Anderson Drive
Locking In the Benefits Study

Aberdeen City Council

Further Local Modelling Assessment

TPNECAD2/74965
November 2012

ANDERSON DRIVE – LOCKING IN THE BENEFITS STUDY

Description:	**Further Local Modelling Assessment**
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1 INTRODUCTION

1.1 Background

SIAS Limited (SIAS) was commissioned by Aberdeen City Council on behalf of Nestrans to undertake further testing of the Anderson Drive Base S-Paramics models.

The two sections of the Anderson Drive corridor that were modelled are:

- A944 Westburn Road
  Ashgrove Road West in the north to Mid Stocket Road in the south
- A93 Great Western Road
  St. Johns Terrace

The further testing follows on from a previous test programme undertaken by SIAS in August 2011 titled *Anderson Drive S-Paramics Model – Option Testing Report (SIAS Ref. 73817, 1 August 2011).*

In the previous study, the models were developed to a 2016 network scenario and various options were modelled as part of 'locking in' any benefits from the AWPR. The predicted benefits of the implementation of the AWPR on the Anderson Drive corridor were that there would be a displacement of north-south routeing traffic from Anderson Drive to the AWPR, thus reducing the traffic demand through the Anderson Drive corridor.

The model testing involved altering the signal control timings at the signalised junctions to provide more benefit to the eastbound and westbound routeing traffic, while retaining the northbound and southbound traffic delay to 2007 Base levels.

The further testing now incorporates the strategic routeing influence from the Aberdeen Sub Area Model (ASAM) of "locking in the benefits" measures on Anderson Drive.

1.2 Study Area

The two separate models developed for the Anderson Drive corridor in Aberdeen are highlighted in Figure 1.1

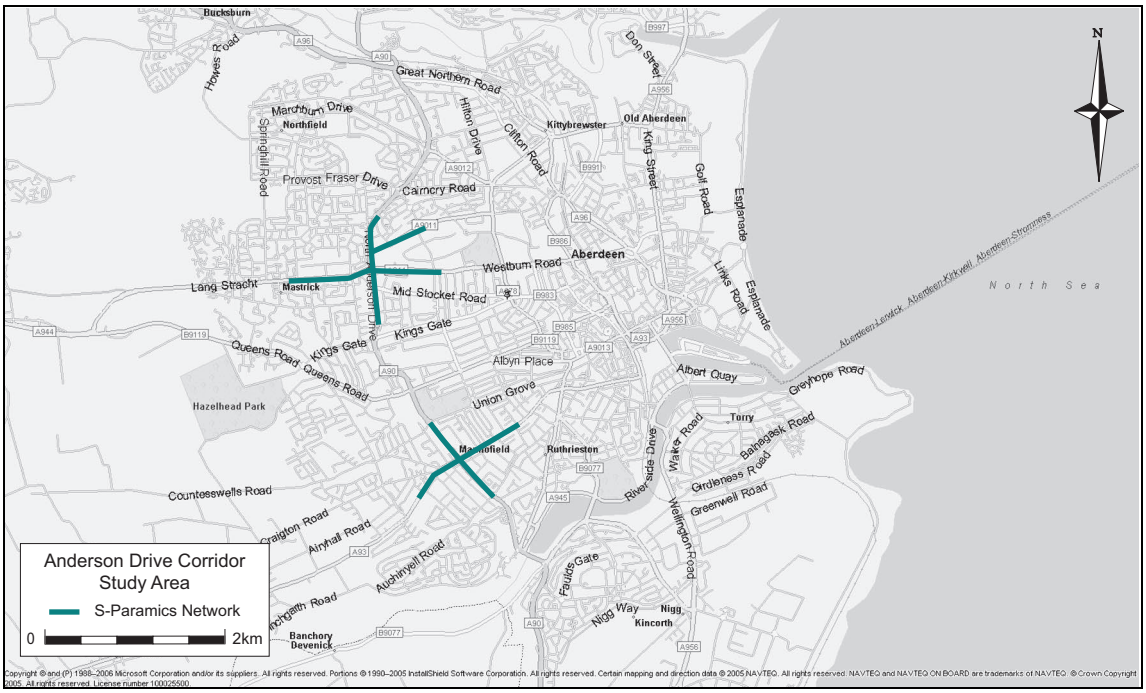


Figure 1.1 : Study Area – Anderson Drive Corridor

1.3 Purpose of Further Study

The August 2011 study utilised the Aberdeen Sub Area Model (ASAM) link data to inform the S-Paramics models of the strategic routeing changes in the network associated with the AWPR. This initial test methodology did not encompass any 'locking in the benefits' measures or influences within the ASAM model. Therefore, a strategic testing methodology was derived by the study team which involved informing the ASAM model of the potential signal timing restriction to the Anderson Drive corridor in a north-south direction and feeding this wide area influence of the signal timing changes into the local S-Paramics model.

This Report details the methodology and findings of this alternative S-Paramics 2016 model development process.

2 S-PARAMICS BASE MODELS

2.1 Introduction

The S-Paramics networks of the Anderson Drive corridor and the zoning system adopted for each model are shown in Figures 2.1 and 2.2

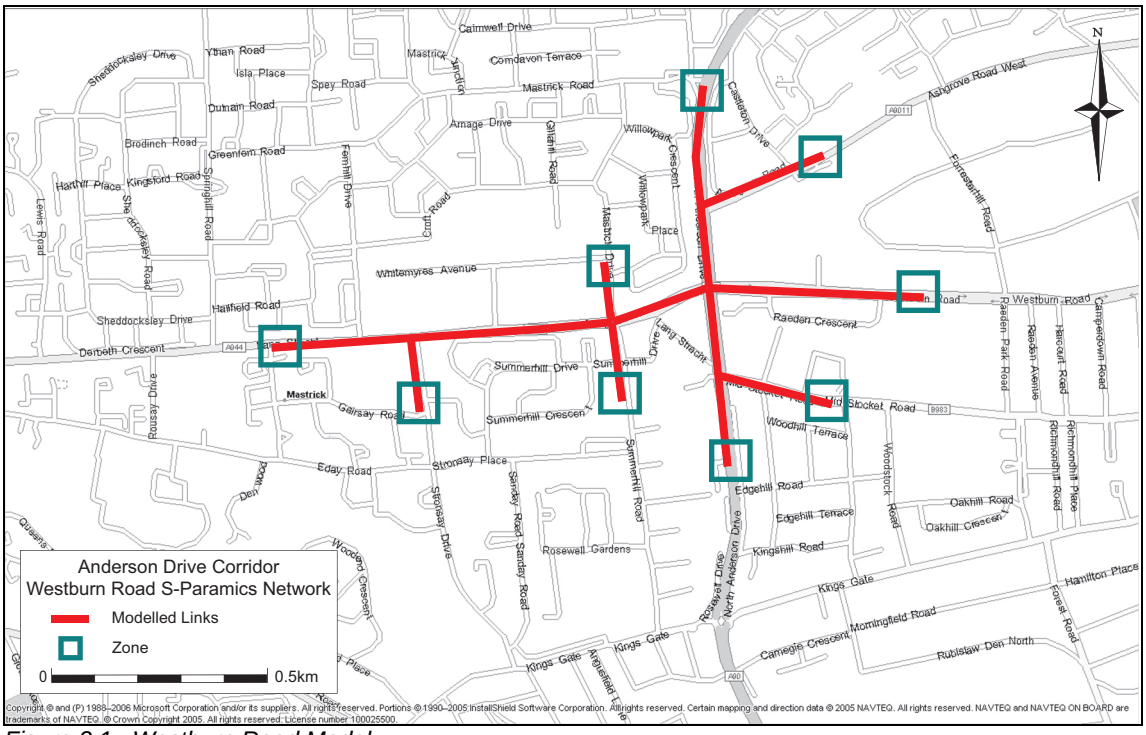


Figure 2.1 : Westburn Road Model

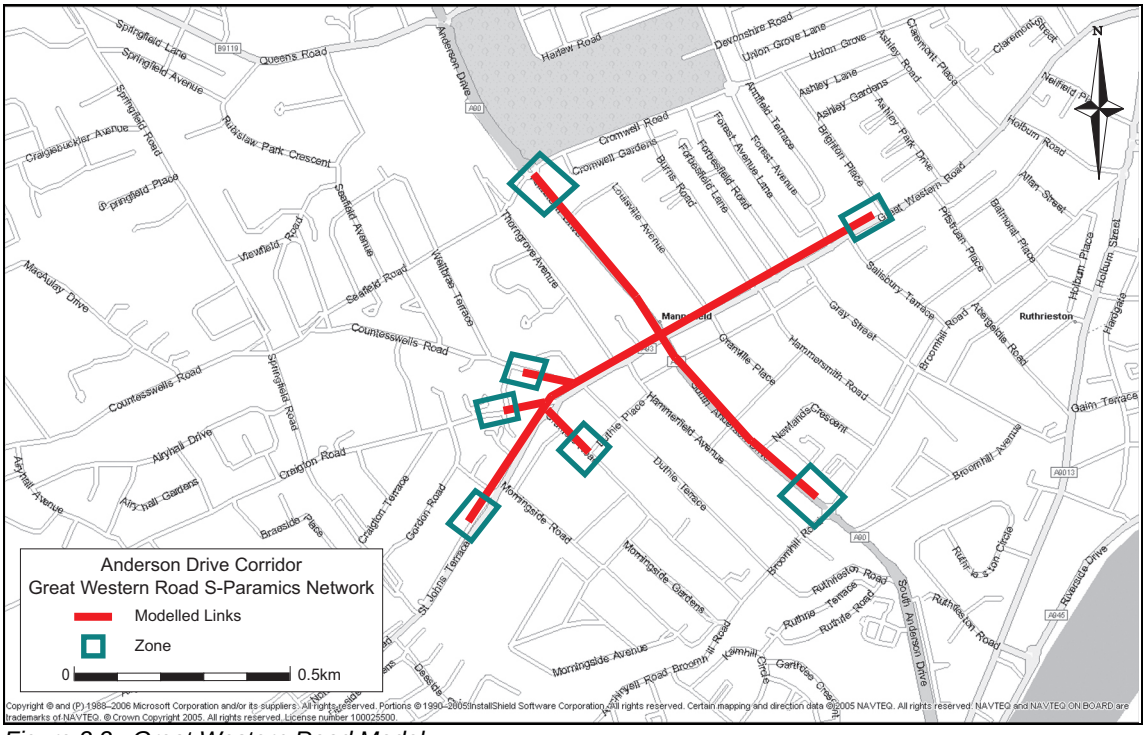


Figure 2.2 : Great Western Road Model

Both the Westburn Road model and the Great Western Road model were developed for the following time periods:

- AM Peak Period (06:30 – 09:30)
- PM Peak Period (15:30 -18:30)

The Anderson Drive base model development is detailed in the (revised) *Anderson Drive Base Model Development Report (Ref. 74794, September 2012)*.

2.2 Modelled Signal Phasing

The signal phasing for the three junctions associated with the Westburn Road model and one for the Great Western Road model are shown in Figure 2.3.

The figure shows that the pedestrian stage of the Ashgrove Road and Mid Stocket Road is called every second cycle. This has been calculated from a review of the number of times the pedestrian crossing phase was called during the peak period from SCOOT data.

There is no pedestrian crossing stage in the Westburn Road junction as no facilitates exists on-site.

The pedestrian crossing stage for the Great Western Road junction is called every cycle. This has been calculated from a review of the number of times the pedestrian crossing phase was called during the peak period from SCOOT data.

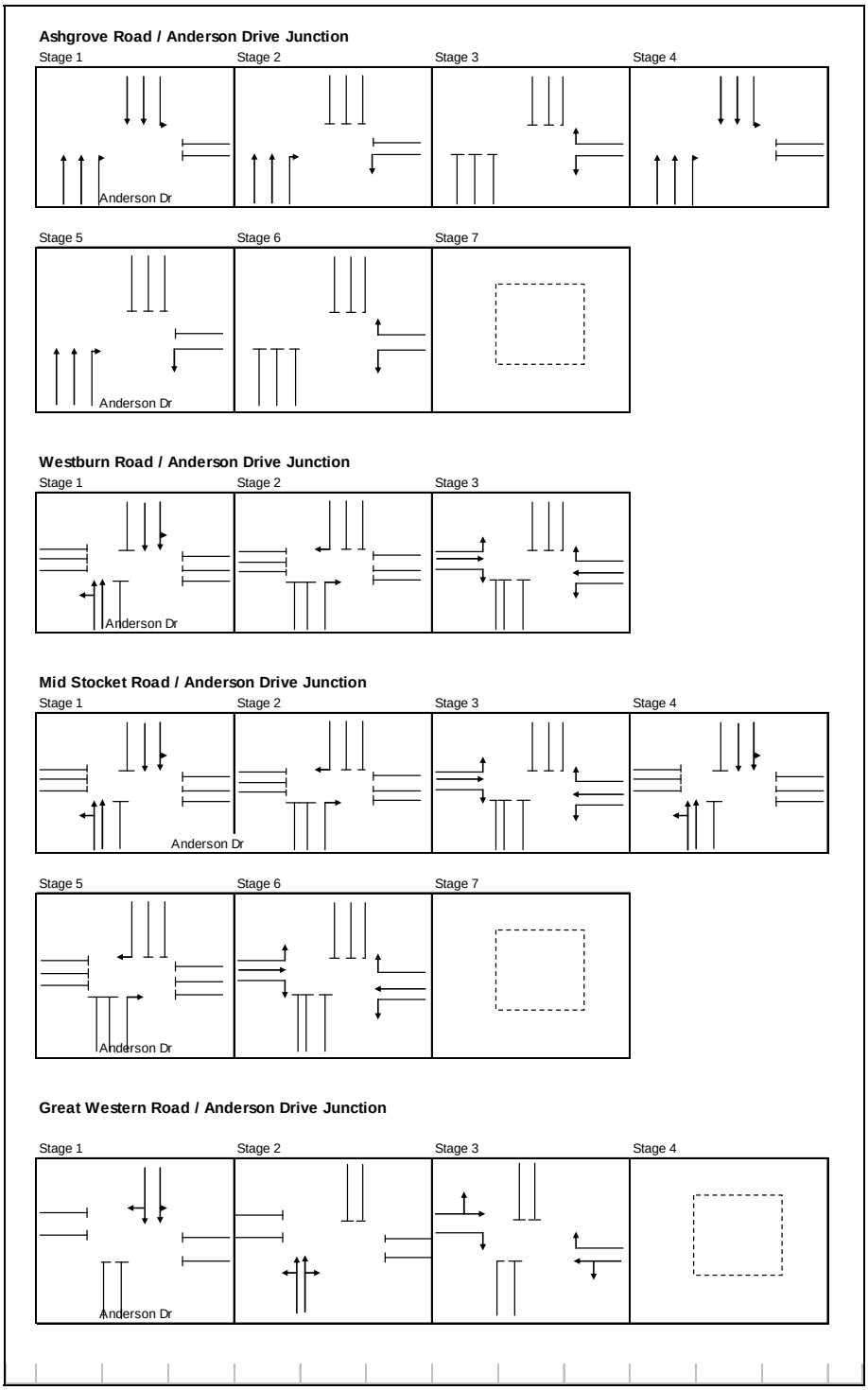


Figure 2.3 : Base Model Signal Phasing

3 2016 S-PARAMICS MODEL DEVELOPMENT

3.1 Methodology

A strategic influence testing methodology was derived by the study team and approved by ACC and nestrans which involved informing the ASAM model of the potential signal timing restriction to the Anderson Drive corridor in a north-south direction. This was undertaken by providing MVA with the Base Model signal timings for the pertinent junctions and also the signal timings with a 30% shift in signal green time from the north-south phases to the east-west phases of the signal stages. The 30% shift proportion was derived and agreed by the study team.

This revised methodology allows the strategic model to inform the S-Paramics models on the strategic influence of both the AWPR and the proposed signalised junction changes on Anderson Drive. This then allows the S-Paramics models to test any potential changes at the signalised junctions on Anderson Drive at a local level, with the wide area impact of the green time restriction already considered within the ASAM model.

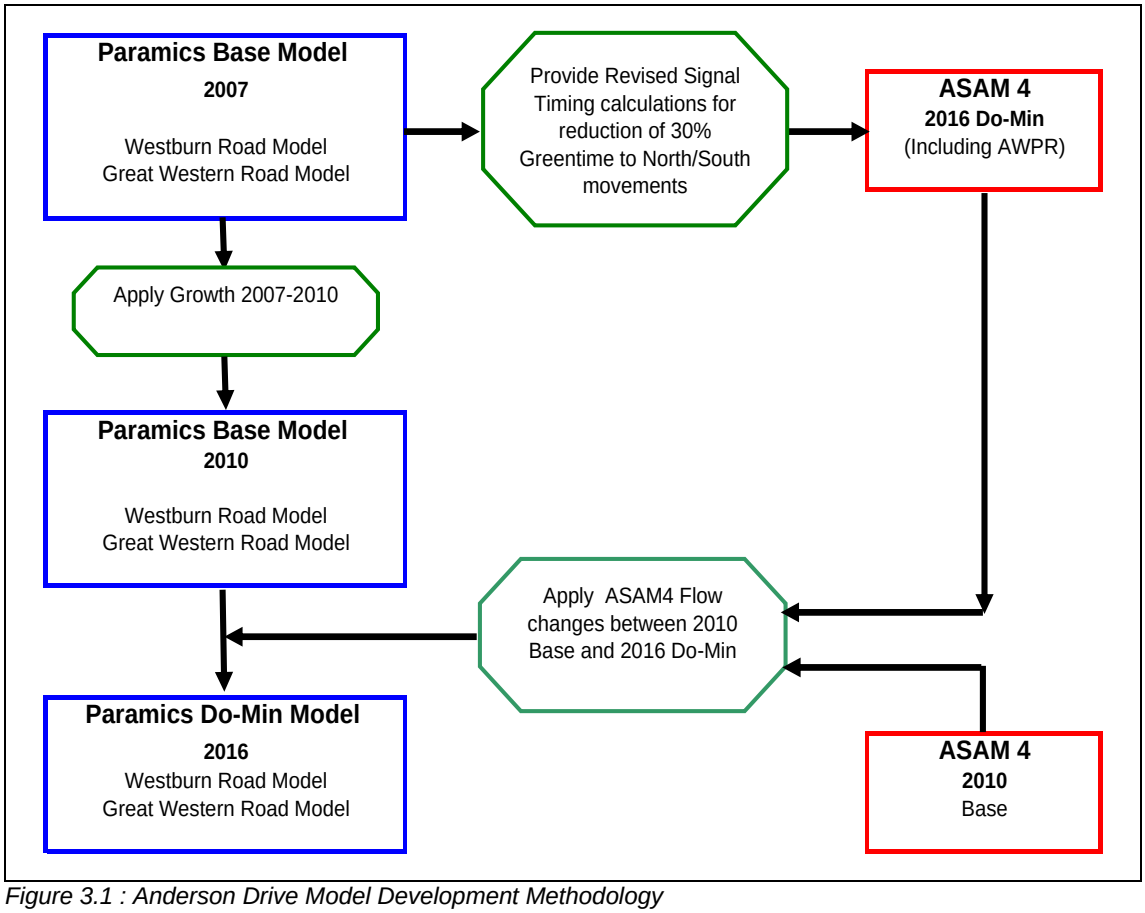


Figure 3.1 : Anderson Drive Model Development Methodology

3.2 ASAM4 2010 and 2016 Models

The ASAM4 2010 Present day network includes consistent overall travel demand as contained in the standard ASAM4 2007 Base Year Scenario (i.e. assuming no change in overall region-wide traffic levels between 2007 and 2010). Updates have been made to the baseline scenario to reflect recent infrastructure along the A944 corridor and additional detail along the Anderson

Drive corridor, including new traffic signal data sets. This scenario includes the following recent transport investments that are now on the ground:

- Strategic Rail (2008) – improved Edinburgh-Aberdeen, Aberdeen-Inverness & Aberdeen-Inverurie services
- Laurencekirk rail station & rail service changes
- Grade separation on the A90 at Findon
- A956 dual carriageway upgrade

The ASAM4 2016 scenario includes the representation of a range of proposed transport infrastructure assumptions as follows:

- Union Street pedestrianisation & traffic management schemes including Berryden Road Dual Carriageway
- A96-to-Aberdeen Airport Link Road
- A90 Balmedie to Tipperty dualling
- Aberdeen Western Peripheral Route (AWPR)
- Park & Ride sites at Chapelbrae, Parkhill & Schoolhill, and associated bus services
- Third Don Crossing
- 30% reduction to north/south green time at signalised intersections along Anderson Drive corridor

ASAM4 uses planning data to forecast changes in traffic levels over time. The planning data applied represents the Aberdeen City and Aberdeenshire Local Development Plans, which reflect the level of growth outlined within the Aberdeen City and Shire Structure Plan (2009).

