steer davies gleave

Buntingford Transport Modelling Assessment

Local Model Validation Report
August 2015

East Hertfordshire Council

Our ref: 22787601
Client ref: EHC25/1024/2014

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1 Introduction

Background

1.1 Steer Davies Gleave has been appointed by East Hertfordshire Council, to provide traffic modelling work that will inform the Plan-making process of the District Plan. This work involves two main tasks:

- Creation of a VISSIM micro-simulation model of the existing operation of the road network in and around Buntingford
- Use of the above model to test various development scenarios, and determine any mitigation measures (if required)

1.2 This Local Model Validation Report (LMVR) sets out the data and assumptions used in the development of the base model. The report is split into the following Chapters, which represent those stages set out in our original proposal for the work:

- Chapter 2 – Model Specification
- Chapter 3 – Data Collection
- Chapter 4 – Base Model Network Development
- Chapter 5 – Base Model Flow Calibration
- Chapter 6 – Base Model Validation
- Chapter 7 – Base Model Output
- Chapter 8 – Summary and Next Steps

Stage	Work Stage – Base Model Development
3A	Model Specification
3B	Base Model Zone Structure
3C	Base Model Network Development
3D	Base Demand Derivation and Flow Calibration
3E	Base Model Validation
3F	Base Model Output

2 Model Specification

Modelling Tool

2.1 The micro-simulation model VISSIM has been used as the key modelling tool for the study. VISSIM is a microscopic, time step, and behaviour based simulation model. Essential to the accuracy of a traffic simulation model is the quality of the actual modelling of vehicles or the methodology of moving vehicles through the network. VISSIM uses lane changing behaviour, vehicle following behaviour and gap acceptance model theories for give-way junctions – this is different to other more traditional traffic models, which use a simplified flow versus capacity approach.

2.2 Consequently, VISSIM requires more complex and detailed inputs than traditional traffic modelling tools; such as speed limits, speed reduction areas dependent upon driver behaviour, detailed public transport information, geometric data including road features and junction features, detailed junction control parameters, classified traffic data for time segments and traffic arrival profiles.

2.3 As an output, VISSIM provides classified information for each mode modelled such as traffic queues, delay information, journey times on identified routes and other specific information that the user may intend to utilise.

Methodology

2.4 In general, base VISSIM models are developed in the following manner:

- Coding of highway network (links and connectors) based on background mapping
- Coding of traffic control systems (signal, stop and give-way control)
- Creation of traffic demand input from available flow information, entered as traffic inputs and routes
- Model calibration
- Model validation
- Model output

Time Periods

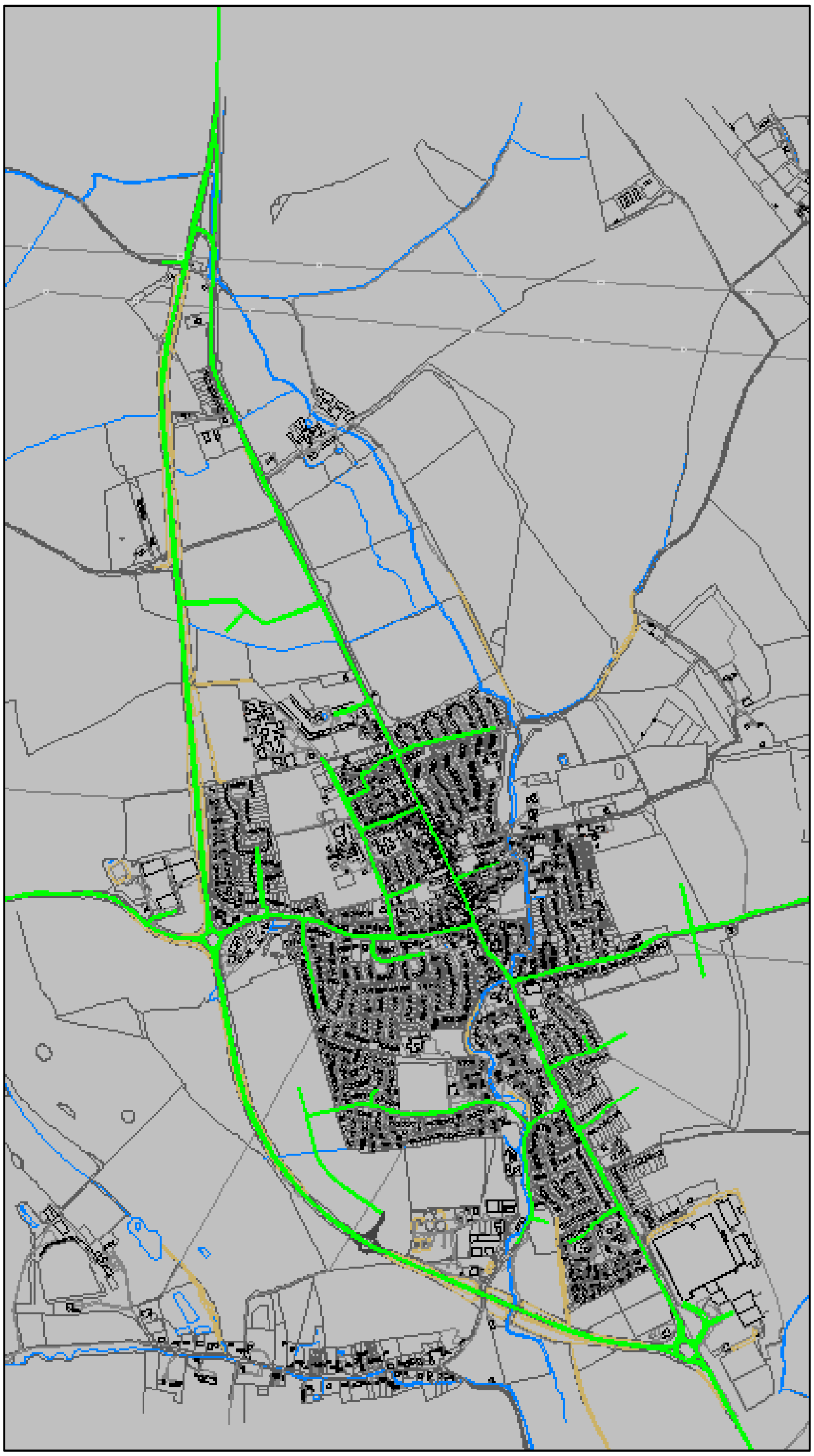
2.5 Data collection was carried out to cover the weekday AM and PM peak periods (see Chapter 3). This data was analysed to determine the peak hour, and the models set up to cover this period, plus a 30 minute warm-up period:

- AM Peak – 07:30-09:00 (peak hour is 08:00 to 09:00)
- PM Peak – 16:30-18:00 (peak hour is 17:00 to 18:00)

Network Scope

2.6 The network was developed for the area shown in Figure 2.1, with links shown in green (and also showing links included in proposed scenario model).

Figure 2.1: Buntingford Model Network Scope



3 Traffic Data Collection

Requirements

3.1 Although the Buntingford road network is relatively simple, some route choice does exist. In addition, the model needs to accurately represent operation both at individual junction level, but also general traffic patterns throughout the network as a whole.

3.2 Consequently, traffic demand for the base model has been developed on a matrix basis for the whole network, rather than providing turning movements on a junction by junction basis. This methodology, and the requirements for model calibration and validation, therefore requires the following data to be collected.

Turning Movements

3.3 Fully classified turning count surveys were commissioned at the following locations on Tuesday 10 February 2015, as shown on Figure 3.1:

- 1 - A10/London Road
- 2 - A10/Baldock Road
- 3 - A10/Ermine Street
- 4 - Baldock Road/Monks Walk
- 5 - Baldock Road/Bowling Green Lane
- 6 - Baldock Road/High Street
- 7 - Station Road/Hare Street Road
- 8 - Station Road/Aspenden Road
- 9 - Ermine Street/Vicarage Road/Freman Drive

3.4 This data is used in the flow calibration process as set out in Chapter 5, but also used to profile vehicle inputs within the model in 15-minute intervals.

Origin-Destination

3.5 In order to determine traffic patterns throughout the network, Bluetooth surveys were undertaken to trace through and non-through movements at the following locations on 10-12 February 2015 inclusive, again as shown in Figure 3.1.

- A - A10 north of Ermine Street junction
- B - A10 south of London Road junction
- C - Baldock Road west of A10 junction
- D - Hare Street Road east of Station Road junction

3.6 This data was also used in the flow calibration process.

Queue Length Surveys

3.7 Queue length surveys were commissioned at the following locations on Tuesday 10 February 2015, as shown on Figure 3.1:

- 1- A10/London Road
- 2 - A10/Baldock Road
- 7 - Station Road/Hare Street Road

3.8 This data is used in the model validation process, as was recorded in 5-minute intervals.

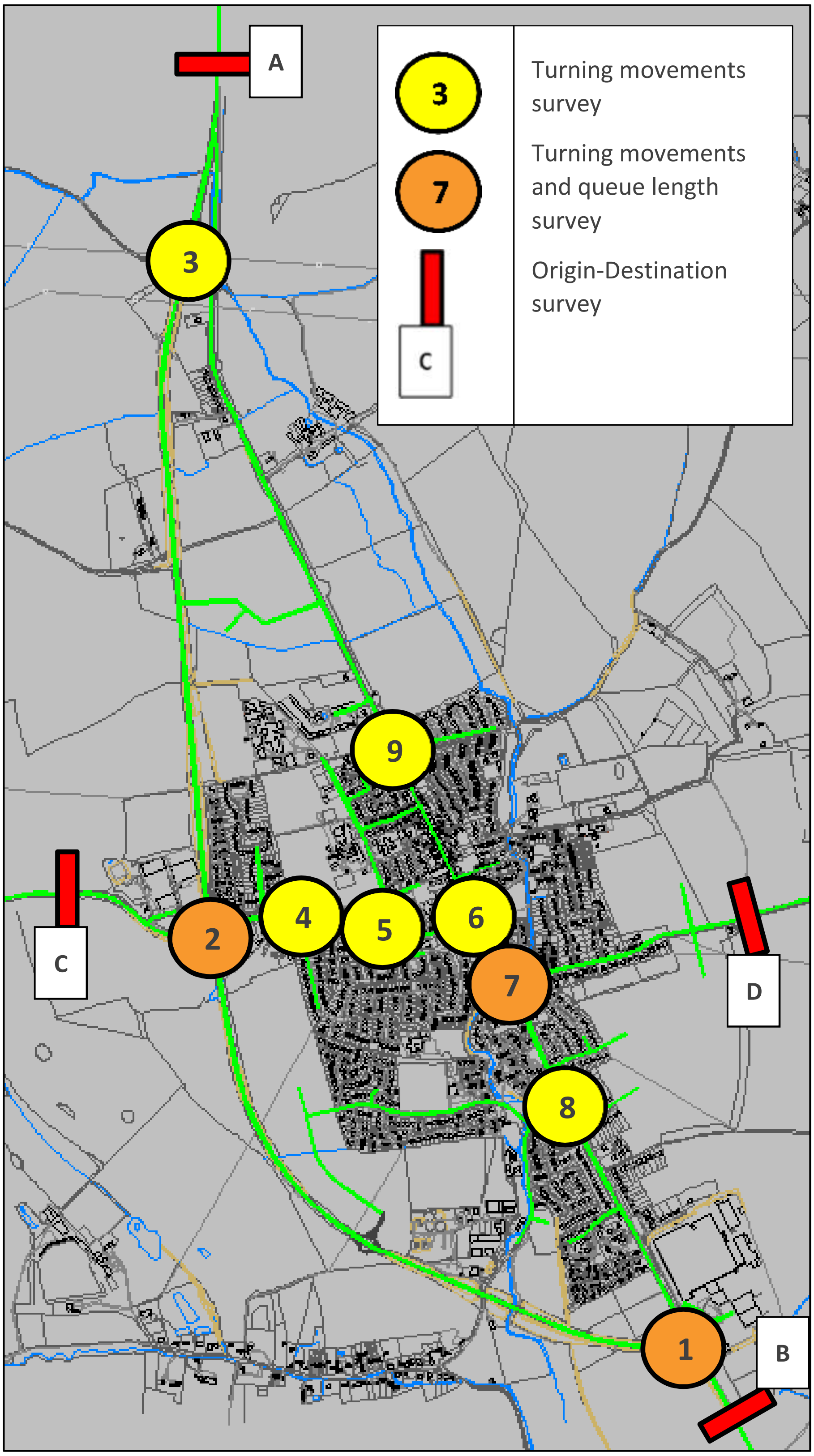
Journey Time Surveys

3.9 The Bluetooth data also provided point to point journey times between the 4 locations. This data is used in the model validation process.

2011 Census

3.10 The 2011 Census provides information on origins and destinations of 'Journey To Work' (JTW) trips, by mode. This data was also used in the flow calibration process.

Figure 3.1: Traffic Survey Data



4 Base Model Network Development

Network Build

4.1 Figure 2.1 set out the link structure of the base model. In addition to existing links, the base model has also included future access links and junctions for development plots, plus:

- New roundabout on A10 between London Road and Baldock Road, to provide access to development plot 3/13/1399/OP
- New link road between A10 and Ermine Street, to provide access to development plot 3/13/1375/OP

4.2 In all cases, these links and access roads are closed to all traffic in the base model. In the case of the new A10 roundabout, the roundabout circulatory and access arm are all closed to traffic in the base model, and the existing through A10 links are retained (with zero delay at this node) – in the latter options scenario models, this arrangement is reversed. The reason for adding them in at the base development stage is to simplify the VISSIM to VISUM export process for flow calibration and future scenario matrix development – this is set out in the following chapter.

Speed Parameters

4.3 In terms of speed limits in the model, a number of sets of speed profiles have been used:

- 90kph (~60mph) on A10 throughout network, plus Baldock Road and Ermine Street outside of the town
- 60kph (~40mph) on Station Road and London Road, from Downhall Ley to the A10 roundabout
- 40kph (~30mph) on most through links within the town

4.4 Other, lower, speed profiles have been applied at other locations within the network:

- 30kph (~20mph) on High Street from Vicarage Road to Baldock Road, to represent the narrow carriageway and resultant reduction in vehicle speeds
- 25kph (~15mph) on all movements at the A10 roundabouts
- 15kph (~10mph) on all turning movements at all priority controlled junctions and mini-roundabouts within the network

Priority Rules

4.5 Priority rules have been applied at all appropriate points within the network, generally:

- Minimum gap acceptance time of 4s at all priority controlled junctions and mini-roundabouts for opposed movements
- Minimum gap acceptance time of 2s at all A10 roundabouts for opposed movements

- Keep clear sections have been added on High Street (Vicarage Road to Baldock Road) to model the restricted carriageway width along this section, and ensure that opposing vehicles do not enter the same road space within the pinch points.
- Keep clear sections have been added on Baldock Road (High Street to Bowling Green Lane) where on-street parking is provided, to ensure that HGVs and buses do not enter the section from either end of the link if another vehicle is already within the section, as there is insufficient road space

Bus movements

4.6 There are very few bus movements within the two modelled periods, but the services that do operate have been added as set out in the timetables available (**http://www.intalink.org.uk/**). The services added are as set out in Table 4.1.

Table 4.1: Bus Services within Buntingford in modelled periods

			AM Peak	PM Peak
Service Number	Entry	Exit	Services added within 90 minute model period	
331 WB	A10 North	B1038	1	1
331 EB	B1038	A10 North	1	-
700 SB	A507	A10 South	1	1

4.7 Bus stops have been added to the network, with default stop times of 20s. Given the level of bus frequencies in the network, bus movements do not have a measurable impact on the operation of the network.

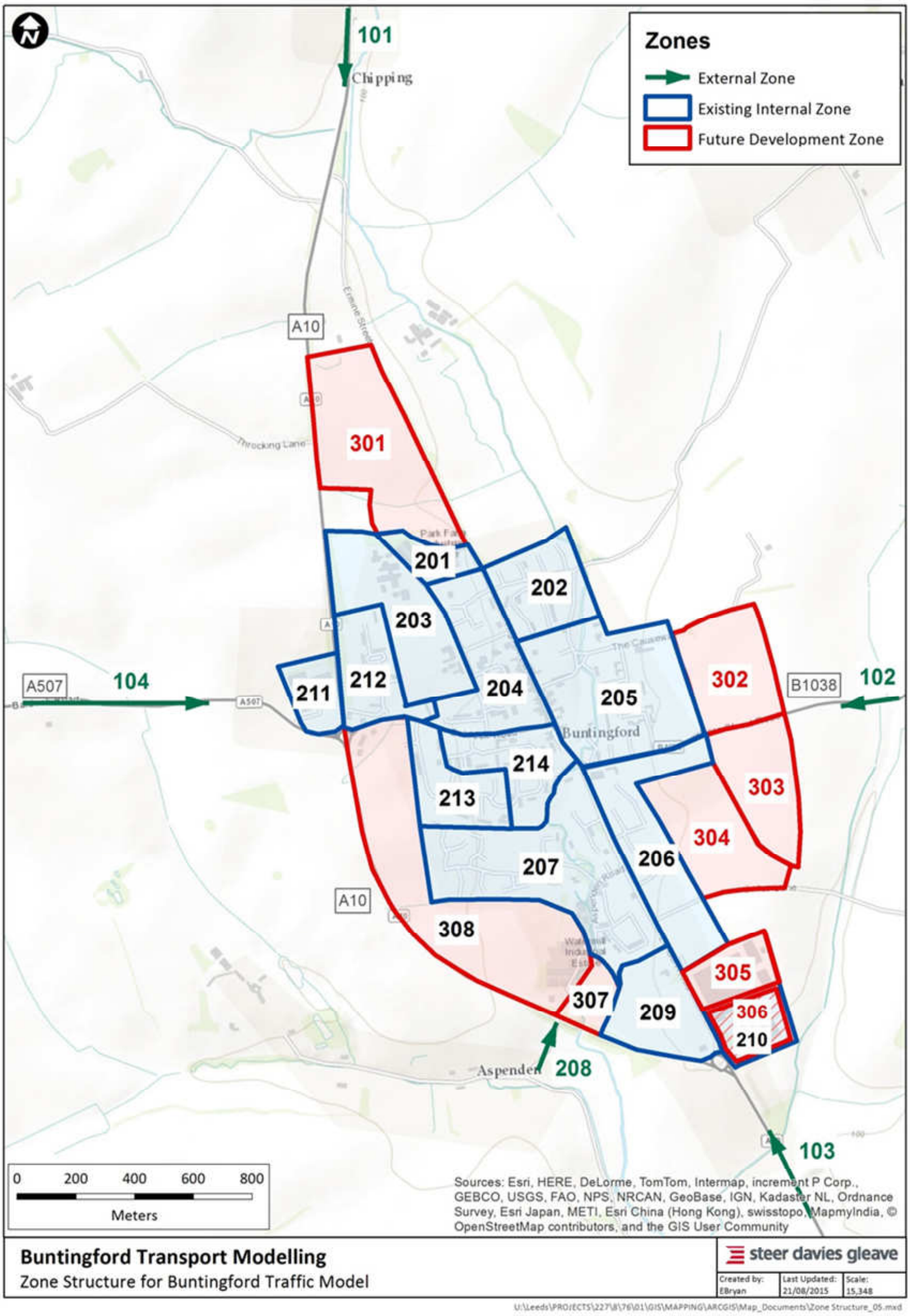
Zones

4.8 In order to create matrices for the addition of traffic demand to the network, zones have been applied. These have been numbered by zone type:

- 100 series – external zones on the 4 main roads (A10, A507 and B1038)
- 200 series – existing internal zones representing residential blocks and other minor external roads
- 300 series – internal zones representing future development sites, added to the base model but closed to traffic

4.9 The zone structure is also shown in Figure 4.1. More detail as to the use of zones is provided in the following chapter. Note that the shaded area for Zones 210/306 indicates that the area consists of both an existing zone and a future development zone.

Figure 4.1: Zone Structure



5 Base Model Flow Calibration

General Process

5.1 The aim of flow calibration is to create a set of demands in the model that matches the observed and surveyed data. For a network of this size (relatively small) and the extent of data collected (relatively good) it should be possible to create a set of demand data in the model that calibrates well against individual turning movement observations.

5.2 The process to create and calibrate a set of demand flows, for both AM and PM peak hours, is as follows:

- Create prior matrix
- Matrix estimation
- Flow calibration
- Flow Profiling

5.3 In order to carry out the demand process the VISSIM model developed in Chapter 4 was exported into VISUM. This package includes a matrix estimation module (whereas VISSIM does not), and so this tool was used to carry out all development of traffic demand, which could be then imported back into VISSIM.

