M42 Junction 9 - 2014 Base Model

Local Model Validation Report

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1 Introduction

Background

1.1 JMP Consultants Ltd has been commissioned by the Highways Agency (HA) and Warwickshire County Council (WCC) to develop a fully calibrated and validated 2014 base year model of the M42 Junction 9 and the adjoining local network.

1.2 The base model has been developed using the micro-simulation package, S-Paramics and in line with current traffic modelling guidelines. This report provides details of the tasks and methodology undertaken to develop the base model, and provides details on the calibration and validation of the model.

Objectives

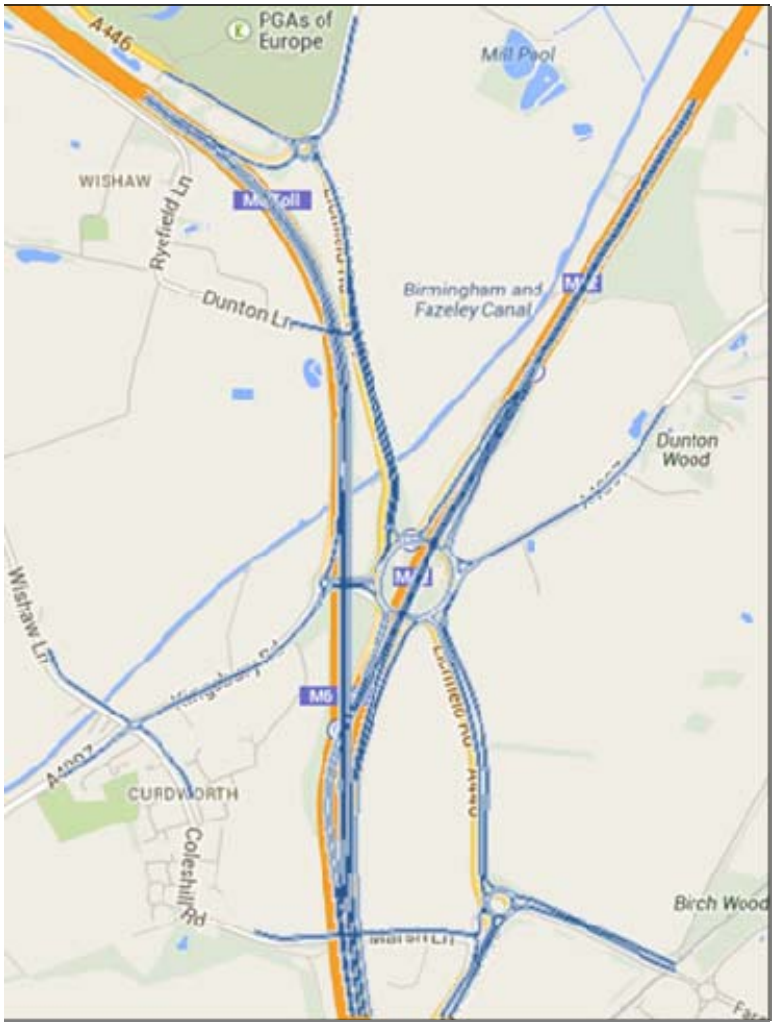
1.3 The aim of this commission has been to produce a calibrated and validated base model of M42 Junction 9 for the AM (07:00 to 10:00) and PM (16:00 to 19:00) periods.

Model Extent

1.4 The network has been developed to cover an area as captured in Figure 1.1 below and includes the following junctions:

- M42 Junction 9
- A446 / A4091 / Lichfield Road / M6 Toll
- A446 / Dunton Lane
- A4097 / Coleshill Road / Kingsbury Road / Wishaw Lane
- A446 / Faraday Avenue / Lichfield Road / Marsh Lane

Figure 1.1 M42 Junction 9 2014 Base Model Extent



Purpose of Report

1.5 The objective of this report is to summarise all the aspects of the base year model and determine that the model has been calibrated and validated to a level in line with its intended use for the study of future year demand forecasting and scheme assessment.

Report Structure

1.6 Chapter 2 of this report includes a summary of the data that was used in the model development process.

1.7 Chapter 3 and 4 provide an overview of network inclusions and matrix development process.

1.8 Chapter 5 and 6 provide details of the model calibration and validation process and presents the final results.

1.9 Chapter 7 provides the summary and conclusions.

2 Survey Data

Data Sources

2.1 A number of data sources have been utilised in the development of the 2014 base model, including:

- Road infrastructure information from digital mapping,
- Manual Classified Count surveys,
- Queue length surveys, and
- Journey time surveys.

Traffic Surveys

2.2 A programme of weekday traffic surveys was carried out by Traffic Survey Partners (TSP) Ltd on Tuesday 25th February 2014, to provide travel demand information for the network. The survey programme is presented in Table 2.1 and the specification summarised below:

- Manual Classified Counts (MCC) – 15 minute count intervals for the AM period 07:00 to 10:00 and PM period 16:00 to 19:00.
- Queue length Surveys – Queues in metres recorded at 15 minute intervals across the AM period 07:30 to 09:30 and PM period 16:30 to 18:30.
- Journey Time Surveys – 16 runs for each route during the AM period 07:30 to 09:30 and the PM period 16:30 to 18:30.

Table 2.1 Survey Programme

Junction / Route	Survey Specification
A446 / Lichfield Rd / Dunton Ln	MCCs & Queue surveys
A446 / Faraday Ave / Lichfield Rd / Marsh Ln	MCCs & Queue surveys
M42 Junction 9	Queue surveys
Kingsbury road. M6 Toll roundabout	Queue surveys
A4097 / Coleshill Road / Kingsbury Road / Wishaw Lane	Queue surveys
A446 / A4091 / Lichfield Rd / M6 Toll Slip	Queue surveys
A446 / A4091 / M6 Toll to A446 / Faraday Ave / Marsh Ln	Journey Time Survey

2.3 Existing MCC data, collected by PCC in November 2013, was also made available by the HA for the following junctions;

- M42 Junction 9
- Kingsbury Road / M6 Toll roundabout
- A4097 / Coleshill Road / Kingsbury Road / Wishaw Lane
- A446 / A4091 / Lichfield Rd / M6 Toll Slip

2.4 ATC data (collected by PCC in November 2013) on Kingsbury Road (west of A4097 / Coleshill Rd / Wishaw Ln) and on A446 Lichfield Road (between Dunton Lane and Junction 9) was also used in model development.

3 NETWORK DEVELOPMENT

Time period

3.1 The following time periods were modelled:

- AM Peak Period: 07:00 – 10:00
- PM Peak Period: 16:00 – 19:00

3.2 S-Paramics version 2011.1 has been used in the development, calibration and validation of the 2014 M42 Junction 9 Base model.

Traffic Signals

3.3 M42 Junction 9 is a signalised roundabout which comprises six arms, with circulating links of up to five lanes. There are no other signals in the model area.

3.4 M42 Junction 9 is Microprocessor Optimised Vehicle Actuation (MOVA) controlled. MOVA optimises the signal timings on the roundabout by meeting the demand requirements and altering green time.

3.5 Fixed signal timings were optimised to represent the MOVA control for the M42 junction 9.

Zone System

3.6 Zones within a traffic model provide loading points where traffic can enter the model. In this model the zone system is defined by route zones only. Each of the roads included in the model has a zone, which is added into the model via a zone connector. Table 3.1 presents details of the modelled zones.

Table 3.1 Model Zones

Zone Number	Description
1	M6 Toll (North)
2	A446 Lichfield Road (North)
3	A4091
4	M42 (North of J9)
5	A4097 Kingsbury Road (East)
6	Faraday Avenue
7	A446 Lichfield Road (South)
8	Marsh Lane
9	M42 (South of J9)
10	Coleshill Road
11	A4097 Kingsbury Road (W)
12	Wishaw Lane
13	Dunton Lane
14	M42 (South of J9) [left lane]

Link Classification

3.7 From the outset a detailed set of road class categories were identified to form a sensible routeing pattern in case the model would be expanded to include route choice in the future.

3.8 The first level of route definition is the distinction between major and minor links. A major link is categorised as a signposted or heavily trafficked route.

3.9 There are four main link categories as follows:

- 30mph minor route, cost of 1.0; Minor or Unclassified Access Roads
- 40mph major route, cost of 1.2; Local Distributors such as 'B Roads'
- 50-60mph major route, cost of 1.0; Primary Signposted Routes Such as 'A Roads'
- 70mph major route, cost of 0.7; Major Signposted Routes such as Motorways

3.10 The model seeks to replicate the route hierarchy as seen on the ground where roads are classified by purpose and their regional importance.

3.11 All links have been coded to the operating carriageway width and speed limits as described on the OS plan and derived from online mapping.

3.12 In summary, the 'physical' network in the model has been calibrated for the model area and reflects existing network conditions in February 2014 in line with the available data and data gathered during recent surveys.

Junction Calibration

3.13 Junction modifiers were applied throughout the network to allow the replication of vehicle behaviour and traffic throughput at the primary junctions and roundabouts in the network. Junction calibration parameters are included in S-Paramics to allow reflection of observed traffic flow and queue levels at individual junctions.

3.14 A standard 10m visibility value was initially applied at all roundabout approach arms in the network. During the calibration process, junction visibility values and gap acceptance values (lane merge / lane cross / path cross) were revised, to allow the model to replicate the junction capacity and vehicles queuing levels observed.

3.15 Vehicle maximum speeds were reduced from the default values to 75mph for cars and LGVs, and to 65mph for OGV1 and OGV2 vehicle types.

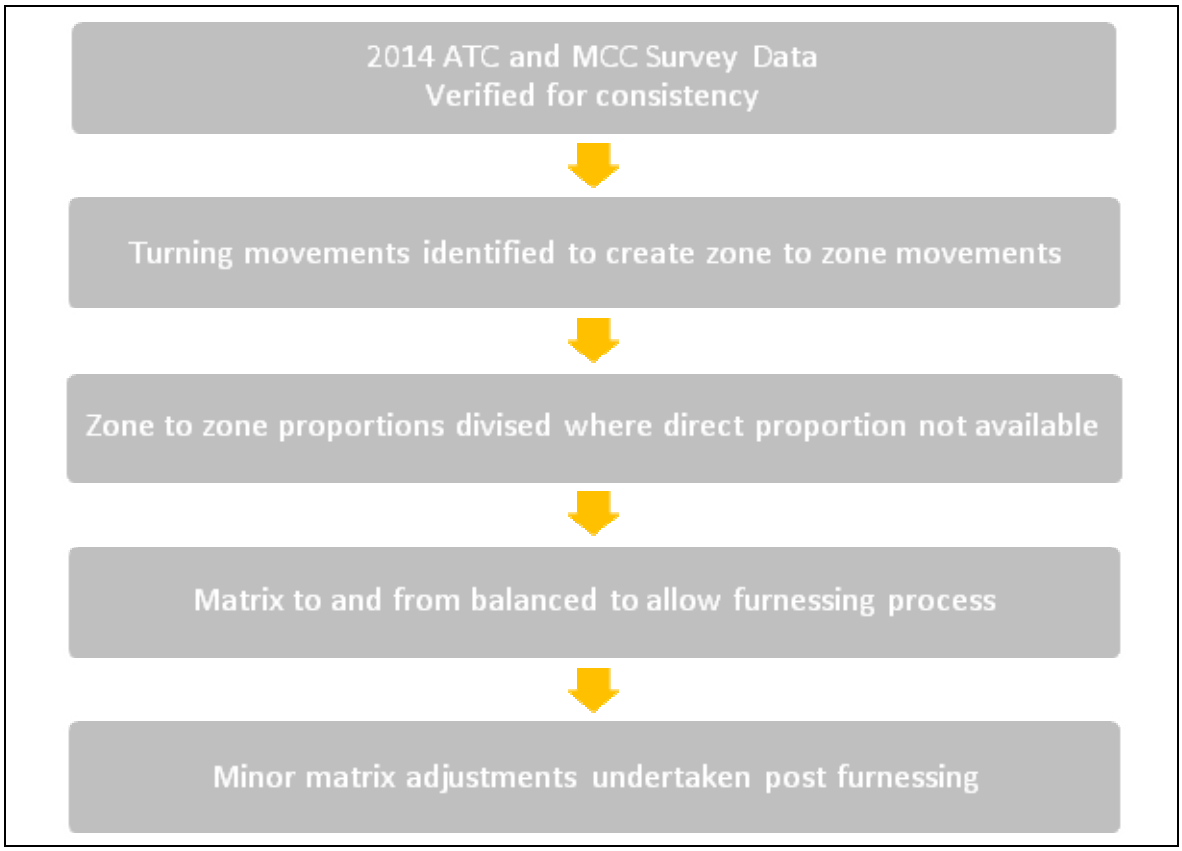
4 TRIP MATRIX DEVELOPMENT

Introduction

4.1 The development of the 2014 trip matrices utilised the relevant information obtained during the data collection exercise. Matrices were derived from the surveyed turn and link count data, with additional data for the M42 and M6 Toll mainline informed by the TRADS database. The detailed methodology to create the demand matrices is discussed in this section.

4.2 Figure 4.1 provides a flow chart representing the basic procedures followed to develop the prior matrices and then refine the model's calibration and routeing.

Figure 4.1 Matrix Development Flow Chart



Matrix Construction

4.3 Once the survey data had been checked for consistency, separate light and heavy turn counts were used to create prior matrices. Working from the origin zone the first turn count was multiplied by the percentage making the next turn and so on until the destination zone.

4.4 The prior matrices were then used to check the totals to and from zones against link counts. There were slight differences between row and column totals with the link counts so the matrices were furnessed. The furnessed matrices were used in the base model as the initial demand matrices.

4.5 A summary of the total derived trip matrices is provided in the tables below.

Table 4.1 AM Demand Matrix Totals

	07:00 – 08:00	08:00 – 09:00	09:00 – 10:00	Period Total
Matrix 1 – Lights	12,592	12,418	9,539	34,549
Matrix 2 - Heavies	2,486	2,238	2,189	6,913
TOTAL	15,078	14,656	11,728	41,462

Table 4.2 PM Demand Matrix Totals

	16:00 – 17:00	17:00 – 18:00	18:00 – 19:00	Period Total
Matrix 1 – Lights	12,925	13,499	10,535	36,959
Matrix 2 - Heavies	2,114	1,711	1,427	5,252
TOTAL	15,039	15,210	11,962	42,211

Demand Profiles

4.6 The release rate of traffic leaving each zone will vary throughout the model period. This is simulated by applying specific demand profiles to each zone.

4.7 The junction turn count data was evaluated to obtain the profiles over the modelled periods, 07:00 to 10:00 and 16:00 to 19:00, for both light and heavy vehicles.

