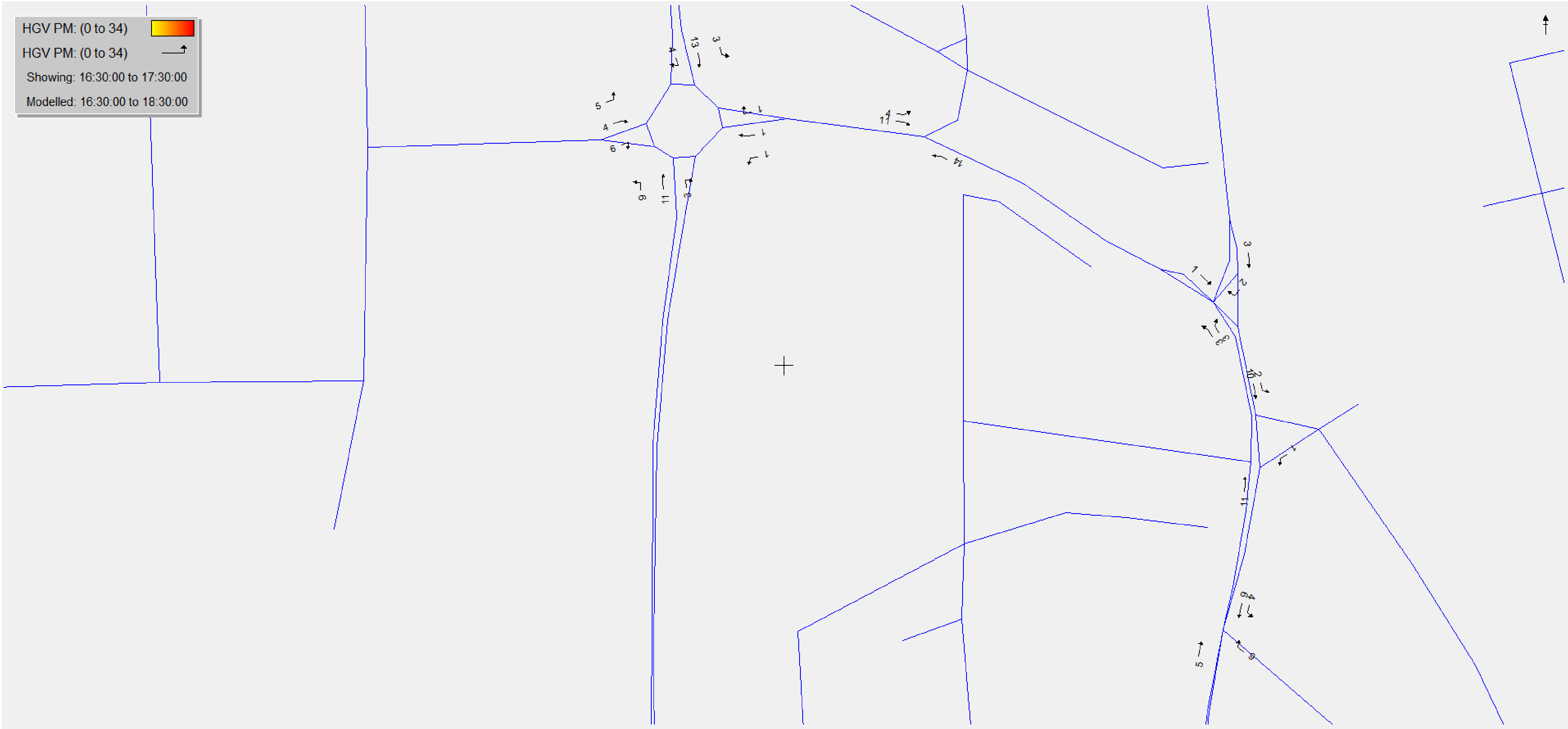
LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP: (0 to 131)
LGV IP: (0 to 131)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

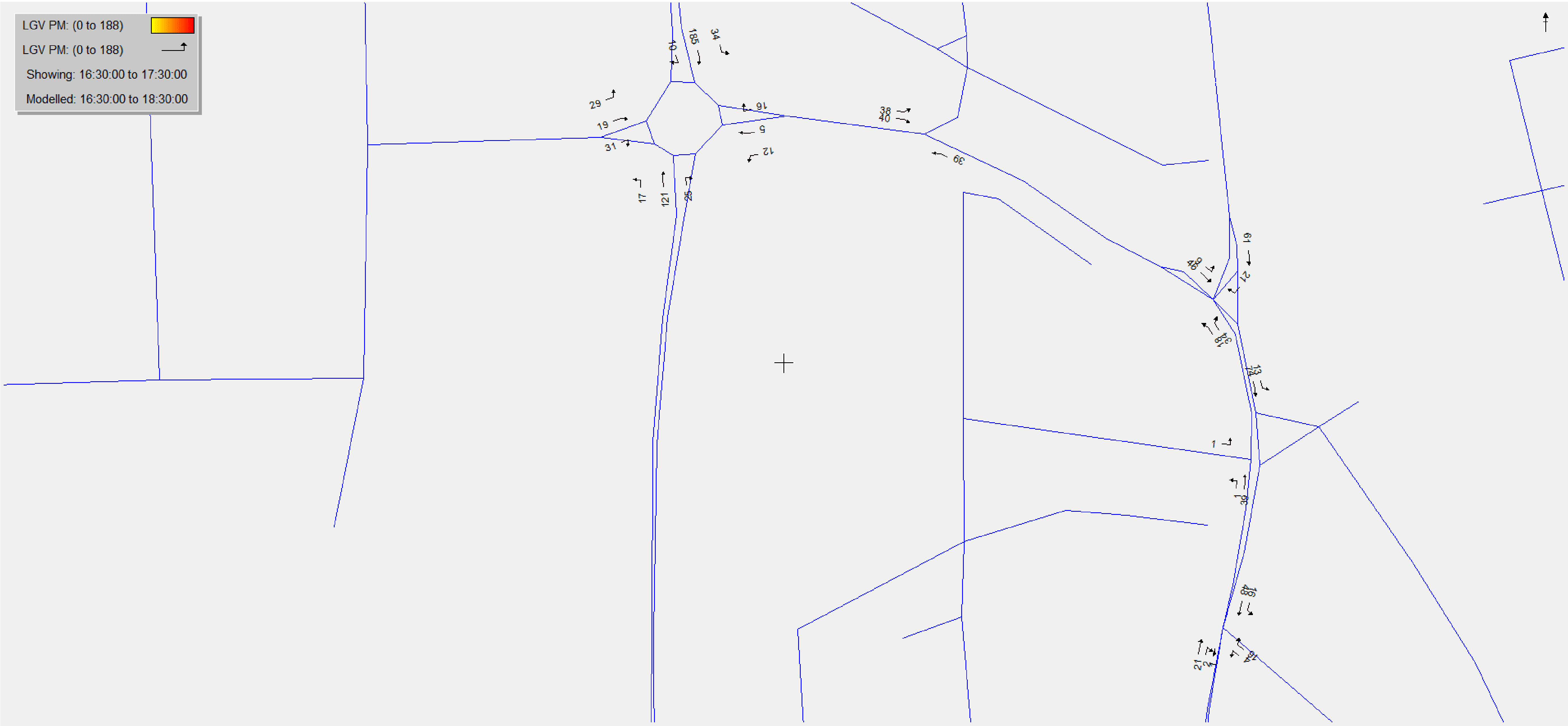
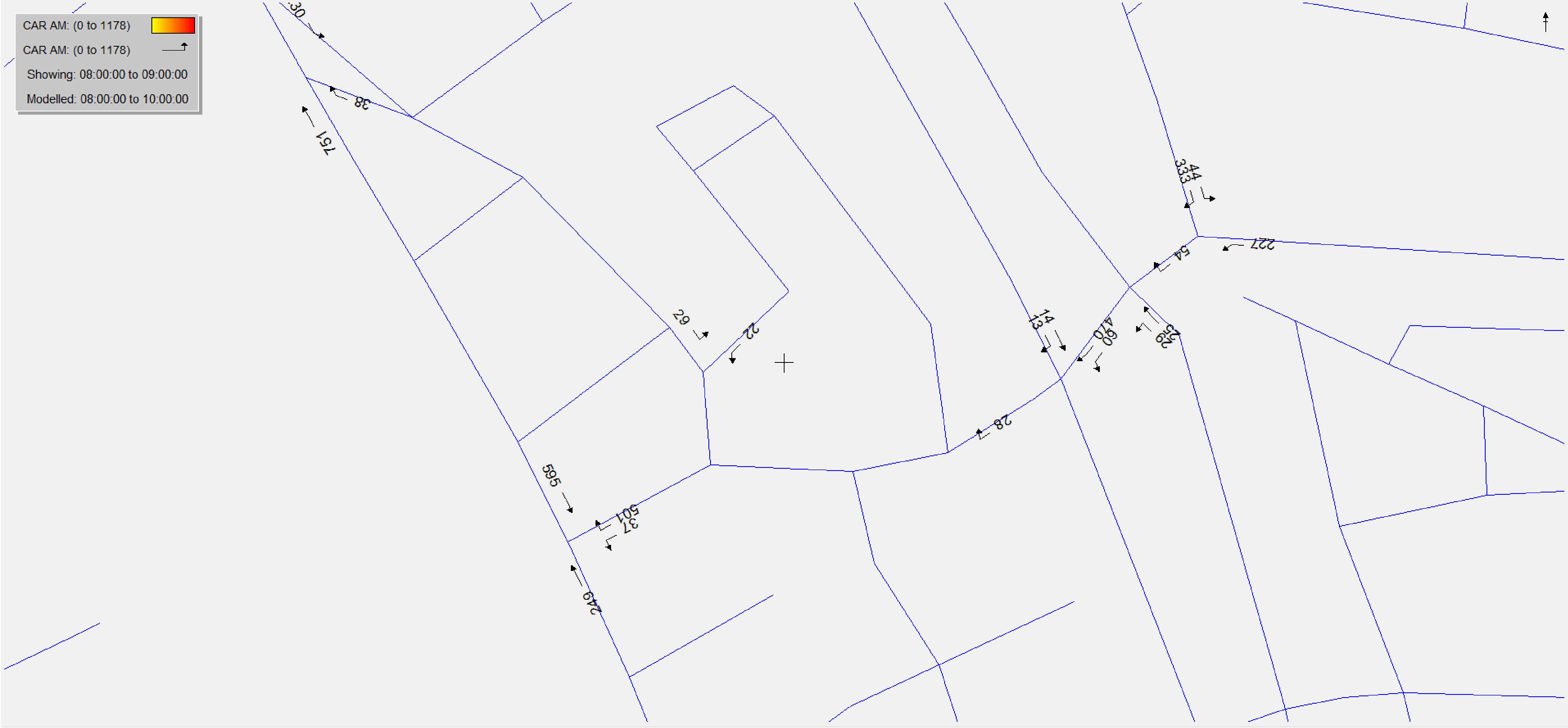
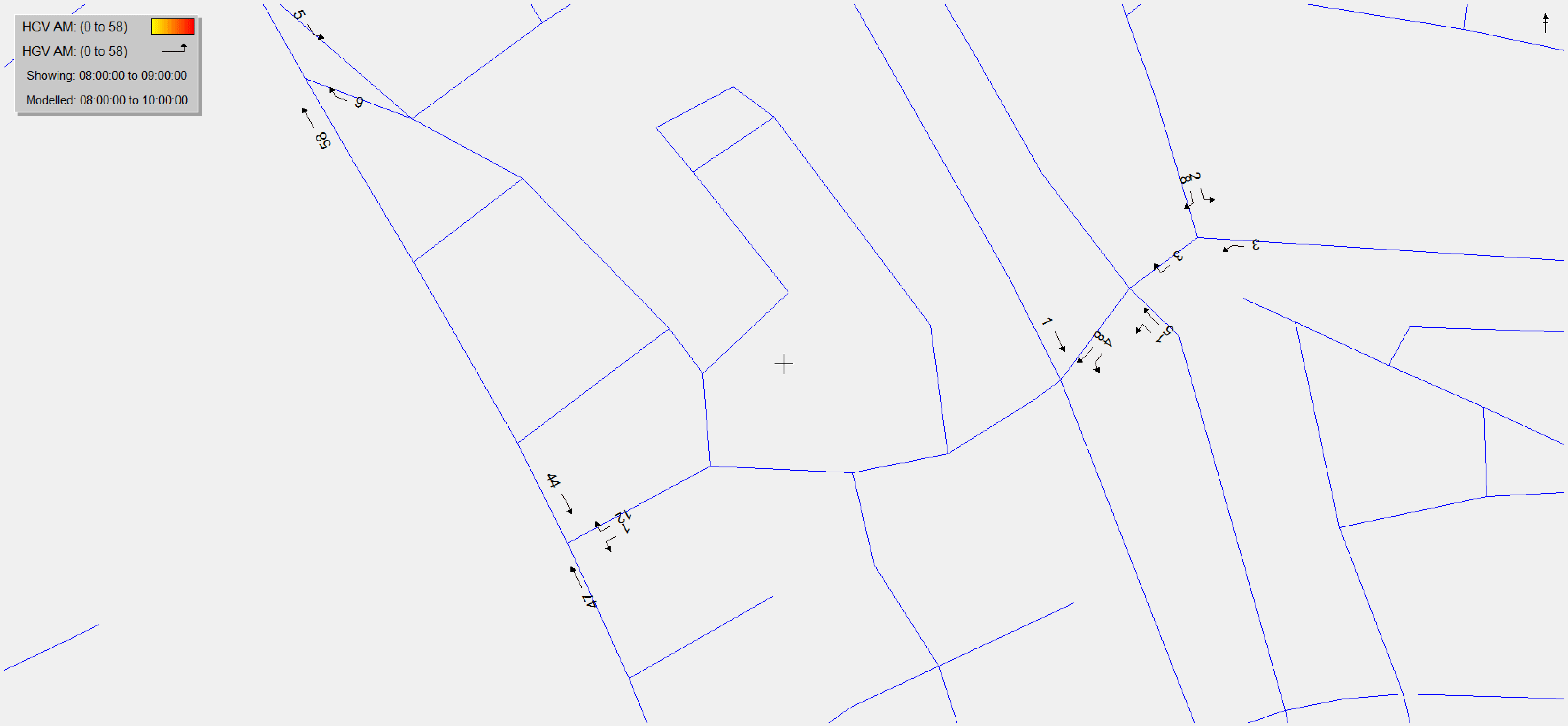

LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

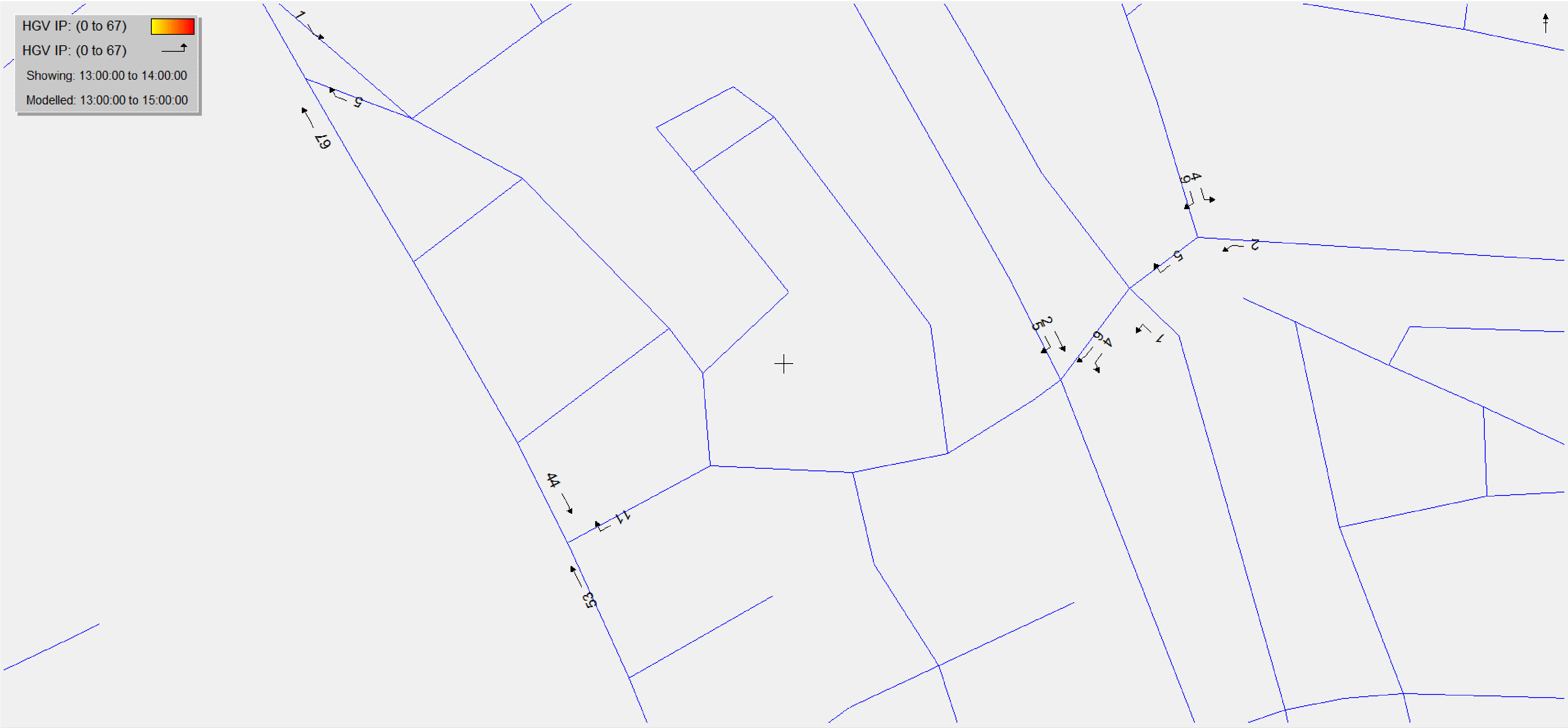
Figure 11 Traffic counts peak hour – Yarmouth Way

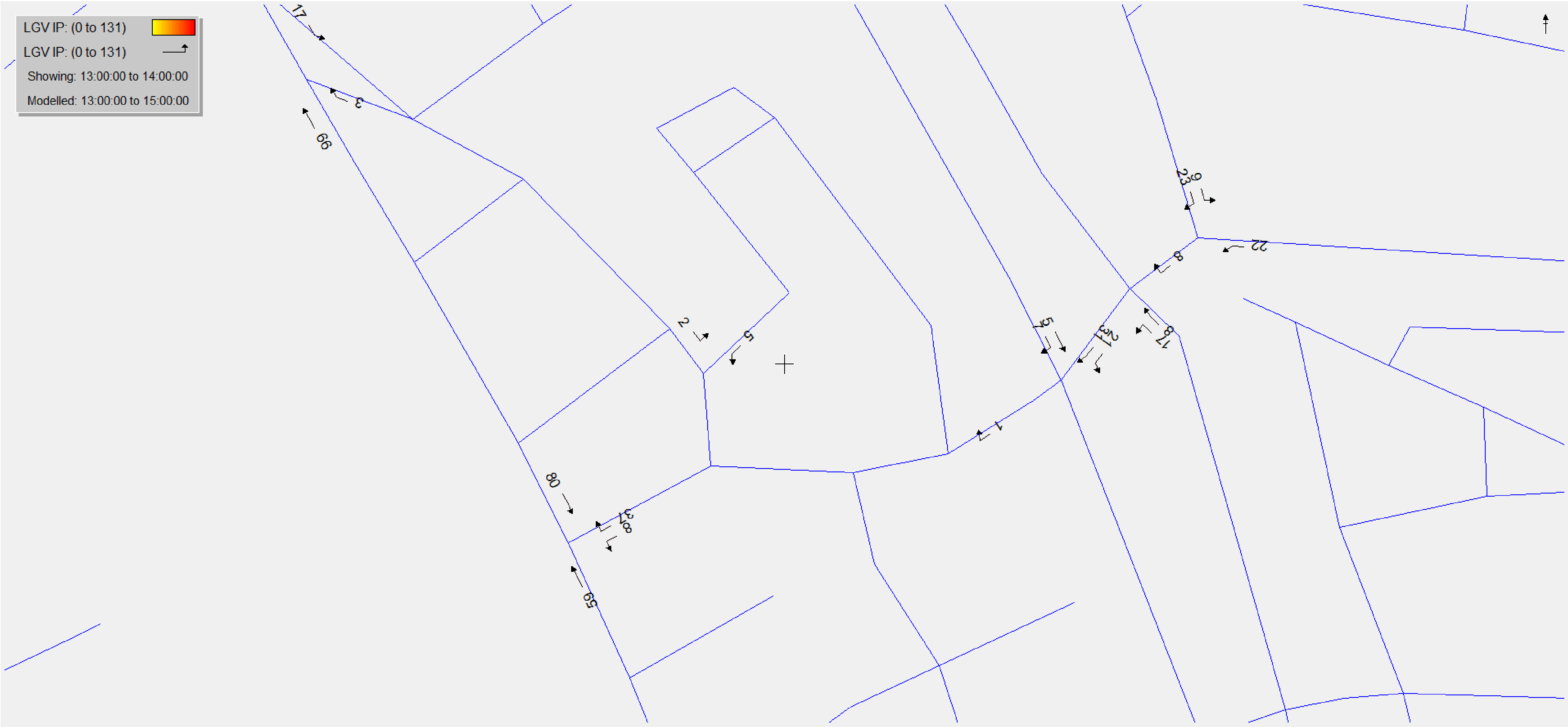



HGV AM: (0 to 58)
HGV AM: (0 to 58)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

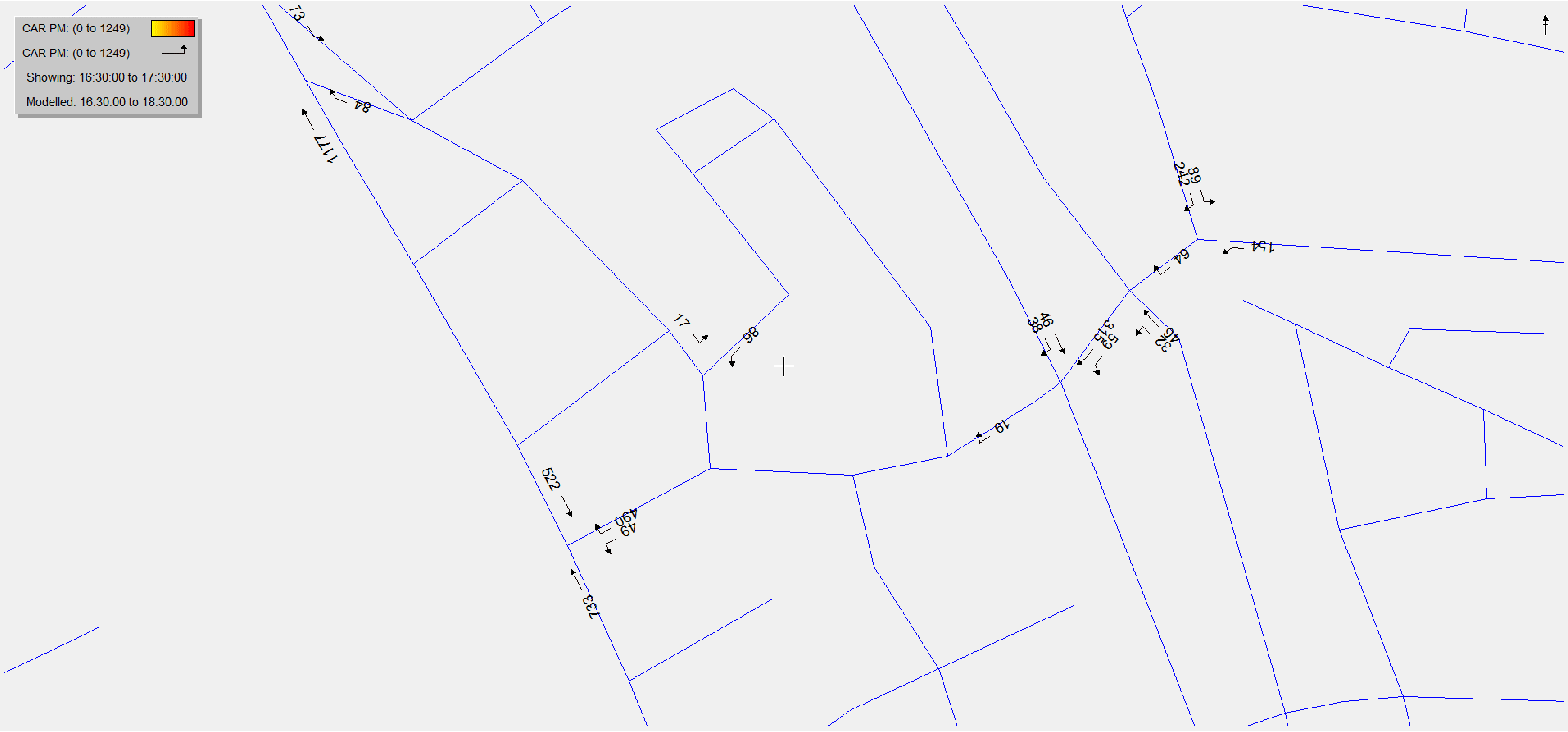

LGV AM: (0 to 167)
LGV AM: (0 to 167)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP: (0 to 1157)
CAR IP: (0 to 1157)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
63
44
831
281
287
105
67
34
56
41
35
297
49
31
17
24
436
469
47
325


HGV IP: (0 to 67)
HGV IP: (0 to 67)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



LGV IP: (0 to 131)
LGV IP: (0 to 131)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM: (0 to 1249)
CAR PM: (0 to 1249)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

HGV PM: (0 to 34)
HGV PM: (0 to 34)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00


LGV PM: (0 to 188)
LGV PM: (0 to 188)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 18:30:00

APPENDIX B. Queue Data

Table 1 AM Queue Survey Data

AM Queue Survey	Max queue (metres)
Area 1. New Surveys 2016	
JUNCTION 1	5.3
A	5.3
B	0.0
C	5.3
JUNCTION 4	36.6
D	22.67
E	24.70
F	26.94
G	36.62
JUNCTION 7/8	63.6
H	40.00
I	63.64
J	22.16
K	0.00
L	5.00
Area 2. New Surveys 2016	
J4	10.0
Kings Road Eastbound	10.00
S Beach Parade Northbound	10.00
S Beach Parade Southbound	0.00
Area 3. New Surveys 2016	
Junction 13	16.8
M	16.75
N	15.96
O	10.68
P	15.18
Q	10.20
R	15.83
Junction 14	61.7
AA	59.97
AB	35.57
AC	0.00
S	44.25
T	61.72
U	5.37
V	26.47
W	49.29
X	0.00
Y	0.00
Z	0.00
Junction 15	61.7
AD	17.04
AE	23.01
AF	61.67
AG	31.70
AH	15.15

AM Queue Survey	Max queue (metres)
Junction 18	78.7
AI	32.34
AJ	78.74
AK	22.67
Junction 20	38.5
AL	16.67
AM	37.20
AN	14.67
AO	38.55
AECOM. Surveys 2015	
Site 1	108.0
A1	81.00
A2	63.00
B1	36.00
C1	90.00
C2	108.00
D1	54.00
D2	15.00
D3	45.00
Site 2	84.0
A1	24.00
A2	18.00
A3	33.00
B1	51.00
B2	84.00
B3	39.00
C1	36.00
C2	33.00
Site 3	66.0
A1	66.00
A2	36.00
B1	33.00
B2	39.00
C1	36.00
C2	54.00
D1	27.00
D2	63.00
Site 4	108.0
A1	99.00
A2	78.00
B1	69.00
B2	24.00
B3	39.00
C1	108.00
C2	99.00
Site 5	144.0
A1	33.00
A2	39.00
B1	30.00

AM Queue Survey	Max queue (metres)
B2	78.00
B3	132.00
C1	99.00
C2	108.00
C3	33.00
D1	36.00
D2	144.00
D3	90.00
Site 6	135.0
A1	66.00
A2	54.00
A3	75.00
A4	48.00
B1	27.00
B2	36.00
B3	0.00
C1	78.00
C2	99.00
C3	15.00
D1	108.00
D2	135.00
Site 7	105.0
A1	39.00
A2	63.00
B1	105.00
B2	27.00
B3	30.00
C1	75.00
C2	36.00
Site 8	84.0
A1	30.00
A2	54.00
B1	45.00
B2	21.00
B3	21.00
C1	84.00
C2	78.00
C3	30.00
D1	54.00
D2	36.00
NCC. Surveys 2015	
2	150.0
2	80.00
4	150.00
5	122.50
1A	100.00
1B	70.00
3A	20.00
3B	50.00

AM Queue Survey	Max queue (metres)
3	155.0
1	155.00
2A	57.50
2B	75.00
2C	15.00
3A	42.50
3B	50.00
8	140.0
1	140.00
2	42.50
3	25.00
4	55.00
5	40.00
6	75.00
7	80.00
8	130.00
1A	155.0
1A	30.00
1B	35.00
2A	25.00
2B	70.00
2C	155.00
3A	70.00
3B	90.00
3C	30.00
4A	30.00
4B	150.00
4C	85.00
1B	120.0
4	70.00
1A	35.00
1B	80.00
2A	20.00
2B	10.00
3A	10.00
3B	120.00

Table 2 IP Queue Survey Data

IP Queue Survey	Max queue (metres)
Area 1. New Surveys 2016	
JUNCTION 1	10.0
A	10.0
B	0.0
C	0.0
JUNCTION 4	31.4
D	28.41
E	30.78
F	20.63
G	31.41
JUNCTION 7/8	27.3
H	25.86
I	27.31
J	10.72
K	5.11
L	0.00
Area 2. New Surveys 2016	
J4	15.0
Kings Road Eastbound	10.00
S Beach Parade Northbound	5.00
S Beach Parade Southbound	15.00
Area 3. New Surveys 2016	
Junction 13	41.9
M	20.59
N	37.76
O	30.71
P	20.38
Q	31.29
R	41.89
Junction 14	51.9
AA	35.28
AB	16.61
AC	0.00
S	51.90
T	25.95
U	5.27
V	19.50
W	19.50
X	0.00
Y	0.00
Z	0.00
Junction 15	58.2
AD	38.41
AE	32.82
AF	58.20
AG	31.41

IP Queue Survey	Max queue (metres)
AH	20.95
Junction 18	0.0
AI	0.00
AJ	0.00
AK	0.00
Junction 20	0.0
AL	0.00
AM	0.00
AN	0.00
AO	0.00
AECOM. Surveys 2015	
Site 1	99.0
A1	72.00
A2	57.00
B1	27.00
C1	69.00
C2	87.00
D1	99.00
D2	27.00
D3	45.00
Site 2	108.0
A1	30.00
A2	24.00
A3	27.00
B1	54.00
B2	108.00
B3	42.00
C1	54.00
C2	54.00
Site 3	87.0
A1	87.00
A2	36.00
B1	39.00
B2	54.00
C1	48.00
C2	81.00
D1	39.00
D2	72.00
Site 4	114.0
A1	63.00
A2	96.00
B1	60.00
B2	60.00
B3	72.00
C1	114.00
C2	105.00
Site 5	135.0
A1	30.00
A2	48.00

IP Queue Survey	Max queue (metres)
B1	30.00
B2	93.00
B3	135.00
C1	66.00
C2	99.00
C3	90.00
D1	54.00
D2	114.00
D3	120.00
Site 6	135.0
A1	54.00
A2	54.00
A3	84.00
A4	57.00
B1	21.00
B2	42.00
B3	0.00
C1	78.00
C2	93.00
C3	24.00
D1	135.00
D2	135.00
Site 7	81.0
A1	45.00
A2	60.00
B1	81.00
B2	18.00
B3	27.00
C1	42.00
C2	24.00
Site 8	69.0
A1	27.00
A2	54.00
B1	69.00
B2	27.00
B3	18.00
C1	27.00
C2	54.00
C3	15.00
D1	30.00
D2	36.00
NCC. Surveys 2015	
2	142.5
2	115.00
4	105.00
5	142.50
1A	80.00
1B	50.00
3A	37.50

IP Queue Survey	Max queue (metres)
3B	120.00
3	137.5
1	137.50
2A	55.00
2B	60.00
2C	15.00
3A	75.00
3B	65.00
8	135.0
1	135.00
2	40.00
3	25.00
4	35.00
5	55.00
6	110.00
7	60.00
8	127.50
1A	140.0
1A	35.00
1B	35.00
2A	35.00
2B	92.50
2C	140.00
3A	55.00
3B	75.00
3C	15.00
4A	45.00
4B	132.50
4C	80.00
1B	110.0
4	70.00
1A	40.00
1B	65.25
2A	20.00
2B	15.00
3A	15.00
3B	110.00

Table 3 PM Queue Survey Data

PM Queue Survey	Max queue (metres)
Area 1. New Surveys 2016	
JUNCTION 1	4.9
A	4.9
B	0.0
C	0.0
JUNCTION 4	59.6
D	28.73
E	30.91
F	52.92
G	59.58
JUNCTION 7/8	42.5
H	25.00
I	42.55
J	21.27
K	10.48
L	4.76
Area 2. New Surveys 2016	
J4	10.0
Kings Road Eastbound	5.00
S Beach Parade Northbound	10.00
S Beach Parade Southbound	0.00
Area 3. New Surveys 2016	
Junction 13	44.6
M	21.74
N	25.96
O	20.24
P	1.42
Q	0.00
R	44.61
Junction 14	56.7
AA	45.55
AB	35.98
AC	0.00
S	41.20
T	35.34
U	10.96
V	36.36
W	56.68
X	0.00
Y	0.00
Z	0.00
Junction 15	62.0
AD	25.72
AE	42.98
AF	61.99
AG	21.96

PM Queue Survey	Max queue (metres)
AH	15.18
Junction 18	53.1
AI	51.60
AJ	53.06
AK	15.47
Junction 20	45.0
AL	21.11
AM	38.01
AN	37.02
AO	45.00
AECOM. Surveys 2015	
Site 1	108.0
A1	75.00
A2	60.00
B1	33.00
C1	108.00
C2	105.00
D1	105.00
D2	18.00
D3	54.00
Site 2	123.0
A1	30.00
A2	30.00
A3	69.00
B1	123.00
B2	87.00
B3	42.00
C1	57.00
C2	54.00
Site 3	132.0
A1	75.00
A2	30.00
B1	39.00
B2	42.00
C1	114.00
C2	132.00
D1	39.00
D2	63.00
Site 4	108.0
A1	105.00
A2	99.00
B1	63.00
B2	78.00
B3	78.00
C1	96.00
C2	108.00
Site 5	138.0
A1	39.00
A2	36.00

PM Queue Survey	Max queue (metres)
B1	42.00
B2	120.00
B3	138.00
C1	81.00
C2	111.00
C3	39.00
D1	69.00
D2	111.00
D3	102.00
Site 6	126.0
A1	84.00
A2	57.00
A3	84.00
A4	36.00
B1	21.00
B2	66.00
B3	0.00
C1	108.00
C2	96.00
C3	18.00
D1	84.00
D2	126.00
Site 7	84.0
A1	54.00
A2	84.00
B1	57.00
B2	24.00
B3	27.00
C1	72.00
C2	36.00
Site 8	66.0
A1	54.00
A2	66.00
B1	54.00
B2	21.00
B3	42.00
C1	27.00
C2	54.00
C3	12.00
D1	51.00
D2	42.00
NCC. Surveys 2015	
2	127.5
2	65.00
4	112.50
5	125.00
1A	127.50
1B	75.00
3A	82.50

PM Queue Survey	Max queue (metres)
3B	120.00
3	125.0
1	125.00
2A	95.00
2B	85.00
2C	20.00
3A	92.50
3B	65.00
8	140.0
1	115.00
2	30.00
3	50.00
4	40.00
5	125.00
6	122.50
7	65.00
8	140.00
1A	150.0
1A	35.00
1B	40.00
2A	37.50
2B	150.00
2C	150.00
3A	75.00
3B	90.00
3C	40.00
4A	35.00
4B	120.00
4C	132.50
1B	132.5
4	120.00
1A	30.00
1B	70.00
2A	30.00
2B	20.00
3A	5.00
3B	132.50

APPENDIX C. Journey Time Data

Table 1 Average Vehicle Journey Times. A12 between A47 and A1243

Time Interval	Bound	Fused Travel Time	Fused Average Speed
00:00:00	NB	98	72
00:15:00	NB	99	72
00:30:00	NB	99	72
00:45:00	NB	99	71
01:00:00	NB	100	71
01:15:00	NB	100	71
01:30:00	NB	99	71
01:45:00	NB	99	72
02:00:00	NB	98	72
02:15:00	NB	98	72
02:30:00	NB	98	72
02:45:00	NB	98	72
03:00:00	NB	97	72
03:15:00	NB	98	72
03:30:00	NB	98	72
03:45:00	NB	98	72
04:00:00	NB	96	73
04:15:00	NB	95	74
04:30:00	NB	95	74
04:45:00	NB	95	74
05:00:00	NB	96	73
05:15:00	NB	96	74
05:30:00	NB	96	74
05:45:00	NB	96	74
06:00:00	NB	96	74
06:15:00	NB	99	71
06:30:00	NB	99	71
06:45:00	NB	101	69
07:00:00	NB	105	67
07:15:00	NB	108	65
07:30:00	NB	109	65
07:45:00	NB	114	62
08:00:00	NB	118	61
08:15:00	NB	119	60
08:30:00	NB	120	60
08:45:00	NB	120	61
09:00:00	NB	121	61
09:15:00	NB	123	60
09:30:00	NB	124	59
09:45:00	NB	126	59
10:00:00	NB	125	59
10:15:00	NB	125	59
10:30:00	NB	127	58
10:45:00	NB	131	57
11:00:00	NB	133	56
11:15:00	NB	135	56
11:30:00	NB	132	56

Time Interval	Bound	Fused Travel Time	Fused Average Speed
11:45:00	NB	134	56
12:00:00	NB	135	56
12:15:00	NB	131	56
12:30:00	NB	129	57
12:45:00	NB	124	59
13:00:00	NB	127	58
13:15:00	NB	133	56
13:30:00	NB	135	56
13:45:00	NB	138	55
14:00:00	NB	137	55
14:15:00	NB	142	54
14:30:00	NB	150	52
14:45:00	NB	153	51
15:00:00	NB	150	52
15:15:00	NB	149	52
15:30:00	NB	153	50
15:45:00	NB	150	51
16:00:00	NB	154	50
16:15:00	NB	168	45
16:30:00	NB	175	43
16:45:00	NB	175	42
17:00:00	NB	172	43
17:15:00	NB	176	43
17:30:00	NB	164	46
17:45:00	NB	163	46
18:00:00	NB	147	52
18:15:00	NB	132	57
18:30:00	NB	123	60
18:45:00	NB	118	62
19:00:00	NB	116	62
19:15:00	NB	123	62
19:30:00	NB	123	63
19:45:00	NB	117	63
20:00:00	NB	109	66
20:15:00	NB	108	67
20:30:00	NB	105	67
20:45:00	NB	104	68
21:00:00	NB	103	68
21:15:00	NB	104	68
21:30:00	NB	104	68
21:45:00	NB	103	69
22:00:00	NB	102	69
22:15:00	NB	102	69
22:30:00	NB	101	70
22:45:00	NB	100	70
23:00:00	NB	99	71
23:15:00	NB	101	70
23:30:00	NB	99	72
23:45:00	NB	98	72

Time Interval	Bound	Fused Travel Time	Fused Average Speed
00:00:00	SB	105	67
00:15:00	SB	104	67
00:30:00	SB	105	67
00:45:00	SB	106	66
01:00:00	SB	105	66
01:15:00	SB	106	66
01:30:00	SB	105	67
01:45:00	SB	105	67
02:00:00	SB	105	67
02:15:00	SB	105	67
02:30:00	SB	104	67
02:45:00	SB	104	67
03:00:00	SB	105	67
03:15:00	SB	104	67
03:30:00	SB	106	66
03:45:00	SB	105	66
04:00:00	SB	104	67
04:15:00	SB	104	67
04:30:00	SB	105	67
04:45:00	SB	106	66
05:00:00	SB	106	66
05:15:00	SB	105	66
05:30:00	SB	106	66
05:45:00	SB	104	67
06:00:00	SB	105	67
06:15:00	SB	108	65
06:30:00	SB	110	64
06:45:00	SB	111	63
07:00:00	SB	110	64
07:15:00	SB	114	62
07:30:00	SB	118	60
07:45:00	SB	123	57
08:00:00	SB	127	56
08:15:00	SB	125	56
08:30:00	SB	124	57
08:45:00	SB	125	57
09:00:00	SB	122	58
09:15:00	SB	123	58
09:30:00	SB	125	57
09:45:00	SB	124	57
10:00:00	SB	125	57
10:15:00	SB	126	56
10:30:00	SB	125	56
10:45:00	SB	127	56
11:00:00	SB	129	55
11:15:00	SB	128	55
11:30:00	SB	128	56
11:45:00	SB	128	56
12:00:00	SB	125	56

Time Interval	Bound	Fused Travel Time	Fused Average Speed
12:15:00	SB	127	56
12:30:00	SB	125	57
12:45:00	SB	124	57
13:00:00	SB	124	57
13:15:00	SB	125	56
13:30:00	SB	125	56
13:45:00	SB	127	56
14:00:00	SB	127	56
14:15:00	SB	127	56
14:30:00	SB	126	56
14:45:00	SB	127	56
15:00:00	SB	127	56
15:15:00	SB	127	56
15:30:00	SB	127	56
15:45:00	SB	129	55
16:00:00	SB	128	56
16:15:00	SB	129	55
16:30:00	SB	128	55
16:45:00	SB	130	55
17:00:00	SB	128	55
17:15:00	SB	130	55
17:30:00	SB	130	55
17:45:00	SB	131	54
18:00:00	SB	129	55
18:15:00	SB	128	55
18:30:00	SB	129	56
18:45:00	SB	125	57
19:00:00	SB	122	59
19:15:00	SB	121	59
19:30:00	SB	120	60
19:45:00	SB	117	61
20:00:00	SB	115	62
20:15:00	SB	114	62
20:30:00	SB	114	62
20:45:00	SB	113	62
21:00:00	SB	112	63
21:15:00	SB	114	62
21:30:00	SB	115	61
21:45:00	SB	112	63
22:00:00	SB	111	63
22:15:00	SB	111	63
22:30:00	SB	111	63
22:45:00	SB	110	64
23:00:00	SB	108	65
23:15:00	SB	107	66
23:30:00	SB	106	66
23:45:00	SB	106	66

Table 2 Average Vehicle Journey Times. A12 between A143 and A1243

Time Interval	Bound	Fused Travel Time	Fused Average Speed
00:00:00	NB	47.15	66.65
00:15:00	NB	47.53	65.92
00:30:00	NB	46.22	67.35
00:45:00	NB	45.34	68.57
01:00:00	NB	46.26	67.40
01:15:00	NB	46.13	67.73
01:30:00	NB	45.38	68.38
01:45:00	NB	46.60	67.24
02:00:00	NB	46.85	67.44
02:15:00	NB	47.29	66.80
02:30:00	NB	46.40	67.47
02:45:00	NB	46.04	67.88
03:00:00	NB	46.05	67.38
03:15:00	NB	46.26	66.98
03:30:00	NB	46.38	67.18
03:45:00	NB	46.09	67.34
04:00:00	NB	45.16	68.58
04:15:00	NB	44.85	69.27
04:30:00	NB	45.10	69.07
04:45:00	NB	45.59	68.45
05:00:00	NB	46.60	67.07
05:15:00	NB	46.85	66.56
05:30:00	NB	45.38	68.17
05:45:00	NB	44.61	69.77
06:00:00	NB	46.53	66.61
06:15:00	NB	48.24	64.79
06:30:00	NB	48.09	64.80
06:45:00	NB	49.65	63.14
07:00:00	NB	50.51	62.90
07:15:00	NB	51.71	60.10
07:30:00	NB	58.04	55.20
07:45:00	NB	86.00	41.08
08:00:00	NB	100.14	37.48
08:15:00	NB	111.86	34.47
08:30:00	NB	116.99	33.41
08:45:00	NB	88.32	42.03
09:00:00	NB	77.78	46.09
09:15:00	NB	65.35	51.99
09:30:00	NB	60.53	54.71
09:45:00	NB	62.33	52.87
10:00:00	NB	68.89	50.26
10:15:00	NB	74.71	47.94
10:30:00	NB	80.34	46.42
10:45:00	NB	83.94	45.56
11:00:00	NB	90.05	43.41
11:15:00	NB	91.43	43.70
11:30:00	NB	97.15	41.72

Time Interval	Bound	Fused Travel Time	Fused Average Speed
11:45:00	NB	104.52	39.52
12:00:00	NB	107.76	39.43
12:15:00	NB	112.72	38.13
12:30:00	NB	110.53	38.17
12:45:00	NB	104.84	40.62
13:00:00	NB	100.09	41.40
13:15:00	NB	103.04	39.95
13:30:00	NB	98.01	41.65
13:45:00	NB	90.90	43.27
14:00:00	NB	82.43	44.87
14:15:00	NB	81.19	45.79
14:30:00	NB	80.65	46.11
14:45:00	NB	82.30	44.53
15:00:00	NB	78.70	47.06
15:15:00	NB	80.92	46.45
15:30:00	NB	88.60	43.08
15:45:00	NB	107.11	36.68
16:00:00	NB	133.03	30.06
16:15:00	NB	176.34	23.08
16:30:00	NB	205.41	19.92
16:45:00	NB	221.86	17.69
17:00:00	NB	203.13	19.73
17:15:00	NB	215.87	18.22
17:30:00	NB	181.10	22.87
17:45:00	NB	122.24	33.83
18:00:00	NB	85.47	46.68
18:15:00	NB	69.29	52.35
18:30:00	NB	57.29	58.08
18:45:00	NB	52.59	61.42
19:00:00	NB	49.04	63.54
19:15:00	NB	48.63	63.75
19:30:00	NB	48.89	64.09
19:45:00	NB	50.65	63.71
20:00:00	NB	49.16	64.41
20:15:00	NB	48.02	64.42
20:30:00	NB	47.55	64.79
20:45:00	NB	46.82	65.70
21:00:00	NB	47.54	64.99
21:15:00	NB	46.99	65.65
21:30:00	NB	47.63	64.80
21:45:00	NB	47.18	65.44
22:00:00	NB	46.56	66.29
22:15:00	NB	45.87	67.17
22:30:00	NB	45.82	67.40
22:45:00	NB	46.37	66.51
23:00:00	NB	46.30	66.28
23:15:00	NB	45.70	67.54
23:30:00	NB	45.32	68.13
23:45:00	NB	45.34	68.55

Time Interval	Bound	Fused Travel Time	Fused Average Speed
00:00:00	SB	47.30	66.76
00:15:00	SB	46.99	67.44
00:30:00	SB	46.75	67.25
00:45:00	SB	46.27	67.60
01:00:00	SB	46.58	67.25
01:15:00	SB	46.84	66.91
01:30:00	SB	46.18	67.18
01:45:00	SB	46.83	66.57
02:00:00	SB	46.91	66.47
02:15:00	SB	46.41	67.32
02:30:00	SB	46.18	67.26
02:45:00	SB	45.50	68.63
03:00:00	SB	46.03	67.27
03:15:00	SB	46.11	67.27
03:30:00	SB	46.12	67.03
03:45:00	SB	44.87	69.01
04:00:00	SB	44.65	69.22
04:15:00	SB	45.53	68.10
04:30:00	SB	46.12	67.40
04:45:00	SB	46.51	66.56
05:00:00	SB	46.38	66.98
05:15:00	SB	46.85	66.55
05:30:00	SB	46.25	66.85
05:45:00	SB	46.70	66.71
06:00:00	SB	45.86	67.47
06:15:00	SB	46.32	66.69
06:30:00	SB	45.69	67.45
06:45:00	SB	46.30	66.23
07:00:00	SB	46.62	66.39
07:15:00	SB	47.43	65.63
07:30:00	SB	47.53	65.00
07:45:00	SB	48.64	63.62
08:00:00	SB	50.07	62.35
08:15:00	SB	51.84	60.66
08:30:00	SB	55.49	57.89
08:45:00	SB	53.31	59.31
09:00:00	SB	50.97	61.70
09:15:00	SB	49.91	62.66
09:30:00	SB	48.89	63.52
09:45:00	SB	48.11	64.28
10:00:00	SB	48.09	64.33
10:15:00	SB	48.96	63.26
10:30:00	SB	49.46	62.84
10:45:00	SB	50.41	61.55
11:00:00	SB	51.08	61.51
11:15:00	SB	50.77	61.59
11:30:00	SB	51.26	61.16
11:45:00	SB	51.48	60.88
12:00:00	SB	51.27	61.16