Create Prior Matrix

5.4 The creation of a prior matrix is an important step in matrix estimation. This matrix provides the basis on which a first assignment onto the network is undertaken, from which the matrix is adjusted to better fit all the internal turning counts and link flows. Consequently, the more effort that is put into developing a prior matrix, the more likely that that the final matrix can be developed without compromising the overall traffic patterns observed for the network as a whole.

5.5 In order to create the prior matrix, firstly the zone structure set out in Figure 4.1 was developed. This essentially sets out two types of zones for the base network:

- 100 series – external zones on the 4 main roads (A10, A507 and B1038)
- 200 series – existing internal zones representing residential blocks and other minor external roads

5.6 A prior matrix is then developed based on the following information:

- Bluetooth O-D (Origin-Destination) observations for the external to external moves between zones
- Turning count data for some of the internal zone totals
- Census data to estimate the relative sizes of internal zone totals

5.7 This creates a prior matrix in Figure 5.1 for the AM peak period (PM peak matrix has the same structure).

Figure 5.1: AM Peak Hour Prior Matrix

O/D	101	102	103	104	201	202	203	204	205	206	207	208	209	210	211	212	213	214	302
101	0	22	350	42	12	10	58	11	12	3	18	5	1	4	6	7	9	7	0
102	26	0	64	47	6	5	20	6	6	8	6	2	1	2	3	2	4	4	0
103	264	32	0	230	24	14	80	24	29	28	30	9	2	19	12	10	16	16	0
104	39	54	319	0	16	9	63	16	23	18	17	6	2	5	8	7	11	11	0
201	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
202	15	7	54	20	0	0	26	3	0	0	0	0	0	0	0	0	0	0	0
203	29	10	40	31	0	11	0	4	5	3	7	0	0	0	0	2	3	3	0
204	11	5	60	15	3	1	7	0	9	8	1	1	1	2	2	0	7	7	0
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	8	6	49	13	2	1	5	1	1	0	0	1	1	2	1	1	5	5	0
207	27	10	66	24	5	1	11	1	3	0	0	2	0	3	3	1	18	18	0
208	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
209	2	1	7	2	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0
210	4	6	10	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
211	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
212	8	4	29	11	1	1	3	0	1	1	1	1	1	1	1	0	3	1	0
213	8	4	46	17	2	1	5	11	9	11	1	1	5	1	1	6	0	9	0
214	7	3	46	17	2	1	5	11	3	6	1	1	1	1	1	4	2	0	0
302	13	7	76	20	3	0	8	1	0	1	1	1	1	2	2	1	8	8	0

*Zone 302 is used as the entry point to the network for the reverse of zone 205 (which is the Church Street exit only link)

5.8 The matrix contains 4 sets of values, calculated in different ways:

- Blue cells – calculated directly from the Bluetooth analysis
- Red cells – obtained directly from turning counts
- Yellow cells – total origin and destination obtained directly from turning counts, and then individual cells factored on postcode data
- White cells – remaining cells with no direct information. These are infilled using estimates of origin and destination totals from postcode data, with the final cell values obtained by furnessing the matrix (i.e. trying to match origin and destination rows and columns iteratively)

Matrix Estimation

5.9 Once the prior matrix has been created, it is input into the VISUM model of the network. At this point, all turning counts (from Figure 3.1) are also loaded into the VISUM models as target flows.

5.10 The VISUM matrix estimation process then attempts to make small adjustments to the prior matrix in order to better match the counts at all junctions. This is again an iterative process, but one which has to carefully controlled.

5.11 In essence, the matrix estimation procedure is trying to solve a complex mathematical equation which has a number of acceptable solutions – however, many of these solutions will not maintain the integrity of the original matrix. For example, a particular solution could result in zero through trips between any of the 4 main external origin and destination points, but would still match all the internal counts (by including lots of external-internal and internal-external trips).

5.12 Consequently, it is important that the general structure of the final matrix is similar to the original prior matrix as far as possible, particularly the proportion of the four types of trip:

- External to External (i.e. through trips)
- External to Internal trips
- Internal to External trips
- Internal to Internal trips (i.e. trips within Buntingford)

5.13 At the end of this process, a final matrix is created that, when assigned to the network, matches as many turning count movements as possible.

Flow Calibration

5.14 In order to check that the final matrix is a reasonable representation of the trips within the Buntingford network, flow calibration is undertaken. We have used a revised version of the DMRB (Highways England, Design Manual for Roads and Bridges) calibration criteria as set out in Figure 5.2.

Figure 5.2: DMRB link flow calibration criteria

Criteria and Measures	Acceptability Guideline
Assigned Hourly flows * compared with observed flows	
1. Individual flows within 15% for flows 700 - 2,700 vph	)
2. Individual flows within 100 vph for flows < 700 vph	) > 85% of cases
3. Individual flows within 400 vph for flows > 2,700 vph	)
4. Total screenline flows (normally > 5 links) to be within 5%	All (or nearly all) screenlines
5. GEH statistic: i) individual flows : GEH < 5	> 85% of cases
ii) screenline (+) totals: GEH < 4	All (or nearly all) screenlines
Notes + Screenlines containing high flow routes such as Motorways should be presented both including and excluding such routes * links or turning movements (but see Paragraph 4.4.37).	

5.15 The DMRB criteria are generally intended as a calibration criteria for link counts in large network models, typically county-wide. For the smaller Buntingford network, we would like greater accuracy, as individual turning movements at junctions are critical to the operation of a small network.

5.16 Consequently, we have extended the GEH criteria (#5 in Figure 5.2) to include all turning movements as well as link volumes. The GEH (Geoffrey E. Havers) statistic is used to ensure a balanced approach is taken to comparing model flow output and count data, incorporating both an absolute difference and relative (percentage) difference.

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

5.17 The overall statistics for flow calibration are as set out in Table 5.1, and full data is shown in Appendix A. The node and zone diagram for the network is shown in Figure 5.3.

Table 5.1: Flow Calibration Results

	Number of values	Values with GEH >5	% Meet Criteria	Pass/Fail
		AM Peak		
Links	63	0	100%	PASS
Turns	81	1	99%	PASS
		PM Peak		
Links	62	0	100%	PASS
Turns	74	1	99%	PASS

5.18 As shown in Table 5.1, the calibration easily passes the criteria, with only a single turning movement failing the calibration in each peak period. This value is for the northbound left turn at the Vicarage Road/High Street mini-roundabout (movement 6-5-21 at node 5), and the discrepancy is a function of the simplified zone structure, see Figure 5.3.

5.19 The model assigns no flow to this movement in either peak, whereas in the count data movements of 24 and 17 vehicles made the movement in the AM and PM peak hours respectively. As shown in Figure 5.4, movements from the south to zone 203 in the model can carry out this movement via node 6 and node 23 (as an alternative to via node 5), or via Baldock Road and Bowling Green Road. In reality, residents of Freman Drive and Aylotts Close will carry out this manoeuvre, but the zone structure is not sensitive enough for trips to assign to the route. However, the volumes are very small, and given that all other movements in the model fit the counts very well, it is not considered that this will have a measurable impact on the operation or integrity of the model.

5.20 We have also carried out a comparison of the overall trip patterns in the prior and final matrices, as shown in Table 5.2.

Table 5.2: Matrix Comparison

Zone Movements	AM Peak Prior	AM Peak Final	Change	PM Peak Prior	PM Peak Final	Change
			Percentage split			
External to External	43%	41%	-2%	47%	47%	=
External to Internal	22%	21%	-1%	25%	20%	-5%
Internal to External	25%	25%	=	19%	18%	-1%
Internal to Internal	11%	14%	+3%	10%	15%	+5%
Total matrix size (v/h)	**3479**	**3580**	**+3%**	**3199**	**3271**	**+2%**

Figure 5.3: Node and Zone Identification

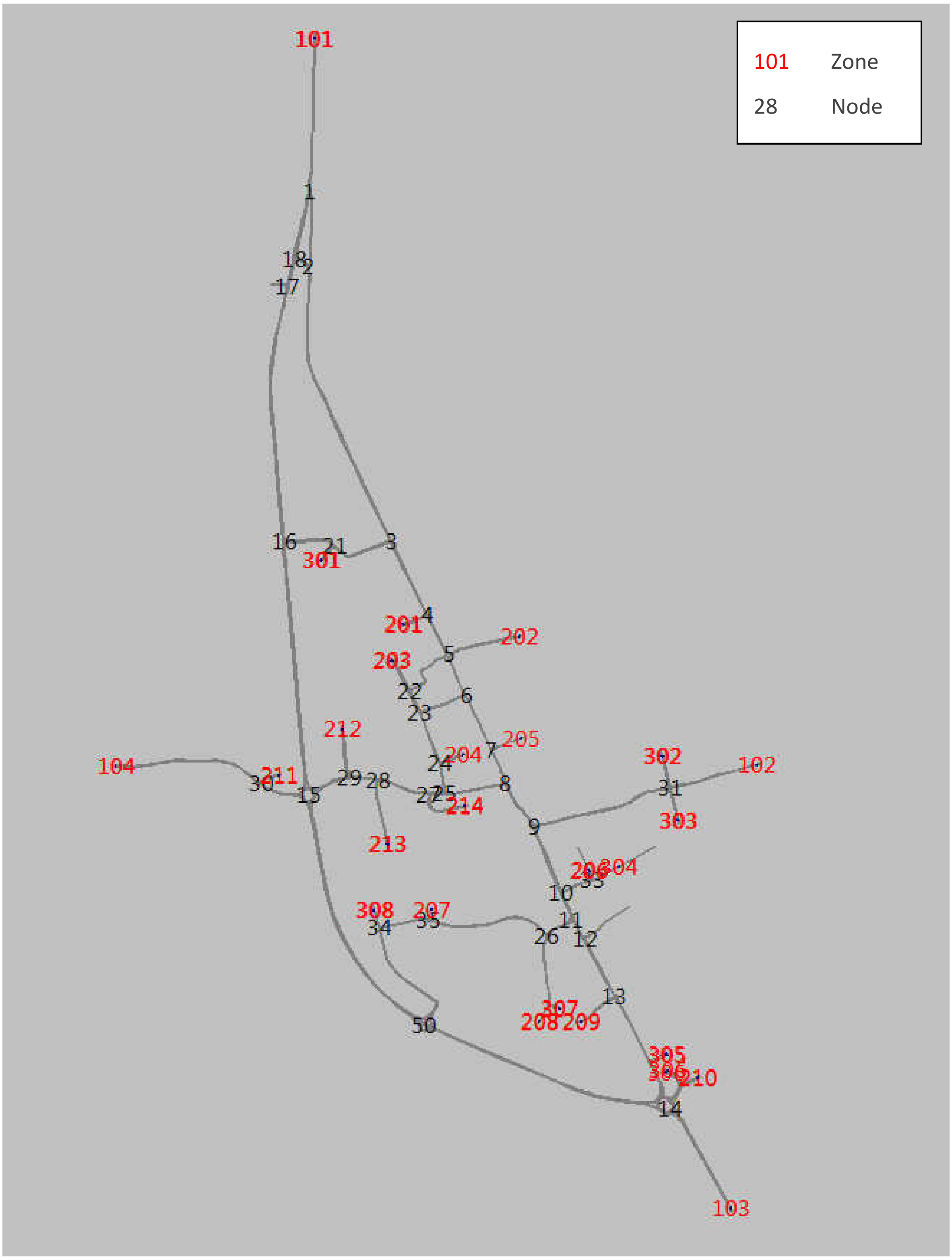


Figure 5.4: Network Coding on High Street

5.21 Table 5.2 shows that there is little change to the traffic patterns, giving some confidence that the matrix estimation procedure has held the integrity of the original prior matrix, with a reasonable split of the 4 O-D trip types.

Flow Profiling

5.22 Once the model demand has been fixed and traffic assigned to the network in VISUM, this assignment is fixed and exported into VISSIM. This creates a set of inputs on each origin (zone) point, plus a set of routes from each origin zone to every other destination zone with an associated volume.

5.23 At this point, the inputs are fixed over a one-hour period. In order to improve the accuracy of the model, each input is then factored up and profiled into 6 x 15-minute intervals, representing 07:30-09:00 in the AM peak period and 16:30-18:00 in the PM peak period. Each input is profiled either by:

- The associated count for that input, if a suitable count is available (e.g. A10 South entry into the network is profiled according to the count profile for that entry from the A10/London Road roundabout count data)
- A general global profile, based on the relative overall traffic across all counts in the network within each 15-minute period. This profile is used where a directly associated count is not available

5.24 In addition to the input data being profiled by time, a vehicle composition is also applied at each input point, to split the input volumes in a percentage of cars and HGVs. The total matrix used in the estimation process included all vehicle classes, and so this composition data is calculated from either an associated count, or the global average for each entry link individually.

6 Base Model Validation

Introduction

6.1 In terms of base model validation, we have carried out three procedures to ensure that the base VISSIM model is a true representation of the operation of the network as observed:

- Queue lengths at key junctions
- Journey times on external to external vehicle movements
- Traffic flow on turning movements at junctions

6.2 In order to obtain model output for the validation, we have run the model for 5 seeds (randomised generator of behaviour) and compiled the output from these runs to create data to compare against the available count and on-street observations.

Flow Validation

6.3 The flow validation of the base model is essentially a check that the export/import of the assignment, the profiling of inputs and the application of vehicle compositions has been carried out correctly. Therefore the validation is a re-check of model output against the same count data as used in the flow calibration, rather than a “true” validation. However, given the extensive use of traffic data used in the calibration data, it is not expected that a comparison against other data (mostly link flows, mostly several years old) would not provide a real benefit to the accuracy of the model.

6.4 Table 6.1 shows that the validation produces a single movement that fails to meet the criteria, as would be expected. Therefore the flow validation is considered a success.

Table 6.1: Flow Validation Results

	Number of values	Values with GEH >5	% Meet Criteria	Pass/Fail
		AM Peak		
Turns	81	1	99%	PASS
		PM Peak		
Turns	74	1	99%	PASS

6.5 Full flow validation statistics are shown in Appendix B.

Journey Time Validation

6.6 The Bluetooth data used to determine the proportion and relative volume of through movements between the 4 main external links also produced journey time readings for all matched trips. Consequently, this allows travel times from the model for such journeys to be compared with the observed Bluetooth data.

6.7 For the observed data, many origin to destination movements had a low number of matched values. Consequently, we have:

- Only compared travel times for the 4 key movements with a significant number of matches:
  - A10 North to A10 South
  - A10 South to A10 North
  - A507 to A10 South
  - A10 South to A507
- Used data for three consecutive days to provide larger sample size:
  - Tuesday 10 February
  - Wednesday 11 February
  - Thursday 12 February

6.8 Table 6.2 shows the results of the comparison of model versus observed travel times, by peak period.

Table 6.2: Travel Time Analysis

Origin	Destination	AM Peak travel time (s)			PM Peak travel time (s)		
		Model	Observed	Difference	Model	Observed	Difference
A10 North	A10 South	236	260	-9%	224	235	-5%
A10 South	A10 North	219	222	-1%	220	221	=
A507	A10 South	158	170	-7%	150	153	-2%
A10 South	A507	141	132	+6%	141	145	-2%

6.9 The results show that all model travel times are within 15% of the observed the journey time – DMRB sets criteria that 85% of model flows should be within 15% of observed flows. Consequently, the validation of travel times in the base model is considered acceptable.

Queue Length Validation

6.10 Queue length surveys were undertaken at the three main junctions within the network, as shown on Figure 3.1.

- 1 - A10/London Road
- 2 - A10/Baldock Road
- 7 - Station Road/Hare Street Road

6.11 The results of the survey have been compared with the model output, for two sets of values:

- Mean Maximum Queue – the maximum queue length recorded in each 5-minute interval, averaged over the peak hour. This gives a general impression of the queue lengths experienced at each junction throughout the peak hour.
- Absolute Maximum Queue – the maximum queue length recorded in the peak hour (in any 5-minute interval). This gives an impression of the maximum queue length experienced at each junction throughout the peak hour.

6.12 Table 6.3 shows the Mean Maximum Queue Length comparison.

Table 6.3: Mean Maximum Queue Length Comparison (in vehicles)

Node	Arm	AM Peak		PM Peak	
		Counts	Base	Counts	Base
High Street/Hare Street Road	High Street (N)	0	0	0	0
	Hare Street Road (E)	2	4	2	2
	Station Road (S)	1	4	1	2
A10/London Road	A10 (S)	2	1	0	1
	A10 (W)	4	4	2	3
	London Road (N)	5	7	2	2
A10/Baldock Road	Baldock Road (E)	3	5	1	1
	A10 (S)	1	3	1	3
	Baldock Road (W)	2	2	3	2
	A10 (N)	4	5	3	2

6.13 Table 6.3 shows that observed mean maximum queue lengths within the network are minimal, through weekday both peak periods. In addition, the comparison of model and observed queue lengths shows good correlation at all 3 junctions.

Table 6.4: Absolute Maximum Queue Length Comparison (in vehicles)

Node	Arm	AM Peak		PM Peak	
		Counts	Base	Counts	Base
High Street/Hare Street Road	High Street (N)	0	0	0	0
	Hare Street Road (E)	4	9	2	4
	Station Road (S)	3	9	2	4
A10/London Road	A10 (S)	11	8	1	5
	A10 (W)	11	10	6	5
	London Road (N)	7	16	4	5
A10/Baldock Road	Baldock Road (E)	7	11	5	3
	A10 (S)	5	8	2	7
	Baldock Road (W)	5	5	6	3
	A10 (N)	6	12	5	5

6.14 Table 6.4 shows that absolute maximum queue lengths are also relatively moderate, with a maximum of 11 vehicles observed on two approaches at the A10/London Road roundabout. The comparison of model and observed queue lengths show some discrepancies – this would be expected, as the absolute value is related to a single event on the day of survey, and therefore subject to individual circumstances.

6.15 Further investigation of the camera footage has indicated that a police car was blocking the nearside lane on the roundabout approach, from 08:40 to 14:15 (see Figure 6.1). Prior to 08:40 zero queues were observed on this approach in the survey, and so the maximum value of 11 vehicles is as a direct result of some driver uncertainty on the approach to the cordoned off lane.

Figure 6.1: Incident on A10 South entry to London Road roundabout towards end of AM peak period

6.16 It is not known what the incident was related to, as all other entry and exit links at the roundabout were operating normally, and thus the incident did not have an impact on traffic demand at the roundabout or downstream junctions. Consequently, given that the AM peak demand on the A10 South entry arm is less than that experienced in the PM peak period, it is assumed that without the incident, minimal queues would be recorded on this approach in line with the modelling results.

6.17 In combination with the above factor, the future scenario model testing (reported in a separate Options Report) indicated an issue with the queue output on this approach (A10 South to London Road roundabout), which has individual characteristics particular to the approach:

- Heavy flows on the A10 South approach
- Little traffic on the circulatory carriageway, to which this traffic must give-way

6.18 In the future option models, when demand on the arm increases towards the link capacity, the momentary slowing down of a vehicle at the roundabout (to give-way to a vehicle on the circulatory carriageway) results in upstream vehicles slowing down, and creating a "queue wave" back along the A10 South approach. This queue wave eventually clears as traffic begins to speed up to the link speed, once downstream vehicles have cleared the give-way line. This phenomenon is relatively common on high capacity links (such as Motorways) where small lane changing incidents can cause a shockwave to pass backwards along a link.

6.19 Queue length recordings output by VISSIM are sensitive to the parameter to which the appearance of a queue is set. In normal circumstances, the location of a back of queue is simple to identify as the last stationary vehicle in a queue – however, in cases where a queue wave is observed, the actual back of queue is difficult to determine as it could be a slow moving vehicle rather than a stationary one, and could be a long way back from the actual give-way point (where traffic could actually be moving freely).

6.20 Consequently, for the A10 South approach only, we have had to set up the parameters to record a queue in a different way to the rest of the model. This, however, provides a more accurate determination of the back of queue point on the A10 South approach (i.e. the back of the queue wave), particularly when the demand increases towards the link capacity in the latter option tests. This ensures that the method of collecting output for all model runs is consistent.

6.21 In terms of trends, the results are able to clearly show that the AM peak period experiences higher levels of queuing compared to the PM peak period (in both the observed and model output). This is also consistent with the relative matrix sizes in the AM peak and PM peak hours of 3580v/h and 3271v/h respectively, representing 9% less total trips in the network in the PM peak period.

6.22 Consequently, it is considered that the base model accurately represents the operation of the network in both peak periods.

7 Base Model Output

7.1 In addition to the specific junction output reported in the previous Chapter, overall measures of network performance are a useful metric to view the operation of the network, particularly when compared with future scenarios.