4.8 In most cases a release profile was derived directly from the downstream junction approaches traffic volumes. In other cases, where this data was not available, a proxy profile was derived from surrounding locations. Separate light and heavy profiles were developed in this way.

5 MODEL CALIBRATION

Introduction

5.1 The model calibration process was carried out using the criteria specified in DMRB, Volume 12, Section 2, Part 1: Traffic Appraisal in Urban Areas. DMRB Volume 12 suggests individual link flows should have a GEH les than 5 in 85% of cases over a one hour interval.

5.2 The 2014 M42 Junction 9 Base model has been calibrated to vehicle link flows, in line with DMRB criteria, which have been derived from the surveyed turning counts. Turning counts and queue lengths have also been compared to observed data as part of the calibration process.

Calibration Criteria

5.3 The model calibration process has been carried out in accordance with the DMRB guidelines, summarised in Table 5.1.

Table 5.1 DMRB Guideline Model Acceptability Criteria

Criteria and Measure	Acceptability
Assigned Hourly Flows	
Individual flows within 100vph (flows<700vph)	85% of all cases
Individual flows within 15% (flows 700-2700vph)	85% of all cases
Individual flows within 400vph (flows>2700vph)	85% of all cases
GEH statistic: individual flows GEH<5	85% of all cases
Modelled Journey Times	
Times within 15% (or 1 minute, if higher)	85% of all cases

5.4 The GEH statistic is used during the calibration of a model to compare the difference between an observed flow and a modelled flow, and is defined as shown below:

$$GEH = \sqrt{\frac{2(Modelled-Observed)^2}{(Modelled+Observed)}}$$

5.5 The GEH statistic is used in preference to the absolute or relative flow difference as it can cope with a wide range of traffic flows. Where an absolute difference of 100 PCUs/hr can be important in a flow of 200 PCUs/hr it is largely irrelevant in a flow of several thousand PCUs/hr.

Model Stability

5.6 S-Paramics is not an equilibrium modelling software and is subject to minor variations in the assignment from one run to the next. This being the case, it is normal to use the mean link flow values derived from the multiple runs. The 2014 M42 Junction 9 Base model has been calibrated using 10 log runs. Due to the Base model not having route choice the stability assessment found that 3 model runs would have been sufficient for this model.

5.7 Full details of the stability assessment are given in Appendix A.

Traffic Flow Comparisons

DMRB Flow Criteria

5.8 DMRB Vol. 12 recommends comparisons with observed flows at an hourly level so each modelled hour has been assessed individually. Total flows across the 3 hours have been combined and assessed against the same criteria as an additional check.

5.9 The percentage of link and turn count locations meeting the DMRB criteria are summarised in the tables below. A total of 48 link flows and 69 turns have been assessed.

Table 5.2 Link Flow Calibration

	AM				PM			
	07 - 08:00	**08 - 09:00**	**09 - 10:00**	**07 – 10:00**	**16 - 17:00**	**17 - 18:00**	**18 - 19:00**	**16 – 19:00**
Obs <700vph	23	20	26	10	23	22	30	10
Mod within 100vph	23	20	26	9	23	22	29	10
% within DMRB	100%	100%	100%	90%	100%	100%	97%	100%
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Obs 700 to 2700vph	24	28	22	24	24	25	18	22
Mod within 15%	24	28	22	24	24	24	18	22
% within DMRB	100%	100%	100%	100%	100%	96%	100%	100%
Pass/Fail	-	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Obs > 2700vph	1	0	0	14	1	1	0	16
Mod within 400vph	1	0	0	14	1	1	0	16
% within DMRB	100%	-	-	100%	100%	100%	-	100%
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Table 5.3 Turn Flow Calibration

	AM				PM			
	07 - 08:00	**08 - 09:00**	**09 - 10:00**	**07 – 10:00**	**16 - 17:00**	**17 - 18:00**	**18 - 19:00**	**16 – 19:00**
Obs <700vph	62	61	65	50	62	62	65	47
Mod within 100vph	62	61	65	49	62	62	64	46
% within DMRB	100%	100%	100%	98%	100%	100%	98%	98%
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Obs 700 to 2700vph	7	8	4	16	7	7	4	18
Mod within 15%	6	8	4	16	7	7	3	17
% within DMRB	86%	100%	100%	100%	100%	100%	75%	94%
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Obs > 2700vph	0	0	0	3	0	0	0	4
Mod within 400vph	0	0	0	2	0	0	0	4
% within DMRB	-	-	-	67%	-	-	-	100%
Pass/Fail	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass

5.10 As more than 85% of the link flows meet DMRB's flow criteria for each simulated hour (and the 3 hour period as a whole), the Base model can be said to calibrate well to traffic flows.

5.11 An assessment of the turn flows against DMRBs criteria for flows indicates a very high level of calibration with only 7 turn flows out of a total of 552 fail to meet DMRB's criteria.

DMRB GEH Assessments

5.12 DMRB recommends that in more than 85% of cases the individual link flows should have a GEH value of less than five.

5.13 Table 5.4 and Table 5.5 present the percentage of link flow sites by GEH value for each modelled hour. For completeness Table 5.6 and Table 5.7 present the equivalent assessment based on the turn counts.

Table 5.4 AM Link Flow Comparison – GEH

	07:00 - 08:00		08:00 - 09:00		09:00 - 10:00	
Link Counts	48		48		48	
GEH ≤ 5	47		47		48	
%	98%		98%		100%	
GEH ≤						
6	47	98%	47	98%	48	100%
7	48	100%	48	100%	48	100%

Table 5.5 PM Link Flow Comparison – GEH

	16:00 - 17:00		17:00 - 18:00		18:00 - 19:00	
Link Counts	48		48		48	
GEH ≤ 5	48		47		48	
%	100%		98%		100%	
GEH ≤						
6	48	100%	48	100%	48	100%
7	48	100%	48	100%	48	100%

Table 5.6 AM Turn Flow Comparison – GEH

	07:00 - 08:00		08:00 - 09:00		09:00 - 10:00	
Turn Counts	69		69		69	
GEH ≤ 5	67		68		69	
%	97%		99%		100%	
GEH ≤						
6	67	97%	68	99%	69	100%
7	67	97%	68	99%	69	100%
8	68	99%	69	100%	69	100%
9	68	99%	69	100%	69	100%
10	68	99%	69	100%	69	100%

Table 5.7 PM Turn Flow Comparison – GEH

	16:00 - 17:00		17:00 - 18:00		18:00 - 19:00	
Turn Counts	69		69		69	
GEH ≤ 5	69		69		69	
%	100%		100%		100%	
GEH ≤						
6	69	100%	69	100%	69	100%
7	69	100%	69	100%	69	100%
8	69	100%	69	100%	69	100%
9	69	100%	69	100%	69	100%
10	69	100%	69	100%	69	100%

5.14 The tables above show that in the AM and PM periods, the percentage of links and turns with a GEH of less than 5 is greater than 85% in all periods. At least 98% of all link count locations have a GEH value of less than 5 and 97% of all turn counts. The Base model therefore meets the DMRB criteria and confirms that the model calibrates well.

5.15 Appendix B presents the link flow locations on a schematic of the network showing the GEH values and DMRBs flow criteria results for each peak hour. A full copy of the GEH assessments for all modelled hours for both links and turns is also included in Appendix B.

Correlation Analysis

5.16 A further form of comparison detailed in DMRB that can be used to demonstrate a 'goodness of model fit' is to undertake a correlation analysis between the modelled and observed flow data. This was undertaken for each modelled period using an X-Y scatter plot.

5.17 The X-Y scatter plot is a good way of presenting the variation in data in a pictorial format and illustrates the relationship between the observed and modelled turn counts in the model. AM and PM Scatter plots are presented in below.

Figure 5.1 Correlation Analysis: Modelled vs Observed Turn Counts (AM Period 07-10:00)

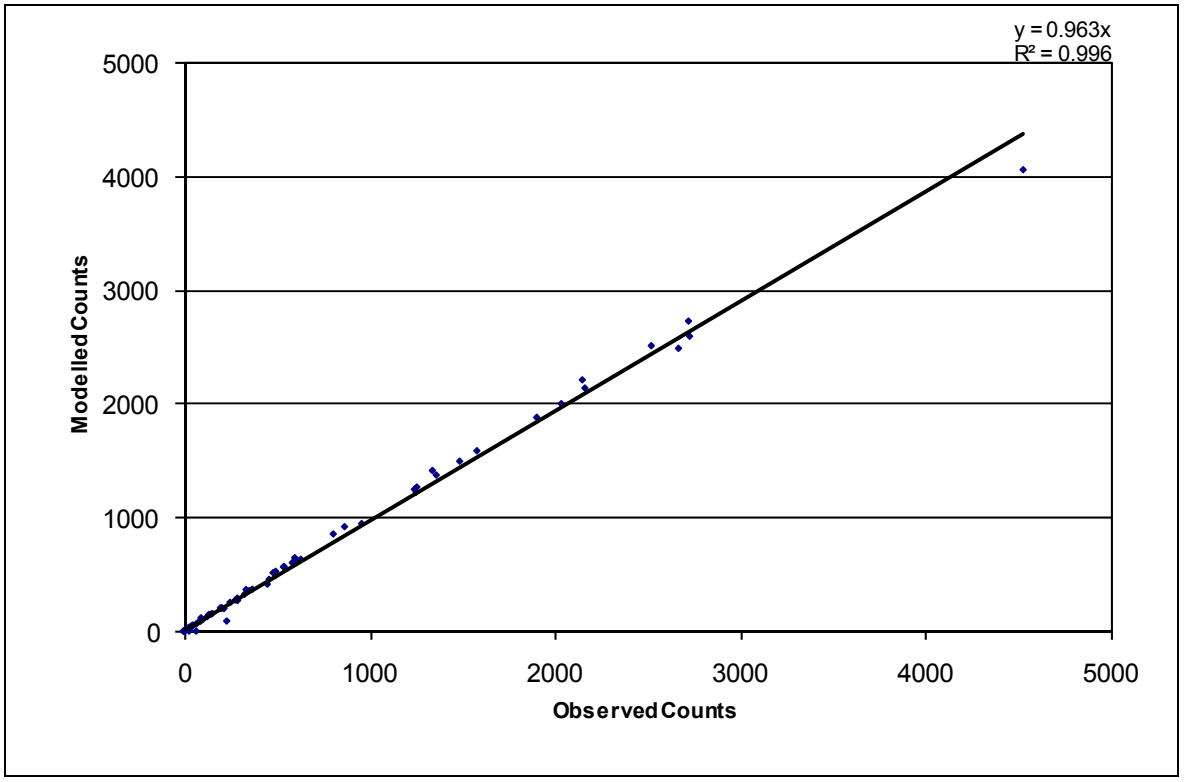
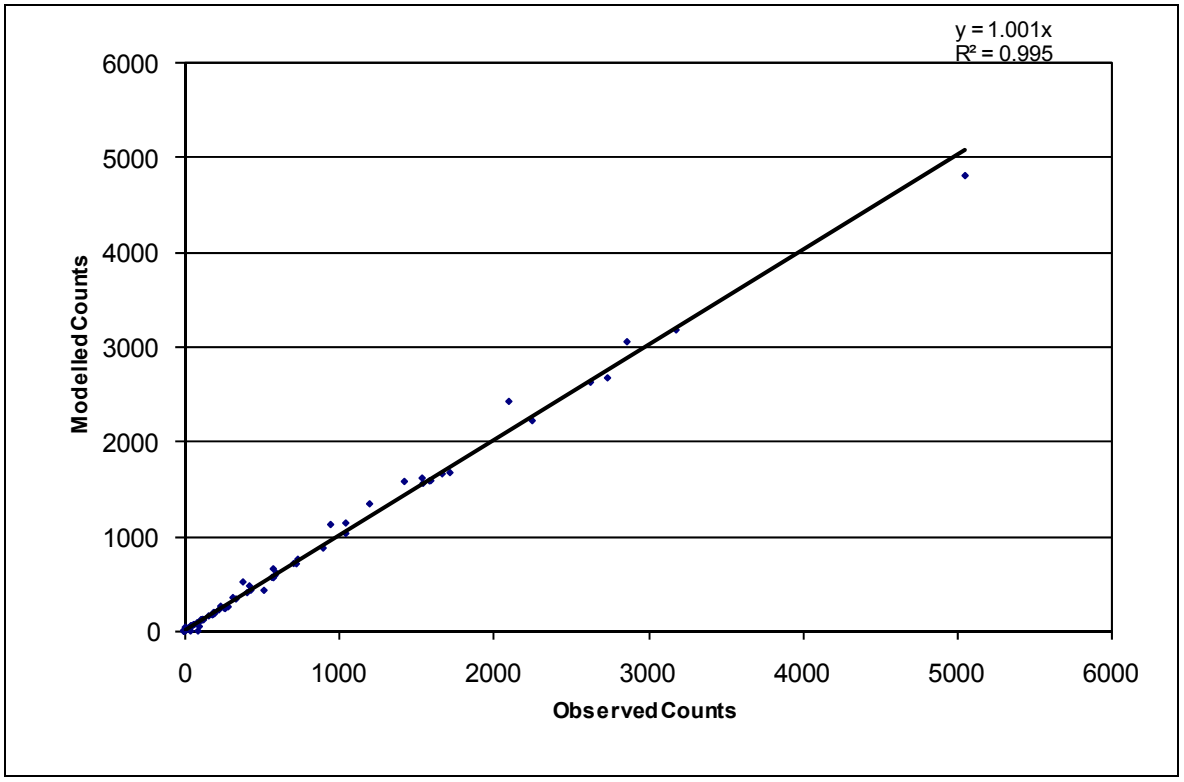


Figure 5.2 Correlation Analysis: Modelled vs Observed Turn Counts (PM Period 16-19:00)



5.18 The linear line of best fit through the data was plotted for comparative purposes. The closer the line of best fit is to the Y=X line, the closer the relationship between each of the observed and modelled flows.

5.19 The slope of the best-fit line through the origin for the modelled data provides an indication of whether modelled values are globally over or under estimated compared to the observed flows. DMRB suggests that acceptable gradient values for this line should be between 0.9 and 1.10. The line of best fit for the AM and PM modelled period are as follows:

- AM Period 07:00 – 10:00; $y = 0.9634x$
- PM Period 07:00 – 10:00; $y = 1.0019x$

5.20 As such, the gradient values satisfy the DMRB criteria.

5.21 In addition, the correlation coefficient (R) gives a measure of the 'goodness' of model fit. DMRB suggest that values of R should be above 0.95. For this reason, the coefficient of determination (R^2) was calculated for each modelled period to present the variability in the data set. This would suggest that R^2 values above 0.9025 (are within the acceptability guidelines set out in DMRB.