Time Interval	Bound	Fused Travel Time	Fused Average Speed
12:15:00	SB	52.94	60.22
12:30:00	SB	50.90	61.94
12:45:00	SB	52.81	60.20
13:00:00	SB	52.72	60.00
13:15:00	SB	51.09	61.49
13:30:00	SB	51.04	61.28
13:45:00	SB	52.62	60.18
14:00:00	SB	51.36	61.16
14:15:00	SB	50.21	62.11
14:30:00	SB	51.47	60.95
14:45:00	SB	51.57	60.62
15:00:00	SB	52.57	60.18
15:15:00	SB	49.57	62.53
15:30:00	SB	51.07	61.08
15:45:00	SB	51.23	61.22
16:00:00	SB	55.75	57.29
16:15:00	SB	63.27	52.84
16:30:00	SB	71.58	49.17
16:45:00	SB	80.73	44.85
17:00:00	SB	70.86	48.61
17:15:00	SB	73.10	48.42
17:30:00	SB	60.22	55.97
17:45:00	SB	54.77	59.27
18:00:00	SB	50.72	62.05
18:15:00	SB	49.77	63.17
18:30:00	SB	48.32	64.35
18:45:00	SB	46.95	65.42
19:00:00	SB	46.38	66.12
19:15:00	SB	46.27	66.44
19:30:00	SB	45.93	66.70
19:45:00	SB	46.88	65.77
20:00:00	SB	46.80	65.84
20:15:00	SB	46.68	66.00
20:30:00	SB	46.57	66.28
20:45:00	SB	45.60	67.51
21:00:00	SB	46.94	66.06
21:15:00	SB	47.39	65.27
21:30:00	SB	47.66	64.85
21:45:00	SB	47.23	65.56
22:00:00	SB	46.68	66.22
22:15:00	SB	46.73	65.99
22:30:00	SB	46.37	66.64
22:45:00	SB	46.53	66.41
23:00:00	SB	45.22	68.03
23:15:00	SB	45.78	67.28
23:30:00	SB	46.05	66.89
23:45:00	SB	46.63	66.62

APPENDIX D. Prior Matrices

APPENDIX D_1. AM Prior Matrices

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14
CAR	1	0.00	21.78	14.86	10.37	78.94	0.00	378.95	74.28	0.00	0.00	16.11	0.00	0.00	214.94
CAR	2	4.28	0.00	3.55	0.00	0.00	16.74	39.38	0.00	0.00	9.44	0.00	0.00	0.00	9.23
CAR	3	0.00	3.00	0.00	0.00	0.00	30.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	75.20
CAR	4	4.46	1.44	0.00	0.00	0.00	2.23	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.94
CAR	5	24.46	7.91	0.00	0.00	0.00	12.21	5.76	0.00	0.00	0.00	0.00	0.00	0.00	5.13
CAR	6	1.11	16.10	31.00	0.05	0.35	0.00	16.10	0.00	0.00	0.00	0.00	0.00	0.00	1.46
CAR	7	306.26	13.65	23.48	13.52	102.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	145.83
CAR	8	43.64	17.63	0.00	2.89	21.96	0.00	0.00	0.00	0.00	0.00	19.77	0.00	0.00	0.00
CAR	9	7.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00	0.00	0.00
CAR	10	26.42	9.80	17.37	3.59	27.29	0.00	0.00	0.00	0.00	0.00	18.74	0.00	0.00	0.00
CAR	11	24.71	0.00	0.00	0.00	0.00	0.00	0.00	5.57	4.56	18.79	0.00	4.56	28.29	0.00
CAR	12	7.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.15	0.00	0.00	0.00
CAR	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.11	0.00	0.00	0.00
CAR	14	167.23	43.74	8.29	20.79	158.22	0.00	19.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	15	26.16	15.85	15.96	0.14	1.07	0.00	144.15	0.00	0.00	31.95	0.00	0.00	0.00	61.92
CAR	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	18	0.00	0.09	0.00	0.00	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	19	42.25	1.69	0.00	0.00	0.00	22.85	23.12	62.81	0.00	6.99	0.00	0.00	0.00	49.20
CAR	20	17.90	0.00	3.13	5.96	45.33	0.00	0.00	0.00	0.00	0.00	23.81	0.00	66.03	0.00
CAR	21	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	22	28.46	8.36	0.00	0.00	0.00	17.09	0.00	0.00	0.00	9.45	0.00	0.00	0.00	4.45
CAR	23	34.34	40.90	91.49	23.14	176.07	0.00	452.12	153.00	0.00	41.93	12.73	0.00	0.00	345.37
CAR	24	0.00	0.00	0.00	0.00	0.00	3.30	9.05	20.26	0.00	2.00	0.00	0.00	0.00	15.49
CAR	25	0.00	0.00	7.94	0.07	0.53	0.00	7.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	26	11.56	0.00	3.26	0.03	0.22	7.69	0.00	0.00	0.00	1.41	0.00	0.00	0.00	1.39
CAR	27	13.39	0.00	3.78	0.03	0.25	8.91	0.00	0.00	0.00	1.63	0.00	0.00	0.00	1.61
CAR	28	0.00	0.00	2.18	0.02	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	29	4.89	0.00	7.98	0.45	3.43	18.78	7.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	30	43.20	1.67	0.00	0.00	0.00	5.60	8.07	0.00	0.00	5.62	0.00	0.00	0.00	2.65
CAR	31	0.00	1.48	0.00	0.00	0.00	12.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	32	28.46	1.69	0.00	0.00	0.00	14.13	51.58	0.00	0.00	13.28	0.00	0.00	0.00	8.02
CAR	33	14.10	1.24	17.11	1.88	14.27	42.71	15.42	0.00	0.00	3.57	0.00	0.00	0.00	3.47
CAR	34	14.33	1.69	0.00	0.00	0.00	13.59	0.00	0.00	0.00	7.17	0.00	0.00	0.00	6.93
CAR	35	31.00	1.24	17.02	0.85	6.45	60.02	7.70	0.00	0.00	0.00	0.00	0.00	0.00	49.06
CAR	36	28.28	1.67	0.00	0.00	0.00	13.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	37	28.58	0.00	0.00	0.00	0.00	13.67	43.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	38	5.12	0.00	0.00	0.00	0.00	2.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.22
CAR	39	20.29	0.56	7.76	0.39	2.94	16.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	40	1.89	2.08	4.42	0.25	1.90	1.52	5.91	0.00	0.00	1.36	0.00	0.00	0.00	17.40

APPENDIX D_2. IP Prior Matrices

Matrix Number	From Zone	To Zone 001	To Zone 002	To Zone 003	To Zone 004	To Zone 005	To Zone 006	To Zone 007	To Zone 008	To Zone 009	To Zone 010	To Zone 011	To Zone 012	To Zone 013
CAR	Zone 001	0.00	27.91	17.89	20.02	41.47	2.18	230.05	34.50	5.04	13.94	6.28	5.04	0.00
CAR	Zone 002	27.04	0.00	5.81	0.00	0.00	22.57	48.03	31.07	2.44	34.82	0.00	2.44	0.00
CAR	Zone 003	17.67	0.93	0.00	0.00	0.00	50.76	42.30	18.40	4.02	0.00	5.79	4.02	0.00
CAR	Zone 004	17.23	7.24	0.00	0.00	0.00	20.71	28.81	13.80	1.76	12.47	1.12	1.76	0.00
CAR	Zone 005	39.99	16.81	0.00	0.00	0.00	48.08	66.87	32.04	4.08	28.96	2.59	4.08	0.00
CAR	Zone 006	1.18	16.68	28.36	1.10	2.29	0.00	10.69	4.49	0.00	0.00	3.27	0.00	0.00
CAR	Zone 007	214.52	41.45	43.35	27.83	57.63	7.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 008	24.00	14.76	15.24	10.09	20.89	3.87	0.00	0.00	0.00	1.63	8.58	0.00	0.00
CAR	Zone 009	4.61	2.60	4.22	2.10	4.35	0.00	0.00	0.00	0.00	10.35	6.15	0.00	0.00
CAR	Zone 010	2.65	6.78	0.00	3.20	6.62	0.00	0.00	0.00	0.00	0.00	13.04	0.00	0.00
CAR	Zone 011	4.17	0.00	4.34	1.29	2.66	2.45	0.00	8.96	7.08	9.87	0.00	7.08	54.51
CAR	Zone 012	4.61	2.60	4.22	2.10	4.35	0.00	0.00	0.00	0.00	10.35	6.15	0.00	0.00
CAR	Zone 013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.35	0.00	0.00
CAR	Zone 014	120.88	55.35	25.44	51.09	105.81	0.42	21.18	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 015	19.49	0.05	9.01	4.19	8.68	0.00	29.05	12.15	5.45	4.29	0.00	5.45	0.00
CAR	Zone 016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 018	24.85	0.49	0.00	0.00	0.00	14.58	20.27	0.00	0.00	1.01	0.00	0.00	0.00
CAR	Zone 019	138.28	0.63	0.00	0.00	0.00	53.76	109.62	5.22	19.10	22.66	7.38	19.10	0.00
CAR	Zone 020	2.84	13.26	9.84	10.15	21.02	0.68	0.00	0.00	0.00	0.00	46.15	0.00	114.83
CAR	Zone 021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 022	0.00	3.11	0.00	0.00	0.00	34.54	10.49	5.41	0.00	0.00	0.00	0.00	0.00
CAR	Zone 023	47.84	103.43	161.01	85.11	176.28	0.00	237.81	81.48	12.58	36.19	12.78	12.58	0.00
CAR	Zone 024	7.05	0.00	0.00	0.00	0.00	1.22	2.89	0.00	0.00	0.42	0.00	0.00	0.00
CAR	Zone 025	9.66	0.00	4.51	2.09	4.34	0.00	3.90	5.22	0.00	0.00	0.00	0.00	0.00
CAR	Zone 026	6.14	0.00	1.85	0.86	1.78	10.31	19.34	6.94	0.00	2.16	0.00	0.00	0.00
CAR	Zone 027	7.11	0.00	2.15	1.00	2.07	11.94	22.40	8.04	0.00	2.50	0.00	0.00	0.00
CAR	Zone 028	0.00	0.00	1.23	0.58	1.19	0.00	1.81	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 029	2.41	0.00	4.51	1.12	2.32	25.13	2.34	0.00	0.00	0.48	0.00	0.00	0.00
CAR	Zone 030	21.87	0.63	0.00	0.00	0.00	2.10	11.82	0.89	2.73	0.81	0.00	2.73	0.00
CAR	Zone 031	27.79	0.55	0.00	0.00	0.00	16.30	22.67	0.00	0.00	1.13	0.00	0.00	0.00
CAR	Zone 032	30.18	0.63	0.00	0.00	0.00	18.64	46.04	0.00	3.08	5.21	0.00	3.08	0.00
CAR	Zone 033	16.96	0.63	20.58	7.05	14.60	67.98	2.19	0.00	2.73	8.52	0.00	2.73	0.00
CAR	Zone 034	17.09	0.63	0.00	0.00	0.00	21.66	3.53	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 035	41.72	0.63	20.54	3.31	6.86	110.54	21.78	0.00	0.00	0.81	0.00	0.00	0.00

APPENDIX D_3. PM Prior Matrices

Matrix Number	From Zone	To Zone 001	To Zone 002	To Zone 003	To Zone 004	To Zone 005	To Zone 006	To Zone 007	To Zone 008	To Zone 009	To Zone 010	To Zone 011	To Zone 012	To Zone 013	To Zone 014	To Zone 015	To Zone 016	To Zone 017	To Zone 018
CAR	Zone 001	0.00	5.93	0.00	23.22	28.93	6.60	344.85	56.19	8.29	44.44	30.40	8.29	0.00	174.26	30.58	0.00	0.00	0.00
CAR	Zone 002	23.05	0.00	18.55	0.00	0.00	18.07	14.70	15.22	0.00	0.00	0.00	0.00	0.00	63.18	14.42	0.00	0.00	1.50
CAR	Zone 003	17.33	2.45	0.00	0.00	0.00	62.22	4.54	0.00	0.00	29.39	0.00	0.00	0.00	4.11	5.48	0.00	0.00	0.00
CAR	Zone 004	17.46	2.45	0.00	0.00	0.00	4.25	27.49	9.83	0.00	10.23	0.00	0.00	0.00	34.50	5.49	0.00	0.00	0.00
CAR	Zone 005	83.46	11.72	0.00	0.00	0.00	20.31	131.41	47.00	0.00	48.91	0.00	0.00	0.00	164.93	26.23	0.00	0.00	0.00
CAR	Zone 006	0.00	14.20	38.48	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.00	0.00	0.00	17.25	0.00	0.00	0.00	3.10
CAR	Zone 007	269.22	35.21	0.00	4.60	5.73	6.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.47	133.90	0.00	0.00	0.00
CAR	Zone 008	35.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.23	17.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 009	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.03	8.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 010	0.00	5.22	0.00	0.16	0.20	0.00	0.00	7.37	1.41	0.00	22.65	1.41	0.00	0.00	16.02	0.00	0.00	0.00
CAR	Zone 011	13.28	0.00	0.00	0.00	0.00	0.00	0.00	10.45	5.89	19.11	0.00	5.89	47.91	0.00	0.00	0.00	0.00	0.00
CAR	Zone 012	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	60.03	8.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 013	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 014	266.32	21.46	88.83	8.02	9.99	0.00	20.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.77	0.00	0.00	0.00
CAR	Zone 015	17.43	17.80	14.26	2.79	3.47	0.00	57.81	0.00	0.00	38.76	0.00	0.00	0.00	8.64	0.00	0.00	0.00	1.16
CAR	Zone 016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAR	Zone 018	7.43	1.14	0.00	0.00	0.00	20.22	0.00	0.00	0.00	0.48	0.00	0.00	0.00	14.99	2.56	0.00	0.00	0.00
CAR	Zone 019	70.39	1.27	0.00	0.00	0.00	72.99	141.48	0.00	0.00	11.20	19.25	0.00	1.03	106.48	2.85	0.00	0.00	0.00
CAR	Zone 020	15.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.72	45.71	0.00	190.50	0.00	0.00	0.00	0.00	0.00
CAR	Zone 021	0.00	0.00	0.00	0.00	0.00	0.37	1.04	0.00	0.00	1.22	0.00	0.00	0.00	1.38	0.16	0.00	0.00	0.00
CAR	Zone 022	8.52	1.91	0.00	0.00	0.00	32.44	1.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	0.00	0.00	0.00
CAR	Zone 023	9.04	95.40	67.64	54.43	67.81	0.00	211.97	24.69	8.62	30.63	0.00	8.62	0.00	200.92	0.00	0.00	0.00	7.88
CAR	Zone 024	0.00	0.00	0.00	0.00	0.00	2.50	24.15	0.00	0.00	0.00	0.00	0.00	0.00	1.45	7.11	0.00	0.00	0.00
CAR	Zone 025	0.00	0.00	7.13	1.39	1.74	0.00	12.52	0.00	0.00	0.00	0.00	0.00	0.00	12.99	0.00	0.00	0.00	0.58
CAR	Zone 026	20.76	0.00	2.91	0.57	0.71	4.58	28.20	7.19	0.00	16.77	0.00	0.00	0.00	47.82	0.00	0.00	0.00	0.24
CAR	Zone 027	24.05	0.00	3.37	0.66	0.83	5.30	32.67	8.32	0.00	19.42	0.00	0.00	0.00	55.39	0.00	0.00	0.00	0.27
CAR	Zone 028	0.00	0.00	1.95	0.38	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
CAR	Zone 029	0.00	0.00	7.13	2.13	2.66	11.21	0.00	12.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58
CAR	Zone 030	17.51	1.27	0.00	0.00	0.00	4.27	18.63	12.86	0.00	1.67	0.00	0.00	0.00	9.29	2.85	0.00	0.00	0.00
CAR	Zone 031	7.38	1.14	0.00	0.00	0.00	20.08	0.00	0.00	0.00	0.48	0.00	0.00	0.00	14.88	2.54	0.00	0.00	0.00
CAR	Zone 032	17.01	1.27	0.00	0.00	0.00	22.93	26.14	6.07	0.00	3.74	0.00	0.00	0.03	11.60	2.90	0.00	0.00	0.00
CAR	Zone 033	1.19	1.45	29.88	7.43	9.25	87.85	48.32	0.00	0.00	2.93	0.00	0.00	0.06	18.49	15.34	0.00	0.00	2.00
CAR	Zone 034	0.00	1.30	0.00	0.00	0.00	35.70	0.00	0.00	0.00	4.00	0.00	0.00	0.03	19.59	2.90	0.00	0.00	0.00
CAR	Zone 035	17.70	1.45	29.77	5.89	7.33	75.48	31.85	12.89	0.00	0.00	0.00	0.00	0.00	0.00	15.29	0.00	0.00	1.99
CAR	Zone 036	0.00	1.27	0.00	0.00	0.00	35.67	19.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.90	0.00	0.00	0.00
CAR	Zone 037	69.98	3.16	0.00	0.00	0.00	35.54	86.00	31.35	6.42	7.30	0.00	6.42	2.78	133.87	2.52	0.00	0.00	0.00
CAR	Zone 038	6.16	3.69	0.00	0.00	0.00	8.08	23.99	4.68	0.00	1.22	5.94	0.00	0.30	19.56	0.93	0.00	0.00	0.00
CAR	Zone 039	5.16	0.55	11.46	2.27	2.83	56.06	34.85	0.00	0.00	1.06	0.00	0.00	0.31	15.68	5.89	0.00	0.00	0.77
CAR	Zone 040	25.12	0.23	2.62	0.79	0.98	62.73	5.43	7.37	0.00	4.55	3.14	0.00	0.63	37.01	0.29	0.00	0.00	0.21

APPENDIX E. Matrix Estimation Changes

APPENDIX E_1. Matrix Estimation Changes. AM OD Differences

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14	To Zone 15	To Zone 16	To Zone 17	To Zone 18	To Zone 19	To Zone 20	To Zone 21
CAR	1	0	91.391	-11.703	-8.296	-62.969	0	141.591	-22.753	0	0	-12.888	0	0	-53.824	-2.901	0	0	1.322	-53.379	0	0
CAR	2	8.091	0	14.717	0	0	3.982	9.013	0	0	-1.905	0	0	0	0.715	5.405	0	0	26.511	-1.441	0	0
CAR	3	0	-1.969	0	0	0	120.066	0	0	0	0	0	0	0	107.744	-0.755	0	0	0	0	0	0
CAR	4	-3.568	-1.152	0	0	0	-1.784	-0.728	0	0	0	0	0	0	-0.747	-2.456	0	0	0	0	0	0
CAR	5	-19.073	-4.256	0	0	0	-9.244	30.936	0	0	0	0	0	0	19.473	-12.312	0	0	0	0	0	0
CAR	6	0.063	0	14.876	-0.039	-0.134	0	-12.043	0	0	0	0	0	0	-1.087	0	0	0	-5.076	-13.733	0	-0.056
CAR	7	394.257	0.192	-14.002	-9.585	43.437	0	0	0	0	0	0	0	0	-87.14	-12.081	0	0	0	49.097	0	14.049
CAR	8	18.713	-0.092	0	-2.07	8.422	0	0	0	0	0	20.337	0	0	0	0	0	0	0	0	0	0
CAR	9	31.902	0	0	0	0	0	0	0	0	0	-4.92	0	0	0	0	0	0	0	0	0	0
CAR	10	1.842	-1.051	-10.646	-2.606	8.024	0	0	0	0	0	-14.992	0	0	0	-8.047	0	0	-0.589	7.537	0	5.707
CAR	11	8.676	0	0	0	0	0	0	6.408	2.37	4.114	0	1.796	2.715	0	0	0	0	0	8.802	63.125	0
CAR	12	30.847	0	0	0	0	0	0	0	0	0	-4.92	0	0	0	0	0	0	0	0	0	0
CAR	13	0	0	0	0	0	0	0	0	0	0	-14.488	0	0	0	0	0	0	0	0	-8.833	0
CAR	14	161.789	-22.631	-6.142	-15.941	-59.638	0	-15.709	0	0	0	0	0	0	0	-11.506	0	0	-3.239	-31.98	0	3.813
CAR	15	-16.327	0	8.863	-0.107	-0.195	0	-26.35	0	0	-11.271	0	0	0	-11.99	0	0	0	1.731	-2.205	0	-0.168
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	0	-0.072	0	0	0	-0.608	0	0	0	0	0	0	0	0	-0.16	0	0	0	0	0	0
CAR	19	-33.794	-1.319	0	0	0	-15.048	-15.446	-36.29	0	-4.189	0	0	0	-34.658	-0.834	0	0	0	0	0	0
CAR	20	-14.18	0	-1.959	2.202	25.651	0	0	0	0	0	-18.754	0	55.058	0	-1.111	0	0	0	2.642	0	0
CAR	21	0	0	0	0	0	-0.264	0	0	0	0	0	0	0	0	-0.64	0	0	0	0	0	0
CAR	22	-22.764	1.699	0	0	0	6.445	0	0	0	-7.007	0	0	0	-3.162	-1.252	0	0	0	0	0	0
CAR	23	130.763	0	76.252	77.44	-15.201	0	-101.289	-69.764	0	-27.581	-10.184	0	0	-169.761	0	0	0	9.282	-157.714	-9.876	-1.608
CAR	24	0	0	0	0	0	-1.307	3.281	1.689	0	-0.272	0	0	0	9.106	0	0	0	0	0	0	0
CAR	25	0	0	25.259	-0.044	0.217	0	1.773	0	0	0	0	0	0	0	0	0	0	5.737	-1.336	0	-0.088
CAR	26	-7.104	0	60.47	-0.022	-0.029	-1.057	0	0	0	-0.29	0	0	0	0.205	0	0	0	9.692	-0.647	0	-0.032
CAR	27	12.869	0	13.55	0.058	-0.005	0.982	0	0	0	-0.063	0	0	0	1.274	0	0	0	14.07	-0.672	0	-0.04
CAR	28	0	0	-0.708	-0.016	-0.113	0	0	0	0	0	0	0	0	0	0	0	0	-0.396	-0.991	0	-0.024
CAR	29	-2.097	0	7.821	-0.356	-1.7	-7.677	-5.289	0	0	0	0	0	0	0	0	0	0	-0.971	-3.318	0	-0.549
CAR	30	10.534	0.532	0	0	0	7.321	-4.258	0	0	-3.206	0	0	0	-0.964	1.15	0	0	0	0	0	0
CAR	31	0	-0.697	0	0	0	-9.9	0	0	0	0	0	0	0	0	-2.625	0	0	0	0	0	0
CAR	32	34.937	3.002	0	0	0	-11.302	-21.483	0	0	-7.306	0	0	0	-2.419	-2.692	0	0	0	0	-24.967	0
CAR	33	-10.829	-0.992	-13.66	-1.502	73.145	-30.237	-10.978	0	0	-2.646	0	0	0	-2.243	-7.491	0	0	-7.968	-3.432	0	-1.22
CAR	34	-11.393	-1.236	0	0	0	-10.871	0	0	0	-5.404	0	0	0	-4.784	-3.023	0	0	0	0	0	0
CAR	35	-24.752	-0.916	-13.552	-0.57	-4.907	-26.14	-6.12	0	0	0	0	0	0	-38.806	-7.337	0	0	-7.936	-7.878	0	-1.184
CAR	36	-22.547	-1.249	0	0	0	-10.843	0	0	0	0	0	0	0	0	-2.661	0	0	0	0	0	0
CAR	37	-22.863	0	0	0	0	-10.936	-34.998	0	0	0	0	0	0	0	-2.83	0	0	0	0	0	0
CAR	38	-4.096	0	0	0	0	-2.321	0	0	0	0	0	0	0	-12.021	-0.978	0	0	0	0	0	0
CAR	39	-16.225	-0.425	-5.09	-0.184	-2.17	-6.443	0	0	0	0	0	0	0	0	-2.83	0	0	-3.595	-3.529	0	-0.328
CAR	40	-1.51	-1.459	-3.371	1.135	0.944	60.442	-4.588	0	0	-1.061	0	0	0	-13.229	-0.322	0	0	-1.064	-1.698	0	-0.28

APPENDIX E_2. Matrix Estimation Changes. IP OD Differences

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14
CAR	1	0	-20.733	-0.788	-15.2	-23.878	-1.74	26.074	0.369	-0.452	-1.25	-0.563	-0.452	0	-9.84
CAR	2	-20.65	0	3.457	0	0	-5.833	-5.226	-6.255	-0.551	-8.283	0	-0.58	0	-2.186
CAR	3	7.525	-0.289	0	0	0	345.012	-17.023	-8.642	-1.929	0	-2.943	-1.95	0	-7.817
CAR	4	10.995	-2.414	0	0	0	-11.732	17.312	4.308	0.377	2.668	0.241	0.377	0	19.523
CAR	5	5.843	0.888	0	0	0	-19.66	-5.375	-4.884	-0.016	-4.663	-0.376	-0.462	0	7.534
CAR	6	9.625	-8.042	93.646	26.866	2.595	0	-5.783	-2.605	0	0	-1.825	0	0	0
CAR	7	139.827	-16.575	9.58	-2.634	-27.655	-5.09	0	0	0	0	0	0	0	-9.275
CAR	8	18.524	-5.905	2.78	-1.114	-9.879	-2.582	0	0	0	7.674	40.495	0	0	0
CAR	9	-2.883	-1.155	0.745	-0.27	-1.942	0	0	0	0	8.79	5.223	0	0	0
CAR	10	-1.672	-3.041	0	-0.497	-2.985	0	0	0	0	0	10.33	0	0	0
CAR	11	-2.27	0	2.732	0.215	-0.678	-1.081	0	2.949	11.428	15.95	0	11.428	88.049	0
CAR	12	-2.886	-1.133	0.73	-0.283	-1.973	0	0	0	0	8.726	5.185	0	0	0
CAR	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	14	85.908	-26.733	1.843	-11.249	-2.846	-0.299	39.525	0	0	0	0	0	0	0
CAR	15	-6.105	0.007	-7.183	0.821	1.21	0	-4.443	-3.446	-1.351	-1.24	0	-1.608	0	-3.523
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	25.622	-0.385	0	0	0	-11.658	-6.751	0	0	-0.401	0	0	0	-2.473
CAR	19	-97.494	-0.329	0	0	0	-20.93	-37.569	-0.527	-6.178	-3.595	-1.806	-5.469	0	1.541
CAR	20	-2.27	-4.795	-0.606	-1.466	-5.37	-0.413	0	0	0	0	-36.914	0	37.218	0
CAR	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	22	0	3.521	0	0	0	14.171	-8.344	-4.308	0	0	0	0	0	-4.343
CAR	23	-35.731	58.577	-38.806	-49.609	9.691	0	-92.849	-27.39	-4.797	-13.805	-4.874	-4.797	0	-89.783
CAR	24	-3.852	0	0	0	0	-0.317	3.076	0	0	0.256	0	0	0	12.031
CAR	25	-7.341	0	-3.609	-1.326	-0.638	0	-0.243	-0.892	0	0	0	0	0	0.001
CAR	26	-3.168	0	-1.366	-0.186	-0.127	-2.664	5.258	0.954	0	0.105	0	0	0	1.707
CAR	27	-3.471	0	-1.716	-0.243	-0.165	-3.084	12.719	2.622	0	0.645	0	0	0	4.052
CAR	28	0	0	-0.633	6.416	-0.055	0	-1.252	0	0	0	0	0	0	0
CAR	29	11.111	0	-1.505	16.595	3.257	-10.733	-0.927	0	0	-0.216	0	0	0	-2.056
CAR	30	90.954	-0.158	0	0	0	-0.927	-4.828	-0.434	-1.298	-0.378	0	-1.327	0	-4.198
CAR	31	13.4	-0.291	0	0	0	-12.997	-5.289	0	0	-0.397	0	0	0	-3.95
CAR	32	-2.465	-0.323	0	0	0	-14.91	-36.7	0	-2.449	-4.148	0	-2.448	0	-16.549
CAR	33	45.825	-0.211	2.897	39.831	2.708	-33.335	-0.852	0	-1.279	-3.993	0	-1.292	0	-9.171
CAR	34	5.93	-0.329	0	0	0	-17.209	0.608	0	0	0	0	0	0	2.295
CAR	35	-21.22	-0.363	0.944	-2.106	-5.292	109.792	-9.201	0	0	65.949	0	0	0	-4.194
CAR	36	0	-0.292	0	0	0	-17.426	0	0	0	0	0	0	0	0.194
CAR	37	-3.76	0	0	0	0	-17.378	-3.374	-5.535	-0.754	-4.074	-0.957	-0.79	0	-11.073
CAR	38	0.295	0	0	0	0	-6.019	0.186	-0.074	0	-0.159	0	0	0	0.085
CAR	39	-3.174	-0.172	2.843	-0.16	-2.407	36.925	-8.336	0	0	0	0	0	0	-4.216
CAR	40	-1.251	-0.208	-4.699	5.79	-1.852	12.332	-2.496	0	0	-0.056	0	0	0	-1.901

APPENDIX E_3. Matrix Estimation Changes. PM OD Differences

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14
CAR	1	0	-3.891	0	-17.261	-14.919	-5.278	190.827	19.629	6.696	35.906	24.564	4.903	0	93.648
CAR	2	4.349	0	46.441	0	0	0	-0.134	-0.161	0	0	0	0	0	-0.536
CAR	3	-13.146	-1.698	0	0	0	319.479	-2.697	0	0	-17.283	0	0	0	-2.376
CAR	4	20.188	-1.809	0	0	0	-3.357	3.099	0.794	0	3.213	0	0	0	1.966
CAR	5	-45.294	-5.009	0	0	0	-5.491	-9.74	-0.591	0	2.738	0	0	0	-5.812
CAR	6	0	0	26.654	0	0	0	-0.37	0	0	0	0	0	0	-12.558
CAR	7	471.394	-8.142	0	2.089	-3.321	-2.609	0	0	0	0	0	0	0	-18.765
CAR	8	94.497	0	0	0	0	0	0	0	0	28.511	27.729	0	0	0
CAR	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	10	0	-1.443	0	0.047	-0.124	0	0	3.619	0	0	0	-0.152	0	0
CAR	11	10.206	0	0	0	0	0	0	5.128	0	0	0	-0.634	0	0
CAR	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	13	0	0	13.842	0	0	0	0	0	0	0	0	0	0	0
CAR	14	-96.047	-8.081	41.401	2.341	-4.362	0	-7.251	0	0	0	0	0	0	0
CAR	15	0.314	0.571	-9.817	0.143	0.409	0	-6.413	0	0	-0.51	0	0	0	-0.996
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	-5.437	-0.904	0	0	0	-16.18	0	0	0	0.047	0	0	0	0.867
CAR	19	-52.339	-0.793	0	0	0	-52.293	-52.05	0	0	0.498	0.186	0	0.831	-25.068
CAR	20	-12.012	0	0	0	0	0	0	0	0	-5.38	-35.514	0	-6.096	0
CAR	21	0	0	0	0	0	-0.3	6.176	0	0	1.56	0	0	0	10.158
CAR	22	-6.817	-1.425	0	0	0	-23.382	-1.388	0	0	0	0	0	0	0
CAR	23	1.705	0	34.437	-19.256	41.121	0	-40.058	-3.898	0.291	1.034	0	-0.677	0	-54.057
CAR	24	0	0	0	0	0	-0.607	2.572	0	0	0	0	0	0	0.251
CAR	25	0	0	-5.463	-0.461	1.084	0	-0.866	0	0	0	0	0	0	-1.13
CAR	26	0.773	0	1.607	-0.042	-0.148	0	9.014	2.042	0	6.575	0	0	0	16.731
CAR	27	4.37	0	-2.388	-0.236	0.467	-0.03	16.088	3.59	0	11.074	0	0	0	32.554
CAR	28	0	0	0.715	3.829	0.764	0	0	0	0	0	0	0	0	0
CAR	29	0	0	1.439	11.723	0.79	0	0	-6.885	0	0	0	0	0	0
CAR	30	34.492	-0.603	0	0	0	-2.021	-8.818	-6.333	0	-0.748	0	0	0	-3.28
CAR	31	-5.843	-0.903	0	0	0	-16.059	0	0	0	-0.367	0	0	0	-11.374
CAR	32	283.316	-0.926	0	0	0	-18.34	-18.886	-4.638	0	-2.859	0	0	-0.019	-8.498
CAR	33	0.425	4.126	-10.353	14.405	88.157	-59.951	-9.42	0	0	-0.433	0	0	0.028	-5.02
CAR	34	0	-0.147	0	0	0	-28.468	0	0	0	1.113	0	0	0.046	9.934
CAR	35	-10.241	2.887	-4.746	-1.118	-5.142	49.291	-23.891	-9.373	0	0	0	0	0	0
CAR	36	0	-0.553	0	0	0	-28.227	-13.67	0	0	0	0	0	0	0
CAR	37	-24.642	-1.567	0	0	0	-28.414	-60.165	-20.541	-4.012	-4.571	0	-4.173	1.165	-92.446
CAR	38	-2.484	-2.503	0	0	0	-6.396	-16.866	-3.08	0	-0.766	-3.712	0	0.138	-13.544
CAR	39	-2.7	-0.062	23.28	0.804	-2.12	50.694	-25.665	0	0	-0.716	0	0	0.006	-11.48
CAR	40	-11.645	0.078	-2.098	2.807	-0.382	49.084	-3.756	-4.84	0	-2.863	-1.963	0	0.152	-24.879

APPENDIX E_4. Matrix Estimation Changes. AM OD Percentage Differences

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14	To Zone 15	To Zone 16	To Zone 17	To Zone 18	To Zone 19	To Zone 20	To Zone 21
CAR	1	0	524.51	-98.45	-100	-99.71	0	46.71	-38.29	0	0	-100	0	0	-31.3	-22	0	0	39.83	-99.68	0	0
CAR	2	236.29	0	518.22	0	0	29.73	28.61	0	0	-25.22	0	0	0	9.69	29.73	0	0	3	68.36	-87.46	0
CAR	3	0	-82.04	0	0	0	484.76	0	0	0	0	0	0	0	179.1	-14.07	0	0	0	0	0	0
CAR	4	-100	-100	0	0	0	-100	-86.65	0	0	0	0	0	0	-99.33	-100	0	0	0	0	0	0
CAR	5	-97.47	-67.26	0	0	0	-94.64	671.35	0	0	0	0	0	0	474.49	-91.44	0	0	0	0	0	0
CAR	6	7.09	0	59.98	-98.03	-47.74	0	-93.5	0	0	0	0	0	0	-93.04	0	0	0	-68	-95.69	0	-99.66
CAR	7	160.92	1.75	-74.54	-88.62	52.78	0	0	0	0	0	0	0	0	-74.69	-30.93	0	0	0	40.74	0	773.6
CAR	8	53.6	-0.65	0	-89.55	47.94	0	0	0	0	0	128.59	0	0	0	0	0	0	0	0	0	0
CAR	9	552.31	0	0	0	0	0	0	0	0	0	-100	0	0	0	0	0	0	0	0	0	0
CAR	10	8.71	-13.4	-76.61	-90.73	36.75	0	0	0	0	0	-100	0	0	0	-39.9	0	0	-35.59	30.26	0	379.45
CAR	11	43.89	0	0	0	0	0	0	143.82	64.97	27.37	0	49.23	11.99	0	0	0	0	0	69.33	150.96	0
CAR	12	534.05	0	0	0	0	0	0	0	0	0	-100	0	0	0	0	0	0	0	0	0	0
CAR	13	0	0	0	0	0	0	0	0	0	0	-100	0	0	0	0	0	0	0	0	-12.81	0
CAR	14	120.93	-64.68	-92.61	-95.84	-47.12	0	-99.83	0	0	0	0	0	0	0	-78.21	0	0	-71.4	-55.49	0	132.02
CAR	15	-78.02	0	69.41	-95.52	-22.84	0	-22.85	0	0	-44.1	0	0	0	-24.2	0	0	0	44.97	-71.78	0	-99.82
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	0	-100	0	0	0	-100	0	0	0	0	0	0	0	0	-100	0	0	0	0	0	0
CAR	19	-99.98	-97.56	0	0	0	-82.32	-83.51	-72.22	0	-74.91	0	0	0	-88.05	-27.52	0	0	0	0	0	0
CAR	20	-99.02	0	-78.24	46.19	70.73	0	0	0	0	0	-98.46	0	104.23	0	-56.22	0	0	0	89.51	0	0
CAR	21	0	0	0	0	0	-100	0	0	0	0	0	0	0	0	-100	0	0	0	0	0	0
CAR	22	-99.98	25.4	0	0	0	47.14	0	0	0	-92.68	0	0	0	-88.82	-41.85	0	0	0	0	0	0
CAR	23	475.99	0	104.18	418.32	-10.79	0	-28	-57	0	-82.22	-100	0	0	-61.44	0	0	0	1	160.23	-93.79	-96.75
CAR	24	0	0	0	0	0	-49.51	45.32	10.42	0	-16.99	0	0	0	73.48	0	0	0	0	0	0	0
CAR	25	0	0	397.66	-79.07	51.24	0	28.45	0	0	0	0	0	0	0	0	0	0	300.03	-72.63	0	-99.91
CAR	26	-76.82	0	2	318.64	-91.76	-16.54	-17.19	0	0	0	-25.74	0	0	0	18.47	0	0	0	1	236.25	-85.19
CAR	27	120.13	0	448.07	240.11	-2.47	13.77	0	0	0	-4.82	0	0	0	98.92	0	0	0	1	556.37	-76.31	0
CAR	28	0	0	-40.58	-99.61	-88.59	0	0	0	0	0	0	0	0	0	0	0	0	-76.09	-98.31	0	-99.91
CAR	29	-53.59	0	122.51	-99.01	-61.95	-51.1	-85.86	0	0	0	0	0	0	0	0	0	0	-50.8	-89.97	0	-99.49
CAR	30	30.48	39.85	0	0	0	163.41	-65.96	0	0	-71.3	0	0	0	-45.47	38.45	0	0	0	0	0	0
CAR	31	0	-58.84	0	0	0	-99.96	0	0	0	0	0	0	0	0	-99.14	0	0	0	0	0	0
CAR	32	153.45	222.06	0	0	0	-99.98	-52.06	0	0	-68.77	0	0	0	-37.7	-88.79	0	0	0	0	-53.05	0
CAR	33	-96	-99.98	-99.8	-99.86	640.72	-88.5	-88.99	0	0	-92.63	0	0	0	-80.79	-99.4	0	0	-100	-43.33	0	-99.67
CAR	34	-99.38	-91.44	0	0	0	-99.99	0	0	0	-94.21	0	0	0	-86.29	-99.71	0	0	0	0	0	0
CAR	35	-99.8	-92.29	-99.53	-83.85	-95.1	-54.44	-99.35	0	0	0	0	0	0	-98.87	-97.36	0	0	-100	-99.97	0	-99.99
CAR	36	-99.66	-93.52	0	0	0	-99.96	0	0	0	0	0	0	0	0	-88.93	0	0	0	0	0	0
CAR	37	-99.99	0	0	0	0	-100	-99.54	0	0	0	0	0	0	0	-93.34	0	0	0	0	0	0
CAR	38	-100	0	0	0	0	-99.38	0	0	0	0	0	0	0	-98.72	-71.52	0	0	0	0	0	0
CAR	39	-99.96	-94.91	-81.98	-58.91	-92.28	-50.18	0	0	0	0	0	0	0	0	-82.64	0	0	-99.85	-98.02	0	-99.99
CAR	40	-99.85	-87.65	-95.34	567.34	62.13	4	970.57	-97.04	0	0	-97.51	0	0	0	-95.03	-57.56	0	0	-99.98	-83.22	0

APPENDIX E_5. Matrix Estimation Changes. IP OD Percentage Differences

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14	To Zone 15	To Zone 16	To Zone 17	To Zone 18	To Zone 19	To Zone 20	To Zone 21
CAR	1	0	-92.85	-5.51	-94.88	-71.97	-99.98	14.17	1.34	-11.21	-11.21	-11.21	-11.21	0	-12.83	-99.12	0	0	261.68	-93.6	-86.74	3
CAR	2	-95.47	0	74.35	0	0	-32.3	-13.6	-25.16	-28.24	-29.73	0	-29.73	0	-10.02	71.27	0	0	217.32	-92.54	-61.88	0
CAR	3	53.22	-39.01	0	0	0	849.57	-50.3	-58.71	-59.9	0	-63.57	-60.55	0	-37.98	-94.95	0	0	0	0	-75.65	0
CAR	4	79.79	-41.69	0	0	0	-70.8	75.11	39.02	26.74	26.74	26.74	26.74	0	71.41	-19.68	0	0	0	0	-48.32	0
CAR	5	18.27	6.6	0	0	0	-51.12	-10.05	-19.06	-0.49	-20.12	-18.18	-14.17	0	11.87	25.63	0	0	0	0	-32.83	0
CAR	6	1	23.92	-60.28	412.72	3	52.91	141.8	0	-67.64	-72.56	0	0	-69.66	0	0	0	0	0	0	-60.48	-96.89
CAR	7	81.47	-49.98	27.63	-11.83	-59.99	-84.27	0	0	0	0	0	0	0	-52.11	-51.01	0	0	114.8	40.74	0	-66.78
CAR	8	96.48	-50	22.81	-13.81	-59.12	-83.28	0	0	0	590.3	590.3	0	0	0	-48.54	0	0	101.69	30.43	0	0
CAR	9	-78.12	-55.51	22.06	-16.07	-55.79	0	0	0	0	106.16	106.16	0	0	0	-54.29	0	0	0	79.08	0	0
CAR	10	-78.88	-56.11	0	-19.42	-56.32	0	0	0	0	0	99.04	0	0	0	-56.22	0	0	104.7	87.03	0	-95.37
CAR	11	-67.96	0	78.74	20.84	-31.84	-55.14	0	41.14	201.9	201.9	0	201.9	201.9	0	0	0	0	0	169.43	-96.97	0
CAR	12	-78.2	-54.49	21.6	-16.86	-56.69	0	0	0	0	105.39	105.39	0	0	0	-54.51	0	0	0	84.33	0	0
CAR	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74.68	0
CAR	14	88.84	-60.37	9.06	-27.52	-3.36	-87.98	233.32	0	0	0	0	0	0	0	-61.25	0	0	88.52	42.06	0	-31.6
CAR	15	-39.16	16.71	-99.63	24.5	17.43	0	-19.12	-35.45	-30.98	-36.14	0	-36.88	0	-16.86	0	0	0	-78.21	-72.44	0	-99.09
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	128.88	-98.74	0	0	0	-99.98	-41.62	0	0	-49.46	0	0	0	-16.21	-98.51	0	0	0	0	-46.69	0
CAR	19	-88.13	-65.7	0	0	0	-48.66	-42.84	-12.61	-40.43	-19.83	-30.62	-35.79	0	1.5	42.96	0	0	0	0	-11.99	0
CAR	20	-100	-45.2	-7.7	-18.05	-31.92	-76.52	0	0	0	0	-99.98	0	40.52	0	0	0	0	33	200.97	0	0
CAR	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	22	0	141.4	0	0	0	51.29	-99.45	-99.5	0	0	0	0	0	-99.15	-90.8	0	0	0	0	0	0
CAR	23	-93.37	70.8	-30.13	-72.86	6.87	0	-48.8	-42.02	-47.69	-47.69	-47.69	-47.69	0	-62.87	0	0	0	-87.57	-90.98	-85.22	-76.91
CAR	24	-68.3	0	0	0	0	-32.3	133.18	0	0	75.31	0	0	0	165.48	71.27	0	0	0	0	15.04	0
CAR	25	-94.97	0	-99.97	-79.4	-18.38	0	-7.8	-21.33	0	0	0	0	0	0.02	0	0	0	-89.03	-97.65	-32.34	-82.92
CAR	26	-64.52	0	-92.28	-27.01	-8.94	-32.3	33.99	17.18	0	6.05	0	0	0	49.91	0	0	0	-78.09	-86.18	-0.83	-98.77
CAR	27	-61.01	0	-99.79	-30.38	-9.97	-32.3	70.98	40.78	0	32.25	0	0	0	102.59	0	0	0	-85.17	-89.57	7.68	-98.67
CAR	28	0	0	-64.59	1	394.82	-5.78	0	-86.35	0	0	0	0	0	0	0	0	0	0	-79.93	-98.2	0
CAR	29	575.71	0	-41.68	1	843.91	175.13	-53.4	-49.58	0	0	-56.86	0	0	0	-54.4	0	0	0	-62.8	-90.05	0
CAR	30	519.74	-31.62	0	0	0	-55.16	-51.04	-61.07	-59.53	-58.12	0	-60.86	0	-43.15	-11.74	0	0	0	0	-62.21	0
CAR	31	60.28	-66.11	0	0	0	-99.67	-29.15	0	0	-44.12	0	0	0	-23.16	-90.72	0	0	0	0	-54.16	0
CAR	32	-10.21	-64.62	0	0	0	-100	-99.65	0	-99.56	-99.48	0	-99.52	0	-99.33	-98.36	0	0	0	0	-99.84	0
CAR	33	337.7	-42.24	17.6	706.23	23.19	-61.3	-48.68	0	-58.69	-58.55	0	-59.26	0	-47.69	-76.82	0	0	-98.85	-95.07	-66.94	-99.36
CAR	34	43.38	-65.72	0	0	0	-99.3	21.56	0	0	0	0	0	0	25.45	-87.62	0	0	0	0	0	0
CAR	35	-63.57	-72.59	5.74	-79.45	-96.4	124.16	-52.82	0	0	10	146	0	0	0	-52.29	-77.86	0	0	-98.97	-99.83	-70.06
CAR	36	0	-58.38	0	0	0	-96.81	0	0	0	0	0	0	0	4.46	-51.36	0	0	0	0	0	0
CAR	37	-32.42	0	0	0	0	-99.87	-16.5	-31.36	-34.58	-35	-34.42	-36.25	0	-30.6	-56.21	0	0	0	0	-37.86	0
CAR	38	13.9	0	0	0	0	-95.69	9.98	-4.76	0	-12.45	0	0	0	3.18	-25.8	0	0	0	0	-28.81	0
CAR	39	-75.93	-74.85	39	-13.53	-98.64	158.2	-83.61	0	0	0	0	0	0	-86.93	-69.52	0	0	-24.41	-99.47	-83.72	-99.94
CAR	40	-27.93	-4.15	-99.99	494.91	-76.53	170.34	-41.81	0	0	-55.97	0	0	0	-46.72	-76.43	0	0	-100	-94.31	-50.22	-99.84

