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Local Model Validation Report
Trinity Way / Clifford Lane Roundabouts
PARAMICS Model

November 2015

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1 INTRODUCTION

1.1 Vectos Microsim (VM) was commissioned by Warwickshire County Council (WCC) and Stratford District Council (SDC) to produce a microsimulation model of the Trinity Way and Clifford Lane Roundabouts to the south of Stratford-upon-Avon. The purpose of the base model is to assist in an assessment of the impacts of local housing and employment developments, and to provide evidence to support the proposed modifications to the Core Strategy.

1.2 This Local Model Validation Report (LMVR) will describe the approach taken to all aspects of the modelling work involved in developing the 2015 Base Model. For further information relating to the future year studies, see document titled "*VM155038.R.002 – Further Assessment of Traffic Implications at SuA"*.

Study Objectives

1.3 The objective of the study is to develop a base model of the Trinity Way and Clifford Lane roundabouts which is reflective of current traffic conditions and which can be forecast forward to enable an assessment of the potential developmental impacts which may occur at this junction as a result of the various developments as outlined in the assessment document detailed in the footnote[1].

1.4 The rationale behind developing a cordon model rather than trying to use the Stratford-upon-Avon Wide Area (SuAWA) model is that it enables more accurate, localised, calibration levels to be achieved. It also enables more options to be tested and assessed within a much quicker timeframe due to the time savings induced by the model size and associated run time. Furthermore, as the assessment is intended to concentrate on just these two junctions there is no need to consider wider network impacts which means there is no need to extend the study area beyond these two junctions.

Study Area

1.5 The model was developed to cover the core study area illustrated within **Figure 1** overleaf.

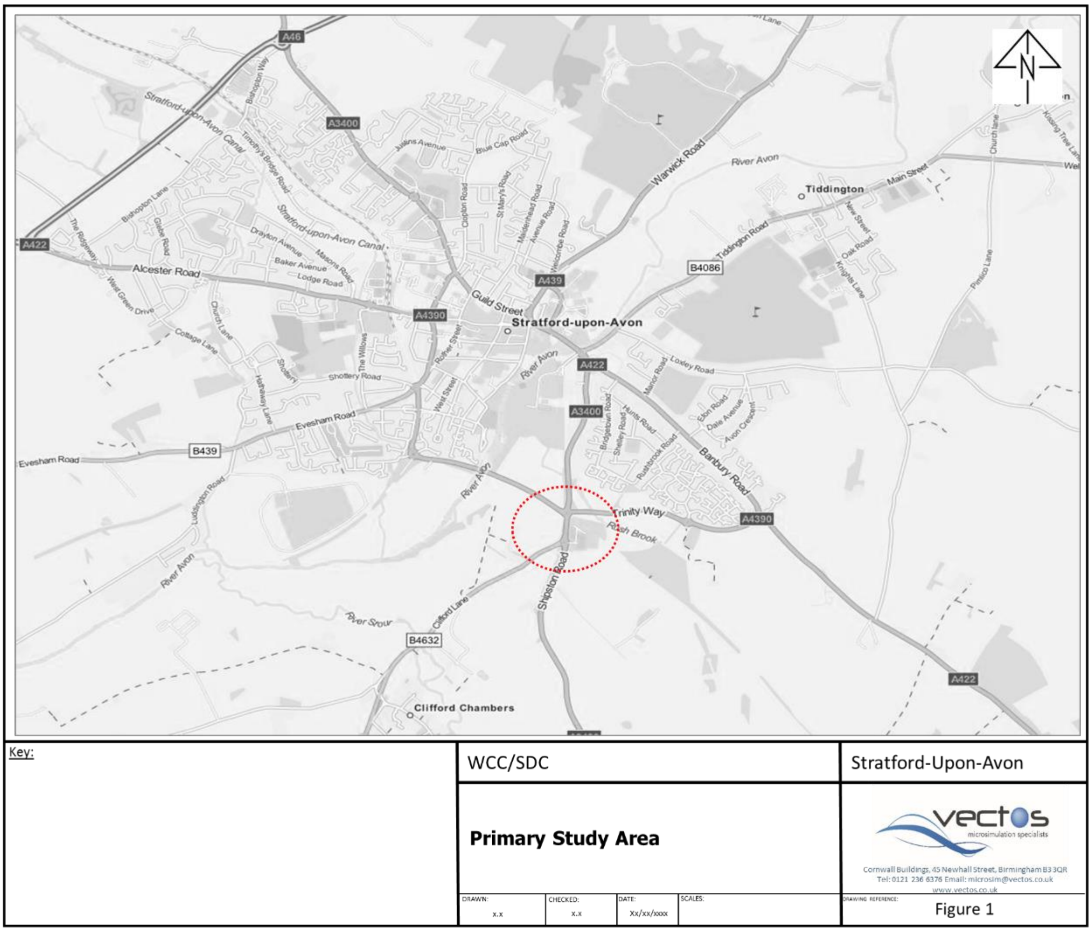
[1] VM155038.R.002 – Further Assessment of Traffic Implications at SuA

Report Structure

1.6 The following report will comprise of the following chapters:

- **Chapter 2** – Observed Data; *an overview of data collection and processing*
- **Chapter 3** – Base Model Development; *an explanation of model parameters used and matrix development methodology*
- **Chapter 4** – Model Calibration; *presentation of link flow calibration results*
- **Chapter 5** – Model Validation; *presentation of queue, ATC vehicle count and vehicle speed validation results*
- **Chapter 6** – Summary & Conclusion

Figure 1. Core Study Area



2 OBSERVED DATA

Manual Classified Counts (MCCs)

2.1 Manual classified turn counts were carried out by Traffic Survey Partners on Thursday 01 October 2015. The counts included 15-minute total movements for all arms of both roundabouts, disaggregated by vehicle type.

Queue Survey

2.2 On the same day, queue surveys were undertaken at 5-minute intervals for each lane of the six approaches. Queues were recorded for each lane at each arm within the study area covering the full 3 hours for both AM and PM peak periods.

Site Surveys

2.3 VM carried out AM and PM site surveys on 29th September 2015. Videos were taken of both junctions during both peak periods, including the interaction between the junctions and the queuing behaviour on all approaches.

2.4 For the purposes of calibrating the model, the surveys assisted the modeller with an understanding of the behaviour and dynamics of the two junctions.