The overall level of development/increase in population/jobs assumed with ASAM4 between 2007 and 2016 is covered in Table 3.1.

Table 3.1 : Planning Data Changes by Corridor: 2007-2016 (High Growth Scenario)

Area	HH's	Emp.	Popn.	Change HH's	Change Emp.	Change Popn.	Change % HH's	Change % Emp.	Change % Popn.
Brownfield	75,278	105,937	151,649	4,000	550	- 2,605	5%	1%	-2%
Regeneration	18,827	8,550	38,441	250	-	- 2,074	1%	0%	-5%
Greenfield	8,089	20,035	19,170	12,000	4,683	20,946	148%	23%	109%
Aberdeen City	**102,195**	**134,522**	**209,260**	**16,250**	**5,233**	**16,266**	**16%**	**4%**	**8%**
Huntly-Pitcaple	5,651	3,658	13,042	300	363	-241	5%	10%	-2%
Inverurie-Blackburn	9,928	8,728	23,172	1,000	1,162	537	10%	13%	2%
Portlethen-Stonehaven	10,378	8,214	25,509	2,200	1,888	2,863	21%	23%	11%
Drumlithie-Laurencekirk	1,849	1,162	4,445	500	399	740	27%	34%	17%
Peterhead-Hatton	11,681	11,079	27,675	800	653	-173	7%	6%	-1%
Ellon-Blackdog	8,845	4,264	21,593	800	980	228	9%	23%	1%
Local Growth (AHMA)	15,557	10,379	38,972	1,000	0	-505	6%	0%	-1%
Local Growth (RHMA)	36,303	23,921	84,752	4,200	0	3,087	12%	0%	4%
Aberdeenshire	**100,191**	**71,405**	**239,160**	**10,800**	**5,445**	**6,536**	**11%**	**8%**	**3%**
Aberdeen & Aberdeenshire	**202,386**	**205,928**	**448,420**	**27,050**	**10,678**	**22,802**	**13%**	**5%**	**5%**

3.3 Analysis of 2016 ASAM4 Model Outputs

MVA provided SIAS with traffic flow difference plots of the Aberdeen Network for the 2016 scenario with and without the influence of reducing the Anderson Drive north/south signal timings by 30%.

Figure 3.2 shows the plot for the AM peak ASAM model. The green bars are where traffic flow has reduced and the red bars are where traffic flow has increased. The thickness of the bars is on a sliding scale with the thickest bar being equivalent to approximately 100 vehicle change per hour.

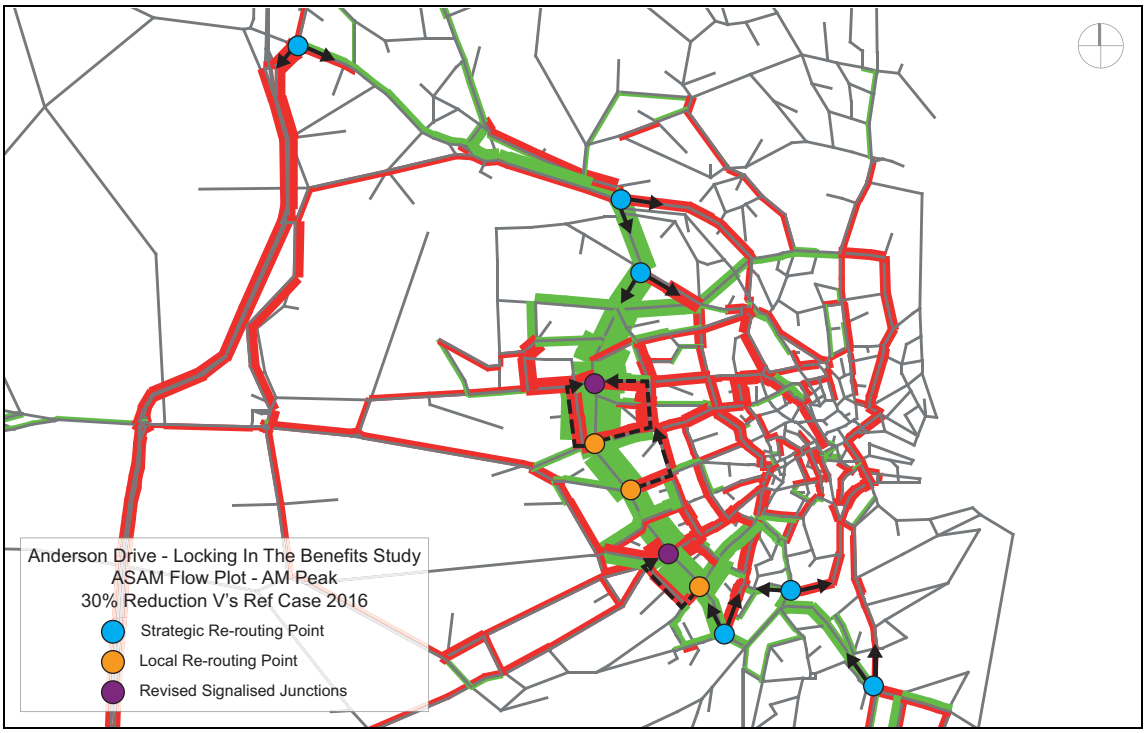


Figure 3.2 : ASAM Network – Influence of Amending Signal Green time on Anderson Drive.

The diagram shows that there is a migration of traffic from Anderson Drive to the AWPR and also towards the city centre area. It is important to emphasis that the plot shows the difference between the 'with' and 'without' signal phasing changes on Anderson Drive only. The plot is not the difference between with and without the AWPR as this is included in both scenarios.

The diagram highlights that there are strategic and local re-routeing points in the local network. The strategic re-routeing points have been identified where alternative routeing decisions have been made to avoid the signalised junctions and primarily Anderson Drive as a whole corridor. The main locations of these strategic re-routeing points have been identified as:

- AWPR/A96 Inverurie Road Southbound
- Haudagain Roundabout (A90/A96) Southbound
- North Anderson Drive/Rosehill Drive Southbound
- Wellington Road/West Tullos Road Northbound
- King George VI Bridge/Riverside Drive Northbound
- South Anderson Drive/Holburn Street Northbound

Local re-routeing points were also identified from the flow difference plots. These are junctions where the traffic re-routes from North Anderson Drive in the vicinity of the two junctions within the study. The flow plots suggest that some north/south routeing traffic re-routes away from Anderson Drive to arrive back on the east/west corridor.

Three (non-exhaustive) locations of local re-routeing can be interpolated from the flow plots, these are:

- South Anderson Drive/Broomhill
- Anderson Drive/Queens Road
- Anderson Drive/Kings Gate

It is likely that North Anderson Drive/Forresterhill Road would also be included in this list, subject to further investigation.

These flow plots suggest that the current study at two areas on the Anderson Drive corridor would need to be included in a future wider scale corridor assessment of all junctions on Anderson Drive.

3.4 Assessment of 2016 ASAM4 Model Matrices

Tables 3.2 and 3.3 provide a summary of the strategic traffic demand differences between the ASAM4 Base 2010 model and the ASAM4 2016 Test Case (with 30% green time adjustment to north/south routeing). These figures have been calculated from the ASAM4 matrices and are therefore representative of the model travel demand as opposed an hourly flow.

Table 3.2 : ASAM4 Traffic Demand Analysis – Great Western Road Junction

Peak	Junction Arm	Direction	ASAM Base 2010 (vehicles per hr)	ASAM 2016 Test Case (vehicles per hr)	Difference (vehicles per hr)
AM					
	Anderson Drive	SB	730	548	-181
	Anderson Drive	NB	1,036	734	-302
	Great Western Rd	WB	250	276	25
	Great Western Rd	EB	408	482	74
PM					
	Anderson Drive	SB	884	630	-254
	Anderson Drive	NB	736	556	-180
	Great Western Rd	WB	393	493	101
	Great Western Rd	EB	339	330	-9

Table 3.3 : ASAM4 Traffic Demand Analysis – Westburn Road Junction

Peak	Junction Arm	Direction	ASAM Base 2010 (vehicles per hr)	ASAM 2016 Test Case (vehicles per hr)	Difference (vehicles per hr)
AM					
	Anderson Drive	SB	1,343	997	-346
	Anderson Drive	NB	1,500	1,102	-398
	Westburn Rd	WB	458	453	-5
	Lang Stracht	EB	1,122	1,106	-16
PM					
	Anderson Drive	SB	1,461	931	-529
	Anderson Drive	NB	1,455	1,169	-286
	Westburn Rd	WB	649	633	-16
	Lang Stracht	EB	623	567	-56

The tables confirm that the influence of the AWPR plus the reducing the Anderson Drive north/south signal timings by 30% results in a significant migration of traffic from Anderson Drive in the ASAM models.

3.5 S-Paramics Background Growth 2007-2010

The ASAM4 models were developed for a base year 2010 with the test case year of 2016. The S-Paramics Base Models have been developed using traffic survey data from 2007.

In order to allow a direct comparison between the S-Paramics and ASAM4 matrices, the S-Paramics model matrices require to be updated to reflect 2010 base traffic flows.

A review of the traffic growth on Anderson Drive between 2007 and 2010 was undertaken via an assessment of four ATC sites on Anderson Drive.

The assessment showed varying flow changes across the four sites with an average flow change of less than 60 vehicles in an hour. The AM peak period showed a slight increase in traffic flow while the PM peak period showed a slight decrease in traffic flow (between 2007 and 2010).

Given the flow change variance between sites and periods, and considering the relatively small change in traffic flow between 2007 and 2010, it was considered that no growth should be applied to the S-Paramics Base models to reflect a 2010 Base scenario.

The application of no growth between 2007 and 2010 is consistent with the development of the ASAM4 model from 2007 to 2010.

3.6 Development of S-Paramics 2016 Model Matrices

The S-Paramics models are calibrated to the surveyed junctions on Anderson Drive, but not to the full model extent. Figure 2.1 and 2.2 show model zones to the west of Anderson Drive, but these are feeder zones to the main junctions on Anderson Drive to correlate to ASAM zoning. Only the Anderson Drive junctions were surveyed in 2007, so all other junction zones in the models are not calibrated to on-site turning counts.

The ASAM zone definition is similar to that of the S-Paramics zone definition. In order to correlate between the ASAM4 model matrices and the S-Paramics model matrices, a sectoring process is required.

The sectoring process allows the absolute difference between the ASAM4 2010 Baseline and the ASAM4 2016 Test Case (30% reduction in N/S green time) to be applied to the calibrated junctions within the S-Paramics models

Figure 3.3 and Table 3.4 show the zone correlation and sectoring process, which was undertaken for the Great Western Road model.

Figure 3.4 and Table 3.5 show the zone correlation and sectoring process, which was undertaken for the Westburn Road model.

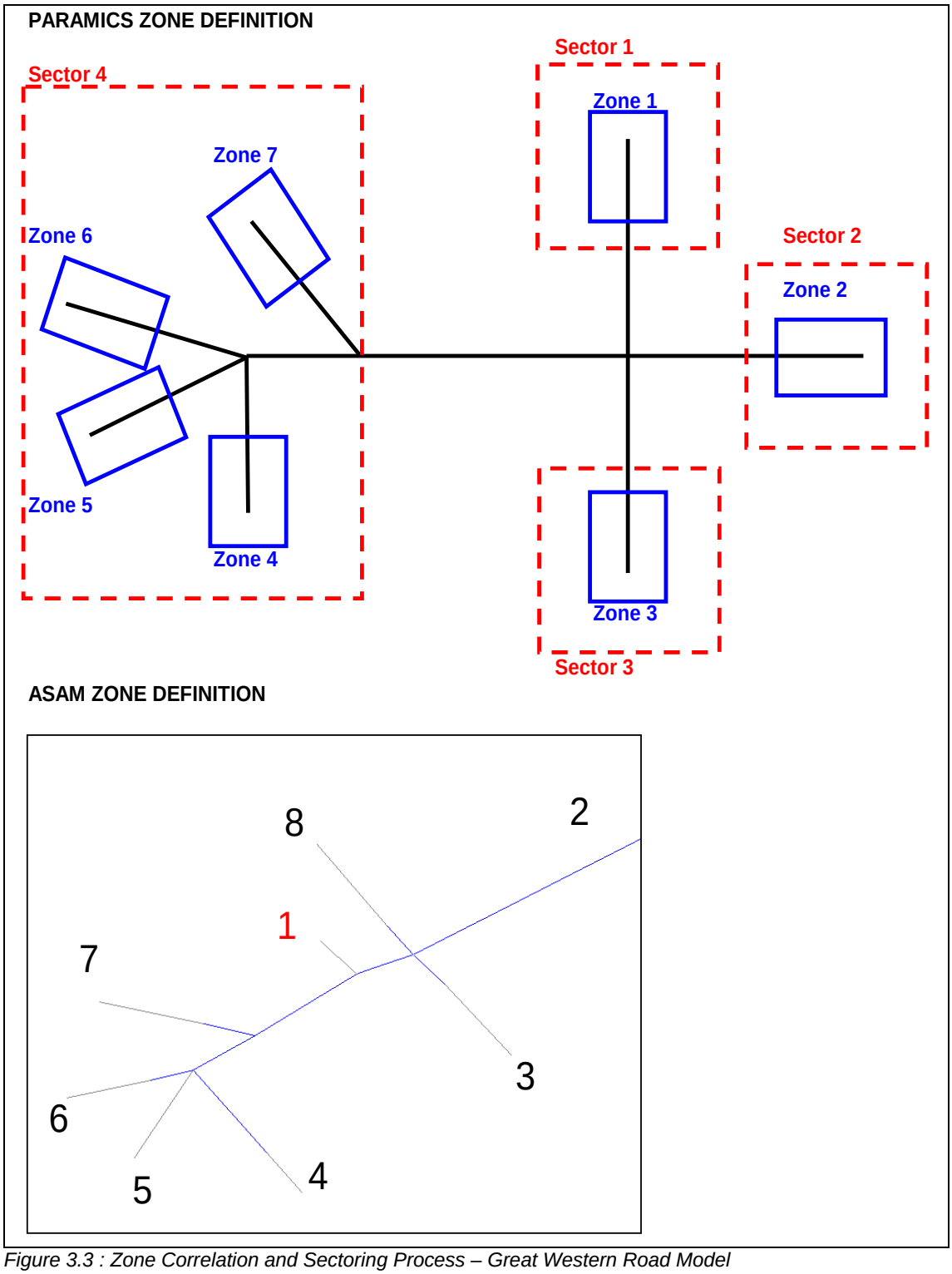


Figure 3.3 : Zone Correlation and Sectoring Process – Great Western Road Model

Table 3.4 : Zone Correlation – Great Western Road Model

ASAM Zone	Detail	Paramics Zone	Sector
1	Internal Zone (not used)	-	-
2	Great Western Rd	2	2
3	South Anderson Drive	3	3
4	Cranford Rd	4	4
5	Great Western Rd / North Deeside Rd	5	4
6	Craigton Rd	6	4
7	Countesswells Rd	7	4
8	North Anderson Drive	1	1

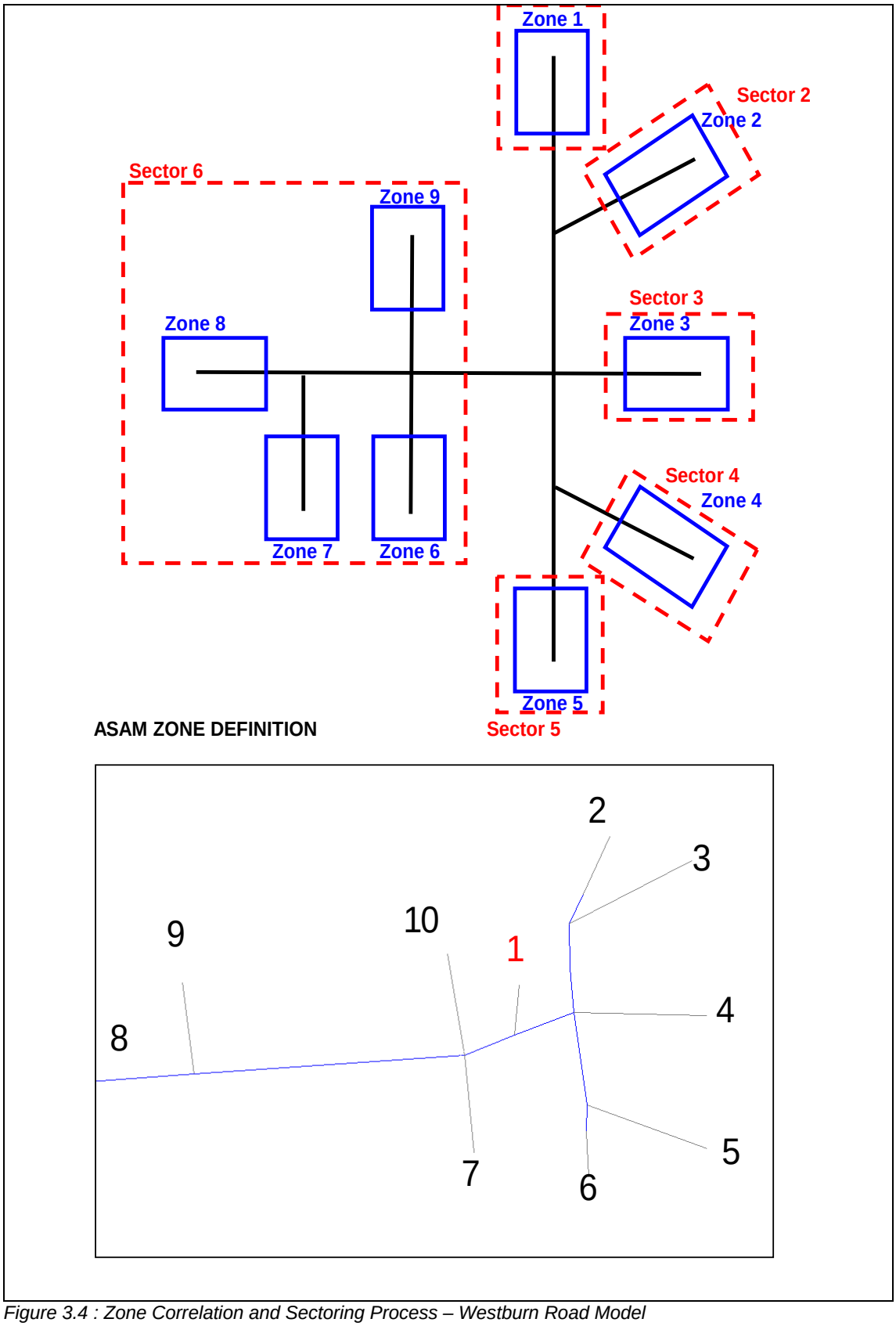


Figure 3.4 : Zone Correlation and Sectoring Process – Westburn Road Model

Table 3.5 : Zone Correlation – Westburn Road Model

ASAM Zone	Detail	Paramics Zone	Sector
1	Internal Zone (not used)	-	-
2	North Anderson Drive	1	1
3	Ashgrove Rd West	2	2
4	Westburn Rd	3	3
5	Midstocket Rd	4	4
6	North Anderson Drive	5	5
7	Summerhill Rd	6	6
8	A944 / Lang Stracht	8	6
9	Fernhill Drive	-	6
10	Mastrick Drive	9	6

3.7 ASAM4/S-Paramics Correlation Checks

In order to check that the 2016 S-Paramics models reflect the traffic flow changes observed in the ASAM4 matrices, an assessment of the strategic flow differences between the S-Paramics Base Models and the S-Paramics 2016 Ref Case Models was undertaken.

Table 3.6 and 3.7 show the summarised flow difference plots for both the S-Paramics models and the ASAM4 models.

Table 3.6 shows the flows for the Great Western Road model and Table 37 shows the results for the Westburn Road model.