5.22 The correlation analysis shows an R^2 for the AM and PM modelled period as follows:

- AM period 07:00 – 10:00; $R^2 = 0.996$
- PM period 07:00 – 10:00; $R^2 = 0.995$

5.23 Both the AM and PM modelled periods therefore satisfy the DMRB criteria.

5.24 In a perfect match, the observed and assigned flows plotted would form a single line and show a positive correlation between each variable, i.e. the line of best fit would be Y=X. Given that traffic flows vary on a day to day basis and that modelling generally aims to simulate an average day then this realistically can never be achieved.

5.25 The results nonetheless show that for all periods the line of best fit closely matches the line Y=X. The results show a close relationship between the observed flows and those assigned within the model and a good level of calibration has been achieved.

Queue lengths

5.26 Queue lengths have been used to calibrate the Base model. DMRB does not specify criteria for queues, but this is included to show how the model compares to observed data.

5.27 Queue data was collected from 07:30 to 09:30 and 16:30 to 18:30 and the queue length observed per lane was recorded. The maximum queue length (metres) over all lanes was used to calibrate the Base model.

5.28 The mean maximum queue length (based on the average of the hour's 15 minute maximums) for the AM and PM peak hour is presented in Table 5.8 and Figure 5.3 highlights the site locations.

5.29 The queue analysis for the full survived period (i.e. including the 30 minutes either side of the peak hours) is provided in Appendix C.

Table 5.8 Maximum Queue Length Comparison (Peak Hours)

		0800-0900				1700-1800			
Site	Approach	Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference	
				m	vehs			m	vehs
Site 1	Dunton Ln	5	0	-5	-1	3	6	3	1
Site 2	Faraday Ave	68	49	-19	-3	54	160	106	18
	A446 (S)	21	26	5	1	38	50	13	2
	Marsh Ln	16	30	14	2	15	29	14	2
	A446 (N)	88	61	-27	-4	38	36	-1	0
Site 3	M42 (N)	49	63	14	2	45	63	18	3
	Kingsbury Rd (E)	51	85	34	6	38	62	24	4
	Lichfield Rd (S)	80	100	20	3	73	121	49	8
	M42 (S)	65	90	25	4	170	216	46	8
	Kingsbury Rd (W)	70	124	54	9	69	89	20	3
	Lichfield Rd (N)	201	191	-11	-2	83	201	119	20
Site 4	Kingsbury Rd (E)	0	22	22	4	0	16	16	3
	Kingsbury Rd (W)	11	28	16	3	36	24	-12	-2
Site 5	Kingsbury Rd (E)	6	7	1	0	25	18	-7	-1
	Coleshill Rd	13	11	-1	0	26	18	-8	-1
	Kingsbury Rd (W)	11	4	-7	-1	8	8	0	0
	Wishaw Ln	60	34	-26	-4	16	15	-2	0
Site 6	A4091	58	22	-36	-6	28	15	-12	-2
	Lichfield Rd (S)	38	27	-10	-2	25	35	10	2
	M6 diverge	16	25	9	1	13	24	11	2
	Lichfield Rd (N)	84	52	-32	-5	64	74	11	2

Figure 5.3 Queue Assessment Locations

5.30 From the comparison of modelled and observed queue lengths the 2014 Base model is shown to calibrate well to queues.

5.31 There are two locations where the queue length is significantly higher in the model compared to observed lengths. This occurs in the PM peak hour at the Lichfield Road (North) southbound approach to M42 Junction 9 and on the Faraday Avenue approach to Marsh Lane / Lichfield Road roundabout.

5.32 The link counts and queues calibrate well upstream and downstream of these locations as do the journey times on these sections. For this reason, and due to the known difficulties in using queue data in model development, it was deemed inappropriate to further refine the model network to replicate more closely the lengths recorded in the on street survey.

6 MODEL VALIDATION

Introduction

6.1 The 2014 Base model was validated to journey times that were independent to the calibration process. The validation is an independent check of the calibrated model.

Journey Time Comparisons

6.2 Journey time surveys were undertaken during the peak periods for two key routes within the model area as shown in Figure 6.1. Up to 10 journey time runs were undertaken for each route, in each direction, and for each peak period.

6.3 Journey times can be defined in S-Paramics and extracted over the modelled periods. Based on a series of 10 model runs, the journey times have been compared against observed data.

6.4 Sub-routes within each corridor were identified to match the observed journey time timing points. This was intended to enable more accurate assessment of the delay on the specific sections of the network.

Figure 6.1 Journey Paths

6.5 DMRB acceptability guidelines recommend that over a journey time route the modelled mean comparison should be within 1 minute or 15% of the observed, in 85% of cases.

6.6 Table 6.1 provides a summary of the AM Peak hour assessment of each individual route and the journey time corridor as a whole. The equivalent PM Peak hour data is summarised in Table 6.2.

6.7 The journey time comparisons have been plotted over time and are presented in Appendix D.

Table 6.1 Journey Time Validation (AM Peak: 08-09:00)

	Observed (hh:mm)			Modelled (hh:mm)			Difference		DMRB?	
	Min	Mean	Max	Min	Mean	Max	hh:mm	%		
Northbound_1	00:49	01:20	01:59	00:32	01:07	02:02	00:13	-16%	Yes	✓
Northbound_2	00:24	00:46	01:02	00:26	00:44	01:05	00:03	-6%	Yes	✓
Northbound_3	01:02	01:15	01:53	00:48	00:51	01:04	00:24	-32%	Yes	✓
Northbound	02:46	03:21	04:04	02:14	02:57	03:40	00:25	-12%	Yes	✓
Southbound_1	01:06	02:52	05:45	00:55	01:30	02:23	01:22	-48%	No	x
Southbound_2	00:27	00:47	01:10	00:20	00:35	01:04	00:12	-26%	Yes	✓
Southbound_3	00:46	00:51	00:57	00:35	00:40	00:56	00:11	-22%	Yes	✓
Southbound	02:33	04:31	07:45	02:01	02:48	03:46	01:43	-38%	No	x

Table 6.2 Journey Time Validation (PM Peak: 17-18:00)

	Observed (hh:mm)			Modelled (hh:mm)			Difference		DMRB?	
	Min	Mean	Max	Min	Mean	Max	hh:mm	%		
Northbound_1	00:55	01:10	01:51	00:32	00:51	01:27	00:19	-27%	Yes	✓
Northbound_2	00:36	01:08	02:03	00:24	00:58	01:33	00:10	-14%	Yes	✓
Northbound_3	01:14	01:33	02:22	01:53	02:30	03:09	00:57	62%	Yes	✓
Northbound	02:51	03:50	05:05	03:28	04:22	05:14	00:31	14%	Yes	✓
Southbound_1	01:04	01:33	02:34	00:58	01:36	02:46	00:03	3%	Yes	✓
Southbound_2	00:23	00:39	01:02	00:21	00:36	01:01	00:04	-9%	Yes	✓
Southbound_3	00:45	00:50	00:55	00:35	00:38	00:46	00:12	-24%	Yes	✓
Southbound	02:21	03:02	04:06	02:07	02:53	03:54	00:09	-5%	Yes	✓

6.8 Table 6.1 and Table 6.2 show that for all six journey time sub-routes 5 of the six calibrate to DMRB criteria in the AM (83%) and all of the journey times calibrate to DMRB criteria in the PM (100%).

6.9 To improve the AM validation the Lichfield Road southbound queue to M42 Junction 9 would have to increase between 08:00 and 09:00. As it stands the queue assessment indicates the model reflects queues on this approach in line with those observed during the site surveys.

7 Summary and Conclusions

Summary

7.1 The 2014 M42 Junction 9 Base model was jointly commissioned by the Highways Agency and Warwickshire County Council in January 2014 and covers the M42 Junction 9 / M6 Toll interchange; A4091 from its junction with A4091 in the north to Faraday Avenue junction to the south; and the A4097 / Wishaw Lane / Coleshill Road to the west. The 2014 Base model has been calibrated and validated using S-Paramics micro-simulation modelling software, version 2011.1.

7.2 Traffic surveys were conducted in February 2014 and observed traffic junction turn counts, queue lengths and journey times were recorded. The Base model has been developed to capture 3 hour AM (0700-1000) and 3 hour PM (1600-1900) hours.

7.3 The observed turn counts were used to derive a prior matrix that was then furnessed to give the Base demand matrices. The count data was also used to create release profiles applied to the modelled zones.

7.4 The model was calibrated to observed flows and queue lengths. For each of the AM modelled hours 100% of the modelled links met the DMRB flow criteria, and 98% of the links in the PM hours. The model also calibrated well to the DMRB GEH criteria with a minimum of 98% of all modelled hourly link flows, and 97% of turn counts, having a GEH value of less than 5.

7.5 In the AM peak period the modelled queues show a good match to the observed queues at all 21 junction approaches. In the PM peak hour 2 of the 21 sites had higher than observed queue lengths, namely on Faraday Avenue at the south of the model and at Lichfield Road (N) on the approach to the M42 Junction 9. However, calibration checks and journey time assessments provided confidence that the model was still realistic at these locations.

7.6 The Base model was validated to observed journey times. In the AM period the modelled journey time southbound along Lichfield Road to M42 Junction 9 was faster than the observed and does meet DMRB criteria at this location only. The modelled queue on the Lichfield (N) approach to M42 Junction 9 was a very close fit to the observed data which would no longer be the case if the journey time on Lichfield Road southbound was to be slowed down to achieve a closer journey time validation. The PM modelled journey times all meet the DMRB criteria.

Conclusions

This report has been produced to detail the 2014 M42 Junction 9 Base model development, and present the calibration and validation results.

Using detailed road network and traffic count data, the micro-simulation model has been successfully developed to reproduce traffic conditions for a typical weekday. The model calibrates well to the observed data and meets DMRB acceptability guidelines.

The model validation demonstrates that the observed and modelled journey times are consistent in terms of average journey times and the variation in journey time across multiple runs throughout the modelled peak periods.

It is therefore considered that this model is fit for considering future year forecasting, assessing any network enhancements, and for use in any future year testing.

Appendix A

Model Stability Assessment

The stability of a model is important when interpreting the results from a model as it ensures a stable average is achieved in terms of travel cost and flows. This also informs the user how many runs should be undertaken to meet the criteria as set out in DMRB Volume 12 Section 2 (pages 4/23 to 4/25 and Appendix H, particularly Appendix H2).

The objective of this assessment is to quantify the number of runs that should be undertaken to ensure a robust output is achieved.

The model was run 10 times in each peak period to undertake the model stability assessment. The results are presented in the tables below.

Table AppA.1 AM Model Stability

Comparison (# of runs)	AAD	RAAD	%FLOW	STDEV	Delta	V
3	0.48	0.05	100	82.35	0.01	0.00
4	0.45	0.03	100	89.54	0.01	0.02
5	0.31	0.02	100	97.06	0.01	0.02
6	0.25	0.02	100	96.73	0.01	0.03
7	0.23	0.02	100	98.69	0.01	0.07
8	0.18	0.02	100	98.37	0.00	0.04
9	0.18	0.01	100	100	0.01	0.03
10	0.14	0.01	100	100	0.00	0.00

Table AppA.2 PM Model Stability

Comparison (# of runs)	AAD	RAAD	%FLOW	STDEV	Delta	V
3	0.51	0.04	100	72.22	0.01	0.40
4	0.34	0.04	100	95.42	0.00	0.54
5	0.33	0.03	100	98.04	0.00	0.75
6	0.25	0.02	100	100	0.00	0.70
7	0.16	0.02	100	100	0.00	0.04
8	0.14	0.02	100	100	0.00	0.15
9	0.13	0.01	100	100	0.00	0.23
10	0.10	0.01	100	100	0.00	0.46

Where there are three runs, the statistics are calculated by comparing the average of Run-001 and Run-002 against the average of Run-001 to Run-003. In similar fashion, the statistics with six runs are calculated by comparing average of run-001 to run-005 against average of run-001 to Run-006, etc.

The definitions and acceptance criteria taken from DMRB (Volume 12 Section 2) are as follows:

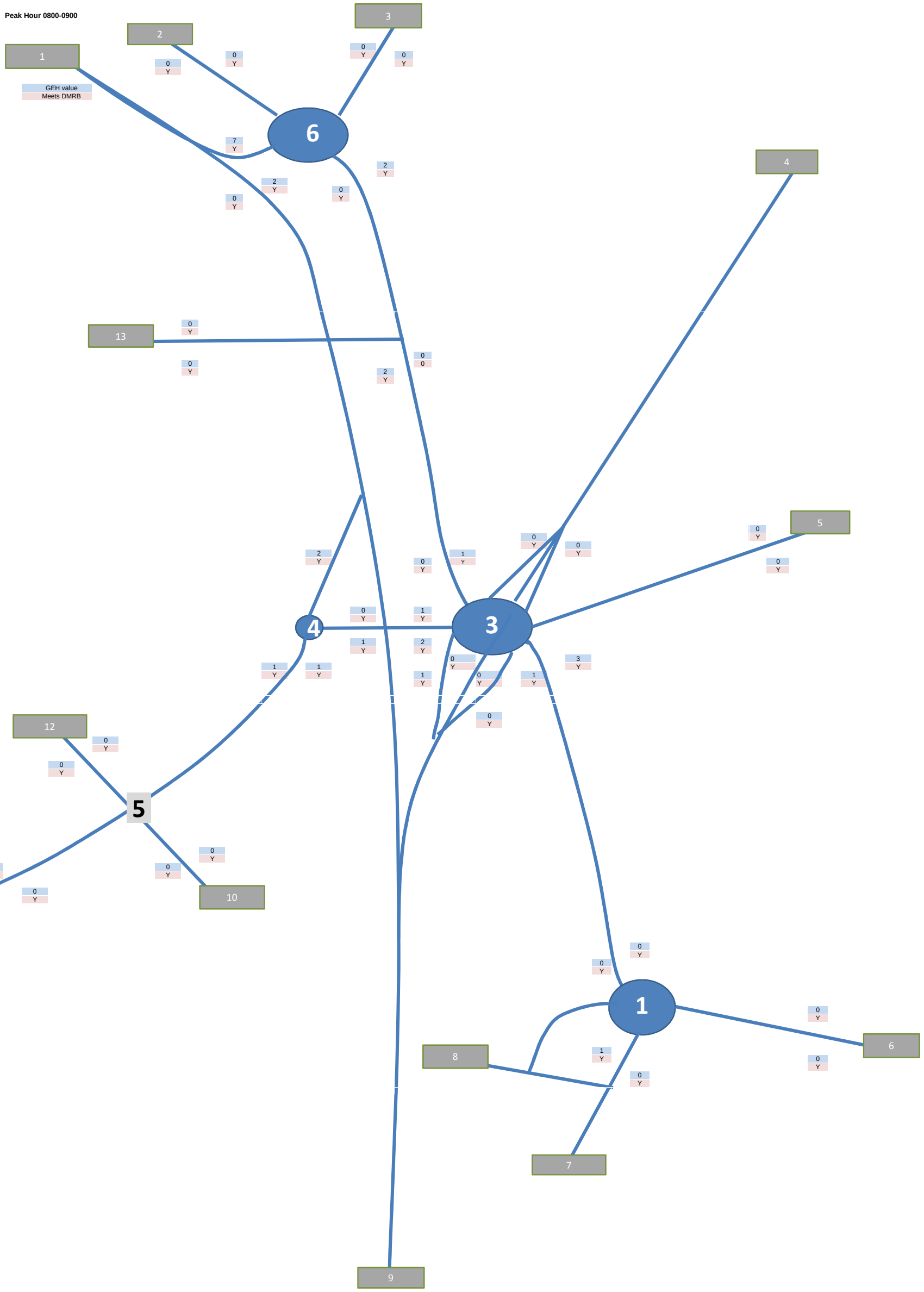
- AAD - The ‘Average Absolute Difference’ in link flows between successive iterations. This is deemed to be acceptable when less than 1.
- RAAD - The ‘Relative Average Absolute Difference’ in link flows between successive iterations. This is deemed to be acceptable when less than 1.