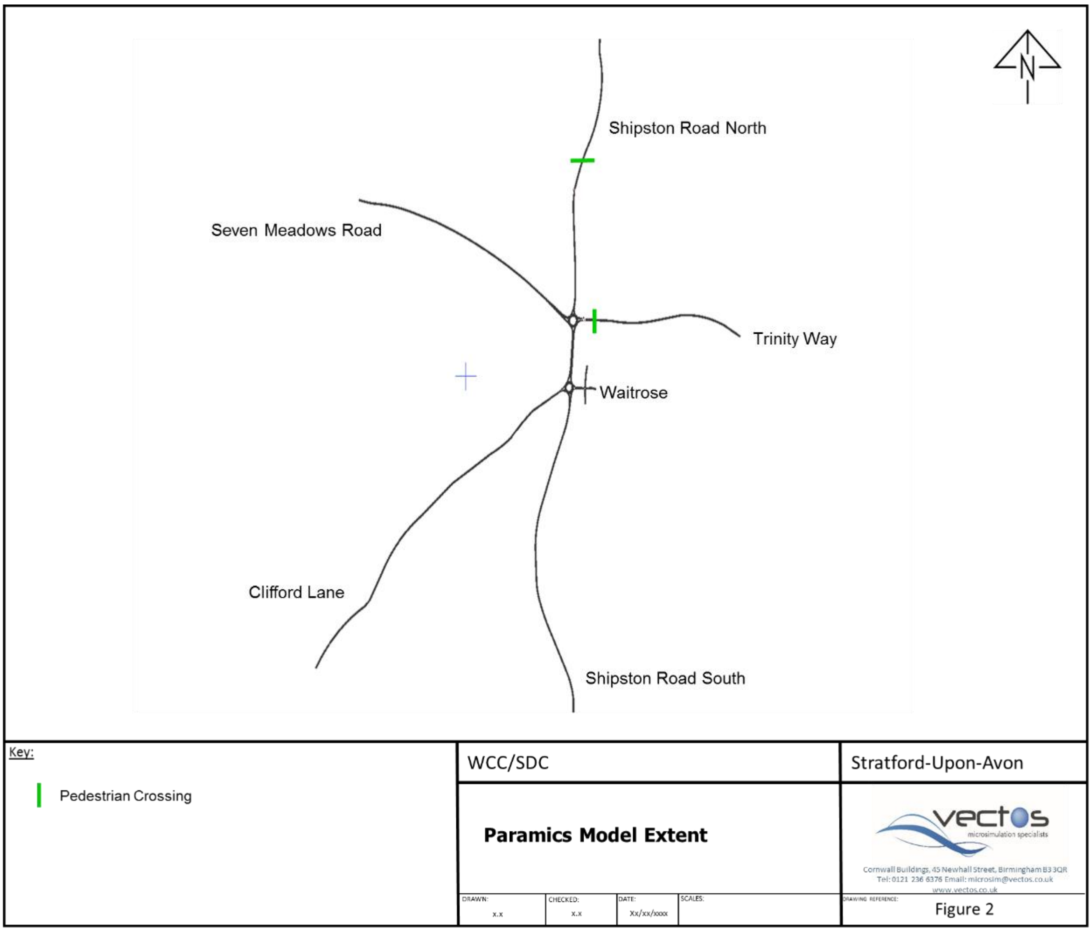
3 BASE MODEL DEVELOPMENT

Model Extent

3.1 The core network has been cordoned from the existing 2013 Stratford-upon-Avon Wide Area (SuAWA) Paramics Model.

3.2 The extent of the model is illustrated below, complete with road names to provide geographical context. The approaches into the network remain long enough such that any extensive queuing and associated impacts are captured within the modelling assessment, with an acknowledgement that this model will be used to test extensive developments as part of the EiP assessments.

Figure 2. Model extent



Matrix Development

3.3 Due to the small size of the model, MCC data was used to directly inform the demand matrices. As the model is only two-junctions, matrix estimation (ME) was not adopted as it offers little benefit to the production of the base model. Instead of ME, proportional distribution was applied to the matrices based on the turn counts at each roundabout.

3.4 Recorded vehicle types were grouped to form three matrix levels:

- Lights (cars and LGVs)
- Heavies (OGV1 and OGV2)
- Buses

3.5 Again resulting from the small model extent, buses were included within a separate matrix level rather than through the use of fixed routes within the model. Despite the presence of bus stops on the section between the roundabouts, the road width dictates that vehicles are not disrupted by buses even when they do stop, and therefore it was deemed unnecessary to include stopping data within the model network. Furthermore there are only 7 (AM) and 6 (PM) buses per hour routing through the short network.

3.6 The model has been developed for 2 different periods:

- Period 01 – 07:00 to 10:00 AM Peak Period
- Period 02 – 16:00 to 19:00 PM Peak Period

3.7 Demands for each time period have been derived on an hourly basis via discrete assignment matrices, each of which was derived directly from the survey data using the turning count proportions to inform cross-network routing.

3.8 The resultant hourly assignment totals, by Matrix Level, are presented within the following Table 1.

Table 1. Assigned Demand Totals

		Lights	Heavies	Buses	Total
AM	0700 - 0800	1592	70	7	1669
	0800 - 0900	2544	79	4	2627
	0900 - 1000	2000	100	10	2110
PM	1600 - 1700	2617	57	6	2680
	1700 - 1800	2933	32	6	2971
	1800 - 1900	2062	14	6	2082

User Classes

3.9 Three different user classes were defined within the network using individual vehicle types to represent the Light (Car & LGV), Heavy (OGV1 & OGV2) and Bus vehicle classes, each of which was assigned to the model network via a discrete matrix level.

Network Calibration

3.10 Following the network cordoning, a thorough network review was carried out to ensure that the model was reflective of the on-site layout.

3.11 Firstly, two pedestrian crossings were passed during the course of the site surveys; 1) Shipston Road North and 2) Trinity Way. The first crossing was present in the wide area model from which this cordon was extracted, and therefore frequency times for this crossing were maintained (the pedestrian phase is called once every 6 minutes). The second crossing however was not as it has been delivered following completion of the Waitrose development. On-site observations suggested that the crossing is used approximately once every 5 minutes, and this has been reflected in the base model.

3.12 Calibration parameters have been applied to specific sections of the network to allow a better representation of the dynamics of the roundabout. Aside from the repositioning of the stop lines, the main Calibration parameters applied within the model include visibility settings and gap acceptance parameters in the form of Path Merge, Lane Cross and Path Cross, respectively.