Table 3.6 : Great Western Road Model - Correlation Checks Between ASAM4 and S-Paramics Matrices

Peak	Junction Arm	Dir	Paramics Base 2010 (vehicles per hr)	Paramics 2016 Test Case (vehicles per hr)	Difference (vehicles per hr)	ASAM Difference (2016 - 2010) (vehicles per hr)
AM						
	Anderson Drive	SB	1,010	826	-184	-181
	Anderson Drive	NB	1,216	926	-290	-302
	Great Western Rd	WB	276	296	20	25
	Great Western Rd	EB	424	478	54	74
PM						
	Anderson Drive	SB	1,464	1,142	-322	-254
	Anderson Drive	NB	994	814	-180	-180
	Great Western Rd	WB	390	510	120	101
	Great Western Rd	EB	284	284	0	-9

Table 3.7 : Westburn Road Model - Correlation Checks Between ASAM4 and S-Paramics Matrices

Peak	Junction Arm	Dir	Paramics Base 2010 (vehicles per hr)	Paramics 2016 Test Case (vehicles per hr)	Difference (vehicles per hr)	ASAM Difference (2016 - 2010) (vehicles per hr)
AM						
	Anderson Drive	SB	1,286	998	-288	-346
	Anderson Drive	NB	1,436	1,116	-320	-398
	Westburn Rd	WB	382	382	0	-5
	Lang Stracht	EB	934	908	-26	-16
PM						
	Anderson Drive	SB	1,304	744	-560	-529
	Anderson Drive	NB	1,238	918	-320	-286
	Westburn Rd	WB	804	818	14	-16
	Lang Stracht	EB	748	684	-64	-56

The tables show that the S-Paramics 2016 Test Case models show a similar change in traffic flows (2016 – 2010) compared to the ASAM4 traffic flow changes (2016 – 2010).

The lower north/south traffic flows on Anderson Drive under the 2016 Test Case scenario should allow improvements to be made to the east/west signal timings and thus queueing and delay. The testing of these potential benefits is detailed in the following sections.

4 2016 OPTION TESTING METHODOLOGY

4.1 Introduction

The objective of the model option testing is to assess the level of benefit that can be attained at the two signalised junctions on Anderson Drive for traffic routeing in the eastbound and westbound directions without significant detriment to the north/south movements.

The methodology proposed and agreed with ACC to assess any benefits that can be achieved for the eastbound and westbound routeing traffic was to firstly carry out a TRANSYT assessment of the junction signal timings, based upon the predicted 2016 flows. This gives the optimum signal timings and offsets for the junctions and provides an initial point at which to carry out incremental testing.

Following the TRANSYT derived Test 1 scenario in which the signal timings and offsets for the junctions are derived from a TRANSYT assessment, an incremental testing process was undertaken which amended the signal timings in small increments to give more green time to the east/west routeing traffic and less green time to the north/south routeing traffic. This process was carried out until the traffic queueing and delay to the north and southbound traffic on Anderson Drive reaches a point which is no worse than that which occurs in the 2010 Base model scenario, i.e. there is no net detriment to the Anderson Drive traffic and all potential benefit is provided to the east and westbound routeing traffic.

4.2 Pedestrian Crossing Improvements

ACC has requested that, for the Westburn Road/Anderson Drive Junction, the primary consideration for this junction would be the introduction of pedestrian crossing facilities, as there is currently no controlled crossing facilities at this location. If any additional capacity is available at the junction, then the remaining benefit should be given to the east/west signal green time.

In the first instance, a pedestrian crossing stage was considered as part of the signal staging. The results of which are provided in Section 6. A walk-with signal staging consideration was also considered and the results of which are provided in Section 7.

4.3 TRANSYT Assessment

TRANSYT decks were built for both the Westburn Road model junctions and the Great Western Road model. The modelled traffic flows were applied to the TRANSYT decks and the optimised signal timings and offsets were applied in the model and run.

The results of the TRANSYT derived signal timing models are provided in the following chapters as TEST 1 (TRANSYT)

It should be noted that, given the traffic flows in the model are predominantly in the north/south direction, even when considering the effect of the 30% green time reduction, the TRANSYT signal timing outputs were predominantly geared towards catering for the Anderson Drive traffic. A significant shift in green time was therefore required in all subsequent tests to shift the balance away from this to the east west movements

4.4 Signal Phasing Incremental Testing

Figure 4.1 shows the signal phasing applied in the option testing for the Westburn Road model and the Great Western Road Model. As noted in Section 4.2, the only difference between the signal phasing in the 2016 Test Case model compared to the 2010 Base models is the introduction of a pedestrian phase in the Westburn Road/Anderson Drive junction.

In line with the other signalised junctions in this model, the pedestrian crossing stage was called every second cycle.

Table 4.1 shows the signal green time applied to the models for each of the incremental tests undertaken in the AM Peak Period. Table 4.2 shows the signal green times applied in the PM Peak Period

In general, the signal timing changes were incrementally adjusted by 5s from the north/south phases to the east/west phases. Each test result was assessed against modelled queue levels and adjusted accordingly to meet the criteria of no net detriment to the Anderson Drive queue levels.

The models queue levels were very sensitive to changes in the signal timings and care had to be given to replicate representative queue and delay levels that were observed in the 2010 Base model conditions. As will be seen in the subsequent chapters, the model test scenario which most closely meets the objective of the testing process was not necessarily the final test undertaken, as some test scenarios resulted in a significant net detriment to the queue and delay levels on Anderson Drive.

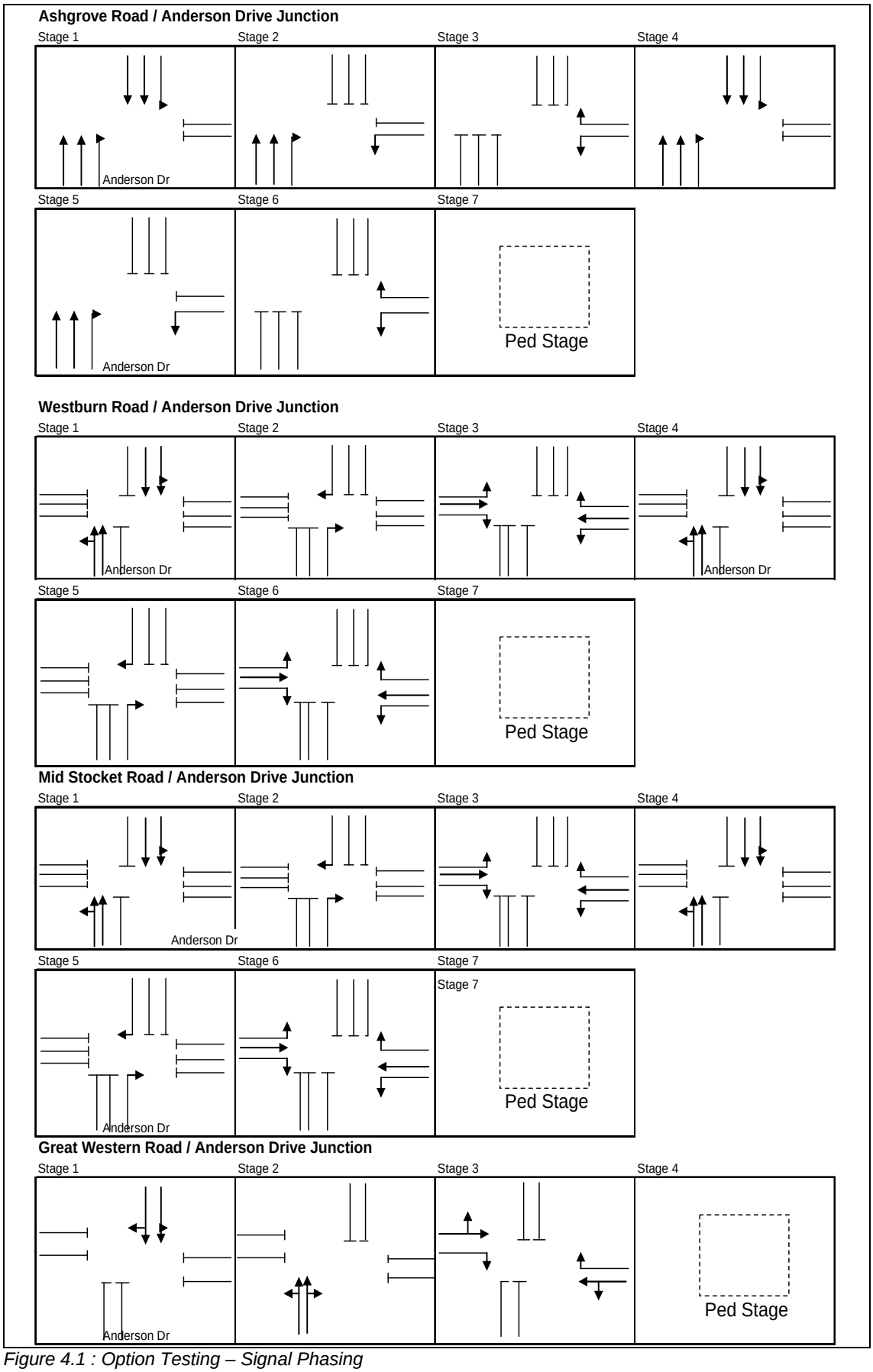


Figure 4.1 : Option Testing – Signal Phasing

Table 4.1 : Incremental Testing – Signal Green time AM Peak

	Signal Greentime							
Test	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**	**Stage 7**	**Cycle**
Ashgrove Road / Anderson Drive Junction								
Base	78	12	26	79	12	26	9	288
(TRANSYT)	88	19	13	81	9	23	9	288
TEST 2	83	19	18	76	9	28	9	288
TEST 3	78	19	23	71	9	33	9	288
TEST4	68	19	33	61	9	43	9	288
TEST5	66	19	35	59	9	45	9	288
Westburn Road / Anderson Drive Junction								
Base	50	28	48	-	-	-	-	144
(TRANSYT)	78	14	58	36	17	25	10	288
TEST 2	73	14	63	31	17	30	10	288
TEST 3	68	14	68	26	17	35	10	288
TEST4	58	14	78	21	12	45	10	288
TEST5	56	13	81	21	11	46	10	288
Mid Stocket Road / Anderson Drive Junction								
Base	82	9	25	82	9	25	17	288
(TRANSYT)	89	7	21	74	7	34	17	288
TEST 2	84	7	26	69	7	39	17	288
TEST 3	79	7	31	64	7	44	17	288
TEST4	69	7	41	54	7	54	17	288
TEST5	67	7	43	52	7	56	17	288
Great Western Road / Anderson Drive Junction								
Base	32	42	22	16	-	-	-	-
(TRANSYT)	33	36	30	16	-	-	-	-
TEST 2	28	31	40	16	-	-	-	-
TEST 3	23	26	50	16	-	-	-	-
TEST4	26	33	40	16	-	-	-	-
TEST5	27	31	41	16	-	-	-	-

Table 4.2 : Incremental Testing – Signal Green time PM Peak

	Signal Greentime							
Test	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**	**Stage 7**	**Cycle**
Ashgrove Road / Anderson Drive Junction								
Base	74	10	33	74	10	32	9	288
(TRANSYT)	53	56	45	53	8	10	17	288
TEST 2	48	56	50	48	8	15	17	288
TEST3	43	56	55	43	8	20	17	288
TEST4	33	56	65	33	8	30	17	288
TEST5	40	56	58	40	8	23	17	288
Westburn Road / Anderson Drive Junction								
Base	57	30	40	-	-	-	-	144
(TRANSYT)	67	12	62	34	17	36	10	288
TEST 2	62	12	67	29	17	41	10	288
TEST3	57	12	72	24	17	46	10	288
TEST4	47	12	82	19	12	56	10	288
TEST5	54	12	75	19	11	57	10	288
Mid Stocket Road / Anderson Drive Junction								
Base	86	9	22	84	9	22	17	288
(TRANSYT)	89	7	17	78	7	34	17	288
TEST 2	84	7	22	73	7	39	17	288
TEST3	79	7	27	68	7	44	17	288
TEST4	69	7	37	58	7	54	17	288
TEST5	69	7	37	58	7	54	17	288
Great Western Road / Anderson Drive Junction								
Base	39	32	25	14	-	-	-	-
(TRANSYT)	42	29	25	14	-	-	-	-
TEST 2	37	24	35	14	-	-	-	-
TEST3	32	19	45	14	-	-	-	-
TEST4	30	26	40	14	-	-	-	-
TEST5	31	25	40	14	-	-	-	-

5 GREAT WESTERN ROAD MODEL – OPTION TEST RESULTS

5.1 AM Peak Test Results

For the Great Western Road Model AM Peak testing, five incremental tests were undertaken with varying signal timings for each test scenario. The Test 1 scenario was based on the signal timings provided by the TRANSYT assessment and all subsequent tests were undertaken by incrementally adjusting the north/south signal green time to the east/west signal green time.

Table 5.1 provides a comprehensive summary of the five incremental tests undertaken. The table provides detail of the signal timings applied in each test, both in terms of the signal green time per cycle and signal green time per hour. In addition, the model statistical results for each test are also summarised. This includes the average journey time, both peak period and peak hour for the key movements of Anderson Drive (north model extent to south model extent and east model extent to west model extent). The average modelled queue length on each approach to the junction is also provided in the table.

The test scenario and result highlighted in yellow (Test 5) is the scenario which most closely meets the objectives of the study. The Test 5 scenario showed journey times and queue lengths on Anderson Drive that were closest to the Base Model levels.

The Test 5 scenario showed a significant improvement to the journey times for traffic routeing east and westbound through Great Western Road with an average 70 to 80s saving in the peak period and an average 110 to 135s saving in the peak hour. The average queue levels eastbound and westbound were also lower to a level (6 vehicles westbound, 11 vehicles eastbound) where they clear with the signal phasing.

Table 5.1 : Great Western Road Model – AM Peak Signal Timings & Test Results

Test Element	Location	Dir	Base	Test 1	Test 2	Test 3	Test 4	Test 5
Signal -Greentime per Cycle	Junction Arm		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	North Arm	SB	32	1	-4	-9	-6	-5
	South Arm	NB	42	-6	-11	-16	-9	-11
	East / West Arm	EB/WB	22	8	18	28	18	19
Signal -Greentime per Hour	Junction Arm		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	North Arm	SB	835	14	-115	-243	-166	-140
	South Arm	NB	1096	-170	-299	-427	-247	-299
	East / West Arm	EB/WB	574	198	455	712	455	480
Average Journey Time (Peak Period)	Route		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	Anderson Drive	SB	133	-26	-10	354	48	5
	Anderson Drive	NB	202	-89	25	310	-75	33
	Great Western Rd	WB	200	-61	-71	-80	-72	-71
	Great Western Rd	EB	210	-18	-80	-90	-79	-81
Average Journey Time (Peak Hour)	Route		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	Anderson Drive	SB	167	-58	-27	480	72	-2
	Anderson Drive	NB	365	-248	17	326	-215	32
	Great Western Rd	WB	248	-103	-113	-120	-120	-111
	Great Western Rd	EB	265	-24	-129	-145	-134	-135
Average Queue Length (Peak Period)	Route		**(v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	**Diff (v)**
	Anderson Drive	SB	19	-6	-4	22	3	-3
	Anderson Drive	NB	24	-12	-2	8	-10	-1
	Great Western Road	WB	9	-3	-3	-4	-3	-3
	Great Western Road	EB	15	2	-4	-5	-4	-4

Appendix A shows graphs of the queue levels throughout the modelled period for the four arms approaching the Great Western Road/Westburn Road junction. The graphs show the comparison between the Base model queue levels and the Test 5 2016 scenario queue levels.

Appendix A shows that the 2016 Test 5 queue levels on Anderson Drive are at a point very similar to the Base model queue levels. The graphs also show the reduction in queue levels that occurs on the eastbound and westbound corridors, particularly through the peak hour.

A further statistic that was extracted from the model test scenarios was the journey time for public transport through the network. Table 5.2 shows the average bus journey time for the four main bus services which route through the Great Western Road/Anderson Drive Junction.

Table 5.2 : Great Western Road Model – AM Peak Bus Journey Times

Bus Route	Base (s)	Test 5 (s)	Diff (s)
F16_E	245.2	237.2	-8.0
F16_W	254.0	229.2	-24.8
F19_E	254.4	237.2	-17.2
F19_W	235.7	225.4	-10.3

It can be seen from Table 5.2 that all the bus routes assessed at this junction route eastbound and westbound through Great Western Road. The bus average journey time results show varying benefits from 8s through to 25s from a base level of approximately just over 4min. Reliability would be benefitted through this corridor also as the east/west queue levels generally clear with the signal green time.

5.2 Great Western Road Model – PM Peak Option Test Results

For the Great Western Road Model PM Peak testing, five incremental tests were undertaken with varying signal timings for each test scenario. The Test 1 scenario was based on the signal timings provided by the TRANSYT assessment and all subsequent tests were undertaken by incrementally adjusting the north/south signal green time to the east/west signal green time.

Table 5.3 provides a comprehensive summary of the five incremental tests undertaken. The test scenario and results highlighted in yellow (Test 5) is the scenario which most closely meets the objectives of the study. The Test 5 scenario showed journey times and queue lengths on Anderson Drive that were closest to the Base model levels.

The Test 5 scenario showed an improvement to the journey times for traffic routeing east and particularly westbound through Great Western Road. The significant savings for traffic routeing westbound in the PM peak (75s in the peak period and 100s in the peak hour) were much higher then eastbound due to the much higher traffic flow and queue levels westbound in the PM Peak.

The average queue levels eastbound and westbound were also lower to a level (11 vehicles westbound, 6 vehicles eastbound) where they clear with the signal phasing.

Table 5.3 : Great Western Road Model – PM Peak Signal Timings & Test Results

Test Element	Location	Direction	Base	Test 1	Test 2	Test 3	Test 4	Test 5
Signal -Greentime per Cycle	Junction Arm		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	North Arm	SB	39	3	-2	-7	-9	-8
	South Arm	NB	32	-3	-8	-13	-6	-7
	East / West Arm	EB/WB	25	0	10	20	15	15
Signal -Greentime per Hour	Junction Arm		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	North Arm	SB	1064	82	-55	-191	-245	-218
	South Arm	NB	873	-82	-218	-355	-164	-191
	East / West Arm	EB/WB	682	0	273	545	409	409
Average Journey Time (Peak Period)	Route		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	Anderson Drive	SB	130	-36	-31	-14	46	7
	Anderson Drive	NB	167	-54	148	446	-37	-22
	Great Western Rd	WB	208	239	-62	-81	-74	-75
	Great Western Rd	EB	137	-3	-12	-21	-18	-17
Average Journey Time (Peak Hour)	Route		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	**Diff (s)**
	Anderson Drive	SB	182	-85	-79	-40	102	12
	Anderson Drive	NB	145	-31	375	714	-1	32
	Great Western Rd	WB	242	351	-87	-106	-98	-101
	Great Western Rd	EB	138	1	-8	-20	-15	-14
Average Queue Length (Peak Period)	Route		**(v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	**Diff (v)**
	Anderson Drive	SB	21	-10	-9	-6	3	-3
	Anderson Drive	NB	18	-7	7	13	-5	-4
	Great Western Road	WB	15	20	-3	-5	-4	-5
	Great Western Road	EB	8	-1	-2	-2	-2	-2

Appendix B shows graphs of the queue levels throughout the modelled period for the four arms approaching the Great Western Road/Westburn Road junction. The graphs show the comparison between the Base Model queue levels and the Test 5 2016 scenario queue levels.

Appendix B shows that the 2016 Test 5 queue levels on Anderson Drive are at a point similar to the Base model queue levels.

Appendix B also shows the reduction in queue levels that occurs on the eastbound and more particularly the westbound corridors through the PM peak period.

Table 5.4 shows the average bus journey time for the four main bus services which route through the Great Western Road/Anderson Drive Junction.

Table 5.4 : Great Western Road Model – PM Peak Bus Journey Times

Bus Route	Base (s)	Test 5 (s)	Diff (s)
F16_E	223.3	210.7	-12.6
F16_W	264.5	250.9	-13.5
F19_E	232.5	222.5	-10.0
F19_W	233.8	226.7	-7.0

It can be seen from Table 5.4 that the bus average journey time results show varying benefits from 7s through to 14s from a base level of approximately 4min. Reliability would be benefitted through this corridor also as the east/west queue levels generally clear with the signal green time.

6 WESTBURN ROAD MODEL – OPTION TESTING

6.1 AM Peak Test Results

For the Westburn Road Model AM Peak testing, five incremental tests were undertaken with varying signal timings for each test scenario. The Test 1 scenario was based upon the signal timings provided by the TRANSYT assessment and all subsequent tests were undertaken by incrementally adjusting the north/south signal green time to the east/west signal green time.

Table 6.1 provides a comprehensive summary of the five incremental tests undertaken. The table provides all the signal timing and output information for the three junctions assessed on Anderson Drive as included in this model scenario.