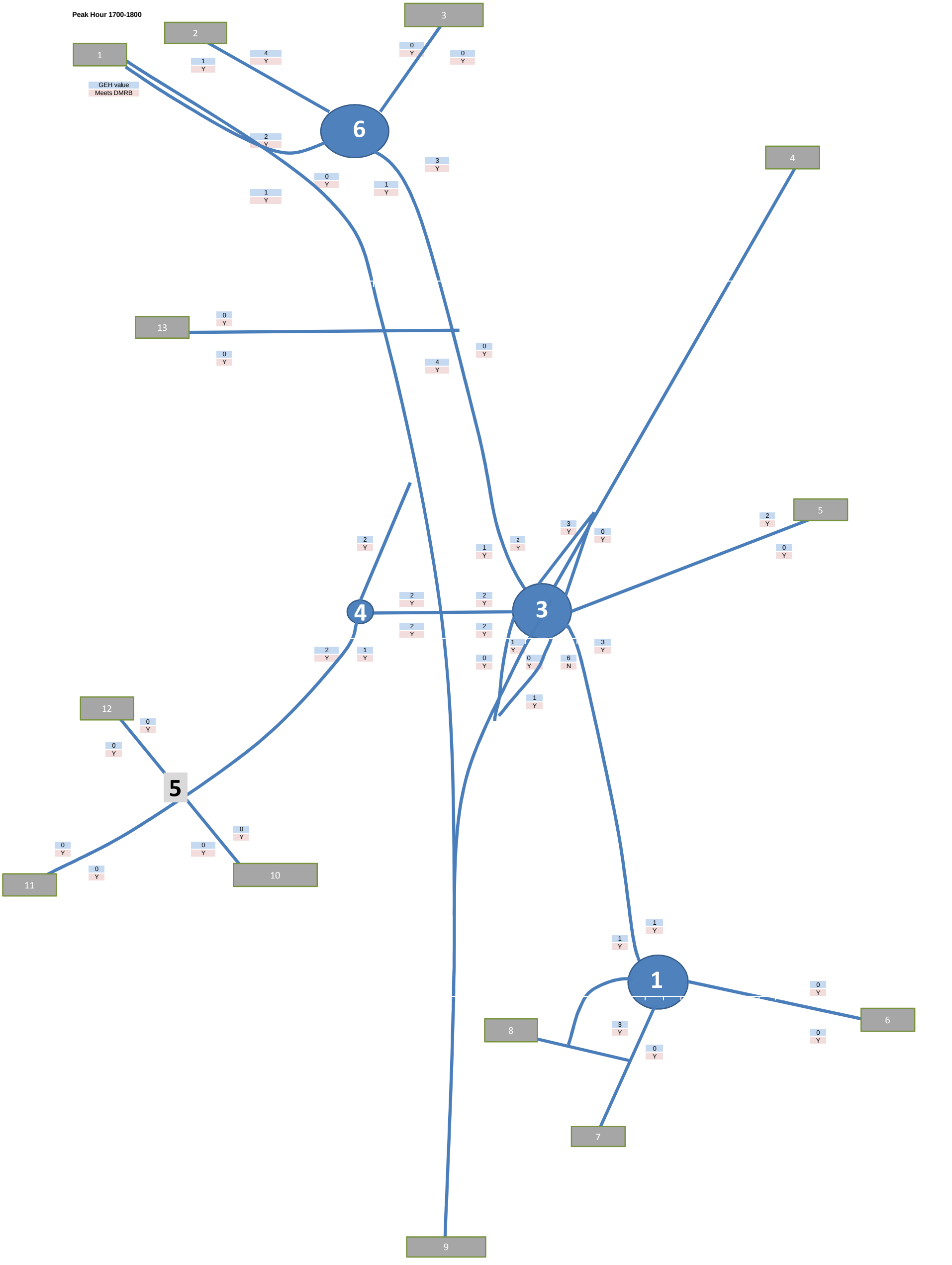
- %FLOW - The proportion of links in the overall network with flows changing less than 5% from the previous iteration. 95% of links must change less than 5% to fit the required criteria.
- STDEV - This is similar to %FLOW. It checks what %age of the current average link flows fall within the previous average +/- the standard deviation of that previous average. The same criterion applies.
- Delta - The Duality Gap, which expresses the flow weighted difference between current total cost estimates on the network and the costs if all traffic would use minimum cost routes as calculated by all-or-nothing assignment. This is deemed to be acceptable when less than 1.
- V - This is the percentage difference in average total travel time between successive runs. It is deemed acceptable when less than 1 for four successive runs.

The analysis shows that the model is stable at approximately 3 runs for both the AM and PM. However, results have been based on a set of 10 runs.

Appendix B

Calibration Results


Peak Hour 0800-0900
1
2
3
4
5
6
7
8
9
10
11
12
13
GEH value
Meets DMRB


Peak Hour 1700-1800
GEH value
Meets DMRB
1
2
3
4
5
6
7
8
9
10
11
12
13

AM Link Count Calibration

Refercence	Turncount	Junction No.	Arm	Name	Direction	Observed Total 08:00 Total	Observed Total 09:00 Total	Observed Total 10:00 Total	Observed Total Period	Modelled Total 08:00 Total	Modelled Total 09:00 Total	Modelled Total 10:00 Total	Modelled Total Period	Modelled Difference 08:00 Total	Modelled Difference 09:00 Total	Modelled Difference 10:00 Total	Modelled Difference Period	Modelled GEH 08:00 Total	Modelled GEH 09:00 Total	Modelled GEH 10:00 Total	Modelled GEH Period
						8	9	10													
1	1-L1	1	A	Faraday Ave	WB	329	292	307	928	321	294	302	917	-8	2	-5	-11	0.4	0.1	0.3	0.4
2	1-L2	1	A	Faraday Ave	EB	795	797	504	2096	760	805	514	2079	-35	8	10	-17	1.3	0.3	0.4	0.4
3	1-L3	1	B	A446 Lichfield Rd (S)	NB	796	797	601	2194	767	767	567	2101	-29	-30	-34	-93	1.0	1.1	1.4	2.0
4	1-L4	1	B	A446 Lichfield Rd (S)	SB	1177	1267	721	3165	1107	1284	749	3140	-70	17	28	-25	2.1	0.5	1.0	0.4
5	1-L5	1	C	Marsh Ln	EB	249	243	94	586	247	244	98	589	-2	1	4	3	0.1	0.1	0.4	0.1
6	1-L6	1	C	Marsh Ln	WB	35	47	42	124	34	48	41	123	-1	1	-1	-1	0.2	0.1	0.2	0.1
7	1-L7	1	D	A446 Lichfield Rd (N)	SB	1439	1502	911	3852	1332	1510	925	3767	-107	8	14	-85	2.9	0.2	0.5	1.4
8	1-L8	1	D	A446 Lichfield Rd (N)	NB	806	723	646	2175	780	712	628	2120	-26	-11	-18	-55	0.9	0.4	0.7	1.2
9	2-L1	2	A	A446 Lichfield Rd (N)	SB																
10	2-L2	2	A	A446 Lichfield Rd (N)	NB	935	1051	785	2771	837	973	813	2623	-98	-78	28	-148	3.3	2.5	1.0	2.8
11	2-L3	2	B	A446 Lichfield Rd (S)	NB	929	1055	785	2769	830	978	812	2620	-99	-77	27	-149	3.3	2.4	1.0	2.9
12	2-L4	2	B	A446 Lichfield Rd (S)	SB																
13	2-L5	2	C	Dunton Ln	EB	22	10	10	42	22	10	10	42	0	0	0	0	0.0	0.0	0.0	0.0
14	2-L6	2	C	Dunton Ln	WB	16	14	10	40	15	15	9	39	-1	1	-1	-1	0.3	0.3	0.3	0.2
15	3-L1	3	1	A446 Lichfield Rd (N)	SB	1409	1671	1148	4228	1280	1631	1126	4037	-129	-40	-22	-191	3.5	1.0	0.7	3.0
16	3-L2	3	1	A446 Lichfield Rd (N)	NB	891	967	801	2659	844	972	809	2625	-47	5	8	-34	1.6	0.2	0.3	0.7
17	3-L3	3	2	M42 (N) Off-Slip	SB	425	486	350	1261	417	492	355	1264	-8	6	5	3	0.4	0.3	0.3	0.1
18	3-L4	3	2	M42 (N) On-Slip	NB	320	347	259	926	335	351	267	953	15	4	8	27	0.8	0.2	0.5	0.9
19	3-L5	3	3	A4097 Kingsbury Rd (E)	NB	245	253	236	734	230	257	238	725	-15	4	2	-9	1.0	0.3	0.1	0.3
20	3-L6	3	3	A4097 Kingsbury Rd (E)	SB	914	801	421	2136	900	813	424	2137	-14	12	3	1	0.5	0.4	0.1	0.0
21	3-L7	3	4	A446 Lichfield Rd (S)	NB	686	738	611	2035	762	723	629	2114	76	-15	18	79	2.8	0.6	0.7	1.7
22	3-L8	3	4	A446 Lichfield Rd (S)	SB	1289	1404	868	3561	1349	1505	919	3773	60	101	51	212	1.7	2.6	1.7	3.5
23	3-L9	3	5	M42 (S) Off-Slip	NB	1302	1294	1145	3741	1291	1341	1179	3811	-11	47	34	70	0.3	1.3	1.0	1.1
24	3-L10	3	5	M42 (S) On-Slip	SB	2278	1859	1394	5531	2116	1854	1380	5350	-162	-5	-14	-181	3.5	0.1	0.4	2.5
25	3-L11	3	6	A4097 Kingsbury Rd (W)	EB	858	681	621	2160	817	726	648	2191	-41	45	27	31	1.4	1.7	1.1	0.7
26	3-L12	3	6	A4097 Kingsbury Rd (W)	WB	571	841	738	2150	516	822	771	2109	-55	-19	33	-41	2.4	0.7	1.2	0.9
27	4-L1	4	1	M6 TOLL On-Slip	NB	42	42	30	114	38	55	46	139	-4	13	16	25	0.6	1.9	2.6	2.2
28	4-L2	4	2	A4097 Kingsbury Rd (E)	WB	561	836	731	2128	515	822	771	2108	-46	-14	40	-20	2.0	0.5	1.5	0.4
29	4-L3	4	2	A4097 Kingsbury Rd (E)	EB	852	678	620	2150	837	716	647	2200	-15	38	27	50	0.5	1.4	1.1	1.1
30	4-L4	4	3	A4097 Kingsbury Rd (W)	SB	522	806	708	2036	479	779	734	1992	-43	-27	26	-44	1.9	1.0	1.0	1.0
31	4-L5	4	3	A4097 Kingsbury Rd (W)	NB	855	690	627	2172	849	721	656	2226	-6	31	29	54	0.2	1.2	1.1	1.2
32	5-L1	5	1	Wishaw Ln	SB	356	358	323	1037	354	359	322	1035	-2	1	-1	-2	0.1	0.1	0.1	0.1
33	5-L2	5	1	Wishaw Ln	NB	37	53	47	137	35	51	45	131	-2	-2	-2	-6	0.3	0.3	0.3	0.5
34	5-L3	5	2	A4097 Kingsbury Rd (E)	SB	494	789	736	2019	478	777	737	1992	-16	-12	1	-27	0.7	0.4	0.0	0.6
35	5-L4	5	2	A4097 Kingsbury Rd (E)	NB	866	713	656	2235	860	714	656	2230	-6	1	0	-5	0.2	0.0	0.0	0.1
36	5-L5	5	3	Coleshill Rd	NB	72	80	65	217	71	81	65	217	-1	1	0	0	0.1	0.1	0.0	0.0
37	5-L6	5	3	Coleshill Rd	SB	173	244	204	621	180	243	203	626	7	-1	-1	5	0.5	0.1	0.1	0.2
38	5-L7	5	4	A4097 Kingsbury Rd (W)	NB	682	602	530	1814	679	603	530	1812	-3	1	0	-2	0.1	0.0	0.0	0.0
39	5-L8	5	4	A4097 Kingsbury Rd (W)	SB	528	819	747	2094	502	811	750	2063	-26	-8	3	-31	1.1	0.3	0.1	0.7
40	6-L1	6	1	A446 Lichfield Rd (N)	SB	813	1150	844	2807	807	1145	849	2801	-6	-5	5	-6	0.2	0.1	0.2	0.1
41	6-L2	6	1	A446 Lichfield Rd (N)	NB	762	865	714	2341	721	868	720	2309	-41	3	6	-32	1.5	0.1	0.2	0.7
42	6-L3	6	2	A4091	EB	185	190	215	590	177	192	213	582	-8	2	-2	-8	0.6	0.1	0.1	0.3
43	6-L4	6	2	A4091	WB	584	477	328	1389	582	477	328	1387	-2	0	0	-2	0.1	0.0	0.0	0.1
44	6-L5	6	3	A446 Lichfield Rd (S)	NB	880	969	810	2659	830	973	815	2618	-50	4	5	-41	1.7	0.1	0.2	0.8
45	6-L6	6	3	A446 Lichfield Rd (S)	SB	1403	1672	1123	4198	1344	1598	1103	4045	-59	-74	-20	-153	1.6	1.8	0.6	2.4
46	6-L7	6	4	M6 TOLL Off-Slip	NB	73	131	70	274	26	64	43	133	-47	-67	-27	-141	6.7	6.8	3.6	9.9
47	M42-WJ	M		M42 Within J9 NB	NB	2144	2122	1892	6158	2064	2125	1885	6074	-80	3	-7	-84	1.7	0.1	0.2	1.1
48	M42-WJ	M		M42 Within J9 SB	SB	3193	2539	2185	7918	3121	2557	2170	7848	-72	18	-15	-70	1.3	0.4	0.3	0.8
49	M6-SB-\	M		M6 Toll Within JT1 SB	SB	2217	2135	1666	6018	2233	2208	1701	6142	16	73	35	124	0.3	1.6	0.9	1.6
50	M6-NB_	M		M6 Toll Within JT1 NB	NB	985	1194	980	3158	953	1191	986	3130	-32	-3	7	-28	1.0	0.1	0.2	0.5