APPENDIX E_6. Matrix Estimation Changes. PM OD Percentage Differences

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14
CAR	1	0	-82.08	0	-92.9	-64.47	-99.97	69.17	43.67	101	101	101	73.95	0	67.17
CAR	2	23.58	0	312.95	0	0	0	-1.14	-1.33	0	0	0	0	0	-1.06
CAR	3	-94.85	-86.64	0	0	0	641.78	-74.29	0	0	-73.51	0	0	0	-72.21
CAR	4	144.51	-92.32	0	0	0	-98.74	14.09	10.1	0	39.28	0	0	0	7.12
CAR	5	-67.84	-53.4	0	0	0	-33.79	-9.26	-1.57	0	7	0	0	0	-4.41
CAR	6	0	0	86.59	0	0	0	-90.24	0	0	0	0	0	0	-91
CAR	7	218.87	-28.9	0	56.75	-72.52	-49.59	0	0	0	0	0	0	0	-99.92
CAR	8	332.15	0	0	0	0	0	0	0	0	195.55	195.55	0	0	0
CAR	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	10	0	-34.52	0	36.52	-77.78	0	0	61.34	0	0	0	-13.46	0	0
CAR	11	96.1	0	0	0	0	0	0	61.34	0	0	0	-13.46	0	0
CAR	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	13	0	0	604.44	0	0	0	0	0	0	0	0	0	0	0
CAR	14	-45.08	-47.07	58.26	36.46	-54.59	0	-44.98	0	0	0	0	0	0	0
CAR	15	2.25	4.01	-86.04	6.43	14.71	0	-13.87	0	0	-1.64	0	0	0	-14.41
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	-91.53	-99.36	0	0	0	-100	0	0	0	12.31	0	0	0	7.23
CAR	19	-92.95	-77.77	0	0	0	-89.56	-45.99	0	0	5.56	1.2	0	101.3	-29.43
CAR	20	-99.6	0	0	0	0	0	0	0	0	-99.99	-97.11	0	-4	0
CAR	21	0	0	0	0	0	-100	744.04	0	0	159.14	0	0	0	923.47
CAR	22	-99.95	-93.17	0	0	0	-90.1	-99.83	0	0	0	0	0	0	0
CAR	23	23.58	0	63.64	-44.23	75.8	0	-23.62	-19.74	4.22	4.22	0	-9.81	0	-33.63
CAR	24	0	0	0	0	0	-30.35	13.31	0	0	0	0	0	0	21.67
CAR	25	0	0	-95.84	-41.58	77.98	0	-8.65	0	0	0	0	0	0	-10.88
CAR	26	4.65	0	68.99	-9.04	-25.91	0	39.96	35.51	0	48.99	0	0	0	43.73
CAR	27	22.71	0	-88.44	-44.62	70.78	-0.7	61.55	53.91	0	71.26	0	0	0	73.47
CAR	28	0	0	45.83	1	276.24	201.09	0	0	0	0	0	0	0	0
CAR	29	0	0	25.25	689.59	37.08	0	0	-66.33	0	0	0	0	0	0
CAR	30	246.2	-59.09	0	0	0	-59.09	-59.18	-61.55	0	-55.83	0	0	0	-44.14
CAR	31	-99.04	-99.21	0	0	0	-100	0	0	0	-96.57	0	0	0	-95.58
CAR	32	2	81.68	-90.83	0	0	0	-100	-90.32	-95.44	0	-95.63	0	0	-95.64
CAR	33	44.78	355.67	-43.32	242.51	1	191.32	-85.3	-24.37	0	0	-18.49	0	0	56.49
CAR	34	0	-14.16	0	0	0	-99.68	0	0	0	34.79	0	0	232.08	63.39
CAR	35	-72.33	248.92	-19.92	-23.74	-87.75	81.63	-93.76	-90.91	0	0	0	0	0	0
CAR	36	0	-54.19	0	0	0	-98.9	-87.97	0	0	0	0	0	0	0
CAR	37	-44.02	-61.95	0	0	0	-99.94	-87.45	-81.9	-78.05	-78.27	0	-81.19	52.46	-86.32
CAR	38	-50.38	-84.85	0	0	0	-99.01	-87.89	-82.35	0	-78.15	-78.15	0	57.46	-86.54
CAR	39	-65.39	-14.07	253.87	44.15	-93.81	113.03	-92.05	0	0	-84.18	0	0	2.25	-91.55
CAR	40	-57.93	43.2	-99.89	445.56	-48.91	97.82	-86.55	-82.04	0	-78.64	-78.2	0	30.32	-84.02

APPENDIX F. Estimated Matrices

APPENDIX F_1. AM Estimated Matrices

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14	To Zone 15	To Zone 16	To Zone 17	To Zone 18	To Zone 19	To Zone 20	To Zone 21
CAR	1	0	108.815	0.185	0	0.183	0	444.751	36.671	0	0	0	0	0	118.128	10.283	0	0	4.642	0.173	0	0
CAR	2	11.515	0	17.557	0	0	17.374	40.517	0	0	5.647	0	0	0	8.099	23.581	0	0	27.375	0.207	0	0
CAR	3	0	0.431	0	0	0	144.834	0	0	0	0	0	0	0	167.904	4.613	0	0	0	0	0	0
CAR	4	0	0	0	0	0	0	0.112	0	0	0	0	0	0	0.005	0	0	0	0	0	0	0
CAR	5	0.495	2.072	0	0	0	0.524	35.544	0	0	0	0	0	0	23.577	1.152	0	0	0	0	0	0
CAR	6	0.951	12.88	39.676	0.001	0.146	0	0.837	0	0	0	0	0	0	0.081	0	0	0	2.388	0.619	0	0
CAR	7	639.265	11.112	4.782	1.231	125.741	0	0	0	0	0	0	0	0	29.524	26.983	0	0	0	169.617	0	15.865
CAR	8	53.625	14.012	0	0.242	25.99	0	0	0	0	0	36.153	0	0	0	0	0	0	0	0	0	0
CAR	9	37.678	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	10	22.978	6.789	3.25	0.266	29.856	0	0	0	0	0	0	0	0	0	12.121	0	0	1.067	32.449	0	7.211
CAR	11	28.444	0	0	0	0	0	0	10.864	6.018	19.146	0	5.444	25.347	0	0	0	0	0	21.498	104.941	0
CAR	12	36.623	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60.143	0
CAR	14	295.573	12.361	0.49	0.691	66.938	0	0.027	0	0	0	0	0	0	0	3.206	0	0	1.297	25.652	0	6.701
CAR	15	4.601	12.68	21.631	0.005	0.661	0	88.97	0	0	14.289	0	0	0	37.546	0	0	0	5.579	0.867	0	0
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	19	0.006	0.033	0	0	0	3.232	3.05	13.958	0	1.403	0	0	0	4.702	2.198	0	0	0	0	0	0
CAR	20	0.14	0	0.545	6.97	61.915	0	0	0	0	0	0.294	0	107.882	0	0.865	0	0	0	5.594	0	0
CAR	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	22	0.004	8.387	0	0	0	20.117	0	0	0	0.553	0	0	0	0.398	1.74	0	0	0	0	0	0
CAR	23	158.235	32.72	149.444	95.952	125.655	0	260.407	52.636	0	5.963	0	0	0	106.535	0	0	0	10.082	10.446	0.332	0
CAR	24	0	0	0	0	0	1.333	10.521	17.897	0	1.328	0	0	0	21.498	1.76	0	0	0	0	0	0
CAR	25	0	0	31.611	0.012	0.641	0	8.005	0	0	0	0	0	0	0	0	0	0	7.649	0.504	0	0
CAR	26	2.144	0	63.078	0.002	0.147	5.095	0	0	0	0.838	0	0	0	1.317	0	0	0	10.476	0.113	0	0
CAR	27	23.581	0	16.574	0.082	0.195	8.11	0	0	0	1.241	0	0	0	2.562	0	0	0	14.974	0.208	0	0
CAR	28	0	0	1.036	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0.124	0.017	0	0
CAR	29	1.815	0	14.205	0.004	1.044	7.347	0.871	0	0	0	0	0	0	0	0	0	0	0.941	0.37	0	0.003
CAR	30	45.094	1.868	0	0	0	11.801	2.198	0	0	1.29	0	0	0	1.156	4.142	0	0	0	0	0	0
CAR	31	0	0.487	0	0	0	0.004	0	0	0	0	0	0	0	0	0.023	0	0	0	0	0	0
CAR	32	57.705	4.354	0	0	0	0.002	19.781	0	0	3.318	0	0	0	3.997	0.34	0	0	0	0	22.097	0
CAR	33	0.451	0	0.028	0.002	84.561	3.931	1.358	0	0	0.21	0	0	0	0.533	0.045	0	0	0	4.488	0	0.004
CAR	34	0.071	0.116	0	0	0	0.001	0	0	0	0.332	0	0	0	0.76	0.009	0	0	0	0	0	0
CAR	35	0.048	0.076	0.064	0.11	0.253	21.876	0.04	0	0	0	0	0	0	0.442	0.199	0	0	0	0.002	0	0
CAR	36	0.077	0.087	0	0	0	0.005	0	0	0	0	0	0	0	0	0.331	0	0	0	0	0	0
CAR	37	0.001	0	0	0	0	0	0.162	0	0	0	0	0	0	0	0.202	0	0	0	0	0	0
CAR	38	0	0	0	0	0	0.015	0	0	0	0	0	0	0	0.155	0.39	0	0	0	0	0	0
CAR	39	0.007	0.023	1.118	0.128	0.182	6.397	0	0	0	0	0	0	0	0	0.594	0	0	0.005	0.071	0	0
CAR	40	0.002	0.205	0.165	1.335	2.464	61.658	0.14	0	0	0.027	0	0	0	0.691	0.238	0	0	0	0.342	0	0

APPENDIX F_2. IP Estimated Matrices

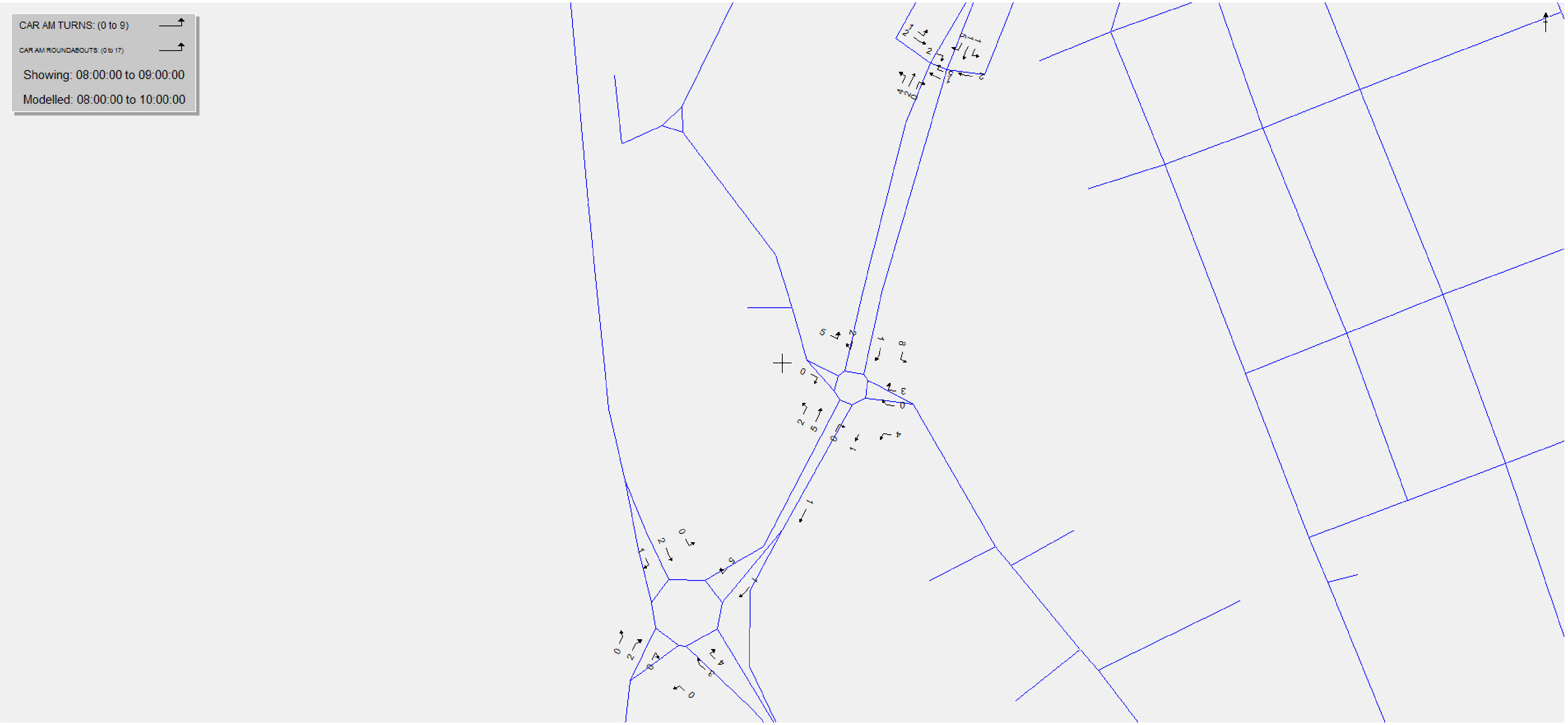
Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14
CAR	1	0	1.597	13.522	0.82	9.302	0	210.114	27.969	3.578	9.9	4.457	3.578	0	66.87
CAR	2	0.98	0	8.107	0	0	12.227	33.194	18.605	1.399	19.577	0	1.37	0	19.624
CAR	3	21.665	0.451	0	0	0	385.622	16.817	6.078	1.291	0	1.687	1.27	0	12.763
CAR	4	24.775	3.376	0	0	0	4.838	40.362	15.348	1.787	12.648	1.141	1.787	0	46.863
CAR	5	37.833	14.338	0	0	0	18.8	48.125	20.746	3.244	18.507	1.694	2.798	0	70.994
CAR	6	10.565	5.298	116.336	27.746	4.425	0	2.767	0.985	0	0	0.795	0	0	0
CAR	7	311.447	16.585	44.26	19.626	18.445	0.95	0	0	0	0	0	0	0	8.525
CAR	8	37.724	5.905	14.97	6.956	6.831	0.518	0	0	0	8.974	47.355	0	0	0
CAR	9	0.807	0.925	4.125	1.41	1.538	0	0	0	0	17.07	10.143	0	0	0
CAR	10	0.448	2.379	0	2.063	2.315	0	0	0	0	0	20.76	0	0	0
CAR	11	1.07	0	6.202	1.245	1.452	0.879	0	10.119	17.088	23.85	0	17.088	131.659	0
CAR	12	0.804	0.947	4.11	1.397	1.507	0	0	0	0	17.006	10.105	0	0	0
CAR	13	0	0	0	0	0	0	0	0	0	0	27.48	0	0	0
CAR	14	182.608	17.547	22.193	29.621	81.804	0.041	56.465	0	0	0	0	0	0	0
CAR	15	9.485	0.047	0.027	4.171	8.15	0	18.797	6.274	3.009	2.19	0	2.752	0	17.367
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	45.502	0.005	0	0	0	0.002	9.469	0	0	0.409	0	0	0	12.787
CAR	19	13.126	0.171	0	0	0	22.08	50.131	3.653	9.102	14.535	4.094	9.811	0	104.511
CAR	20	0	5.815	7.264	6.654	11.45	0.127	0	0	0	0	0.006	0	129.078	0
CAR	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	22	0	6.011	0	0	0	41.801	0.046	0.022	0	0	0	0	0	0.037
CAR	23	2.539	141.317	90.004	18.481	150.711	0	97.401	37.79	5.263	15.145	5.346	5.263	0	53.027
CAR	24	1.788	0	0	0	0	0.663	5.386	0	0	0.596	0	0	0	19.301
CAR	25	0.389	0	0.001	0.344	2.832	0	2.877	3.288	0	0	0	0	0	4.361
CAR	26	1.742	0	0.114	0.504	1.293	5.586	20.728	6.504	0	1.835	0	0	0	5.127
CAR	27	2.219	0	0.004	0.557	1.495	6.466	30.639	9.052	0	2.645	0	0	0	8.002
CAR	28	0	0	0.347	6.876	0.895	0	0.198	0	0	0	0	0	0	0
CAR	29	13.041	0	2.105	17.495	5.117	9.367	0.943	0	0	0.164	0	0	0	1.724
CAR	30	108.454	0.342	0	0	0	0.753	4.632	0.276	0.882	0.272	0	0.853	0	5.532
CAR	31	35.63	0.149	0	0	0	0.043	12.851	0	0	0.503	0	0	0	13.11
CAR	32	21.675	0.177	0	0	0	0	0.13	0	0.011	0.022	0	0.012	0	0.111
CAR	33	59.395	0.289	19.357	45.471	14.388	21.045	0.898	0	0.901	2.827	0	0.888	0	10.059
CAR	34	19.6	0.171	0	0	0	0.121	3.428	0	0	0	0	0	0	11.315
CAR	35	12.16	0.137	17.374	0.544	0.198	198.222	8.219	0	0	66.599	0	0	0	3.826
CAR	36	0	0.208	0	0	0	0.574	0	0	0	0	0	0	0	4.554
CAR	37	7.84	0	0	0	0	0.022	17.076	12.115	1.426	7.566	1.823	1.39	0	25.117
CAR	38	2.415	0	0	0	0	0.271	2.046	1.486	0	1.121	0	0	0	2.745
CAR	39	1.006	0.058	10.133	1.02	0.033	60.265	1.634	0	0	0	0	0	0	0.634
CAR	40	3.229	4.802	0.001	6.96	0.568	19.572	3.474	0	0	0.044	0	0	0	2.169

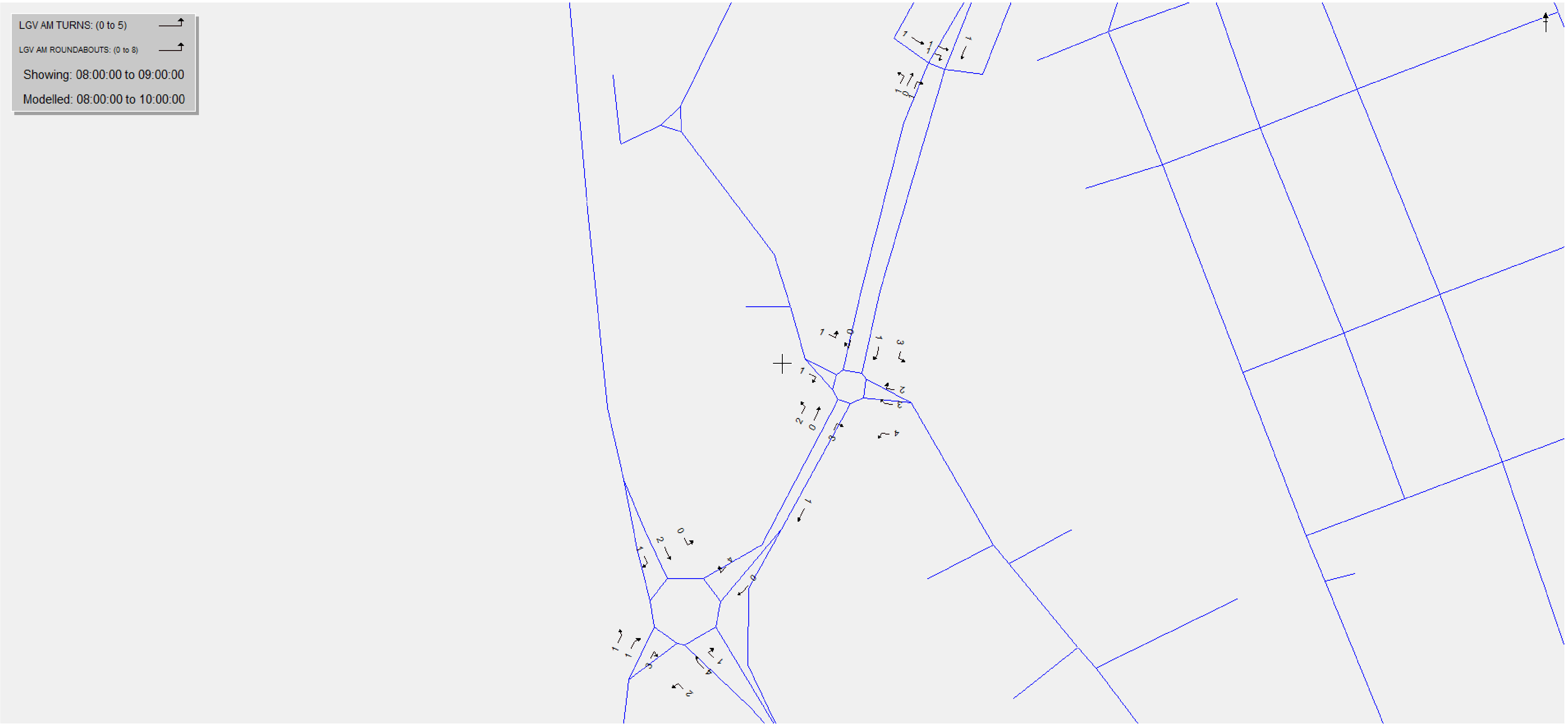
APPENDIX F_3. PM Estimated Matrices

Matrix Number	From Zone	To Zone 1	To Zone 2	To Zone 3	To Zone 4	To Zone 5	To Zone 6	To Zone 7	To Zone 8	To Zone 9	To Zone 10	To Zone 11	To Zone 12	To Zone 13	To Zone 14
CAR	1	0	0.849	0	1.319	8.221	0.002	466.707	64.579	13.326	71.456	48.884	11.533	0	233.058
CAR	2	22.789	0	61.281	0	0	14.46	11.626	12.019	0	0	0	0	0	50.004
CAR	3	0.714	0.262	0	0	0	369.259	0.933	0	0	6.227	0	0	0	0.914
CAR	4	34.158	0.151	0	0	0	0.043	25.089	8.654	0	11.393	0	0	0	29.566
CAR	5	21.476	4.371	0	0	0	10.759	95.39	37.009	0	41.868	0	0	0	126.128
CAR	6	0	11.36	57.434	0	0	0	0.04	0	0	0	0	0	0	1.242
CAR	7	686.774	20.028	0	5.769	1.259	2.651	0	0	0	0	0	0	0	0.015
CAR	8	122.947	0	0	0	0	0	0	0	0	43.091	41.909	0	0	0
CAR	9	0	0	0	0	0	0	0	0	0	48.02	6.65	0	0	0
CAR	10	0	2.737	0	0.177	0.036	0	0	9.519	1.13	0	18.12	0.978	0	0
CAR	11	20.826	0	0	0	0	0	0	13.488	4.71	15.29	0	4.076	38.33	0
CAR	12	0	0	0	0	0	0	0	0	0	48.02	6.65	0	0	0
CAR	13	0	0	16.132	0	0	0	0	0	0	0	31.62	0	0	0
CAR	14	117.013	9.089	112.461	8.761	3.628	0	8.869	0	0	0	0	0	0	0
CAR	15	14.254	14.811	1.593	2.373	3.189	0	39.837	0	0	30.5	0	0	0	5.914
CAR	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAR	18	0.503	0.006	0	0	0	0	0	0	0	0.427	0	0	0	12.857
CAR	19	3.971	0.227	0	0	0	6.097	61.13	0	0	9.458	15.586	0	1.651	60.112
CAR	20	0.048	0	0	0	0	0	0	0	0	0	1.056	0	146.304	0
CAR	21	0	0	0	0	0	0	7.006	0	0	2.54	0	0	0	11.258
CAR	22	0.003	0.105	0	0	0	2.568	0.002	0	0	0	0	0	0	0
CAR	23	8.935	76.32	88.547	24.284	95.371	0	129.522	15.852	7.191	25.534	0	6.223	0	106.683
CAR	24	0	0	0	0	0	1.393	21.892	0	0	0	0	0	0	1.411
CAR	25	0	0	0.237	0.649	2.474	0	9.154	0	0	0	0	0	0	9.26
CAR	26	17.383	0	3.937	0.418	0.422	3.66	31.574	7.792	0	19.995	0	0	0	54.991
CAR	27	23.61	0	0.312	0.294	1.127	4.21	42.228	10.25	0	26.614	0	0	0	76.864
CAR	28	0	0	2.275	4.129	1.144	0	0	0	0	0	0	0	0	0
CAR	29	0	0	7.139	13.423	2.92	8.97	0	3.495	0	0	0	0	0	0
CAR	30	48.502	0.417	0	0	0	1.399	6.082	3.957	0	0.592	0	0	0	4.15
CAR	31	0.057	0.007	0	0	0	0.001	0	0	0	0.013	0	0	0	0.526
CAR	32	296.926	0.094	0	0	0	0	2.024	0.222	0	0.131	0	0	0.001	0.782
CAR	33	1.375	5.286	13.547	20.345	95.557	10.329	29.24	0	0	1.907	0	0	0.078	9.77
CAR	34	0	0.893	0	0	0	0.092	0	0	0	4.313	0	0	0.066	25.604
CAR	35	3.919	4.047	19.074	3.592	0.718	109.671	1.589	0.937	0	0	0	0	0	0
CAR	36	0	0.467	0	0	0	0.313	1.87	0	0	0	0	0	0	0
CAR	37	31.338	0.963	0	0	0	0.016	8.635	4.539	1.128	1.269	0	0.967	3.385	14.654
CAR	38	2.446	0.447	0	0	0	0.064	2.324	0.66	0	0.214	1.038	0	0.378	2.106
CAR	39	1.43	0.378	32.45	2.624	0.14	95.544	2.215	0	0	0.134	0	0	0.256	1.06
CAR	40	8.455	0.258	0.002	3.437	0.398	99.264	0.584	1.06	0	0.777	0.547	0	0.652	4.731

APPENDIX G. GEH

Figure 1 GEH Pasteur Road Roundabout

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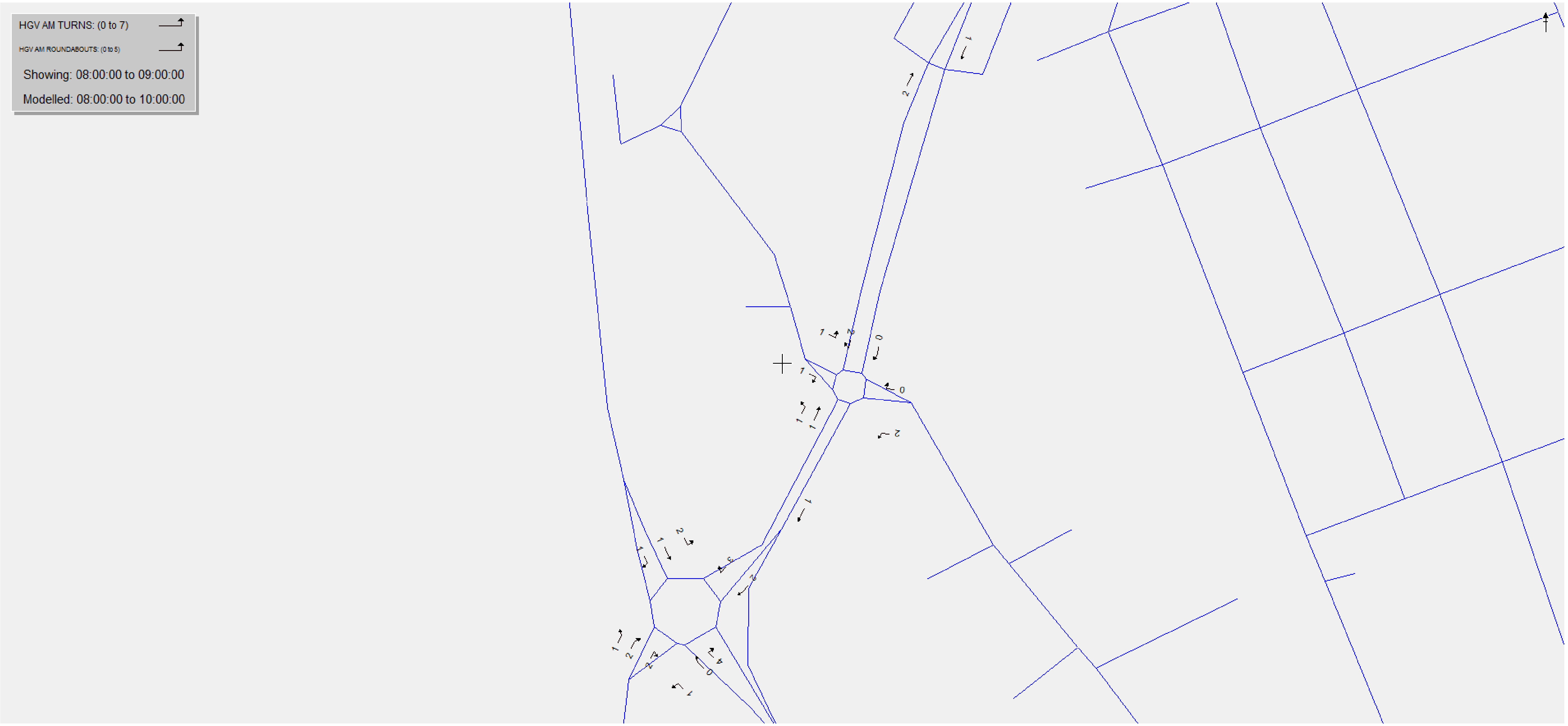
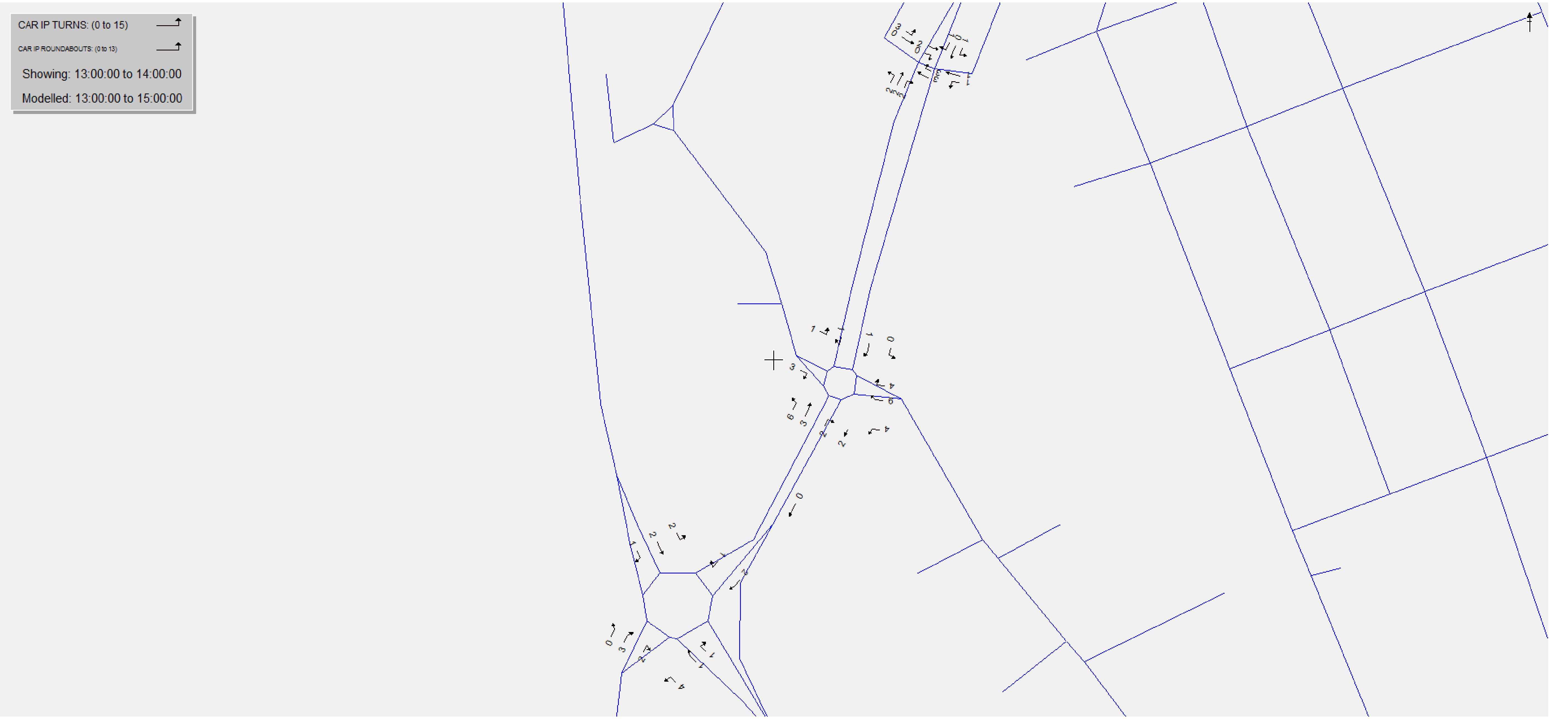
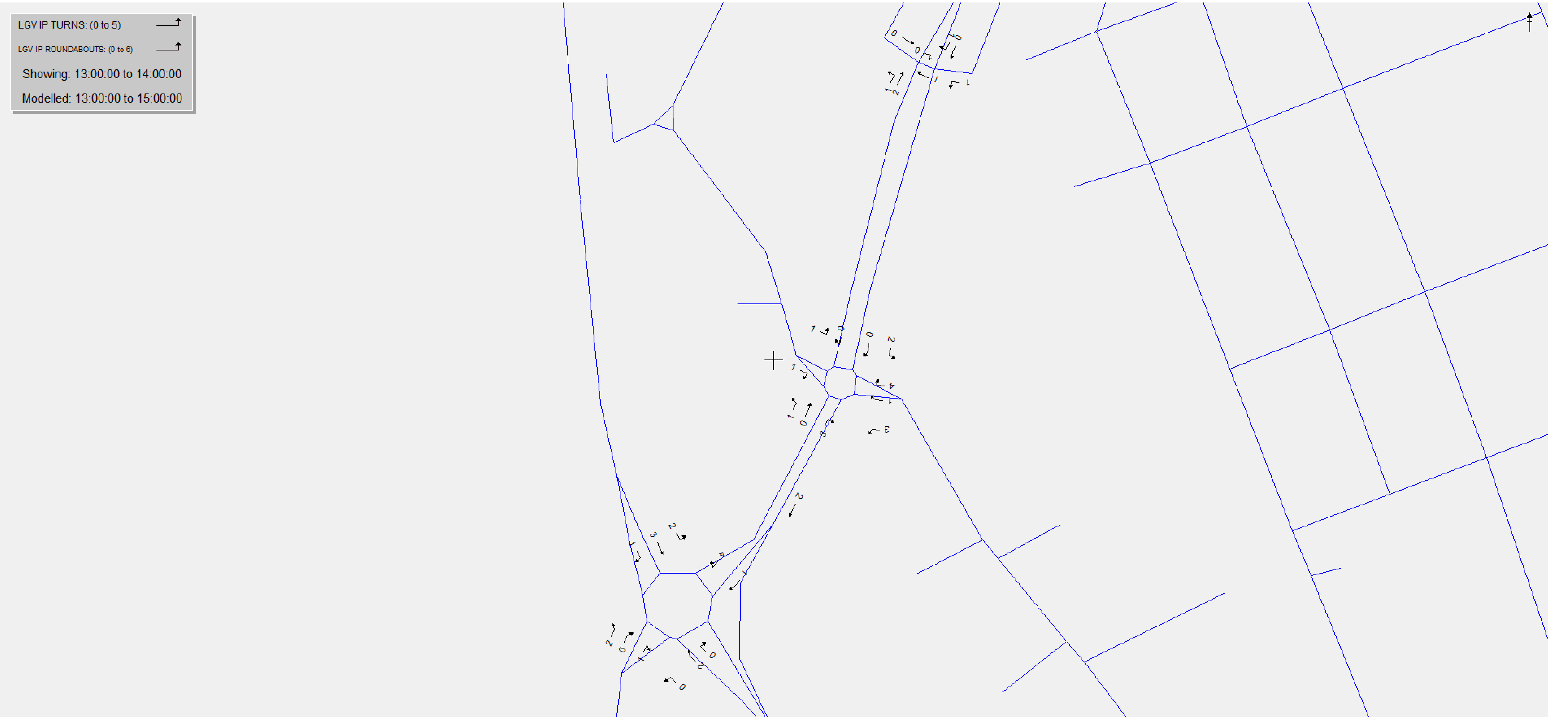
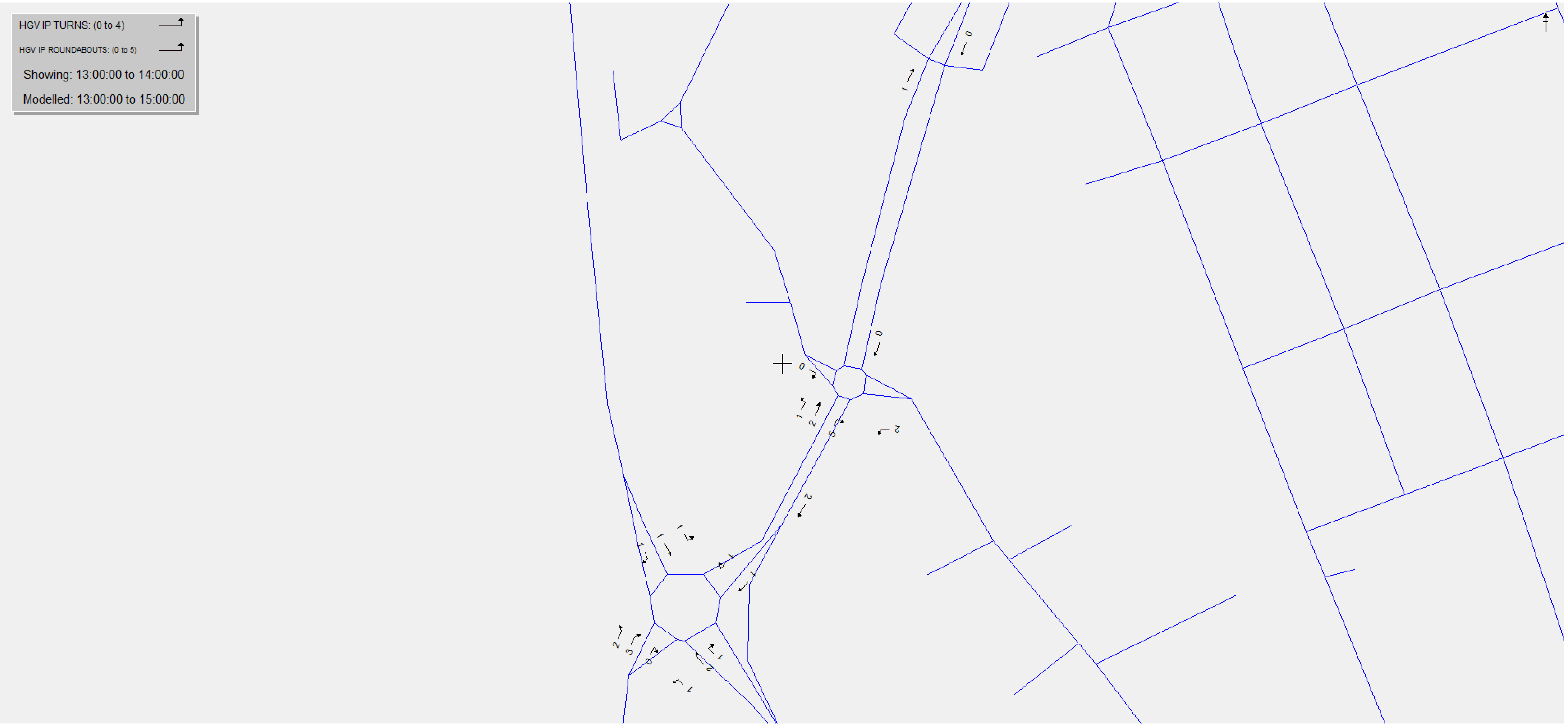
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

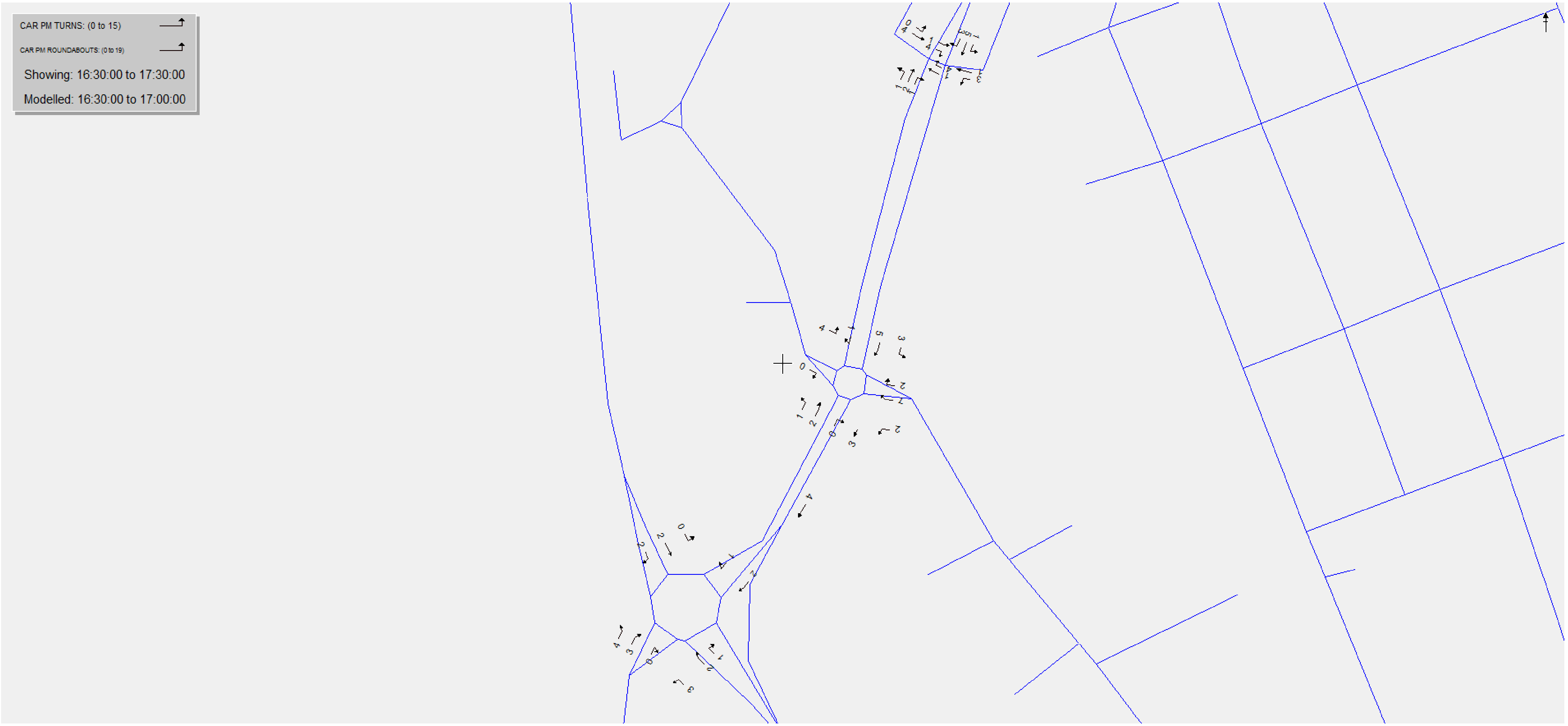


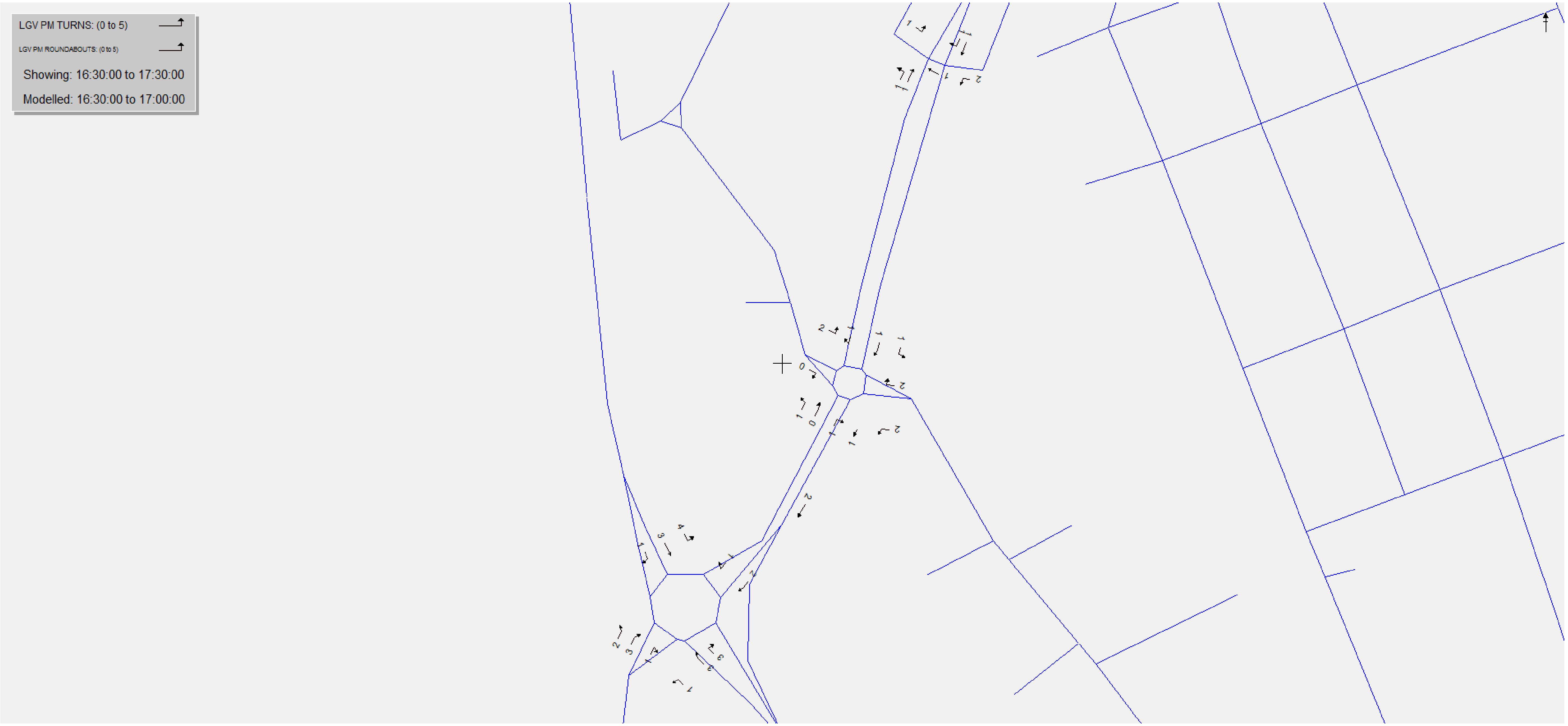
CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