The test scenario and results highlighted in yellow (Test 4) is the scenario which most closely meets the objectives of the study. The Test 4 scenario showed journey times and queue lengths on Anderson Drive that were closest to the Base Model levels as the Test 5 results showed higher journey times on Anderson Drive northbound

The Test 4 scenario showed only a minor improvement to the journey times for traffic routeing east and westbound through Westburn Road with an average of 6 to 7s saving. This is also reflected in the average queue length statistics which show only a minor improvement to queue levels (Base Model queue levels are also low on east/west corridors).

It should be noted that all the test model scenarios include a pedestrian crossing phase which is not present in the Base Model scenario.

Table 6.1 : Westburn Road Model – AM Peak Signal Timings & Test Results

Test Element	Junction	Location	Direction	Base	Test 1	Test 2	Test 3	Test 4	Test 5
Signal -Greentime per Double Cycle		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	181	16	6	-4	-24	-28
		Anderson Drive	SB	157	12	2	-8	-28	-32
		Ashgrove Rd	WB-Lft Turn	76	-12	-2	8	28	32
		Ashgrove Rd	WB-Rt Turn	52	-16	-6	4	24	28
	J2 (Central)	Anderson Drive	NB/SB	100	14	4	-6	-21	-23
		Anderson Drive	NB/SB-Rt Turn	56	-25	-25	-25	-30	-32
		Westburn Rd	EB/WB	96	-13	-3	7	27	31
		Westburn Rd	EB/WB-Rt Turn	-	-	-	-	-	-
	J3 (South)	Anderson Drive	NB/SB	164	-1	-11	-21	-41	-45
		Anderson Drive	NB/SB-Rt Turn	18	-4	-4	-4	-4	-4
		Mid Stocket Road	WB	50	5	15	25	45	49
Signal -Greentime per Hour		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	2263	200	75	-50	-300	-350
		Anderson Drive	SB	1963	150	25	-100	-350	-400
		Ashgrove Rd	WB-Lft Turn	950	-150	-25	100	350	400
		Ashgrove Rd	WB-Rt Turn	650	-200	-75	50	300	350
	J2 (Central)	Anderson Drive	NB/SB	1250	175	50	-75	-263	-288
		Anderson Drive	NB/SB-Rt Turn	700	-313	-313	-313	-375	-400
		Westburn Rd	EB/WB	1200	-163	-38	88	338	388
		Westburn Rd	EB/WB-Rt Turn	-	-	-	-	-	-
	J3 (South)	Anderson Drive	NB/SB	2050	-13	-138	-263	-513	-563
		Anderson Drive	NB/SB-Rt Turn	225	-50	-50	-50	-50	-50
		Mid Stocket Road	WB	625	63	188	313	563	613
Average Journey Time (Peak Period)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	174	-57	-49	-36	9	24
		Anderson Drive	SB	159	-44	-38	-27	-3	0
		Westburn Rd	WB	200	12	7	4	-5	-6
		Lang Stracht	EB	185	12	7	1	-5	-7
Average Journey Time (Peak Hour)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	190	-70	-60	-44	17	44
		Anderson Drive	SB	180	-64	-55	-42	-20	-12
		Westburn Rd	WB	203	12	8	1	-3	-6
		Lang Stracht	EB	192	15	7	1	-6	-7
Average Queue Length Peak Period		**Route**		**(v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**
	J1 (North)	Anderson Drive	NB	10	-6	-6	-5	-4	-4
		Anderson Drive	SB	12	-5	-5	-4	-3	-3
		Ashgrove Rd	WB	4	1	0	0	0	-1
	J2 (Central)	Anderson Drive	NB	20	-12	-10	-9	-3	-2
		Anderson Drive	SB	17	-7	-6	-5	-4	-4
		Westburn Rd	WB	5	1	1	1	0	0
		Lang Stracht	EB	10	1	1	0	0	0
	J3 (South)	Anderson Drive	NB	11	-2	-2	-1	0	2
		Anderson Drive	SB	5	-1	-1	-1	-1	0
		Mid Stocket Road	WB	5	0	0	-1	-1	-1

Appendix B shows the queue levels throughout the modelled period for each of the approach arms to the three junctions in the Westburn Road model (Ashgrove Road/Anderson Drive, Westburn Road/Anderson Drive, Mid Stocket Road/Anderson Drive). The graphs show the comparison between the Base Model queue levels and the Test 4 2016 scenario queue levels.

Appendix B shows that the 2016 Test 4 queue levels on Anderson Drive and each of the arms leading into Anderson Drive are at a level similar to the Base Model queue levels.

Table 6.2 shows the average bus journey time for the 14 bus services which route through the Westburn Road/Anderson Drive Junction.

Table 6.2 : Westburn Road Model – AM Peak Bus Journey Times

Bus Route	Base (s)	Test 4 (s)	Diff (s)
F23_E	272	258	-14
F23_W	280	263	-17
F25_N	299	308	9
F25_S	243	291	49
F27_N	238	220	-18
F27_S	199	233	35
F40_E	283	282	-1
F40_W	253	253	0
SC10_E	105	97	-8
SC10_W	128	136	8
SC215_E	266	261	-5
SC215_W	257	291	34
SC305_E	137	95	-42
SC305_W	136	134	-2

The results from Table 6.2 show that the average bus journey time changes on the east and westbound corridors varies from 8s longer to 42s quicker, depending upon the service. There are also some journey time increases for buses routeing on Anderson Drive, with changes varying from a saving of 18s to a loss of 49s. These results are somewhat complicated by the varying bus routes that occur through this model. Some buses route partially through Anderson Drive and partially along an east/west corridor.

To summarise the varied bus journey time results, the data suggests that there is no significant overall improvement to the bus journey times in the 2016 Test Case Scenario compared to the 2010 Base model.

6.2 PM Peak Test Results

For the Westburn Road Model PM Peak testing, five incremental tests were undertaken with varying signal timings for each test scenario. The Test 1 scenario was based upon the signal timings provided by the TRANSYT assessment and all subsequent tests were undertaken by incrementally adjusting the north/south signal green time to the east/west signal green time.

Table 6.1 provides a comprehensive summary of the five incremental tests undertaken. The table provides all the signal timing and output information for the three junctions assessed on Anderson Drive as included in this model scenario.

The test scenario and results highlighted in yellow (Test 3) is the scenario which most closely meets the objectives of the study. The Test 3 scenario showed journey times and queue lengths on Anderson Drive that were closest to the Base model levels. The Test 4 and 5 results showed much higher journey times on Anderson Drive northbound

The Test 3 scenario showed an improvement to the journey times for traffic routeing east and westbound through Westburn Road and Lang Stracht. The savings for traffic routeing westbound in the PM peak (73s in the peak period and 110s in the peak hour) and also eastbound in the PM Peak (21s in the peak period and 36s in the peak hour) are better than those observed in the AM Peak.

The average queue level improvements varied across the model, with the most significant queue length improvement on Westburn Road westbound, with an average 8 vehicles queueing less than the Base Model level of 18 vehicles.

Appendix D shows the queue levels throughout the modelled period for each of the approach arms to the three junctions in the Westburn Road Model (Ashgrove Road/Anderson Drive, Westburn Road/Anderson Drive, Mid Stocket Road/Anderson Drive). The graphs show the comparison between the Base model queue levels and the Test 3 2016 scenario queue levels.

Appendix D shows that the 2016 Test 3 PM Peak queue levels are generally lower than that of the Base Model. Of particular note are the significantly lower queue levels on Westburn Road westbound throughout the PM Peak Period.

Table 6.3 : Westburn Road Model – PM Peak Signal Timings & Test Results

Test Element	Junction	Location	Direction	Base	Test 1	Test 2	Test 3	Test 4	Test 5
Signal -Greentime per Double Cycle		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	168	2	-8	-18	-38	-24
		Anderson Drive	SB	148	-42	-52	-62	-82	-68
		Ashgrove Rd	WB-Lft Turn	85	34	44	54	74	60
		Ashgrove Rd	WB-Rt Turn	65	-10	0	10	30	16
	J2 (Central)	Anderson Drive	NB/SB	114	-13	-23	-33	-48	-41
		Anderson Drive	NB/SB-Rt Turn	60	-31	-31	-31	-36	-37
		Westburn Rd	EB/WB	80	18	28	38	58	52
		Westburn Rd	EB/WB-Rt Turn	-	-	-	-	-	-
	J3 (South)	Anderson Drive	NB/SB	170	-3	-13	-23	-43	-43
		Anderson Drive	NB/SB-Rt Turn	18	-4	-4	-4	-4	-4
		Mid Stocket Road	WB	44	7	17	27	47	47
Signal -Greentime per Hour		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	2100	25	-100	-225	-475	-300
		Anderson Drive	SB	1850	-525	-650	-775	-1025	-850
		Ashgrove Rd	WB-Lft Turn	1063	425	550	675	925	750
		Ashgrove Rd	WB-Rt Turn	813	-125	0	125	375	200
	J2 (Central)	Anderson Drive	NB/SB	1425	-163	-288	-413	-600	-513
		Anderson Drive	NB/SB-Rt Turn	750	-388	-388	-388	-450	-463
		Westburn Rd	EB/WB	1000	225	350	475	725	650
		Westburn Rd	EB/WB-Rt Turn	-	-	-	-	-	-
	J3 (South)	Anderson Drive	NB/SB	2125	-38	-163	-288	-538	-538
		Anderson Drive	NB/SB-Rt Turn	225	-50	-50	-50	-50	-50
		Mid Stocket Road	WB	550	88	213	338	588	588
Average Journey Time (Peak Period)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	146	-15	-4	19	97	57
		Anderson Drive	SB	181	-31	-24	-20	-8	-15
		Westburn Rd	WB	273	-67	-69	-73	-80	-77
		Lang Stracht	EB	197	-14	-17	-21	-26	-24
Average Journey Time (Peak Hour)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	144	-14	-1	19	103	58
		Anderson Drive	SB	193	-41	-32	-29	-18	-23
		Westburn Rd	WB	311	-101	-103	-110	-118	-112
		Lang Stracht	EB	215	-30	-33	-36	-43	-40
Average Queue Length Peak Period		**Route**		**(v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**
	J1 (North)	Anderson Drive	NB	11	-3	-4	-4	2	-1
		Anderson Drive	SB	12	-5	-5	-5	-4	-4
		Ashgrove Rd	WB	7	-1	-1	-2	-2	-2
	J2 (Central)	Anderson Drive	NB	15	-6	-4	-2	4	2
		Anderson Drive	SB	17	-8	-8	-7	-6	-6
		Westburn Rd	WB	18	-8	-7	-8	-9	-8
		Lang Stracht	EB	10	-1	-1	-2	-2	-2
	J3 (South)	Anderson Drive	NB	9	-1	-1	0	1	1
		Anderson Drive	SB	11	-5	-4	-5	-5	-5
		Mid Stocket Road	WB	8	-1	-2	-2	-2	-2

Table 6.4 shows the average bus journey time for the fourteen bus services which route through the Westburn Road/Anderson Drive Junction.

Table 6.4 : Westburn Road Model – PM Peak Bus Journey Times

Bus Route	Base (s)	Test 5 (s)	Diff (s)
F23_E	277	247	-31
F23_W	337	258	-79
F25_N	235	328	93
F25_S	246	203	-43
F27_N	207	292	85
F27_S	259	176	-83
F40_E	282	255	-27
F40_W	346	250	-96
SC10_E	108	99	-9
SC10_W	192	148	-44
SC215_E	282	271	-11
SC215_W	375	245	-130
SC305_E	126	118	-9
SC305_W	197	154	-43

The results from Table 6.4 show that the average bus journey time saving on the east/west corridors varies from 9 to 130s. There are also some journey time increases for buses routeing on Anderson Drive, with changes varying from a saving of 83s to a loss of 93s. As per the AM peak results, these results are somewhat complicated by the varying bus routes that occur through this model. Some buses route partially through Anderson Drive and partially along an east/west corridor.

To summarise the varied bus journey time results, the data suggests that there is some overall improvement to the bus journey times in the 2016 Test Case Scenario compared to the 2010 Base model. The journey time changes for each individual bus service will vary depending on the route these services take.

6.3 Implications of Pedestrian Crossing Provision

The above test results have shown that the benefits accrued from the signal timing changes were primarily given to the introduction of a pedestrian crossing signal stage at the Westburn Road/Anderson Drive junction. Some journey time savings were also made in the predominant westbound routeing queues and delays in the PM peak period.

The existing crossing facilities at Westburn Road consist of drop kerbs on three arms of the junction (not Lang Stracht). The nearest controlled crossing points are over 100m away in any direction.

The introduction of a pedestrian phase at this junction provides a significant road safety improvement for pedestrians crossing any arm of this junction.

7 WESTBURN ROAD MODEL – WALK-WITH JUNCTION OPTION TESTING

7.1 Introduction

ACC have requested that, for the Westburn Road/Anderson Drive Junction, the primary consideration for this junction would be the introduction of pedestrian crossing facilities, as there are currently no controlled crossing facilities at this location. If any additional capacity is available at the junction, then the remaining benefit should be given to the east/west signal green time.

As noted in Section 4.2, a pedestrian crossing stage was firstly considered as part of the signal staging. The results of which are provided in Section 6. The results suggest that benefits accrued from the reduction in north/southbound traffic would be the introduction of an all-round pedestrian phase at the Westburn Road/Anderson Drive junction. The model test results suggested that journey time and queue length savings could also be made for traffic routeing east and west across this junction, but only in the PM Peak.

From these results, a walk-with signal staging scenario was also considered at the Westburn Road/Anderson Drive junction.

A walk-with junction scenario would require a central reserve on all arms of the Westburn Road/Anderson Drive junction. There are currently drop kerb reserves on three arms of the junction (not Lang Stracht), but these would require to be widened to meet *DMRB* specifications for a fully signalised pedestrian reserve.

Figure 7.1 shows the general geometry of the junction with lane width and footway measurements. The figure shows that the existing road and lane widths do not allow much scope to be narrowed to allow widening of the central reserves. There may be scope to adjust the road and footway geometry at various locations around the junction (particularly on the north west and south west sides) to enable central reserves to be located on each arm of the junction. This would require a more detailed assessment of the junction geometry by the ACC design team.

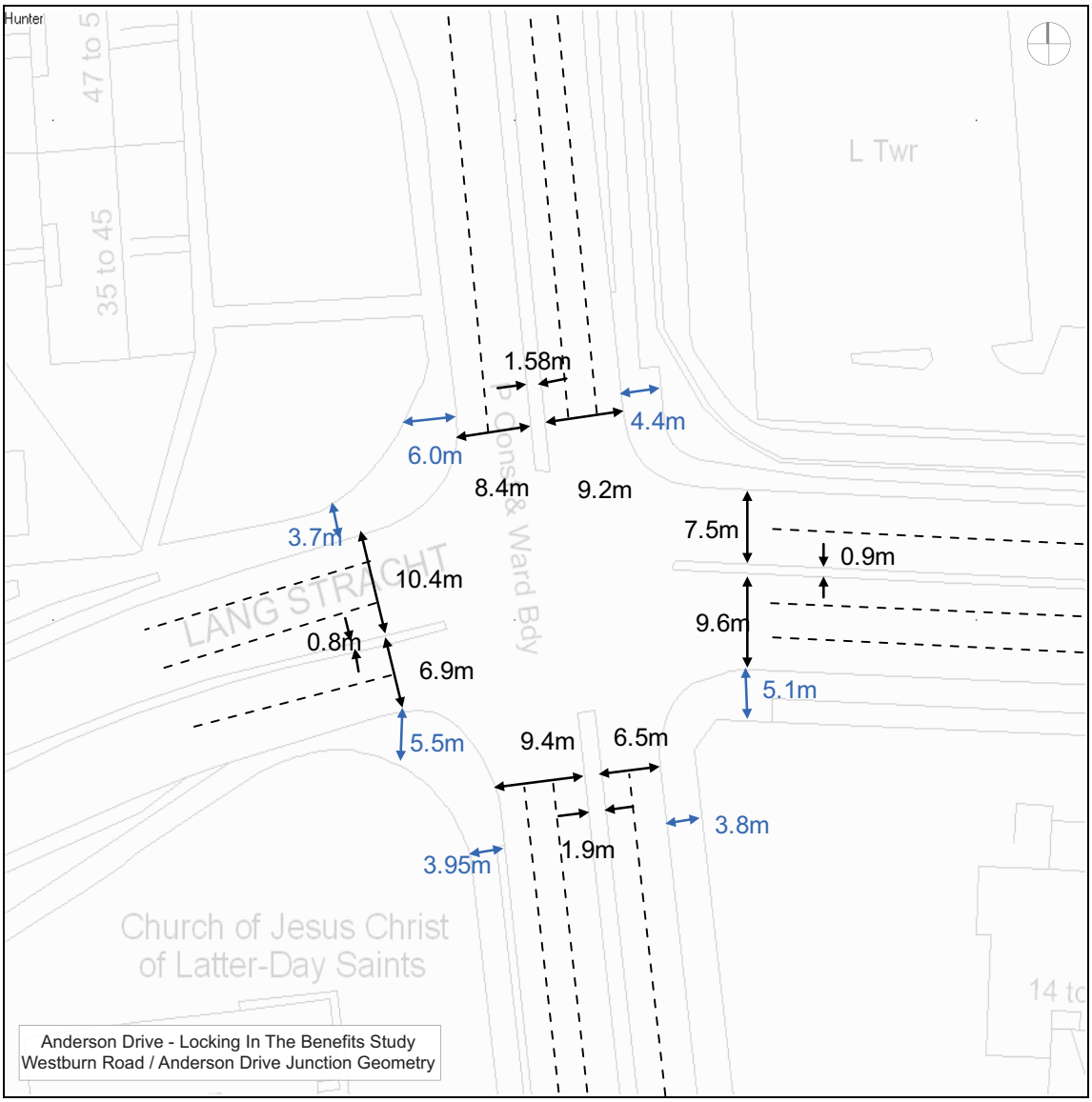
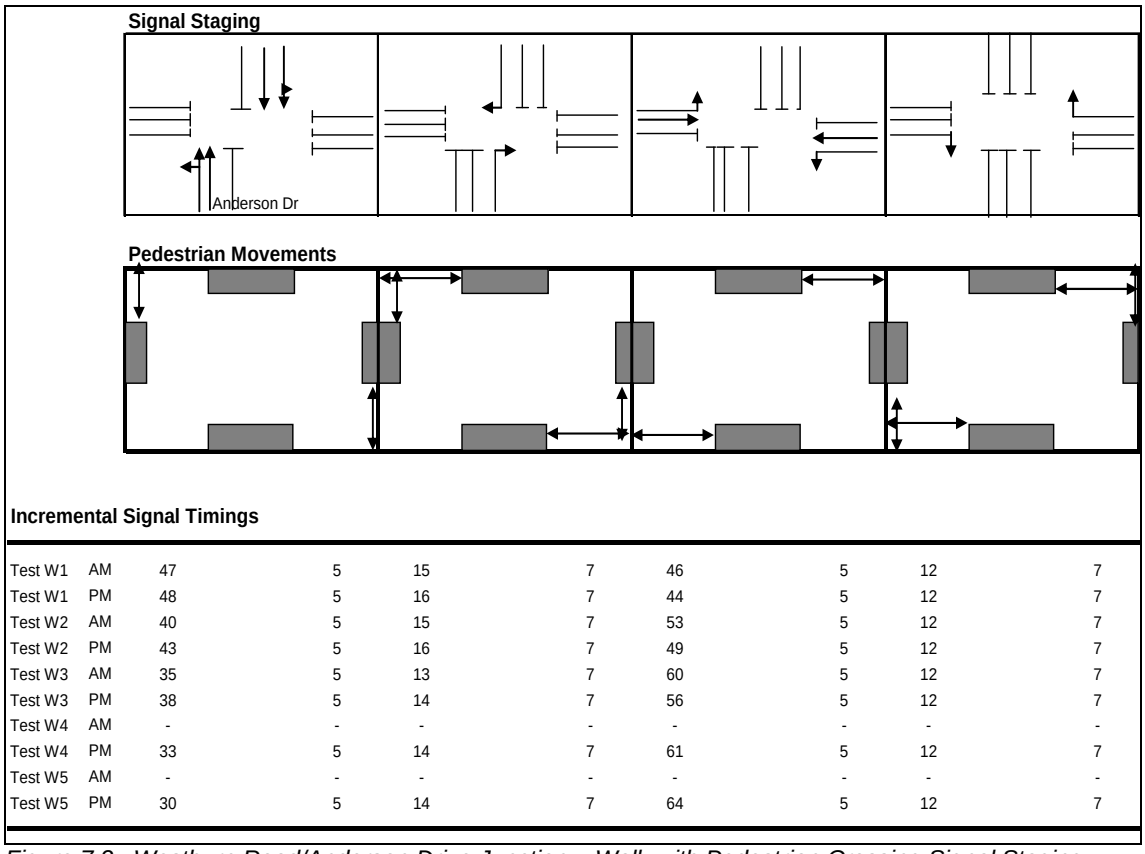


Figure 7.1 : Geometry of Westburn Road/Anderson Drive Junction

7.2 Walk-With Signal Staging

Figure 7.2 shows the signal staging which was applied in the model at the Westburn Road/Anderson Drive junction. The figure shows that a central reserve on all arms of the junction are required to allow a walk-with junction to operate. A right turn filter phase for traffic routeing east and westbound would require to be included in the signal staging to allow a full walk-with junction to operate.