	End	08:00 Total	09:00 Total	10:00 Total
Locations	48	48	48	48
GEH <4	98%	98%	100%	98%
<5	98%	98%	100%	98%
<6	98%	98%	100%	98%
<7	100%	100%	100%	98%
<8	100%	100%	100%	98%
<9	100%	100%	100%	98%
<10	100%	100%	100%	100%
<12	100%	100%	100%	100%
<15	100%	100%	100%	100%
<20	100%	100%	100%	100%
<25	100%	100%	100%	100%
Max	6.7	6.8	3.6	9.9
Average	1.3	0.7	0.6	1.1

AM Turn Count Calibration

Refercence	Turncount	Junction No.	Arm	Name	Arm	Name	Observed Total				Modelled Total				Modelled Difference				Modelled GEH			
							08:00 Total	09:00 Total	10:00 Total	Period	08:00 Total	09:00 Total	10:00 Total	Period	08:00 Total	09:00 Total	10:00 Total	Period	08:00 Total	09:00 Total	10:00 Total	Period
1	1-T1	1	A	Faraday Ave	A	Faraday Ave																
2	1-T2	1	A	Faraday Ave	B	A446 Lichfield Rd (S)	97	100	91	288	97	101	90	288	0	1	-1	0	0.0	0.1	0.1	0.0
3	1-T3	1	A	Faraday Ave	C	Marsh Ln	8	14	5	27	10	16	5	31	2	2	0	4	0.7	0.5	0.0	0.7
4	1-T4	1	A	Faraday Ave	D	A446 Lichfield Rd (N)	218	167	200	585	215	177	207	599	-3	10	7	14	0.2	0.8	0.5	0.6
5	1-T5	1	B	A446 Lichfield Rd (S)	A	Faraday Ave	221	243	150	614	219	243	151	613	-2	0	1	-1	0.1	0.0	0.1	0.0
6	1-T6	1	B	A446 Lichfield Rd (S)	B	A446 Lichfield Rd (S)																
7	1-T7	1	B	A446 Lichfield Rd (S)	C	Marsh Ln	24	32	34	90	24	31	35	90	0	-1	1	0	0.0	0.2	0.2	0.0
8	1-T8	1	B	A446 Lichfield Rd (S)	D	A446 Lichfield Rd (N)	551	522	415	1488	549	524	416	1489	-2	2	1	1	0.1	0.1	0.0	0.0
9	1-T9	1	C	Marsh Ln	A	Faraday Ave	82	82	33	197	84	83	36	203	2	1	3	6	0.2	0.1	0.5	0.4
10	1-T10	1	C	Marsh Ln	B	A446 Lichfield Rd (S)	146	150	57	353	146	150	58	354	0	0	1	1	0.0	0.0	0.1	0.1
11	1-T11	1	C	Marsh Ln	C	Marsh Ln																
12	1-T12	1	C	Marsh Ln	D	A446 Lichfield Rd (N)	21	11	4	36	19	11	5	35	-2	0	1	-1	0.4	0.0	0.5	0.2
13	1-T13	1	D	A446 Lichfield Rd (N)	A	Faraday Ave	486	461	310	1257	459	477	326	1262	-27	16	16	5	1.2	0.7	0.9	0.1
14	1-T14	1	D	A446 Lichfield Rd (N)	B	A446 Lichfield Rd (S)	934	1017	571	2522	872	1032	597	2501	-62	15	26	-21	2.1	0.5	1.1	0.4
15	1-T15	1	D	A446 Lichfield Rd (N)	C	Marsh Ln	3	1	3	7	0	0	2	2	-3	-1	-1	-5	2.4	1.4	0.6	2.4
16	1-T16	1	D	A446 Lichfield Rd (N)	D	A446 Lichfield Rd (N)																
17	2-T1	2	A	A446 Lichfield Rd (N)	A	A446 Lichfield Rd (N)																
18	2-T2	2	A	A446 Lichfield Rd (N)	B	A446 Lichfield Rd (S)	1836	1619	1074	4529	1340	1599	1105	4044	-496	-20	31	-485	12.4	0.5	0.9	7.4
19	2-T3	2	A	A446 Lichfield Rd (N)	C	Dunton Ln																
20	2-T4	2	B	A446 Lichfield Rd (S)	A	A446 Lichfield Rd (N)	913	1041	775	2729	817	963	804	2584	-96	-78	29	-145	3.3	2.5	1.0	2.8
21	2-T5	2	B	A446 Lichfield Rd (S)	B	A446 Lichfield Rd (S)																
22	2-T6	2	B	A446 Lichfield Rd (S)	C	Dunton Ln	16	14	10	40	15	15	9	39	-1	1	-1	-1	0.3	0.3	0.3	0.2
23	2-T7	2	C	Dunton Ln	A	A446 Lichfield Rd (N)	22	10	10	42	22	10	10	42	0	0	0	0	0.0	0.0	0.0	0.0
24	2-T8	2	C	Dunton Ln	B	A446 Lichfield Rd (S)																
25	2-T9	2	C	Dunton Ln	C	Dunton Ln																
26	3-T1	3	1	A446 Lichfield Rd (N)	1	A446 Lichfield Rd (N)																
27	3-T2	3	1	A446 Lichfield Rd (N)	2	M42 (N) On-Slip	22	39	40	101	21	40	39	100	-1	1	-1	-1	0.2	0.2	0.2	0.1
28	3-T3	3	1	A446 Lichfield Rd (N)	3	A4097 Kingsbury Rd (E)	50	75	77	202	45	76	77	198	-5	1	0	-4	0.7	0.1	0.0	0.3
29	3-T4	3	1	A446 Lichfield Rd (N)	4	A446 Lichfield Rd (S)	219	351	236	806	228	372	251	851	9	21	15	45	0.6	1.1	1.0	1.6
30	3-T5	3	1	A446 Lichfield Rd (N)	5	M42 (S) On-Slip	1008	997	664	2669	898	951	629	2478	-110	-46	-35	-191	3.6	1.5	1.4	3.8
31	3-T6	3	1	A446 Lichfield Rd (N)	6	A4097 Kingsbury Rd (W)	110	209	131	450	88	193	130	411	-22	-16	-1	-39	2.2	1.1	0.1	1.9
32	3-T7	3	2	M42 (N) Off-Slip	1	A446 Lichfield Rd (N)	144	172	144	460	133	173	147	453	-11	1	3	-7	0.9	0.1	0.2	0.3
33	3-T8	3	2	M42 (N) Off-Slip	3	A4097 Kingsbury Rd (E)	13	10	7	30	12	10	7	29	-1	0	0	-1	0.3	0.0	0.0	0.2
34	3-T9	3	2	M42 (N) Off-Slip	4	A446 Lichfield Rd (S)	184	187	110	481	201	199	111	511	17	12	1	30	1.2	0.9	0.1	1.3
35	3-T10	3	2	M42 (N) Off-Slip	5	M42 (S) On-Slip																
36	3-T11	3	2	M42 (N) Off-Slip	6	A4097 Kingsbury Rd (W)	84	117	89	290	69	109	91	269	-15	-8	2	-21	1.7	0.8	0.2	1.3
37	3-T12	3	3	A4097 Kingsbury Rd (E)	1	A446 Lichfield Rd (N)	97	114	71	282	88	114	71	273	-9	0	0	-9	0.9	0.0	0.0	0.5
38	3-T13	3	3	A4097 Kingsbury Rd (E)	2	M42 (N) On-Slip	32	30	19	81	32	31	19	82	0	1	0	1	0.0	0.2	0.0	0.1
39	3-T14	3	3	A4097 Kingsbury Rd (E)	3	A4097 Kingsbury Rd (E)																
40	3-T15	3	3	A4097 Kingsbury Rd (E)	4	A446 Lichfield Rd (S)	232	258	108	598	254	274	115	643	22	16	7	45	1.4	1.0	0.7	1.8
41	3-T16	3	3	A4097 Kingsbury Rd (E)	5	M42 (S) On-Slip	481	313	165	959	466	313	163	942	-15	0	-2	-17	0.7	0.0	0.2	0.6
42	3-T17	3	3	A4097 Kingsbury Rd (E)	6	A4097 Kingsbury Rd (W)	72	86	58	216	60	79	58	197	-12	-7	0	-19	1.5	0.8	0.0	1.3
43	3-T18	3	4	A446 Lichfield Rd (S)	1	A446 Lichfield Rd (N)	162	200	175	537	182	203	177	562	20	3	2	25	1.5	0.2	0.2	1.1
44	3-T19	3	4	A446 Lichfield Rd (S)	2	M42 (N) On-Slip	175	189	131	495	200	188	135	523	25	-1	4	28	1.8	0.1	0.3	1.2
45	3-T20	3	4	A446 Lichfield Rd (S)	3	A4097 Kingsbury Rd (E)	42	49	44	135	49	49	47	145	7	0	3	10	1.0	0.0	0.4	0.8
46	3-T21	3	4	A446 Lichfield Rd (S)	4	A446 Lichfield Rd (S)																
47	3-T22	3	4	A446 Lichfield Rd (S)	5	M42 (S) On-Slip	214	169	158	541	235	161	168	564	21	-8	10	23	1.4	0.6	0.8	1.0
48	3-T23	3	4	A446 Lichfield Rd (S)	6	A4097 Kingsbury Rd (W)	93	131	103	327	95	122	105	322	2	-9	2	-5	0.2	0.8	0.2	0.3
49	3-T24	3	5	M42 (S) Off-Slip	1	A446 Lichfield Rd (N)	454	431	369	1254	418	431	370	1219	-36	0	1	-35	1.7	0.0	0.1	1.0
50	3-T25	3	5	M42 (S) Off-Slip	3	A4097 Kingsbury Rd (E)	107	91	81	279	100	93	81	274	-7	2	0	-5	0.7	0.2	0.0	0.3
51	3-T26	3	5	M42 (S) Off-Slip	4	A446 Lichfield Rd (S)	529	474	338	1341	565	499	343	1407	36	25	5	66	1.5	1.1	0.3	1.8
52	3-T27	3	5	M42 (S) Off-Slip	5	M42 (S) On-Slip																
53	3-T28	3	5	M42 (S) Off-Slip	6	A4097 Kingsbury Rd (W)	212	298	357	867	209	318	388	915	-3	20	31	48	0.2	1.1	1.6	1.6
54	3-T29	3	6	A4097 Kingsbury Rd (W)	1	A446 Lichfield Rd (N)	34	50	42	126	31	51	44	126	-3	1	2	0	0.5	0.1	0.3	0.0
55	3-T30	3	6	A4097 Kingsbury Rd (W)	2	M42 (N) On-Slip	91	89	69	249	86	92	73	251	-5	3	4	2	0.5	0.3	0.5	0.1
56	3-T31	3	6	A4097 Kingsbury Rd (W)	3	A4097 Kingsbury Rd (E)	33	28	27	88	30	29	27	86	-3	1	0	-2	0.5	0.2	0.0	0.2
57	3-T32	3	6	A4097 Kingsbury Rd (W)	4	A446 Lichfield Rd (S)	125	134	76	335	134	145	85	364	9	11	9	29	0.8	0.9	1.0	1.6
58	3-T33	3	6	A4097 Kingsbury Rd (W)	5	M42 (S) On-Slip	575	380	407	1362	538	410	419	1367	-37	30	12	5	1.6	1.5	0.6	0.1
59	3-T34	3	6	A4097 Kingsbury Rd (W)	6	A4097 Kingsbury Rd (W)																
60	4-T1	4	2	A4097 Kingsbury Rd (E)	1	M6 TOLL On-Slip	39	30	23	92	36	42	38	116	-3	12	15	24	0.5	2.0	2.7	2.4
61	4-T2	4	2	A4097 Kingsbury Rd (E)	3	A4097 Kingsbury Rd (W)	522	806	708	2036	479	780	734	1993	-43	-26	26	-43	1.9	0.9	1.0	1.0
62	4-T3	4	3	A4097 Kingsbury Rd (W)	1	M6 TOLL On-Slip	3	12	7	22	4	13	8	25	1	1	1	3	0.5	0.3	0.4	0.6
63	4-T4	4	3	A4097 Kingsbury Rd (W)	2	A4097 Kingsbury Rd (E)	852	678	620	2150	846	708	648	2202	-6	30	28	52	0.2	1.1	1.1	1.1
64	5-T1	5	1	Wishaw Ln	1	Wishaw Ln																
65	5-T2	5	1	Wishaw Ln	2	A4097 Kingsbury Rd (E)	263	194	174	631	261	195	173	629	-2	1	-1	-2	0.1	0.1	0.1	0.1
66	5-T3	5	1	Wishaw Ln	3	Coleshill Rd	88	144	137	369	87	143	136	366	-1	-1	-1	-3	0.1	0.1	0.1	0.2
67	5-T4	5	1	Wishaw Ln	4	A4097 Kingsbury Rd (W)	5	20	12	37	5	20	12	37	0	0	0	0	0.0	0.0	0.0	0.0
68	5-T5	5	2	A4097 Kingsbury Rd (E)	1	Wishaw Ln	17	25	25	67	15	23	25	63	-2	-2	0	-4	0.5	0.4	0.0	0.5
69	5-T6	5	2	A4097 Kingsbury Rd (E)	2	A4097 Kingsbury Rd (E)																
70	5-T7	5	2	A4097 Kingsbury Rd (E)	3	Coleshill Rd	6	19	23	48	14	17	22	53	8	-2	-1	5	2.5	0.5	0.2	0.7
71	5-T8	5	2	A4097 Kingsbury Rd (E)	4	A4097 Kingsbury Rd (W)	471	745	688	1904	447	736	690	1873	-24	-9	2	-31	1.1	0.3	0.1	0.7
72	5-T9	5	3	Coleshill Rd	1	Wishaw Ln	10	19	12	41	11	19	12	42	1	0	0	1	0.3	0.0	0.0	0.2
73	5-T10	5	3	Coleshill Rd	2	A4097 Kingsbury Rd (E)	10	7	6	23	9	7	6	22	-1	0	0	-1	0.3	0.0	0.0	0.2
74	5-T11	5	3	Coleshill Rd	3	Coleshill Rd																
75	5-T12	5	3	Coleshill Rd	4	A4097 Kingsbury Rd (W)	52	54	47	153	51	56	46	153	-1	2	-1	0	0.1	0.3	0.1	0.0
76	5-T13	5	4	A4097 Kingsbury Rd (W)	1	Wishaw Ln	10	9	10	29	10	9	11	30	0	0	1	1	0.0	0.0	0.3	0.2
77	5-T14	5	4	A4097 Kingsbury Rd (W)	2	A4097 Kingsbury Rd (E)	593	512	476	1581	590	513	477	1580	-3	1	1	-1	0.1	0.0	0.0	0.0
78	5-T15	5	4	A4097 Kingsbury Rd (W)	3	Coleshill Rd	79	81	44	204	79	81	44	204	0	0	0	0	0.0	0.0	0.0	0.0
79	5-T16	5	4	A4097 Kingsbury Rd (W)	4	A4097 Kingsbury Rd (W)																
80	6-T1	6	1	A446 Lichfield Rd (N)	1	A446 Lichfield Rd (N)																
81	6-T2	6	1	A446 Lichfield Rd (N)	2	A4091	18	24	42	84	18	25	43	86	0	1	1	2	0.0	0.2	0.2	0.2
82	6-T3	6	1	A446 Lichfield Rd (N)	3	A446 Lichfield Rd (S)	795	1126	802	2723	789	1121	807	2717	-6	-5	5	-6	0.2	0.1	0.2	0.1
83	6-T4	6	1	A446 Lichfield Rd (N)	4	M6 TOLL Off-Slip																
84	6-T5	6	2	A4091	1	A446 Lichfield Rd (N)	41	47	57	145	41	48	57	146	0	1	0	1	0.0	0.1	0.0	0.1
85	6-T6	6	2	A4091	3	A446 Lichfield Rd (S)	543	430	271	1244	541	428	273	1242	-2	-2	2	-2	0.1	0.1	0.1	0.1
86	6-T7	6	2	A4091	4	M6 TOLL Off-Slip																
87	6-T8	6	3	A446 Lichfield Rd (S)	1	A446 Lichfield Rd (N)	716	807	641	2164	675	808	647	2130	-41	1	6	-34	1.6	0.0	0.2	0.7
88	6-T9	6	3	A446 Lichfield Rd (S)	2	A4091	164	162	169	495	155	165	167	487	-9	3	-2	-8	0.7	0.2	0.2	0.4
89	6-T10	6	3	A446 Lichfield Rd (S)	3	A446 Lichfield Rd (S)																
90	6-T11	6	3	A446 Lichfield Rd (S)	4	M6 TOLL Off-Slip																
91	6-T12	6	4	M6 TOLL Off-Slip	1	A446 Lichfield Rd (N)	5	11	16	32	5	11	16	32	0	0	0	0	0.0	0.0	0.0	0.0
92	6-T13	6	4	M6 TOLL Off-Slip	2	A4091	3	4	4	11	4	4	4	12	1	0	0	1	0.5	0.0	0.0	0.3
93	6-T14	6	4	M6 TOLL Off-Slip	3	A446 Lichfield Rd (S)	65	116	50	231	17	48	23	88	-48	-68	-27	-143	7.5	7.5	4.5	11.3
94	6-T15	6	4	M6 TOLL Off-Slip	4	M6 TOLL Off-Slip																