Visibility

3.13 Default visibility within PARAMICS is set to 0m and any increase on this will increase the distance from which the vehicles will begin to check whether or not their entry into a junction is unopposed. Application of visibility within PARAMICS is a standard mechanism through which the throughput of individual junction entry arms can be increased.

Gap Acceptance

3.14 A reduction in gap acceptance from the default of 4 (and 3 for Path Cross) reduces the gap which vehicles deem acceptable between themselves and oncoming vehicles when entering a junction.

3.15 The variables which are controlled by the link modifiers tab are essentially 'buffer' values as this time is added to the time it takes a vehicles tail to clear the collision point to give the true gap acceptance value.

3.16 The true gap acceptance values are therefore set as a minimum of 6[2] (and 5 for lane cross). Altering these parameters tends to be done on an ad-hoc basis as a means of calibration, and this has been altered on some approaches to achieve calibration of flows and validation of queue lengths.

Calibration by Approach

3.17 The following visibility and gap acceptance parameters were applied to all approaches as follows:

Table 2. Calibration Parameters (by approach)

		Visibility	Lane Merge	Lane Cross	Path Cross
Site 1	Shipston Road North	20m	1	1	1
	Trinity Way	30m	-2	-2	-2
	Shipston Road South	25m	0	0	0
	Seven Meadows Road	20m	0	0	0
Site 2	Shipston Road North	20m	0	0	0
	Waitrose	5m	4	4	3
	Shipston Road South	5m	4	4	3
	Clifford Lane	20m	4	4	3

[2] See SiAS PARAMICS Support Knowledgebase Article 194 (www.paramics-support.com) for further information.

Vehicle Assignment Profiles

3.18 The profiles within the model have been derived directly from proximate count data. In all cases, 15 minute count data was available and therefore robust profiling has been applied on an input-by-input basis.

3.19 Profiles derived from the all vehicle totals were used to control the assignment of demands within all matrix levels.

3.20 The profiles are illustrated in the graphs overleaf. The graphs demonstrate the small volumes of both buses and HGVs across the study area:

Figure 3. AM Assignment Rate

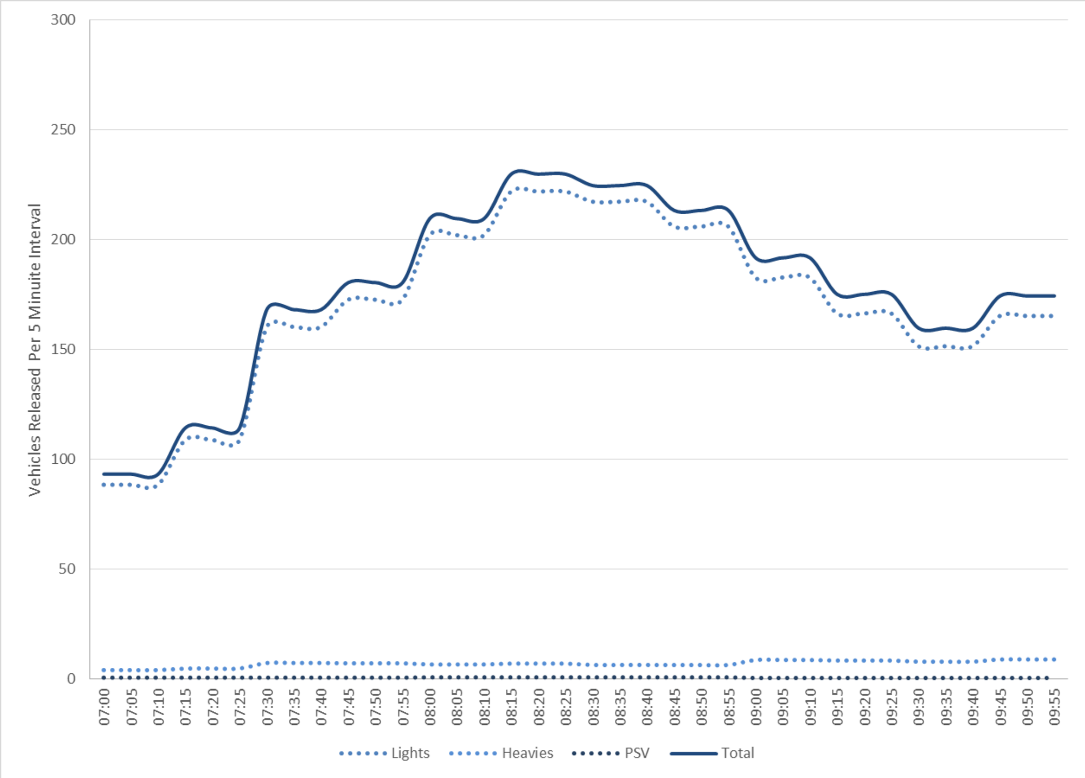
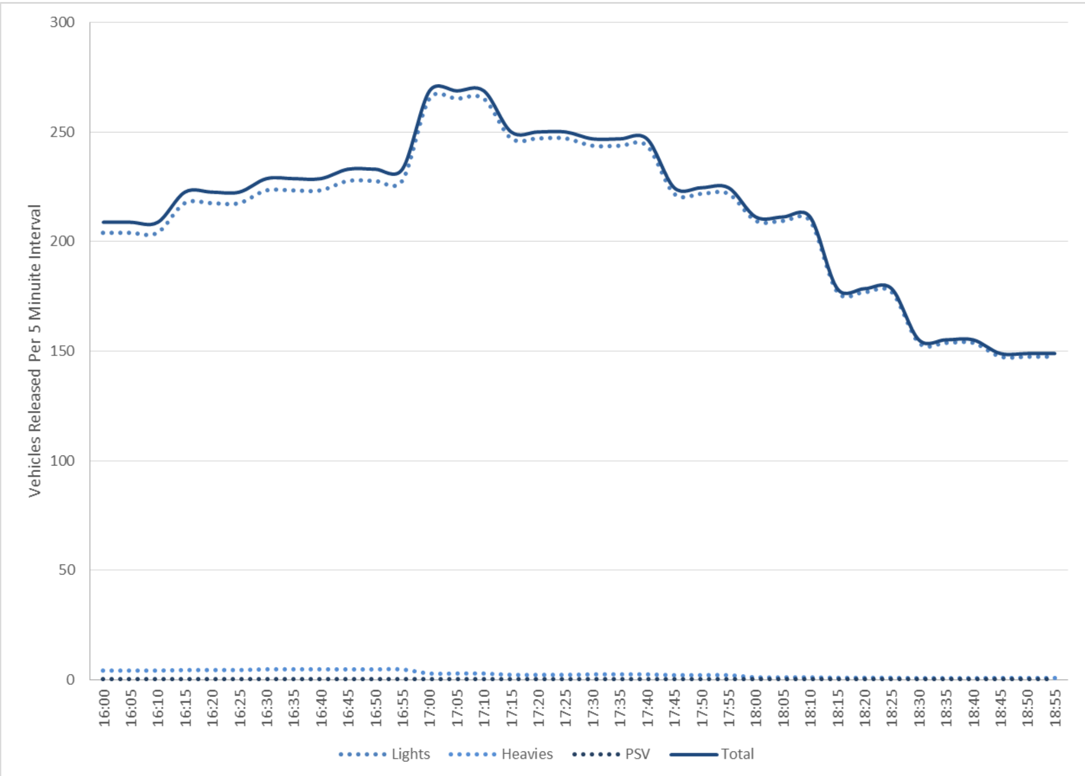