7.2 Table 7.1 shows some overall statistics of network performance, as output by the model.

Table 7.1: Network Performance

	AM Peak	PM Peak
Average delay per vehicle (s)	25	21
Average speed (mph)	35	37
Total distance travelled (veh-km)	10,200	9,600

7.3 The results in Table 7.1 are consistent with those in the previous Chapter, with the operation of the AM peak showing a greater average delay per vehicle, a lower average speed and more vehicle-kilometres. The first statistic is worthy of note, as the order of delay experienced by vehicles in the network (20-25 seconds per vehicle) is relatively low, and suggest that the existing network could accommodate additional traffic without a significant impact on network performance.

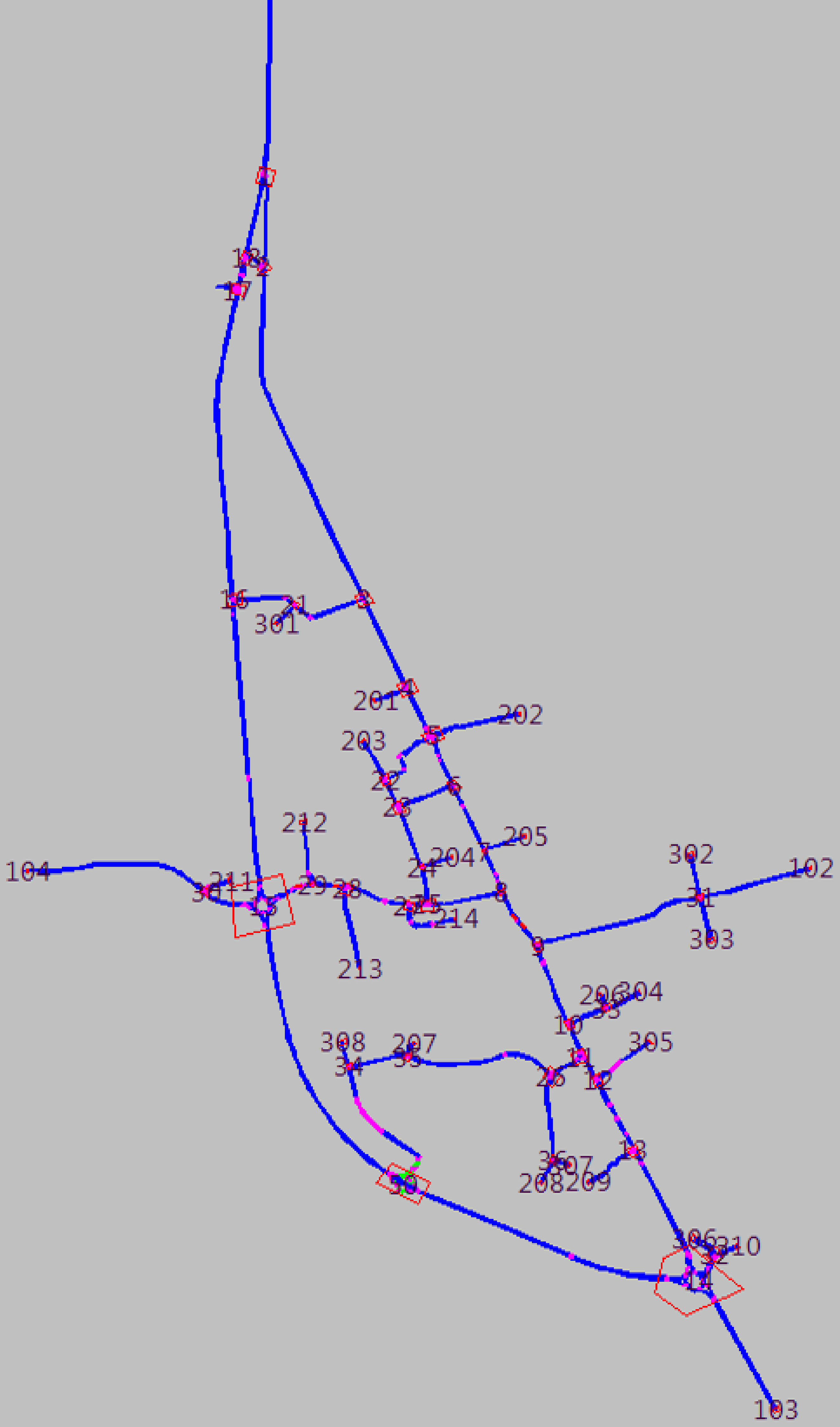
8 Summary and Next Steps

8.1 A VISSIM model of Buntingford has been developed to show the operation of the existing network in the weekday AM and PM peak periods. The base models have been calibrated and validated for traffic flows, journey times and queues based (generally) on DMRB criteria.

- 100% validation has been achieved for link flows in both peak periods
- 99% validation has been achieved for turning movements in both peak periods
- AM and PM peak modelled journey times are within the acceptable level
- Observed queue lengths are replicated well in the model in both peak periods

8.2 The base model can therefore be utilised to test future development scenarios.

A Model Calibration Statistics



301
201
202
203
212
205
104
211
302
102
303
213
214
308
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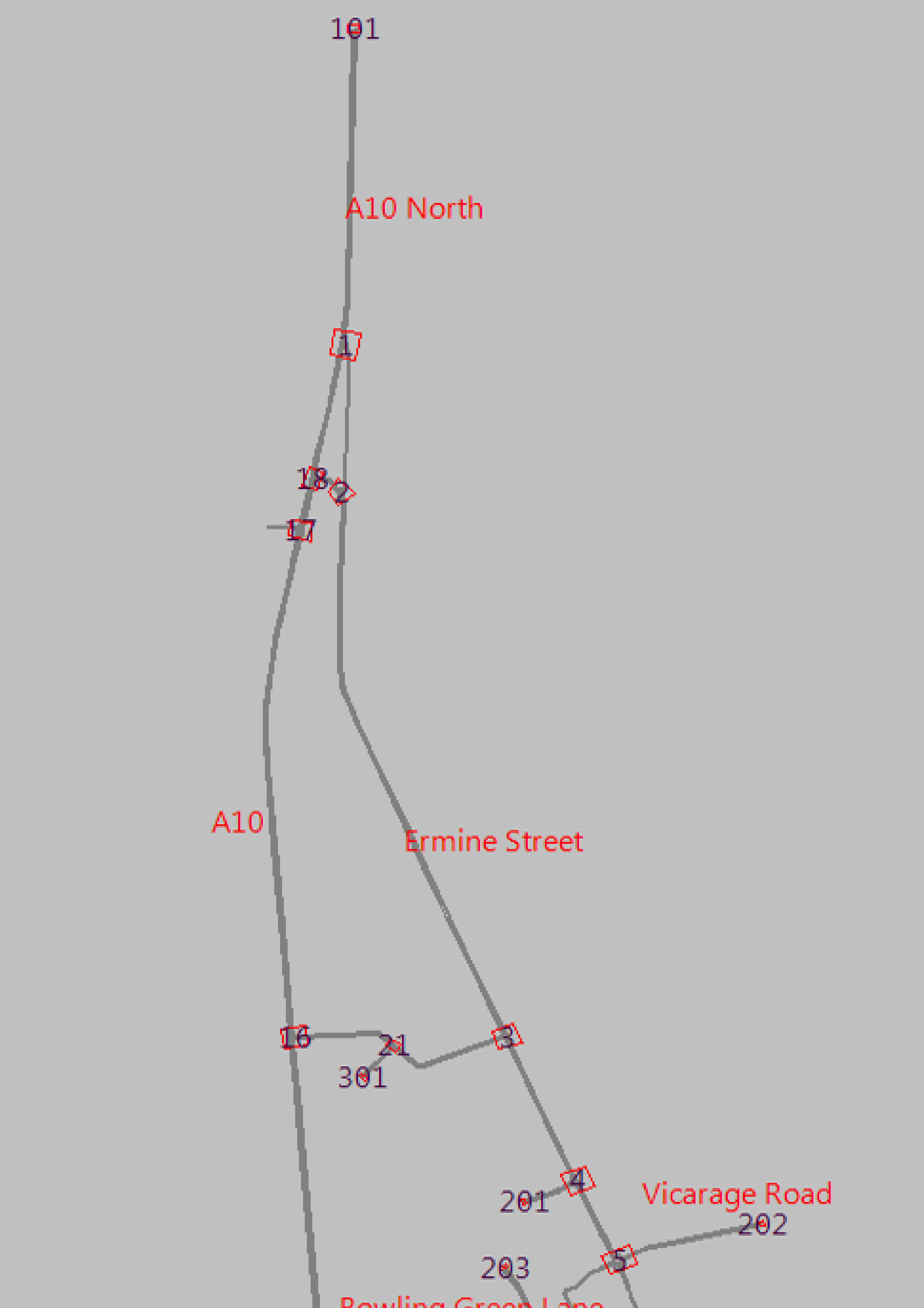
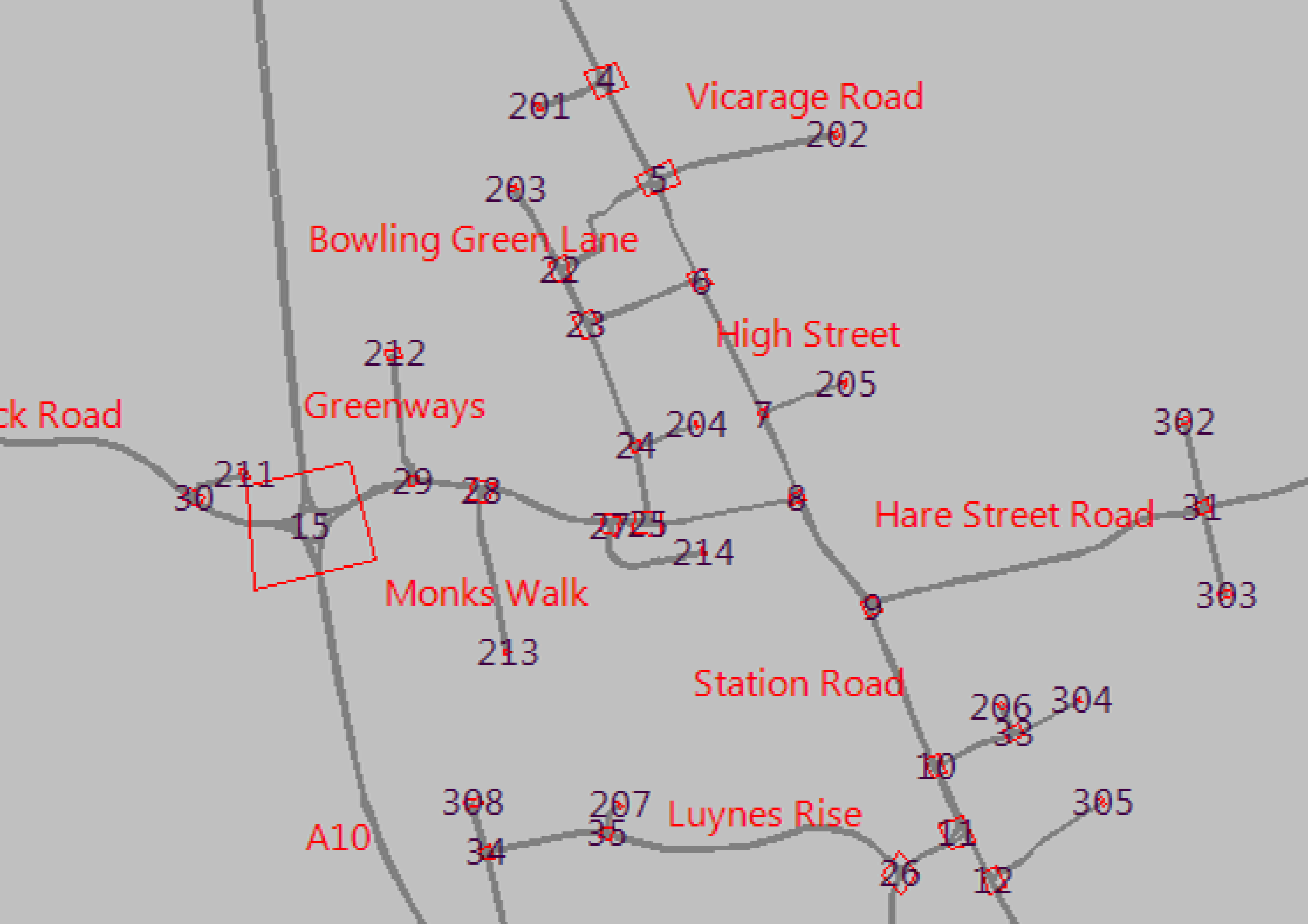
103


101
A10 North
1
18
2
17
A10
Ermine Street
16
21
301
3
4
201
Vicarage Road
202
5
203


Vicarage Road
Bowling Green Lane
High Street
Greenways
Hare Street Road
Monks Walk
Station Road
Luynes Rise
A10
ck Road
201
202
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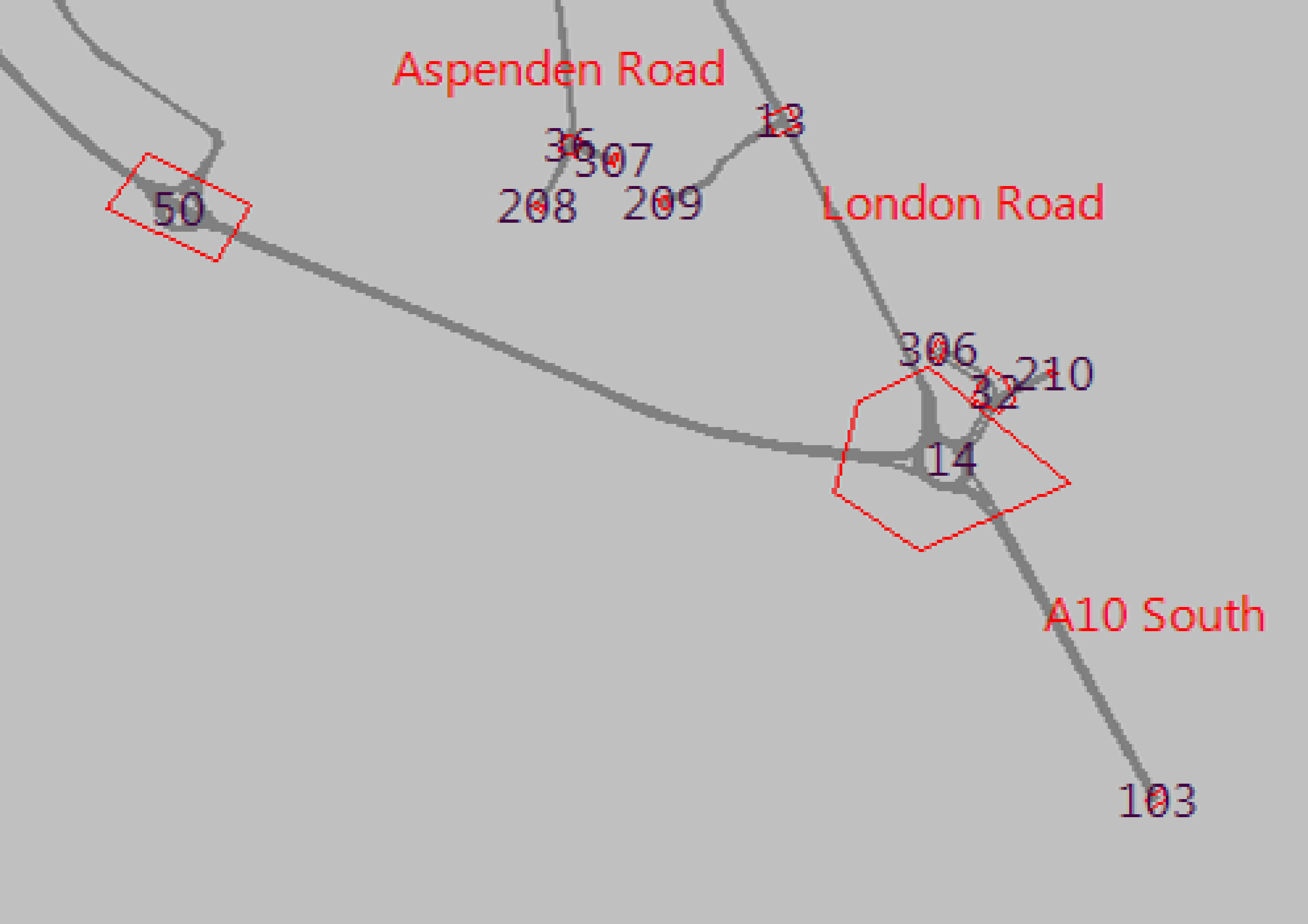
Aspenden Road
13
36
307
208
209
London Road
50
306
210
32
14
A10 South
103

FLOW CALIBRATION - AM PEAK HOUR

TURNS					LINKS				
Movement	Model	Count	difference	geh	Movement	Model	Count	difference	geh
1-18-17	469	451	4.0%	0.84	1-18	469	451	4.0%	0.84
101-1-2	129	126	2.4%	0.27	101-1	129	126	2.4%	0.27
2-18-1	72	67	7.5%	0.60	2-18	85	81	4.9%	0.44
2-18-17	13	14	-7.1%	0.27	4-5	123	131	-6.1%	0.71
4-5-4	0	10	-100.0%	4.47	6-5	108	137	-21.2%	2.62
4-5-6	42	38	10.5%	0.63	22-5	48	61	-21.3%	1.76
4-5-22	71	73	-2.7%	0.24	202-5	131	124	5.6%	0.62
4-5-202	10	10	0.0%	0.00	7-8	126	140	-10.0%	1.21
6-5-4	79	77	2.6%	0.23	8-9	397	361	10.0%	1.85
6-5-6	0	8	-100.0%	4.00	9-8	489	504	-3.0%	0.67
6-5-22	0	24	-100.0%	6.93	8-25	366	368	-0.5%	0.10
6-5-202	29	28	3.6%	0.19	25-8	361	316	14.2%	2.45
22-5-4	31	33	-6.1%	0.35	10-9	437	447	-2.2%	0.48
22-5-6	0	11	-100.0%	4.69	31-9	219	211	3.8%	0.55
22-5-202	17	17	0.0%	0.00	10-11	387	345	12.2%	2.20
202-5-4	18	19	-5.3%	0.23	12-11	279	299	-6.7%	1.18
202-5-6	84	76	10.5%	0.89	26-11	197	196	0.5%	0.07
202-5-22	29	29	0.0%	0.00	13-14	386	338	14.2%	2.52
7-8-9	87	97	-10.3%	1.04	32-14	26	25	4.0%	0.20
7-8-25	39	43	-9.3%	0.62	50-14	876	953	-8.1%	2.55
8-9-10	310	273	13.6%	2.17	103-14	842	840	0.2%	0.07
8-9-31	87	88	-1.1%	0.11	16-15	483	492	-1.8%	0.41
9-8-7	162	169	-4.1%	0.54	29-15	387	423	-8.5%	1.79
9-8-25	327	335	-2.4%	0.44	30-15	638	619	3.1%	0.76
8-25-8	0	3	-100.0%	2.45	50-15	619	613	1.0%	0.24
8-25-24	113	110	2.7%	0.28	17-18	419	414	1.2%	0.24
8-25-27	253	255	-0.8%	0.13	24-25	225	227	-0.9%	0.13
25-8-7	51	52	-1.9%	0.14	27-25	397	359	10.6%	1.95
25-8-9	310	264	17.4%	2.72	27-28	295	342	-13.7%	2.63
10-9-8	356	363	-1.9%	0.37	29-28	324	325	-0.3%	0.06
10-9-31	81	84	-3.6%	0.33	213-28	140	139	0.7%	0.08
31-9-8	133	129	3.1%	0.35	302-31	120	124	-3.2%	0.36
31-9-10	86	82	4.9%	0.44	9-31	168	172	-2.3%	0.31
10-11-12	309	267	15.7%	2.47	18-1	474	463	2.4%	0.51
10-11-26	78	78	0.0%	0.00	1-2	129	126	2.4%	0.27
12-11-10	247	264	-6.4%	1.06	18-2	17	18	-5.6%	0.24
12-11-26	32	35	-8.6%	0.52	5-4	128	139	-7.9%	0.95
26-11-10	132	130	1.5%	0.17	5-6	126	133	-5.3%	0.62
26-11-12	65	66	-1.5%	0.12	8-7	213	221	-3.6%	0.54
13-14-13	0	1	-100.0%	1.41	9-8	489	492	-0.6%	0.14
13-14-32	6	4	50.0%	0.89	25-8	361	315	14.6%	2.50
13-14-50	22	24	-8.3%	0.42	8-9	397	361	10.0%	1.85
13-14-103	358	309	15.9%	2.68	9-10	396	355	11.5%	2.12
32-14-13	7	6	16.7%	0.39	11-10	379	394	-3.8%	0.76
32-14-50	9	9	0.0%	0.00	11-12	374	333	12.3%	2.18
32-14-103	10	10	0.0%	0.00	5-22	100	126	-20.6%	2.45
50-14-13	32	36	-11.1%	0.69	8-25	366	378	-3.2%	0.62
50-14-32	18	20	-10.0%	0.46	11-26	110	113	-2.7%	0.28
50-14-50	0	1	-100.0%	1.41	14-103	1194	1219	-2.1%	0.72
50-14-103	826	896	-7.8%	2.39	14-13	274	260	5.4%	0.86
103-14-13	235	217	8.3%	1.20	14-32	43	43	0.0%	0.00
103-14-32	19	19	0.0%	0.00	14-50	619	634	-2.4%	0.60
103-14-50	588	600	-2.0%	0.49	15-16	419	422	-0.7%	0.15
103-14-103	0	4	-100.0%	2.83	15-29	318	312	1.9%	0.34
16-15-29	49	52	-5.8%	0.42	15-30	514	497	3.4%	0.76
16-15-30	25	24	4.2%	0.20	15-50	876	916	-4.4%	1.34
16-15-50	409	416	-1.7%	0.34	18-17	482	465	3.7%	0.78
29-15-16	94	100	-6.0%	0.61	25-24	252	254	-0.8%	0.13
29-15-30	221	210	5.2%	0.75	25-27	375	385	-2.6%	0.51
29-15-50	72	113	-36.3%	4.26	28-213	86	85	1.2%	0.11
30-15-16	28	27	3.7%	0.19	28-29	356	406	-12.3%	2.56
30-15-29	215	207	3.9%	0.55	31-9	120	124	-3.2%	0.36
30-15-50	395	385	2.6%	0.51	5-202	56	55	1.8%	0.13
50-15-16	297	295	0.7%	0.12					
50-15-29	54	53	1.9%	0.14					
50-15-30	268	263	1.9%	0.31					
50-15-50	0	2	-100.0%	2.00					
17-18-1	402	396	1.5%	0.30					
17-18-2	17	18	-5.6%	0.24					
24-25-8	103	98	5.1%	0.50					
24-25-27	122	129	-5.4%	0.62					
27-25-8	258	214	20.6%	2.86					
27-25-24	139	144	-3.5%	0.42					
27-25-27	0	1	-100.0%	1.41					
27-28-29	268	317	-15.5%	2.87					
27-28-213	27	25	8.0%	0.39					
29-28-27	265	265	0.0%	0.00					
29-28-213	59	60	-1.7%	0.13					
213-28-27	52	50	4.0%	0.28					
213-28-29	88	89	-1.1%	0.11					
302-31-9	120	124	-3.2%	0.36					