		End	08:00 Total	09:00 Total	10:00 Total	Period
Locations			69	69	69	69
GEH	<4		97%	99%	99%	97%
	<5		97%	99%	100%	97%
	<6		97%	99%	100%	97%
	<7		97%	99%	100%	97%
	<8		99%	100%	100%	99%
	<9		99%	100%	100%	99%
	<10		99%	100%	100%	99%
	<12		99%	100%	100%	100%
	<15		100%	100%	100%	100%
	<20		100%	100%	100%	100%
	<25		100%	100%	100%	100%

PM Link Count Validation

Refercence	Turncount	Junction No.	Arm	Name	Direction	Observed Total 17:00 Total	Observed Total 18:00 Total	Observed Total 19:00 Total	Observed Total Period	Modelled Total 17:00 Total	Modelled Total 18:00 Total	Modelled Total 19:00 Total	Modelled Total Period	Modelled Difference 17:00 Total	Modelled Difference 18:00 Total	Modelled Difference 19:00 Total	Modelled Difference Period	Modelled GEH 17:00 Total	Modelled GEH 18:00 Total	Modelled GEH 19:00 Total	Modelled GEH Period
						8	9	10													
1	1-L1	1	A	Faraday Ave	WB	802	989	613	2404	792	982	614	2388	-10	-7	1	-16	0.4	0.2	0.0	0.3
2	1-L2	1	A	Faraday Ave	EB	314	480	258	1052	304	470	274	1048	-10	-10	16	-4	0.6	0.5	1.0	0.1
3	1-L3	1	B	A446 Lichfield Rd (S)	NB	1179	1262	760	3201	1086	1165	708	2959	-93	-97	-52	-242	2.8	2.8	1.9	4.4
4	1-L4	1	B	A446 Lichfield Rd (S)	SB	809	959	624	2392	781	952	649	2382	-28	-7	25	-10	1.0	0.2	1.0	0.2
5	1-L5	1	C	Marsh Ln	EB	65	76	51	192	64	74	53	191	-1	-2	2	-1	0.1	0.2	0.3	0.1
6	1-L6	1	C	Marsh Ln	WB	102	133	66	301	101	134	67	302	-1	1	1	1	0.1	0.1	0.1	0.1
7	1-L7	1	D	A446 Lichfield Rd (N)	SB	725	891	565	2181	699	924	598	2221	-26	33	33	40	1.0	1.1	1.4	0.9
8	1-L8	1	D	A446 Lichfield Rd (N)	NB	1546	1646	1041	4233	1529	1675	1047	4251	-17	29	6	18	0.4	0.7	0.2	0.3
9	2-L1	2	A	A446 Lichfield Rd (N)	SB																
10	2-L2	2	A	A446 Lichfield Rd (N)	NB	1776	1868	1443	5087	1648	1696	1489	4833	-128	-172	46	-254	3.1	4.1	1.2	3.6
11	2-L3	2	B	A446 Lichfield Rd (S)	NB	1795	1934	1485	5214	1681	1758	1519	4958	-114	-176	34	-256	2.7	4.1	0.9	3.6
12	2-L4	2	B	A446 Lichfield Rd (S)	SB																
13	2-L5	2	C	Dunton Ln	EB	17	11	6	34	15	12	7	34	-2	1	1	0	0.5	0.3	0.4	0.0
14	2-L6	2	C	Dunton Ln	WB	36	77	48	161	33	75	51	159	-3	-2	3	-2	0.5	0.2	0.4	0.2
15	3-L1	3	1	A446 Lichfield Rd (N)	SB	1009	1039	798	2846	1041	1094	908	3043	32	55	110	197	1.0	1.7	3.8	3.6
16	3-L2	3	1	A446 Lichfield Rd (N)	NB	1806	1709	1395	4910	1722	1743	1500	4965	-84	34	105	55	2.0	0.8	2.8	0.8
17	3-L3	3	2	M42 (N) Off-Slip	SB	391	435	325	1151	384	434	333	1151	-7	-1	8	0	0.4	0.0	0.4	0.0
18	3-L4	3	2	M42 (N) On-Slip	NB	618	593	368	1579	650	678	429	1757	32	85	61	178	1.3	3.4	3.1	4.4
19	3-L5	3	3	A4097 Kingsbury Rd (E)	NB	655	736	531	1922	677	781	608	2066	22	45	77	144	0.9	1.6	3.2	3.2
20	3-L6	3	3	A4097 Kingsbury Rd (E)	SB	328	342	270	940	325	340	271	936	-3	-2	1	-4	0.2	0.1	0.1	0.1
21	3-L7	3	4	A446 Lichfield Rd (S)	NB	1493	1438	959	3890	1520	1672	1059	4251	27	234	100	361	0.7	5.9	3.1	5.7
22	3-L8	3	4	A446 Lichfield Rd (S)	SB	765	838	605	2208	706	927	593	2226	-59	89	-12	18	2.2	3.0	0.5	0.4
23	3-L9	3	5	M42 (S) Off-Slip	NB	2035	2056	1644	5735	1906	2065	1736	5707	-129	9	92	-28	2.9	0.2	2.2	0.4
24	3-L10	3	5	M42 (S) On-Slip	SB	1229	1136	786	3151	1237	1186	858	3281	8	50	72	130	0.2	1.5	2.5	2.3
25	3-L11	3	6	A4097 Kingsbury Rd (W)	EB	641	686	401	1728	615	632	418	1665	-26	-54	17	-63	1.0	2.1	0.8	1.5
26	3-L12	3	6	A4097 Kingsbury Rd (W)	WB	824	984	712	2520	766	919	770	2455	-58	-65	58	-65	2.1	2.1	2.1	1.3
27	4-L1	4	1	M6 TOLL On-Slip	NB	122	118	64	304	96	95	86	277	-26	-23	22	-27	2.5	2.2	2.5	1.6
28	4-L2	4	2	A4097 Kingsbury Rd (E)	WB	821	985	714	2520	765	918	771	2454	-56	-67	57	-66	2.0	2.2	2.1	1.3
29	4-L3	4	2	A4097 Kingsbury Rd (E)	EB	638	682	401	1721	626	630	414	1670	-12	-52	13	-51	0.5	2.0	0.6	1.2
30	4-L4	4	3	A4097 Kingsbury Rd (W)	SB	715	882	656	2253	688	839	691	2218	-27	-43	35	-35	1.0	1.5	1.3	0.7
31	4-L5	4	3	A4097 Kingsbury Rd (W)	NB	654	697	407	1758	643	647	418	1708	-11	-50	11	-50	0.4	1.9	0.5	1.2
32	5-L1	5	1	Wishaw Ln	SB	70	67	57	194	69	67	58	194	-1	0	1	0	0.1	0.0	0.1	0.0
33	5-L2	5	1	Wishaw Ln	NB	184	290	177	651	179	282	186	647	-5	-8	9	-4	0.4	0.5	0.7	0.2
34	5-L3	5	2	A4097 Kingsbury Rd (E)	SB	712	844	671	2227	685	838	693	2216	-27	-6	22	-11	1.0	0.2	0.8	0.2
35	5-L4	5	2	A4097 Kingsbury Rd (E)	NB	658	654	419	1731	648	646	416	1710	-10	-8	-3	-21	0.4	0.3	0.1	0.5
36	5-L5	5	3	Coleshill Rd	NB	92	49	47	188	89	48	45	182	-3	-1	-2	-6	0.3	0.1	0.3	0.4
37	5-L6	5	3	Coleshill Rd	SB	109	115	85	309	107	117	86	310	-2	2	1	1	0.2	0.2	0.1	0.1
38	5-L7	5	4	A4097 Kingsbury Rd (W)	NB	687	693	440	1820	681	687	438	1806	-6	-6	-2	-14	0.2	0.2	0.1	0.3
39	5-L8	5	4	A4097 Kingsbury Rd (W)	SB	610	594	534	1738	589	595	548	1732	-21	1	14	-6	0.9	0.0	0.6	0.1
40	6-L1	6	1	A446 Lichfield Rd (N)	SB	810	787	620	2217	907	896	733	2536	97	109	113	319	3.3	3.8	4.3	6.5
41	6-L2	6	1	A446 Lichfield Rd (N)	NB	1260	1188	939	3387	1165	1219	1022	3406	-95	31	83	19	2.7	0.9	2.7	0.3
42	6-L3	6	2	A4091	EB	623	622	550	1795	569	624	589	1782	-54	2	39	-13	2.2	0.1	1.6	0.3
43	6-L4	6	2	A4091	WB	249	319	215	783	248	315	214	777	-1	-4	-1	-6	0.1	0.2	0.1	0.2
44	6-L5	6	3	A446 Lichfield Rd (S)	NB	1772	1673	1410	4855	1615	1697	1518	4830	-157	24	108	-25	3.8	0.6	2.8	0.4
45	6-L6	6	3	A446 Lichfield Rd (S)	SB	988	1013	790	2791	1059	1100	891	3050	71	87	101	259	2.2	2.7	3.5	4.8
46	6-L7	6	4	M6 TOLL Off-Slip	NB	40	44	34	118	29	33	33	95	-11	-11	-1	-23	1.9	1.8	0.2	2.2
47	M42-WJ	M		M42 Within J9 NB	NB	2925	2904	2230	8058	2782	2824	2254	7860	-143	-80	25	-198	2.7	1.5	0.5	2.2
48	M42-WJ	M		M42 Within J9 SB	SB	2131	2079	1621	5830	2107	2077	1642	5826	-24	-2	21	-4	0.5	0.0	0.5	0.1
49	M6-SB-\	M		M6 Toll Within JT1 SB	SB	1317	1267	923	3507	1326	1281	936	3543	9	14	13	36	0.2	0.4	0.4	0.6
50	M6-NB_	M		M6 Toll Within JT1 NB	NB	1949	1885	2051	5884	1957	1936	2112	6005	9	52	61	121	0.2	1.2	1.3	1.6

	48	48	48	48
<4	100%	94%	98%	90%
<5	100%	98%	100%	96%
<6	100%	100%	100%	98%
<7	100%	100%	100%	100%
<8	100%	100%	100%	100%
<9	100%	100%	100%	100%
<10	100%	100%	100%	100%
<12	100%	100%	100%	100%
<15	100%	100%	100%	100%
<20	100%	100%	100%	100%
<25	100%	100%	100%	100%