Incremental Signal Timings

Test W1	AM	47	5	15	7	46	5	12	7
Test W1	PM	48	5	16	7	44	5	12	7
Test W2	AM	40	5	15	7	53	5	12	7
Test W2	PM	43	5	16	7	49	5	12	7
Test W3	AM	35	5	13	7	60	5	12	7
Test W3	PM	38	5	14	7	56	5	12	7
Test W4	AM	-	-	-	-	-	-	-	-
Test W4	PM	33	5	14	7	61	5	12	7
Test W5	AM	-	-	-	-	-	-	-	-
Test W5	PM	30	5	14	7	64	5	12	7

Figure 7.2 : Westburn Road/Anderson Drive Junction – Walk-with Pedestrian Crossing Signal Staging

7.3 AM Peak Test Results

For the Westburn Road Model (walk-with junction scenario) AM Peak testing, three incremental tests were undertaken with varying signal timings for each test scenario. All tests were undertaken by incrementally adjusting the north/south signal green time to the east/west signal green time.

Table 7.1 provides a comprehensive summary of the three incremental tests undertaken. The table provides all the signal timing and output information for the three junctions assessed on Anderson Drive as included in this model scenario.

The test scenario and results highlighted in yellow (Test W3) is the scenario which most closely meets the objectives of the study.

The Test W3 scenario showed journey times and queue lengths on Anderson Drive that were closest to the Base Model levels. No further test scenarios were undertaken.

The Test W3 scenario showed only a minor improvement to the journey times for traffic routeing east and westbound through Westburn Road with an average of between 6 to 12s saving. This is also reflected in the average queue length statistics which show only a minor improvement to queue levels (Base Model queue levels are also low on east/west corridors).

These results are very similar to the all round pedestrian crossing test results except for the journey times and queue lengths on Anderson Drive, which are lower than the Base model and the all round pedestrian crossing scenario (Test 4).

Table 7.1 : Westburn Rd Model – (Walk-with) AM Pk Signal Timings & Test Results

Test Element	Junction	Location	Direction	Base	Test W1	Test W2	Test W3	Test W4	Test W5
Signal -Greentime per Double Cycle		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	181	-28	-32	-32	-	-
		Anderson Drive	SB	157	-32	-36	-36	-	-
		Ashgrove Rd	WB-Lft Turn	76	32	36	36	-	-
		Ashgrove Rd	WB-Rt Turn	52	28	32	32	-	-
	J2 (Central)	Anderson Drive	NB/SB	100	-6	-20	-30	-	-
		Anderson Drive	NB/SB-Rt Turn	56	-26	-26	-30	-	-
		Westburn Rd	EB/WB	96	-4	10	24	-	-
		Westburn Rd	EB/WB-Rt Turn	-	24	24	24	-	-
	J3 (South)	Anderson Drive	NB/SB	164	-45	-55	-55	-	-
		Anderson Drive	NB/SB-Rt Turn	18	-4	-4	-4	-	-
		Mid Stocket Road	WB	50	49	59	59	-	-
Signal -Greentime per Hour		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	2263	-350	-400	-400	-	-
		Anderson Drive	SB	1963	-400	-450	-450	-	-
		Ashgrove Rd	WB-Lft Turn	950	400	450	450	-	-
		Ashgrove Rd	WB-Rt Turn	650	350	400	400	-	-
	J2 (Central)	Anderson Drive	NB/SB	1250	-75	-250	-375	-	-
		Anderson Drive	NB/SB-Rt Turn	700	-325	-325	-375	-	-
		Westburn Rd	EB/WB	1200	-50	125	300	-	-
		Westburn Rd	EB/WB-Rt Turn	-	300	300	300	-	-
	J3 (South)	Anderson Drive	NB/SB	2050	-563	-688	-688	-	-
		Anderson Drive	NB/SB-Rt Turn	225	-50	-50	-50	-	-
		Mid Stocket Road	WB	625	613	738	738	-	-
Average Journey Time (Peak Period)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	174	-52	-35	-10	-	-
		Anderson Drive	SB	159	-36	-27	-28	-	-
		Westburn Rd	WB	200	2	-2	-8	-	-
		Lang Stracht	EB	185	1	-6	-10	-	-
Average Journey Time (Peak Hour)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	190	-63	-42	3	-	-
		Anderson Drive	SB	180	-50	-41	-39	-	-
		Westburn Rd	WB	203	4	-2	-6	-	-
		Lang Stracht	EB	192	2	-6	-12	-	-
Average Queue Length Peak Period		**Route**		**(v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* *(v)***
	J1 (North)	Anderson Drive	NB	10	-6	-6	-6	-	-
		Anderson Drive	SB	12	-3	-3	-2	-	-
		Ashgrove Rd	WB	4	0	0	0	-	-
	J2 (Central)	Anderson Drive	NB	20	-13	-11	-7	-	-
		Anderson Drive	SB	17	-9	-9	-8	-	-
		Westburn Rd	WB	5	0	0	0	-	-
		Lang Stracht	EB	10	0	-1	-1	-	-
	J3 (South)	Anderson Drive	NB	11	0	1	1	-	-
		Anderson Drive	SB	5	-2	-1	-3	-	-
		Mid Stocket Road	WB	5	-1	-1	-1	-	-

Appendix A shows the queue levels throughout the modelled period for each of the approach arms to the three junctions within the Westburn Road Model (Ashgrove Road/Anderson Drive, Westburn Road/Anderson Drive, Mid Stocket Road/Anderson Drive). The graphs show the comparison between the Base model queue levels, the Test 4 queue levels and the Test 3W 2016 scenario queue levels.

Appendix A shows that the 2016 Test 3W AM Peak queue levels are very similar to the 2016 Test 5 scenario except for some lower queue levels on Anderson Drive.

Table 7.2 shows the average bus journey time for the fourteen bus services which route through the Westburn Road/Anderson Drive Junction.

Table 7.2 : Westburn Rd Model – (Walk-with) AM Peak Bus Journey Times

Bus Route	Base (s)	Test W3 (s)	Diff (s)
F23_E	272	269	-3
F23_W	280	277	-4
F25_N	299	332	33
F25_S	243	268	25
F27_N	238	216	-21
F27_S	199	203	4
F40_E	283	275	-8
F40_W	253	242	-11
SC10_E	105	96	-9
SC10_W	128	131	3
SC215_E	266	246	-20
SC215_W	257	255	-2
SC305_E	137	98	-39
SC305_W	136	128	-8

The results from Table 7.2 show that the average bus journey time changes on the east and westbound corridors varies from an additional 3s to a saving of 39s, depending upon the service. There are also some journey time savings for buses routeing on Anderson Drive, with changes varying from a saving of 21s to a loss of 33s. These results show a slight improvement for the bus services routeing on Anderson Drive compared to the Test 5 results. A comparison of the walk-with (Test W3) and pedestrian stage (Test 5) scenarios is provided in Section 7.5.

7.4 PM Peak Test Results

For the Westburn Road Model (walk-with junction scenario) PM Peak testing, five incremental tests were undertaken with varying signal timings for each test scenario. All tests were undertaken by incrementally adjusting the north/south signal green time to the east/west signal green time.

Table 7.3 provides a comprehensive summary of the five incremental tests undertaken. The table provides all the signal timing and output information for the three junctions assessed on Anderson Drive as included in this model scenario.

The Test W1 scenario showed journey times and queue lengths on Anderson Drive that were closest to the Base model levels.

The Test W1 scenario showed an improvement to the journey times for traffic routeing east and westbound through Westburn Road and Lang Stracht. The savings for traffic routeing westbound in the PM peak (62s in the peak period and 102s in the peak hour) and also eastbound in the PM Peak (11s in the peak period and 29s in the peak hour) are better than those observed in the AM Peak, and very similar the PM peak results for Test 3 (all-round pedestrian scenario).

The average queue level improvements varied across the model, with the most significant queue length improvements on Westburn Road westbound, with an average 7 vehicles queueing less than the Base Model level of 18 vehicles, and on Anderson Drive northbound on approach to the Westburn Road junction, with an average 8 vehicles queueing less than the Base model level of 14 vehicles.

Appendix B shows the queue levels throughout the modelled period for each of the approach arms to the three junctions within the Westburn Road model (Ashgrove Road/Anderson Drive, Westburn Road/Anderson Drive, Mid Stocket Road/Anderson Drive). The graphs show the comparison between the Base model queue levels and the Test W1 2016 PM Peak scenario queue levels.

Appendix B shows that the 2016 Test W1 PM Peak queue levels are generally lower than that of the Base Model and similar to the results for Test 3 (all-round pedestrian scenario). Section 7.5 details a comparison between the 'walk-with' and 'all round' pedestrian crossing option tests.

Table 7.3 : Westburn Rd Model – (Walk-with) PM Pk Signal Timings & Test Results

Test Element	Junction	Location	Direction	Base	Test W1	Test W2	Test W3	Test W4	Test W5
Signal -Greentime per Double Cycle		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	168	-24	-42	-42	-24	-7
		Anderson Drive	SB	148	-68	-80	-80	-68	-58
		Ashgrove Rd	WB-Lft Turn	85	60	72	72	60	50
		Ashgrove Rd	WB-Rt Turn	65	16	34	34	16	-1
	J2 (Central)	Anderson Drive	NB/SB	114	-18	-28	-38	-48	-54
		Anderson Drive	NB/SB-Rt Turn	60	-28	-28	-32	-32	-32
		Westburn Rd	EB/WB	80	8	18	32	42	48
		Westburn Rd	EB/WB-Rt Turn	-	24	24	24	24	24
	J3 (South)	Anderson Drive	NB/SB	170	-43	-53	-53	-53	-53
		Anderson Drive	NB/SB-Rt Turn	18	-4	-4	-4	-4	-4
		Mid Stocket Road	WB	44	47	57	57	57	57
Signal -Greentime per Hour		**Junction Arm**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
	J1 (North)	Anderson Drive	NB	2100	-300	-525	-525	-300	-113
		Anderson Drive	SB	1850	-850	-1000	-1000	-850	-200
		Ashgrove Rd	WB-Lft Turn	1063	750	900	900	750	200
		Ashgrove Rd	WB-Rt Turn	813	200	425	425	200	113
	J2 (Central)	Anderson Drive	NB/SB	1425	-225	-350	-475	-600	-513
		Anderson Drive	NB/SB-Rt Turn	750	-350	-350	-400	-400	-13
		Westburn Rd	EB/WB	1000	100	225	400	525	375
		Westburn Rd	EB/WB-Rt Turn	-	300	300	300	300	300
	J3 (South)	Anderson Drive	NB/SB	2125	-538	-663	-663	-663	-625
		Anderson Drive	NB/SB-Rt Turn	225	-50	-50	-50	-50	0
		Mid Stocket Road	WB	550	588	713	713	713	625
Average Journey Time (Peak Period)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	146	26	32	41	43	39
		Anderson Drive	SB	181	1	2	3	-1	-6
		Westburn Rd	WB	273	-62	-68	-75	-79	-82
		Lang Stracht	EB	197	-11	-17	-20	-24	-26
Average Journey Time (Peak Hour)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	144	30	35	44	47	41
		Anderson Drive	SB	193	-10	-9	-4	-10	-15
		Westburn Rd	WB	311	-102	-107	-112	-116	-118
		Lang Stracht	EB	215	-29	-34	-37	-41	-42
Average Queue Length Peak Period		**Route**		**(v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff* (v)**	***Diff (v)***
	J1 (North)	Anderson Drive	NB	11	4	4	5	4	1
		Anderson Drive	SB	12	-4	-4	-4	-4	-5
		Ashgrove Rd	WB	7	-2	-2	-2	-2	-1
	J2 (Central)	Anderson Drive	NB	15	-8	-8	-6	-5	-3
		Anderson Drive	SB	17	-5	-4	-4	-4	-5
		Westburn Rd	WB	18	-7	-8	-9	-9	-10
		Lang Stracht	EB	10	-1	-2	-2	-2	-2
	J3 (South)	Anderson Drive	NB	9	1	2	1	1	1
		Anderson Drive	SB	11	-6	-6	-6	-6	-6
		Mid Stocket Road	WB	8	-2	-2	-3	-2	-2

Table 7.4 shows the average bus journey time for the fourteen bus services which route through the Westburn Road/Anderson Drive Junction.

Table 7.4 : Westburn Rd Model – (Walk-with) AM Peak Bus Journey Times

Bus Route	Base (s)	Test W1 (s)	Diff (s)
F23_E	277	282	4
F23_W	337	298	-39
F25_N	235	228	-7
F25_S	246	209	-37
F27_N	207	224	17
F27_S	259	254	-4
F40_E	282	287	5
F40_W	346	288	-58
SC10_E	108	103	-5
SC10_W	192	146	-46
SC215_E	282	287	6
SC215_W	375	266	-108
SC305_E	126	126	-1
SC305_W	197	149	-49

The results from Table 7.4 show that the average bus journey time changes on the east and westbound corridors varies from an additional 6s to a saving of 108s, depending upon the service. There are also some journey time savings for buses routeing on Anderson Drive, with changes varying from a saving of 37s to a loss of 17s. These results show a slight improvement for the bus services routeing on Anderson Drive compared to the Test 5 results. A comparison of the walk-with (Test W3) and pedestrian stage (Test 5) scenarios is provided in Section 7.5.

7.5 Comparison of Walk-with Option against All-Round Pedestrian Crossing Option for Westburn Road/Anderson Drive Junction

Table 7.5 details a comparison of model testing results between the Westburn Road model Test 4 (all-round pedestrian stage) and Test W3 (Walk-with pedestrian stage) for the AM Peak period.

Table 7.5 : Comparison between Walk-with and All-Round Pedestrian Crossing at Westburn Road/Anderson Drive – AM Peak

Test Element	Junction	Location	Dir	Base	All-Round Ped at Westburn Rd (Test 4)	Walk-With Ped at Westburn Rd (Test W3)
Average Journey Time (Peak Period)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	174	9	-10
		Anderson Drive	SB	159	-3	-28
		Westburn Rd	WB	200	-5	-8
		Lang Stracht	EB	185	-5	-10
Average Journey Time (Peak Hour)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	190	17	3
		Anderson Drive	SB	180	-20	-39
		Westburn Rd	WB	203	-3	-6
		Lang Stracht	EB	192	-6	-12
Average Queue Length Peak Period		**Route**		**(v)**	***Diff* (v)**	***Diff* (v)**
	J1 (North)	Anderson Drive	NB	10.0	-4.4	-6.0
		Anderson Drive	SB	11.9	-2.9	-2.4
		Ashgrove Rd	WB	3.6	-0.3	-0.5
	J2 (Central)	Anderson Drive	NB	20.1	-3.1	-7.2
		Anderson Drive	SB	16.9	-3.7	-8.2
		Westburn Rd	WB	4.7	0.1	-0.3
		Lang Stracht	EB	9.7	-0.1	-0.8
	J3 (South)	Anderson Drive	NB	11.4	0.3	1.0
		Anderson Drive	SB	5.5	-0.6	-2.8
		Mid Stocket Road	WB	5.5	-1.1	-1.1
Average Bus Journey Time (Peak Period)		Direction		**(s)**	***Diff* (s)**	***Diff* (s)**
		Northbound Buses	NB	269	-4	6
		Southbound Buses	SB	221	42	15
		Eastbound Buses	EB	212	-14	-16
		Westbound Buses	WB	211	5	-4

Table 7.5 shows that there is little difference between the two options with respect to the journey times and queue lengths on the east/west corridors.

The walk-with junction option appears to result in lower queueing and journey times than the all-round pedestrian option for traffic routeing on Anderson Drive, particularly through the middle section of the corridor on approach to the Westburn Road/Anderson Drive corridor.

Table 7.6 details a comparison of model testing results between the Westburn Road Model Test 4 (all-round pedestrian stage) and Test W3 (Walk-with pedestrian stage) for the PM Peak period.

Table 7.6 : Comparison between Walk-with and All-Round Pedestrian Crossing at Westburn Road/Anderson Drive – PM Peak

Test Element	Junction	Location	Dir	Base	All-Round Ped at Westburn Rd (Test 3)	Walk-With Ped at Westburn Rd (Test W1)
Average Journey Time (Peak Period)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	146	19	26
		Anderson Drive	SB	181	-20	1
		Westburn Rd	WB	273	-73	-62
		Lang Stracht	EB	197	-21	-11
Average Journey Time (Peak Hour)		**Route**		**(s)**	***Diff* (s)**	***Diff* (s)**
		Anderson Drive	NB	144	19	30
		Anderson Drive	SB	193	-29	-10
		Westburn Rd	WB	311	-110	-102
		Lang Stracht	EB	215	-36	-29
Average Queue Length Peak Period		**Route**		**(v)**	***Diff* (v)**	***Diff* (v)**
	J1 (North)	Anderson Drive	NB	10.7	-3.7	3.7
		Anderson Drive	SB	11.6	-4.6	-3.8
		Ashgrove Rd	WB	7.2	-1.5	-2.1
	J2 (Central)	Anderson Drive	NB	14.6	-1.7	-8.3
		Anderson Drive	SB	17.0	-7.1	-4.9
		Westburn Rd	WB	18.4	-7.8	-7.2
		Lang Stracht	EB	10.3	-1.8	-1.2
	J3 (South)	Anderson Drive	NB	8.7	-0.1	1.0
		Anderson Drive	SB	11.3	-4.9	-6.1
		Mid Stocket Road	WB	8.2	-1.9	-2.3
Average Bus Journey Time (Peak Period)		Direction		**(s)**	***Diff* (s)**	***Diff* (s)**
		Northbound Buses	NB	221	89	5
		Southbound Buses	SB	252	-63	-21
		Eastbound Buses	EB	215	-17	2
		Westbound Buses	WB	289	-78	-60

Table 7.6 shows that there is little difference between the two options with respect to the journey times and queue lengths on the east/west corridors. There are conflicting trends when comparing the statistics for the Anderson Drive corridor, but over all there is not a significant difference between the two options. The only significant difference is for the bus journey times on Anderson Drive are quicker for the walk-with option.

The results suggest that the introduction of a walk-with junction scenario at Westburn Road/Anderson Drive improves the queue lengths at this junction compared to an all-round pedestrian crossing scenario. However, when considering the Anderson Drive Corridor, through

Ashgrove Road, Westburn Road and Mid Stocket Road, the benefits of the walk-with junction at Westburn Road lose some of the benefit due to the all-round pedestrian crossing stages at the Ashgrove Road and Mid Stocket Road junctions.

8 ANDERSON DRIVE BUS LANE SENSITIVITY TESTING

8.1 Introduction

At the request of ACC, a further test scenario was required which involved the introduction of bus lanes in both directions on Anderson Drive. The bus lanes were coded into both the Westburn Road Model and the Great Western Road Model. The bus lanes were stopped 50m in advance of each junction stop line to allow all vehicle turning movements at the junctions.

8.2 Great Western Road Model

For the Great Western Road Model, an iterative process of signal timing changes were made based upon model observations of the traffic queue levels. The queue levels on Anderson Drive were significant with a large volume of traffic queueing off the extents of the model on Anderson Drive. Even when the signal timings were amended to a point where the east/west green time was at a level lower than the Base Model level, traffic was observed to queue off the network on all arms of the junction.

Table 8.1 shows the signal timings applied in the Great Western Road Model compared to the Base Model.

Table 8.1 : Great Western Road Model – Bus Test Signal Timings

	Signal Greentime				
Test	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Cycle**
AM Peak					
Base	32	42	22	16	138
2016 Bus Test	42	45	12	16	140
PM Peak					
Base	39	32	25	14	132
2016 Bus Test	47	34	15	14	132

Tables 8.2 and 8.3 show the number of vehicles queued off the model network on all four arms of the junction for the AM peak and PM peak periods.