Figure 4. PM Assignment rate



Vehicle Compositions

3.21 To split the Lights and Heavies vehicle types into Cars/LGVs and OGV1s/OGV2s respectively, hourly proportions were calculated for each vehicle type and for each of the six inputs in the model.

3.22 The resultant proportions are tabulated below:

Table 3. Vehicle Compositions

	Car	LGV	OGV1	OGV2
07:00-08:00	87.1%	12.9%	47.7%	52.3%
08:00-09:00	90.0%	10.0%	53.4%	46.6%
09:00-10:00	88.0%	12.0%	43.2%	56.8%
16:00-17:00	90.8%	9.2%	54.5%	45.5%
17:00-18:00	93.9%	6.1%	38.6%	61.4%
18:00-19:00	95.0%	5.0%	42.3%	57.7%

4 MODEL CALIBRATION

Overview

4.1 Model calibration is a process to adjust the key parameters used in the model development so that these parameters reflect an appropriate proxy to the observed traffic conditions.

4.2 The approach to the application of calibration parameters, across the model network, has been outlined within the previous chapter of this report whilst this chapter describes the calibration results achieved as a result of the application of those parameters.

4.3 All results are averaged from 10 random seed runs.

Flow calibration

4.4 Flow calibration is a process whereby modelled flow outputs are compared and calibrated to match observed traffic flows throughout the network.

4.5 The Geoffrey E. Havers (GEH) statistic is a standard way of comparing the observed and modelled flows, as defined in DMRB, Volume 12, Chapter 4. The GEH value is similar to a chi-squared test and also incorporates both relative and absolute errors in order to give an overall measure of the accuracy of the modelled flow.

4.6 The GEH statistic has the benefit of removing bias that exists when comparing flows of different magnitudes using percentages, such that a difference of 10 in a flow of 100 vehicles per hour (vph) is less significant than a difference of 100 in a flow of 1000 vph.

4.7 The GEH statistic is calculated by:

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

where:

GEH = GEH statistic

M = Modelled flow

C = Observed flow

4.8 The DMRB guidance indicates that the GEH statistics should be less than 5.0 for 85% of modelled hourly flows.

4.9 Furthermore, the difference between observed and modelled link flows is also examined. DMRB provides a guidance for acceptable absolute or percentage differences in observed vehicles per hour (vph):

- For observed flows 700-2,700 vph, modelled flow within 15% of observed flow
- For observed flows < 700 vph, modelled flow within 100 vph of observed flow
- For observed flows > 2,700 vph, modelled flow within 400 vph of observed flow

4.10 Again, 85% of hourly flows should be within these criteria.

4.11 All MCC data was used for the purposes of calibrating the model. Table 4 to details the summarised GEH flow calibration statistics for each model period.

Table 4. Hourly Calibration Results

AM Peak Period	**GEH**				
No. of turn counts p/h = 24	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5
07:00-08:00	100.0%	100.0%	100.0%	100.0%	100.0%
08:00-09:00	100.0%	100.0%	100.0%	100.0%	100.0%
09:00-10:00	100.0%	100.0%	100.0%	100.0%	100.0%
16:00-17:00	100.0%	100.0%	100.0%	100.0%	100.0%
17:00-18:00	100.0%	100.0%	100.0%	100.0%	100.0%
18:00-19:00	100.0%	100.0%	100.0%	100.0%	100.0%

4.12 The p/h total relates to the number of counts considered per hour (8 approaches * 3 possible movements [U-turns are not considered]).

4.13 Due to the small nature of the model, it is expected that hourly turn counts should achieve such a high level of calibration. To further reinforce the suitability of the model as a representation of base conditions, 15-minute turn count calibration was assessed further disaggregated by vehicle type. This assessment far exceeds the necessary DMRB requirements, however due to the size of the model it is deemed to be appropriate.

4.14 A summary of these results is found below; full disclosure of 15-minute turn count calibration can be found in the Appendix:

Table 5. 15-minute Calibration Results

AM Peak Period	GEH				
No. of turn counts p/h = 288	≤ 1	≤ 2	≤ 3	≤ 4	≤ 5
07:00-08:00	79.2%	96.5%	99.7%	100.0%	100.0%
08:00-09:00	72.2%	97.9%	99.7%	100.0%	100.0%
09:00-10:00	83.3%	97.9%	100.0%	100.0%	100.0%
16:00-17:00	85.1%	99.0%	100.0%	100.0%	100.0%
17:00-18:00	84.7%	99.3%	100.0%	100.0%	100.0%
18:00-19:00	82.3%	99.0%	100.0%	100.0%	100.0%

4.15 The per hour total of 288 is calculated by 24 movements * 3 vehicle types (Lights, Heavies & Buses) * 4 15-minute periods

4.16 Table 6 below summarises the results of the DMRB link flow calibration standards:

Table 6. Link Flow Calibration Results

No. of link counts p/h = 16	Number of passes	%
07:00-08:00	16	100.00%
08:00-09:00	16	100.00%
09:00-10:00	16	100.00%
16:00-17:00	16	100.00%
17:00-18:00	16	100.00%
18:00-19:00	16	100.00%

4.17 Full disclosure of hourly calibration results can be found in Appendix A.

4.18 The results show that in all model periods, more than 85% of the 288 turn counts across each 15-minute period and for each individual vehicle falls below a GEH value of 2 and therefore the model exceeds DMRB guidance and can be considered to be well calibrated to observed MCC turn count data.