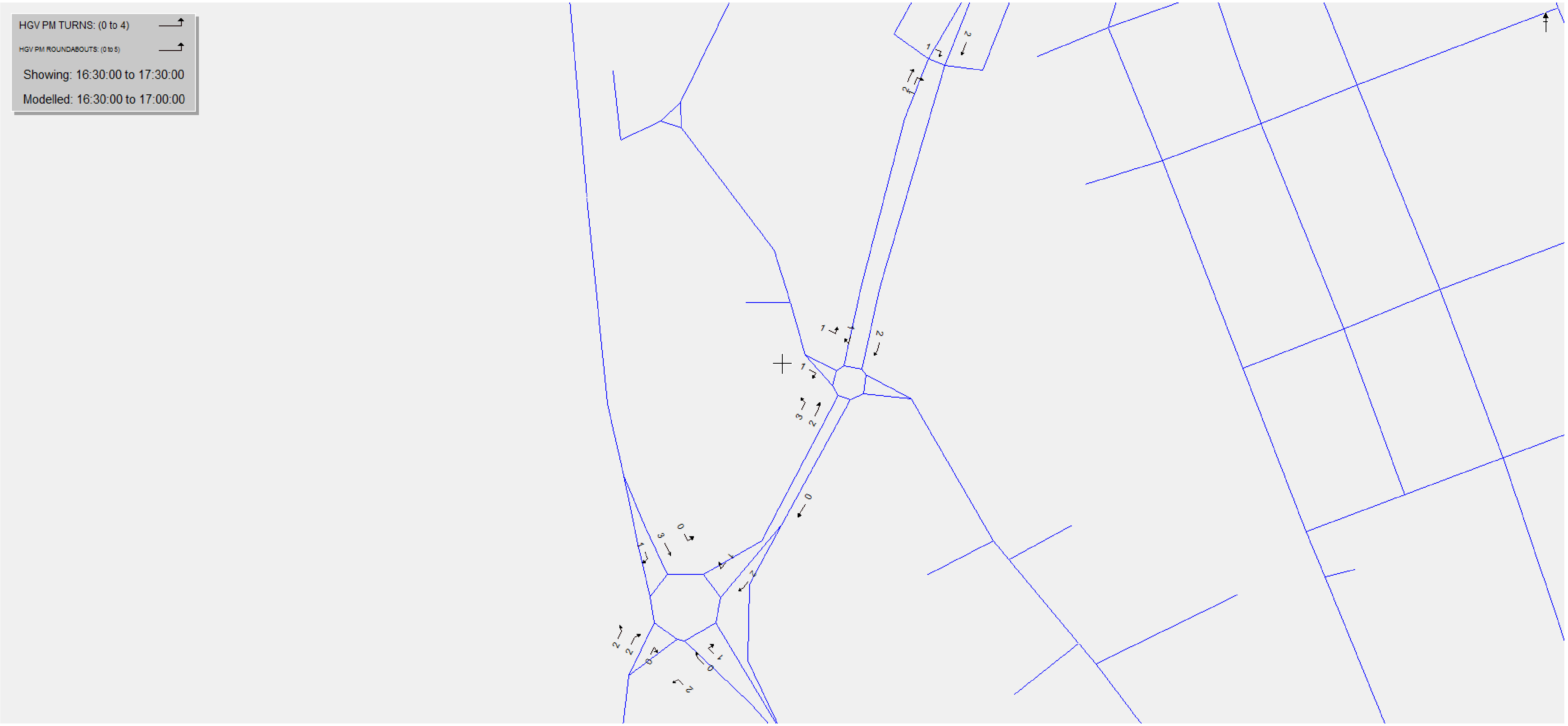


HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

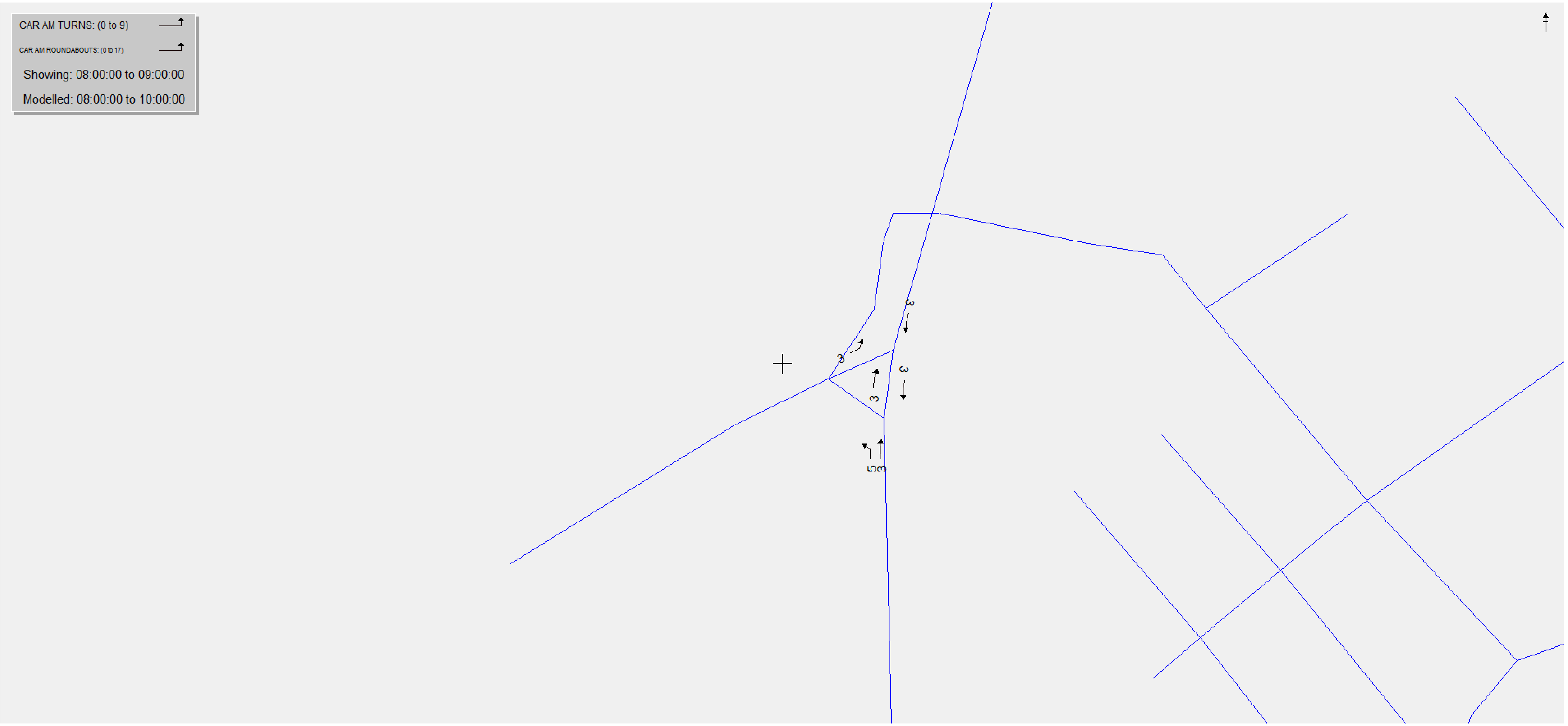


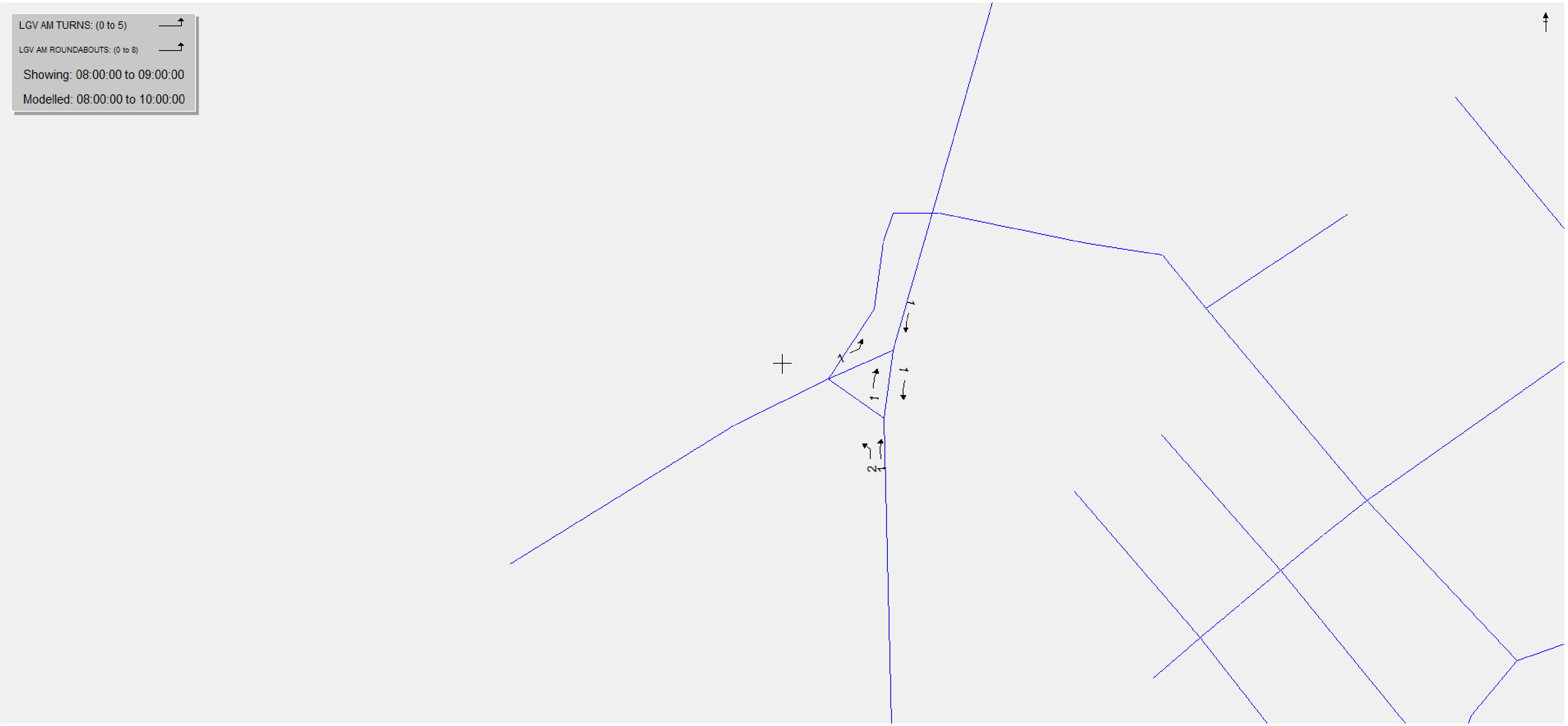
LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00



HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

Figure 2 GEH Rugby Club Intersection

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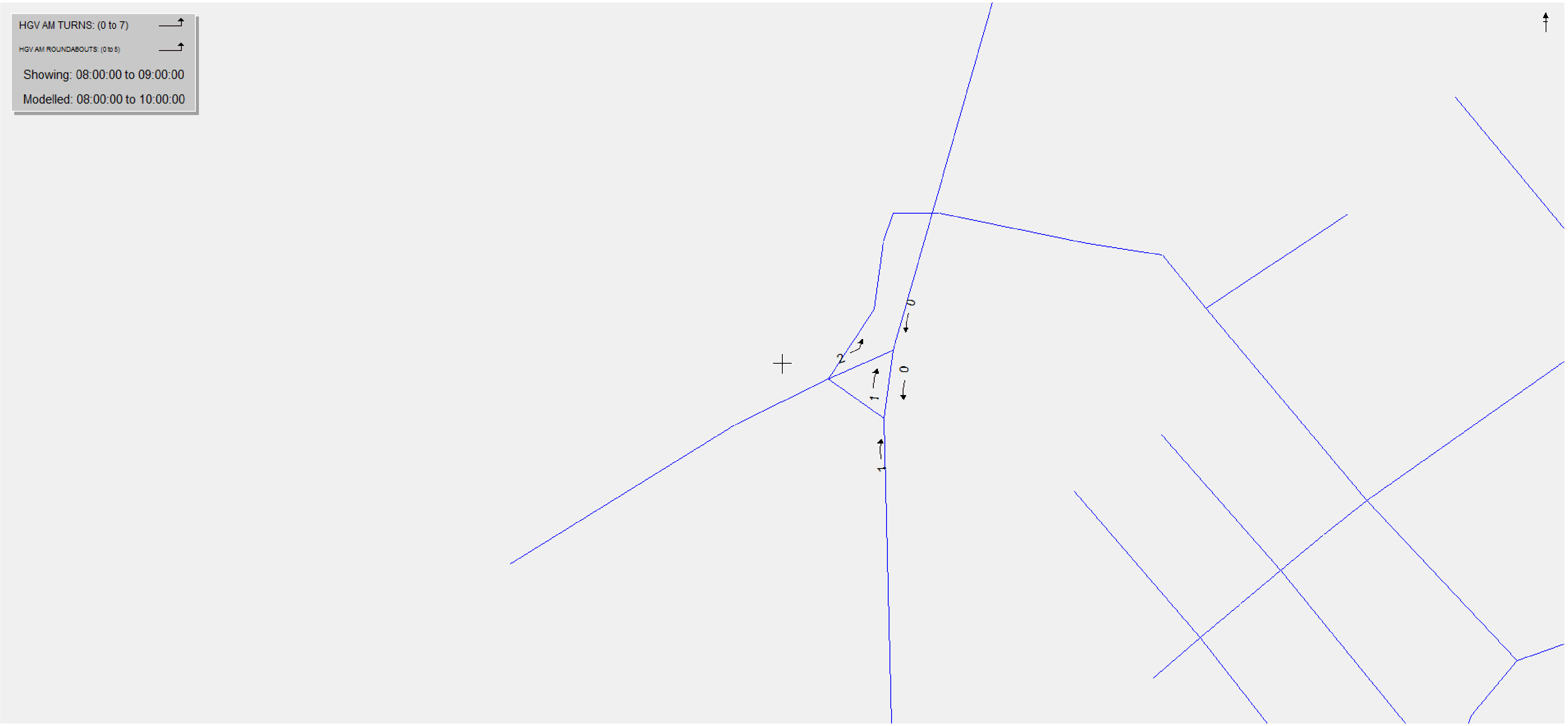
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00



HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
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Modelled: 08:00:00 to 10:00:00
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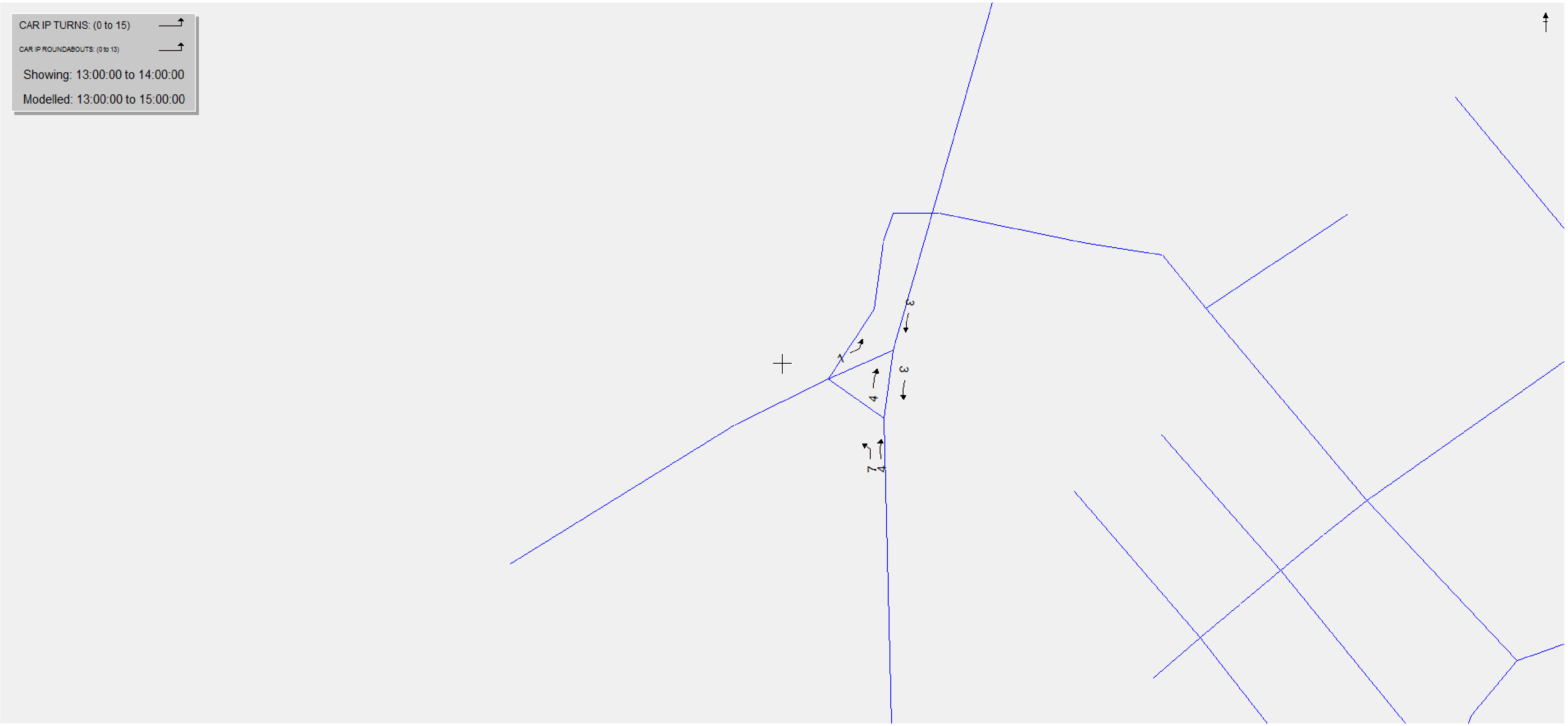
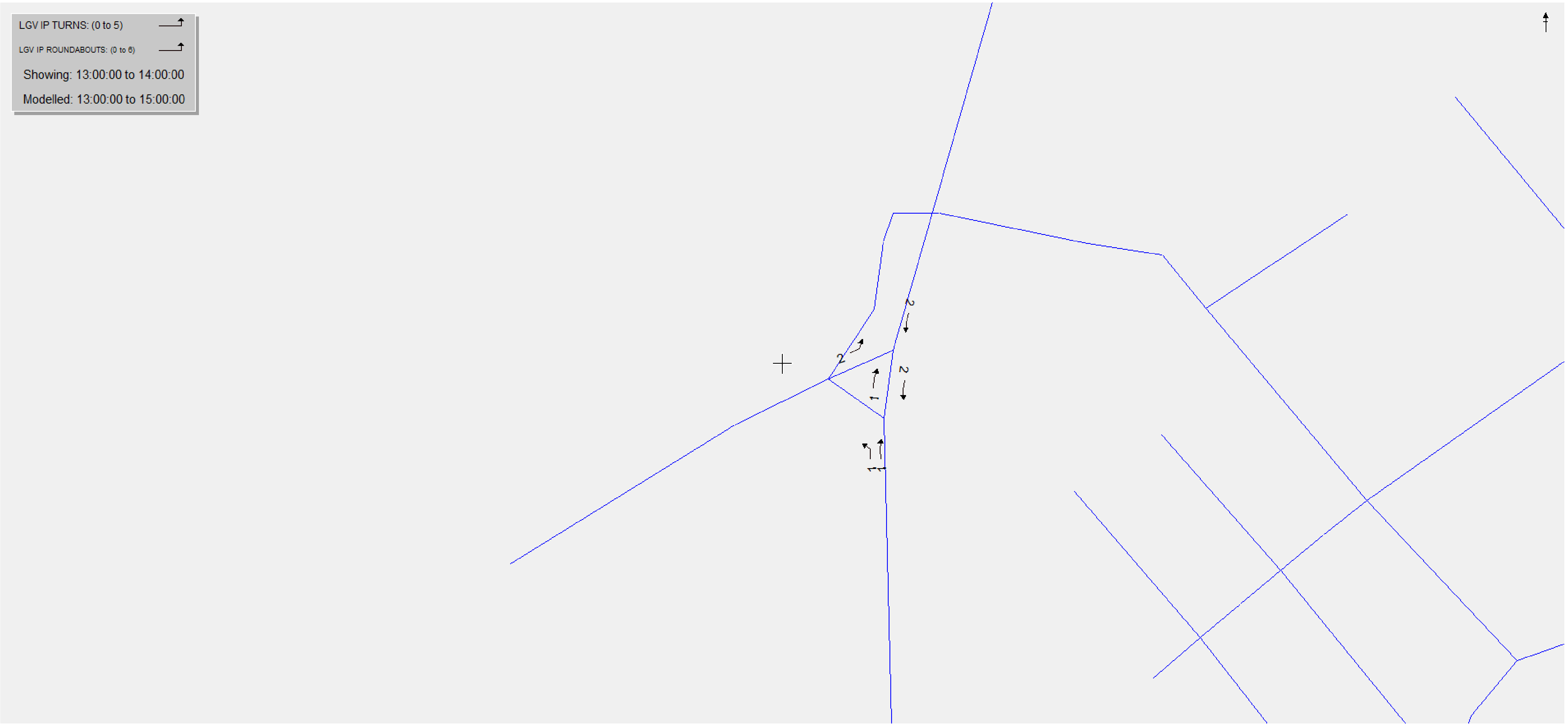
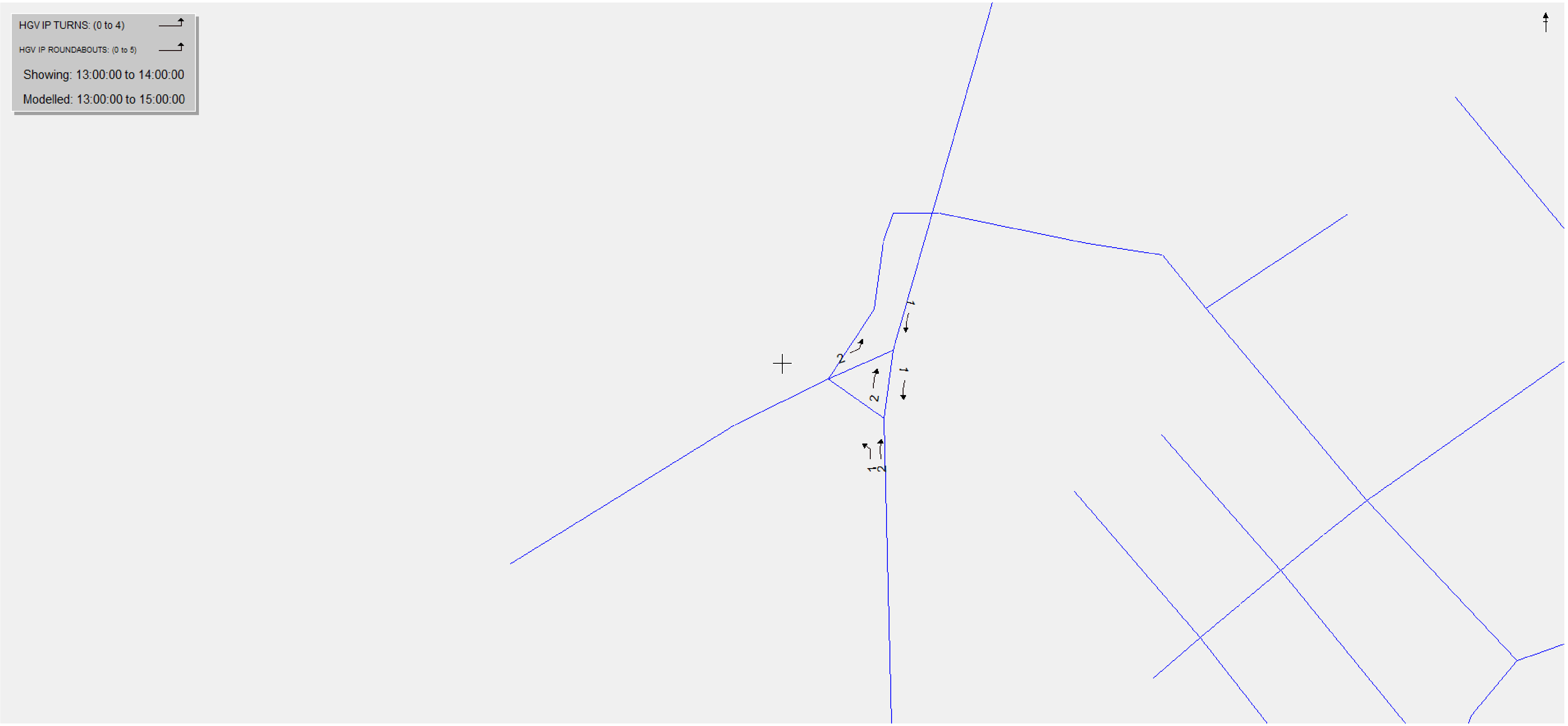
1
0
0
1

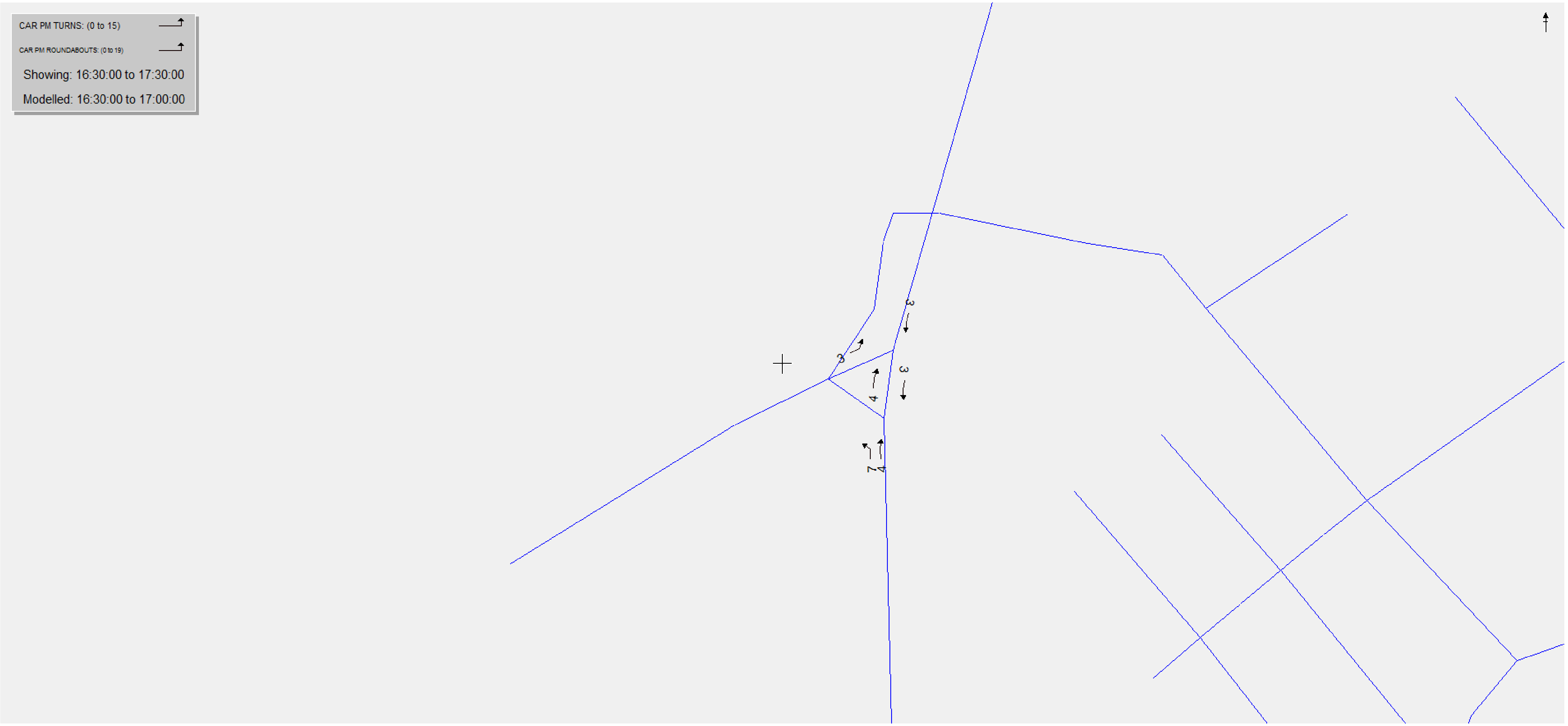


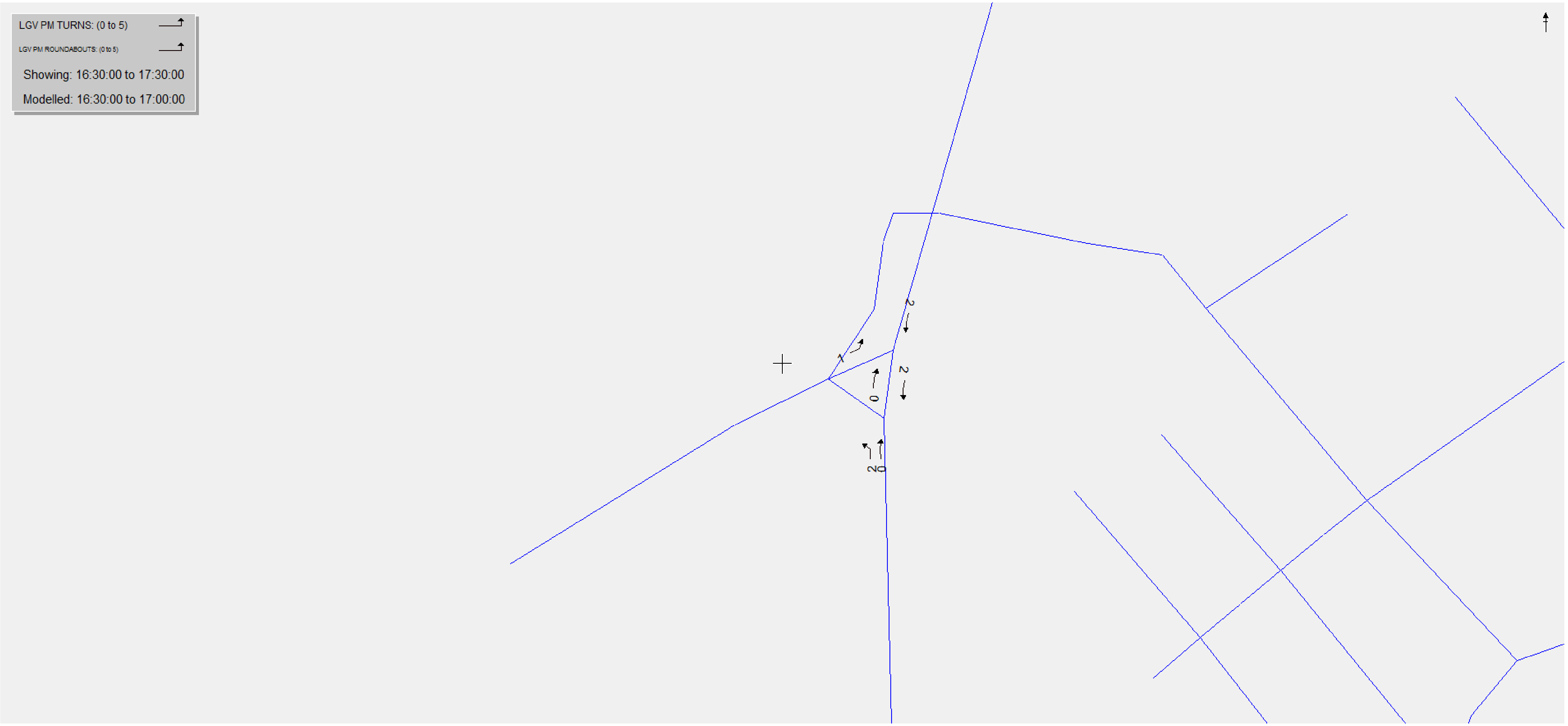
CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
2
2
2
1


HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
2
2
1
1
1
2


CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00
3
3
3
4
7
4



LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

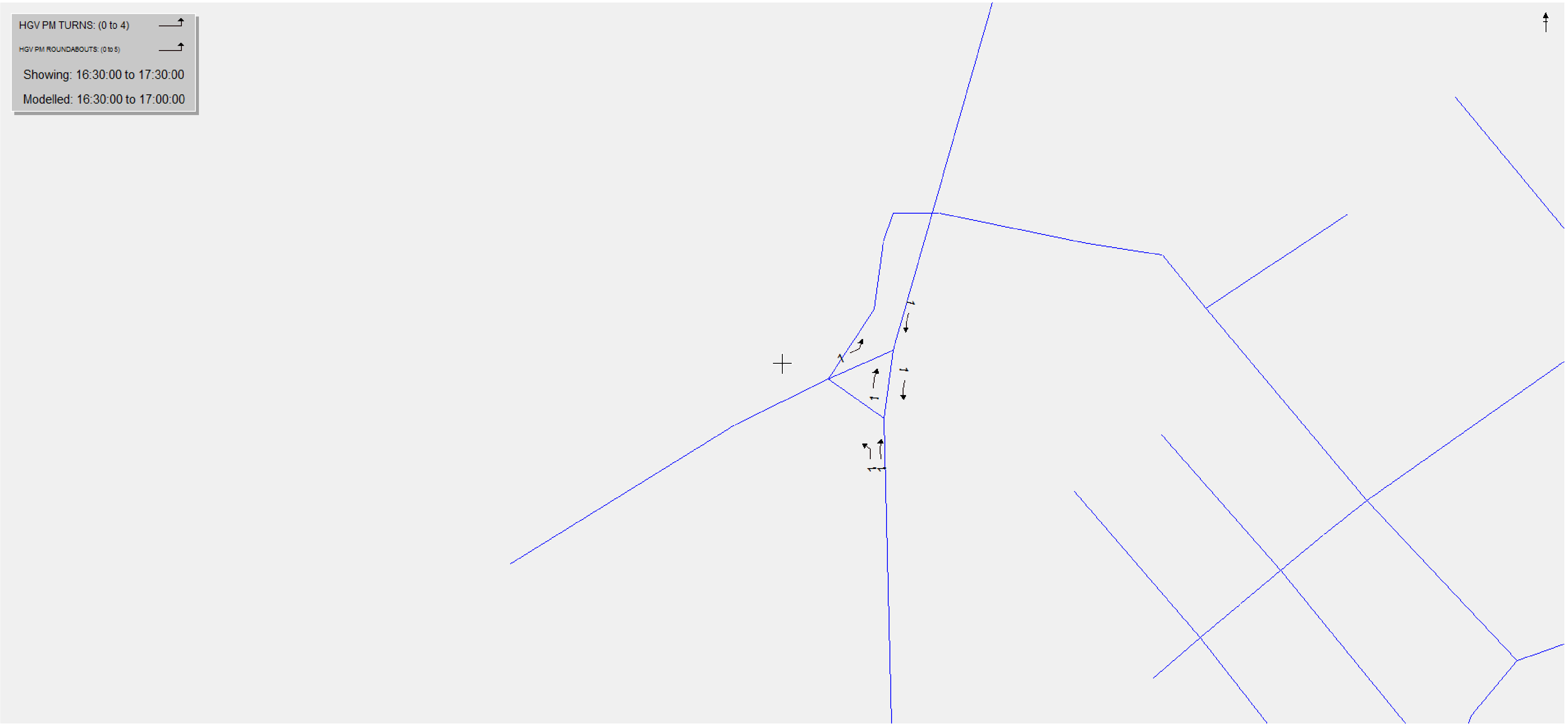
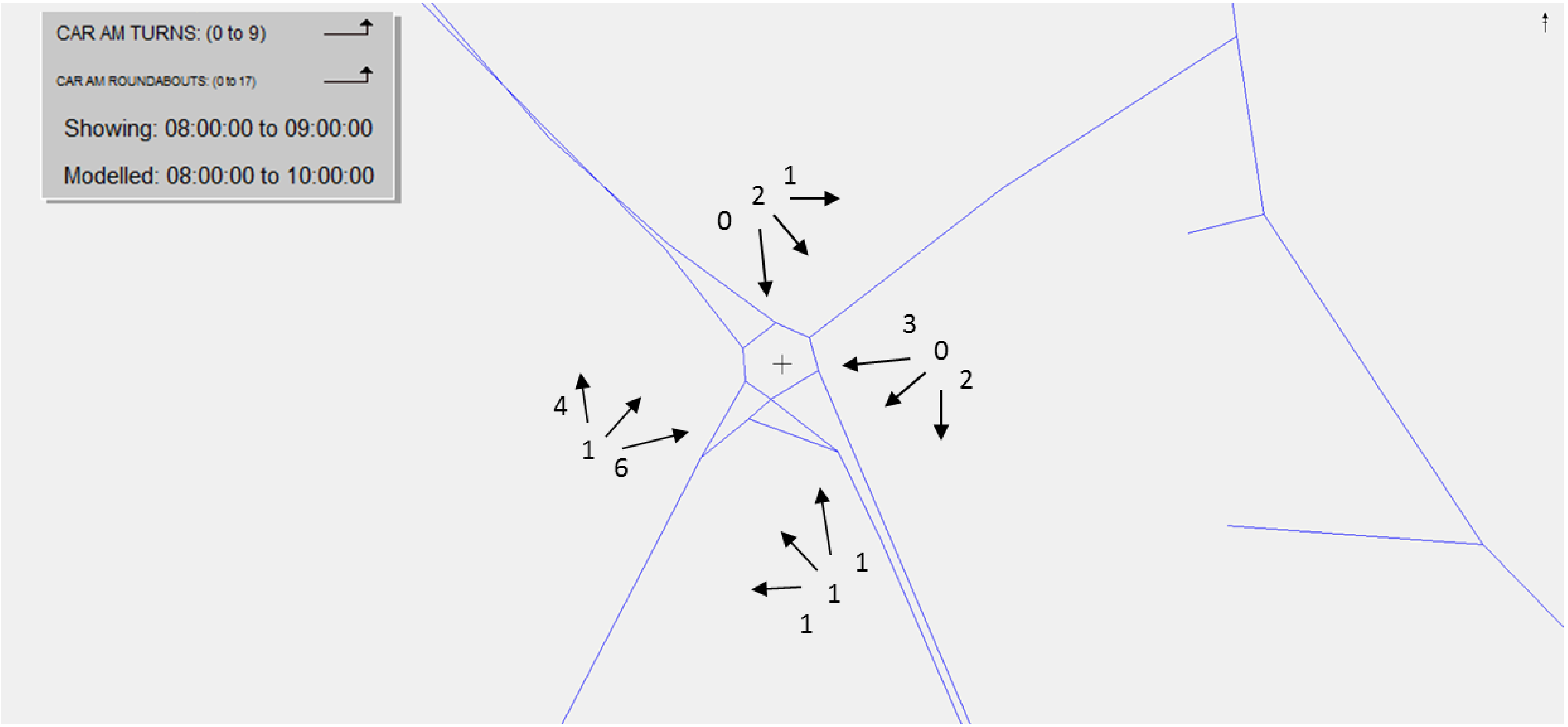
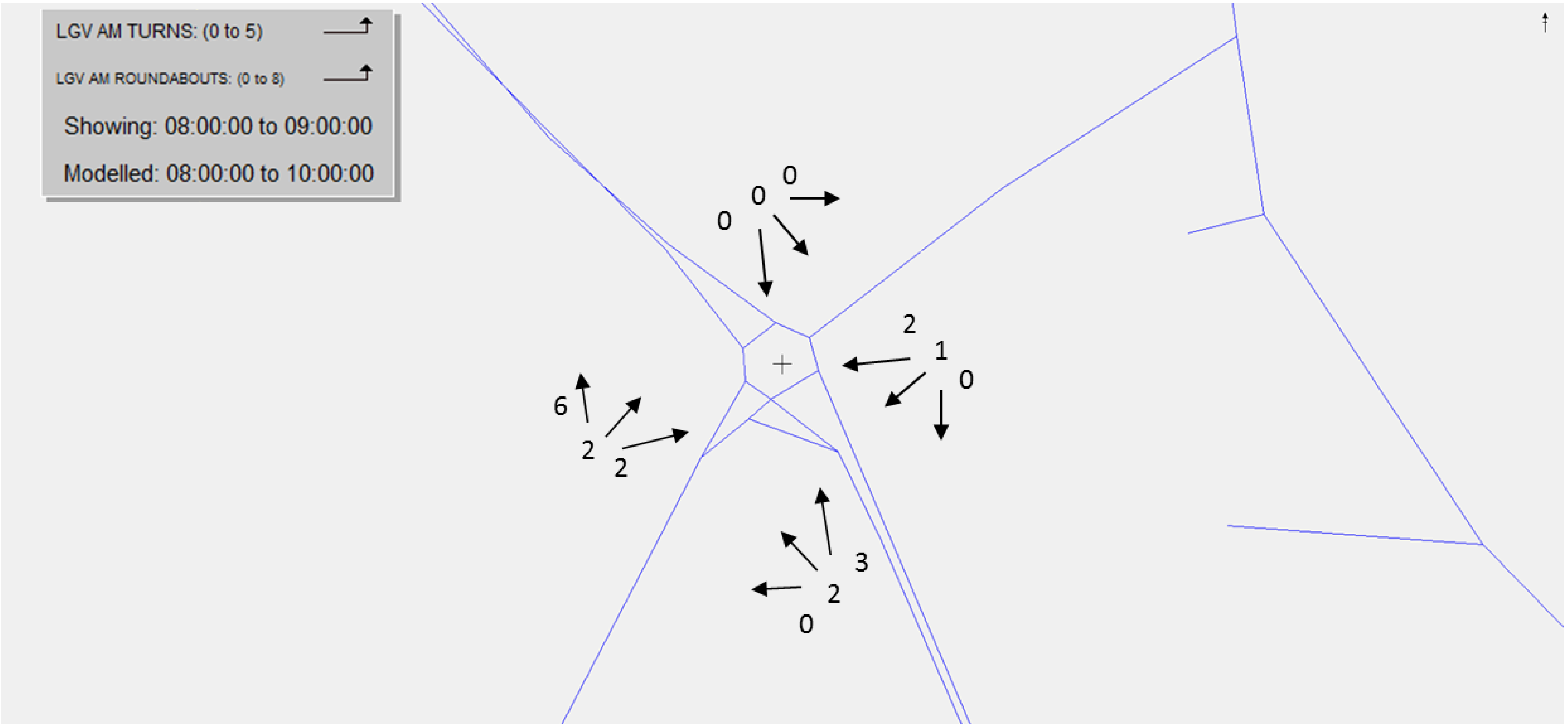

HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

Figure 3 GEH Accle New Road





LGV AM TURNS: (0 to 5)
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00
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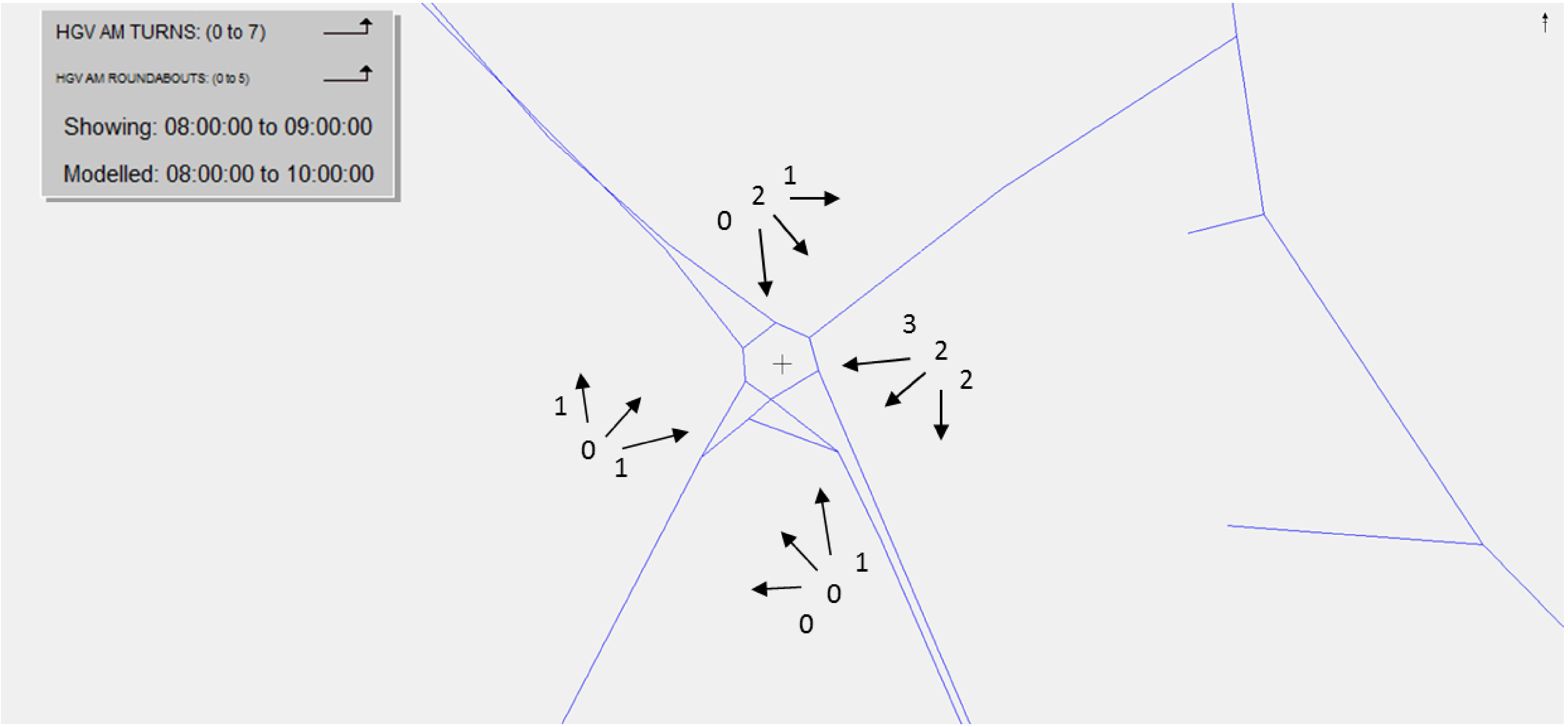
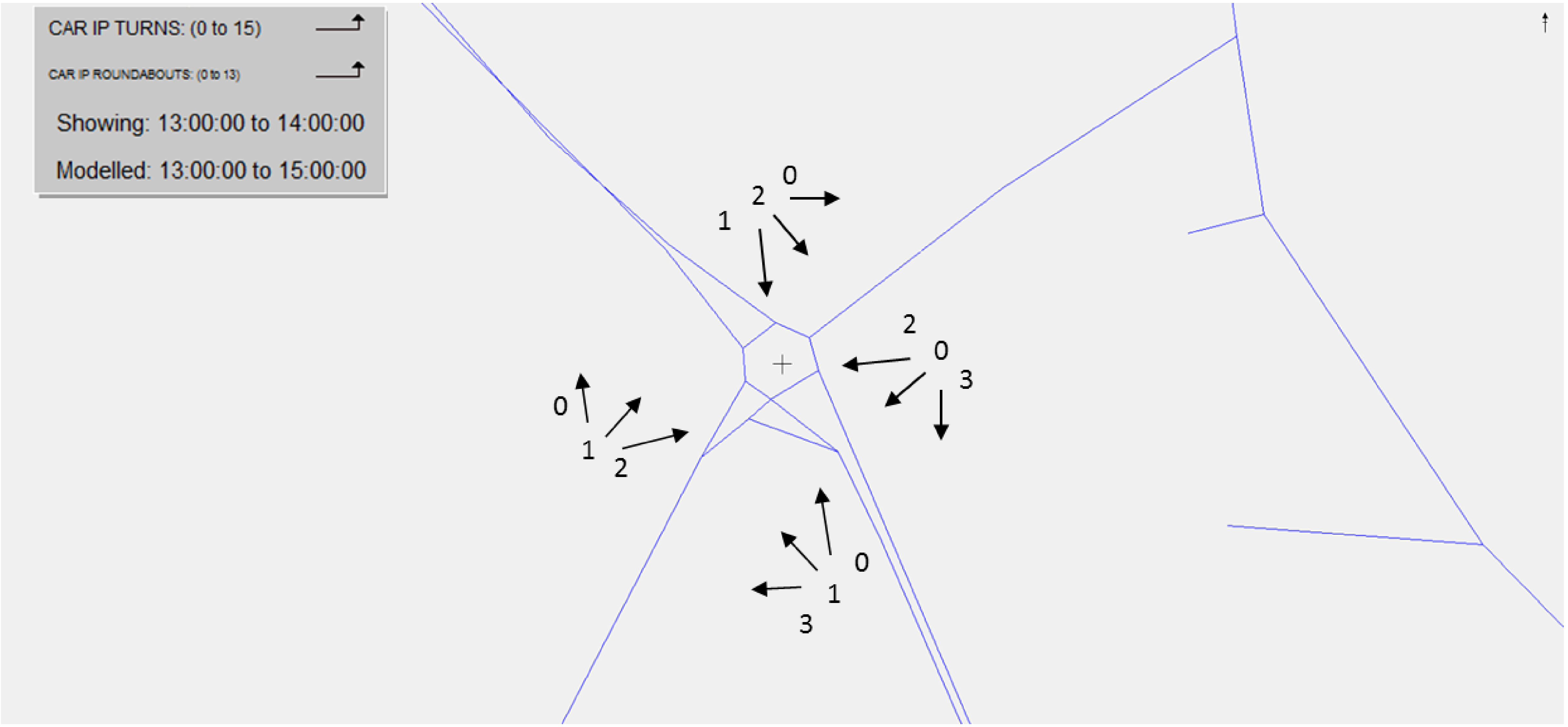
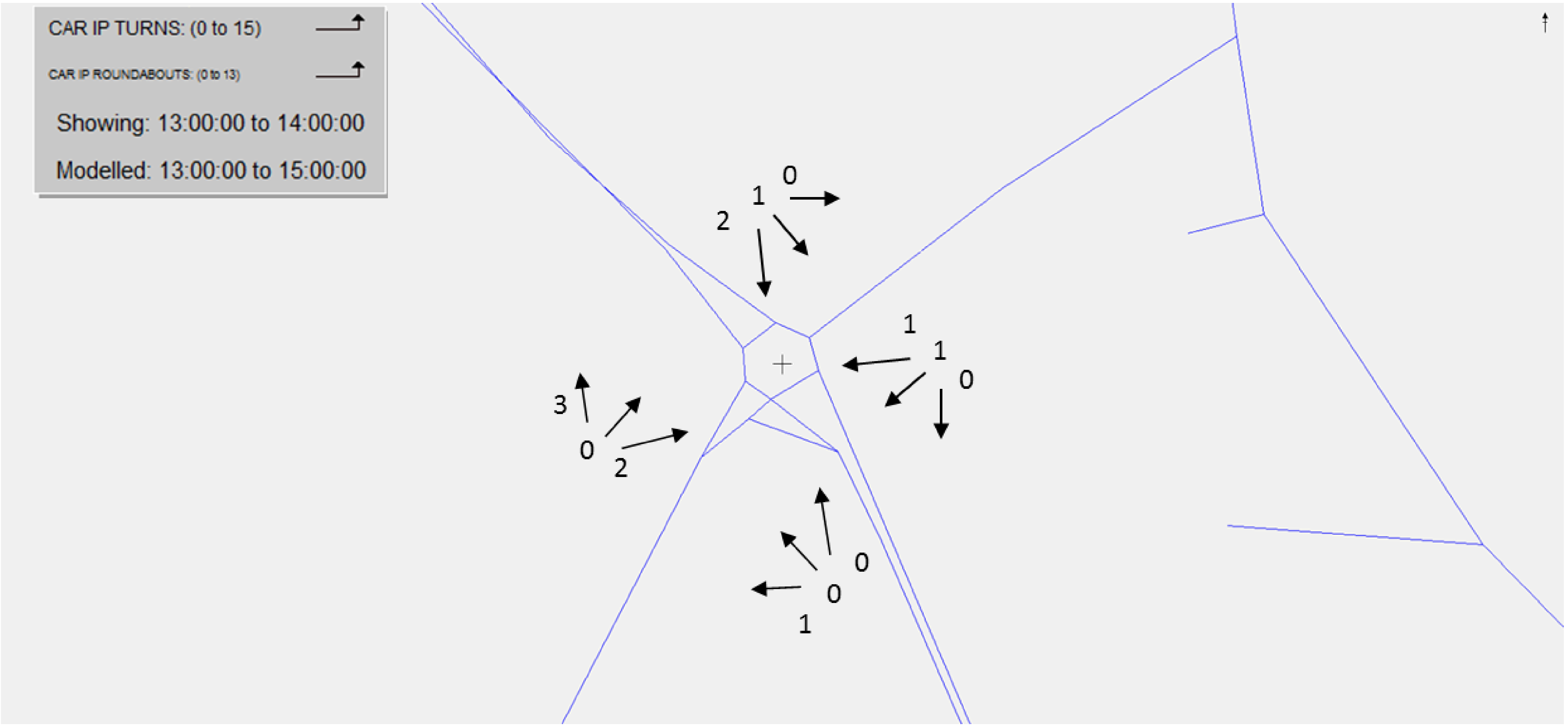
2
1
0
6
2
2
3
2
0


HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00
1
2
0
3
2
2
1
0
1
1
0
0



CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
0
2
1
2
0
3
0
1
2
0
1
3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CAR IP ROUNDABOUTS: (0 to 13)
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Modelled: 13:00:00 to 15:00:00
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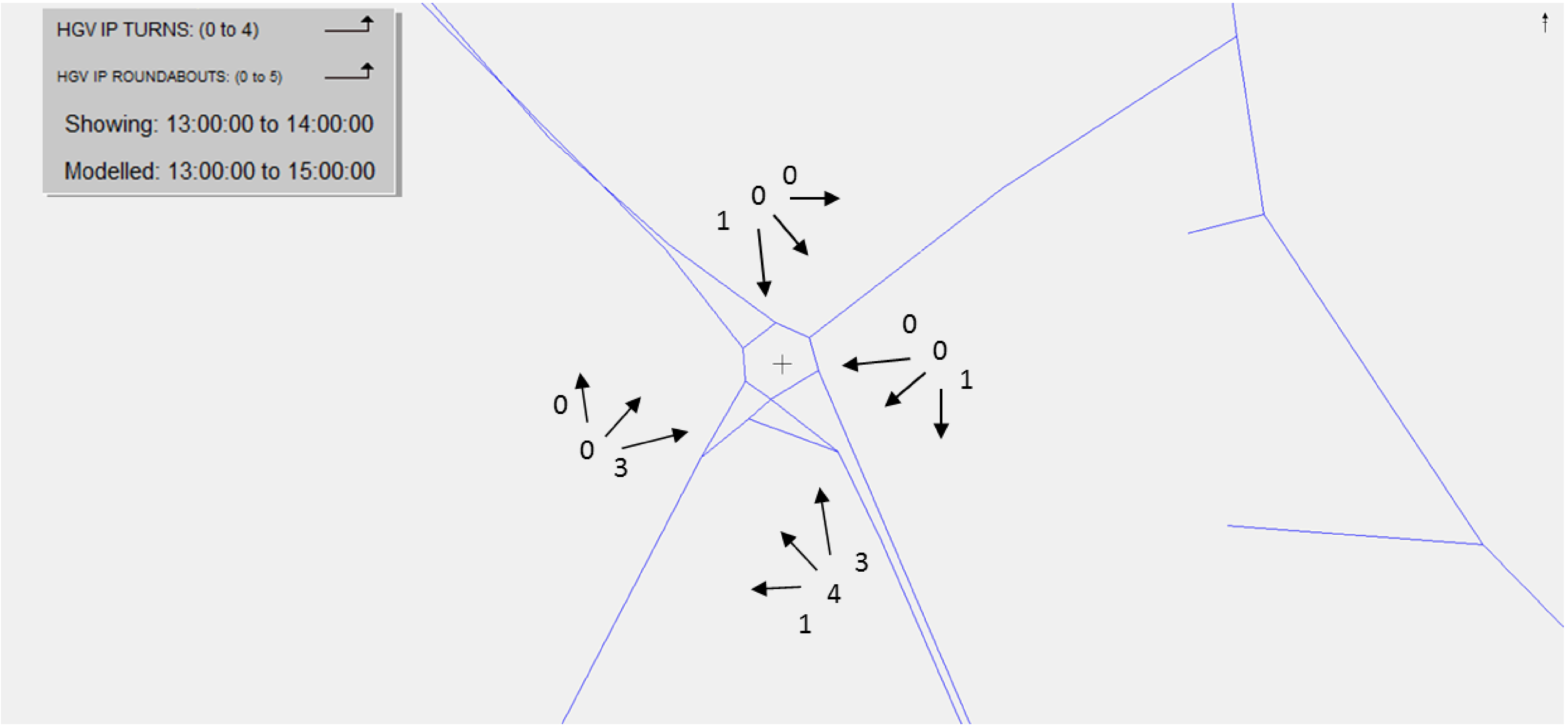
1
2
1
1
0
3
0
2
0
0
1


HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00
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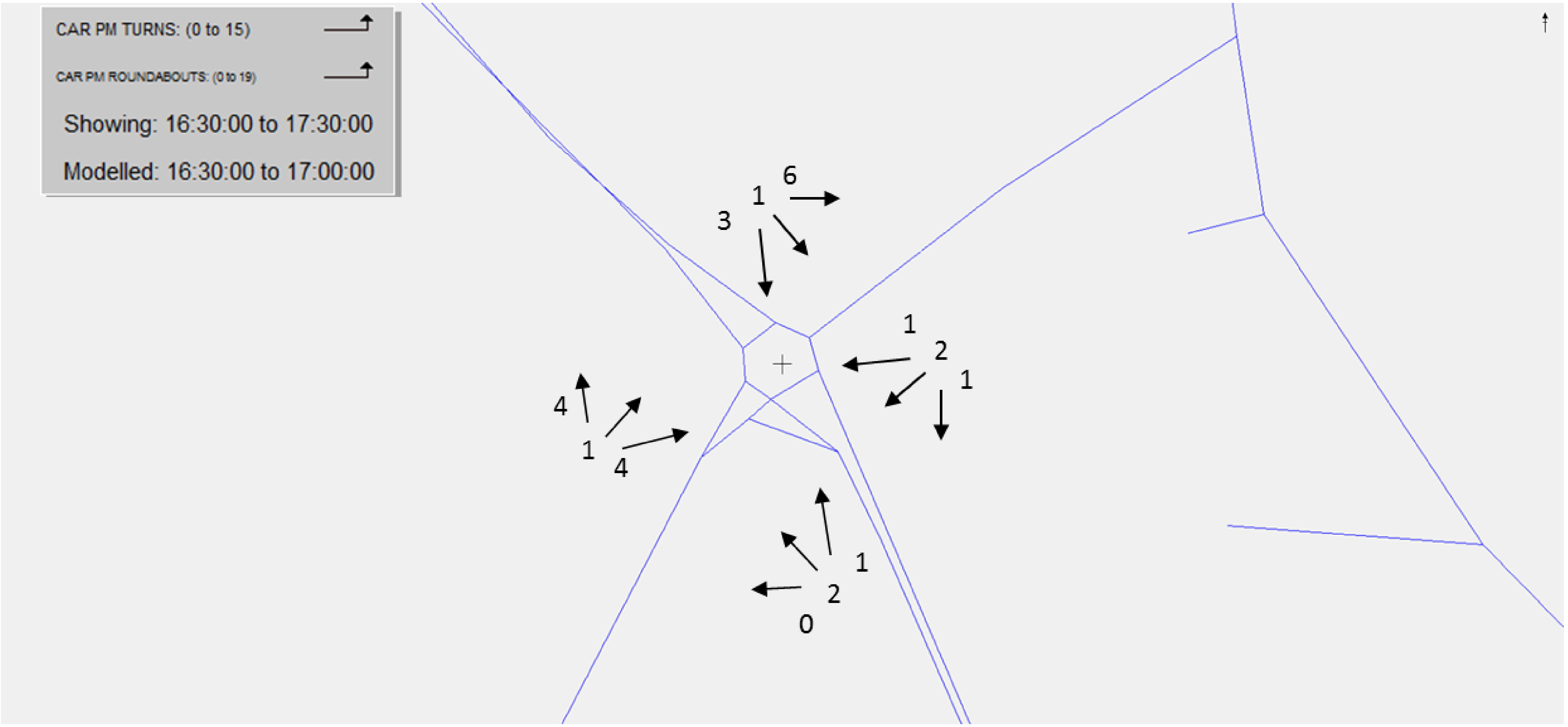
0
3
3
4
1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CAR PM ROUNDABOUTS: (0 to 19)
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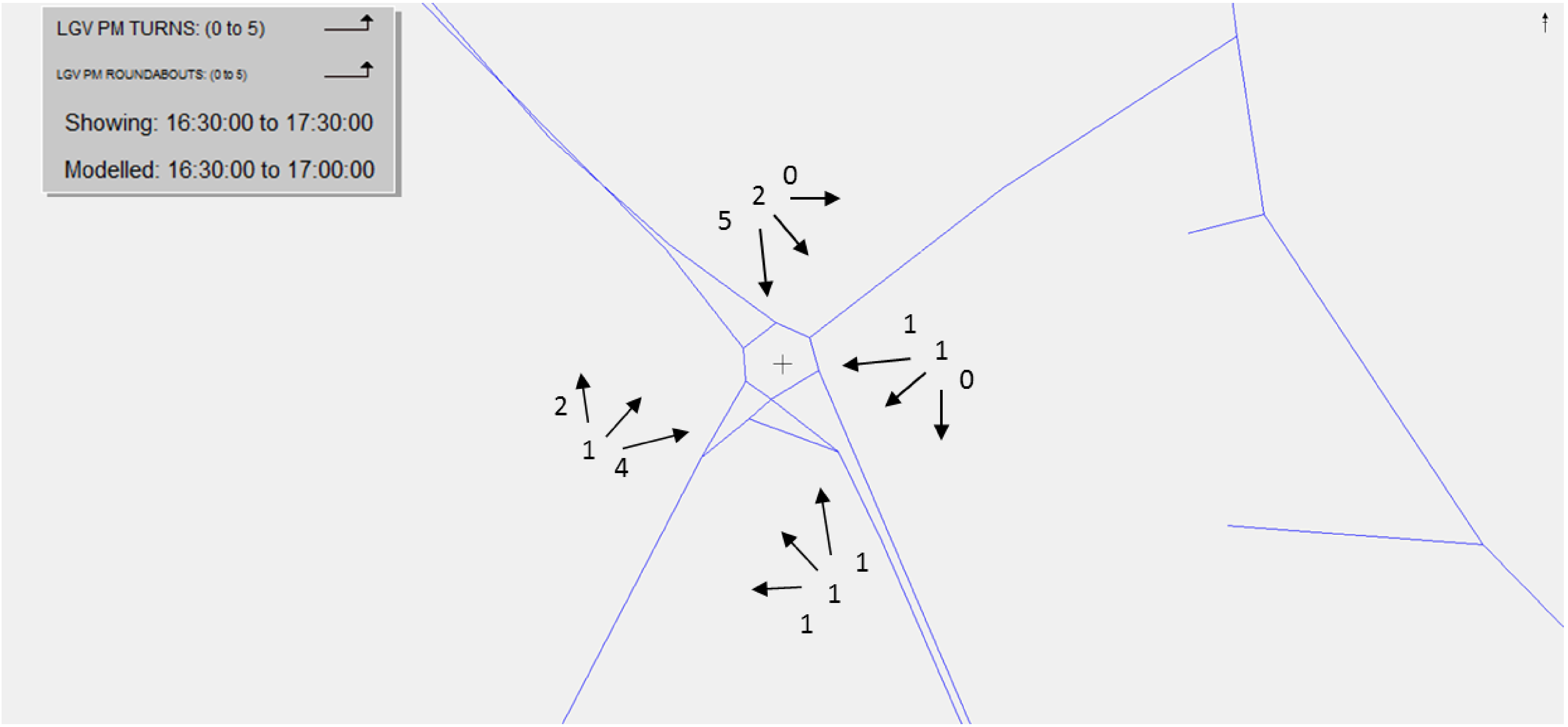
3
1
2
1
4
1
4
1
2
0


LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00
0
2
5
1
1
0
2
1
4
1
1
1

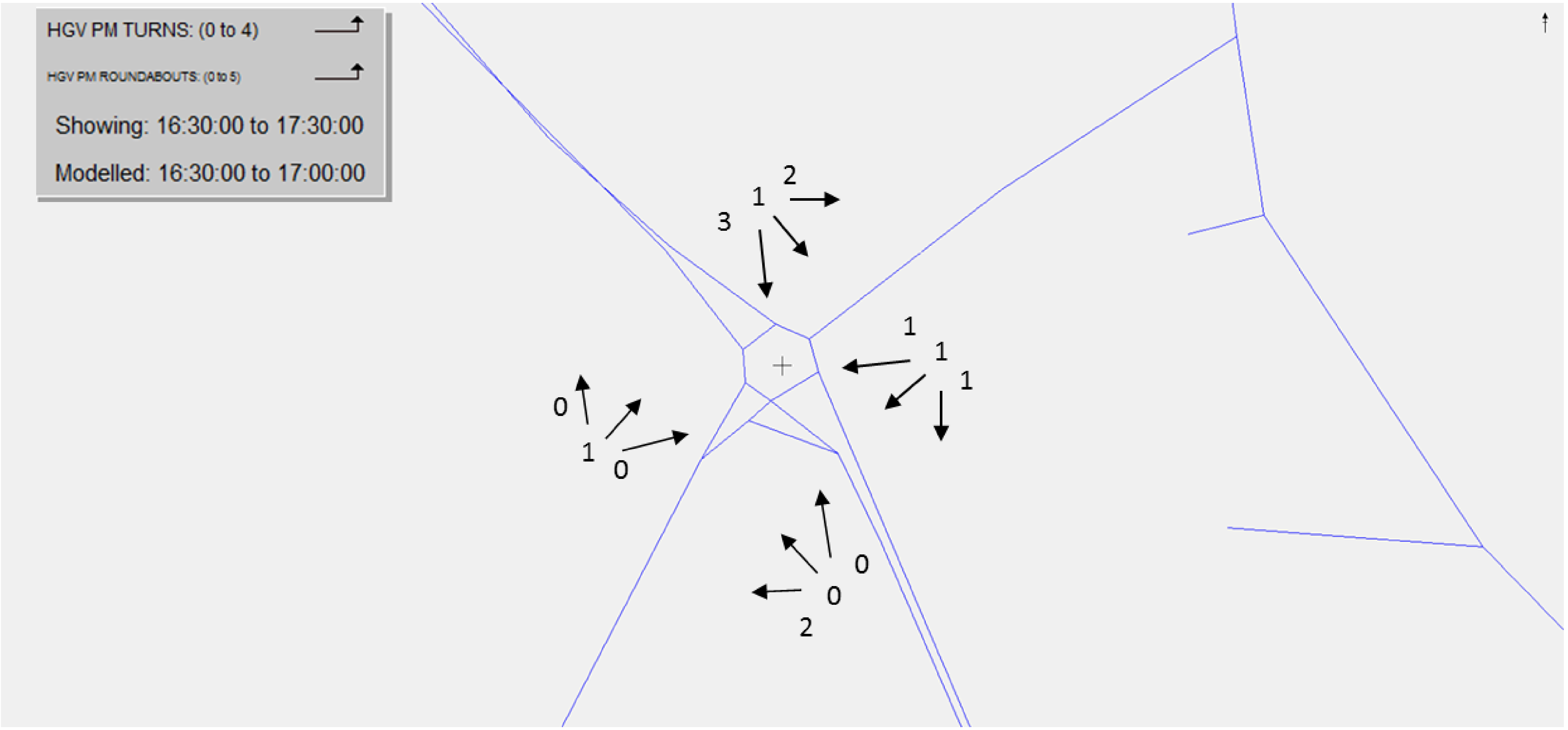
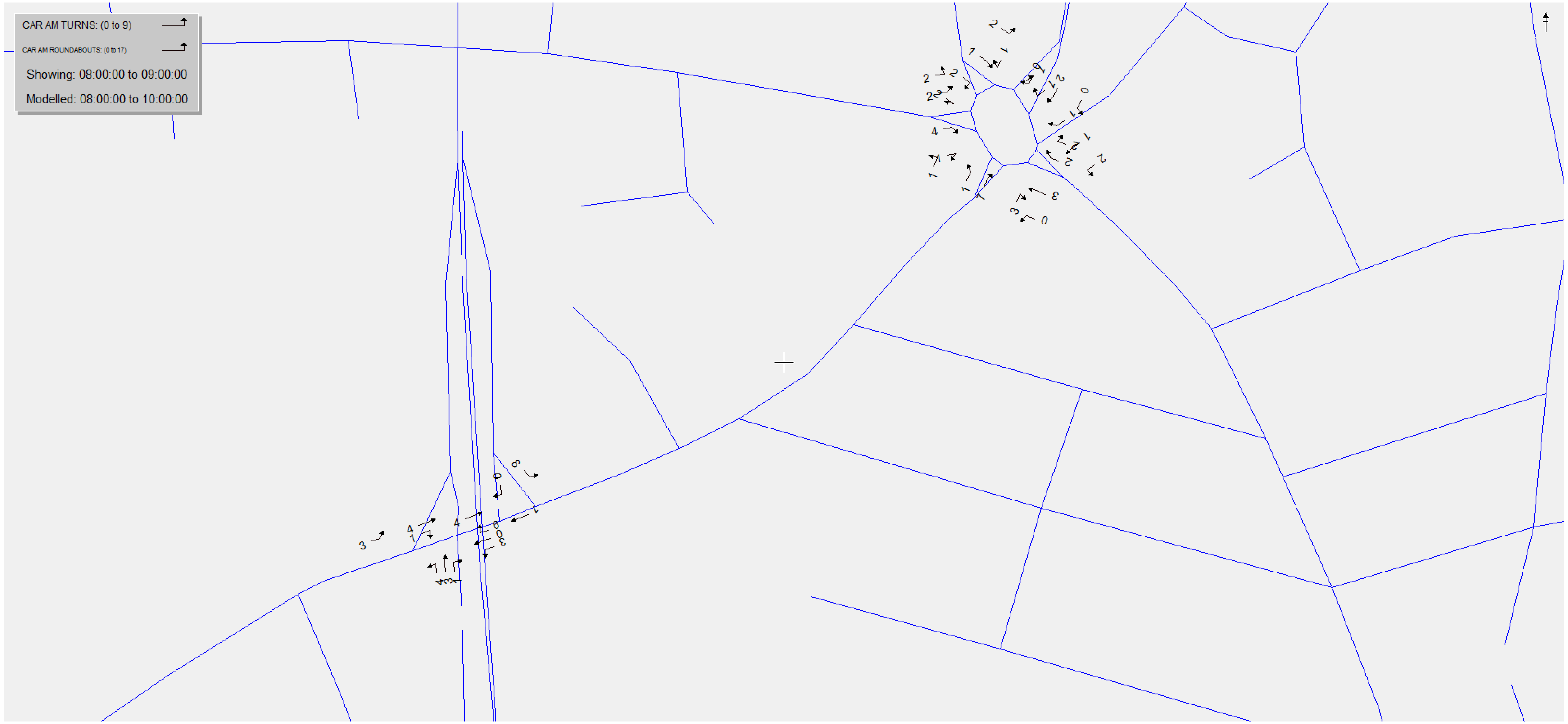
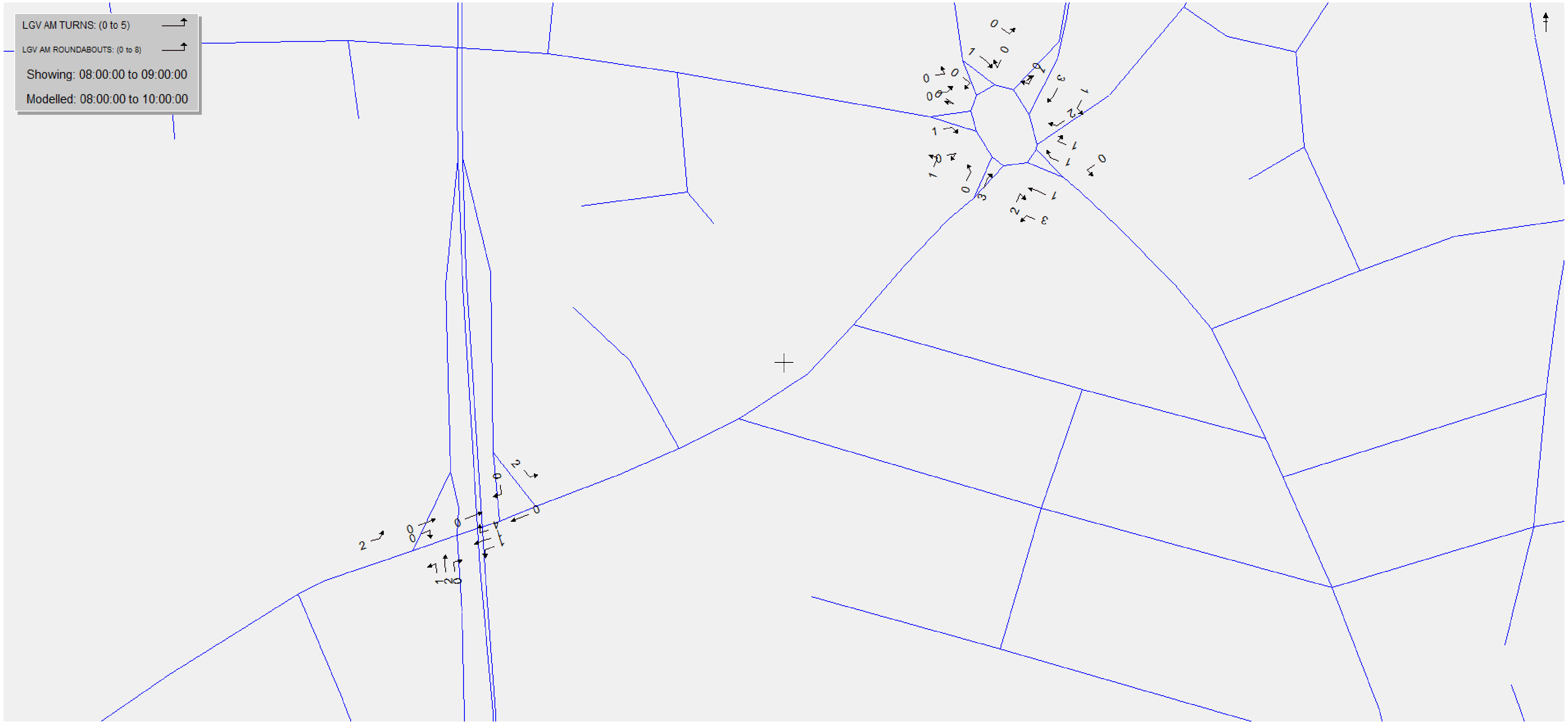
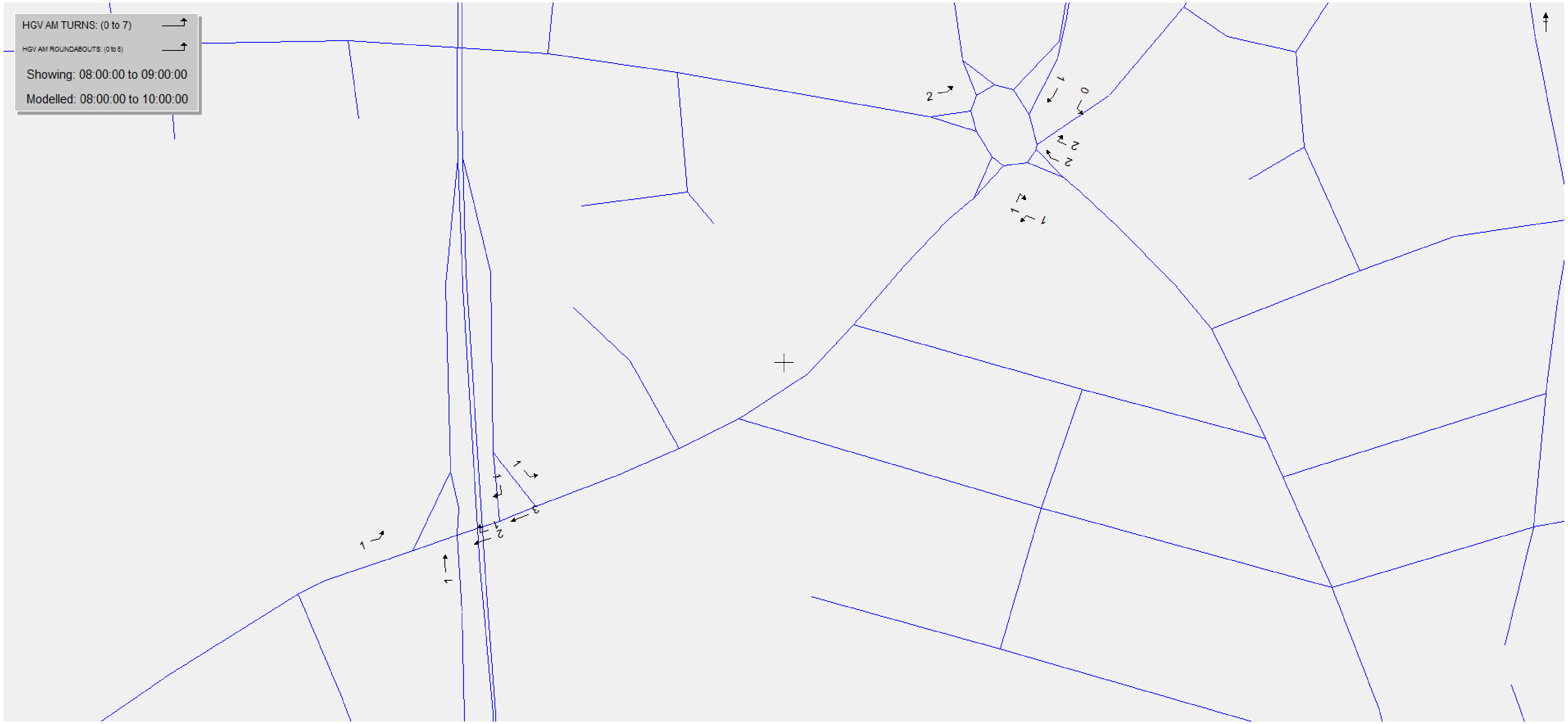

HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00
2
1
3
1
1
1
0
1
0
0
0
2

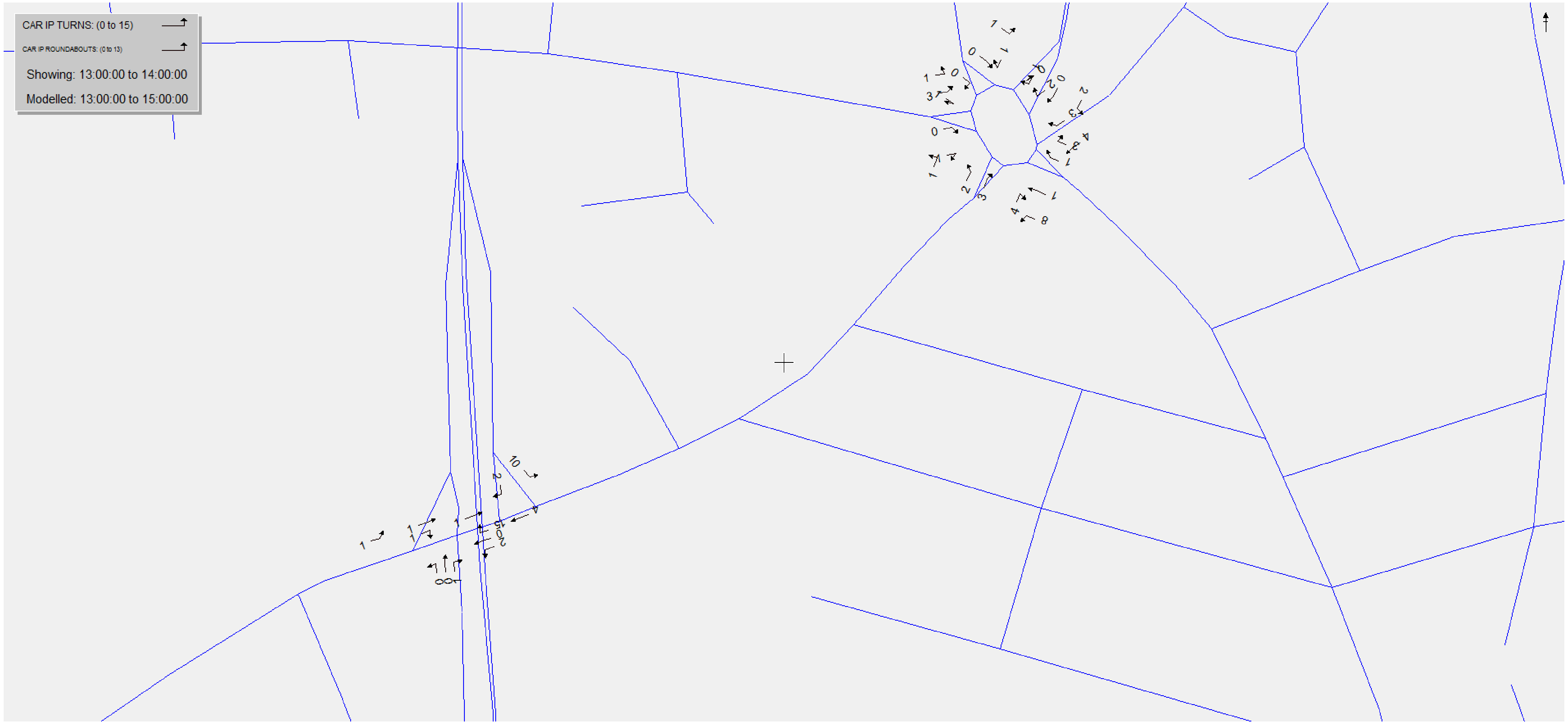
Figure 4 GEH Beccles Road Junction

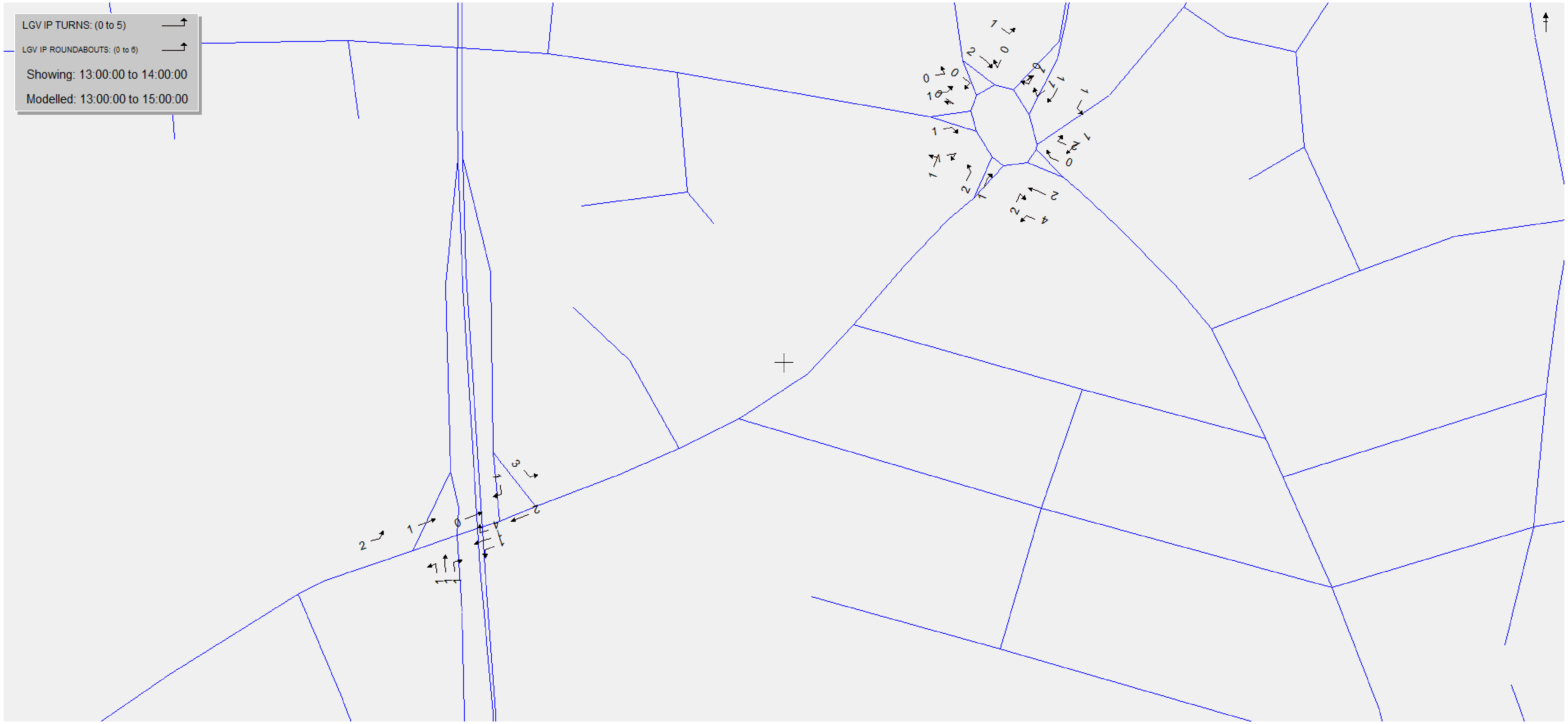




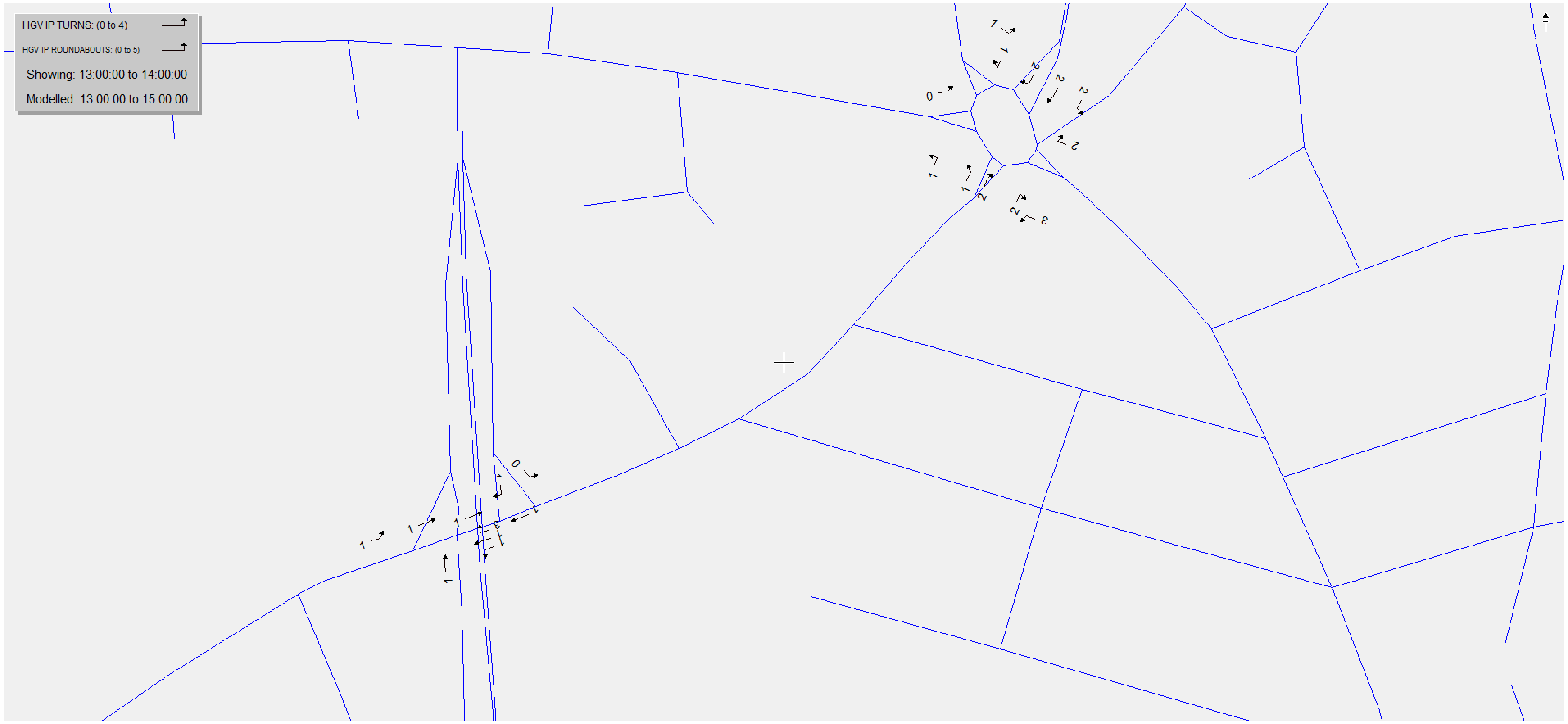
LGV AM TURNS: (0 to 5)
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

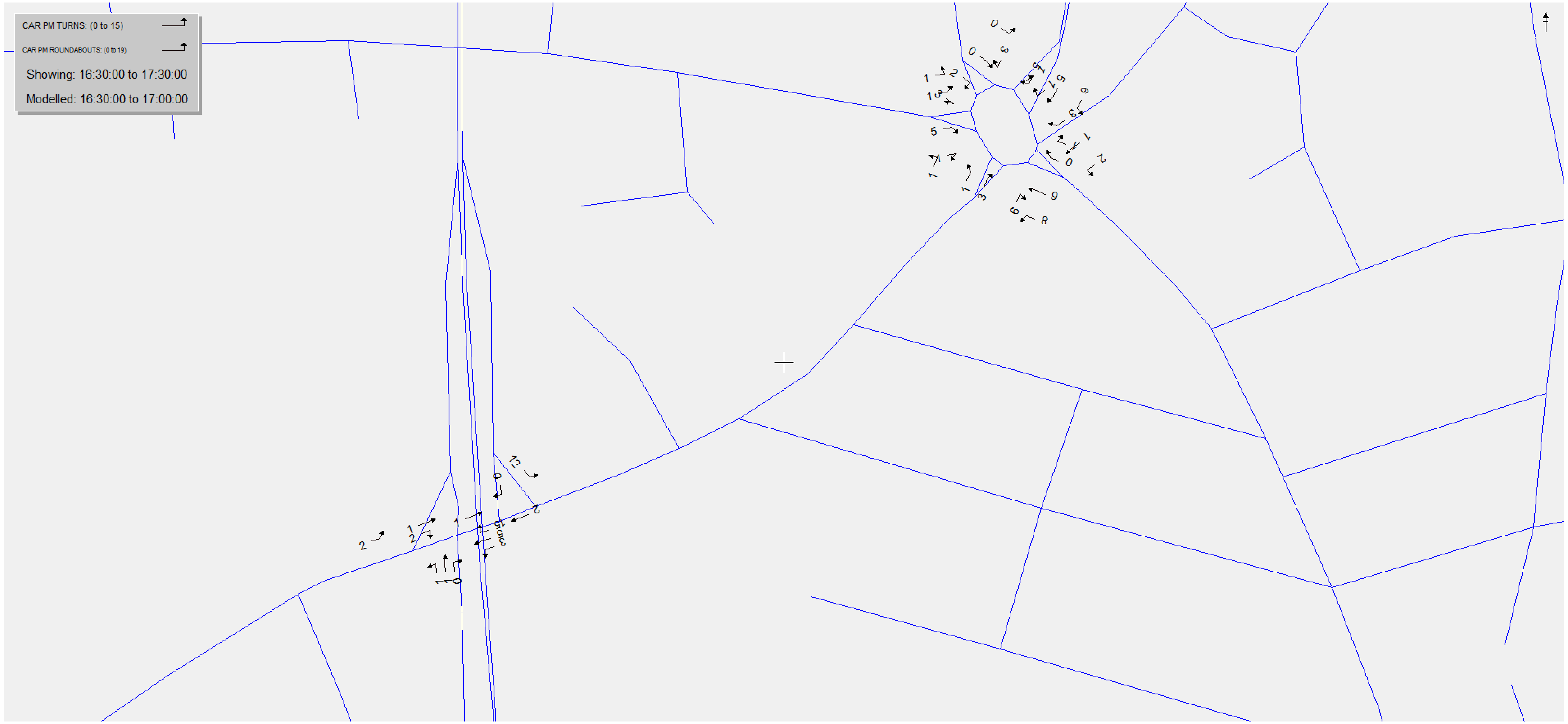

CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



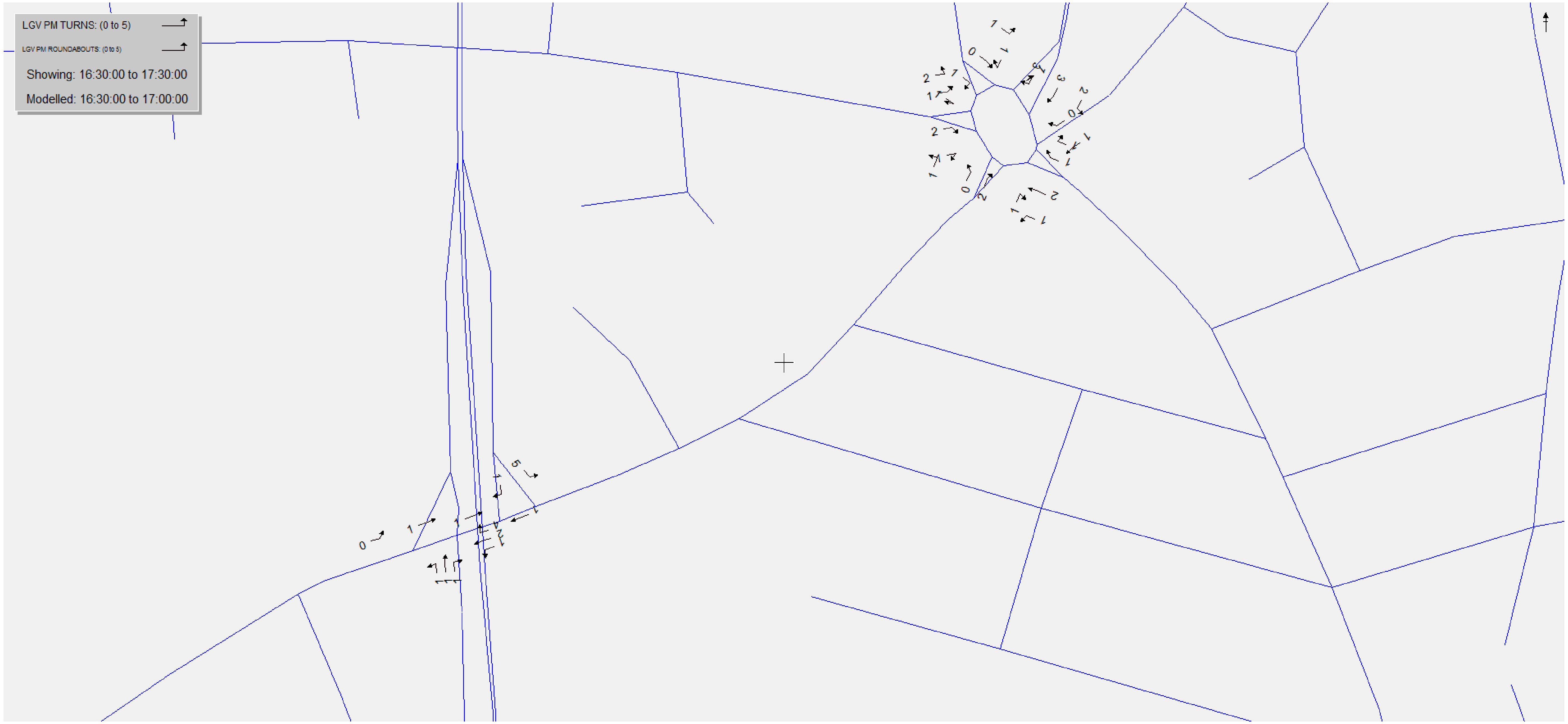
LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00


LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

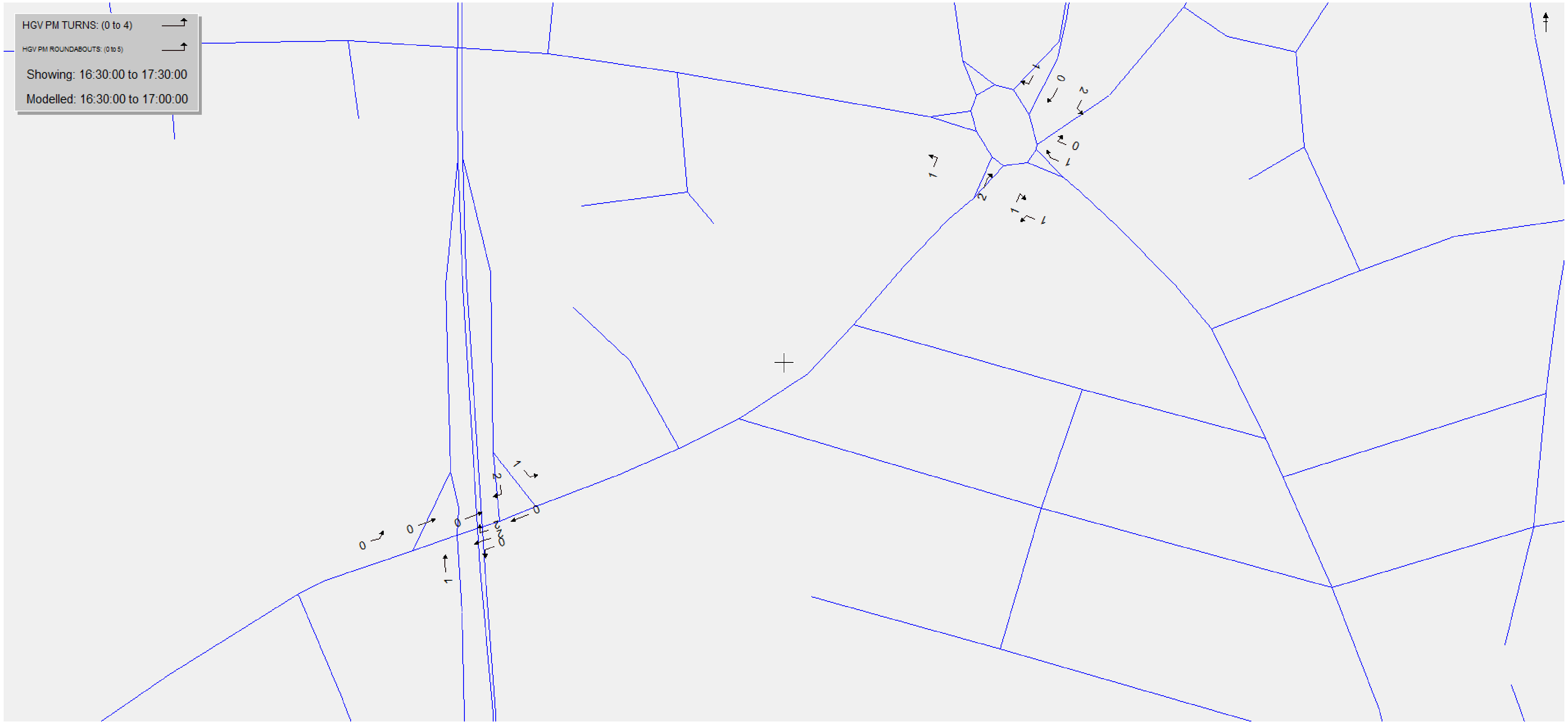
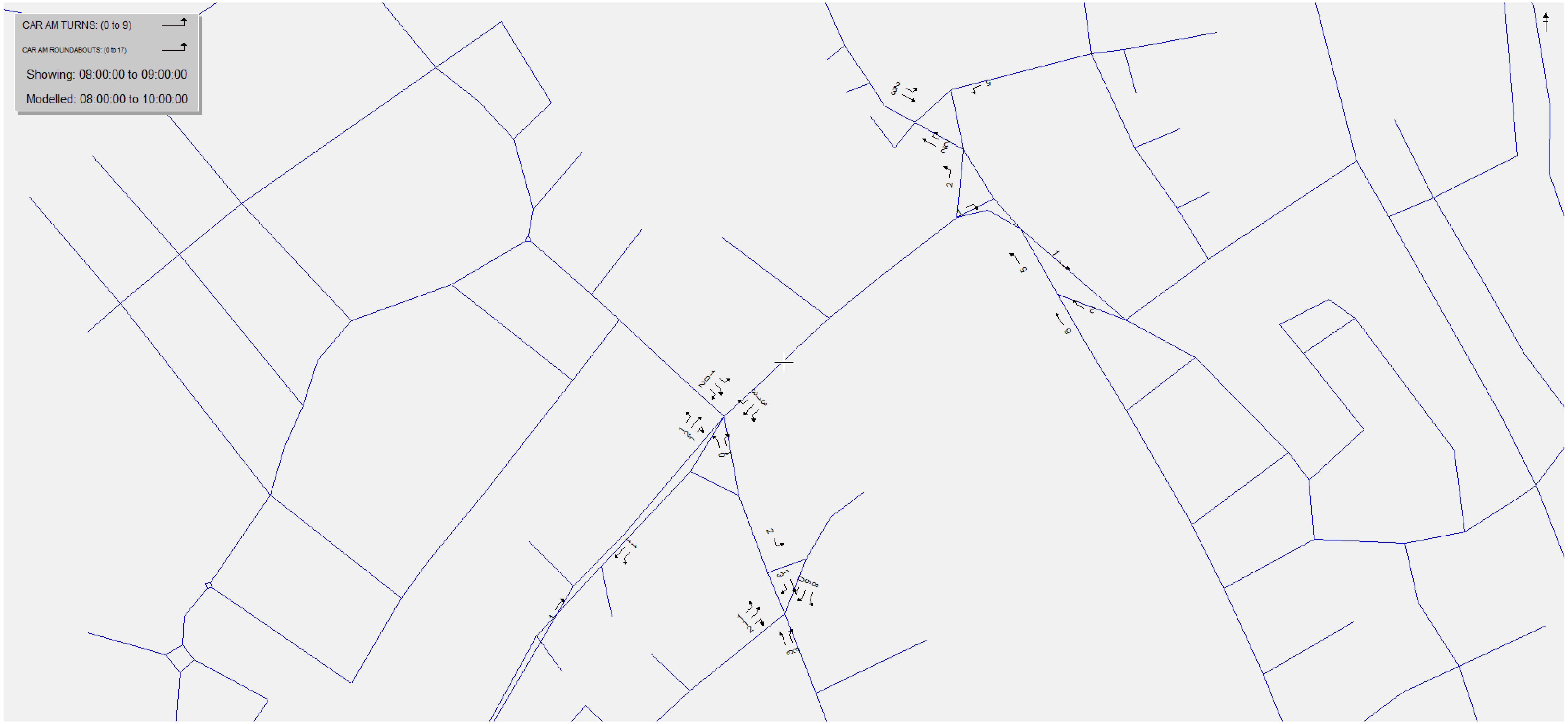
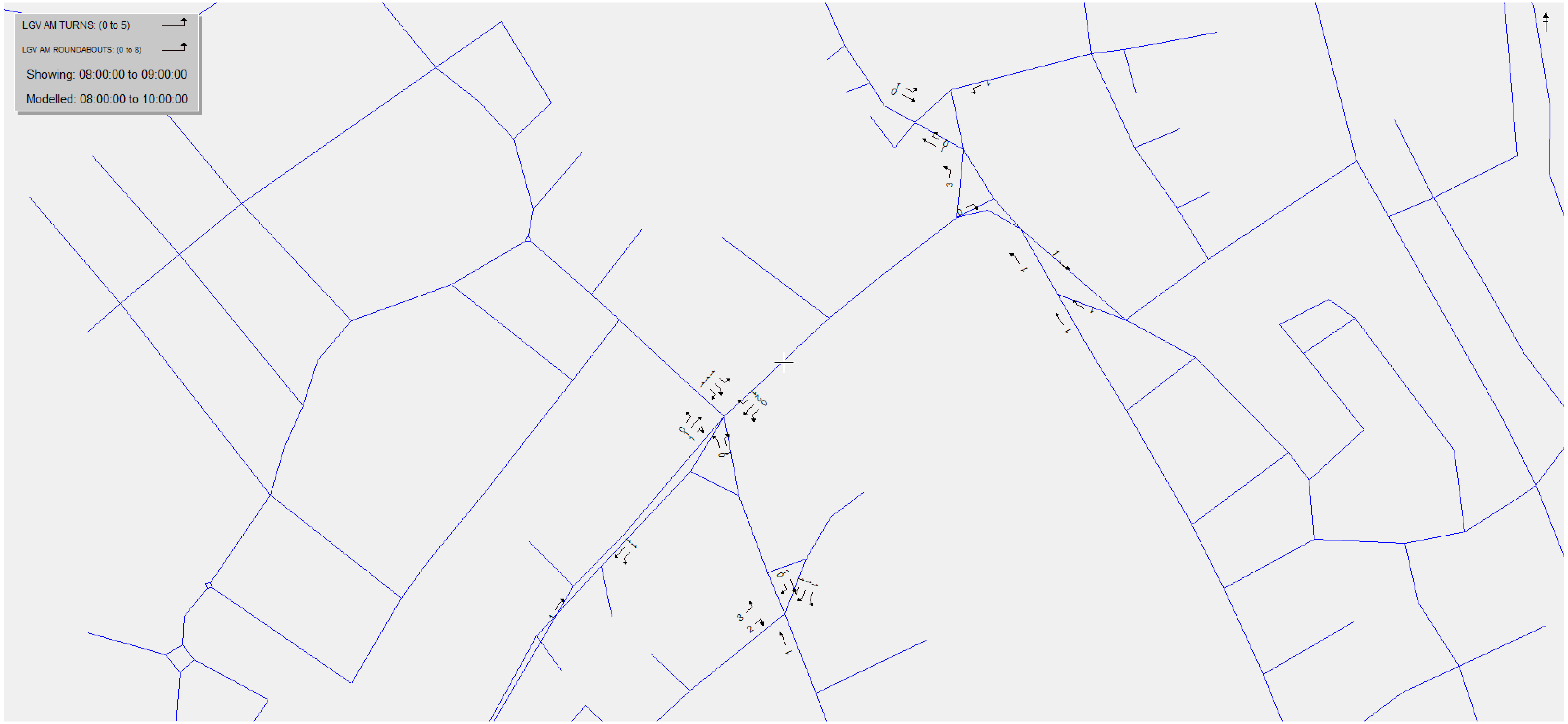
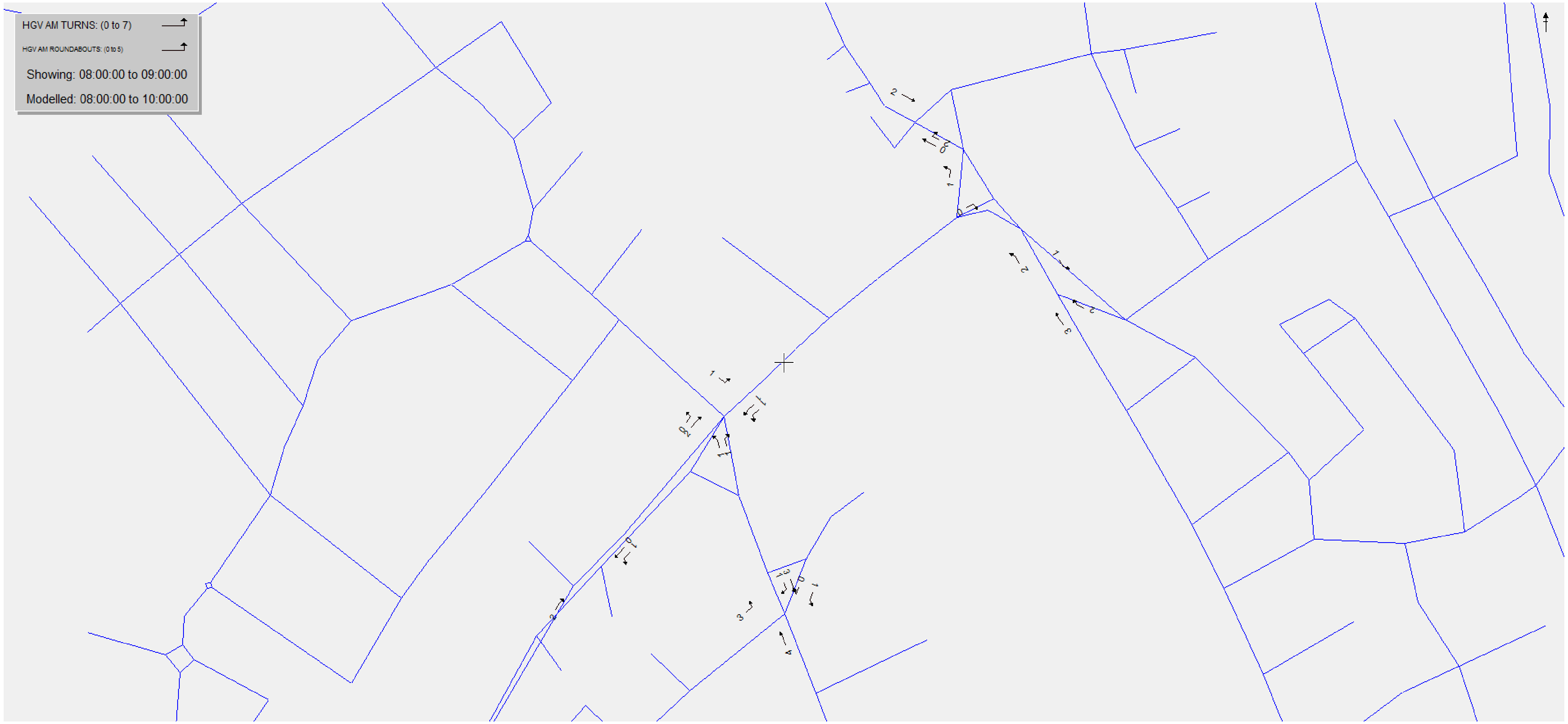

HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

Figure 5 GEH Haven Bridge

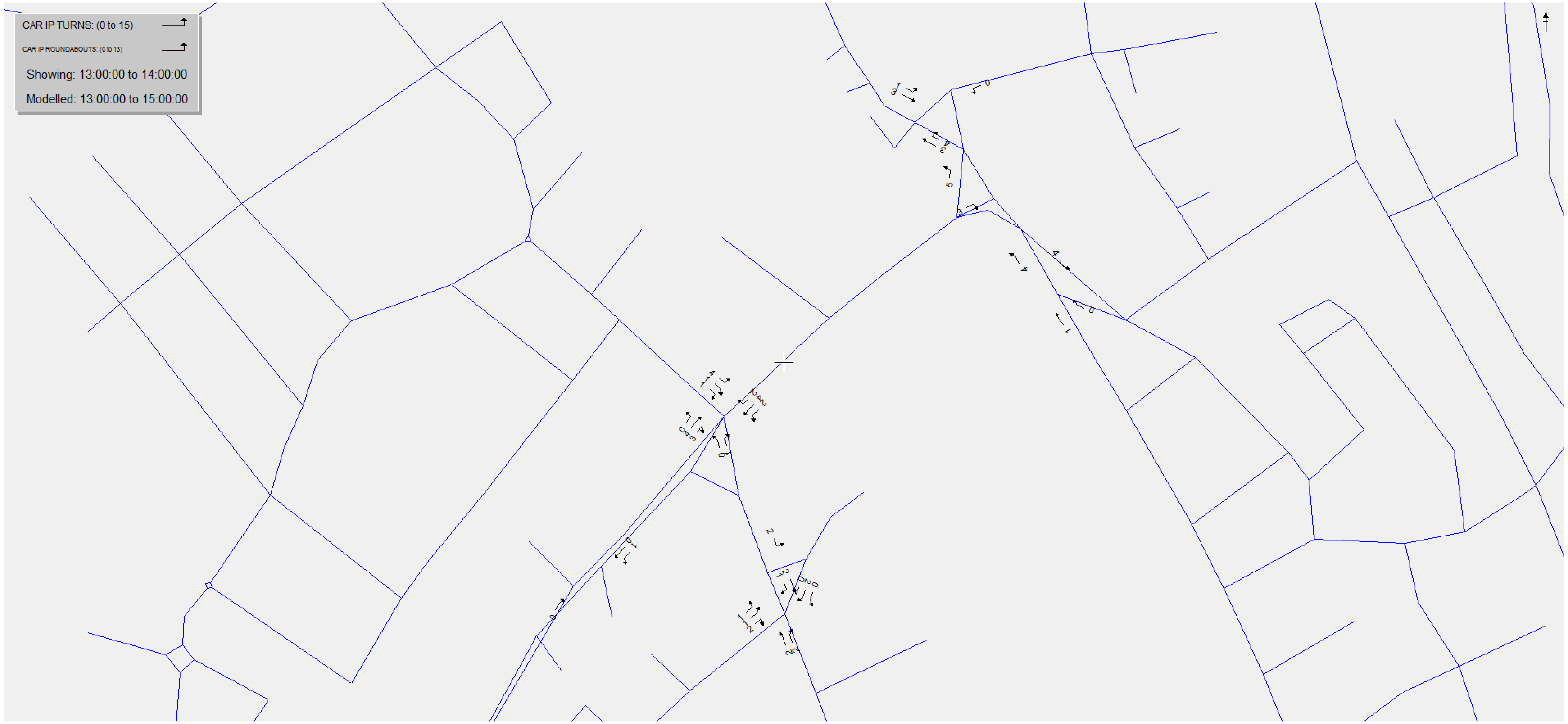


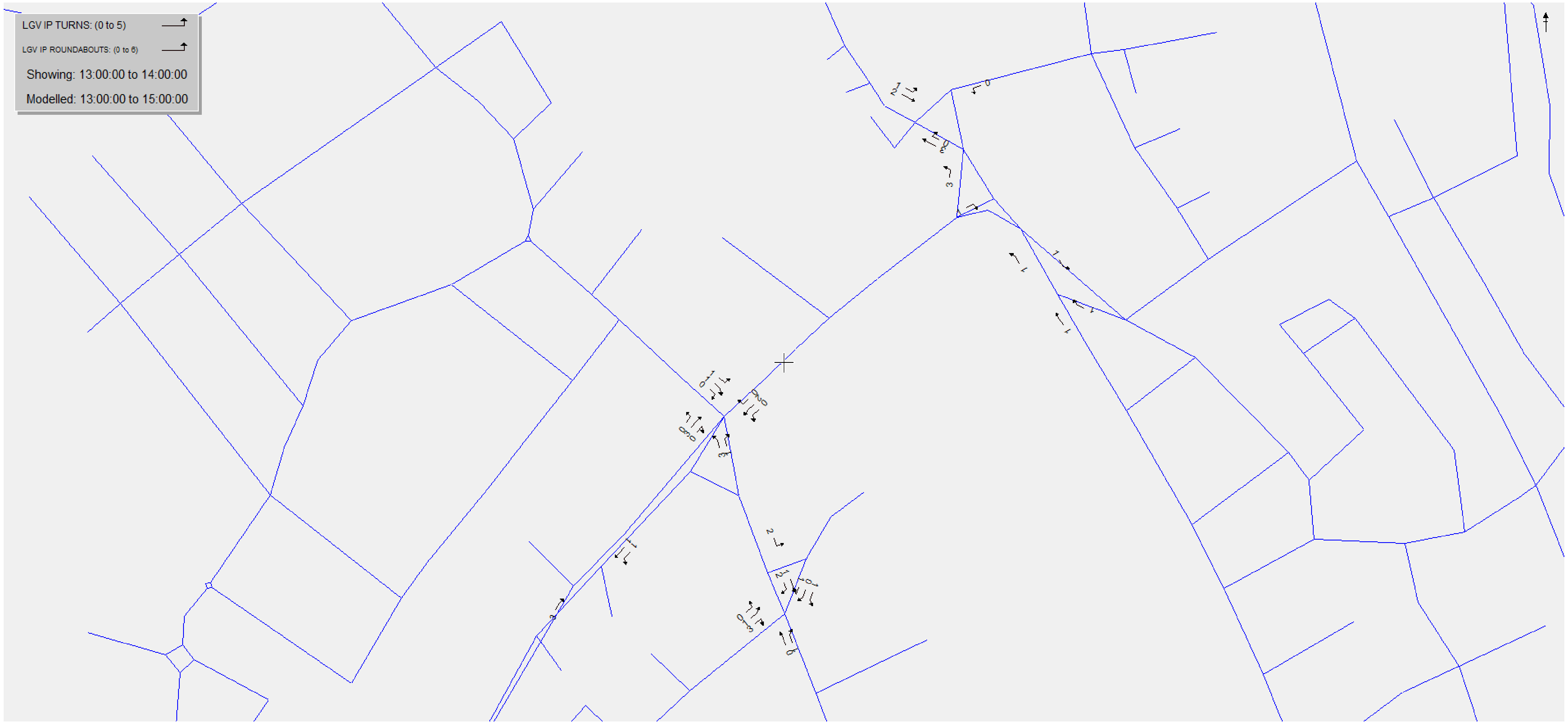


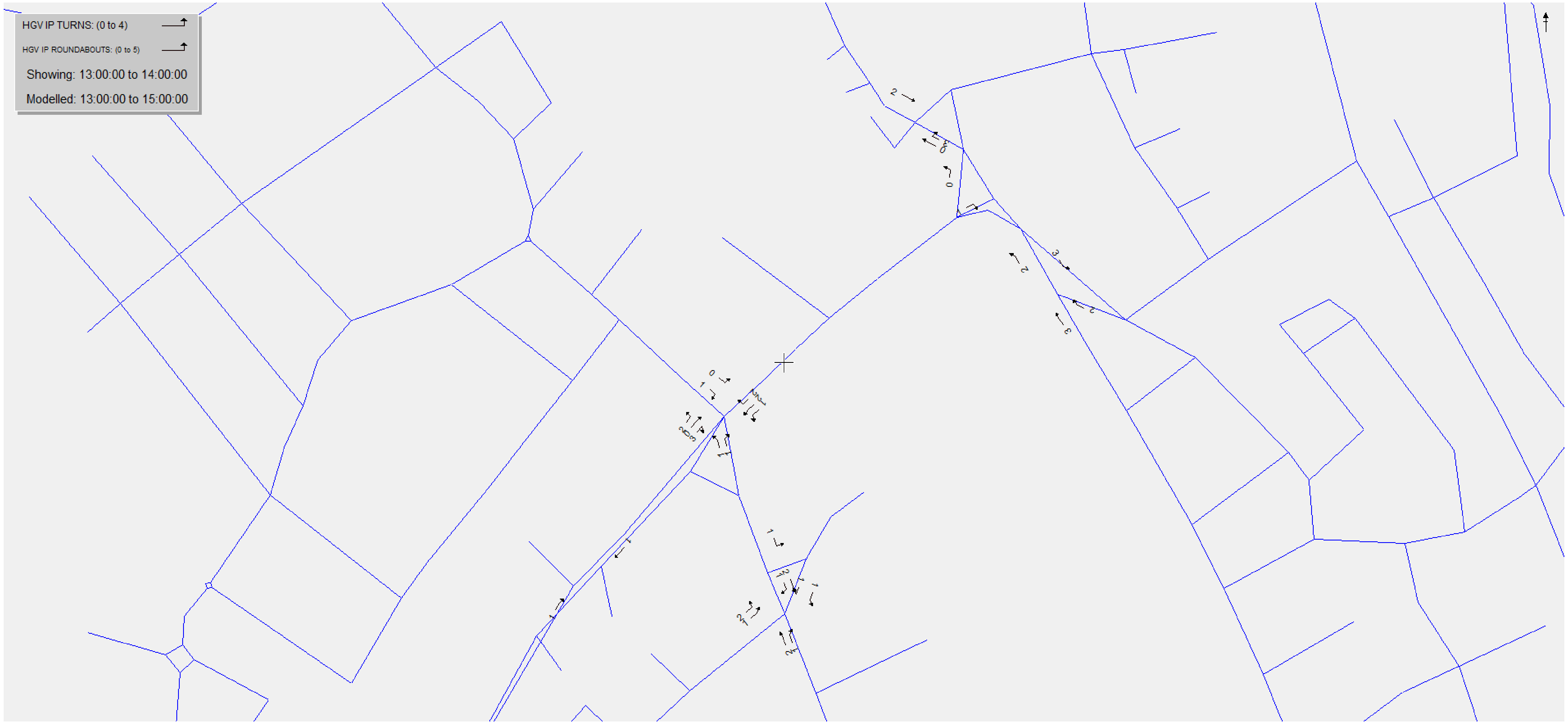
LGV AM TURNS: (0 to 5)
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

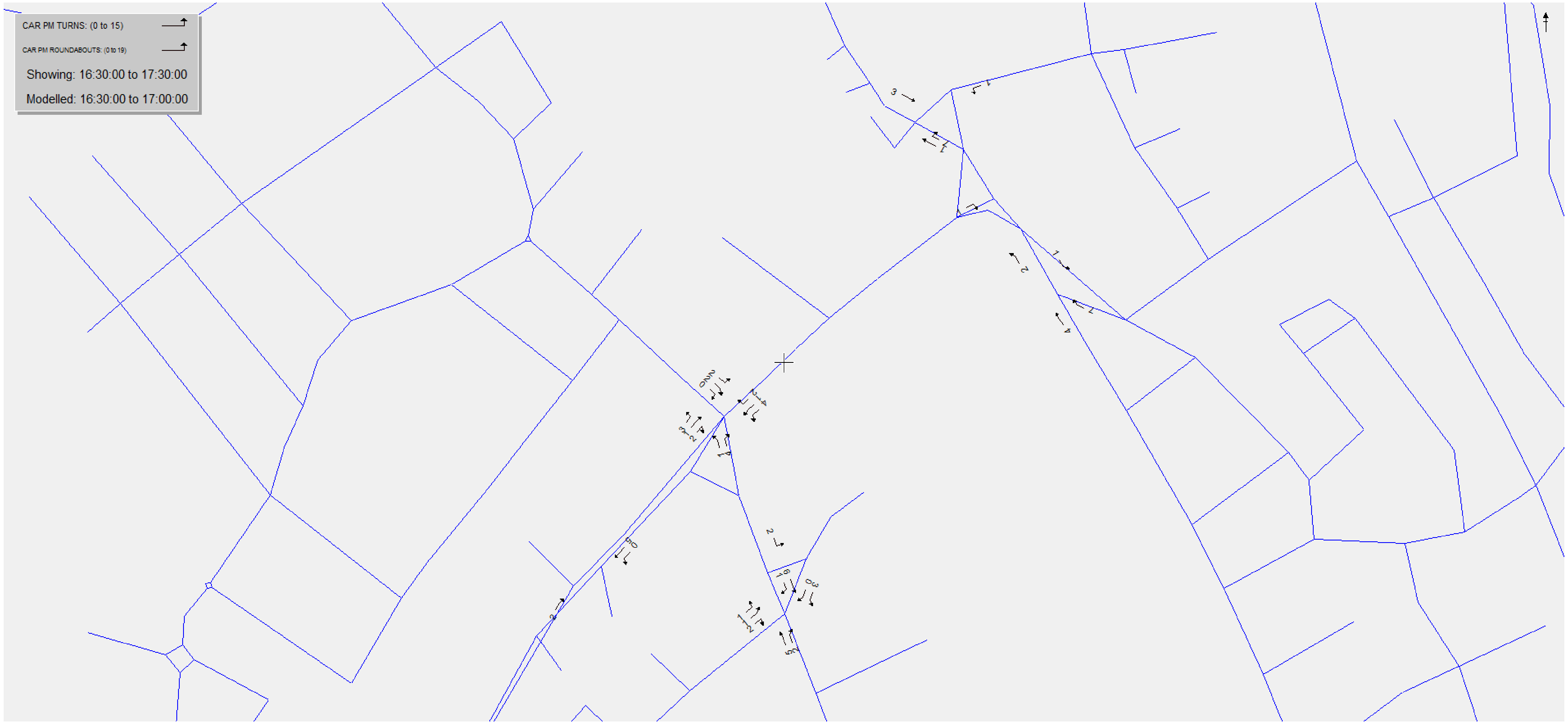


HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

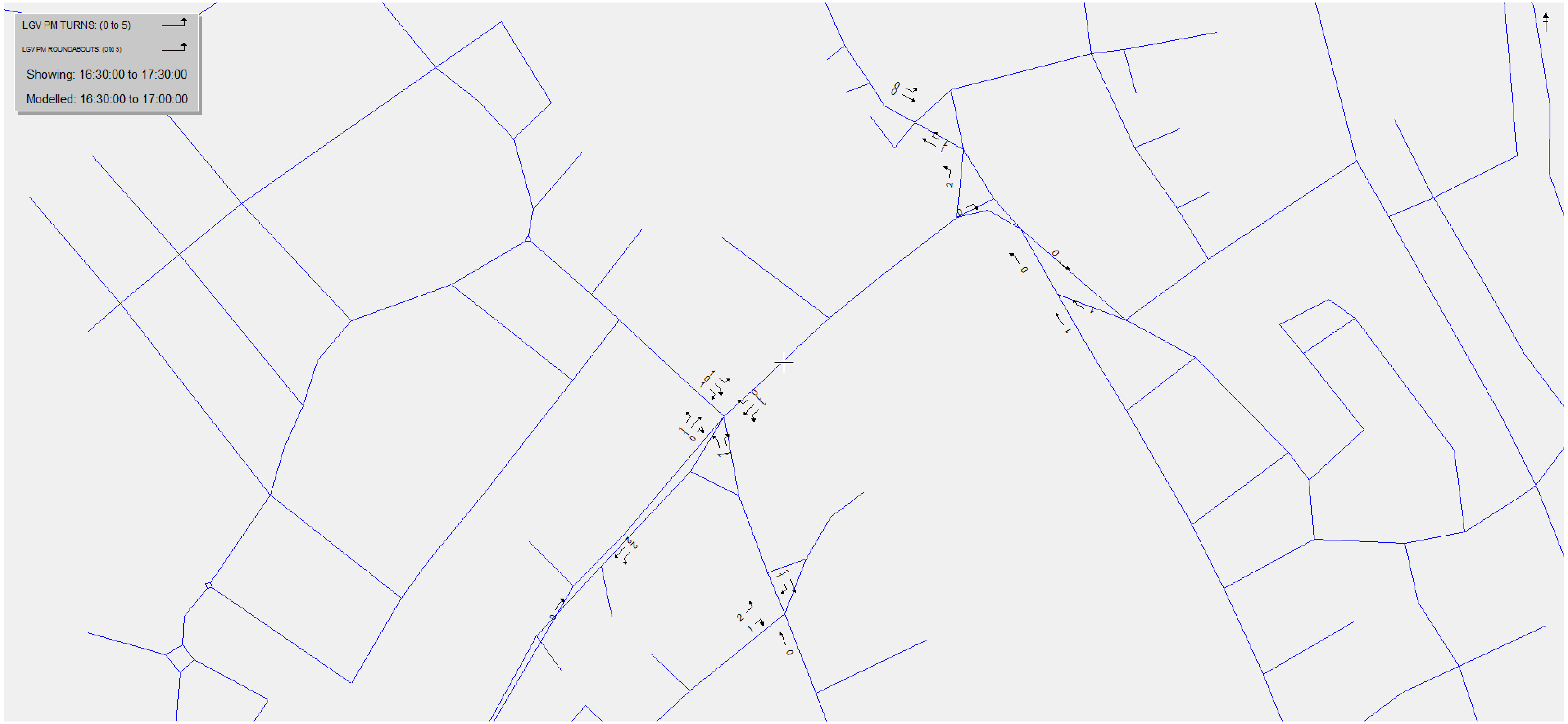

CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00



CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00


LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

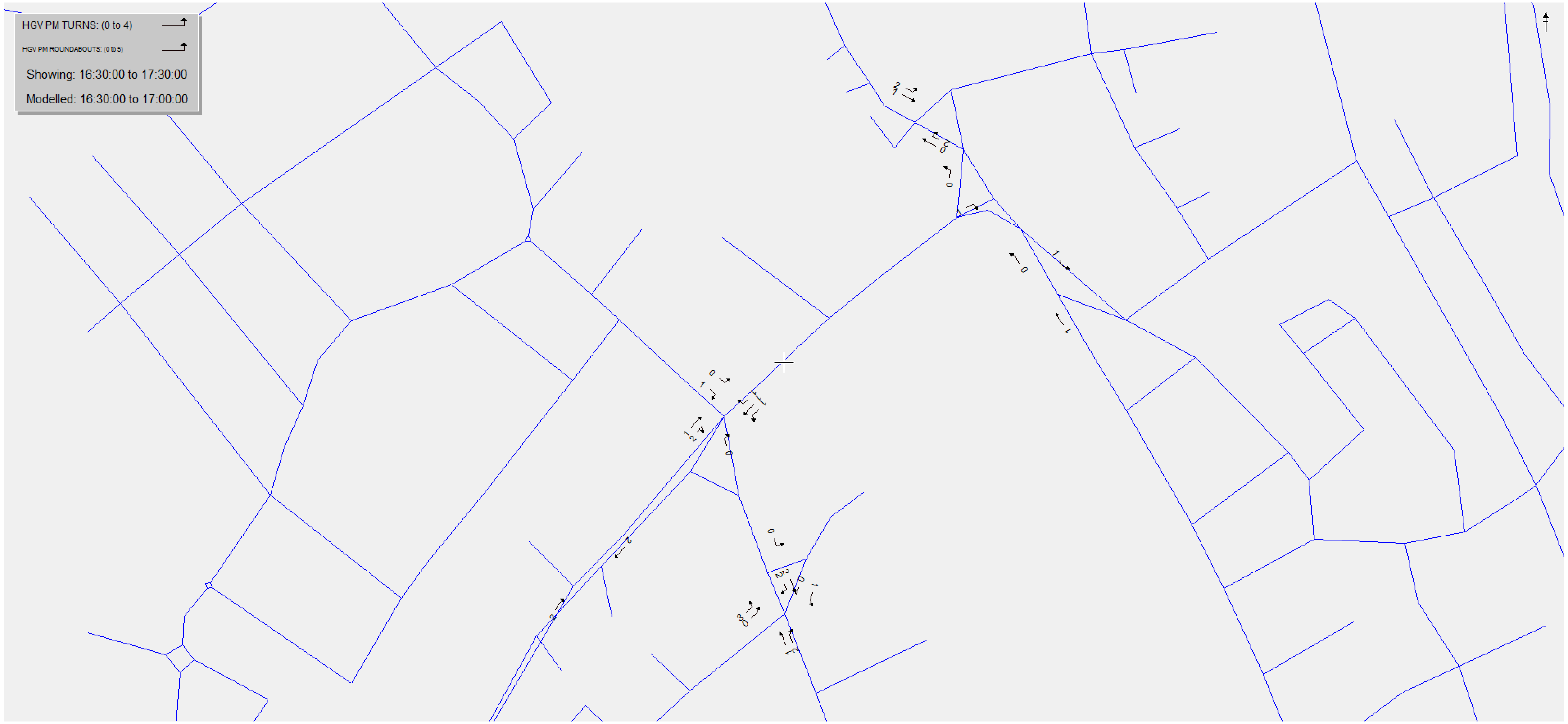
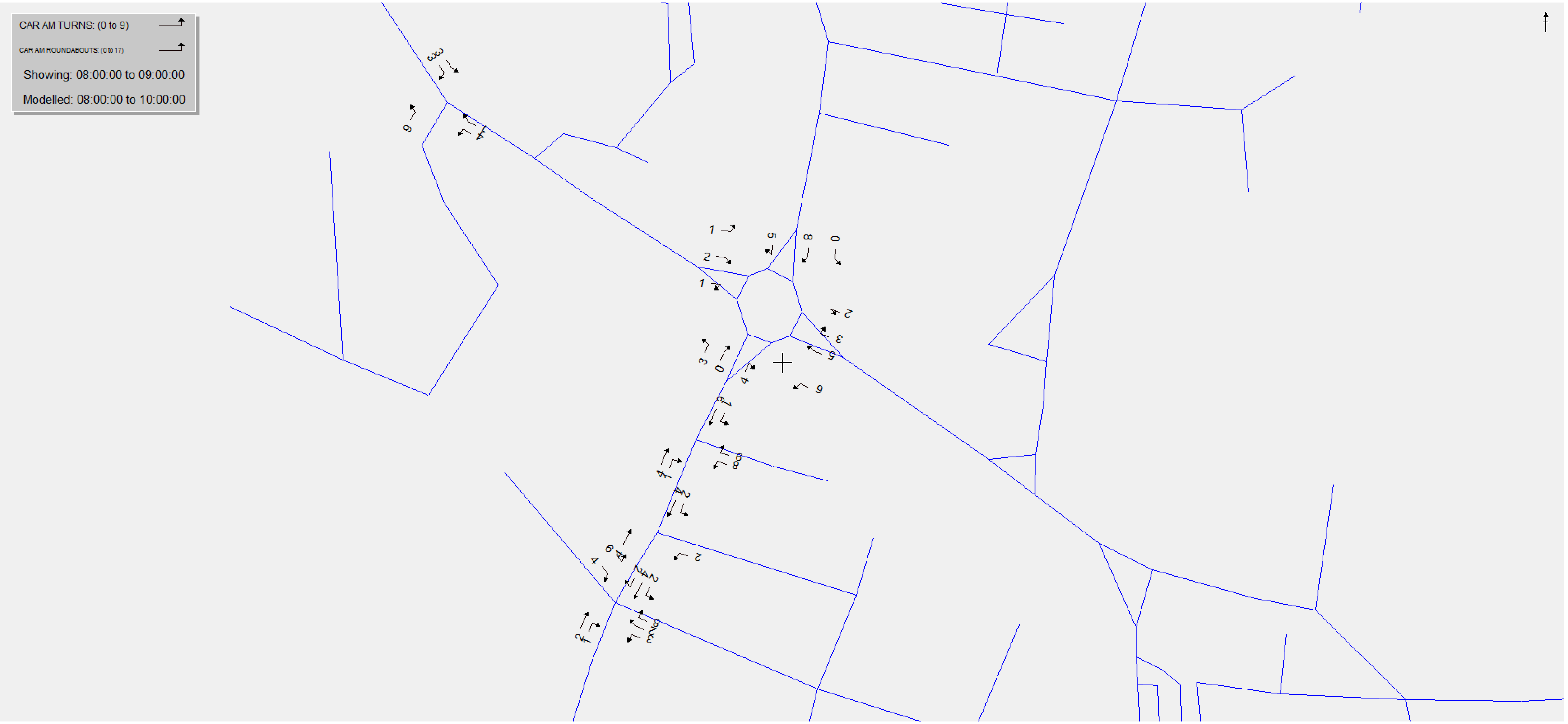
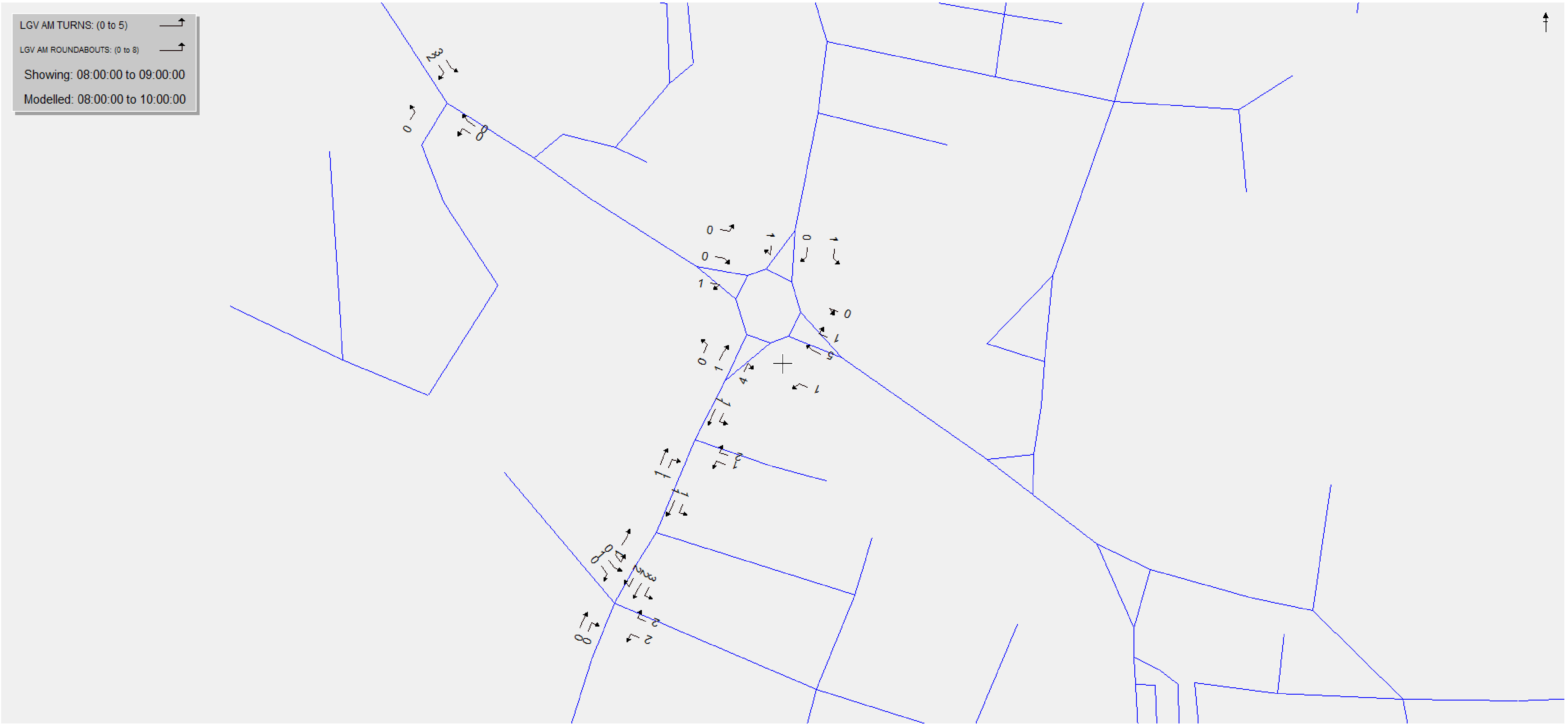
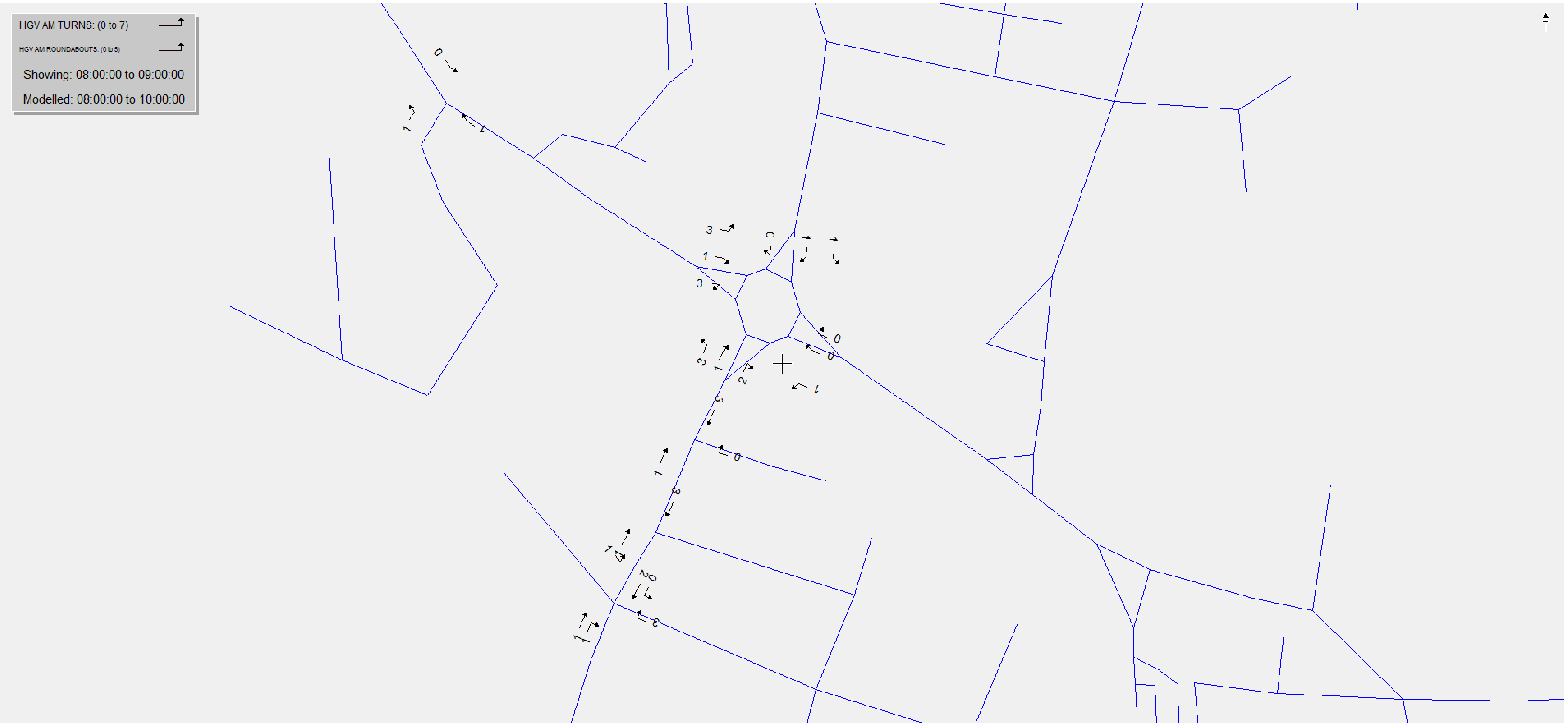

HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

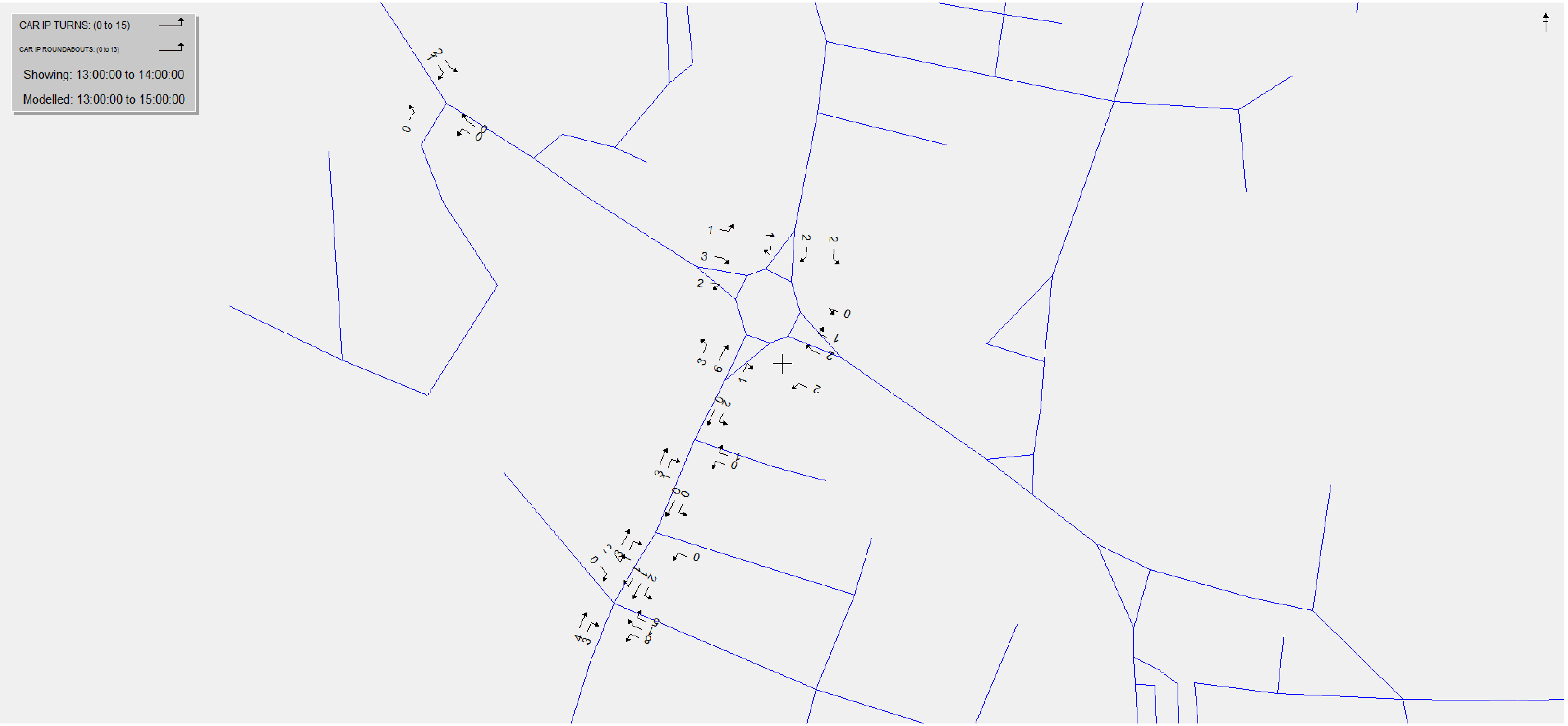
Figure 6 GEH North Quay Roundabout

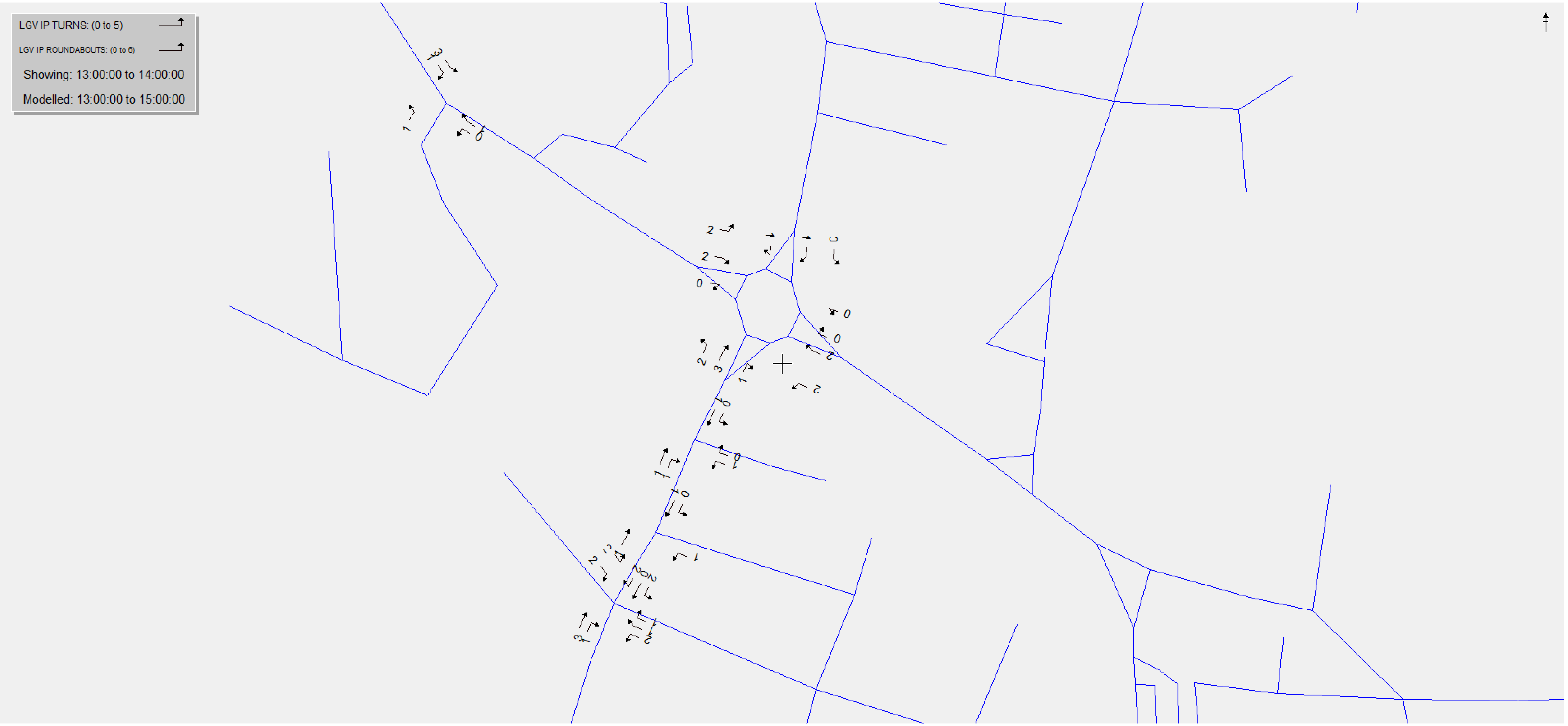


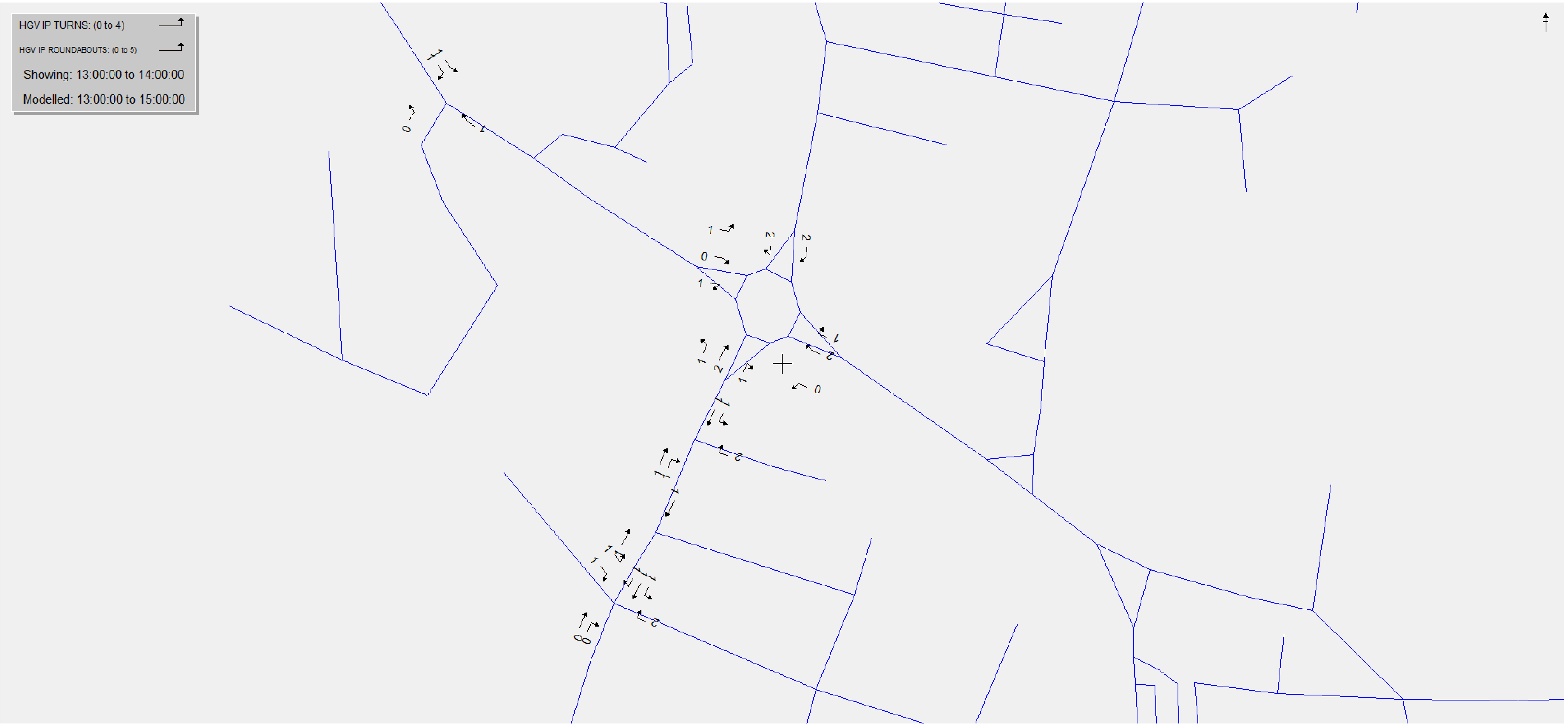

LGV AM TURNS: (0 to 5)
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

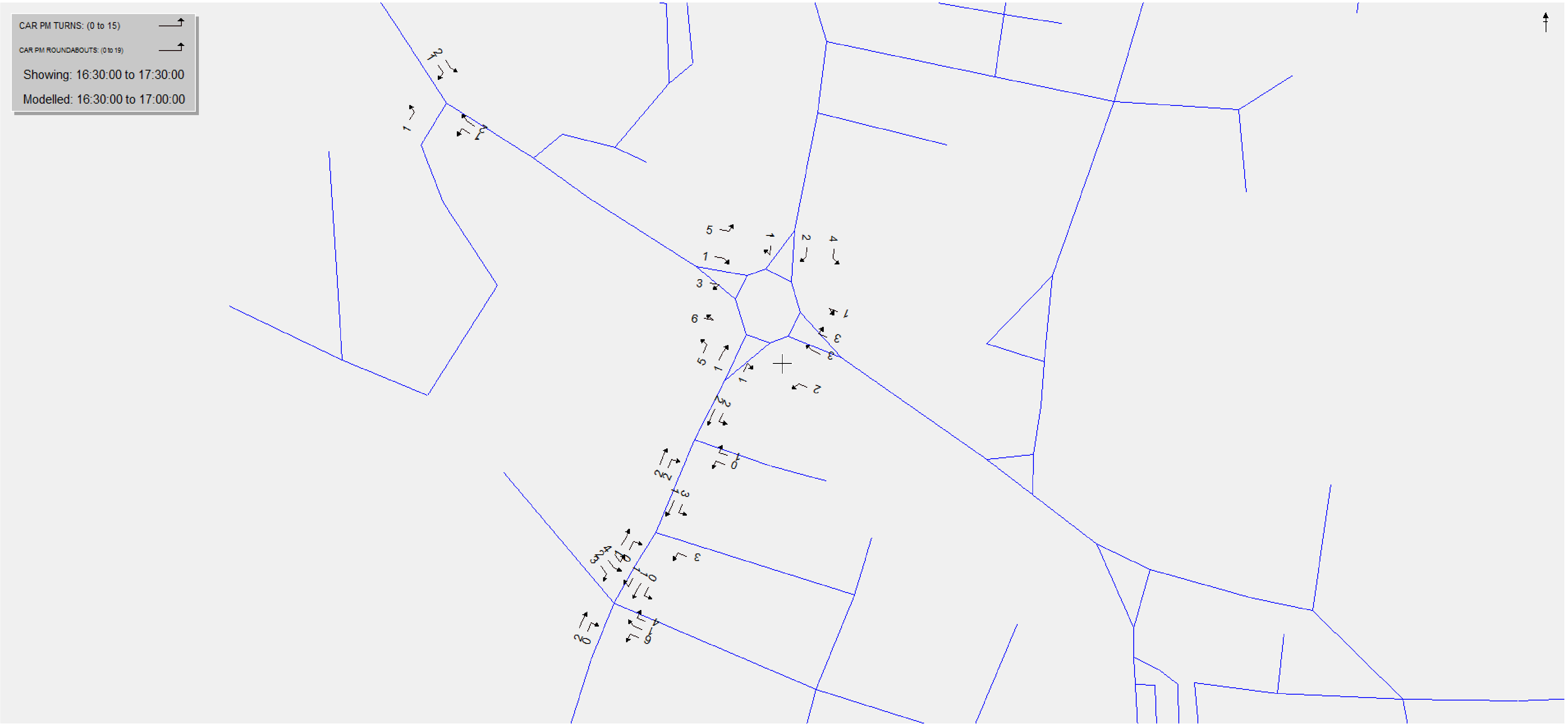


HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
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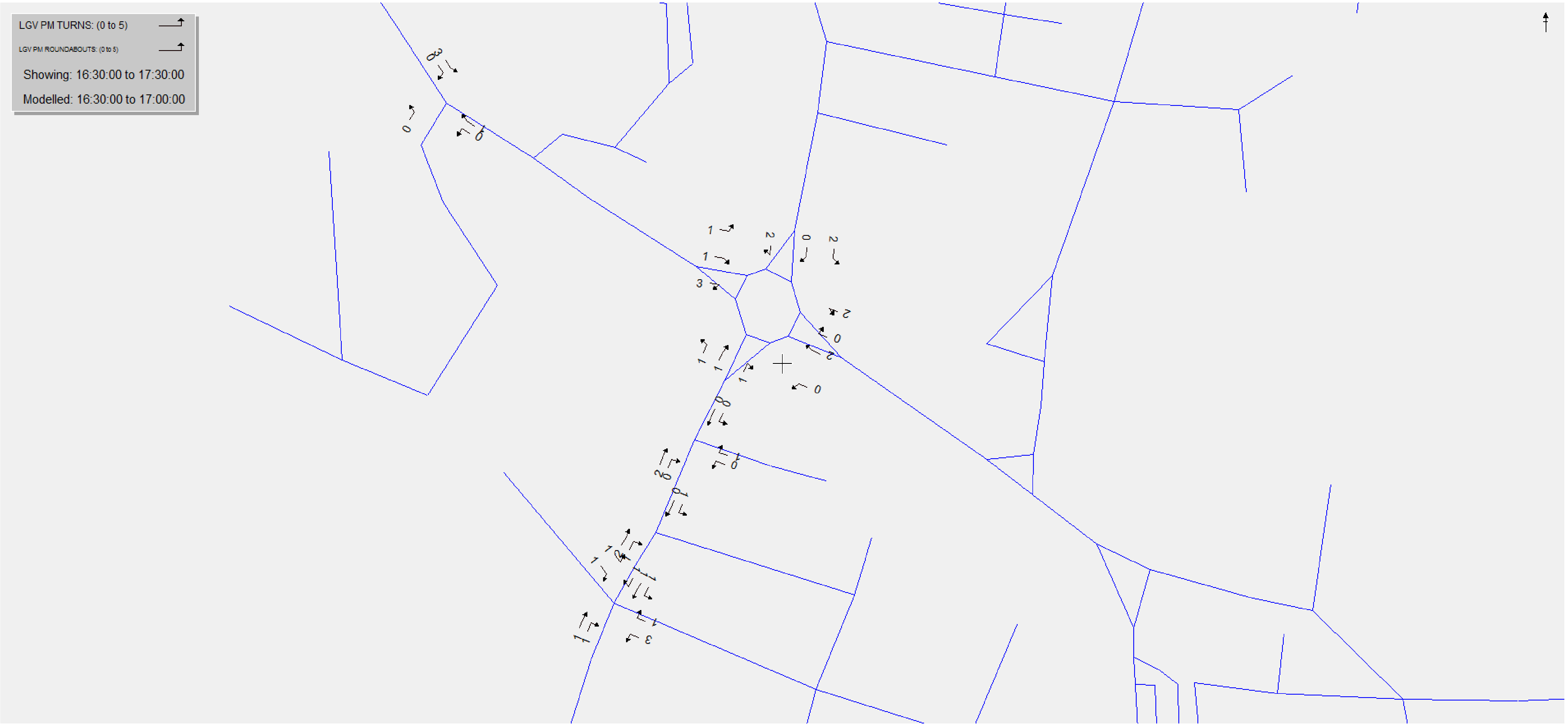
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LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

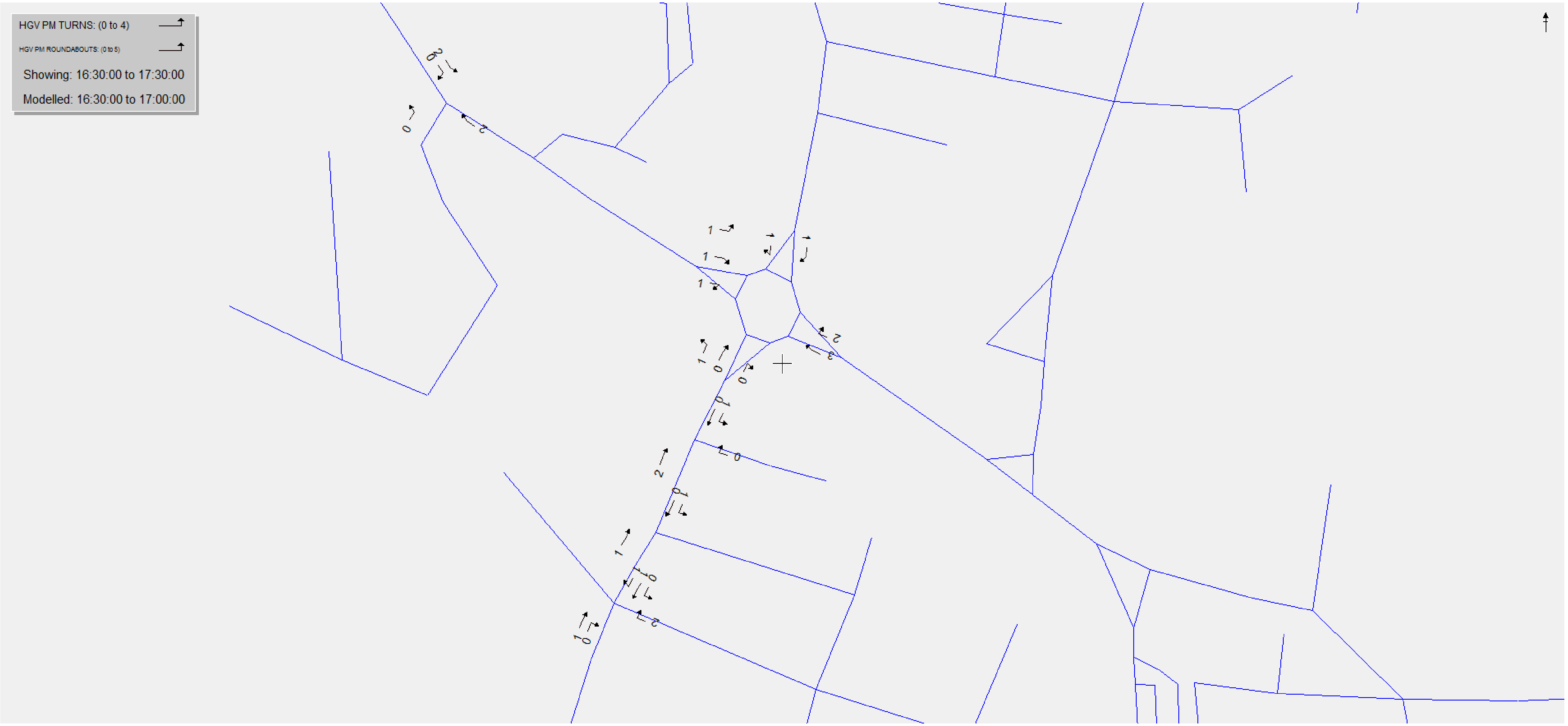
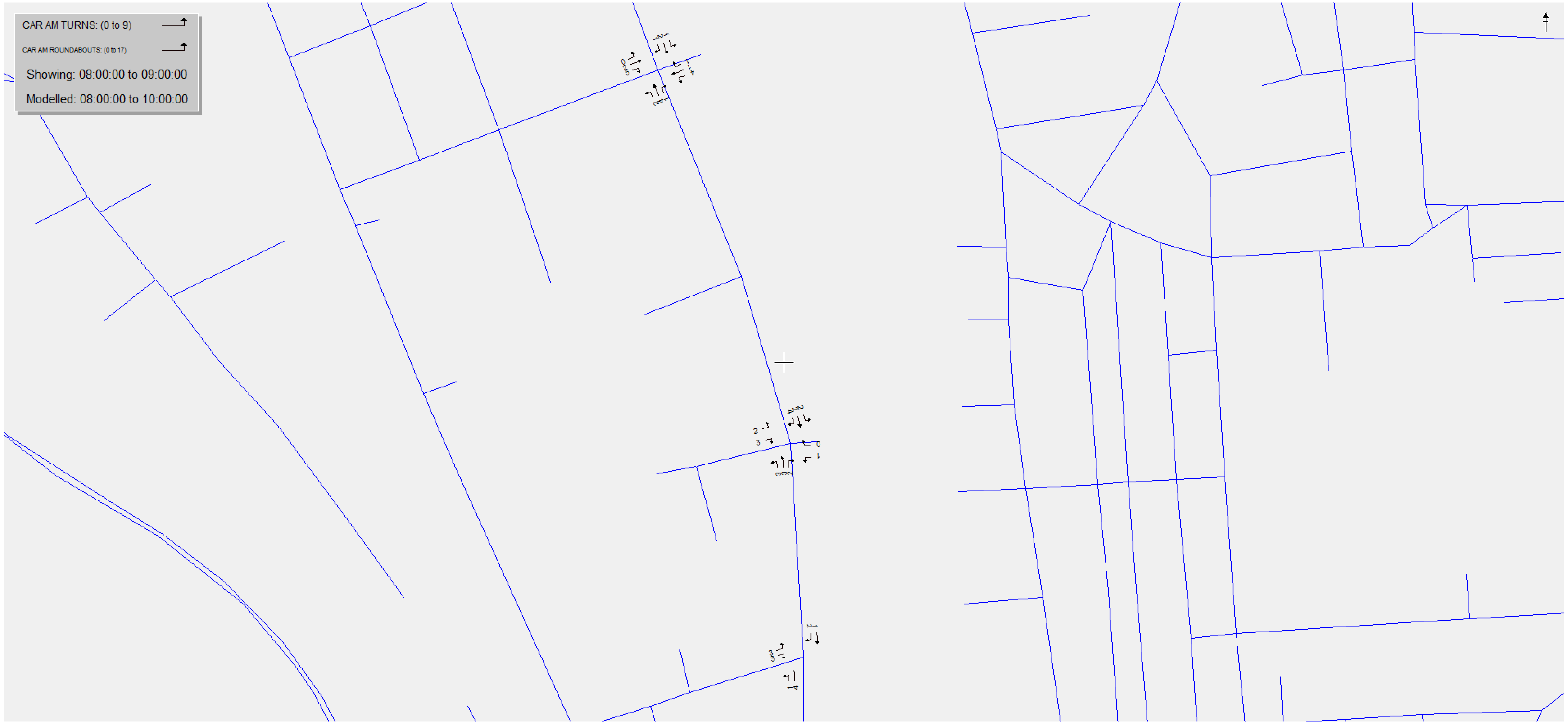
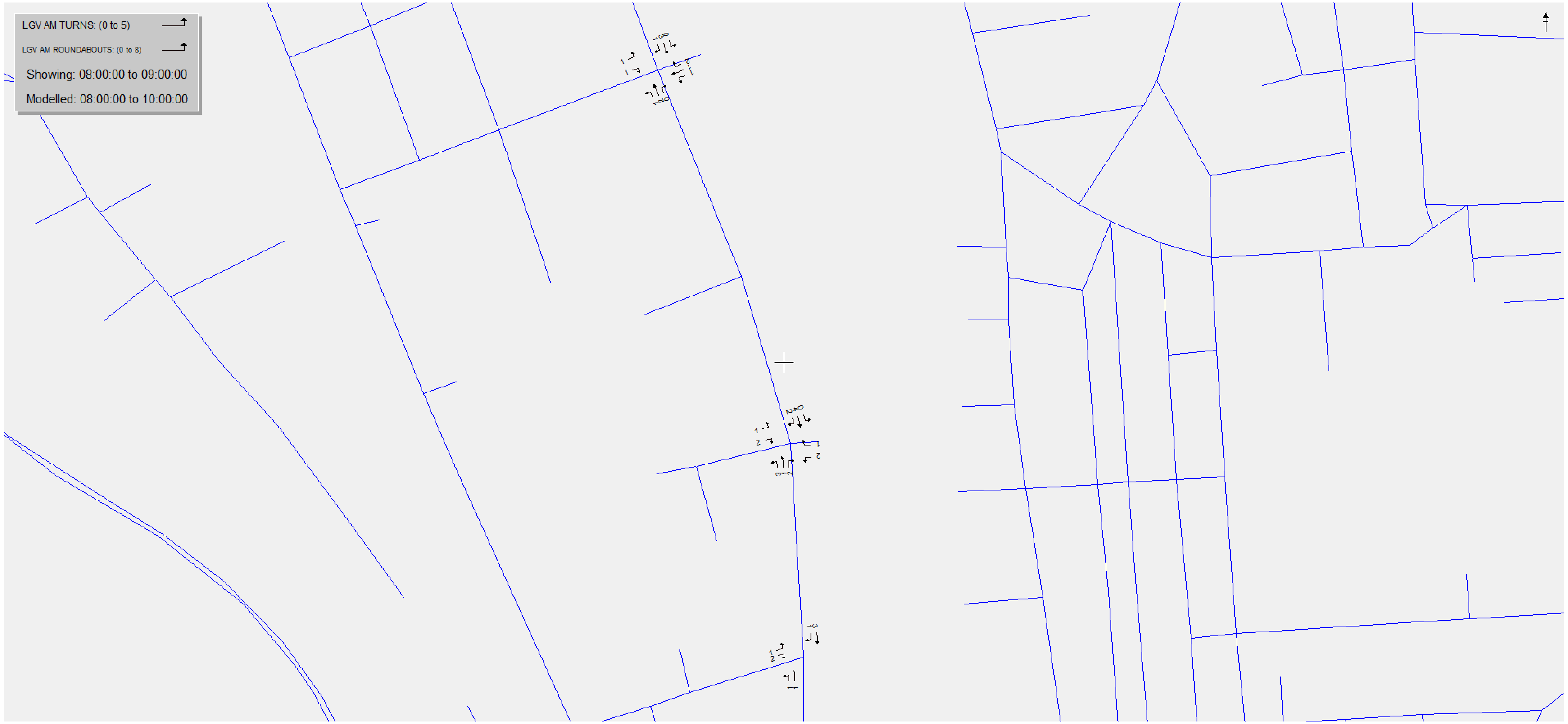
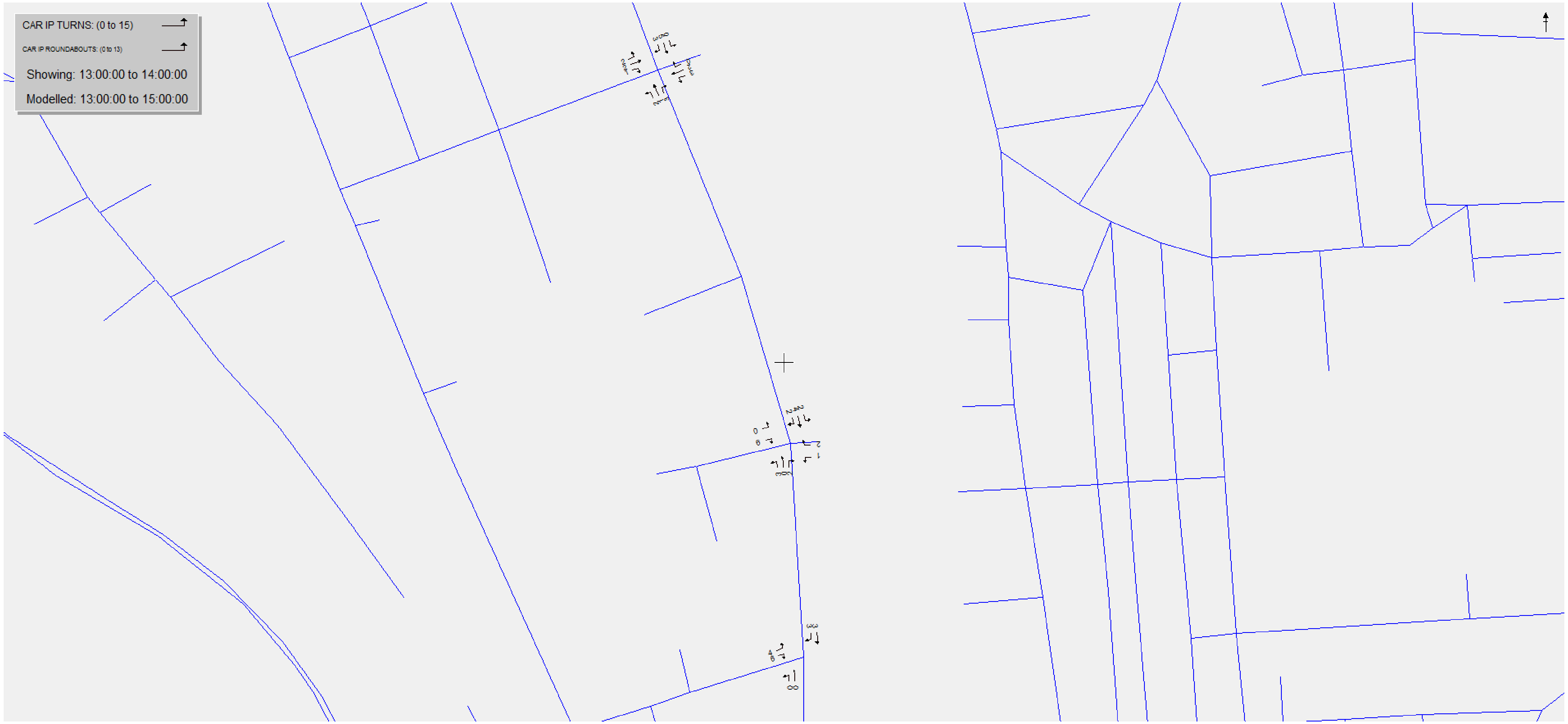

HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

Figure 7 GEH Southtown Road



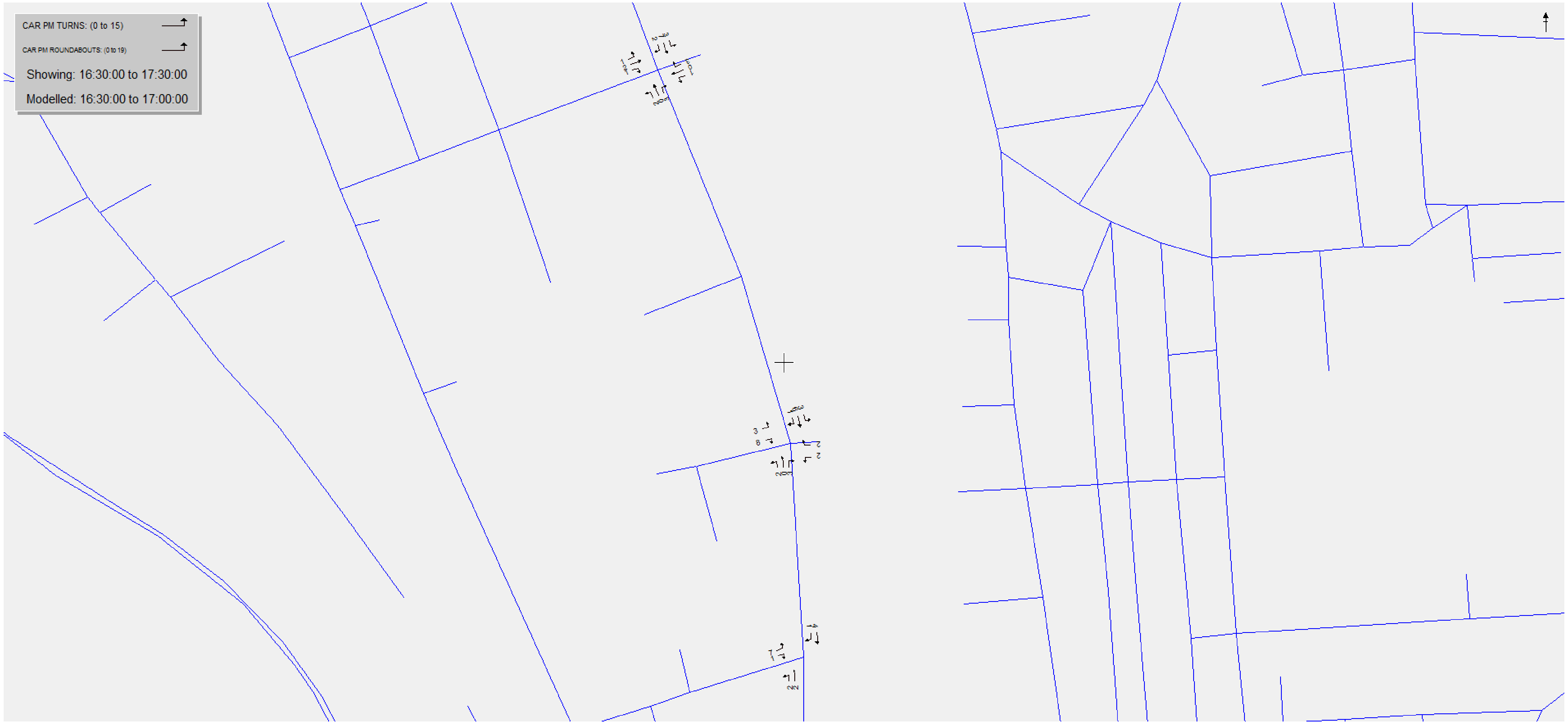

LGV AM TURNS: (0 to 5)
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00


CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

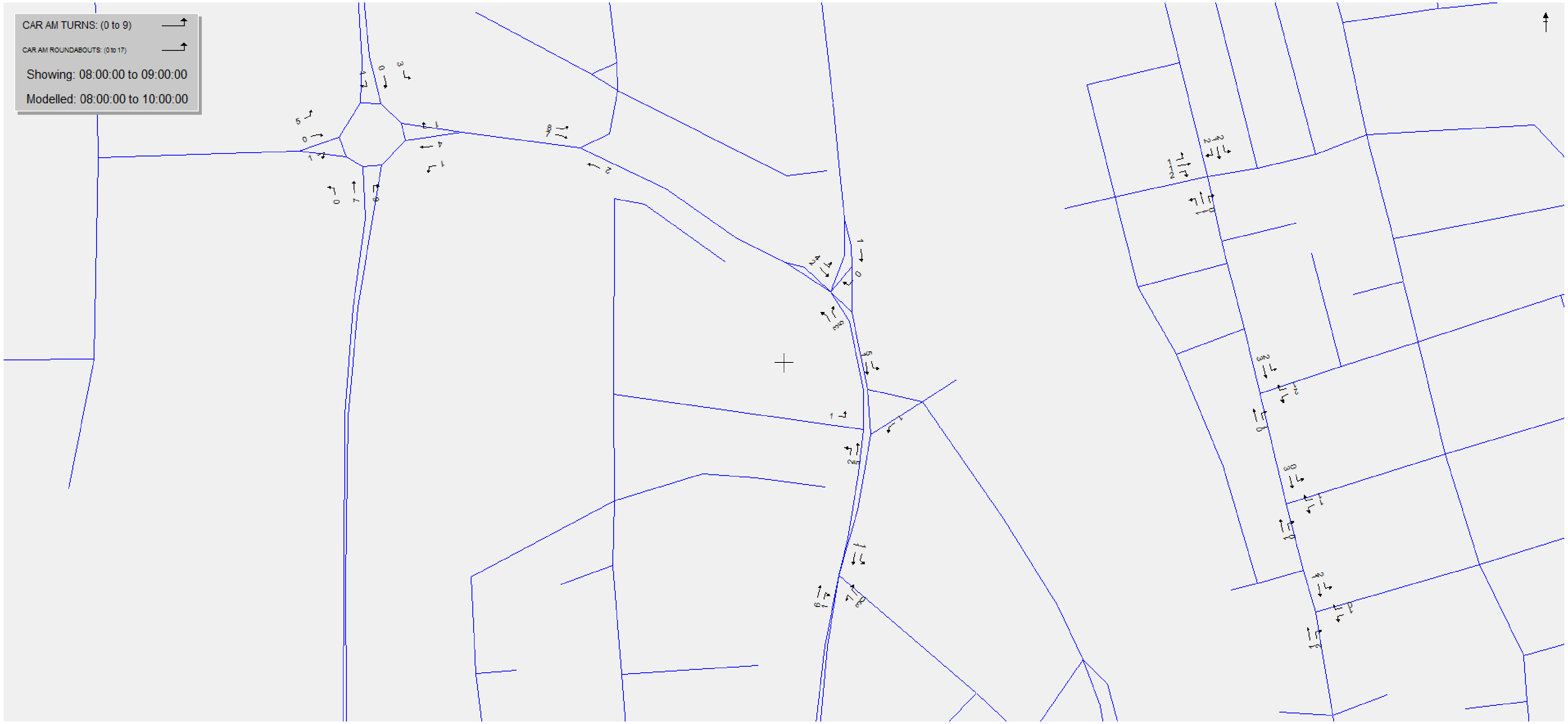

HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00

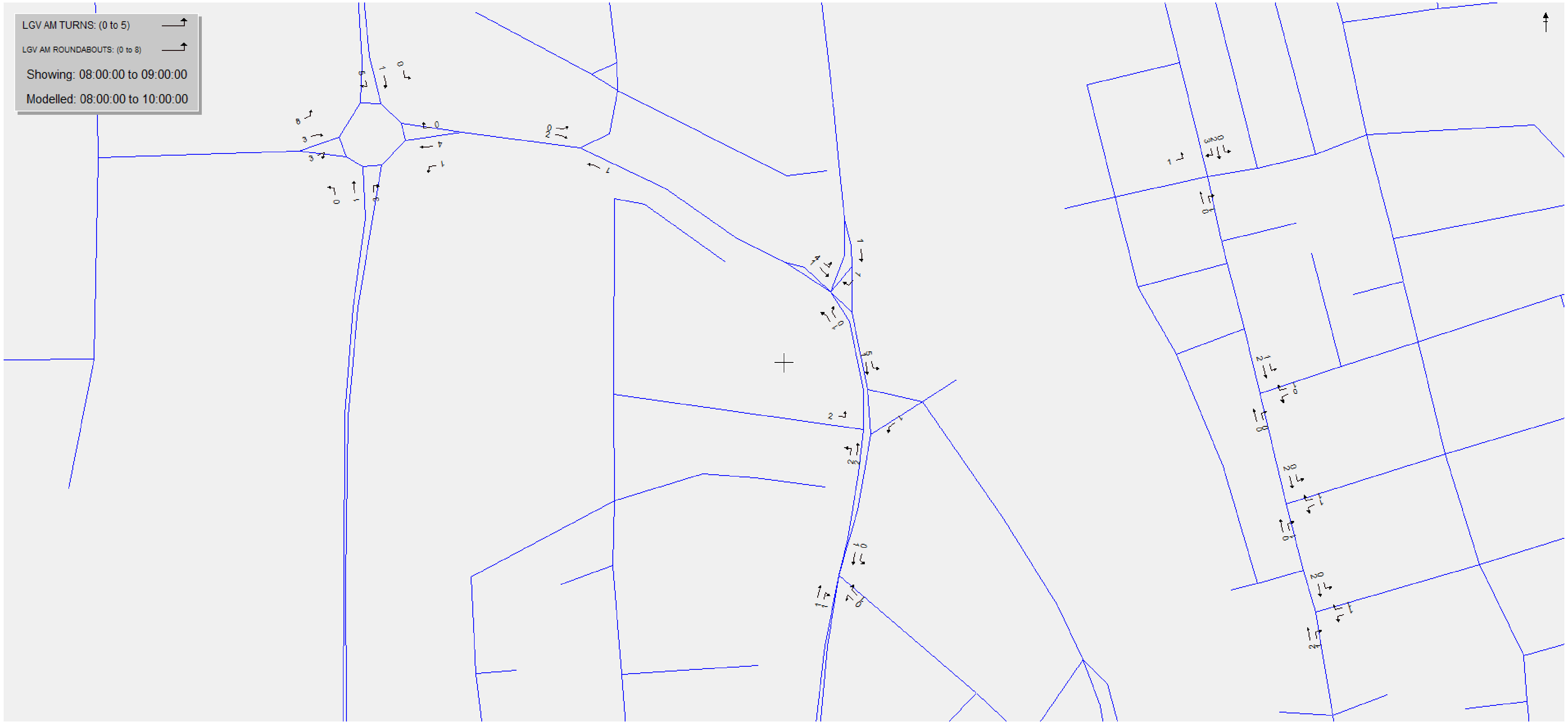

CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

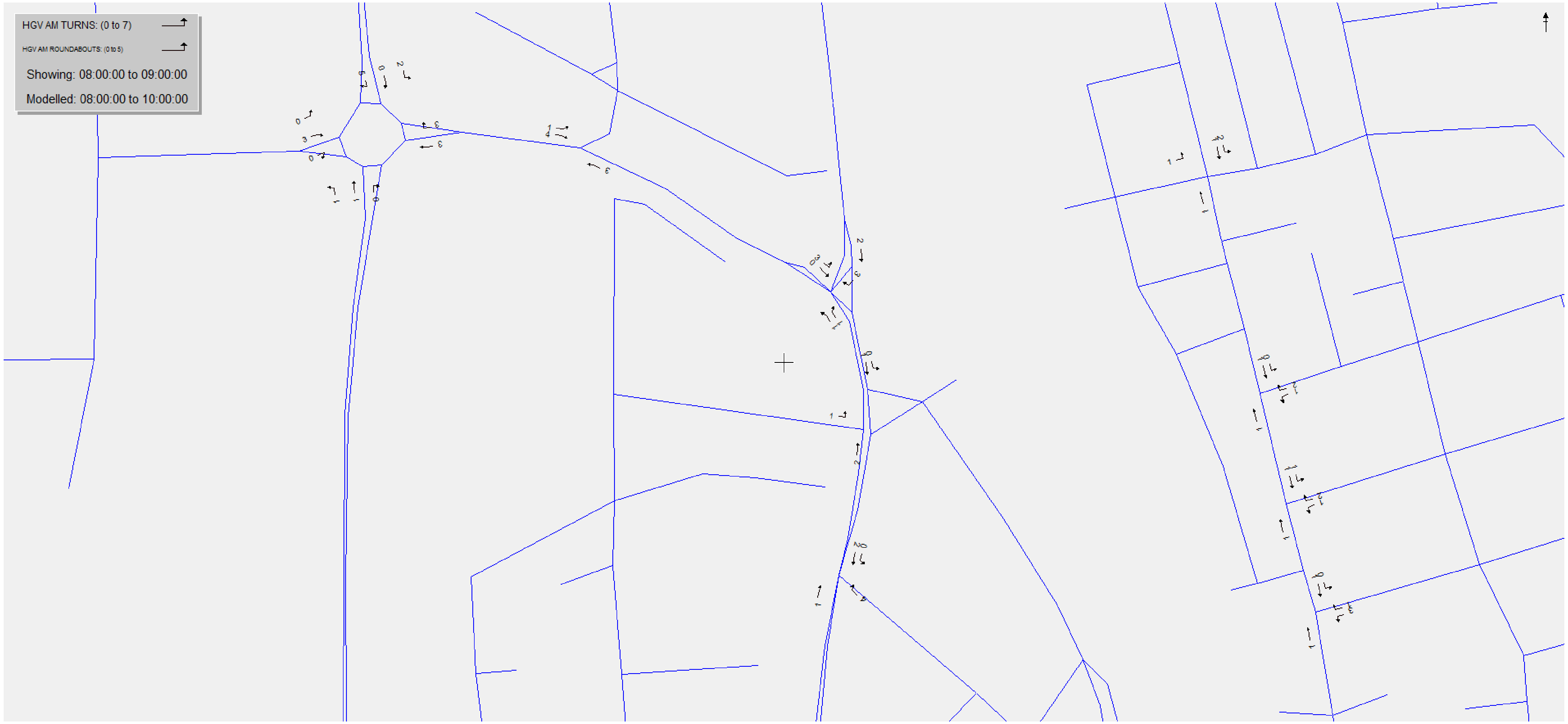
LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