Table 8.2 : AM Peak Great Western Road Model – Off Network Queues

Timeframe	Off Model Queuing			
	North Arm (v)	South Arm (v)	East Arm (v)	West Arm (v)
07:00	-	35	-	-
07:10	-	39	-	14
07:20	82	81	-	33
07:30	110	100	-	60
07:40	98	78	-	96
07:50	93	91	-	120
08:00	95	151	-	148
08:10	122	205	7	177
08:20	178	204	14	198
08:30	210	215	27	223
08:40	219	271	41	244
08:50	229	265	66	272
09:00	272	245	81	292
Approximate Max Queue Length in Model	65	65	65	65

Table 8.3 : PM Peak Great Western Road Model – Off Network Queues

Timeframe	Off Model Queuing			
	North Arm (v)	South Arm (v)	East Arm (v)	West Arm (v)
16:00	-	-	-	-
16:10	-	19	37	-
16:20	-	63	89	-
16:30	31	121	98	-
16:40	82	140	135	-
16:50	68	154	165	-
17:00	94	185	209	-
17:10	99	243	254	-
17:20	170	252	310	-
17:30	182	275	367	-
17:40	210	279	411	-
17:50	158	291	444	-
18:00	110	290	454	-
Approximate Max Queue Length in Model	65	65	65	65

Table 8.2 and 8.3 show that the inclusion of bus lanes on Anderson Drive in the Great Western Road model results in significant queueing on all arms of the junction with over 200 vehicles queueing off the model network on several arms of the junction.

These results suggest that there is insufficient capacity in the junction to cater for the proposed bus lanes on Anderson Drive under a 2016 Test Case scenario.

8.3 Westburn Road Model

For the Westburn Road Model, Table 8.4 shows the signal timings applied in the Great Western Road Model compared to the Base model.

Table 8.4 : Westburn Road Model – Bus Test Signal Timings

		Signal Greentime							
Peak	**Test**	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**	**Stage 7**	**Cycle**
AM	**Ashgrove Road / Anderson Drive Junction**								
	Base	74	10	33	74	10	32	9	288
	2016 Bus Test	53	56	45	53	8	10	17	288
AM	**Westburn Road / Anderson Drive Junction**								
	Base	57	30	40	-	-	-	-	144
	2016 Bus Test	54	16	38	12				144
AM	**Mid Stocket Road / Anderson Drive Junction**								
	Base	86	9	22	84	9	22	17	288
	2016 Bus Test	89	7	17	78	7	34	17	288
PM	**Ashgrove Road / Anderson Drive Junction**								
	Base	78	12	26	79	12	26	9	288
	2016 Bus Test	88	19	13	81	9	23	9	288
PM	**Westburn Road / Anderson Drive Junction**								
	Base	50	28	48	-	-	-	-	144
	2016 Bus Test	67	15	25	12	-	-	-	144
PM	**Mid Stocket Road / Anderson Drive Junction**								
	Base	82	9	25	82	9	25	17	288
	2016 Bus Test	89	7	21	74	7	34	17	288

Tables 8.5 and 8.6 show the number of vehicles queued off the model network on the four outer arms approaching the modelled junctions for the AM peak and PM peak periods.

Table 8.5 : AM Peak Westburn Road Model – Off Network Queues

Timeframe	Off Model Queuing			
	North Arm (v)	South Arm (v)	East Arm (v)	West Arm (v)
07:00	-	-	-	-
07:10	-	-	-	-
07:20	-	-	-	-
07:30	-	-	-	-
07:40	-	-	-	-
07:50	-	-	-	-
08:00	-	-	-	-
08:10	-	9	-	-
08:20	-	9	-	-
08:30	-	18	-	5
08:40	-	24	-	56
08:50	-	13	-	56
09:00	-	21	-	26
Approximate Max Queue Length in Model	75	75	100	100

Table 8.6 : PM Peak Westburn Road Model – Off Network Queues

Timeframe	Off Model Queuing			
	North Arm (v)	South Arm (v)	East Arm (v)	West Arm (v)
16:00	-	-	-	-
16:10	-	-	-	-
16:20	-	5	-	-
16:30	-	10	-	-
16:40	-	10	-	-
16:50	-	-	-	-
17:00	-	-	-	-
17:10	-	-	-	-
17:20	-	-	-	-
17:30	-	-	-	-
17:40	-	-	-	-
17:50	-	-	-	-
18:00	-	-	-	-
Approximate Max Queue Length in Model	75	75	100	100

Table 8.5 and 8.6 show that the inclusion of bus lanes on Anderson Drive within the Westburn Road model results in some queueing off the model network on the south and west outer arms of the junctions assessed.

These results are far less severe compared to the queue levels observed in the Great Western Road model.

To further assess the impact of the bus lanes on the Westburn Road model, Table 8.7 provides a summary for the average queue lengths on all junction arms in the model for the Base model, Initial Testing model, Walk-with Option Test model, and the Bus Test model.

Table 8.7 : Average Queue Length Summary – Westburn Road Model

Peak	Junction	Route	Dir.	BASE (v)	TEST 4 *Diff* (v)	TEST W3 *Diff* (v)	BUS TEST *Diff* (v)
AM Peak							
	J1 (North)	Anderson Drive	NB	10	-4	-6	-5
		Anderson Drive	SB	12	-3	-2	-2
		Ashgrove Rd	WB	4	0	0	1
	J2 (Central)	Anderson Drive	NB	20	-3	-7	-7
		Anderson Drive	SB	17	-4	-8	-7
		Westburn Rd	WB	5	0	0	3
		Lang Stracht	EB	10	0	-1	13
	J3 (South)	Anderson Drive	NB	11	0	1	7
		Anderson Drive	SB	5	-1	-3	0
		Mid Stocket Road	WB	5	-1	-1	0
		Total		**99**	**-16**	**-28**	**3**
PM Peak							
	J1 (North)	Anderson Drive	NB	11	-4	4	5
		Anderson Drive	SB	12	-5	-4	-3
		Ashgrove Rd	WB	7	-2	-2	1
	J2 (Central)	Anderson Drive	NB	15	-2	-8	1
		Anderson Drive	SB	17	-7	-5	-2
		Westburn Rd	WB	18	-8	-7	1
		Lang Stracht	EB	10	-2	-1	-1
	J3 (South)	Anderson Drive	NB	9	0	1	9
		Anderson Drive	SB	11	-5	-6	-3
		Mid Stocket Road	WB	8	-2	-2	0
		Total		**118**	**-35**	**-31**	**8**

Table 8.7 shows that, for the AM Peak, the queue levels on Anderson Drive NB and Lang Stracht eastbound are higher than the Base model, this ties in with the observations noted in Table 8.5.

Table 8.7 also shows that, for the PM peak, the queue levels on Anderson Drive NB are higher than the Base model, this ties in with the observations noted in Table 8.4.

It should be noted that the average queue lengths noted in Table 8.5 do not include the traffic that queues outwith the model area.

The figures for the total queueing levels show that the overall queueing in the bus test model is slightly higher than the Base model queue levels, even without the consideration of queueing outwith the model. The total average queue levels will be even higher than these figures compared to the Base model queue levels.

The results for the Westburn Road model suggest that there is capacity in the network to introduce bus lanes at the Westburn Road/Lang Stracht/Ashgrove Road corridor of Anderson Drive under a 2016 Test Case scenario, however, the traffic queue levels would be higher than the 2010 Base model on the north/south and east/west corridors.

9 SUMMARY AND CONCLUSIONS

9.1 Summary

SIAS Limited (SIAS) was commissioned by Aberdeen City Council (ACC) on behalf of Nestrans to undertake further testing of the Anderson Drive Base S-Paramics models.

The two sections of the Anderson Drive corridor that were modelled are:

- A944 Westburn Road
  Ashgrove Road West in the north to Mid Stocket Road in the south
- A93 Great Western Road
  St. Johns Terrace

The further testing follows on from a previous test programme undertaken - *Anderson Drive S-Paramics Model – Option Testing Report (SIAS Ref. 73817, 1 August 2011).*

9.1.1 ASAM Model Testing

A strategic testing methodology was derived by the study team which involved informing the ASAM4 2016 model of the potential signal timing restriction to the Anderson Drive corridor in a north-south direction. This was undertaken by testing a 30% shift in signal green time from the north-south phases to the east-west phases of the signal stages. This methodology allows the strategic model to inform the S-Paramics models on the strategic influence of both the AWPR and the proposed signalised junction changes on Anderson Drive.

Analysis of the ASAM model flows showed there is a migration of strategic traffic routeing from Anderson Drive to the AWPR and also towards the city centre area when the signalised junctions on Anderson Drive have reduced north/south green time. Local re-routeing also occurs to avoid traffic routeing through the signalised junctions in a north and southbound direction.

The influence of reducing the Anderson Drive north/south signal timings by 30% results in a migration of traffic from Anderson Drive in the ASAM models.

9.1.2 S-Paramics 2016 Test Scenario

No growth was applied to the S-Paramics Base (2007) Models to reflect a 2010 Base scenario. This is consistent with the development of the ASAM4 model from 2007 to 2010.

A sectoring process was applied to the ASAM4 matrices for the development of the S-Paramics 2016 Test Case. The sectoring process allows the absolute difference between the ASAM4 2010 Baseline and the ASAM4 2016 Test Case (30% reduction in N/S green time) to be applied to the calibrated junctions within the S-Paramics models.

9.1.3 S-Paramics 2016 Option Testing

The model testing methodology proposed and agreed with ACC to assess any benefits that can be achieved for the eastbound and westbound routeing traffic was to carry out an incremental testing process amending the signal timings in small increments to give more green time to the east/west routeing traffic and less green time to the north/south routeing traffic. This process was carried out until the traffic queueing and delay to the north and southbound traffic on

Anderson Drive reaches a point which is no worse than that which occurs in the 2010 Base model.

For the Westburn Road/Anderson Drive Junction, the primary consideration for this junction was the introduction of pedestrian crossing facilities, as there are currently no controlled crossing facilities at this location.

9.1.4 Model Test Results – Great Western Road Model

The model test scenario which most closely met the test criteria showed an improvement to the east/west routeing delay and queueing with approximately 60 to 120s lower journey times observed in the AM peak period. In the PM peak, the more predominant westbound traffic queues were considerably lower with a journey time saving of 75 to 100s.

The bus journey times were also improved with the increased east/west signal green times, with individual service journey time savings of 10 to 25s in the AM peak, and 10 to 15s in the PM Peak.

9.1.5 Model Test Results – Westburn Road Model

The model test scenario which most closely met the test criteria displayed only a minor improvement to the journey times for traffic routeing east and westbound through Westburn Road, with an average of 6 to 7s saving in the AM Peak. In the PM peak, the more predominant westbound traffic queues were considerably lower than the Base model with a journey time saving of 70 to 100s.

These test scenarios also included the additional provision of a pedestrian crossing phase at the Westburn Road/Anderson Drive junction. This provision is significant, as the existing crossing facilities at Westburn Road consist of drop kerbs on three arms of the junction (not Lang Stracht). The nearest controlled crossing points are over 100m away in any direction. The introduction of a pedestrian phase at this junction provides a significant road safety improvement for pedestrians crossing any arm of this junction.

The bus journey time assessment showed that some bus services had improved journey times and some had longer journey times depending on the route that each bus took. Overall, there was little improvement to the bus journey times in the AM peak with some improvement in the PM Peak.

9.1.6 Model Test Results – Westburn Road Model with walk-with pedestrian crossing at Westburn Road

A walk-with signal staging scenario was also considered at the Westburn Road/Anderson Drive junction. This scenario would require a central reserve on all arms of the Westburn Road/Anderson Drive junction. There are currently drop kerb reserves on three arms of the junction (not Lang Stracht), but these would require to be widened to meet *DMRB* specifications for a fully signalised pedestrian reserve

The results showed that there is little difference between the two options (all round pedestrian crossing vs. walk-with pedestrian crossing) with respect to the journey times and queue lengths on the east/west corridors. The walk-with junction option appeared to result in lower queueing and journey times for traffic routeing on Anderson Drive, particularly through the middle section of the corridor on approach to the Westburn Road/Anderson Drive corridor.

The results suggest that the introduction of a walk-with junction scenario at Westburn Road/Anderson Drive improves the queue lengths at this junction compared to an all-round pedestrian crossing scenario, however, when considering the Anderson Drive Corridor, through Ashgrove Road, Westburn Road and Mid Stocket Road, some of the benefits of the walk-with junction at Westburn Road are reduced due to the all-round pedestrian crossing stages at the Ashgrove Road and Mid Stocket Road junctions.

9.1.7 Model Test Results –Anderson Drive Bus Lane Sensitivity Testing

At the request of ACC, a further test scenario was required which involved the introduction of bus lanes in both directions on Anderson Drive. The bus lanes were coded into both the Westburn Road model and the Great Western Road model. The bus lanes were stopped 50m in advance of each junction stop line to allow all vehicle turning movements at the junctions.

For the Great Western Road model, the queue levels were significant with a large volume of traffic (100 – 450 vehicles) queueing off the extents of the model on several arms of the junction in both peak periods.

For the Westburn Road model, the results showed some queueing off the model network on the south and west outer arms of the junctions assessed (less than 60 vehicles). Further queue length assessment showed that the overall queueing in the bus test model is slightly higher than the Base model queue levels, even without the consideration of traffic queueing outwith the model extent.

The results for the Westburn Road model suggest that there is capacity in the network to introduce bus lanes at the Westburn Road/Lang Stracht/Ashgrove Road corridor of Anderson Drive under a 2016 Test Case scenario, however, the traffic queue levels would be higher than the 2010 Base Model on the north/south and east/west corridors.

9.2 Conclusions

The model testing showed that the combination of the AWPR plus the reduction of green time for north/south phasing at the signalised junctions on Anderson Drive, allowed varying benefits to the operation of these junctions.

For the Great Western Road model, the benefits accrued from the signal timing changes were given to traffic routeing eastbound and westbound through the junction, with significant queue and delay improvements in both peak periods.

For the Westburn Road model, the benefits accrued from the signal timing changes were primarily given to the introduction of a pedestrian crossing signal stage at the Westburn Road/Anderson Drive junction. Some journey time savings were also made in the predominant westbound routeing queues and delays in the PM peak period.

The alternative walk-with pedestrian crossing proposals, requiring infrastructure changes, provide slightly higher traffic capacity at the Westburn Road/Anderson Drive junction.

The introduction of bus lanes on Anderson Drive result in the Great Western Road junction operating over capacity with significant queueing and delay. The effect of the bus lanes at the Westburn Road junction is less severe but the resulting queueing and delay is higher than the Base Model conditions, so any benefit to buses routeing north south is to the detriment of buses routeing east/west, resulting in additional delay and is against the objectives of the study.

This modelling exercise has looked at the impact of the AWPR on the two signalised junctions on Anderson Drive in isolation. From the ASAM model outputs, it was observed that restricting the signal green time at these junctions for traffic routeing north and southbound results in traffic re-routeing away from the Anderson Drive corridor, not just to the AWPR, but also through alternative routes in the city.

A recommendation for further assessment of the Anderson Drive locking in the benefits study would be to consider the impact of the proposals from this study on the full Anderson Drive corridor, including all junctions and roundabouts. This would allow a robust assessment of the impact of the AWPR on the Anderson Drive corridor and provide an opportunity to assess the benefits and opportunities form the implementation of the AWPR on the full Anderson Drive corridor.

The optimum timings from the study could be now incorporated into the strategic ASAM model to assist in further development of a corridor strategy.