Max	3.8	5.9	4.3	6.5
Average	1.2	1.3	1.3	1.3

PM Turn Count Calibration

Refercence	Turncount	Junction No.	Arm	Name	Arm	Name	Observed Total 17:00 Total	Observed Total 18:00 Total	Observed Total 19:00 Total	Observed Total Period	Modelled Total 17:00 Total	Modelled Total 18:00 Total	Modelled Total 19:00 Total	Modelled Total Period	Modelled Difference 17:00 Total	Modelled Difference 18:00 Total	Modelled Difference 19:00 Total	Modelled Difference Period	Modelled GEH 17:00 Total	Modelled GEH 18:00 Total	Modelled GEH 19:00 Total	Modelled GEH Period
1	1-T1	1	A	Faraday Ave	A	Faraday Ave																
2	1-T2	1	A	Faraday Ave	B	A446 Lichfield Rd (S)	248	277	185	710	248	277	186	711	0	0	1	1	0.0	0.0	0.1	0.0
3	1-T3	1	A	Faraday Ave	C	Marsh Ln	15	39	8	62	17	42	8	67	2	3	0	5	0.5	0.5	0.0	0.6
4	1-T4	1	A	Faraday Ave	D	A446 Lichfield Rd (N)	515	616	410	1541	529	663	420	1612	14	47	10	71	0.6	1.9	0.5	1.8
5	1-T5	1	B	A446 Lichfield Rd (S)	A	Faraday Ave	93	155	89	337	92	155	90	337	-1	0	1	0	0.1	0.0	0.1	0.0
6	1-T6	1	B	A446 Lichfield Rd (S)	B	A446 Lichfield Rd (S)																
7	1-T7	1	B	A446 Lichfield Rd (S)	C	Marsh Ln	81	89	56	226	79	87	56	222	-2	-2	0	-4	0.2	0.2	0.0	0.3
8	1-T8	1	B	A446 Lichfield Rd (S)	D	A446 Lichfield Rd (N)	1005	1014	611	2630	994	1010	618	2622	-11	-4	7	-8	0.3	0.1	0.3	0.2
9	1-T9	1	C	Marsh Ln	A	Faraday Ave	13	24	9	46	16	30	10	56	3	6	1	10	0.8	1.2	0.3	1.4
10	1-T10	1	C	Marsh Ln	B	A446 Lichfield Rd (S)	41	49	37	127	38	44	36	118	-3	-5	-1	-9	0.5	0.7	0.2	0.8
11	1-T11	1	C	Marsh Ln	C	Marsh Ln																
12	1-T12	1	C	Marsh Ln	D	A446 Lichfield Rd (N)	11	3	5	19	10	0	6	16	-1	-3	1	-3	0.3	2.4	0.4	0.7
13	1-T13	1	D	A446 Lichfield Rd (N)	A	Faraday Ave	184	244	150	578	195	287	173	655	11	43	23	77	0.8	2.6	1.8	3.1
14	1-T14	1	D	A446 Lichfield Rd (N)	B	A446 Lichfield Rd (S)	520	629	398	1547	498	633	425	1556	-22	4	27	9	1.0	0.2	1.3	0.2
15	1-T15	1	D	A446 Lichfield Rd (N)	C	Marsh Ln	6	5	2	13	7	5	0	12	1	0	-2	-1	0.4	0.0	2.0	0.3
16	1-T16	1	D	A446 Lichfield Rd (N)	D	A446 Lichfield Rd (N)																
17	2-T1	2	A	A446 Lichfield Rd (N)	A	A446 Lichfield Rd (N)																
18	2-T2	2	A	A446 Lichfield Rd (N)	B	A446 Lichfield Rd (S)	989	1111	766	2866	1058	1098	893	3049	69	-13	127	183	2.2	0.4	4.4	3.4
19	2-T3	2	A	A446 Lichfield Rd (N)	C	Dunton Ln																
20	2-T4	2	B	A446 Lichfield Rd (S)	A	A446 Lichfield Rd (N)	1759	1857	1437	5053	1648	1683	1469	4800	-111	-174	32	-253	2.7	4.1	0.8	3.6
21	2-T5	2	B	A446 Lichfield Rd (S)	B	A446 Lichfield Rd (S)																
22	2-T6	2	B	A446 Lichfield Rd (S)	C	Dunton Ln	36	77	48	161	34	75	50	159	-2	-2	2	-2	0.3	0.2	0.3	0.2
23	2-T7	2	C	Dunton Ln	A	A446 Lichfield Rd (N)	17	11	6	34	15	12	6	33	-2	1	0	-1	0.5	0.3	0.0	0.2
24	2-T8	2	C	Dunton Ln	B	A446 Lichfield Rd (S)																
25	2-T9	2	C	Dunton Ln	C	Dunton Ln																
26	3-T1	3	1	A446 Lichfield Rd (N)	1	A446 Lichfield Rd (N)																
27	3-T2	3	1	A446 Lichfield Rd (N)	2	M42 (N) On-Slip	46	42	23	111	48	44	27	119	2	2	4	8	0.3	0.3	0.8	0.7
28	3-T3	3	1	A446 Lichfield Rd (N)	3	A4097 Kingsbury Rd (E)	117	144	121	382	160	182	175	517	43	38	54	135	3.7	3.0	4.4	6.4
29	3-T4	3	1	A446 Lichfield Rd (N)	4	A446 Lichfield Rd (S)	134	153	122	409	116	170	118	404	-18	17	-4	-5	1.6	1.3	0.4	0.2
30	3-T5	3	1	A446 Lichfield Rd (N)	5	M42 (S) On-Slip	559	500	367	1426	594	547	435	1576	35	47	68	150	1.5	2.1	3.4	3.9
31	3-T6	3	1	A446 Lichfield Rd (N)	6	A4097 Kingsbury Rd (W)	153	200	165	518	123	153	152	428	-30	-47	-13	-90	2.6	3.5	1.0	4.1
32	3-T7	3	2	M42 (N) Off-Slip	1	A446 Lichfield Rd (N)	206	222	170	598	204	221	185	610	-2	-1	15	12	0.1	0.1	1.1	0.5
33	3-T8	3	2	M42 (N) Off-Slip	3	A4097 Kingsbury Rd (E)	16	7	6	29	15	8	6	29	-1	1	0	0	0.3	0.4	0.0	0.0
34	3-T9	3	2	M42 (N) Off-Slip	4	A446 Lichfield Rd (S)	73	99	66	238	83	115	63	261	10	16	-3	23	1.1	1.5	0.4	1.5
35	3-T10	3	2	M42 (N) Off-Slip	5	M42 (S) On-Slip																
36	3-T11	3	2	M42 (N) Off-Slip	6	A4097 Kingsbury Rd (W)	96	107	83	286	83	93	79	255	-13	-14	-4	-31	1.4	1.4	0.4	1.9
37	3-T12	3	3	A4097 Kingsbury Rd (E)	1	A446 Lichfield Rd (N)	62	68	57	187	60	59	58	177	-2	-9	1	-10	0.3	1.1	0.1	0.7
38	3-T13	3	3	A4097 Kingsbury Rd (E)	2	M42 (N) On-Slip	30	28	28	86	31	27	29	87	1	-1	1	1	0.2	0.2	0.2	0.1
39	3-T14	3	3	A4097 Kingsbury Rd (E)	3	A4097 Kingsbury Rd (E)																
40	3-T15	3	3	A4097 Kingsbury Rd (E)	4	A446 Lichfield Rd (S)	109	117	91	317	113	137	102	352	4	20	11	35	0.4	1.8	1.1	1.9
41	3-T16	3	3	A4097 Kingsbury Rd (E)	5	M42 (S) On-Slip	98	94	68	260	94	88	60	242	-4	-6	-8	-18	0.4	0.6	1.0	1.1
42	3-T17	3	3	A4097 Kingsbury Rd (E)	6	A4097 Kingsbury Rd (W)	29	35	26	90	27	28	24	79	-2	-7	-2	-11	0.4	1.2	0.4	1.2
43	3-T18	3	4	A446 Lichfield Rd (S)	1	A446 Lichfield Rd (N)	460	448	293	1201	477	524	339	1340	17	76	46	139	0.8	3.4	2.6	3.9
44	3-T19	3	4	A446 Lichfield Rd (S)	2	M42 (N) On-Slip	383	365	201	949	419	459	244	1122	36	94	43	173	1.8	4.6	2.9	5.4
45	3-T20	3	4	A446 Lichfield Rd (S)	3	A4097 Kingsbury Rd (E)	154	168	102	424	159	201	115	475	5	33	13	51	0.4	2.4	1.2	2.4
46	3-T21	3	4	A446 Lichfield Rd (S)	4	A446 Lichfield Rd (S)																
47	3-T22	3	4	A446 Lichfield Rd (S)	5	M42 (S) On-Slip	283	246	208	737	276	275	205	756	-7	29	-3	19	0.4	1.8	0.2	0.7
48	3-T23	3	4	A446 Lichfield Rd (S)	6	A4097 Kingsbury Rd (W)	213	211	155	579	191	214	157	562	-22	3	2	-17	1.5	0.2	0.2	0.7
49	3-T24	3	5	M42 (S) Off-Slip	1	A446 Lichfield Rd (N)	1007	898	835	2740	923	876	869	2668	-84	-22	34	-72	2.7	0.7	1.2	1.4
50	3-T25	3	5	M42 (S) Off-Slip	3	A4097 Kingsbury Rd (E)	310	338	253	901	295	326	253	874	-15	-12	0	-27	0.9	0.7	0.0	0.9
51	3-T26	3	5	M42 (S) Off-Slip	4	A446 Lichfield Rd (S)	385	389	273	1047	340	429	259	1028	-45	40	-14	-19	2.4	2.0	0.9	0.6
52	3-T27	3	5	M42 (S) Off-Slip	5	M42 (S) On-Slip																
53	3-T28	3	5	M42 (S) Off-Slip	6	A4097 Kingsbury Rd (W)	333	431	283	1047	347	435	356	1138	14	4	73	91	0.8	0.2	4.1	2.8
54	3-T29	3	6	A4097 Kingsbury Rd (W)	1	A446 Lichfield Rd (N)	71	73	40	184	66	64	42	172	-5	-9	2	-12	0.6	1.1	0.3	0.9
55	3-T30	3	6	A4097 Kingsbury Rd (W)	2	M42 (N) On-Slip	159	158	116	433	157	145	128	430	-2	-13	12	-3	0.2	1.1	1.1	0.1
56	3-T31	3	6	A4097 Kingsbury Rd (W)	3	A4097 Kingsbury Rd (E)	58	79	49	186	54	68	50	172	-4	-11	1	-14	0.5	1.3	0.1	1.0
57	3-T32	3	6	A4097 Kingsbury Rd (W)	4	A446 Lichfield Rd (S)	64	80	53	197	59	79	44	182	-5	-1	-9	-15	0.6	0.1	1.3	1.1
58	3-T33	3	6	A4097 Kingsbury Rd (W)	5	M42 (S) On-Slip	289	296	143	728	278	276	154	708	-11	-20	11	-20	0.7	1.2	0.9	0.7
59	3-T34	3	6	A4097 Kingsbury Rd (W)	6	A4097 Kingsbury Rd (W)																
60	4-T1	4	2	A4097 Kingsbury Rd (E)	1	M6 TOLL On-Slip	106	103	58	267	77	79	80	236	-29	-24	22	-31	3.0	2.5	2.6	2.0
61	4-T2	4	2	A4097 Kingsbury Rd (E)	3	A4097 Kingsbury Rd (W)	715	882	656	2253	689	839	689	2217	-26	-43	33	-36	1.0	1.5	1.3	0.8
62	4-T3	4	3	A4097 Kingsbury Rd (W)	1	M6 TOLL On-Slip	16	15	6	37	19	15	6	40	3	0	0	3	0.7	0.0	0.0	0.5
63	4-T4	4	3	A4097 Kingsbury Rd (W)	2	A4097 Kingsbury Rd (E)	638	682	401	1721	626	630	413	1669	-12	-52	12	-52	0.5	2.0	0.6	1.3
64	5-T1	5	1	Wishaw Ln	1	Wishaw Ln																
65	5-T2	5	1	Wishaw Ln	2	A4097 Kingsbury Rd (E)	41	42	37	120	40	42	38	120	-1	0	1	0	0.2	0.0	0.2	0.0
66	5-T3	5	1	Wishaw Ln	3	Coleshill Rd	21	14	12	47	21	14	13	48	0	0	1	1	0.0	0.0	0.3	0.1
67	5-T4	5	1	Wishaw Ln	4	A4097 Kingsbury Rd (W)	8	11	8	27	8	12	8	28	0	1	0	1	0.0	0.3	0.0	0.2
68	5-T5	5	2	A4097 Kingsbury Rd (E)	1	Wishaw Ln	144	266	160	570	139	258	168	565	-5	-8	8	-5	0.4	0.5	0.6	0.2
69	5-T6	5	2	A4097 Kingsbury Rd (E)	2	A4097 Kingsbury Rd (E)																
70	5-T7	5	2	A4097 Kingsbury Rd (E)	3	Coleshill Rd	23	29	16	68	21	30	17	68	-2	1	1	0	0.4	0.2	0.2	0.0
71	5-T8	5	2	A4097 Kingsbury Rd (E)	4	A4097 Kingsbury Rd (W)	545	549	495	1589	524	550	508	1582	-21	1	13	-7	0.9	0.0	0.6	0.2
72	5-T9	5	3	Coleshill Rd	1	Wishaw Ln	29	11	12	52	29	11	11	51	0	0	-1	-1	0.0	0.0	0.3	0.1
73	5-T10	5	3	Coleshill Rd	2	A4097 Kingsbury Rd (E)	6	4	4	14	4	4	3	11	-2	0	-1	-3	0.9	0.0	0.5	0.8
74	5-T11	5	3	Coleshill Rd	3	Coleshill Rd																
75	5-T12	5	3	Coleshill Rd	4	A4097 Kingsbury Rd (W)	57	34	31	122	56	34	32	122	-1	0	1	0	0.1	0.0	0.2	0.0
76	5-T13	5	4	A4097 Kingsbury Rd (W)	1	Wishaw Ln	11	13	5	29	12	13	5	30	1	0	0	1	0.3	0.0	0.0	0.2
77	5-T14	5	4	A4097 Kingsbury Rd (W)	2	A4097 Kingsbury Rd (E)	611	608	378	1597	606	602	377	1585	-5	-6	-1	-12	0.2	0.2	0.1	0.3
78	5-T15	5	4	A4097 Kingsbury Rd (W)	3	Coleshill Rd	65	72	57	194	65	72	57	194	0	0	0	0	0.0	0.0	0.0	0.0
79	5-T16	5	4	A4097 Kingsbury Rd (W)	4	A4097 Kingsbury Rd (W)																
80	6-T1	6	1	A446 Lichfield Rd (N)	1	A446 Lichfield Rd (N)																
81	6-T2	6	1	A446 Lichfield Rd (N)	2	A4091	41	42	32	115	41	42	32	115	0	0	0	0	0.0	0.0	0.0	0.0
82	6-T3	6	1	A446 Lichfield Rd (N)	3	A446 Lichfield Rd (S)	769	745	588	2102	866	854	700	2420	97	109	112	318	3.4	3.9	4.4	6.7
83	6-T4	6	1	A446 Lichfield Rd (N)	4	M6 TOLL Off-Slip																
84	6-T5	6	2	A4091	1	A446 Lichfield Rd (N)	65	90	39	194	65	90	39	194	0	0	0	0	0.0	0.0	0.0	0.0
85	6-T6	6	2	A4091	3	A446 Lichfield Rd (S)	184	229	176	589	184	226	175	585	0	-3	-1	-4	0.0	0.2	0.1	0.2
86	6-T7	6	2	A4091	4	M6 TOLL Off-Slip																
87	6-T8	6	3	A446 Lichfield Rd (S)	1	A446 Lichfield Rd (N)	1195	1094	895	3184	1092	1115	966	3173	-103	21	71	-11	3.0	0.6	2.3	0.2
88	6-T9	6	3	A446 Lichfield Rd (S)	2	A4091	577	579	515	1671	523	581	552	1656	-54	2	37	-15	2.3	0.1	1.6	0.4
89	6-T10	6	3	A446 Lichfield Rd (S)	3	A446 Lichfield Rd (S)																
90	6-T11	6	3	A446 Lichfield Rd (S)	4	M6 TOLL Off-Slip																
91	6-T12	6	4	M6 TOLL Off-Slip	1	A446 Lichfield Rd (N)	0	4	5	9	10	14	15	39	10	10	10	30	4.5	3.3	3.2	6.1
92	6-T13	6	4	M6 TOLL Off-Slip	2	A4091	5	1	3	9	4	0	3	7	-1	-1	0	-2	0.5	1.4	0.0	0.7
93	6-T14	6	4	M6 TOLL Off-Slip	3	A446 Lichfield Rd (S)	35	39	26	100	13	19	15	47	-22	-20	-11	-53	4.5	3.7	2.4	6.2
94	6-T15	6	4	M6 TOLL Off-Slip	4	M6 TOLL Off-Slip																