FLOW CALIBRATION - PM PEAK HOUR

TURNS

Movement	Model	Count	difference	geh
1-18-17	372	366	1.6%	0.31
2-18-1	69	59	16.9%	1.25
2-18-17	12	13	-7.7%	0.28
4-5-6	93	87	6.9%	0.63
4-5-22	22	23	-4.3%	0.21
4-5-202	14	14	0.0%	0.00
6-5-4	31	23	34.8%	1.54
6-5-6	0	5	-100.0%	3.16
6-5-22	0	17	-100.0%	5.83
6-5-202	62	62	0.0%	0.00
22-5-4	22	22	0.0%	0.00
22-5-6	0	6	-100.0%	3.46
22-5-202	23	24	-4.2%	0.21
202-5-4	13	14	-7.1%	0.27
202-5-6	51	47	8.5%	0.57
202-5-22	25	25	0.0%	0.00
7-8-9	99	104	-4.8%	0.50
7-8-25	39	42	-7.1%	0.47
8-9-10	299	316	-5.4%	0.97
8-9-31	86	87	-1.1%	0.11
9-8-7	147	140	5.0%	0.58
9-8-25	319	305	4.6%	0.79
8-25-24	85	81	4.9%	0.44
8-25-27	272	249	9.2%	1.43
25-8-7	43	42	2.4%	0.15
25-8-9	285	294	-3.1%	0.53
10-9-8	388	349	11.2%	2.03
10-9-31	78	79	-1.3%	0.11
31-9-8	78	74	5.4%	0.46
31-9-10	59	56	5.4%	0.40
10-11-12	228	244	-6.6%	1.04
10-11-26	103	111	-7.2%	0.77
12-11-10	339	312	8.7%	1.50
12-11-26	87	82	6.1%	0.54
26-11-10	103	103	0.0%	0.00
26-11-12	51	53	-3.8%	0.28
13-14-13	0	2	-100.0%	2.00
13-14-32	0	1	-100.0%	1.41
13-14-50	20	30	-33.3%	2.00
13-14-103	247	238	3.8%	0.58
32-14-13	0	1	-100.0%	1.41
32-14-50	1	1	0.0%	0.00
32-14-103	8	8	0.0%	0.00
50-14-13	23	17	35.3%	1.34
50-14-32	1	1	0.0%	0.00
50-14-103	540	546	-1.1%	0.26
103-14-13	399	358	11.5%	2.11
103-14-50	857	906	-5.4%	1.65
16-15-29	71	77	-7.8%	0.70
16-15-30	27	26	3.8%	0.19
16-15-50	286	289	-1.0%	0.18
29-15-16	61	67	-9.0%	0.75
29-15-30	144	139	3.6%	0.42
29-15-50	32	32	0.0%	0.00
30-15-16	27	27	0.0%	0.00
30-15-29	183	182	0.5%	0.07
30-15-50	246	236	4.2%	0.64
50-15-16	415	430	-3.5%	0.73
50-15-29	47	73	-35.6%	3.36
50-15-30	416	412	1.0%	0.20
50-15-50	0	3	-100.0%	2.45
17-18-1	504	499	1.0%	0.22
17-18-2	0	7	-100.0%	3.74
24-25-8	110	104	5.8%	0.58
24-25-27	86	89	-3.4%	0.32
27-25-8	218	235	-7.2%	1.13
27-25-24	66	70	-5.7%	0.49
27-28-29	266	262	1.5%	0.25
27-28-213	23	23	0.0%	0.00
29-28-27	230	267	-13.9%	2.35
29-28-213	51	51	0.0%	0.00
213-28-27	36	36	0.0%	0.00
213-28-29	21	20	5.0%	0.22

LINKS

Movement	Model	Count	difference	geh
1-2	0	0	0.0%	0.00
1-18	372	366	1.6%	0.31
2-18	81	72	12.5%	1.03
4-5	129	124	4.0%	0.44
6-5	93	107	-13.1%	1.40
22-5	45	52	-13.5%	1.01
202-5	89	86	3.5%	0.32
7-8	138	146	-5.5%	0.67
8-9	385	403	-4.5%	0.91
9-8	466	445	4.7%	0.98
8-25	357	330	8.2%	1.46
25-8	328	336	-2.4%	0.44
10-9	466	428	8.9%	1.80
31-9	137	130	5.4%	0.61
10-11	331	355	-6.8%	1.30
12-11	426	394	8.1%	1.58
26-11	154	156	-1.3%	0.16
13-14	267	271	-1.5%	0.24
32-14	9	10	-10.0%	0.32
50-14	564	564	0.0%	0.00
103-14	1256	1264	-0.6%	0.23
16-15	384	392	-2.0%	0.41
29-15	237	238	-0.4%	0.06
30-15	456	445	2.5%	0.52
50-15	878	918	-4.4%	1.33
17-18	504	506	-0.4%	0.09
24-25	196	193	1.6%	0.22
27-25	284	305	-6.9%	1.22
27-28	289	285	1.4%	0.24
29-28	281	318	-11.6%	2.14
213-28	57	56	1.8%	0.13
9-31	164	166	-1.2%	0.16
18-1	573	558	2.7%	0.63
1-2	0	0	0.0%	0.00
18-2	0	7	-100.0%	3.74
5-4	66	59	11.9%	0.89
5-6	144	145	-0.7%	0.08
8-7	190	182	4.4%	0.59
9-8	466	423	10.2%	2.04
25-8	328	339	-3.2%	0.60
8-9	384	398	-3.5%	0.71
9-10	358	372	-3.8%	0.73
11-10	442	415	6.5%	1.30
11-12	279	297	-6.1%	1.06
5-22	47	65	-27.7%	2.41
8-25	358	347	3.2%	0.59
11-26	190	193	-1.6%	0.22
14-103	795	792	0.4%	0.11
14-13	422	378	11.6%	2.20
14-32	1	2	-50.0%	0.82
14-50	878	937	-6.3%	1.96
15-16	503	524	-4.0%	0.93
15-29	301	332	-9.3%	1.74
15-30	587	577	1.7%	0.41
15-50	564	560	0.7%	0.17
18-17	384	379	1.3%	0.26
25-24	151	151	0.0%	0.00
25-27	358	338	5.9%	1.07
28-213	74	74	0.0%	0.00
28-29	287	282	1.8%	0.30
31-9	0	0	0.0%	0.00
5-202	99	100	-1.0%	0.10

B Model Validation Statistics

TURNING FLOW VALIDATION - AM PEAK HOUR

Movement	Model	Count	%Dif	GEH
1-18-17	474	451	5%	1.07
2-18-1	61	67	-9%	0.75
2-18-17	10	14	-29%	1.15
4-5-4	0	10	-100%	4.47
4-5-6	50	38	32%	1.81
4-5-22	59	73	-19%	1.72
4-5-202	12	10	20%	0.60
6-5-4	69	77	-10%	0.94
6-5-6	0	8	-100%	4.00
6-5-22	0	24	-100%	6.93
6-5-202	23	28	-18%	0.99
7-8-9	92	97	-5%	0.51
7-8-25	47	43	9%	0.60
8-9-31	89	88	1%	0.11
8-9-10	309	273	13%	2.11
8-25-24	113	110	3%	0.28
8-25-27	260	255	2%	0.31
8-25-8	0	3	-100%	2.45
9-8-7	165	169	-2%	0.31
9-8-25	330	335	-1%	0.27
10-9-31	75	84	-11%	1.01
10-9-8	350	363	-4%	0.69
10-11-12	306	267	15%	2.30
10-11-26	78	78	0%	0.00
12-11-10	243	264	-8%	1.32
12-11-26	26	35	-26%	1.63
13-14-103	364	309	18%	3.00
13-14-13	0	1	-100%	1.41
13-14-32	8	4	100%	1.63
13-14-50	21	24	-13%	0.63
16-15-29	40	52	-23%	1.77
16-15-30	28	24	17%	0.78
16-15-50	416	416	0%	0.00
17-18-1	415	396	5%	0.94
17-18-2	20	18	11%	0.46
22-5-4	33	33	0%	0.00
22-5-6	0	11	-100%	4.69
22-5-202	22	17	29%	1.13
24-25-27	123	129	-5%	0.53
24-25-8	98	98	0%	0.00
25-8-7	52	52	0%	0.00
25-8-9	305	264	16%	2.43
26-11-10	130	130	0%	0.00
26-11-12	62	66	-6%	0.50
27-25-24	122	144	-15%	1.91
27-25-27	0	1	-100%	1.41
27-25-8	258	214	21%	2.86
27-28-213	31	25	24%	1.13
27-28-29	280	317	-12%	2.14
29-15-16	108	100	8%	0.78
29-15-30	228	210	9%	1.22
29-15-50	77	113	-32%	3.69
29-28-213	45	60	-25%	2.07
29-28-27	250	265	-6%	0.93
30-15-16	26	27	-4%	0.19
30-15-29	203	207	-2%	0.28
30-15-50	411	385	7%	1.30
31-9-10	80	82	-2%	0.22
31-9-8	144	129	12%	1.28
32-14-103	10	10	0%	0.00
32-14-13	4	6	-33%	0.89
32-14-50	10	9	11%	0.32
50-14-103	867	896	-3%	0.98
50-14-13	27	36	-25%	1.60
50-14-32	17	20	-15%	0.70
50-14-50	0	1	-100%	1.41
50-15-16	305	295	3%	0.58
50-15-29	59	53	11%	0.80
50-15-30	257	263	-2%	0.37
50-15-50	0	2	-100%	2.00
101-1-2	127	126	1%	0.09
103-14-103	0	4	-100%	2.83
103-14-13	229	217	6%	0.80
103-14-32	22	19	16%	0.66
103-14-50	588	600	-2%	0.49
202-5-22	23	29	-21%	1.18
202-5-4	16	19	-16%	0.72
202-5-6	89	76	17%	1.43
213-28-27	52	50	4%	0.28
213-28-29	84	89	-6%	0.54
302-31-9	115	124	-7%	0.82

TURNING FLOW VALIDATION - PM PEAK HOUR

Movement	Model	Count	%Dif	GEH
1-18-17	365	366	0%	0.05
2-18-1	57	59	-3%	0.26
2-18-17	11	13	-15%	0.58
4-5-6	105	87	21%	1.84
4-5-22	22	23	-4%	0.21
4-5-202	12	14	-14%	0.55
6-5-4	27	23	17%	0.80
6-5-6	0	5	-100%	3.16
6-5-22	0	17	-100%	5.83
6-5-202	57	62	-8%	0.65
22-5-4	19	22	-14%	0.66
22-5-6	0	6	-100%	3.46
22-5-202	22	24	-8%	0.42
202-5-4	13	14	-7%	0.27
202-5-6	46	47	-2%	0.15
202-5-22	27	25	8%	0.39
7-8-9	104	104	0%	0.00
7-8-25	35	42	-17%	1.13
8-9-10	316	316	0%	0.00
8-9-31	80	87	-8%	0.77
9-8-7	147	140	5%	0.58
9-8-25	317	305	4%	0.68
8-25-24	87	81	7%	0.65
8-25-27	264	249	6%	0.94
25-8-7	41	42	-2%	0.16
25-8-9	292	294	-1%	0.12
10-9-8	390	349	12%	2.13
10-9-31	62	79	-22%	2.02
31-9-8	73	74	-1%	0.12
31-9-10	63	56	13%	0.91
10-11-12	250	244	2%	0.38
10-11-26	96	111	-14%	1.47
12-11-10	334	312	7%	1.22
12-11-26	85	82	4%	0.33
26-11-10	99	103	-4%	0.40
26-11-12	50	53	-6%	0.42
13-14-13	0	2	-100%	2.00
13-14-32	0	1	-100%	1.41
13-14-50	11	30	-63%	4.20
13-14-103	267	238	12%	1.83
32-14-13	0	1	-100%	1.41
32-14-50	1	1	0%	0.00
32-14-103	7	8	-13%	0.37
50-14-13	24	17	41%	1.55
50-14-32	1	1	0%	0.00
50-14-103	565	546	3%	0.81
103-14-13	392	358	9%	1.76
103-14-50	854	906	-6%	1.75
16-15-29	57	77	-26%	2.44
16-15-30	18	26	-31%	1.71
16-15-50	297	289	3%	0.47
29-15-16	57	67	-15%	1.27
29-15-30	151	139	9%	1.00
29-15-50	31	32	-3%	0.18
30-15-16	24	27	-11%	0.59
30-15-29	166	182	-9%	1.21
30-15-50	258	236	9%	1.40
50-15-16	404	430	-6%	1.27
50-15-29	46	73	-37%	3.50
50-15-30	415	412	1%	0.15
50-15-50	0	3	-100%	2.45
17-18-1	489	499	-2%	0.45
17-18-2	0	7	-100%	3.74
24-25-8	125	104	20%	1.96
24-25-27	72	89	-19%	1.89
27-25-8	208	235	-11%	1.81
27-25-24	62	70	-11%	0.98
27-28-29	250	262	-5%	0.75
27-28-213	21	23	-9%	0.43
29-28-27	202	267	-24%	4.24
29-28-213	43	51	-16%	1.17
213-28-27	39	36	8%	0.49
213-28-29	15	20	-25%	1.20

Control Sheet

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Buntingford Transport Modelling Assessment

Future Scenarios Testing Report
August 2015

East Hertfordshire Council

Our ref: 22787601
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Appendices

1 Introduction

Background

1.1 Steer Davies Gleave has been appointed by East Hertfordshire Council, to provide traffic modelling work that will inform the Plan-making process of the District Plan. This work involves two main tasks:

- Creation of a VISSIM micro-simulation model of the existing operation of the road network in and around Buntingford
- Use of the above model to test various development scenarios, and determine any mitigation measures (if required)

1.2 Following the production of base model report this Future Scenario Testing Report describes the different options considered. The report is split into the following chapters.

- Chapter 2 – Future Scenarios Description
- Chapter 3 – Future Model Network
- Chapter 4 – Future Flow Demand
- Chapter 5 – Future Model Output
- Chapter 6 – Mitigation Tests
- Chapter 7 – Summary and Conclusions

2 Future Scenarios Description

2.1 For the future year tests, a total of six scenarios were set up based on the developments either proposed within the emerging District Plane and those brought forward through planning applications.

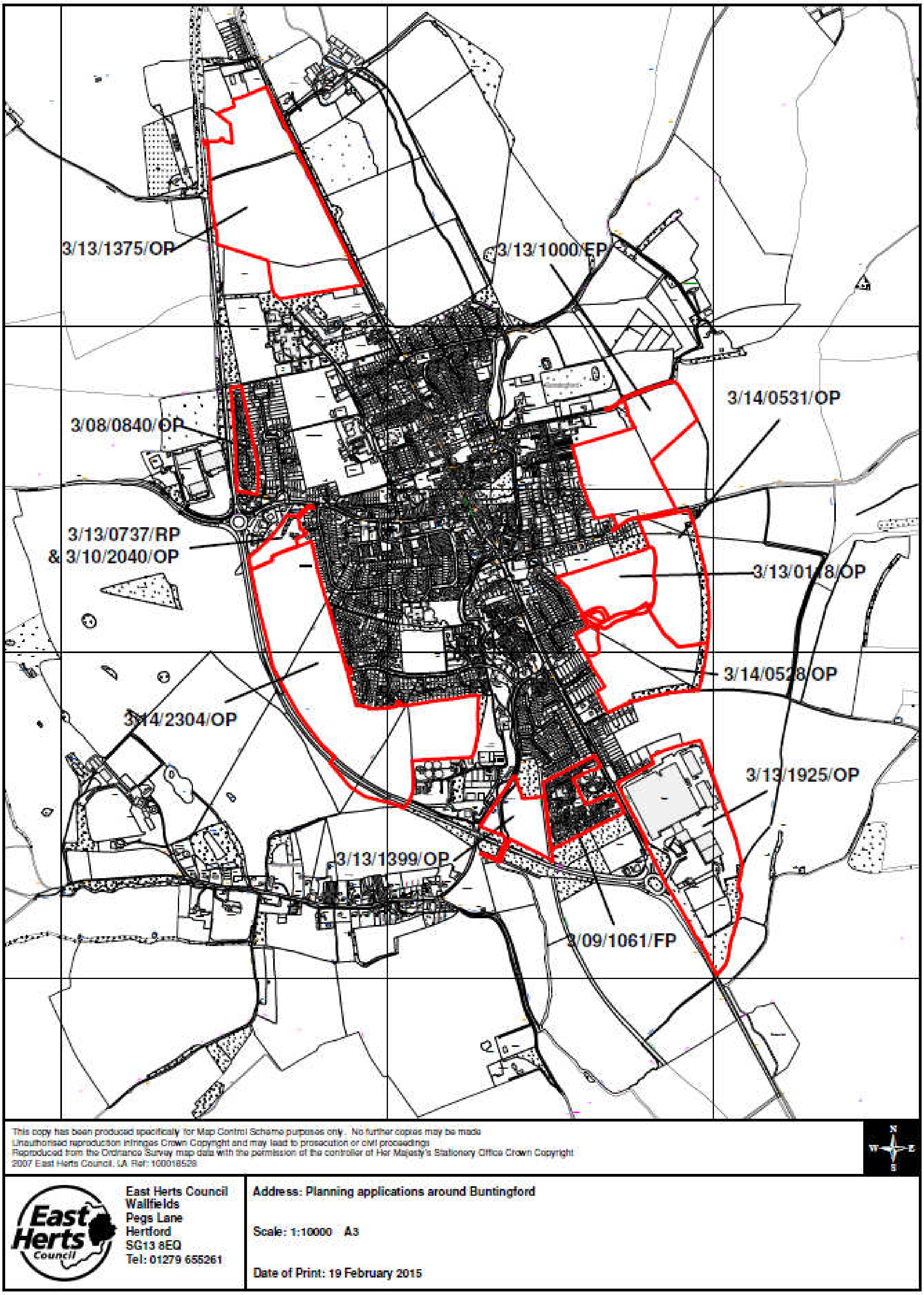
2.2 The seven scenarios are cumulative, hence each scenario involves all developments introduced by previous scenarios. Table 2.1 shows which developments were introduced at each scenario and the proposed access arrangements, plus the Base (existing situation).