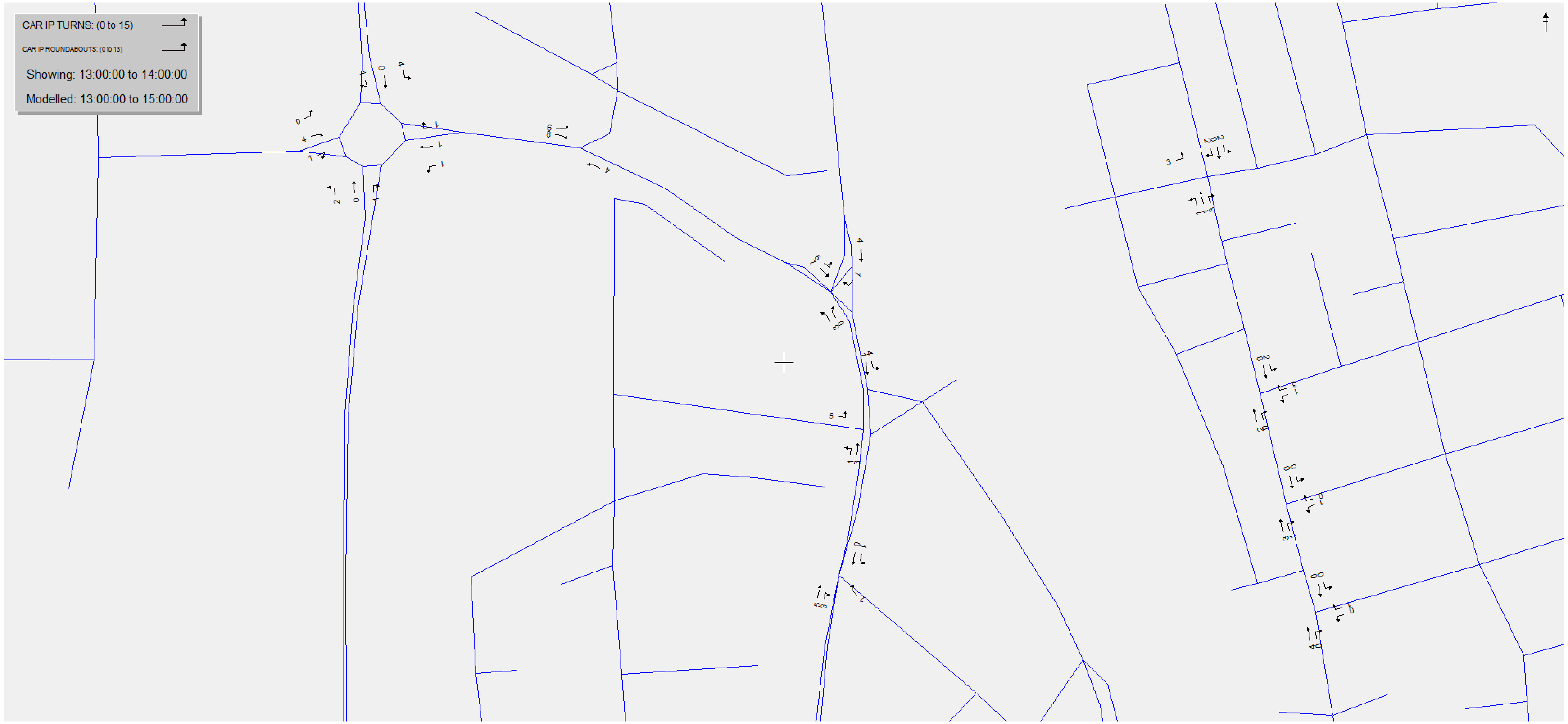

HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

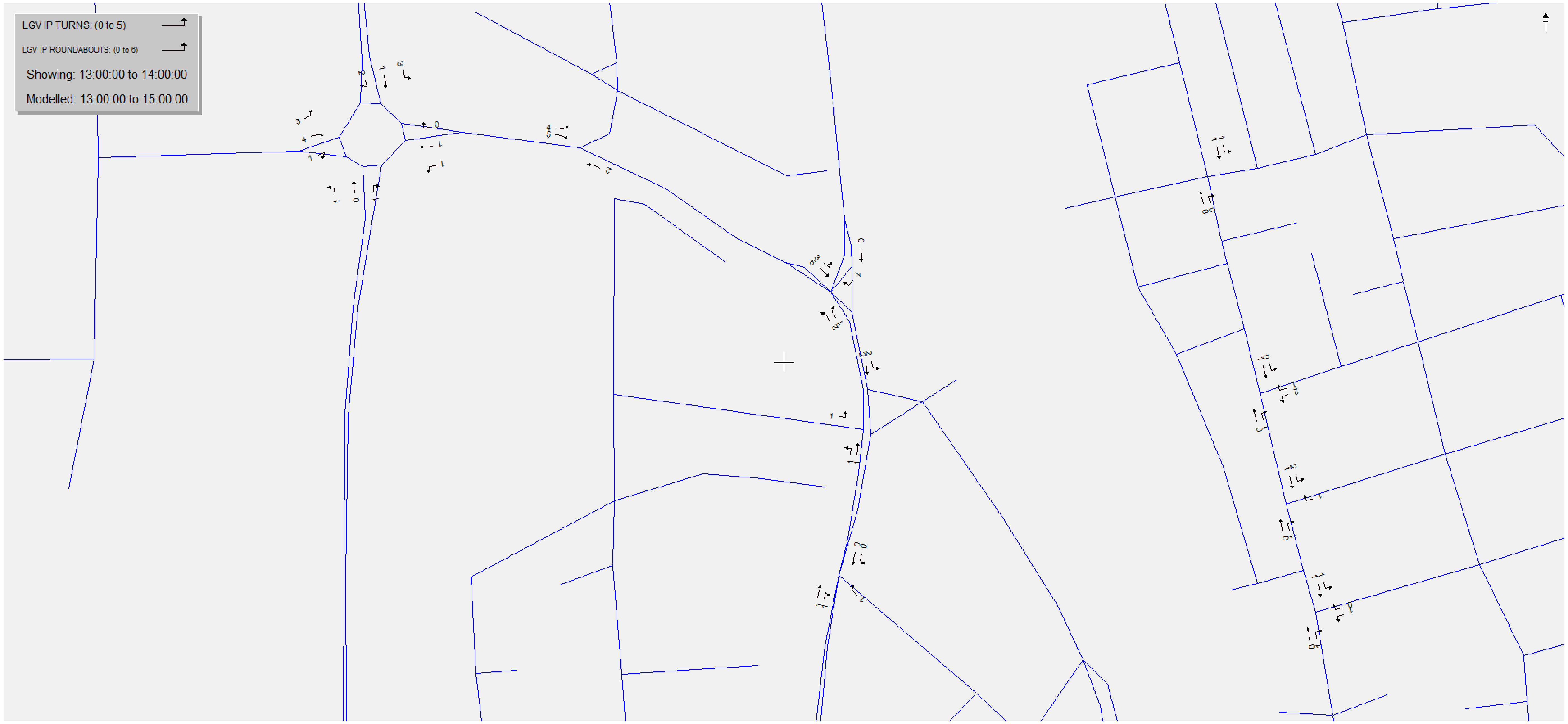
Figure 8 GEH William Adams Roundabout

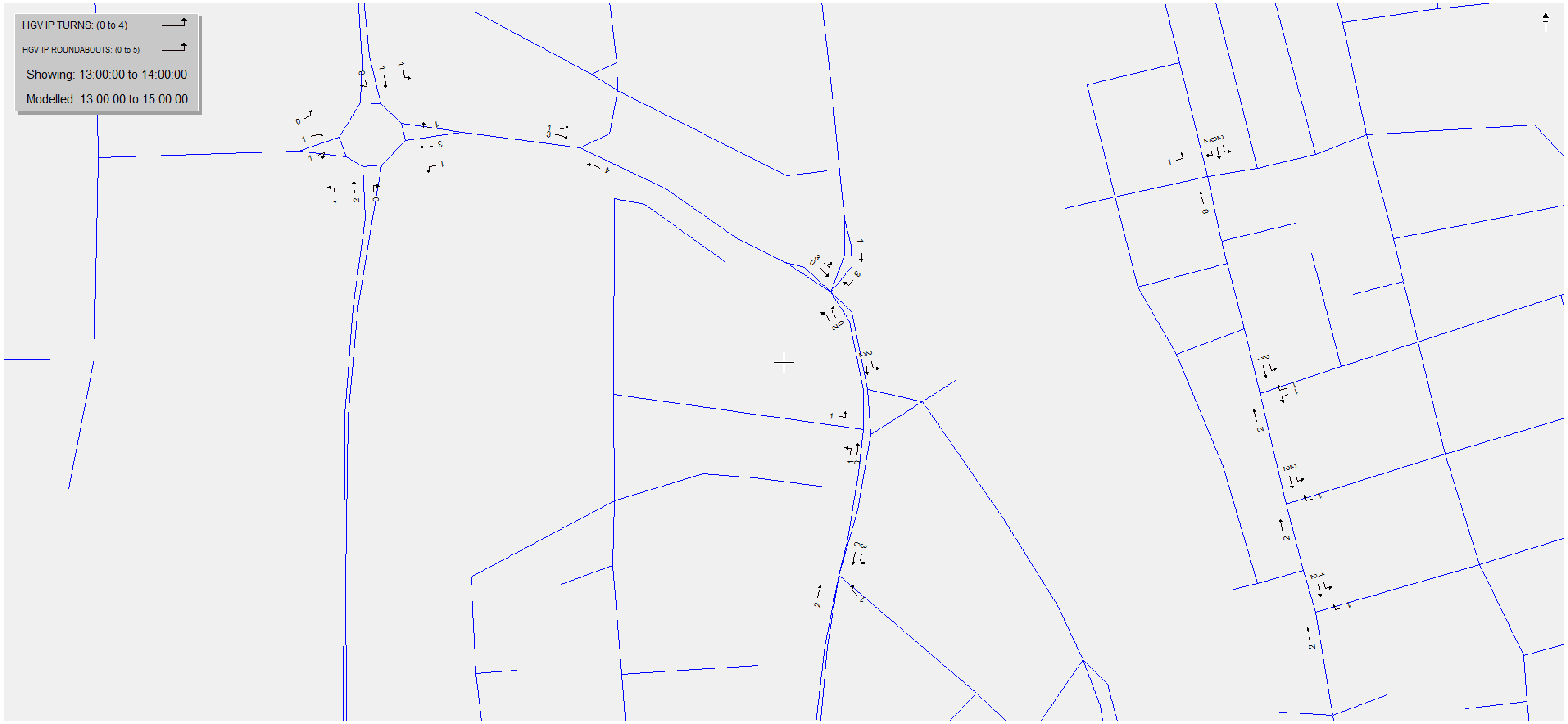


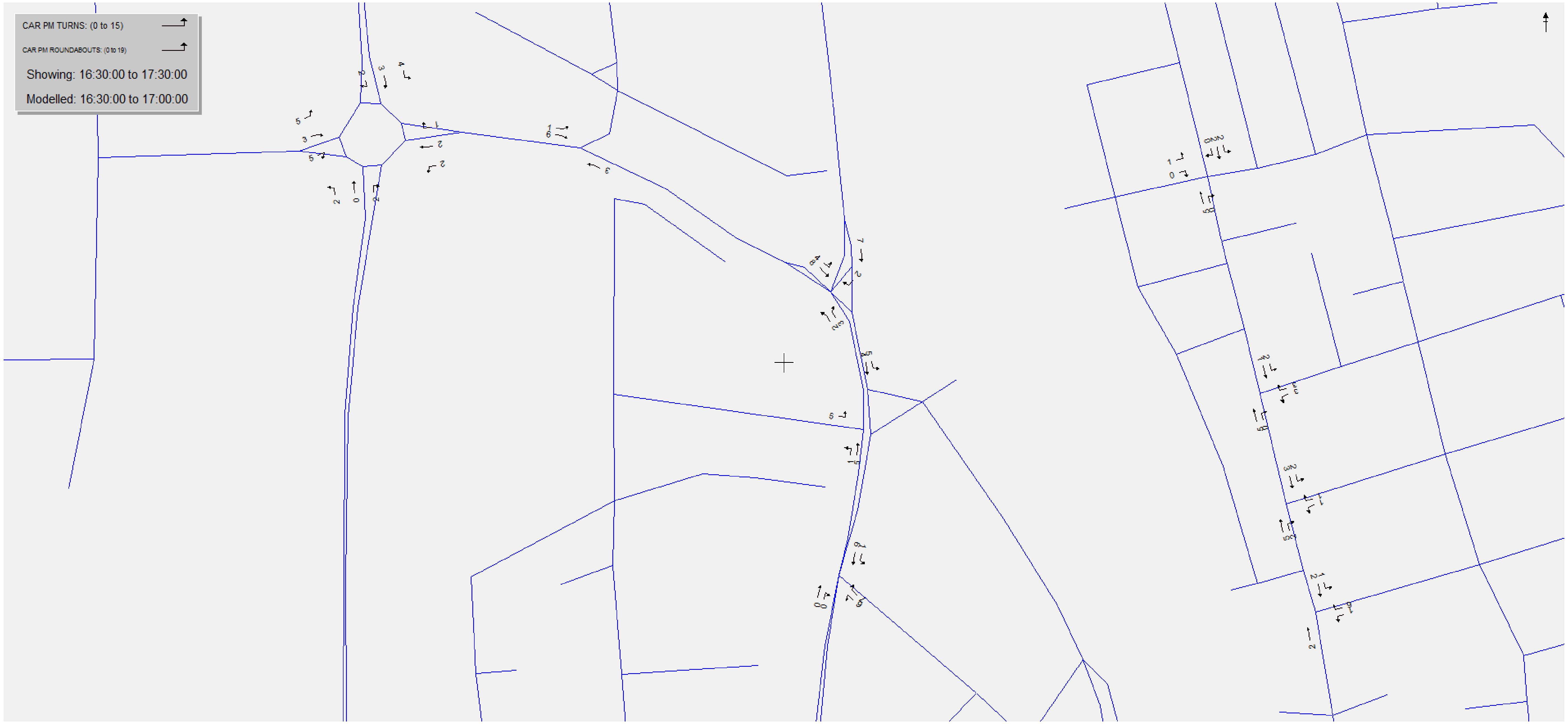

LGV AM TURNS: (0 to 5)
LGV AM ROUNDABOUTS: (0 to 8)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

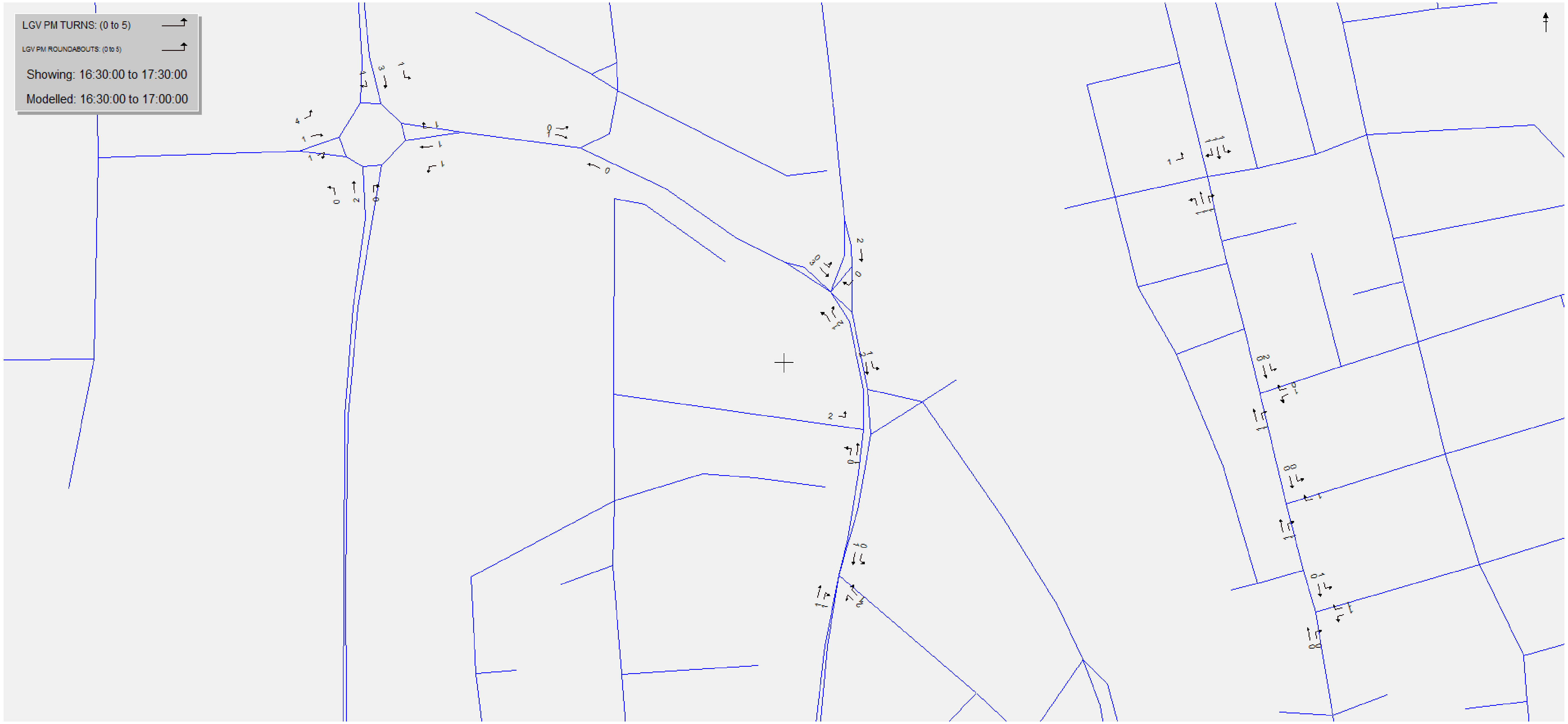

HGV AM TURNS: (0 to 7)
HGV AM ROUNDABOUTS: (0 to 5)
Showing: 08:00:00 to 09:00:00
Modelled: 08:00:00 to 10:00:00

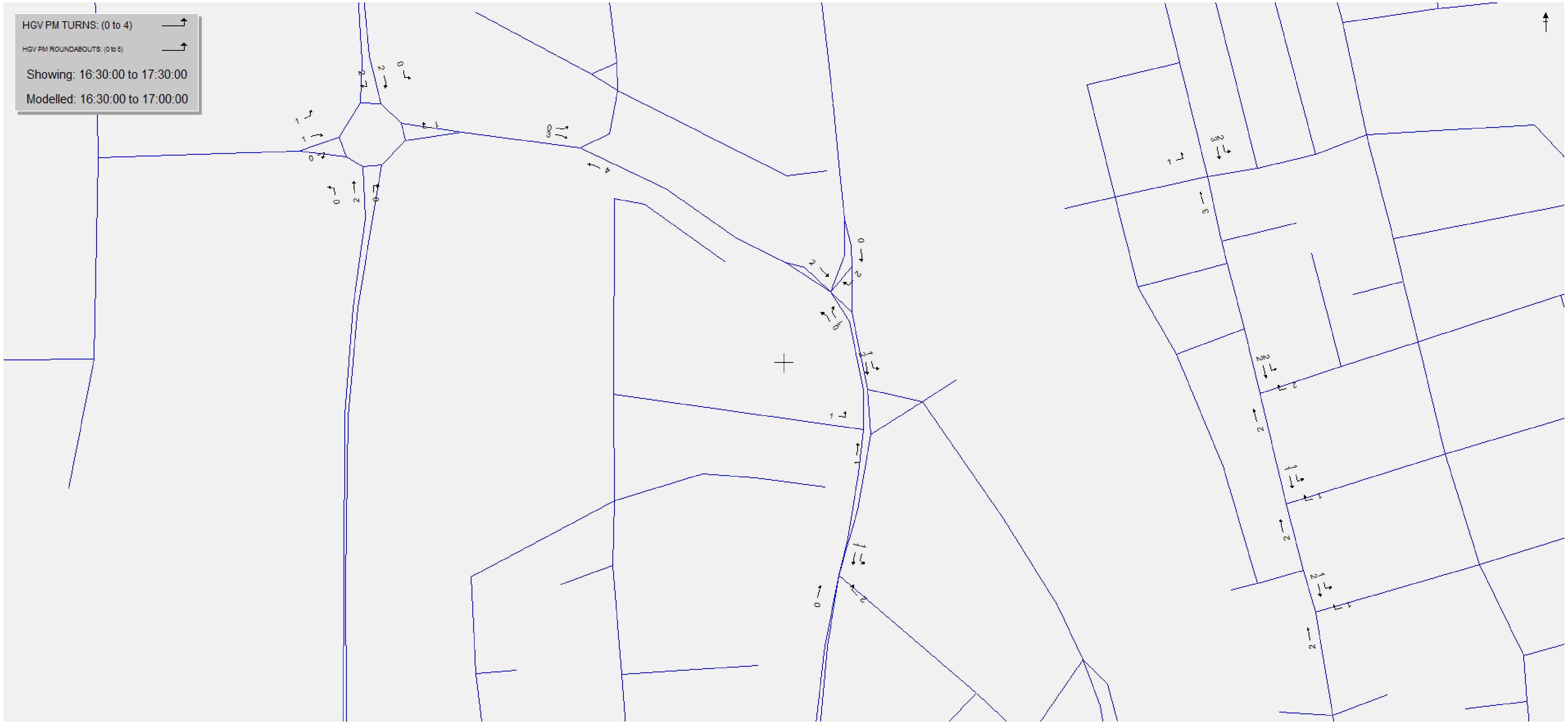

CAR IP TURNS: (0 to 15)
CAR IP ROUNDABOUTS: (0 to 13)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


LGV IP TURNS: (0 to 5)
LGV IP ROUNDABOUTS: (0 to 6)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


HGV IP TURNS: (0 to 4)
HGV IP ROUNDABOUTS: (0 to 5)
Showing: 13:00:00 to 14:00:00
Modelled: 13:00:00 to 15:00:00


CAR PM TURNS: (0 to 15)
CAR PM ROUNDABOUTS: (0 to 19)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00


LGV PM TURNS: (0 to 5)
LGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00


HGV PM TURNS: (0 to 4)
HGV PM ROUNDABOUTS: (0 to 5)
Showing: 16:30:00 to 17:30:00
Modelled: 16:30:00 to 17:00:00

APPENDIX H. Queue Comparison

Table 1 AM Queue Comparison

AM Queue Survey	Max queue (metres)
Area 1. New Surveys 2016	
JUNCTION 1	5.3
A	5.3
B	0.0
C	5.3
JUNCTION 4	36.6
D	22.67
E	24.70
F	26.94
G	36.62
JUNCTION 7/8	63.6
H	40.00
I	63.64
J	22.16
K	0.00
L	5.00
Area 2. New Surveys 2016	
J4	10.0
Kings Road Eastbound	10.00
S Beach Parade Northbound	10.00
S Beach Parade Southbound	0.00
Area 3. New Surveys 2016	
Junction 13	16.8
M	16.75
N	15.96
O	10.68
P	15.18
Q	10.20
R	15.83
Junction 14	61.7
AA	59.97
AB	35.57
AC	0.00
S	44.25
T	61.72
U	5.37
V	26.47
W	49.29
X	0.00
Y	0.00
Z	0.00
Junction 15	61.7
AD	17.04
AE	23.01
AF	61.67
AG	31.70
AH	15.15

AM Queue Survey	Max queue (metres)
Junction 18	78.7
AI	32.34
AJ	78.74
AK	22.67
Junction 20	38.5
AL	16.67
AM	37.20
AN	14.67
AO	38.55
AECOM. Surveys 2015	
Site 1	108.0
A1	81.00
A2	63.00
B1	36.00
C1	90.00
C2	108.00
D1	54.00
D2	15.00
D3	45.00
Site 2	84.0
A1	24.00
A2	18.00
A3	33.00
B1	51.00
B2	84.00
B3	39.00
C1	36.00
C2	33.00
Site 3	66.0
A1	66.00
A2	36.00
B1	33.00
B2	39.00
C1	36.00
C2	54.00
D1	27.00
D2	63.00
Site 4	108.0
A1	99.00
A2	78.00
B1	69.00
B2	24.00
B3	39.00
C1	108.00
C2	99.00
Site 5	144.0
A1	33.00
A2	39.00
B1	30.00

AM Queue Survey	Max queue (metres)
B2	78.00
B3	132.00
C1	99.00
C2	108.00
C3	33.00
D1	36.00
D2	144.00
D3	90.00
Site 6	135.0
A1	66.00
A2	54.00
A3	75.00
A4	48.00
B1	27.00
B2	36.00
B3	0.00
C1	78.00
C2	99.00
C3	15.00
D1	108.00
D2	135.00
Site 7	105.0
A1	39.00
A2	63.00
B1	105.00
B2	27.00
B3	30.00
C1	75.00
C2	36.00
Site 8	84.0
A1	30.00
A2	54.00
B1	45.00
B2	21.00
B3	21.00
C1	84.00
C2	78.00
C3	30.00
D1	54.00
D2	36.00
NCC. Surveys 2015	
2	150.0
2	80.00
4	150.00
5	122.50
1A	100.00
1B	70.00
3A	20.00
3B	50.00

AM Queue Survey	Max queue (metres)
3	155.0
1	155.00
2A	57.50
2B	75.00
2C	15.00
3A	42.50
3B	50.00
8	140.0
1	140.00
2	42.50
3	25.00
4	55.00
5	40.00
6	75.00
7	80.00
8	130.00
1A	155.0
1A	30.00
1B	35.00
2A	25.00
2B	70.00
2C	155.00
3A	70.00
3B	90.00
3C	30.00
4A	30.00
4B	150.00
4C	85.00
1B	120.0
4	70.00
1A	35.00
1B	80.00
2A	20.00
2B	10.00
3A	10.00
3B	120.00

Junction	AM Modelled Max Queue (m)
Area 1. New Surveys 2016	
JUNCTION 1	16.2
A	16.2
B	0.0
C	5.1
JUNCTION 4	76.5
D	76.5
E	21.4
F	27.3
G	35.7
JUNCTION 7/8	75.5
H	23.5
I	75.5
J	16.2
K	25.5
L	5.1
Area 2. New Surveys 2016	
J4	9.1
Kings Road Eastbound	0.0
S Beach Parade Northbound	0.0
S Beach Parade Southbound	9.1
Area 3. New Surveys 2016	
Junction 13	36.4
M	17.2
N	36.4
O	22.4
P	29.1
Q	19.3
R	22.4
Junction 14	57.6
AA	46.8
AB	20.4
AC	0.0
S	41.7
T	57.6
U	56.0
V	47.8
W	29.5
X	0.0
Y	19.4
Z	7.0
Junction 15	53.0
AD	23.5
AE	34.7
AF	53.0
AG	45.9
AH	22.3
AECOM. Surveys 2015	

Junction	AM Modelled Max Queue (m)
Site 1	99.6
A1	17.2
A2	21.1
B1	16.1
C1	61.7
C2	65.1
D1	99.6
D2	18.4
D3	24.3
Site 2	34.8
A1	26.5
A2	7.1
A3	0.0
B1	32.5
B2	34.8
B3	17.3
C1	28.6
C2	28.6
Site 6	298.0
A1	216.4
A2	73.0
A3	21.2
A4	19.4
B1	15.7
B2	44.0
B3	0.0
C1	298.0
C2	253.2
C3	41.0
D1	31.3
D2	213.8
Site 7	99.0
A1	46.9
A2	45.9
B1	99.0
B2	41.5
B3	0.0
C1	45.7
C2	20.3
Site 8	111.0
A1	36.5
A2	30.2
B1	34.0
B2	31.5
B3	13.3
C1	111.0
C2	107.7
C3	26.4

Junction	AM Modelled Max Queue (m)
D1	57.2
D2	14.1
NCC. Surveys 2015	
2	80.9
2	44.0
4	80.9
5	72.0
1A	34.4
1B	34.4
3A	51.2
3B	73.5
3	107.5
1	107.5
2A	35.6
2B	55.0
2C	27.3
3A	23.2
3B	24.3
8	236.1
1	236.1
2	13.3
3	35.7
4	23.5
5	69.6
6	72.8
7	22.3
8	25.4
1A	124.6
1A	27.5
1B	34.5
2A	75.9
2B	124.6
2C	60.0
3A	82.6
3B	71.0
3C	54.2
4A	45.4
4B	105.3
4C	119.3
1B	203.1
4	141.2
1A	34.6
1B	62.9
2A	31.0
2B	47.7
3A	0.0
3B	203.1

Junction	Max Difference Between Real and Modelled (m)	AM Max PCUs Difference
Area 1. New Surveys 2016		
JUNCTION 1		
A	-10.9	-2.0
B	0.0	0
C	0.2	0
JUNCTION 4		
D	-53.8	-11
E	3.3	1
F	-0.4	0
G	0.9	0
JUNCTION 7/8		
H	16.5	3
I	-11.8	-2
J	5.9	1
K	-25.5	-5
L	-0.1	0
Area 2. New Surveys 2016		
J4		
Kings Road Eastbound	10.0	2
S Beach Parade Northbound	10.0	2
S Beach Parade Southbound	-9.1	-2
Area 3. New Surveys 2016		
Junction 13		
M	-0.5	0
N	-20.5	-4
O	-11.8	-2
P	-13.9	-3
Q	-9.1	-2
R	-6.6	-1
Junction 14		
AA	13.2	3
AB	15.2	3
AC	0.0	0
S	2.5	0
T	4.1	1
U	-50.6	-10
V	-21.4	-4
W	19.8	4
X	0.0	0
Y	-19.4	-4
Z	-7.0	-1
Junction 15		
AD	-6.4	-1
AE	-11.7	-2
AF	8.6	2
AG	-14.2	-3
AH	-7.2	-1

Junction	Max Difference Between Real and Modelled (m)	AM Max PCUs Difference
AECOM. Surveys 2015		
Site 1		
A1	63.8	13
A2	41.9	8
B1	19.9	4
C1	28.3	6
C2	42.9	8
D1	-45.6	-9
D2	-3.4	-1
D3	20.7	4
Site 2		
A1	-2.5	0
A2	10.9	2
A3	33.0	6
B1	18.5	4
B2	49.2	10
B3	21.7	4
C1	7.4	1
C2	4.4	1
Site 6		
A1	-150.4	-29
A2	-19.0	-4
A3	53.8	11
A4	28.6	6
B1	11.3	2
B2	-8.0	-2
B3	0.0	0
C1	-220.0	-43
C2	-154.2	-30
C3	-26.0	-5
D1	76.7	15
D2	-78.8	-15
Site 7		
A1	-7.9	-2
A2	17.1	3
B1	6.0	1
B2	-14.5	-3
B3	30.0	6
C1	29.3	6
C2	15.7	3
Site 8		
A1	-6.5	-1
A2	23.8	5
B1	11.0	2
B2	-10.5	-2
B3	7.7	2
C1	-27.0	-5

Junction	Max Difference Between Real and Modelled (m)	AM Max PCUs Difference
C2	-29.7	-6
C3	3.6	1
D1	-3.2	-1
D2	21.9	4
NCC. Surveys 2015		
2		
2	36.0	7
4	69.1	14
5	50.5	10
1A	65.6	13
1B	35.6	7
3A	-31.2	-6
3B	-23.5	-5
3		
1	47.5	9
2A	21.9	4
2B	20.0	4
2C	-12.3	-2
3A	19.3	4
3B	25.7	5
8		
1	-96.1	-19
2	29.2	6
3	-10.7	-2
4	31.5	6
5	-29.6	-6
6	2.2	0
7	57.7	11
8	104.6	21
1A		
1A	2.5	0
1B	0.5	0
2A	-50.9	-10
2B	-54.6	-11
2C	95.0	19
3A	-12.6	-2
3B	19.0	4
3C	-24.2	-5
4A	-15.4	-3
4B	44.7	9
4C	-34.3	-7
1B		
4	-71.2	-14
1A	0.4	0
1B	17.1	3
2A	-11.0	-2
2B	-37.7	-7

Junction	Max Difference Between Real and Modelled (m)	AM Max PCUs Difference
3A	10.0	2
3B	-83.1	-16

Table 2 IP Queue Comparison

IP Queue Survey	Max queue (metres)
Area 1. New Surveys 2016	
JUNCTION 1	10.0
A	10.0
B	0.0
C	0.0
JUNCTION 4	31.4
D	28.41
E	30.78
F	20.63
G	31.41
JUNCTION 7/8	27.3
H	25.86
I	27.31
J	10.72
K	5.11
L	0.00
Area 2. New Surveys 2016	
J4	15.0
Kings Road Eastbound	10.00
S Beach Parade Northbound	5.00
S Beach Parade Southbound	15.00
Area 3. New Surveys 2016	
Junction 13	41.9
M	20.59
N	37.76
O	30.71
P	20.38
Q	31.29
R	41.89
Junction 14	51.9
AA	35.28
AB	16.61
AC	0.00
S	51.90
T	25.95
U	5.27
V	19.50
W	19.50
X	0.00

IP Queue Survey	Max queue (metres)
Y	0.00
Z	0.00
Junction 15	58.2
AD	38.41
AE	32.82
AF	58.20
AG	31.41
AH	20.95
Junction 18	0.0
AI	0.00
AJ	0.00
AK	0.00
Junction 20	0.0
AL	0.00
AM	0.00
AN	0.00
AO	0.00
AECOM. Surveys 2015	
Site 1	99.0
A1	72.00
A2	57.00
B1	27.00
C1	69.00
C2	87.00
D1	99.00
D2	27.00
D3	45.00
Site 2	108.0
A1	30.00
A2	24.00
A3	27.00
B1	54.00
B2	108.00
B3	42.00
C1	54.00
C2	54.00
Site 3	87.0
A1	87.00
A2	36.00
B1	39.00
B2	54.00
C1	48.00
C2	81.00
D1	39.00
D2	72.00
Site 4	114.0
A1	63.00
A2	96.00
B1	60.00

IP Queue Survey	Max queue (metres)
B2	60.00
B3	72.00
C1	114.00
C2	105.00
Site 5	135.0
A1	30.00
A2	48.00
B1	30.00
B2	93.00
B3	135.00
C1	66.00
C2	99.00
C3	90.00
D1	54.00
D2	114.00
D3	120.00
Site 6	135.0
A1	54.00
A2	54.00
A3	84.00
A4	57.00
B1	21.00
B2	42.00
B3	0.00
C1	78.00
C2	93.00
C3	24.00
D1	135.00
D2	135.00
Site 7	81.0
A1	45.00
A2	60.00
B1	81.00
B2	18.00
B3	27.00
C1	42.00
C2	24.00
Site 8	69.0
A1	27.00
A2	54.00
B1	69.00
B2	27.00
B3	18.00
C1	27.00
C2	54.00
C3	15.00
D1	30.00
D2	36.00
NCC. Surveys 2015	

IP Queue Survey	Max queue (metres)
2	142.5
2	115.00
4	105.00
5	142.50
1A	80.00
1B	50.00
3A	37.50
3B	120.00
3	137.5
1	137.50
2A	55.00
2B	60.00
2C	15.00
3A	75.00
3B	65.00
8	135.0
1	135.00
2	40.00
3	25.00
4	35.00
5	55.00
6	110.00
7	60.00
8	127.50
1A	140.0
1A	35.00
1B	35.00
2A	35.00
2B	92.50
2C	140.00
3A	55.00
3B	75.00
3C	15.00
4A	45.00
4B	132.50
4C	80.00
1B	110.0
4	70.00
1A	40.00
1B	65.25
2A	20.00
2B	15.00
3A	15.00
3B	110.00

Junction	IP Modelled Max Queue (m)
Area 1. New Surveys 2016	
JUNCTION 1	12.2
A	8.2
B	0.0
C	12.2
JUNCTION 4	42.3
D	42.3
E	21.4
F	33.7
G	38.7
JUNCTION 7/8	34.6
H	23.5
I	34.6
J	16.3
K	25.5
L	6.1
Area 2. New Surveys 2016	
J4	8.2
Kings Road Eastbound	6.1
S Beach Parade Northbound	8.2
S Beach Parade Southbound	0.0
Area 3. New Surveys 2016	
Junction 13	47.1
M	25.3
N	47.1
O	43.7
P	24.4
Q	24.5
R	23.5
Junction 14	44.9
AA	41.7
AB	15.3
AC	0.0
S	31.4
T	40.1
U	28.5
V	44.9
W	21.3
X	0.0
Y	22.1
Z	10.1
Junction 15	49.9
AD	20.2
AE	34.6
AF	49.9
AG	32.5
AH	15.3
AECOM. Surveys 2015	

Junction	IP Modelled Max Queue (m)
Site 1	93.0
A1	17.1
A2	20.0
B1	18.1
C1	67.9
C2	43.9
D1	93.0
D2	14.2
D3	22.2
Site 2	43.9
A1	21.4
A2	11.2
A3	10.2
B1	30.6
B2	35.4
B3	25.5
C1	43.9
C2	43.9
Site 6	182.4
A1	122.6
A2	66.2
A3	32.2
A4	26.3
B1	13.2
B2	30.4
B3	0.0
C1	182.4
C2	127.9
C3	41.6
D1	30.3
D2	115.8
Site 7	66.1
A1	59.1
A2	50.2
B1	66.1
B2	26.0
B3	0.0
C1	30.5
C2	18.2
Site 8	46.3
A1	26.9
A2	18.4
B1	25.5
B2	20.3
B3	9.2
C1	34.2
C2	46.3
C3	16.3

Junction	IP Modelled Max Queue (m)
D1	40.5
D2	13.0
NCC. Surveys 2015	
2	82.7
2	48.6
4	78.9
5	82.7
1A	32.8
1B	32.8
3A	42.7
3B	67.5
3	79.2
1	79.2
2A	24.5
2B	46.8
2C	27.4
3A	30.9
3B	26.9
8	78.6
1	57.8
2	17.2
3	22.4
4	26.5
5	64.7
6	78.6
7	40.3
8	53.4
1A	113.8
1A	33.6
1B	42.6
2A	73.7
2B	113.8
2C	57.9
3A	76.7
3B	64.1
3C	47.9
4A	46.8
4B	87.4
4C	96.6
1B	143.5
4	111.1
1A	32.6
1B	62.6
2A	26.3
2B	13.3
3A	0.0
3B	143.5

Junction	Max Difference Between Real and Modelled (m)	IP Max PCUs Difference
Area 1. New Surveys 2016		
JUNCTION 1		
A	1.8	0
B	0.0	0
C	-12.2	-2
JUNCTION 4		
D	-13.9	-3
E	9.4	2
F	-13.0	-3
G	-7.2	-1
JUNCTION 7/8		
H	2.4	0
I	-7.3	-1
J	-5.6	-1
K	-20.4	-4
L	-6.1	-1
Area 2. New Surveys 2016		
J4		
Kings Road Eastbound	3.9	1
S Beach Parade Northbound	-3.2	-1
S Beach Parade Southbound	15.0	3
Area 3. New Surveys 2016		
Junction 13		
M	-4.7	-1
N	-9.4	-2
O	-12.9	-3
P	-4.0	-1
Q	6.8	1
R	18.4	4
Junction 14		
AA	-6.4	-1
AB	1.3	0
AC	0.0	0
S	20.5	4
T	-14.1	-3
U	-23.2	-5
V	-25.4	-5
W	-1.8	0
X	0.0	0
Y	-22.1	-4
Z	-10.1	-2
Junction 15		
AD	18.2	4
AE	-1.8	0
AF	8.3	2
AG	-1.1	0
AH	5.6	1

AECOM. Surveys 2015		
Site 1		
A1	54.9	11
A2	37.0	7
B1	8.9	2
C1	1.1	0
C2	43.1	8
D1	6.0	1
D2	12.8	3
D3	22.8	4
Site 2		
A1	8.6	2
A2	12.8	3
A3	16.8	3
B1	23.4	5
B2	72.6	14
B3	16.5	3
C1	10.1	2
C2	10.1	2
Site 6		
A1	-68.6	-13
A2	-12.2	-2
A3	51.8	10
A4	30.7	6
B1	7.8	2
B2	11.6	2
B3	0.0	0
C1	-104.4	-20
C2	-34.9	-7
C3	-17.6	-3
D1	104.7	21
D2	19.2	4
Site 7		
A1	-14.1	-3
A2	9.8	2
B1	14.9	3
B2	-8.0	-2
B3	27.0	5
C1	11.5	2
C2	5.8	1
Site 8		
A1	0.1	0
A2	35.6	7
B1	43.5	9
B2	6.7	1
B3	8.8	2
C1	-7.2	-1
C2	7.7	2
C3	-1.3	0
D1	-10.5	-2

D2	23.0	5
NCC. Surveys 2015		
2		
2	66.4	13
4	26.1	5
5	59.8	12
1A	47.2	9
1B	17.2	3
3A	-5.2	-1
3B	52.5	10
3		
1	58.3	11
2A	30.5	6
2B	13.2	3
2C	-12.4	-2
3A	44.1	9
3B	38.1	7
8		
1	77.2	15
2	22.8	4
3	2.6	1
4	8.5	2
5	-9.7	-2
6	31.4	6
7	19.7	4
8	74.1	15
1A		
1A	1.4	0
1B	-7.6	-1
2A	-38.7	-8
2B	-21.3	-4
2C	82.1	16
3A	-21.7	-4
3B	10.9	2
3C	-32.9	-6
4A	-1.8	0
4B	45.1	9
4C	-16.6	-3
1B		
4	-41.1	-8
1A	7.4	1
1B	2.6	1
2A	-6.3	-1
2B	1.7	0
3A	15.0	3
3B	-33.5	-7

Table 3 PM Queue Comparison

PM Queue Survey	Max queue (metres)
Area 1. New Surveys 2016	
JUNCTION 1	4.9
A	4.9
B	0.0
C	0.0
JUNCTION 4	59.6
D	28.73
E	30.91
F	52.92
G	59.58
JUNCTION 7/8	42.5
H	25.00
I	42.55
J	21.27
K	10.48
L	4.76
Area 2. New Surveys 2016	
J4	10.0
Kings Road Eastbound	5.00
S Beach Parade Northbound	10.00
S Beach Parade Southbound	0.00
Area 3. New Surveys 2016	
Junction 13	44.6
M	21.74
N	25.96
O	20.24
P	1.42
Q	0.00
R	44.61
Junction 14	56.7
AA	45.55
AB	35.98
AC	0.00
S	41.20
T	35.34
U	10.96
V	36.36
W	56.68
X	0.00
Y	0.00
Z	0.00
Junction 15	62.0
AD	25.72
AE	42.98
AF	61.99

PM Queue Survey	Max queue (metres)
AG	21.96
AH	15.18
Junction 18	53.1
AI	51.60
AJ	53.06
AK	15.47
Junction 20	45.0
AL	21.11
AM	38.01
AN	37.02
AO	45.00
AECOM. Surveys 2015	
Site 1	108.0
A1	75.00
A2	60.00
B1	33.00
C1	108.00
C2	105.00
D1	105.00
D2	18.00
D3	54.00
Site 2	123.0
A1	30.00
A2	30.00
A3	69.00
B1	123.00
B2	87.00
B3	42.00
C1	57.00
C2	54.00
Site 3	132.0
A1	75.00
A2	30.00
B1	39.00
B2	42.00
C1	114.00
C2	132.00
D1	39.00
D2	63.00
Site 4	108.0
A1	105.00
A2	99.00
B1	63.00
B2	78.00
B3	78.00
C1	96.00
C2	108.00
Site 5	138.0
A1	39.00

PM Queue Survey	Max queue (metres)
A2	36.00
B1	42.00
B2	120.00
B3	138.00
C1	81.00
C2	111.00
C3	39.00
D1	69.00
D2	111.00
D3	102.00
Site 6	126.0
A1	84.00
A2	57.00
A3	84.00
A4	36.00
B1	21.00
B2	66.00
B3	0.00
C1	108.00
C2	96.00
C3	18.00
D1	84.00
D2	126.00
Site 7	84.0
A1	54.00
A2	84.00
B1	57.00
B2	24.00
B3	27.00
C1	72.00
C2	36.00
Site 8	66.0
A1	54.00
A2	66.00
B1	54.00
B2	21.00
B3	42.00
C1	27.00
C2	54.00
C3	12.00
D1	51.00
D2	42.00
NCC. Surveys 2015	
2	127.5
2	65.00
4	112.50
5	125.00
1A	127.50
1B	75.00

PM Queue Survey	Max queue (metres)
3A	82.50
3B	120.00
3	125.0
1	125.00
2A	95.00
2B	85.00
2C	20.00
3A	92.50
3B	65.00
8	140.0
1	115.00
2	30.00
3	50.00
4	40.00
5	125.00
6	122.50
7	65.00
8	140.00
1A	150.0
1A	35.00
1B	40.00
2A	37.50
2B	150.00
2C	150.00
3A	75.00
3B	90.00
3C	40.00
4A	35.00
4B	120.00
4C	132.50
1B	132.5
4	120.00
1A	30.00
1B	70.00
2A	30.00
2B	20.00
3A	5.00
3B	132.50

Junction	PM Modelled Max Queue (m)
Area 1. New Surveys 2016	
JUNCTION 1	13.3
A	8.2
B	0.0
C	13.3
JUNCTION 4	52.9
D	52.9
E	21.4
F	47.9
G	49.0
JUNCTION 7/8	38.6
H	22.4
I	38.6
J	14.3
K	25.5
L	0.0
Area 2. New Surveys 2016	
J4	18.4
Kings Road Eastbound	0.0
S Beach Parade Northbound	18.4
S Beach Parade Southbound	0.0
Area 3. New Surveys 2016	
Junction 13	67.3
M	33.7
N	57.0
O	67.3
P	20.3
Q	26.4
R	27.5
Junction 14	75.4
AA	39.8
AB	19.3
AC	0.0
S	51.3
T	64.9
U	64.9
V	75.4
W	33.7
X	0.0
Y	25.3
Z	12.1
Junction 15	39.8
AD	19.4
AE	35.7
AF	39.8
AG	35.7
AH	15.3
AECOM. Surveys 2015	

Junction	PM Modelled Max Queue (m)
Site 1	169.7
A1	21.2
A2	23.5
B1	34.5
C1	169.7
C2	139.6
D1	120.6
D2	44.7
D3	29.3
Site 2	97.5
A1	19.4
A2	0.0
A3	0.0
B1	90.2
B2	97.5
B3	27.5
C1	96.9
C2	96.9
Site 6	392.5
A1	147.4
A2	68.1
A3	18.4
A4	21.2
B1	21.4
B2	69.0
B3	0.0
C1	392.5
C2	343.3
C3	43.7
D1	33.2
D2	273.8
Site 7	134.5
A1	134.5
A2	50.9
B1	84.2
B2	32.6
B3	0.0
C1	51.9
C2	23.4
Site 8	141.9
A1	104.0
A2	116.2
B1	85.0
B2	35.2
B3	19.4
C1	41.8
C2	49.0
C3	15.3

Junction	PM Modelled Max Queue (m)
D1	141.9
D2	18.3
NCC. Surveys 2015	
2	139.4
2	56.5
4	75.2
5	94.2
1A	32.4
1B	32.4
3A	118.0
3B	139.4
3	66.4
1	66.4
2A	38.7
2B	55.9
2C	32.5
3A	31.5
3B	38.1
8	116.8
1	102.8
2	17.2
3	34.6
4	26.4
5	110.2
6	116.8
7	40.3
8	76.5
1A	169.1
1A	42.7
1B	41.2
2A	159.9
2B	169.1
2C	45.8
3A	82.8
3B	75.7
3C	62.5
4A	38.7
4B	96.3
4C	103.5
1B	208.6
4	162.9
1A	47.8
1B	72.8
2A	21.2
2B	12.1
3A	0.0
3B	208.6

Junction	Max Difference Between Real and Modelled (m)	PM Max PCUs Difference
Area 1. New Surveys 2016		
JUNCTION 1		
A	-3.2	-1.0
B	0.0	0.0
C	-13.3	-3.0
JUNCTION 4		
D	-24.2	-5.0
E	9.5	2.0
F	5.0	1.0
G	10.6	2.0
JUNCTION 7/8		
H	2.6	1.0
I	4.0	1.0
J	7.0	1.0
K	-15.0	-3.0
L	4.8	1.0
Area 2. New Surveys 2016		
J4		
Kings Road Eastbound	5.0	1.0
S Beach Parade Northbound	-8.4	-2.0
S Beach Parade Southbound	0.0	0.0
Area 3. New Surveys 2016		
Junction 13		
M	-11.9	-2.0
N	-31.1	-6.0
O	-47.1	-9.0
P	-18.9	-4.0
Q	-26.4	-5.0
R	17.1	3.0
Junction 14		
AA	5.8	1.0
AB	16.7	3.0
AC	0.0	0.0
S	-10.1	-2.0
T	-29.5	-6.0
U	-53.9	-11.0
V	-39.0	-8.0
W	23.0	5.0
X	0.0	0.0
Y	-25.3	-5.0
Z	-12.1	-2.0
Junction 15		
AD	6.3	1.0
AE	7.3	1.0
AF	22.2	4.0
AG	-13.7	-3.0
AH	-0.1	0.0

Junction	Max Difference Between Real and Modelled (m)	PM Max PCUs Difference
AECOM. Surveys 2015		
Site 1		
A1	53.8	11.0
A2	36.5	7.0
B1	-1.5	0.0
C1	-61.7	-12.0
C2	-34.6	-7.0
D1	-15.6	-3.0
D2	-26.7	-5.0
D3	24.7	5.0
Site 2		
A1	10.6	2.0
A2	30.0	6.0
A3	69.0	14.0
B1	32.8	6.0
B2	-10.5	-2.0
B3	14.5	3.0
C1	-39.9	-8.0
C2	-42.9	-8.0
Site 6		
A1	-63.4	-12.0
A2	-11.1	-2.0
A3	65.6	13.0
A4	14.8	3.0
B1	-0.4	0.0
B2	-3.0	-1.0
B3	0.0	0.0
C1	-284.5	-56.0
C2	-247.3	-48.0
C3	-25.7	-5.0
D1	50.9	10.0
D2	-147.8	-29.0
Site 7		
A1	-80.5	-16.0
A2	33.1	6.0
B1	-27.2	-5.0
B2	-8.6	-2.0
B3	27.0	5.0
C1	20.1	4.0
C2	12.6	2.0
Site 8		
A1	-50.0	-10.0
A2	-50.2	-10.0
B1	-31.0	-6.0
B2	-14.2	-3.0
B3	22.6	4.0
C1	-14.8	-3.0

Junction	Max Difference Between Real and Modelled (m)	PM Max PCUs Difference
C2	5.0	1.0
C3	-3.3	-1.0
D1	-90.9	-18.0
D2	23.7	5.0
NCC. Surveys 2015		
2		
2	8.5	2.0
4	37.3	7.0
5	30.8	6.0
1A	95.1	19.0
1B	42.6	8.0
3A	-35.5	-7.0
3B	-19.4	-4.0
3		
1	58.6	11.0
2A	56.3	11.0
2B	29.1	6.0
2C	-12.5	-2.0
3A	61.0	12.0
3B	26.9	5.0
8		
1	12.2	2.0
2	12.8	3.0
3	15.4	3.0
4	13.6	3.0
5	14.8	3.0
6	5.7	1.0
7	24.7	5.0
8	63.5	12.0
1A		
1A	-7.7	-2.0
1B	-1.2	0.0
2A	-122.4	-24.0
2B	-19.1	-4.0
2C	104.2	20.0
3A	-7.8	-2.0
3B	14.3	3.0
3C	-22.5	-4.0
4A	-3.7	-1.0
4B	23.7	5.0
4C	29.0	6.0
1B		
4	-42.9	-8.0
1A	-17.8	-3.0
1B	-2.8	-1.0
2A	8.8	2.0
2B	7.9	2.0

Junction	Max Difference Between Real and Modelled (m)	PM Max PCUs Difference
3A	5.0	1.0
3B	-76.1	-15.0