A GREAT WESTERN ROAD MODEL – AM PEAK QUEUE LENGTH GRAPHS

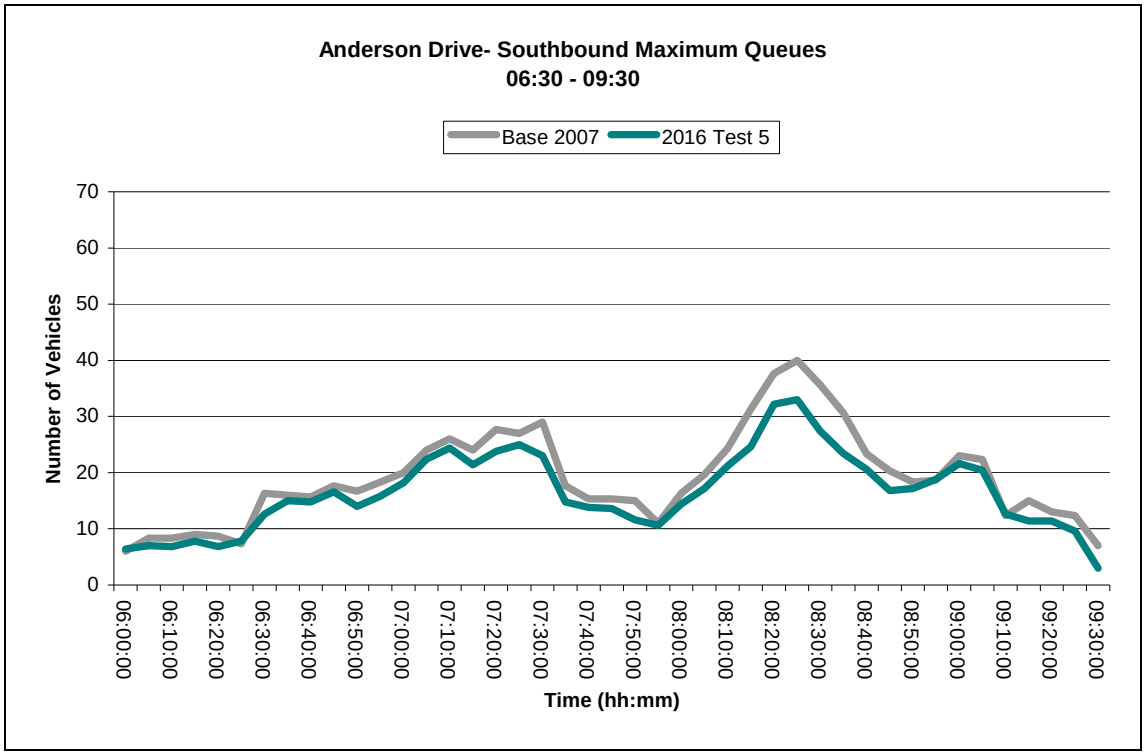


Figure A.1 : Anderson Drive – AM Peak Southbound, Maximum Queue levels

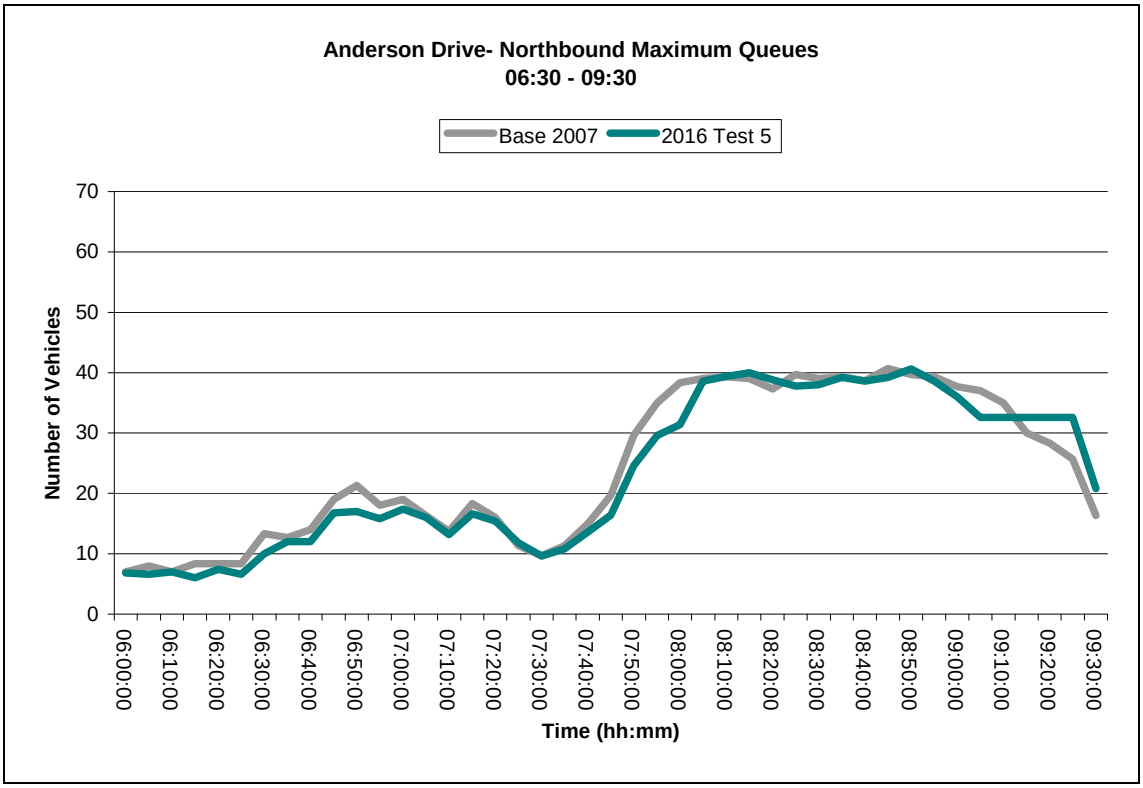


Figure A.2 : Anderson Drive – AM Peak Northbound, Maximum Queue levels

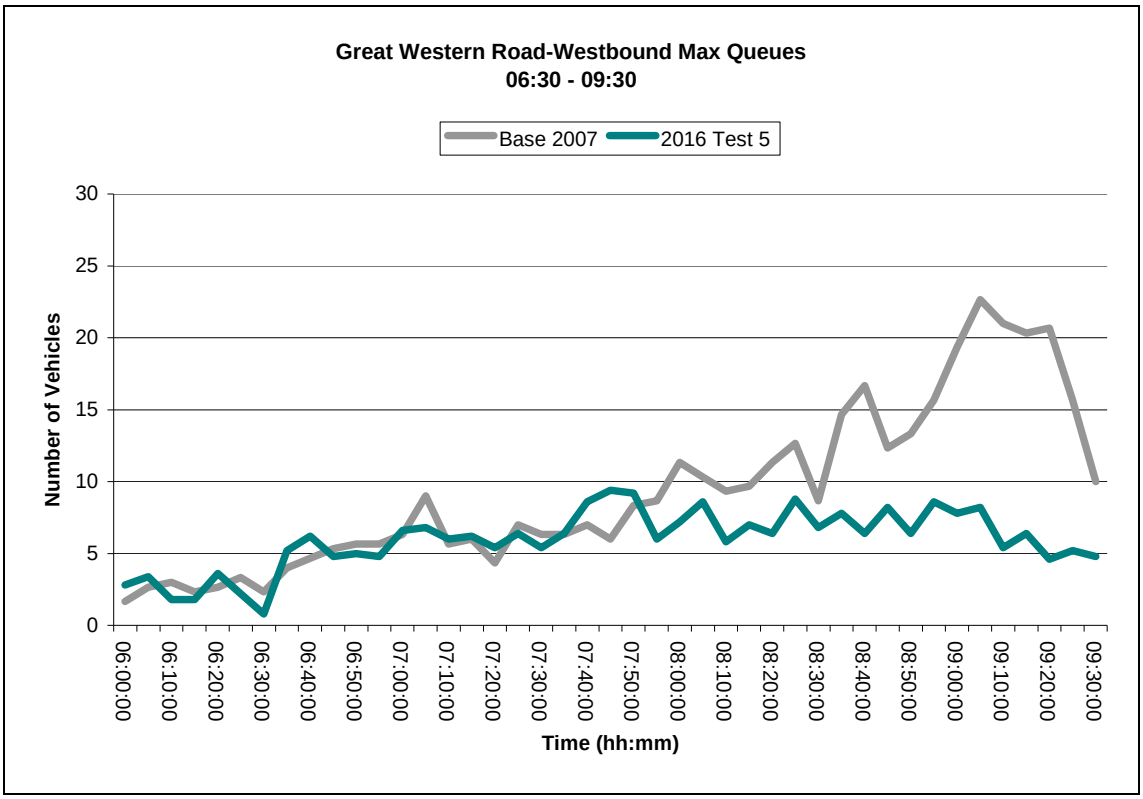


Figure A.3 : Great Western Road – AM Peak Westbound, Maximum Queue levels

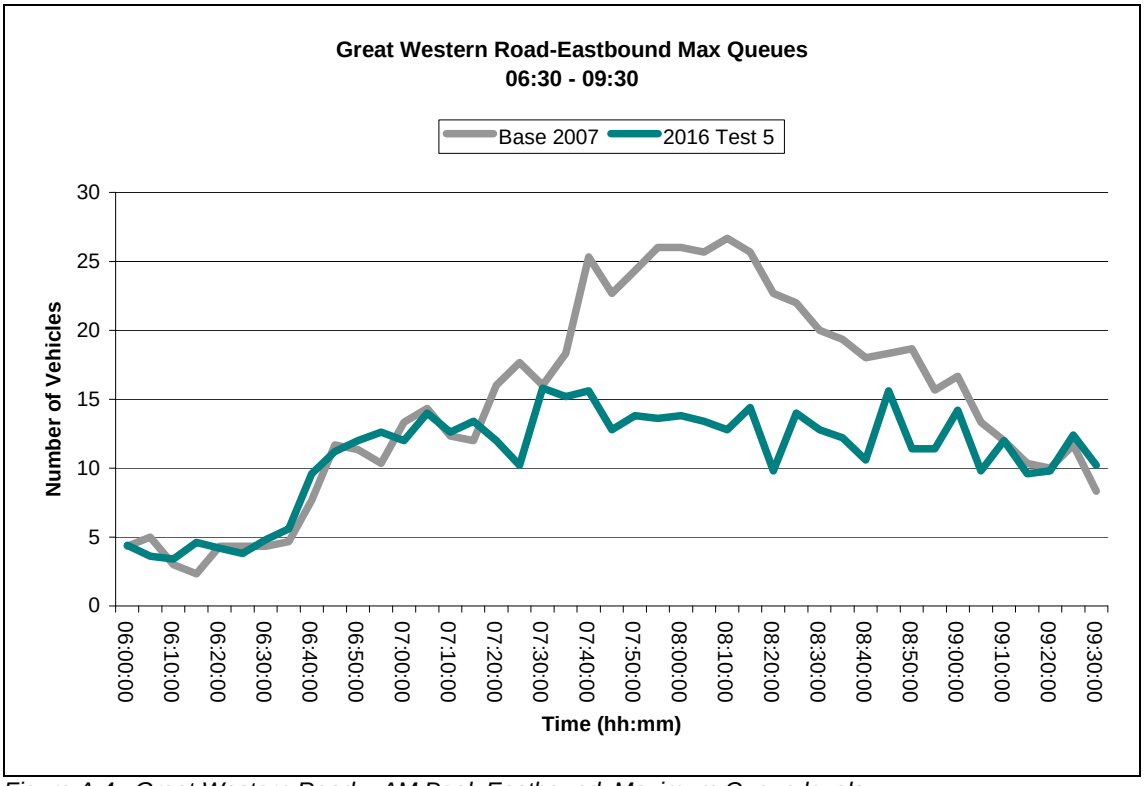


Figure A.4 : Great Western Road – AM Peak Eastbound, Maximum Queue levels

B GREAT WESTERN ROAD MODEL – PM PEAK QUEUE LENGTH GRAPHS

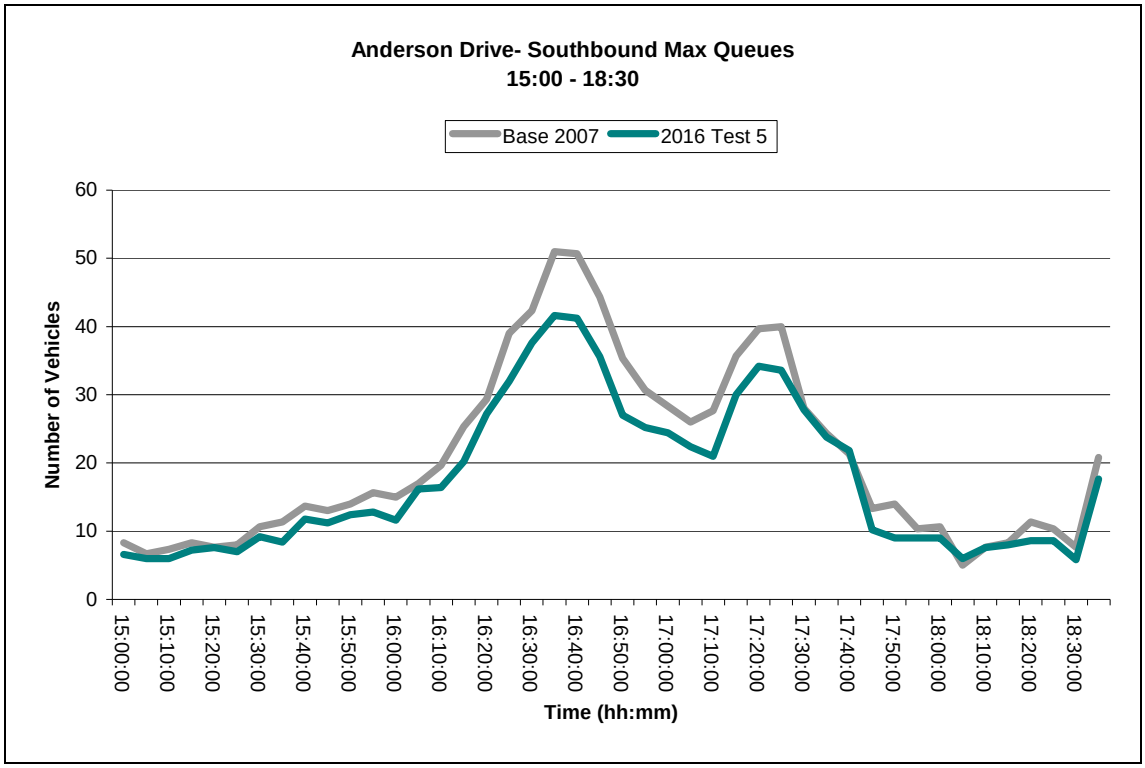


Figure B.1 : Anderson Drive – PM Peak Southbound, Maximum Queue levels

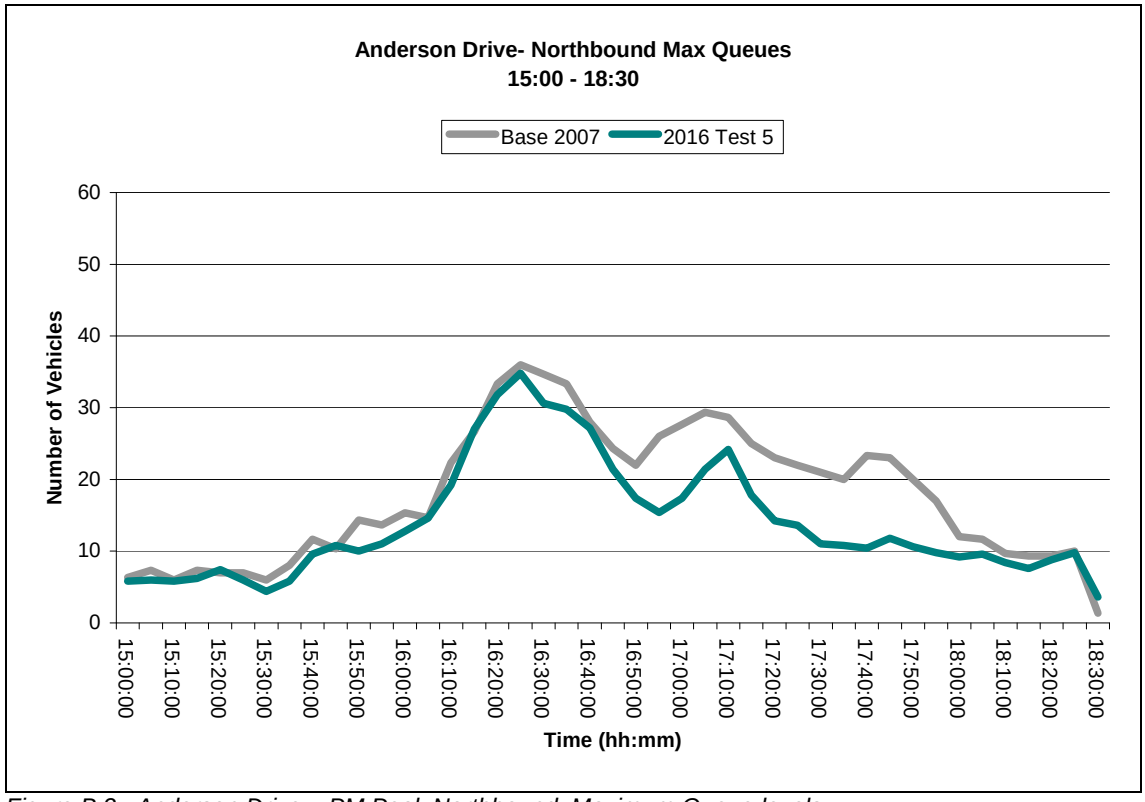


Figure B.2 : Anderson Drive – PM Peak Northbound, Maximum Queue levels

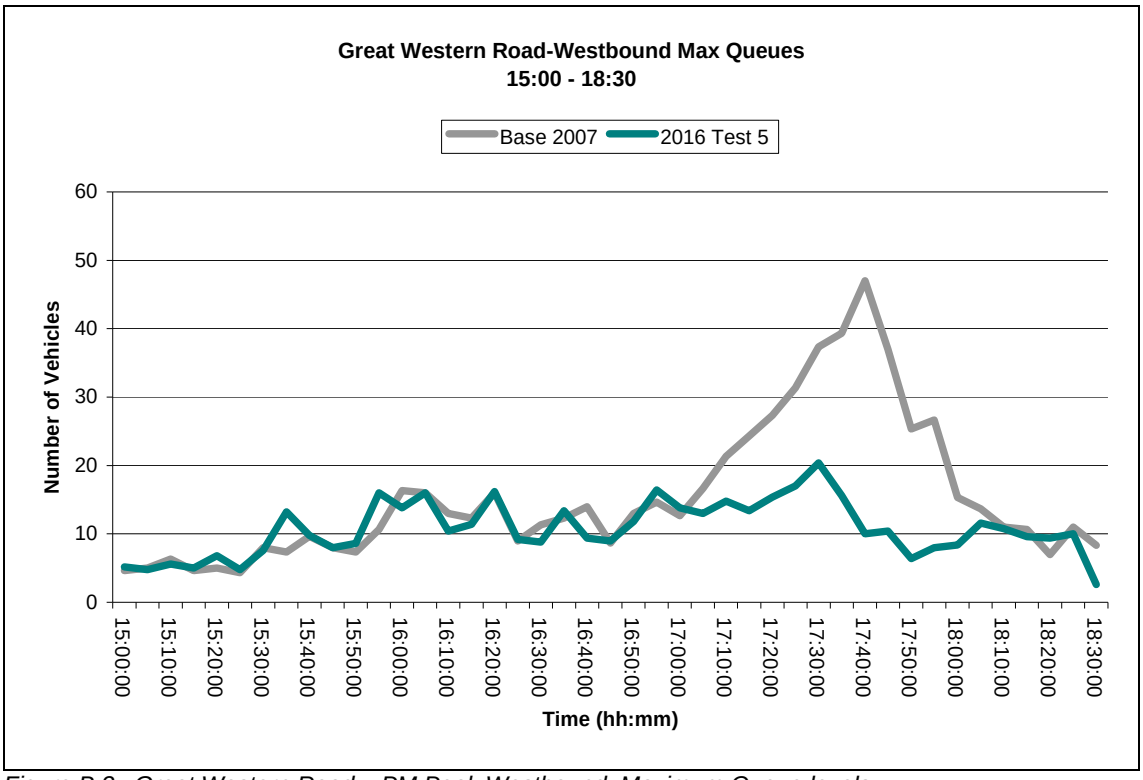


Figure B.3 : Great Western Road – PM Peak Westbound, Maximum Queue levels

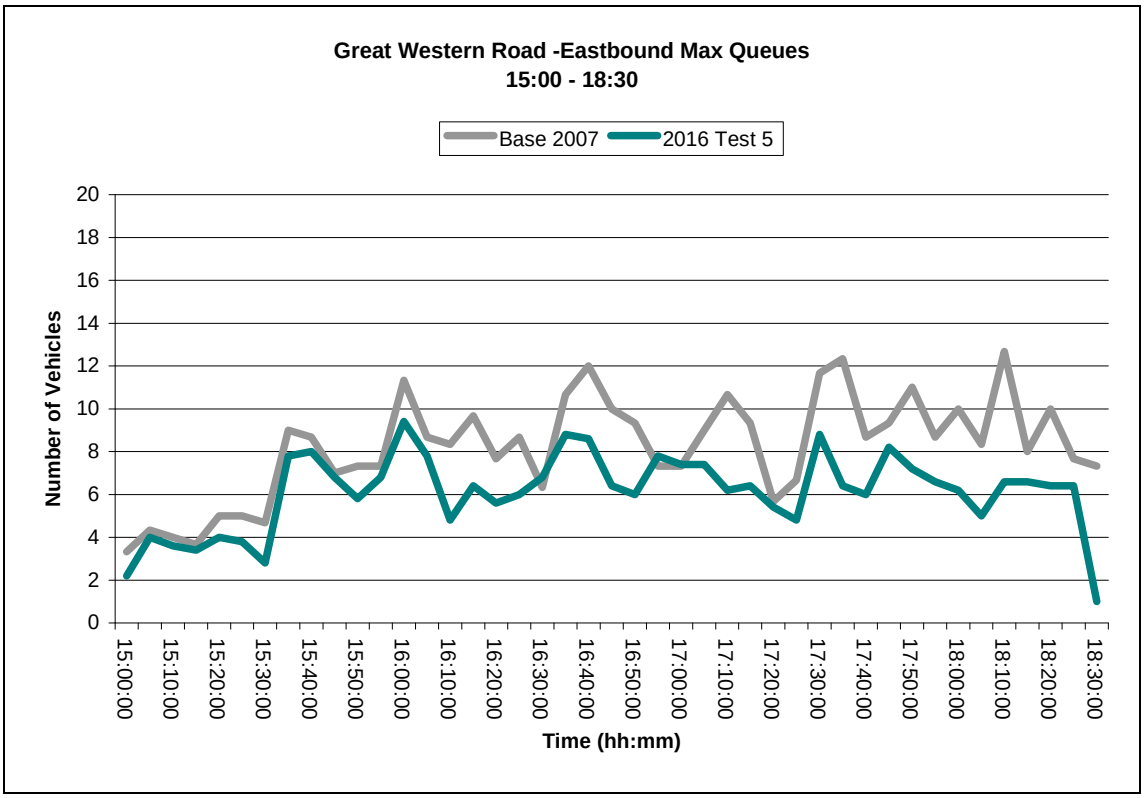


Figure B.4 : Great Western Road – PM Peak Eastbound, Maximum Queue levels

C WESTBURN ROAD MODEL – AM PEAK QUEUE LENGTH GRAPHS

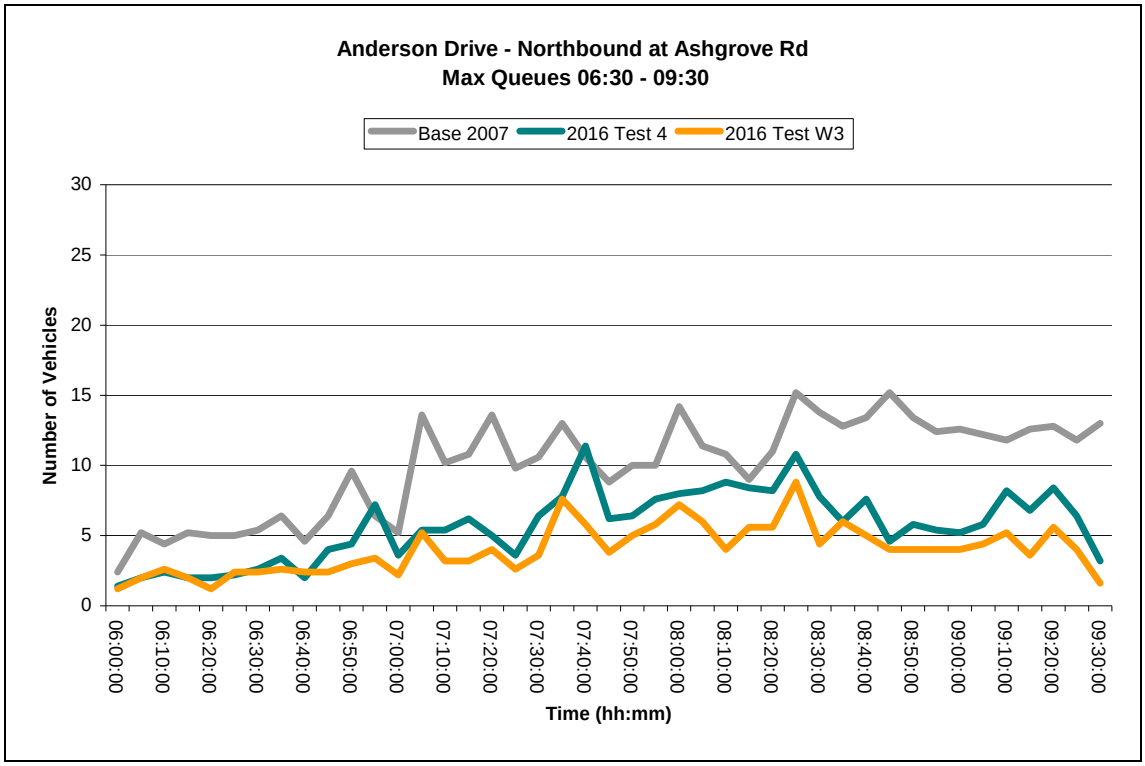


Figure C.1 : Anderson Drive – AM Peak Northbound at J1 Ashgrove Road, Maximum Queue levels