Table 2.1: Future Scenarios

No.	Scenario	Description	Developments added	Residential Units	Access to Network
0	Base 2015	Existing Situation	3/08/0840/OP 3/09/1061/FP	50 149	- Greenways - London Road
1	Do Minimum 2021	Background Growth plus Development under Construction	3/12/1000/FP 3/13/0737/RP and 3/10/2040/OP 3/13/0118/OP	160 26 100	- Hare Street Road - Longmead - Snells Mead
2	Do Committed 2021	Background Growth plus Development under Construction plus Committed Development	3/13/13/1375/OP 3/13/1925/OP	180 328	- A10 and Ermine Street (plus new link road) - London Road (2 access points)
3	Do At Appeal 2021	Background Growth plus Development under Construction plus Committed Development plus Development At Appeal	3/14/0531/OP 3/14/0528/OP 3/13/1399/OP	80 100 56	- Hare Street Road - Snells Mead - Aspenden Road
4	Do Something 2021	Background Growth plus Development under Construction plus Committed Development plus Development At Appeal + 3/14/2304/OP Phase 1	3/14/2304/OP Phase 1	108	- Luynes Rise
5	Do Maximum 2021	Background Growth plus Development under Construction plus Committed Development plus Development At Appeal + 3/14/2304/OP All Phases	3/14/2304/OP All Phases	400 + school	- A10 (new roundabout)
5A	Do Maximum Alternative 2021	Background Growth plus Development under Construction plus Committed Development plus Development At Appeal + 3/14/2304/OP All Phases	3/14/2304/OP All Phases	400 + school	- Luynes Rise (i.e. without new roundabout on A10)

2.3 The location of each development can be found at Figure 2.1.

Figure 2.1: Plan of Proposed Development Sites



2.4 A couple of scenarios are worthy of further note:

- Scenario 0 is the base (existing) situation, and therefore has also been developed

- Scenario 5A was included as an additional Scenario, to test the addition of all development traffic, but without the construction of a new roundabout on the A10 to serve the site. All traffic would therefore use the existing Luynes Rise link to access London Road

3 Future Model Network

Network changes

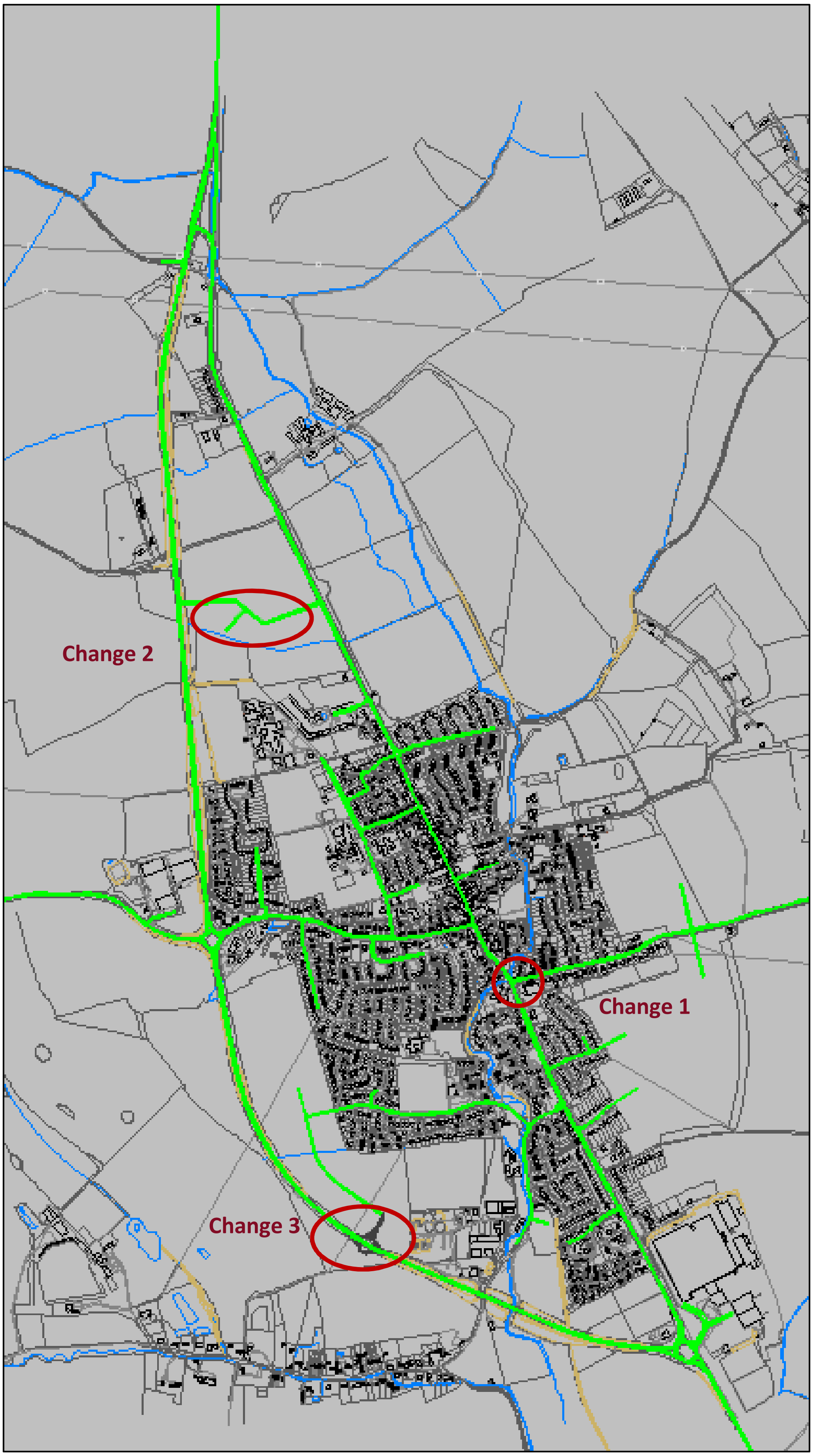
3.1 The link structure of the future model is similar to the existing base, as future links and junctions had already been coded into the base model (but with use of these links and junctions disabled in the base model). Allowing access to these links in two locations were the changes to the future model while one more junction was amended. A total of three network changes were made, as set out in Table 3.1.

No.	Proposed Change	Development	Scenarios Affected
1	Hare Street Road / High Street junction was converted from a priority junction to a mini-roundabout with similar structure to the one at Baldock Road / Monks Walk junction	3/12/1000/FP and 3/13/0118/OP	Scenarios 1, 2, 3, 4, 5, 5A
2	Allowing access to the new link road between A10 and Ermine Street, to provide access to development plot	3/13/1375/OP	Scenarios 2, 3, 4, 5, 5A
3	Allowing access to the new roundabout on A10 between London Road and Baldock Road, to provide access to development plot	3/13/2304/OP	Scenario 5 only

3.2 These changes were agreed with East Hertfordshire Council at the model scoping meeting, and were all included in the respective TAs for each development proposal.

3.3 Figure 3.1 shows the location of all three changes.

Figure 3.1: Buntingford Future Model Network



4 Future Flow Demand

Introduction

4.1 The calculation of the future flow demand was based on a set of assumptions:

- Background growth was applied to external trips only – this was to ensure that any developments included within TEMPRO were not double counted
- All scenario tests were carried out at future year 2021, regardless of when each development is scheduled to be opened
- Trip generation and distribution for each development plot was obtained (where possible) from the Transport Assessment for each respective development

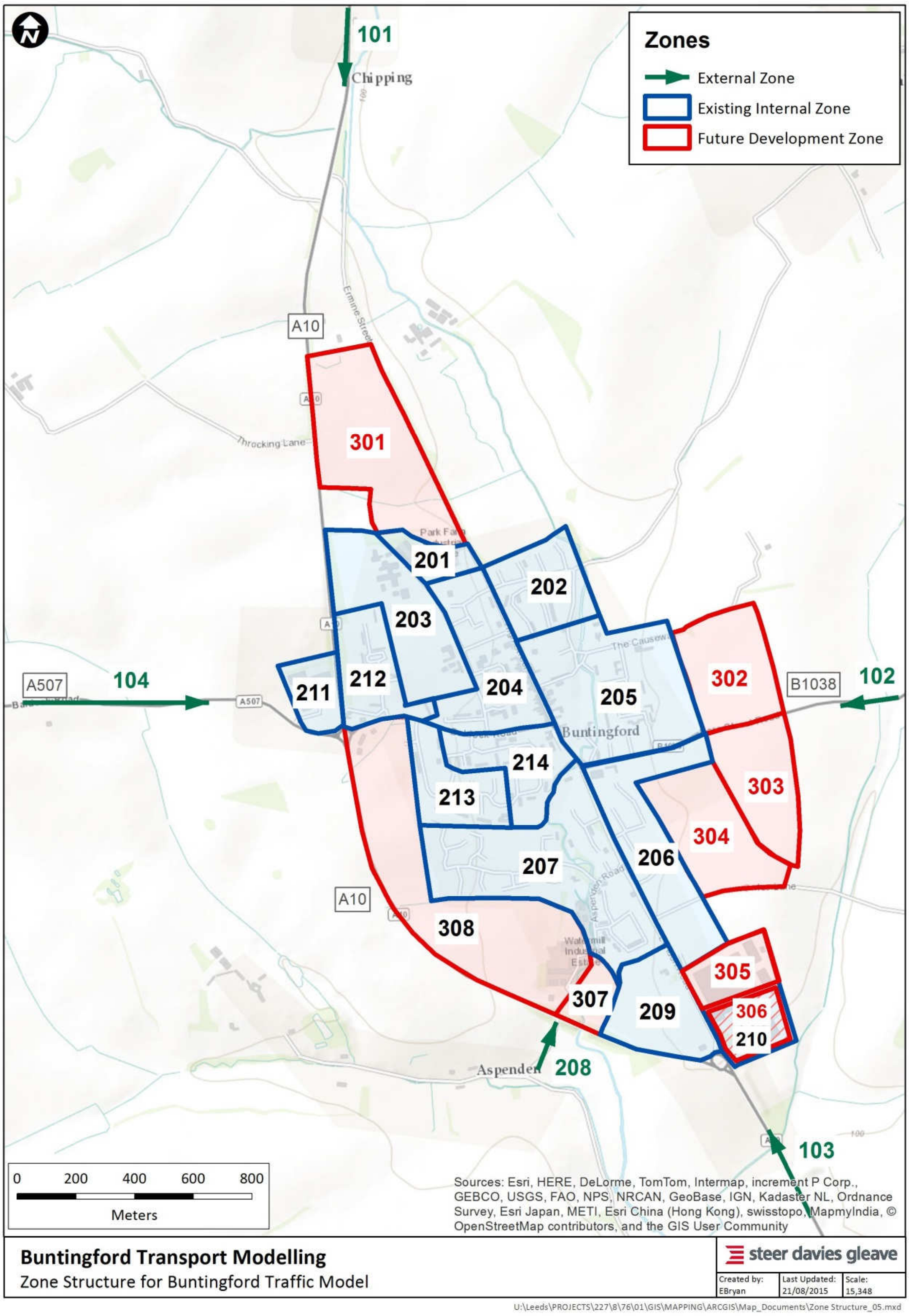
Zones

4.2 For each scenario, depending on the new developments that were included, a set of new Origin-Destination pairs were generated to be added to the total trip matrix. The future development zones were already coded into the base model, but without any traffic assigned to them (they were added to the network at this stage to simplify the VISSIM to VISUM export process). Table 3.1 shows the future zones and the associated development planning application number. The location of these zones is shown in Figure 4.1, with future zones shown in red. Note that the shaded area for Zones 210/306 indicates that the area consists of both an existing zone and a future development zone.

Table 4.1: Future Zones

Zone	Developments	Scenarios Added
301	3/13/1375/OP	2, 3, 4, 5, 5A
302	3/13/1000/FP	1, 2, 3, 4, 5, 5A
303	3/14/05/31/OP	3, 4, 5, 5A
304	3/13/0118/OP	1, 2, 3, 4, 5, 5A
	3/14/0528/OP	3, 4, 5, 5A
305	3/13/1925/OP (residential)	2, 3, 4, 5, 5A
306	3/13/1925/OP (offices)	2, 3, 4, 5, 5A
307	3/13/1399/OP	3, 4, 5, 5A
308	3/14/2304/OP Phase 1	4, 5, 5A
	3/14/2304/OP All Phases	5, 5A
213	3/13/0737/RP	1, 2, 3, 4, 5, 5A
	3/10/2040/OP	1, 2, 3, 4. 5, 5A

Figure 4.1: Zone Locations



4.3 As shown in Table 4.1, an individual 300 series zone was introduced for most development plots. However there are a few anomalies:

- Developments 3/13/0737/RP and 3/10/2040/OP are assigned through existing zone 213

- Developments 3/13/0118/OP and 3/14/0528/OP were assigned to and from zone 304
- Development 3/13/1925/OP includes a residential component and a commercial component that is proposed to be accessed from different points on the network. Therefore, development trips were assigned to two different zones, and two separate access points
- Development 3/14/2304/OP is developed in two phases:
  - The first phase consists of 108 dwellings of the total 400 proposed, and is added at Scenario 4 in zone 308
  - The second phase consists of the remaining dwellings plus first school, and is added at Scenario 5 (and 5A) in zone 308

Future Matrices

4.4 For each future scenario, a trip matrix was generated similarly to the one of the base model, an example for Scenario 5 is shown in Figures 4.2 and 4.3 for the AM and PM peak respectively, which show where the trip levels have changed compared to the base model's matrix by green shading. Thus the development of a trip matrix for each scenario was based on the following process:

- All scenarios are assumed to be in year 2021, hence the appropriate background growth was applied to all external trips (4x4 matrix at top left corner of Figure 4.2), using the TEMPRO 6.2 database – this results in a growth factor of 1.041 (4.1%) for both AM and PM peak hours
- Trip totals for each development plot was then added to the matrix, into the relevant Origin-Destination Cell
- Trips were distributed on the basis on information contained within the respective TA for each development. If trip distribution information was not provided in the TA, then trips to and from each development were assigned using a generic distribution – this was based on the relative total volumes on each of the four external origin and destination points (Zones 101 to 104).

4.5 It was assumed that no internal zone to future zone trips (or vice versa) were generated. In reality a small number of these trips may be generated, but by assuming that all new trips have either an origin or destination in an external zone, the future models will be robust (as these trips will most likely be longer and pass through more key junctions than internal trips).

4.6 Table 4.1 shows the additional traffic assigned at each scenario and the matrix totals.

Figure 4.2: Future Scenario 5 Matrix - AM Peak

		External				Internal														Future								
	O/D	101	102	103	104	201	202	203	204	205	206	207	208	209	210	211	212	213	214	301	302	303	304	305	306	307	308	Total
External	101	0	14	419	10	8	10	71	0	0	3	17	5	1	7	1	13	24	13	3	3	4	10	5	1	2	23	668
	102	5	0	24	24	5	4	10	3	8	3	2	1	0	0	1	3	1	5	1	0	1	2	3	1	0	6	115
	103	293	35	0	250	26	14	50	15	50	14	25	7	0	19	13	11	27	18	20	15	7	16	26	8	3	57	1,019
	104	12	46	377	0	17	4	64	16	20	21	22	8	24	8	8	3	8	5	0	9	6	12	1	0	2	35	730
Internal	201	0	1	1	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
	202	18	4	41	39	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	131
	203	31	5	30	46	0	17	0	4	5	2	5	0	0	0	0	9	2	10	0	0	0	0	0	0	0	0	166
	204	1	3	44	22	2	1	7	0	5	6	1	1	1	1	3	0	6	24	0	0	0	0	0	0	0	0	127
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	206	4	13	52	17	5	2	7	1	4	0	0	1	1	1	1	4	4	15	0	0	0	0	0	0	0	0	132
	207	9	16	63	23	8	1	11	1	8	0	0	2	0	1	3	3	9	39	0	0	0	0	0	0	0	0	198
	208	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	209	11	11	5	11	0	0	6	0	0	5	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	65
	210	4	7	10	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
	211	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	212	29	8	22	4	1	1	7	0	2	3	3	3	8	1	0	0	4	1	0	0	0	0	0	0	0	0	96
	213	36	4	46	10	1	0	5	10	7	12	1	1	7	1	0	7	0	4	0	0	0	0	0	0	0	0	154
	214	32	5	44	8	2	1	11	25	6	16	3	3	4	1	0	5	0	0	0	0	0	0	0	0	0	0	167
Future	301	8	3	36	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
	302	19	7	90	31	5	0	8	1	0	1	1	1	1	1	2	3	4	18	0	0	0	0	0	0	0	0	192
	303	9	4	21	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
	304	21	10	49	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106
	305	18	9	89	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123
	306	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	307	4	2	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
	308	19	5	111	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	179
	Total	583	213	1,585	611	81	55	287	77	115	84	80	32	48	43	34	61	90	167	24	27	18	40	35	10	7	121	4,527

Figure 4.3: Future Scenario 5 Matrix - PM Peak

		External				Internal														Future								
	O/D	101	102	103	104	201	202	203	204	205	206	207	208	209	210	211	212	213	214	301	302	303	304	305	306	307	308	Total
External	101	0	16	291	15	4	10	22	2	2	8	17	0	6	1	0	18	26	29	5	10	11	24	10	0	5	10	543
	102	3	0	25	29	0	1	1	1	1	1	2	0	0	0	0	1	3	3	4	0	1	2	15	0	0	2	95
	103	432	75	0	412	1	38	30	41	62	43	77	1	3	0	4	18	30	29	43	32	27	60	71	1	12	68	1,612
	104	23	54	227	0	0	7	16	19	10	19	45	0	10	1	1	3	5	4	1	14	10	22	2	0	5	26	524
Internal	201	5	2	22	12	0	3	0	1	1	3	6	0	0	0	0	5	0	10	0	0	0	0	0	0	0	0	69
	202	13	0	22	9	0	0	25	0	0	2	1	0	0	0	0	9	0	6	0	0	0	0	0	0	0	0	89
	203	22	4	48	21	0	23	0	5	6	2	5	0	3	0	0	3	10	9	0	0	0	0	0	0	0	0	159
	204	5	0	29	12	0	2	0	0	2	3	2	0	13	0	0	12	8	11	0	0	0	0	0	0	0	0	98
	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	206	3	1	38	17	0	1	0	3	5	0	1	0	0	0	0	32	0	12	0	0	0	0	0	0	0	0	113
	207	7	2	34	32	0	1	0	5	7	5	0	0	10	0	0	8	0	18	0	0	0	0	0	0	0	0	128
	208	2	2	7	6	0	1	0	1	1	1	1	0	0	0	0	3	0	4	0	0	0	0	0	0	0	0	28
	209	8	0	1	16	0	2	0	1	2	2	2	0	0	0	0	4	0	7	0	0	0	0	0	0	0	0	44
	210	1	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	211	5	3	10	7	0	1	0	2	1	2	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	34
	212	23	3	12	3	0	3	0	7	3	4	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	64
	213	13	3	9	4	0	2	0	9	4	8	8	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	63
	214	26	3	14	4	0	4	0	13	6	13	14	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	101
Future	301	4	1	24	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
	302	11	2	40	14	0	1	0	2	0	2	1	0	7	0	0	13	2	7	0	0	0	0	0	0	0	0	102
	303	6	1	12	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
	304	12	2	26	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54
	305	10	5	37	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58
	306	1	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
	307	2	0	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
	308	9	2	54	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	87
	Total	645	184	1,002	669	6	99	95	112	113	116	190	1	51	1	5	133	84	152	53	56	49	108	98	1	22	106	4,151

Table 4.2: Future Trip Totals for each Scenario (peak hour, totals are cumulative)

Development	Access to Network	AM Peak			PM Peak		
		Origin	Destination	Total	Origin	Destination	Total
3/08/0840/OP	- Greenways	0	0	-	0	0	-
3/09/1061/FP	- London Road	0	0	-	0	0	-
Scenario 0		**0**	**0**	**3580**	**0**	**0**	**3271**
Background Growth (+4.1% on External to External)		-	-	60	-	-	64
3/12/1000/FP	- Hare Street Road	64	27	-	32	56	-
3/13/0737/RP and 3/10/2040/OP	- Longmead	13	4	-	6	10	-
3/13/0118/OP	- Snells Mead	50	20	-	27	54	-
Scenario 1		**127**	**51**	**3818 (+7%)**	**65**	**120**	**3520 (+8%)**
3/13/13/1375/OP	- A10 and Ermine Street (plus new link road)	50	24	-	32	53	-
3/13/1925/OP	- London Road (2 access points)	124	45	-	66	99	-
Scenario 2		**301**	**120**	**4061 (+13%)**	**163**	**272**	**3770 (+15%)**
3/14/0531/OP	- Hare Street Road	45	18	-	26	49	-
3/14/0528/OP	- Snells Mead	56	20	-	27	54	-
3/13/1399/OP	- Aspenden Road	20	7	-	10	22	-
Scenario 3		**422**	**165**	**4227 (+18%)**	**226**	**397**	**3958 (+21%)**
3/14/2304/OP	- Luynes Rise (Phase 1)	42	11	-	22	28	-
Scenario 4		**464**	**176**	**4280 (+20%)**	**248**	**425**	**4008 (+23%)**
3/14/2304/OP	- A10 new roundabout (Completion)	137	110	-	65	78	-
Scenario 5		**601**	**286**	**4527 (+26%)**	**313**	**503**	**4151 (+27%)**