4.19 Furthermore, in all model periods 100% of link counts adhere to DMRB link flow calibration standards.

5 MODEL VALIDATION

Queue Validation

5.1 Queues were chosen as the preferable method for validating the model. Due to the size of the model, journey times were deemed unsuitable as each route would likely result in a low travel time making validation easier to achieve.

5.2 Neither TfL, DMRB nor WebTAG provide any specific guidelines on queue assessments. DMRB actually states that “precise validation of queue lengths can be difficult because of the volatility of the observed data”.

5.3 Likewise, TfL identify that “the level of accuracy in queue measurement surveys can often [sic] lower than for other surveys as the definition of a queue can be ambiguous as well as difficult to identify”.

5.4 Queue length surveys are able to provide an estimation of conditions at the site but cannot be expected to be replicated accurately within a model. Reasons for this include:

- The tendency for the model results to fluctuate between different model runs;
- The day-to-day variance in real-life conditions at the site meaning that results taken from one day cannot be applied too rigidly; and
- The software’s mathematical interpretation of queue lengths compared with the subjective nature of human interpretation during manual surveys.

5.5 In this instance queues provide the best source of validation data. Although matching the observed data precisely is unlikely, the comparisons between observed and modelled can ensure that no disparity exists between general queue patterns.

5.6 Queue records were gathered from Paramics at 5-minute intervals to match the frequency with which observed queue counts have been provided.

5.7 As observed data was broken down by vehicle type and lane on a particular approach, each vehicle type queue count was added together to give one 5-minute queue count for each lane. The maximum value for each lane on an approach was taken to give one queue count per 5 minutes per approach. Paramics is unable to provide queues disaggregated by lanes so, whilst this information was useful in ensuring the model exhibited the correct pattern of queuing via model observations, only one count was required.

5.8 The results presented in Tables 7 and 8 below detail the difference between modelled and observed records for each 5-minute period during the AM and PM peak periods respectively

Table 7. AM Queue Validation Results

No. of counts p/h = 36		No. of vehicles difference			
Site	**Arm**	**0-2**	**2-5**	**5-10**	**>10**
Site 1	Shipston Road North	25	11	0	0
	Trinity Way	27	7	1	1
	Shipston Road South	33	3	0	0
	Seven Meadows Road	32	4	0	0
Site 2	Shipston Road North	36	0	0	0
	Waitrose	34	2	0	0
	Shipston Road South	29	4	3	0
	Clifford Lane	22	12	2	0
Combined	**Total %**	**82.64%**	**14.93%**	**2.08%**	**0.35%**

Table 8. PM Queue Validation Results

No. of counts p/h = 36		No. of vehicles difference			
Site	**Arm**	**0-2**	**2-5**	**5-10**	**>10**
Site 1	Shipston Road North	22	12	2	0
	Trinity Way	25	8	3	0
	Shipston Road South	31	5	0	0
	Seven Meadows Road	22	14	0	0
Site 2	Shipston Road North	30	6	0	0
	Waitrose	20	15	1	0
	Shipston Road South	21	15	0	0
	Clifford Lane	26	8	2	0
Combined	**Total %**	**68.40%**	**28.82%**	**2.78%**	**0.00%**

5.9 The number of peak hour counts in the table relates to the number of 5-minute intervals in each 3-hour peak period.

5.10 Queue graphs for each approach and for each peak period, with appropriate confidence intervals, are supplied in Appendix B.

5.11 The results show that the majority of modelled vehicle counts (75.5%) fall within 2 vehicles of the observed for each 5-minute recorded queue length across both peak hours. A further 21.8% fall within between 2 and 5 vehicles meaning that only 2.4% of the 576 modelled queue comparisons are greater than 5 vehicles difference from the observed queues.

5.12 As a result of this, it can be concluded that the base model is a very accurate reflection of on-site conditions. No queues exist on-site that are not represented during the simulation, and likewise the model does not exhibit any queuing behaviour that is not repeated in reality.

5.13 This also demonstrates that the profiling deployed in the model is a suitable reflection of on-site, as queues build at approximately the same time in the model as on-street.

6 SUMMARY AND CONCLUSION

6.1 Vectos Microsim was commissioned by Stratford District Council and Warwickshire County Council to produce a microsimulation model of Trinity Way and Clifford Lane roundabouts to the south of Stratford-upon-Avon.

6.2 The base model will be used to inform the impacts of various housing and employment developments around Stratford-upon-Avon.

6.3 The extent of the model is limited to the two roundabouts with approach links coded to ensure queuing and approach behaviour can be accurately represented.

6.4 The results show that the model exhibits a high level of turn count calibration and queue validation based on the available 2015 observed data.

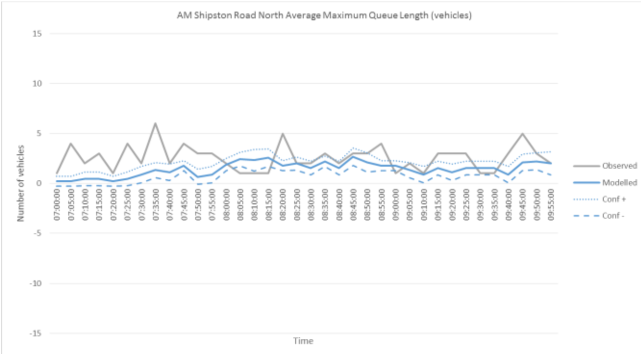
6.5 Based on these results, the 2015 base models can now be reliably used initially to test the impacts of forecasted regional growth. The model will now be used as a base upon which to forecast forward to future year 2031. The forecasting methodology is fully disclosed in the Core Strategy document submitted alongside this LMVR (*VM155038.R002 – Further Assessment of Traffic Implications at SuA*) microsimulation specialists