	End	17:00 Total	18:00 Total	19:00 Total	Period
Locations		69	69	69	69
GEH	<4	97%	97%	94%	91%
	<5	100%	100%	100%	93%
	<6	100%	100%	100%	94%
	<7	100%	100%	100%	100%
	<8	100%	100%	100%	100%
	<9	100%	100%	100%	100%
	<10	100%	100%	100%	100%
	<12	100%	100%	100%	100%
	<15	100%	100%	100%	100%
	<20	100%	100%	100%	100%
	<25	100%	100%	100%	100%

Appendix C

Queue Assessments

Table AppC.1 AM Queue Assessments

		07:30 – 08:00				08:00 – 08:30				08:30 – 09:00				09:00 – 09:30			
Ref.	Approach	Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference	
				m	vehs			m	vehs			m	vehs			m	vehs
Site 1	Dunton Ln	8	0	-8	-1	5	0	-5	-1	5	0	-5	-1	5	0	-5	-1
Site 2	Faraday Ave	83	57	-26	-4	78	54	-23	-4	58	44	-14	-2	40	42	2	0
Site 2	A446 (S)	18	30	12	2	28	28	1	0	15	24	9	1	25	23	-2	0
Site 2	Marsh Ln	23	33	11	2	20	33	13	2	13	27	15	2	13	25	13	2
Site 2	A446 (N)	88	68	-19	-3	75	64	-11	-2	100	57	-43	-7	45	42	-3	-1
Site 3	M42 (N)	45	64	19	3	40	63	23	4	58	63	6	1	45	60	15	3
Site 3	Kingsbury Rd (E)	65	108	43	7	58	99	42	7	45	71	26	4	48	65	18	3
Site 3	Lichfield Rd (S)	115	144	29	5	75	107	32	5	85	93	8	1	60	98	38	6
Site 3	M42 (S)	75	94	19	3	63	92	29	5	68	88	20	3	65	90	25	4
Site 3	Kingsbury Rd (W)	65	184	119	20	68	145	78	13	73	102	29	5	33	111	79	13
Site 3	Lichfield Rd (N)	228	219	-9	-1	228	211	-17	-3	175	170	-5	-1	50	133	83	14
Site 4	Kingsbury Rd (E)	0	0	0	0	0	31	31	5	0	14	14	2	0	15	15	3
Site 4	Kingsbury Rd (W)	43	52	10	2	10	32	22	4	13	24	11	2	0	24	24	4
Site 5	Kingsbury Rd (E)	5	0	-5	-1	8	0	-8	-1	5	14	9	2	3	0	-3	0
Site 5	Coleshill Rd	28	13	-14	-2	15	12	-3	0	10	10	0	0	18	21	3	1
Site 5	Kingsbury Rd (W)	20	21	1	0	13	0	-13	-2	10	8	-2	0	5	12	7	1
Site 5	Wishaw Ln	58	35	-23	-4	60	36	-24	-4	60	31	-29	-5	18	32	14	2
Site 6	A4091	68	28	-39	-7	60	23	-37	-6	55	21	-34	-6	35	10	-25	-4
Site 6	Lichfield Rd (S)	55	26	-29	-5	63	30	-33	-5	13	24	12	2	5	27	22	4
Site 6	M6 diverge	30	23	-7	-1	20	28	8	1	13	22	10	2	8	23	15	3
Site 6	Lichfield Rd (N)	105	35	-70	-12	100	52	-48	-8	68	52	-15	-3	73	37	-35	-6

Table AppC.2 PM Queue Assessments

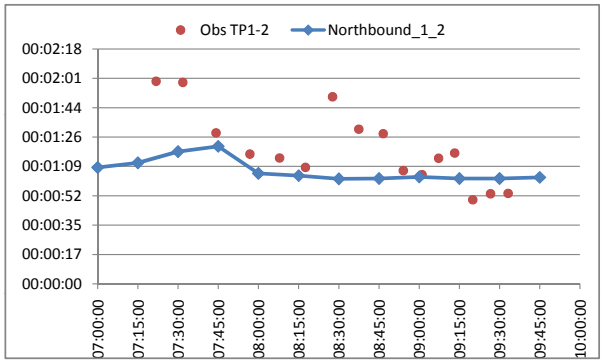
		16:30 – 17:00				17:00 – 17:30				17:30 – 18:00				18:00 – 18:30			
Ref.	Approach	Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference		Obs (m)	Mod (m)	Difference	
				m	vehs			m	vehs			m	vehs			m	vehs
Site 1	Dunton Ln	5	15	10	2	5	11	6	1	0	0	0	0	10	0	-10	-2
Site 2	Faraday Ave	63	60	-3	0	65	221	156	26	43	99	57	9	40	55	15	3
Site 2	A446 (S)	23	36	13	2	38	56	19	3	38	44	7	1	35	33	-2	0
Site 2	Marsh Ln	20	29	9	1	18	30	13	2	13	28	15	3	10	26	16	3
Site 2	A446 (N)	18	38	20	3	38	37	-1	0	38	36	-1	0	25	33	8	1
Site 3	M42 (N)	40	64	24	4	53	64	12	2	38	61	24	4	45	64	19	3
Site 3	Kingsbury Rd (E)	43	58	15	3	40	63	23	4	35	61	26	4	38	63	26	4
Site 3	Lichfield Rd (S)	90	112	22	4	78	126	49	8	68	117	49	8	75	95	20	3
Site 3	M42 (S)	123	216	93	16	175	222	47	8	165	210	45	8	148	260	112	19
Site 3	Kingsbury Rd (W)	120	92	-28	-5	75	90	15	2	63	88	25	4	43	78	36	6
Site 3	Lichfield Rd (N)	63	116	53	9	78	193	115	19	88	210	122	20	58	111	54	9
Site 4	Kingsbury Rd (E)	0	16	16	3	0	15	15	3	0	17	17	3	0	14	14	2
Site 4	Kingsbury Rd (W)	25	25	0	0	45	24	-21	-3	28	24	-3	-1	25	22	-3	-1
Site 5	Kingsbury Rd (E)	23	17	-6	-1	28	20	-7	-1	23	16	-6	-1	10	18	8	1
Site 5	Coleshill Rd	45	22	-23	-4	33	24	-8	-1	20	11	-9	-1	20	9	-11	-2
Site 5	Kingsbury Rd (W)	10	7	-3	-1	8	8	0	0	8	7	0	0	13	8	-4	-1
Site 5	Wishaw Ln	10	28	18	3	20	14	-6	-1	13	16	3	1	8	13	6	1
Site 6	A4091	43	20	-22	-4	28	20	-7	-1	28	10	-18	-3	25	11	-14	-2
Site 6	Lichfield Rd (S)	15	31	16	3	33	37	5	1	18	32	15	2	18	35	17	3
Site 6	M6 diverge	8	23	16	3	10	24	14	2	15	24	9	1	10	29	19	3
Site 6	Lichfield Rd (N)	58	85	27	5	70	89	19	3	58	59	2	0	63	73	10	2

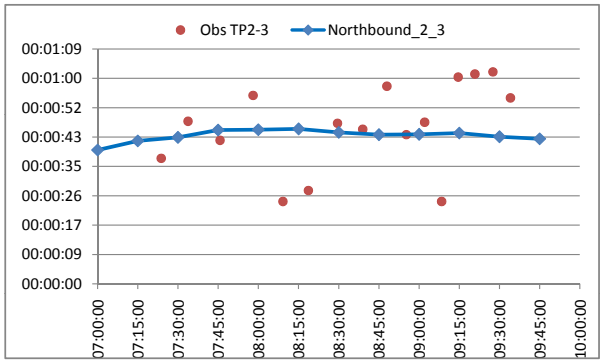
Appendix D

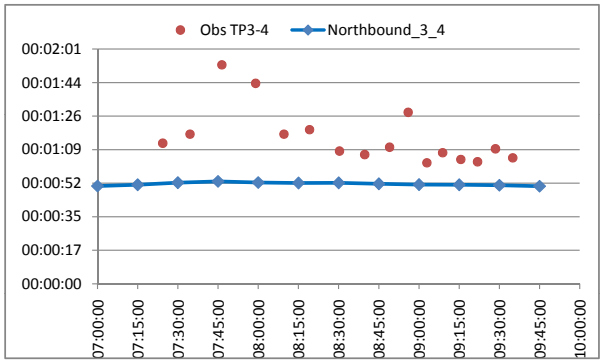
Journey Time Validation

AM Journey Time Validation

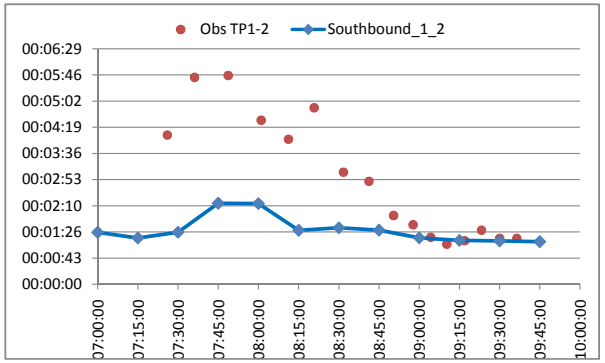
Northbound

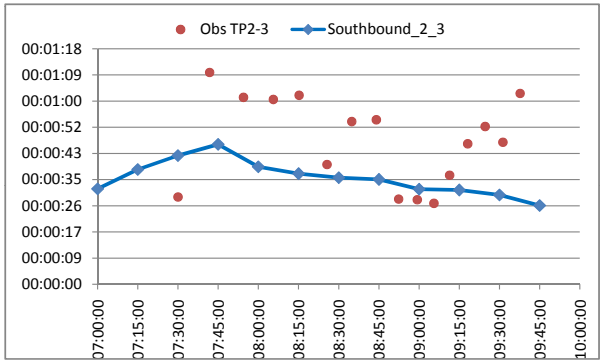


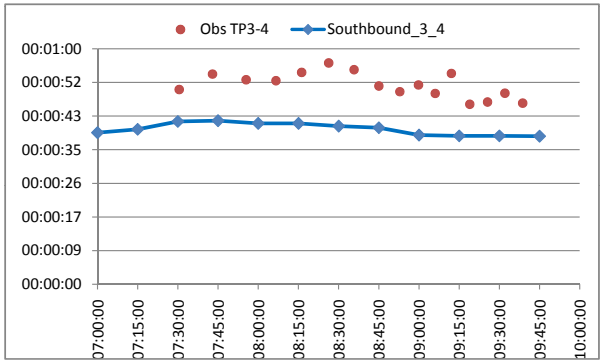




Southbound

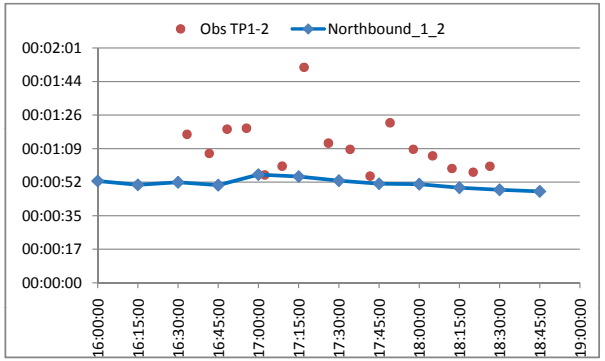


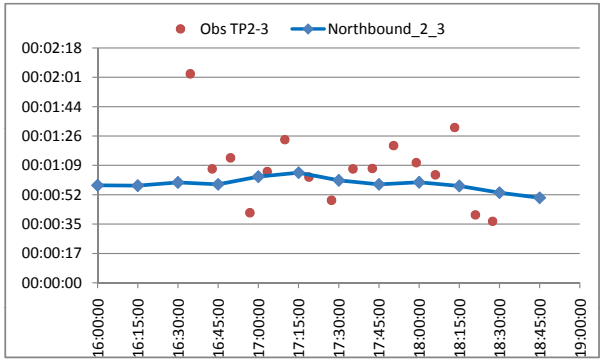


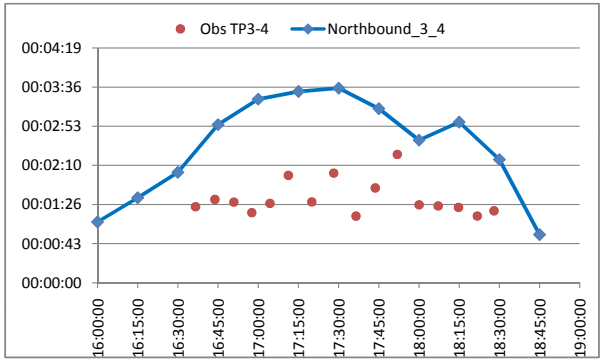


PM Journey Time Validation

Northbound







Southbou