5 Future Model Output

Introduction

5.1 The new developments were introduced to the network gradually, through six future scenarios. A total of twelve scenario runs (six for each peak hour) were carried out and the following outputs were extracted:

- Queue lengths at key junctions
- Journey times on external to external vehicle movements
- Traffic flow on turning movements at junctions
- Overall network performance statistics

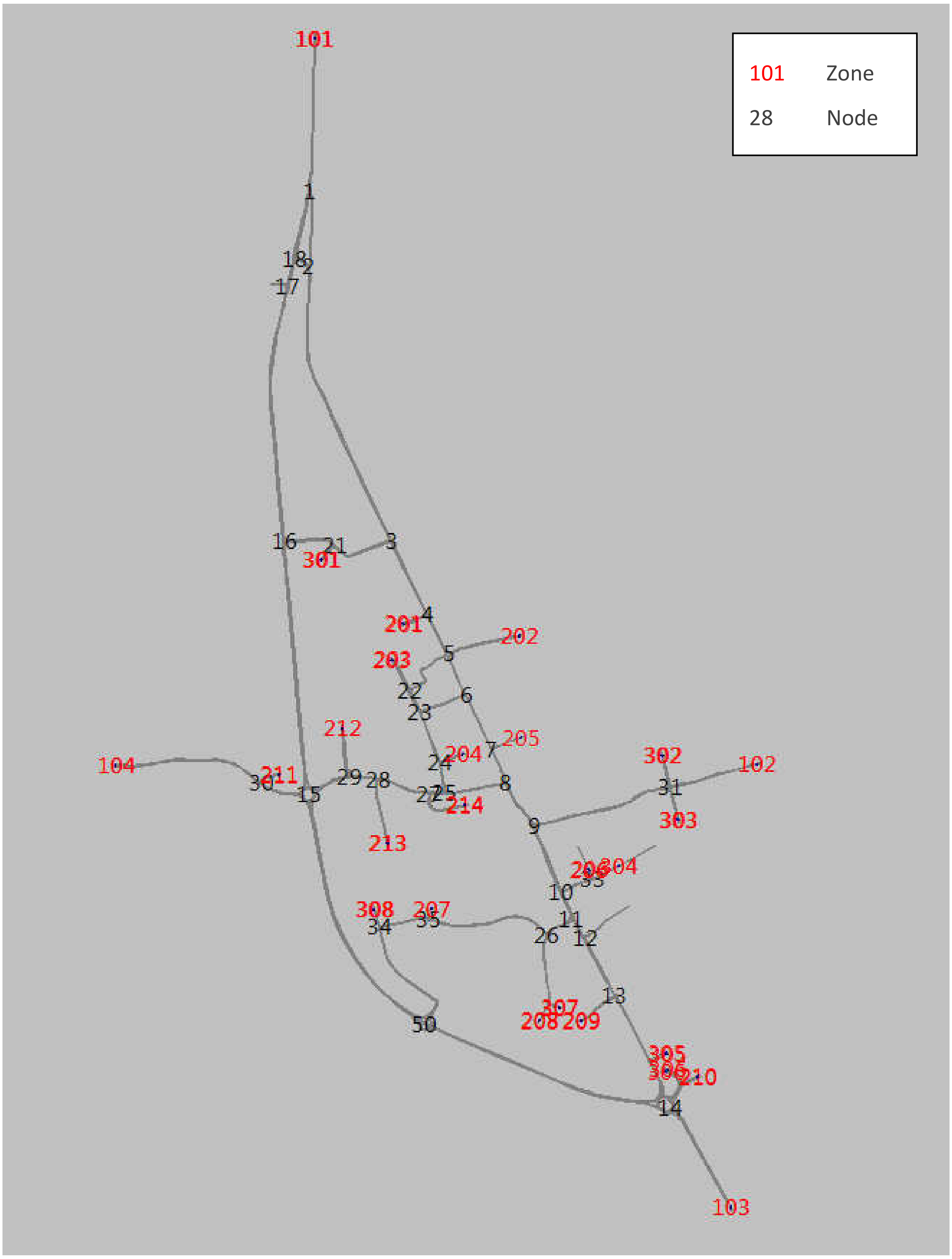
Traffic flows

5.2 The traffic flows on turning movements were extracted to check the consistency among different scenarios and to identify different trip patterns. As an example, Table 5.1 shows the flows of all southbound movements at Ermine Street, High Street and London Road, coded as nodes 1 to 14, as shown in Figure 5.1.

Table 5.1: Ermine St / High St / London Rd Southbound flows (vehicles) – AM Peak

From node – To node	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
1-2	122	136	140	148	151	160	174
2-3	140	154	135	145	147	155	170
3-4	115	130	133	145	147	155	172
4-5	39	53	56	62	63	70	93
5-6	123	135	102	107	107	114	139
6-7	122	133	102	108	107	113	139
7-8	83	90	101	108	107	113	139
8-9	310	310	329	337	333	336	399
9-10	334	365	383	400	398	415	475
10-11	308	365	390	433	424	438	434
11-12	372	430	445	495	511	434	617
12-13	358	416	537	588	597	490	588
13-14	359	416	516	558	557	461	575

Figure 5.1: Future Model – Zone and Node Identification



5.3 Table 5.1 shows that there is a trend of increasing traffic levels through the scenarios, as would be expected due to the increase in traffic flows. There are some flow reductions on certain sections along the north-south route movements:

- The implementation of the new junction between the A10 and Ermine Street (west of node 3, Figure 5.1) from Scenarios 2 onwards results in re-assignment of traffic around the northern section of Ermine Street and High Street to re-assign away from the link
- The implementation of the new A10 roundabout in Scenario 5 results in some re-assignment of trips off London Road, as some existing traffic chooses to use the new direct link to the A10

5.4 Similar patterns are shown in the northbound direction in the AM peak, and both directions in the PM peak, as shown in Figures 5.2 to 5.5 (Figure 5.2 contains the same data as that presented in Table 5.1).

Figure 5.2: Ermine St / High St / London Rd Southbound flows (vehicles) – AM Peak

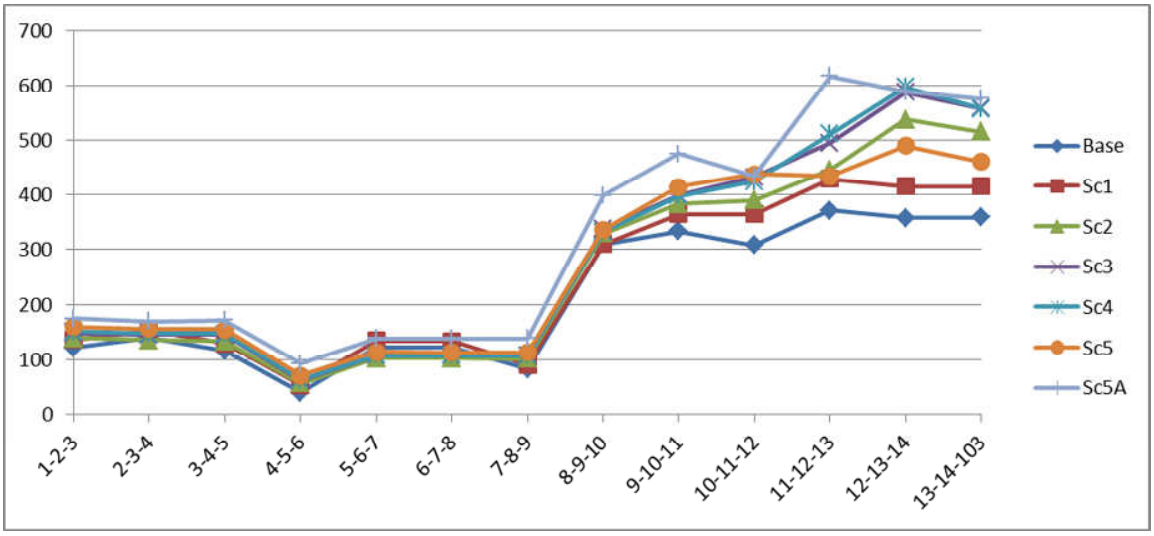


Figure 5.3: Ermine St / High St / London Rd Northbound flows (vehicles) – AM Peak

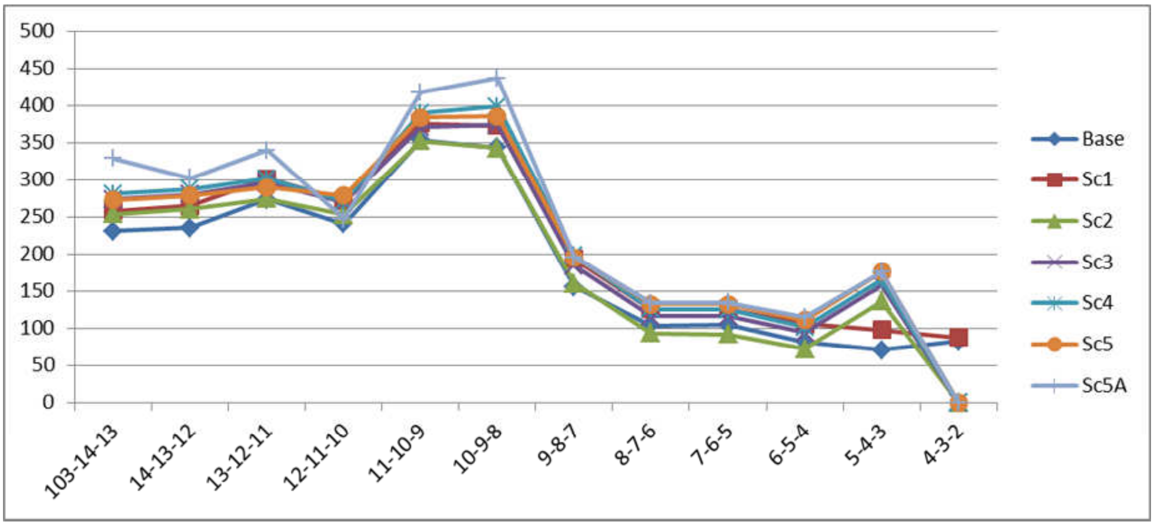


Figure 5.4: Ermine St / High St / London Rd Southbound flows (vehicles) – PM Peak

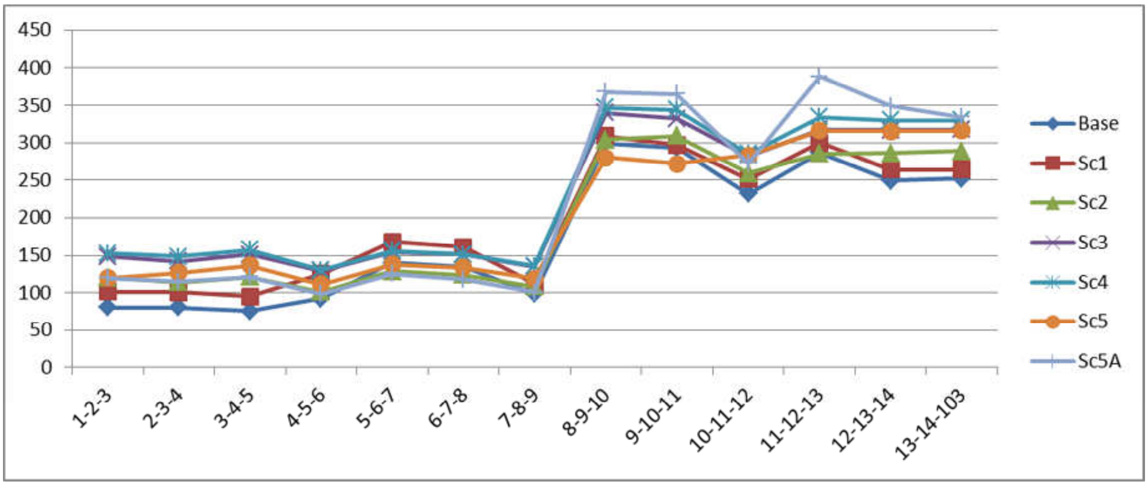
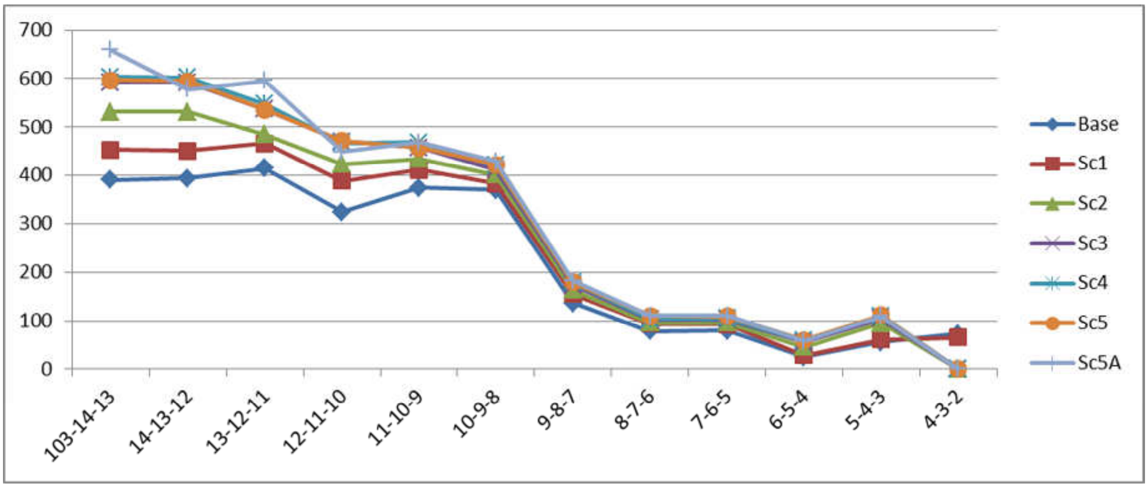


Figure 5.5: Ermine St / High St / London Rd Northbound flows (vehicles) – PM Peak



5.5 The general trends in Figures 5.4 to 5.5 for the PM peak are as for the AM peak. A further point worthy of note is that Scenario 5A has the highest volumes on the most southern section of London Road (in both directions), due to development trips being unable to use the new A10 roundabout in this Scenario.

5.6 In terms of flows at junctions, Tables 4.2 and 4.3 show the total vehicles/hour at each of the following key junctions:

- A10/Baldock Road
- A10/London Road
- Station Road/Hare Street Road
- High Street/Baldock Road

Table 5.2: AM Peak Hourly Junction Flows

Junction		Base	Sc1	Sc2	Sc3	Sc4	Sc5	Sc5A
A10/Baldock Road	Total	2147	2250	2371	2415	2427	2507	2466
	Diff	-	5%	10%	12%	13%	17%	15%
A10/London Road	Total	2138	2275	2487	2552	2557	2630	2591
	Diff	-	6%	16%	19%	20%	23%	21%
Station Road/Hare Street Road	Total	1046	1180	1182	1288	1305	1313	1414
	Diff	-	13%	13%	23%	25%	26%	35%
High Street/Baldock Road	Total	959	1033	981	1049	1077	1069	1187
	Diff	-	8%	2%	9%	12%	11%	24%

Table 5.3: PM Peak Hourly Junction Flows

Junction		Base	Sc1	Sc2	Sc3	Sc4	Sc5	Sc5A
A10/Baldock Road	Total	1949	2075	2162	2219	2243	2298	2304
	Diff	-	6%	11%	14%	15%	18%	18%
A10/London Road	Total	2098	2235	2421	2527	2553	2622	2603
	Diff	-	7%	15%	20%	22%	25%	24%
Station Road/Hare Street Road	Total	971	1073	1122	1234	1254	1188	1276
	Diff	-	11%	16%	27%	29%	22%	31%
High Street/Baldock Road	Total	919	985	971	1043	1052	997	1073
	Diff	-	7%	6%	13%	14%	9%	17%

5.7 Tables 5.2 and 5.3 show a number of expected trends, such as the general increase of trips on the network through the Scenarios. At the Station Road/Hare Street Road and High Street/Baldock Road junction, there is significantly less traffic volumes through the junction in Scenario 5, compared to Scenario 5A. This is due to the inclusion of the new A10 roundabout in this Scenario, which provides an alternative route to the A10 without passing through the centre of the town. Indeed, compared to Scenario 5A, there are around 100veh/hour less passing through the junction.

Journey Time

5.8 For journey time comparison, there are four key through movements for which there were significant data on travel times from the traffic counts, and were used for the base model validation. These are:

- A10 North to A10 South
- A10 South to A10 North
- A507 to A10 South
- A10 South to A507

5.9 Tables 5.4 and 5.5 show the results of the comparison of travel times between the Scenarios, for the AM and PM peak periods respectively.

Table 5.4: AM Peak Travel Time Analysis

Origin	Destination	AM Peak travel time (s)						
		Base	Sc1	Sc2	Sc3	Sc4	Sc5	Sc5A
A10 North	A10 South	236	238	246	248	249	270	251
A10 South	A10 North	219	220	224	224	224	238	223
A507	A10 South	158	159	162	161	163	177	158
A10 South	A507	141	141	144	143	145	157	142

Table 5.5: PM Peak Travel Time Analysis

Origin	Destination	PM Peak travel time (s)						
		Base	Sc1	Sc2	Sc3	Sc4	Sc5	Sc5A
A10 North	A10 South	224	227	235	239	238	257	242
A10 South	A10 North	220	224	226	228	229	248	232
A507	A10 South	149	153	157	158	158	177	161
A10 South	A507	142	145	146	148	149	167	151

5.10 The results show a rising trend of travel times from Base Scenario to Scenario 5, as more traffic is assigned to the network, as would be expected.

5.11 In Scenario 5A, journey times generally drop on these four key routes – this is due to more traffic using the local roads within Buntingford for journeys, as the new direct link from Luynes Rise to the A10 is not available in this scenario.

Queue Length

5.12 Similarly to the base model, queue length outputs were extracted for the 3 main junctions of the network:

- A10/London Road
- A10/Baldock Road
- Station Road/Hare Street Road

5.13 Two different sets of queue values have been calculated:

- Mean Maximum Queue – the maximum queue length recorded in each 5-minute interval, averaged over the peak hour. This gives a general impression of the queue lengths experienced at each junction throughout the peak hour.
- Absolute Maximum Queue – the maximum queue length recorded in the peak hour (in any 5-minute interval). This gives an impression of the maximum queue length experienced at each junction throughout the peak hour.

5.14 Table 5.6 shows the Mean Maximum Queue (MMQ) Length comparison, for the AM peak hour. Two main issues are observed:

- London Road approach to the A10 roundabout, where the increase of traffic flows from Scenario 1 to Scenario to 5 causes the formation of significant queues
- High Street South approach to the Baldock Road junction. This is caused by the poor visibility on the right turn into High Street (north), and therefore queues are experienced back to the High Street/Hare Street Road junction in the latter Scenarios, especially in Scenario 5A where the alternative route to the A10 is not available. The rest of the network operates without any problems, with only modest increase to queue length predictions.

Table 5.6: Mean Maximum Queue Length Comparison (in vehicles) – AM Peak

Node	Arm	Counts	Model	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
High Street/Hare Street Road	High Street (N)	0	0	2	3	3	15	6	6
	Hare Street Road (E)	2	4	3	4	4	5	4	5
	High Street (S)	1	4	5	4	6	7	7	15
A10/London Road	A10 (S)	2	0	1	2	2	3	2	1
	A10 (W)	4	4	4	6	6	8	5	7
	London Road	5	7	8	32	47	49	51	40
A10/Baldock Road	Baldock Road (E)	3	5	4	5	6	6	6	8
	A10 (S)	1	3	3	5	4	4	4	5
	Bladock Road (W)	2	2	2	3	3	3	2	2
	A10 (N)	4	5	5	7	7	7	9	8
High St/Baldock Rd	High St (N)	-	2	5	2	2	2	2	2
	Station Road (S)	-	5	9	9	11	15	14	23
	Baldock Road (W)	-	0	0	0	0	0	0	0

5.15 Table 5.7 shows the Absolute Maximum Queue Length comparison, for the AM peak hour. This way of measuring queues is more sensitive to individual circumstances and subsequently shows more extreme values.