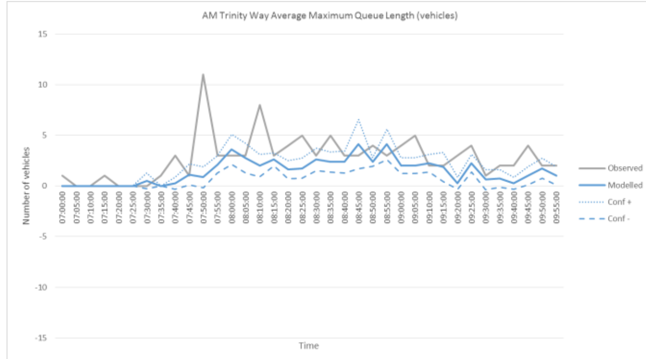
Appendix A

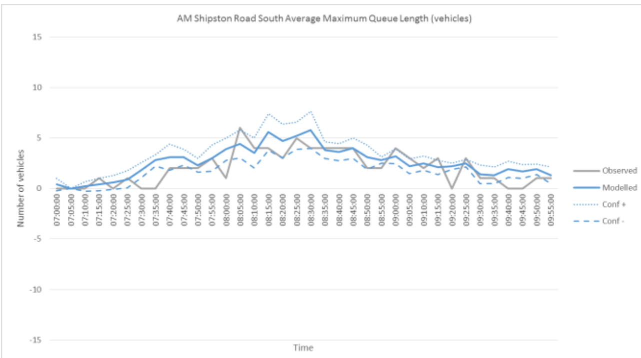
Site	From Arm	To Arm	Arm Ref.	Approach	Exit	07:00-08:00			08:00-09:00			09:00-10:00			16:00-17:00			17:00-18:00			18:00-19:00		
						Observed	Modelled	GEH	Observed	Modelled	GEH	Observed	Modelled	GEH	Observed	Modelled	GEH	Observed	Modelled	GEH	Observed	Modelled	GEH
						All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh	All Veh
1	A	B	A to B	Shipston Rd N	Trinity Way	7	7	0.0	13	13	0.0	11	11	0.0	16	16	0.1	20	20	0.1	23	23	0.0
1	A	C	A to C	Shipston Rd N	Shipston Rd S	219	216	0.2	230	229	0.1	272	271	0.1	346	338	0.4	394	393	0.1	323	327	0.2
1	A	D	A to D	Shipston Rd N	Seven Meadows Road	54	52	0.3	39	40	0.2	59	59	0.0	106	103	0.3	105	106	0.1	66	67	0.1
1	B	A	B to A	Trinity Way	Shipston Rd N	25	25	0.1	21	21	0.0	12	12	0.1	12	12	0.0	18	18	0.0	17	17	0.1
1	B	C	B to C	Trinity Way	Shipston Rd S	53	52	0.1	176	174	0.1	155	156	0.1	157	155	0.2	196	196	0.0	108	109	0.1
1	B	D	B to D	Trinity Way	Seven Meadows Road	130	128	0.2	342	341	0.0	197	198	0.1	250	247	0.2	294	295	0.0	146	146	0.0
1	C	A	C to A	Shipston Rd S	Shipston Rd N	391	378	0.6	353	358	0.3	313	317	0.2	279	270	0.5	274	280	0.3	241	239	0.1
1	C	B	C to B	Shipston Rd S	Trinity Way	67	65	0.2	205	203	0.1	99	102	0.3	145	140	0.4	181	185	0.3	124	122	0.1
1	C	D	C to D	Shipston Rd S	Seven Meadows Road	247	238	0.6	468	465	0.1	346	352	0.3	387	376	0.6	387	395	0.4	259	257	0.2
1	D	A	D to A	Seven Meadows Road	Shipston Rd N	60	59	0.2	32	33	0.2	55	54	0.1	59	58	0.1	63	63	0.0	44	44	0.0
1	D	B	D to B	Seven Meadows Road	Trinity Way	148	145	0.2	308	308	0.0	149	150	0.1	258	255	0.2	326	325	0.1	196	199	0.2
1	D	C	D to C	Seven Meadows Road	Shipston Rd S	212	208	0.3	299	304	0.3	278	276	0.1	428	422	0.3	451	452	0.1	370	372	0.1
2	A	B	A to B	Shipston Rd N	Waitrose	33	32	0.1	118	116	0.2	140	140	0.0	225	217	0.6	233	232	0.1	181	182	0.1
2	A	C	A to C	Shipston Rd N	Shipston Rd S	205	200	0.4	237	237	0.0	223	224	0.1	304	295	0.5	325	322	0.2	258	260	0.1
2	A	D	A to D	Shipston Rd N	Clifford Lane	245	240	0.3	353	354	0.1	339	338	0.1	408	396	0.6	494	488	0.3	365	368	0.1
2	B	A	B to A	Waitrose	Shipston Rd N	25	25	0.1	65	65	0.0	89	90	0.1	160	158	0.2	164	166	0.1	159	159	0.0
2	B	C	B to C	Waitrose	Shipston Rd S	2	2	0.0	19	19	0.0	21	21	0.0	46	46	0.1	56	56	0.0	45	45	0.0
2	B	D	B to D	Waitrose	Clifford Lane	11	11	0.0	24	24	0.0	33	33	0.0	84	83	0.1	88	89	0.1	65	65	0.0
2	C	A	C to A	Shipston Rd S	Shipston Rd N	221	213	0.5	352	353	0.1	292	293	0.1	278	271	0.4	294	296	0.1	197	200	0.2
2	C	B	C to B	Shipston Rd S	Waitrose	8	8	0.0	21	21	0.1	25	25	0.1	36	35	0.2	34	35	0.1	21	21	0.0
2	C	D	C to D	Shipston Rd S	Clifford Lane	8	8	0.1	23	23	0.0	30	30	0.0	19	19	0.1	25	25	0.0	14	14	0.1
2	D	A	D to A	Clifford Lane	Shipston Rd N	459	449	0.5	610	609	0.0	380	385	0.3	369	362	0.4	396	398	0.1	257	258	0.1
2	D	B	D to B	Clifford Lane	Waitrose	17	17	0.0	25	24	0.1	35	35	0.1	37	36	0.1	37	36	0.1	24	25	0.2
2	D	C	D to C	Clifford Lane	Shipston Rd S	10	10	0.0	28	27	0.1	17	18	0.1	19	19	0.0	10	10	0.0	7	7	0.0