5.16 For the maximum average queue measures, the two main issues are again the southbound London Road approach to the A10 roundabout, and the northbound High Street approach to the Baldock Road junction.

5.17 Table 5.8 shows the Mean Maximum Queue (MMQ) Length comparison for the PM peak hour. Two main issues are observed:

- A10 northbound approach to the London Road roundabout, where the increase of traffic flows from Scenario 1 to Scenario to 5 causes the formation of significant queues
- As per the AM peak period, High Street South approach to the Baldock Road junction. Again, this is caused by the poor visibility on the right turn into High Street (north), and therefore queues are experienced back to the High Street/Hare Street Road junction in the latter Scenarios, especially in Scenario 5A where the alternative route to the A10 is not available.

Table 5.7: Absolute Maximum Queue Length Comparison (in vehicles) – AM Peak

Node	Arm	Counts	Model	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
High Street/Hare Street Road	High Street (N)	0	0	7	5	8	9	11	18
	Hare Street Road (E)	4	9	4	8	8	13	9	18
	High Street (S)	3	9	8	8	14	19	16	34
A10/London Road	A10 (S)	11	2	3	9	7	12	6	2
	A10 (W)	11	10	2	20	17	26	17	19
	London Road	7	16	9	61	100	122	160	110
A10/Baldock Road	Baldock Road (E)	7	11	16	14	15	16	15	17
	A10 (S)	5	8	12	18	11	13	9	15
	Bladock Road (W)	5	5	7	9	9	9	4	4
	A10 (N)	6	12	6	16	16	20	22	19
High St/Baldock Rd	High St (N)	-	7	10	4	3	3	4	4
	Station Road (S)	-	14	38	33	46	50	50	76
	Baldock Road (W)	-	0	0	0	0	0	0	2

Table 5.8: Mean Maximum Queue Length Comparison (in vehicles) – PM Peak

Node	Arm	Counts	Model	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
High Street/Hare Street Road	High Street (N)	0	0	3	3	4	4	4	5
	Hare Street Road (E)	2	1	2	3	3	3	3	4
	High Street (S)	1	1	4	5	6	6	7	5
A10/London Road	A10 (S)	2	4	4	9	22	18	30	37
	A10 (W)	4	1	4	6	9	7	9	10
	London Road	5	3	2	2	3	2	3	3
A10/Baldock Road	Baldock Road (E)	3	2	1	2	2	2	2	2
	A10 (S)	1	5	3	4	4	4	4	4
	Bladock Road (W)	2	2	2	2	2	2	2	3
	A10 (N)	4	4	2	2	3	3	4	3
High St/Baldock Rd	High St (N)	-	3	4	4	4	4	3	4
	Station Road (S)	-	3	7	8	9	9	8	14
	Baldock Road (W)	-	0	0	0	0	0	0	0

5.18 Table 5.9 shows the Absolute Maximum Queue Length comparison for the PM peak hour, with trends similar to the maximum average queue analysis. It should be noted, however, that the queues on the A10 northbound approach to the London Road are significant at a maximum of 142 vehicles in Scenario 5A, equivalent to a queue of over 1km.

5.19 Although demand levels are the same between Scenarios 5 and 5A, the larger queue in Scenario 5A is a result of development-based traffic having to access via London Road, rather than via the A10, and therefore increasing demand for a conflicted movement through the roundabout from the south.

Table 5.9: Absolute Maximum Queue Length Comparison (in vehicles) – PM Peak

Node	Arm	Counts	Model	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
High Street/Hare Street Road	High Street (N)	0	0	5	8	9	10	8	14
	Hare Street Road (E)	2	4	5	6	6	6	5	7
	High Street (S)	2	4	7	13	13	15	14	18
A10/London Road	A10 (S)	1	2	27	57	98	80	118	142
	A10 (W)	4	5	10	15	19	13	28	24
	London Road	4	5	10	5	9	7	8	7
A10/Baldock Road	Baldock Road (E)	6	3	4	3	4	4	6	6
	A10 (S)	2	7	8	14	9	11	10	9
	Bladock Road (W)	5	3	4	5	6	5	4	7
	A10 (N)	5	5	5	5	10	8	7	11
High St/Baldock Rd	High St (N)	-	5	6	12	6	6	5	5
	Station Road (S)	-	13	26	33	37	37	33	56
	Baldock Road (W)	-	0	0	0	0	0	0	0

Network Performance

5.20 In addition to specific junction output, and the travel times of specific routes, overall measures of network performance are particularly useful to give a general picture of network operation. They also allow a direct comparison of different scenarios.

5.21 Table 5.10 shows some overall statistics of network performance, as output by the model, for the AM peak hour. Table 5.11 shows similar statistics for the PM peak hour.

5.22 The results in Table 5.10 show that as more traffic is added at the network the average speed progressively reduces from Base Scenario to Scenario 5/5A. The reverse pattern is observed with average delay per vehicle which is rising from Base scenario to be more than double at Scenario 5. This is as a result of the problems already indicated in the above sections.

Table 5.10: Network Performance – AM Peak

Parameter	Base	Sc1	Sc2	Sc3	Sc4	Sc5	Sc5A
Average delay per vehicle (s)	25	29	41	54	62	66	62
Average speed (mph)	35	34	32	30	28	27	28
Total distance travelled (veh-km)	10,232	10,977	11,518	11,880	11,976	12,509	12,451
Additional traffic	-	237	480	646	699	946	946

5.23 The results in Table 5.11 for the PM peak hour show a similar pattern to the AM peak – however, the deterioration of network conditions is less severe This can be linked to the higher level of traffic in the AM peak hour compared to the PM peak hour, and therefore capacity issues are being encountered sooner (in reference to the addition of development related trips).

Table 5.11: Network Performance – PM Peak

Parameter	Base	Sc1	Sc2	Sc3	Sc4	Sc5	Sc5A
Average delay per vehicle (s)	21	25	28	33	29	38	44
Average speed (mph)	36	36	35	33	34	34	33
Total distance travelled (veh-km)	7,717	10,313	10,807	11,251	10,939	13,011	13,573
Additional traffic	-	249	499	687	737	880	880

Discussion of Issues

5.24 The above sections have provided a comprehensive set of data as output from the model. From the above, a number of issues can be identified as relates to network performance under each Scenario, at the key junctions.

A10/Baldock Road

5.25 As shown in Table 5.6 to 5.9, although queue lengths do increase through the scenarios, the roundabout is predicted to operate satisfactorily. The absolute maximum queue length is predicted to be 22 vehicles on the A10 (north) approach in the AM peak in Scenario 5 (compared to 12 vehicles on the same approach in the Base).

5.26 Consequently, the existing roundabout has the capacity to accommodate all forecast development traffic up to year 2021.

A10/London Road

5.27 Tables 5.6 to 5.9 show that queue lengths at this roundabout increase significantly through the Scenarios, principally on the London Road approach in the AM peak, and the A10 (south) approach in the PM peak.

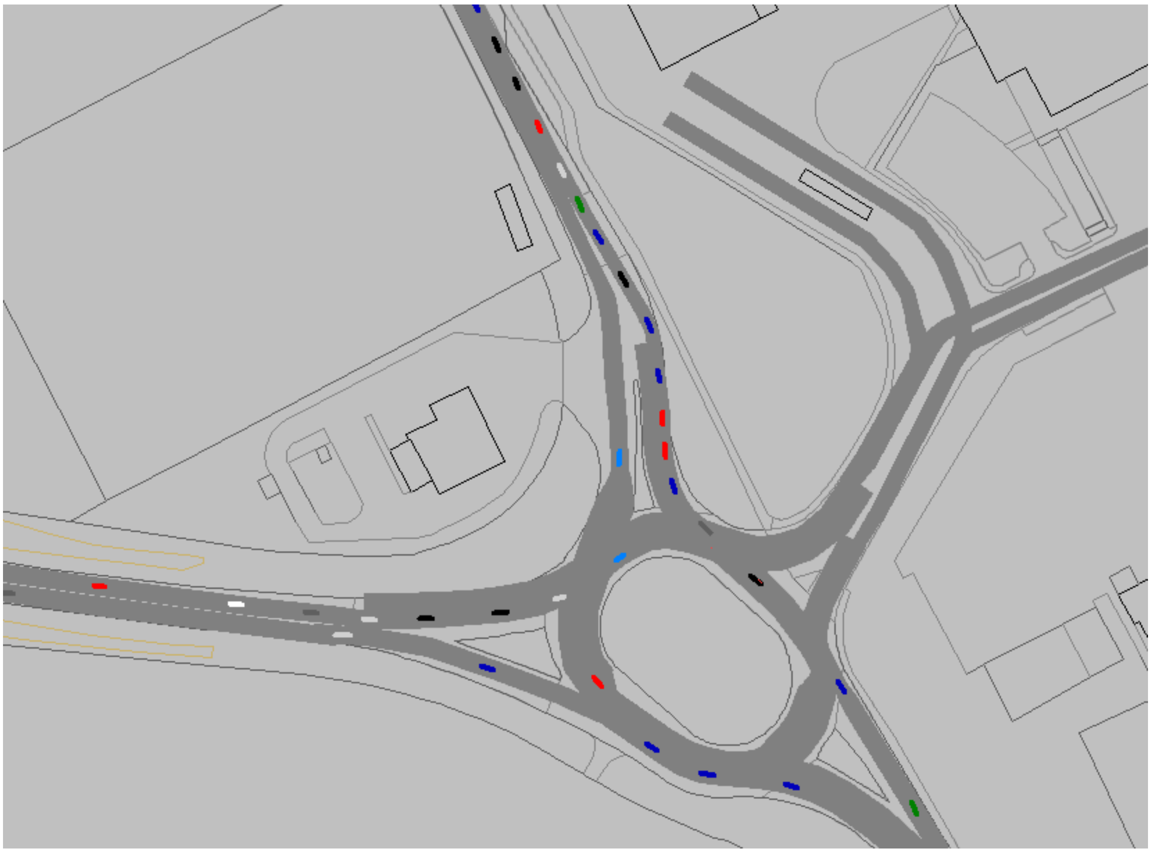
5.28 In the case of the former, this is due to the volumes of traffic heading on the A10 towards Hertford. The origin of these vehicles is split between the A10 (west) and London Road approaches. However, those arriving at the roundabout on the latter approach must give-way to those arriving on the former.

5.29 Consequently, as traffic volumes increase on the A10 (west) approach, it becomes more difficult for traffic on London Road to enter the roundabout circulatory. This results in the queue length predictions shown in Tables 5.6 and 5.7, with traffic blocking back as far as High Street in the latter Scenarios. Figure 5.6 shows the start of this queue developing in one of the Scenarios.

5.30 Traffic on the A10 (west) approach is relatively free-flow in this period, as there is only a modest flow of traffic heading northwards into Buntingford on London Road in the AM peak. In addition, due to the single lane southbound exit on the A10 towards Hertford, this traffic tends to only use the offside lane on the approach (with the kerbside lane used predominantly by traffic turning left into London Road). Consequently, this single lane of traffic moves through the roundabout in a steady line, with few opportunities for London Road traffic to find a gap.

5.31 Consequently, it is considered that this level of operation is not acceptable at the future year from Scenario 2 onwards, and that a mitigation measure should be considered – this is set out in the next Chapter.

Figure 5.6: Operation of A10/London Road junction in AM peak (Scenario 5 shown)



5.32 In the PM peak period at the roundabout, a problem is encountered on the A10 (south) approach as traffic moves northbound from Hertford. As shown in Tables 5.8 and 5.9, the queue on this approach increases through the Scenarios.

5.33 Table 5.12 shows the source of the issue.

Table 5.12: A10 volumes South of A10/London Road roundabout (vehicles/hour)

Scenario	0	1	2	3	4	5	5A
AM Northbound	839	887	939	959	966	1017	1017
AM Southbound	1209	1300	1435	1477	1475	1523	1489
PM Northbound	1250	1361	1468	1540	1555	1605	1607
PM Southbound	805	831	912	940	948	977	942

5.34 In the PM peak, Table 5.12 shows that the northbound traffic levels in the latter Scenarios are reaching towards the one-way link capacity of a single carriageway road, typically around 1,600-2,000veh/hour.

5.35 Although the roundabout approach on the A10 (south) arm does widen out to two lanes, this does not result in any extra capacity being gained as the majority of traffic is heading for the A10 (west), and as the exit to this lane is also a single carriageway link, the majority of the traffic uses the kerbside lane (the mirror effect of the southbound move in the AM peak period). In addition, as the traffic volumes on the circulatory carriageway across this approach are light, there are only infrequent occasions of vehicles on the approach being delayed, and therefore the offside section of flare length rarely gets utilised.

5.36 The consequence of this effect, is that when a northbound vehicle does momentarily stop at the give-way line, then a queue does develop back from this vehicle which then takes some time to clear – the phenomenon of a backwards traffic wave is then experienced, as more traffic slows at the back of the queue before the vehicle in front has started to accelerate. This is more commonly experienced on motorways, but is essentially experienced wherever the traffic demand is close to the traffic capacity, and therefore small incidents have a disproportionally large impact on operation. Figure 5.7 shows this effect, with near-stationary vehicles around 200m from the roundabout (small headways), but with vehicles already clearing through the roundabout (with a higher headway).

Figure 5.7: Operation of A10/London Road junction in PM peak (Scenario 5 shown)

5.37 Also in Tables 5.8 and 5.9, the queues on the A10 (west) arm are significantly higher in latter Scenarios. This is due, particularly in Scenario 5A, to the increase in vehicles heading into Buntingford (on London Road) from the South, and therefore more vehicles on the circulatory carriageway across the A10 (west) approach.

5.38 Consequently, it is considered that the level of operation predicted at the roundabout provides a cause for concern particularly in the latter Scenarios, and supports the recommendation from the AM peak that a mitigation measure should be considered – this is set out in the next Chapter.

High Street/Baldock Road and Station Road/Hare Street Road

5.39 As shown in Tables 5.6 to 5.9, queues at the High Street/Baldock Road junction increase through the Scenarios. The key operational issue is the extra traffic expected to pass through the junctions in these Scenarios. As Tables 5.2 and 5.3 show, the traffic volumes increase at a steady rate between scenarios.

5.40 However, the layout and operation of this junction is relatively unpredictable, with potential blocking issues on the Baldock Road and High Street (north) links. In addition, the visibility of the right turn movement from High Street (south) to High Street (north) is poor. Therefore an increase in volumes does not have a proportional impact on capacity, as some turning moves block other moves leading to a significant change in operation.

5.41 Figure 5.8 shows a screenshot of the model, showing a queue from the Baldock Road junction stretching back to the mini-roundabout at Hare Street Road.

Figure 5.8: Operation of High Street/Baldock Road junction in AM peak (Scenario 5A shown)

5.42 For the High Street/Baldock Road junction, it is considered that there is little that can be improved at the junction, due to the nature of the surrounding streetscape and the poor visibility at the junction. We have looked into improving the junction by converting to a mini-roundabout or traffic signal control, but both options would result in a drop in capacity compared to the existing priority-controlled arrangement.

5.43 In addition, the operation of the junction can be highly variable – in the instances of high queues on the High Street (south) approach, this was a result of a number of right turning vehicles arriving together, and therefore causing a queue. In addition, the parking arrangements on the Baldock Road arm can create a platoon of eastbound vehicles arriving at the junction, thereby introducing a significant delay for the northbound right turning vehicles.

5.44 It should be noted, however, that within the peak hour all traffic volumes were still accommodated, with no residual queues at the end of the peak hour (either AM or PM peak). This shows that the junction is still operating within capacity in the peak hour – it is within a more central 15-30 minute section of each peak that the problems are being encountered.

6 Mitigation Tests

6.1 As described in Chapter 5, future scenario testing showed the additional traffic, added gradually throughout scenarios 1 to 5/5A, causes the formation of respectively increasing queues within the network.

6.2 At most junctions, queue increases are modest. However at the A10/London Road junction, significant queues and traffic delays are experienced, in the southbound direction in the AM peak and northbound direction in the PM peak.

6.3 Consequently, mitigation measures have been identified, developed and tested using the traffic model. These mitigation measures were applied to Scenarios 2, 3, 4, 5 and 5A.

Mitigation Measure 1

6.4 As set out in Chapter 5, the issue in the AM peak period is southbound throughput at the A10/London Road roundabout, and the interaction in traffic capacity between the A10(west) and London Road approaches.

6.5 Consequently, Mitigation Measure 1 was to test the provision of a two-lane section on the A10 (south) exit from the roundabout, for around 100m before merging back into a single lane south of the roundabout. This arrangement is shown in Appendix A.

6.6 This would enable:

- Vehicles on the A10 (west) approach being able to use both lanes on the flared approach to head towards the A10 (south) exit
- In turn, the clearance of these vehicles from the give-way line more efficiently should increase gaps for the traffic on the London Road approach to enter the circulatory carriageway
- Vehicles on the London Road approach being able to use both lanes on the flared approach to head towards the A10 (south) exit

6.7 In the PM peak, a similar issue was identified, and therefore Appendix A also shows the northbound mitigation measure. This provides a two-lane section on the A10 (west) exit from the roundabout, for around 100m before merging back into a single lane north-west of the roundabout. Again, this allows traffic on the A10 (south) approach to use both lanes to head to the A10 (west) exit from the roundabout.

6.8 Table 6.1 shows a comparison of the A10/London Road operation in the AM peak period, with and without Mitigation Measure 1, for absolute maximum queue lengths.

Table 6.1: Absolute Maximum Queue Length Comparison (in vehicles) for Mitigation Measure 1 – AM Peak

Node	Arm	Counts	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
Without Mitigation									
A10/London Road	A10 (S)	11	2	3	9	7	12	6	2
	A10 (W)	11	10	2	20	17	26	17	19
	London Road	7	16	9	61	100	122	160	110
With Mitigation Measure 1									
A10/London Road	A10 (S)	-	-	-	3	3	4	3	3
	A10 (W)	-	-	-	3	3	4	3	3
	London Road	-	-	-	3	4	4	4	4

6.9 The results show that the mitigation measure has a significant impact on roundabout operation in the southbound direction, with minimal queues predicted on both the A10 (west) and London Road approaches. The mitigation measure has more than doubled the capacity on the London Road approach – by allowing both lanes to be used for the exit towards the A10 (south)), and also increasing capacity on the A10 (west) approach thus clearing traffic through the circulatory carriageway more efficiently.

6.10 Table 6.2 shows corresponding results for the PM peak period, with and without Mitigation Measure 1, for absolute maximum queue lengths.

Table 6.2: Absolute Maximum Queue Length Comparison (in vehicles) for Mitigation Measure 1 – PM Peak

Node	Arm	Counts	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
Without Mitigation									
A10/London Road	A10 (S)	1	2	27	57	98	80	118	142
	A10 (W)	4	5	3	15	19	13	28	24
	London Road	4	5	10	5	9	7	8	7
With Mitigation Measure 1									
A10/London Road	A10 (S)	-	-	-	43	33	31	81	78
	A10 (W)	-	-	-	4	4	5	5	6
	London Road	-	-	-	2	3	3	3	3

6.11 Table 6.2 shows that in the PM peak period, the mitigation measure has some impact on reducing queue lengths in the northbound direction. However, significant queues on this arm are still recorded.

Mitigation Measure 2

6.12 An alternative southbound mitigation measure has been identified to increase capacity in the AM peak period.

6.13 Mitigation Measure 2 is shown in Appendix B, and consists of providing part-time signal control (AM peak only) on the A10 (west) approach and associated carriageway.

6.14 The purpose of the measure is to provide a lower cost solution (compared to Mitigation Measure 1). The rationale is that the signal control would stack vehicles on the A10 (west), so as to then release in platoons. This would allow a significant period to be created (during the red signal) for London Road traffic to enter the circulatory carriageway. Figure 6.1 sets out the general approach.

Figure 6.1: Operation of Part-time Signals at A10/London Road

Left: A10 (west) signal on green; Right: A10 (west) signal on red, allows London Road traffic to enter roundabout circulatory

6.15 Table 6.3 shows a comparison of the A10/London operation in the AM peak period, with and without Mitigation Measure 1, for absolute maximum queue lengths.