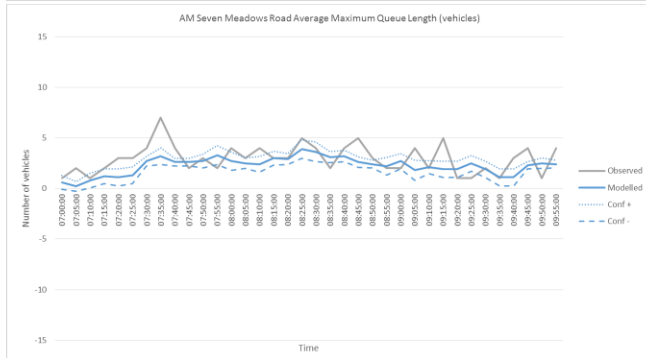
		Observed	Modelled	Pass?	Observed	Modelled	Pass?	Observed	Modelled	Pass?	Observed	Modelled	Pass?	Observed	Modelled	Pass?	Observed	Modelled	Pass?
From	Shipston Road North	280	274	Pass	282	282	Pass	342	341	Pass	468	457	Pass	519	518	Pass	412	417	Pass
To	Shipston Road North	476	462	Pass	406	412	Pass	380	383	Pass	350	341	Pass	355	360	Pass	302	300	Pass
From	Trinity Way	208	205	Pass	539	537	Pass	364	367	Pass	419	414	Pass	508	508	Pass	271	272	Pass
To	Trinity Way	222	217	Pass	526	524	Pass	259	263	Pass	419	411	Pass	527	530	Pass	343	345	Pass
From	Shipston Road South	705	682	Pass	1026	1026	Pass	758	770	Pass	811	787	Pass	842	859	Pass	624	618	Pass
To	Shipston Road South	484	476	Pass	705	708	Pass	705	703	Pass	931	915	Pass	1041	1041	Pass	801	808	Pass
From	Seven Meadows Road	420	412	Pass	639	645	Pass	482	481	Pass	745	735	Pass	840	840	Pass	610	615	Pass
To	Seven Meadows Road	431	418	Pass	849	847	Pass	602	609	Pass	743	726	Pass	786	795	Pass	471	470	Pass
From	Shipston Road North	483	472	Pass	708	707	Pass	702	702	Pass	937	908	Pass	1052	1042	Pass	804	810	Pass
To	Shipston Road North	705	687	Pass	1027	1027	Pass	761	768	Pass	807	791	Pass	854	859	Pass	613	617	Pass
From	Waitrose	38	38	Pass	108	108	Pass	143	144	Pass	290	286	Pass	308	311	Pass	269	269	Pass
To	Waitrose	58	57	Pass	164	161	Pass	200	200	Pass	298	288	Pass	304	302	Pass	226	228	Pass
From	Shipston Road South	237	229	Pass	396	397	Pass	347	348	Pass	333	325	Pass	353	355	Pass	232	234	Pass
To	Shipston Road South	217	212	Pass	284	284	Pass	261	263	Pass	369	359	Pass	391	388	Pass	310	312	Pass
From	Clifford Lane	486	476	Pass	663	661	Pass	432	437	Pass	425	417	Pass	443	444	Pass	288	290	Pass
To	Clifford Lane	264	259	Pass	400	401	Pass	402	400	Pass	511	497	Pass	607	603	Pass	444	446	Pass

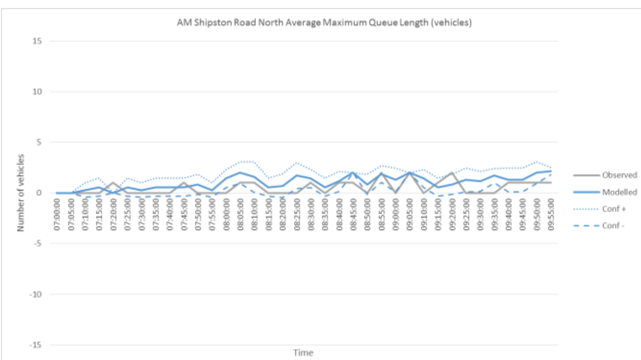
Appendix B

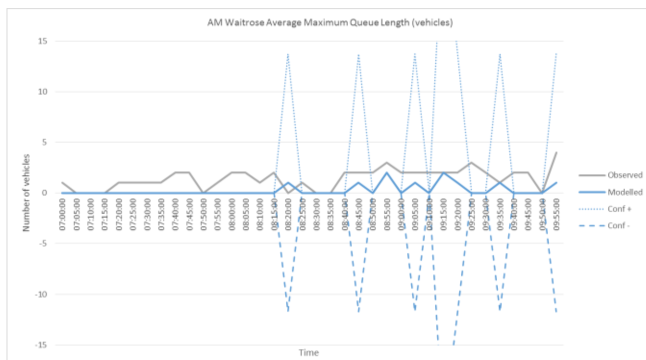

AM Shipston Road North Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

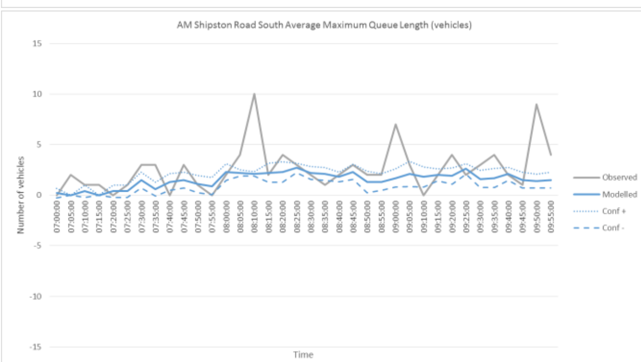

AM Trinity Way Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

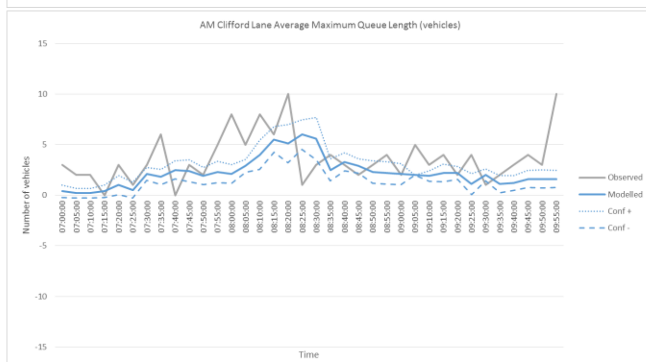

AM Shipston Road South Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

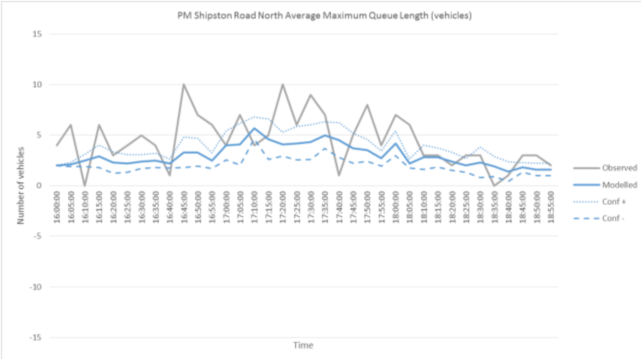

AM Seven Meadows Road Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

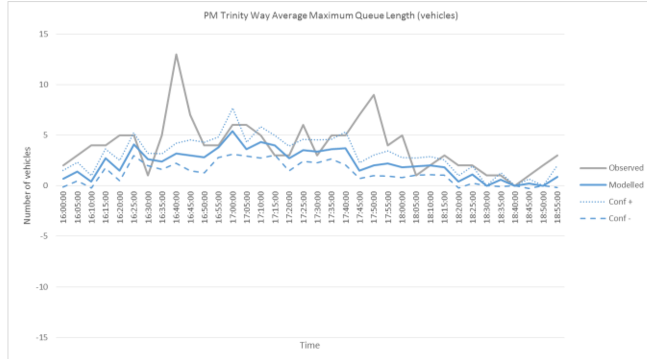

AM Shipston Road North Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

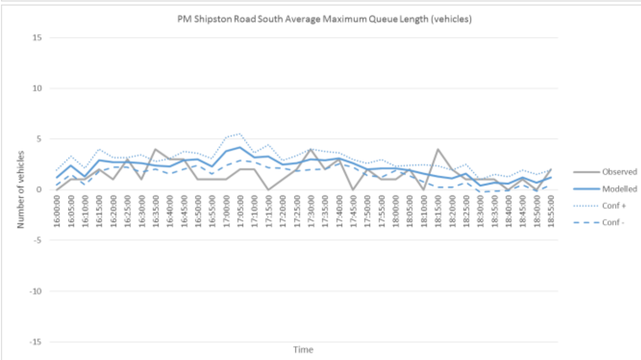

AM Waitrose Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

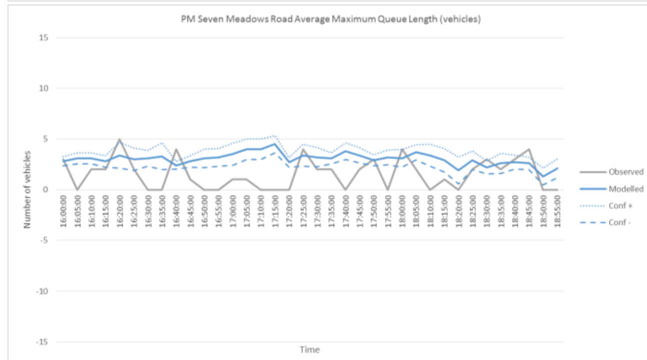

AM Shipston Road South Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

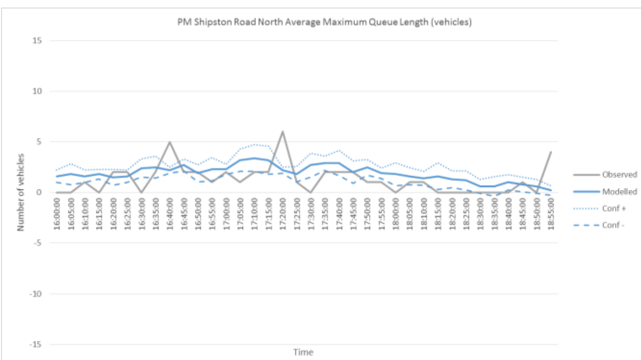

AM Clifford Lane Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

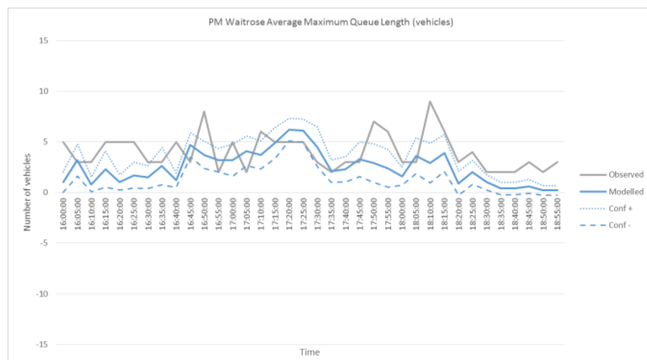

PM Shipston Road North Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

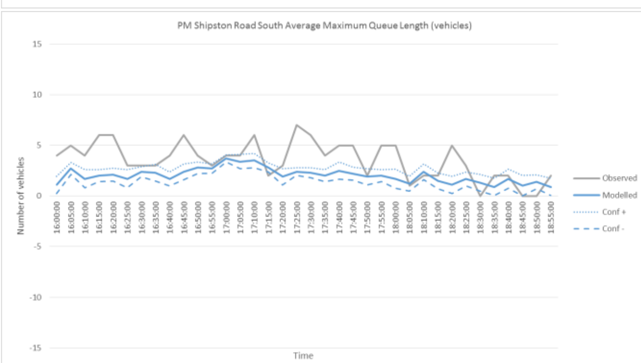

PM Trinity Way Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -

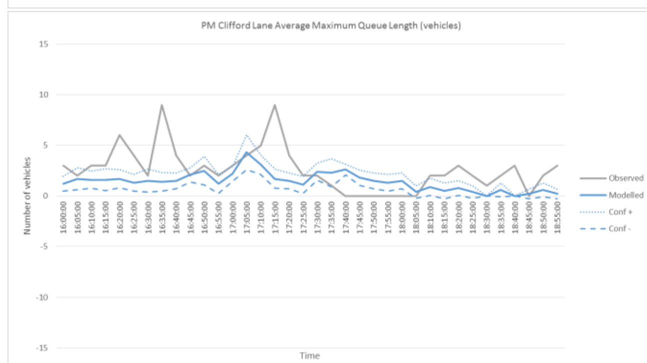

PM Shipston Road South Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -


PM Seven Meadows Road Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -


PM Shipston Road North Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -


PM Waitrose Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -


PM Shipston Road South Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -


PM Clifford Lane Average Maximum Queue Length (vehicles)
Number of vehicles
Time
Observed
Modelled
Conf +
Conf -