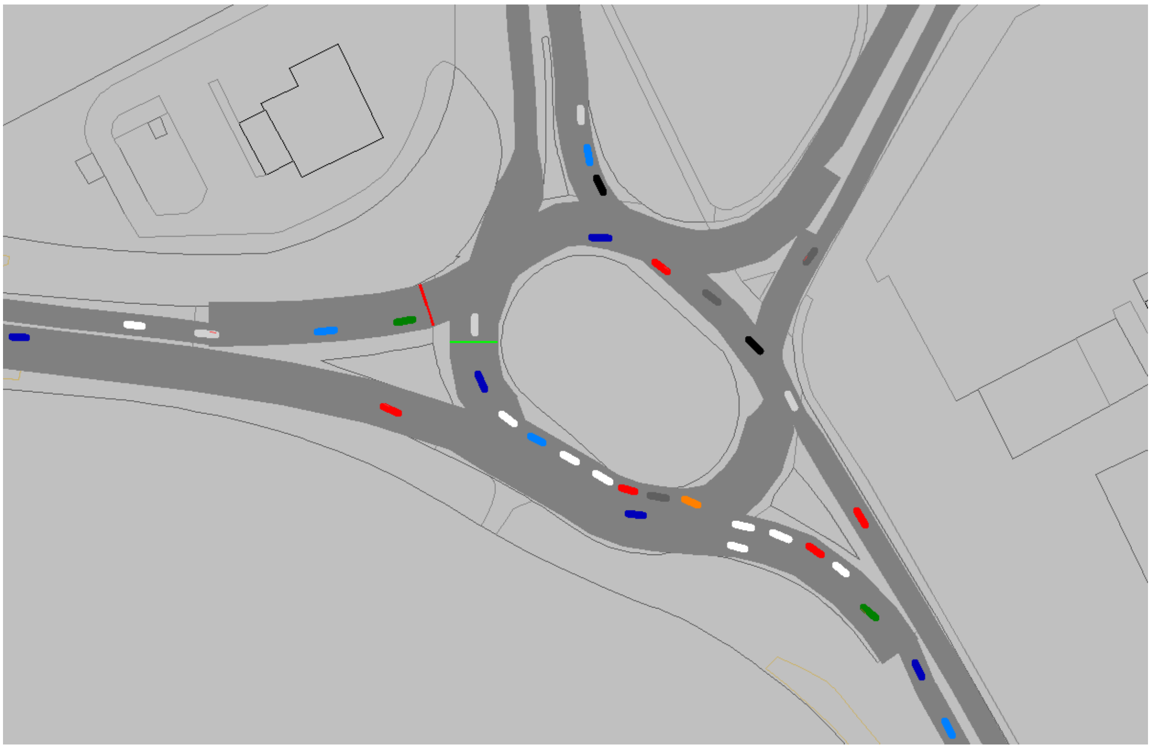
Table 6.3: Absolute Maximum Queue Length Comparison (in vehicles) for Mitigation Measure 2 – AM Peak

Node	Arm	Counts	Base	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5A
Without Mitigation									
A10/London Road	A10 (S)	11	2	3	9	7	12	6	2
	A10 (W)	11	10	2	20	17	26	17	19
	London Road	7	16	9	61	100	122	160	110
With Mitigation Measure 2									
A10/London Road	A10 (S)	-	-	-	5	9	18	10	23
	A10 (W)	-	-	-	27	28	29	59	35
	London Road	-	-	-	17	19	32	34	42

6.16 The results show that the mitigation measure provides an improvement in roundabout operation in the southbound direction. However, queues are still generated on the A10 (west) and London Road approaches, albeit significantly less than those predicted without mitigation.

6.17 However, queues are also generated on the A10 (south) approach, which suggests that the queue generated at the stopline on the circulatory carriageway results in some blocking back around the circulatory and onto the A10 (south) approach. This is a potential road safety issue, and is shown in Figure 6.2.

Figure 6.2: Queueing on Circulatory Carriageway in Mitigation Measure 1 – Scenario 5A shown



6.18 In the PM peak period, the part-time signals would not be in operation, and so the results are as those shown in Table 6.2.

Mitigation Conclusions

6.19 The results in the previous section provide the following key conclusions:

- Mitigation Measure 1 involves local widening in the southbound direction at the A10/London Road roundabout, and results in a significant improvement in operation across all future Scenarios in the AM peak period
- Mitigation Measure 1 also provides benefits in the northbound direction in the PM peak at the same location, again due to local widening, but with significant queues still predicted in Scenarios 5 and 5A
- Mitigation Measure 2 provides AM peak part-time signal control operation of the A10 (west) approach, which provides an improvement in operation in the southbound direction. However, a road safety issue is created on the northbound section of the circulatory, with insufficient space to accommodate the queue of vehicles at the circulatory stopline heading for the London Road exit link

6.20 Consequently, it is recommended that Mitigation Measure 1 be taken forward for implementation, ideally before Scenario 3 (and the associated development proposals within this Scenario) becomes live.

6.21 As set out in the previous Chapter, the A10 (south) link to and from Hertford is predicted to be carrying traffic volumes close to the link capacity. Consequently, the improvement of the

A10/London Road roundabout may not be the key constraint in the network after the implementation of the mitigation measure. South of the A10/London Road, the A10 is a single carriageway link for around 2km before becoming a dual carriageway with two lanes in each direction. Within the 2km section, there are limited side roads, but no right turning bays are provided and so a single vehicle turning across the opposing traffic stream can cause queues to develop quickly particularly in the tidal direction in the weekday peak hours. In addition, during these peak periods, it will be increasingly difficult to enter the A10 from these side roads as the A10 demand increases through the Scenarios.

6.22 Table 6.4 shows the two-way volumes on the A10 on three sections within the network.

Table 6.4: A10 two-way volumes South of A10/London Road roundabout (vehicles/hour)

Scenario	0	1	2	3	4	5	5A
AM Peak							
South of London Road	2049	2187	2375	2436	2441	2540	2505
London Road to Baldock Road	1506	1560	1672	1673	1673	1850	1643
North of Baldock Road	918	942	1110	1115	1103	1117	1085
PM Peak							
South of London Road	2054	2192	2380	2480	2503	2582	2549
London Road to Baldock Road	1447	1510	1586	1602	1605	1695	1595
North of Baldock Road	877	907	1045	1049	1056	1084	1093

6.23 Table 6.4 shows that the section of the A10 south of the London Road roundabout are significantly higher than volumes further north – this is due to traffic with an origin or destination in Buntingford moving off the A10 at this point. It is therefore likely that at some point in the future, the volumes of trips on this section of the A10 may reach the link capacity and therefore southbound queues may block back to the London Road roundabout in the AM peak, and northbound queues block back from the roundabout in the PM peak.

6.24 Whilst outside the scope of this study, it is considered that the dual carriageway section of the A10 would therefore need to be extended up to the London Road roundabout in the future, to prevent slow moving queues developing in this section. As demand on the A10 north of the London Road roundabout is significantly less, it is not expected that this section to Baldock Road would need to be dualled. However, it should be noted that the layout of Mitigation Measure 1 is consistent with the dualling of the A10 (in both directions).

6.25 In the previous Chapter, operational issues were also experienced at the High Street/Baldock Road junction, particularly in the central 30 minutes of the AM peak hour. Table 5.7 showed that queues on the High Street (south) approach block back to the Station Road/Hare Street Road junction in Scenario 5A at a much higher frequency than in the previous Scenarios.

6.26 This is due to traffic from the proposed development site 3/14/2304/OP using Luynes Rise to access the local network in Scenario 5A. Traffic to and from the north and west of the network is predicted to use Station Road and Baldock Road to move through the network, rather than use the longer route via the A10/London Road roundabout to access the A10.

6.27 Consequently, in Scenario 5A, there is more traffic on local roads through Buntingford, compared to Scenario 5. In Scenario 5, a new roundabout on the A10 is provided as part of the development, and therefore both trips to and from this development, and other local trips associated with Luynes Rise have an alternative route, relieving pressure on key junctions in the centre of the town and providing a more direct route for local traffic to reach the strategic highway network (i.e. the A10).

7 Summary and Conclusions

7.1 Following the development of a VISSIM base model of Buntingford, representing the present operation of the network, a number of future development Scenarios were defined in order to identify the impact of introducing a set of business and residential developments to the current network.

7.2 The VISSIM model was then developed to test the impact of each Scenario on network operation, in both the weekday AM and PM peak period. The results of the Scenario testing indicated that, in the most part, the network can accommodate the new developments given the network changes that have already been planned.

7.3 However, operational issues were identified at the following locations:

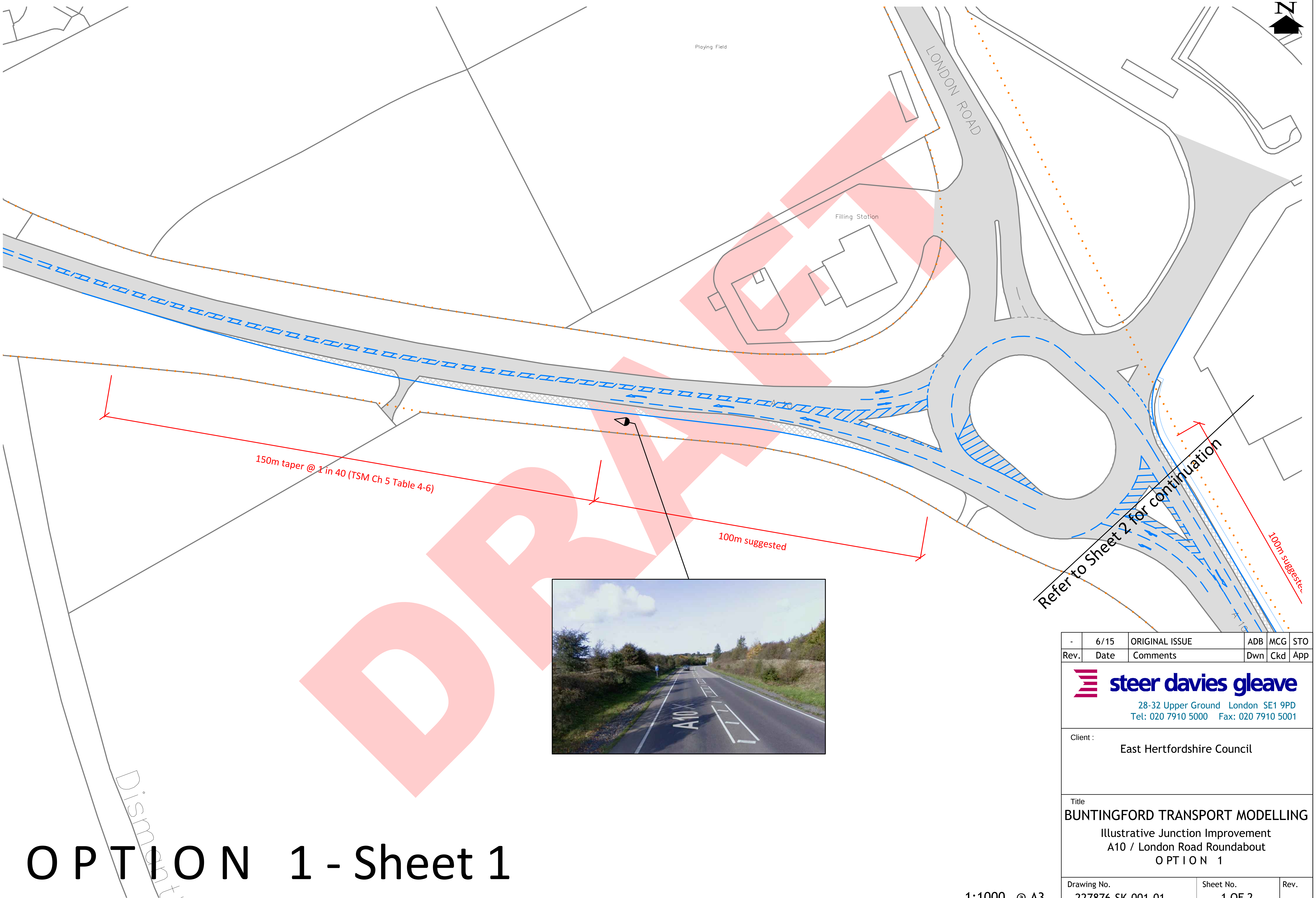
- A10/London Road – southbound in the AM peak, and northbound in the PM peak
- High Street/Baldock Road – northbound, principally in the AM peak

7.4 In terms of the A10/London Road roundabout, two mitigation measures were tested. The results showed that local widening of the two A10 exit links at the roundabout (to provide a two-lane section before merging back to a single lane) provided a significant improvement in operation, particularly in the AM peak. This mitigation measure should be considered in the near future, ideally in line with developments within Scenario 3 coming on line.

7.5 However, there is an ongoing issue with the link capacity of the A10, between the London Road roundabout and the dual-carriageway section around 2km south of the town. Within the latter Scenarios 4, 5 and 5A, the traffic demand on this section of the A10 gets close to the link capacity, southbound in the weekday AM peak period and northbound in the weekday PM peak period. So whilst the mitigation measure proposed above for the A10/London Road roundabout does improve the operation at this location, there should be a longer term aspiration to extend the dual carriageway section up to this roundabout.

7.6 At the High Street/Baldock Road junction, operational issues were identified particularly in Scenario 5A. This was due to there being more traffic passing through the town centre, as the new link to the proposed A10 roundabout is not available in this Scenario. For the local road network, the addition of this new roundabout on the A10 provides benefits in terms of reducing traffic levels within the town centre, without having a measureable disbenefits on A10 operation. Therefore, it is recommended that this new access point on the A10 be taken forward.

A Mitigation Measure 1



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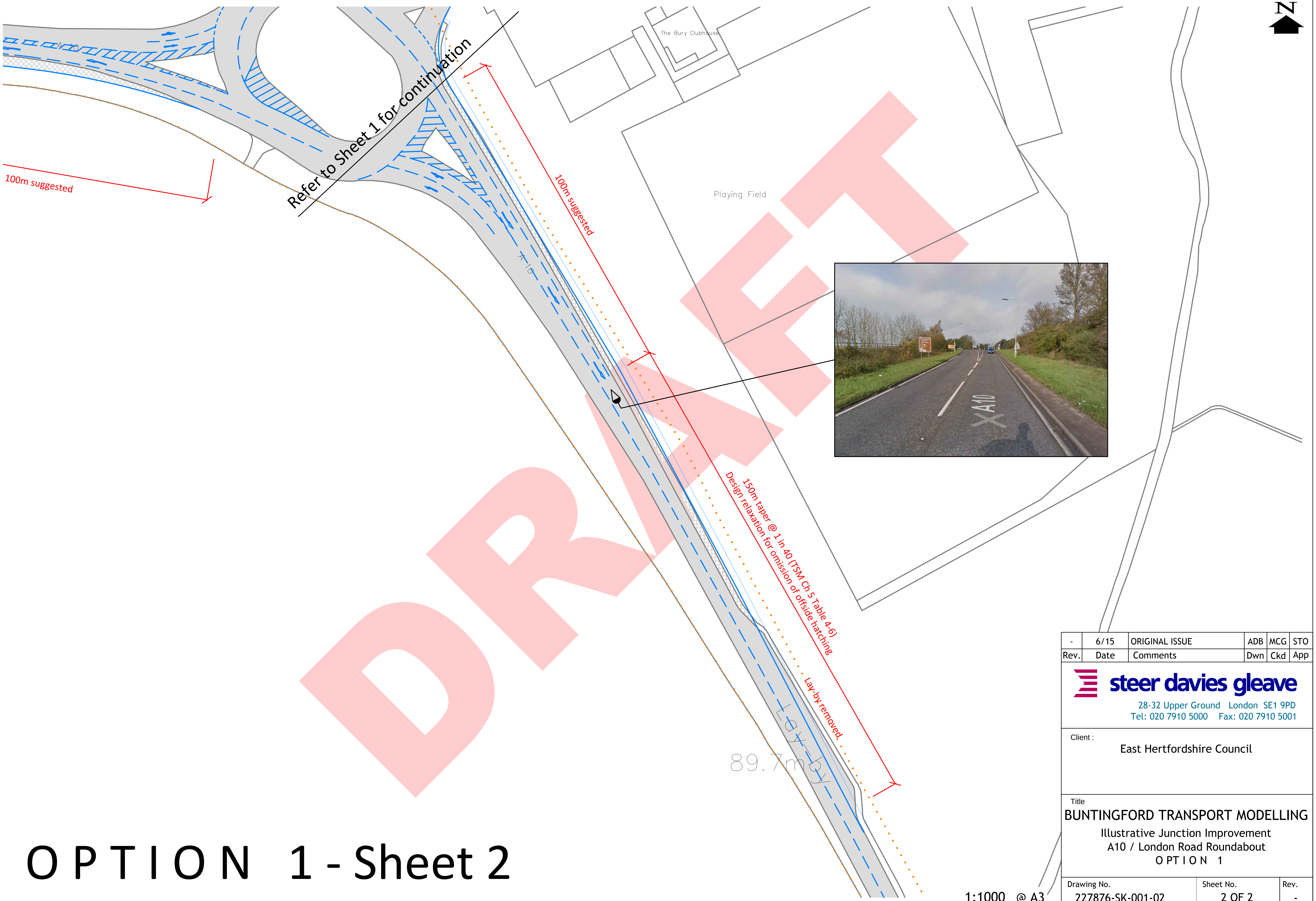

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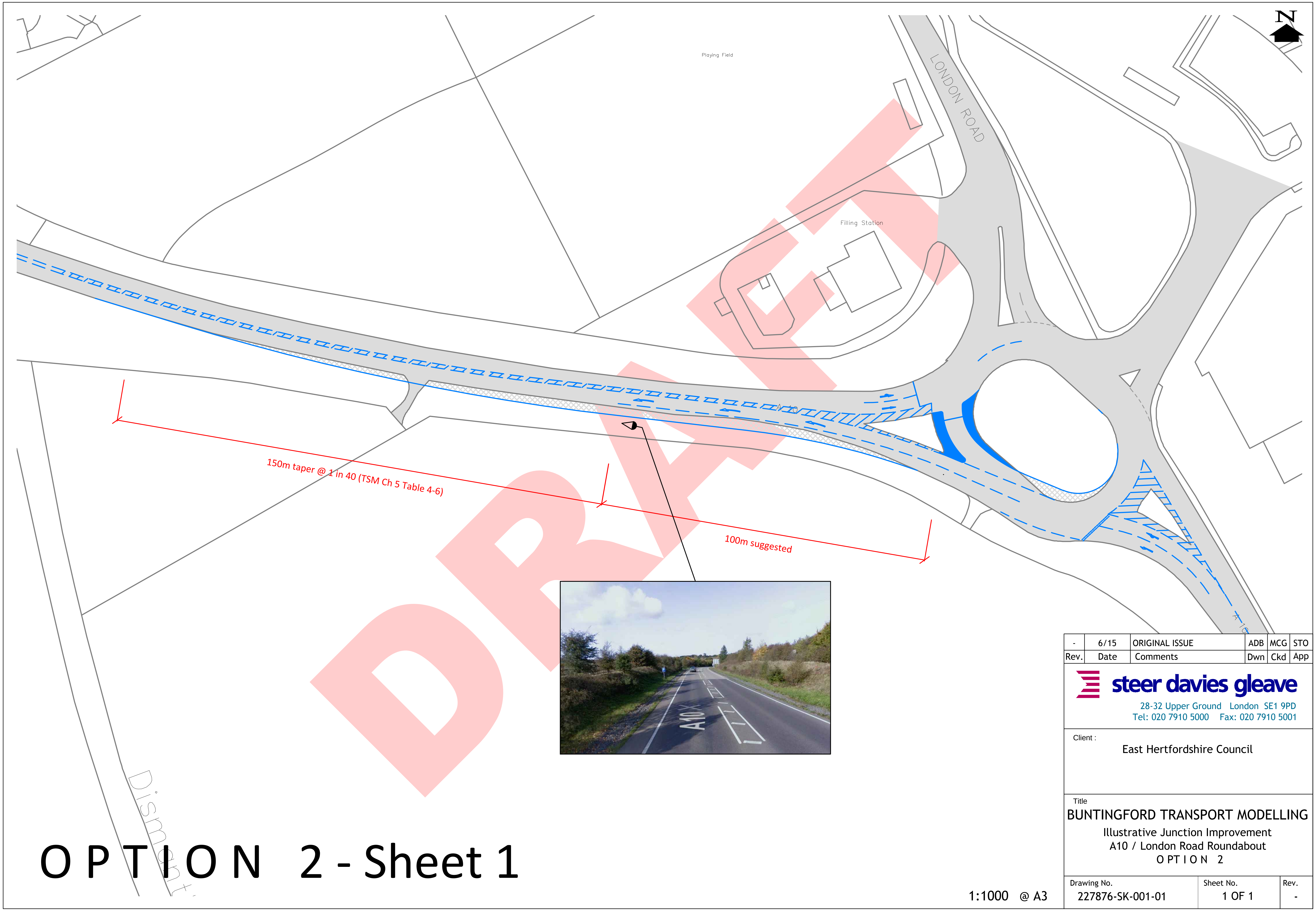
B Mitigation Measure 2



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