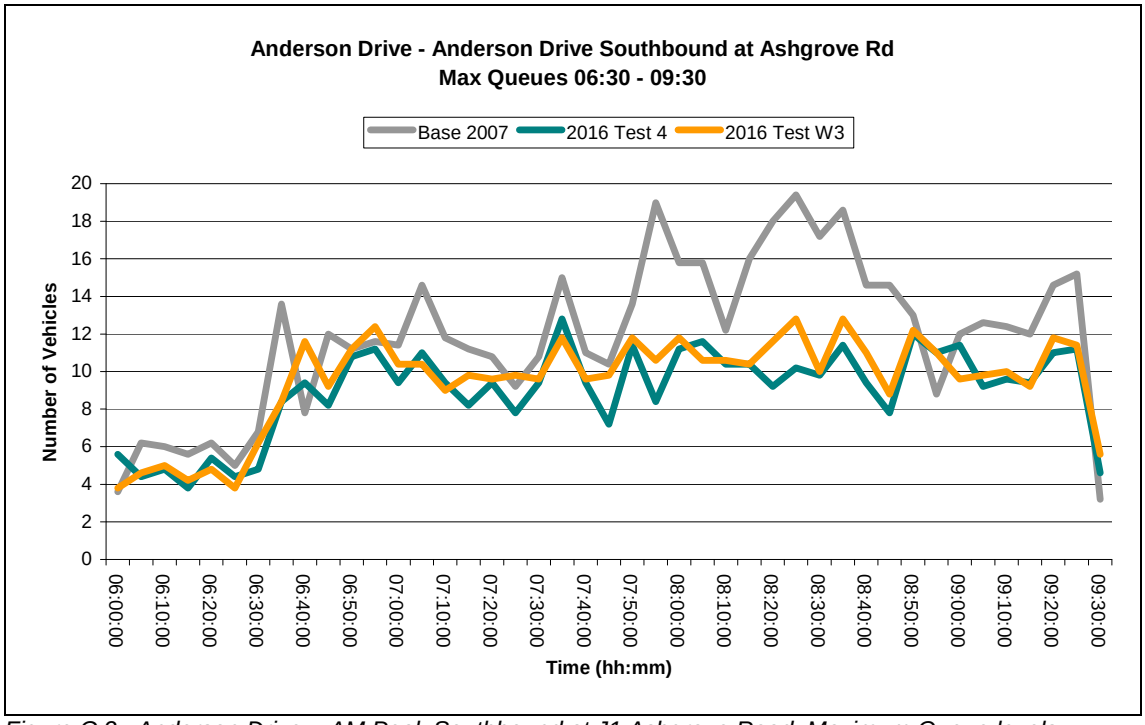


Figure C.2 : Anderson Drive – AM Peak Southbound at J1 Ashgrove Road, Maximum Queue levels

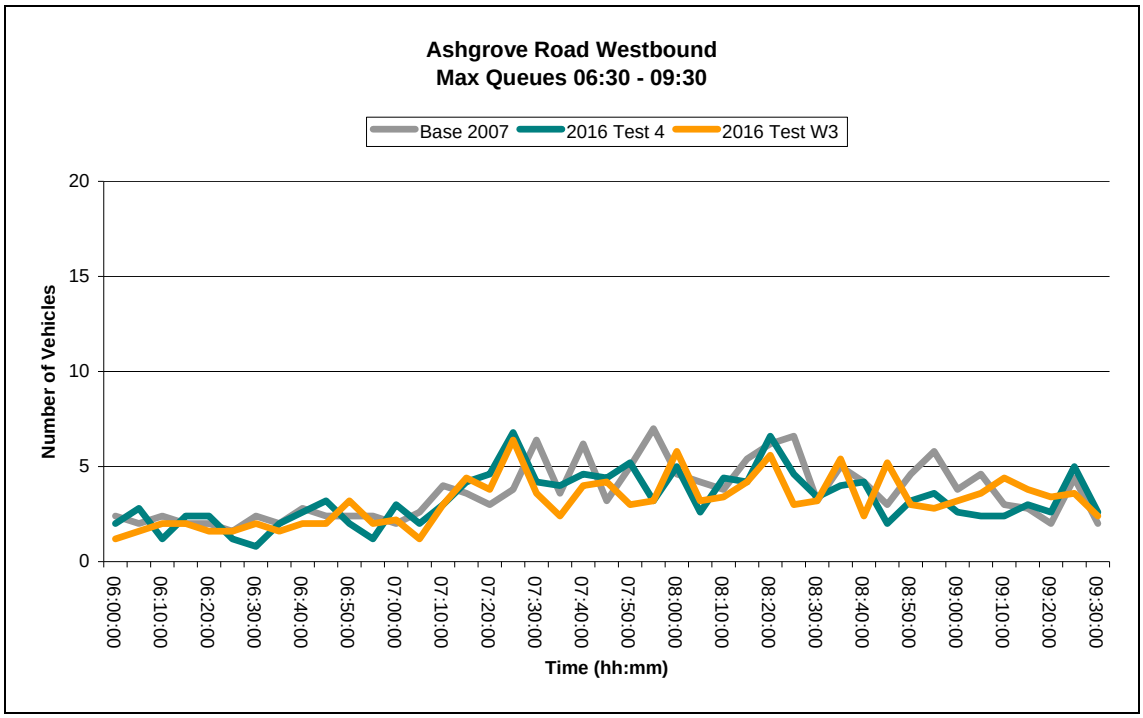


Figure C.3 : Ashgrove Road – AM Peak Westbound at J1, Maximum Queue levels

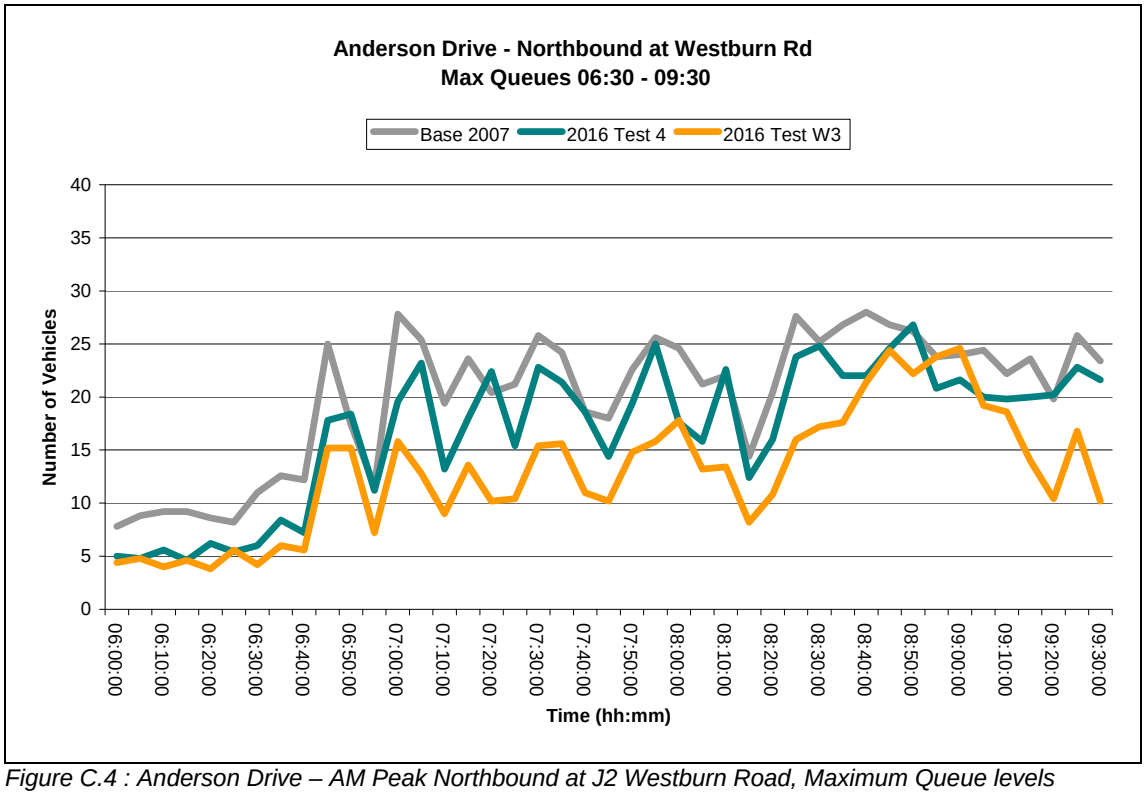


Figure C.4 : Anderson Drive – AM Peak Northbound at J2 Westburn Road, Maximum Queue levels

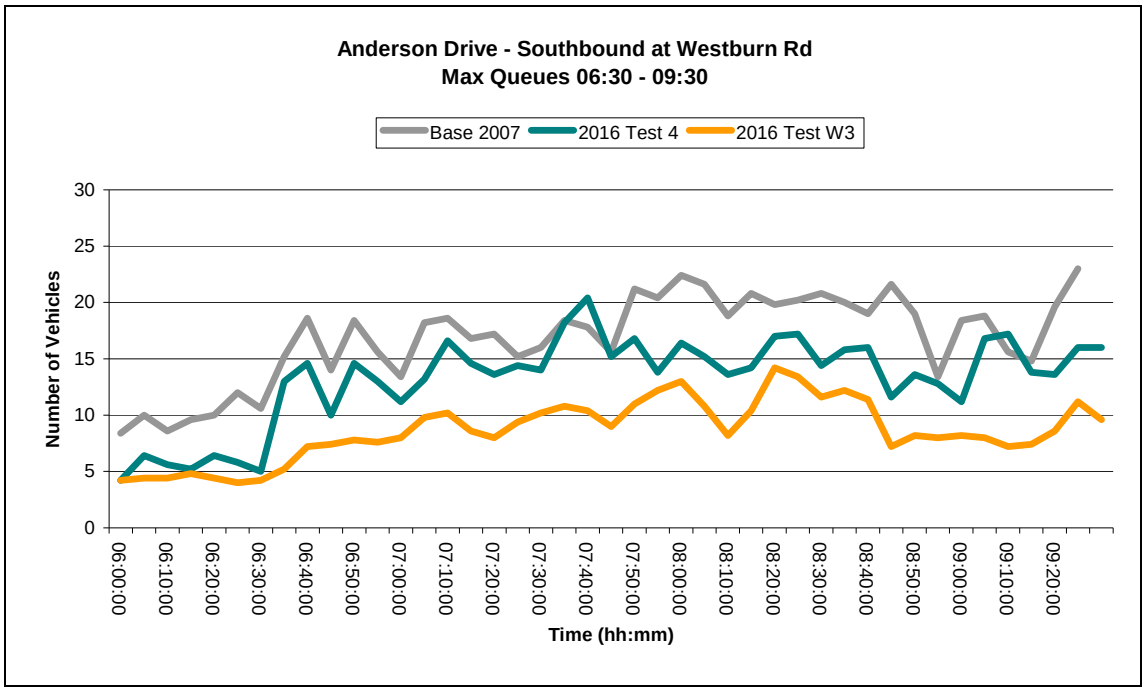


Figure C.5 : Anderson Drive – AM Peak Southbound at J2 Westburn Road, Maximum Queue levels

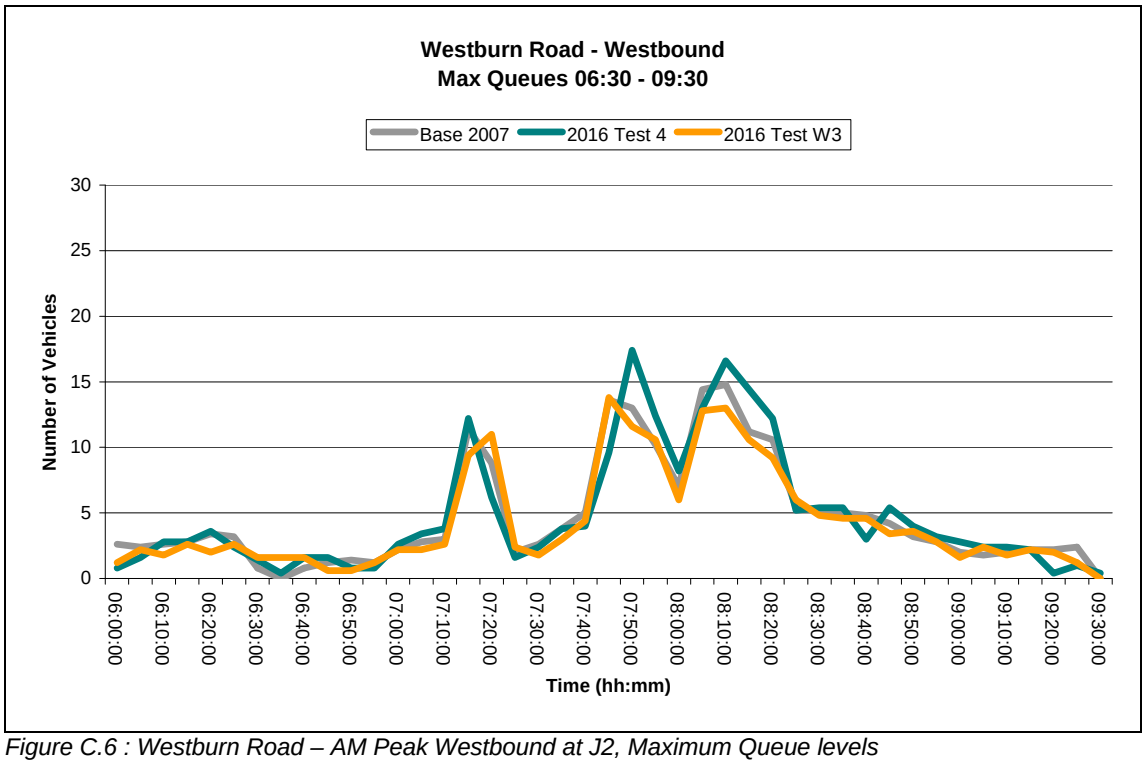


Figure C.6 : Westburn Road – AM Peak Westbound at J2, Maximum Queue levels

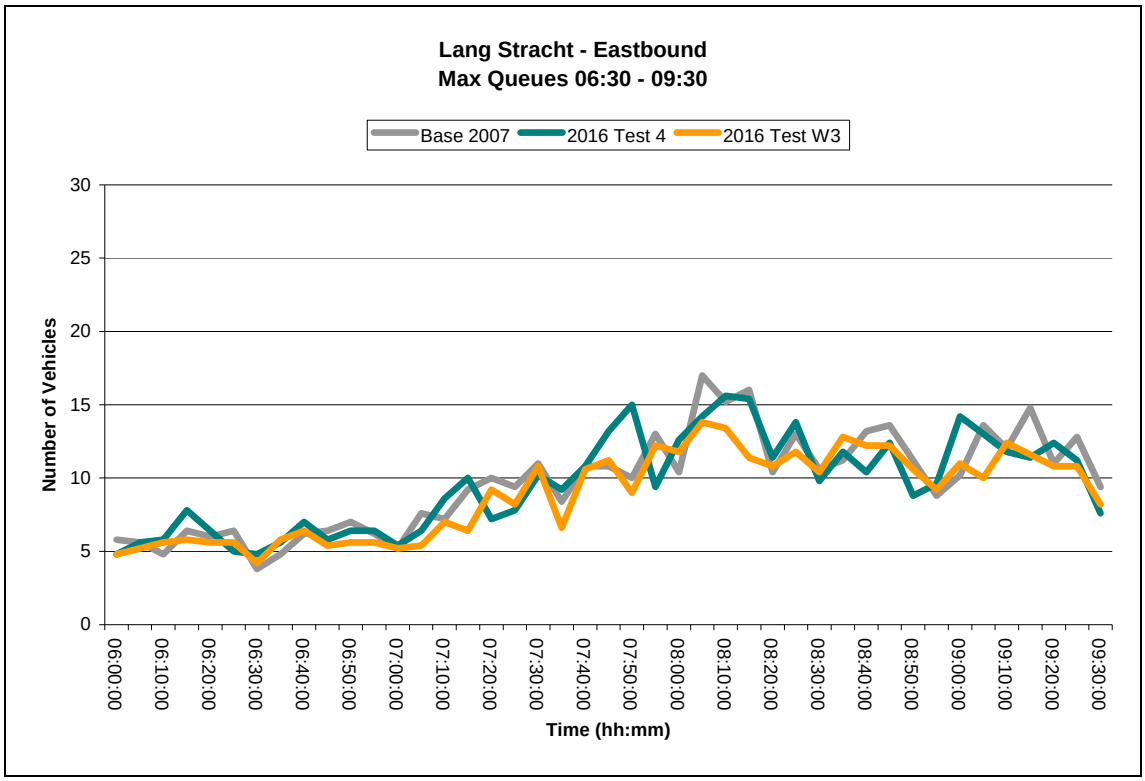


Figure C.7 : Lang Stracht – AM Peak Eastbound at J2, Maximum Queue levels

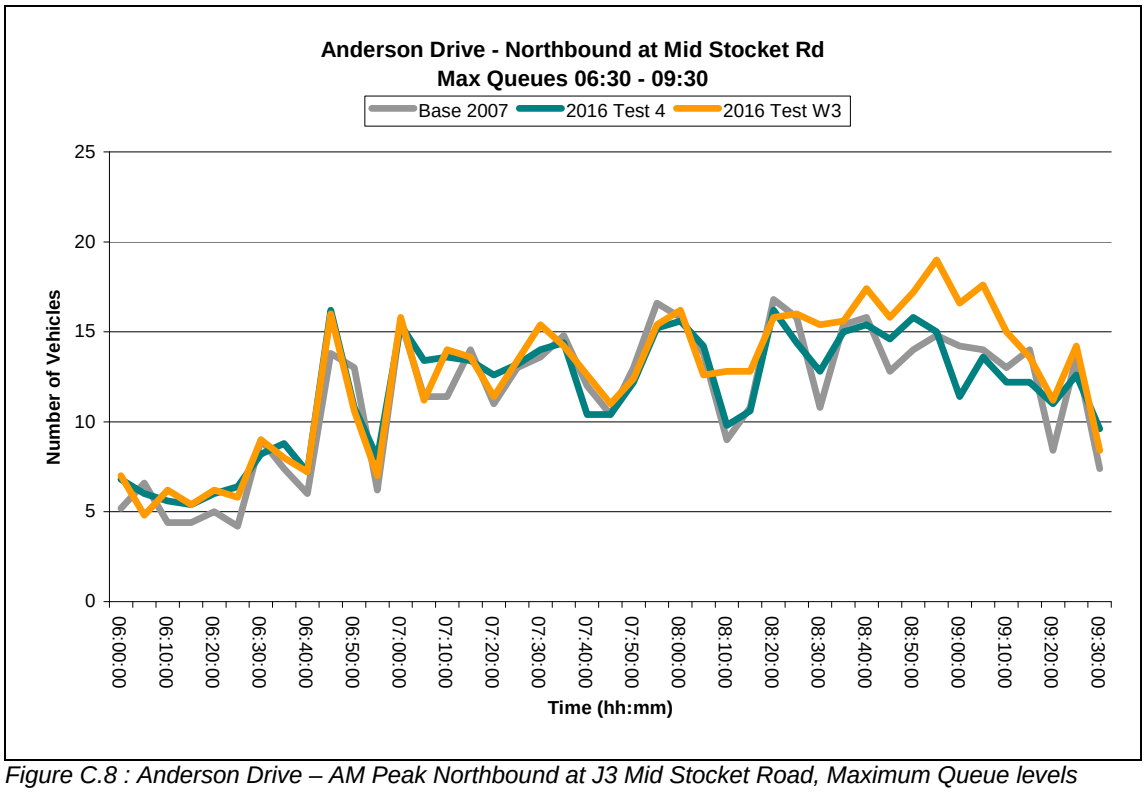


Figure C.8 : Anderson Drive – AM Peak Northbound at J3 Mid Stocket Road, Maximum Queue levels

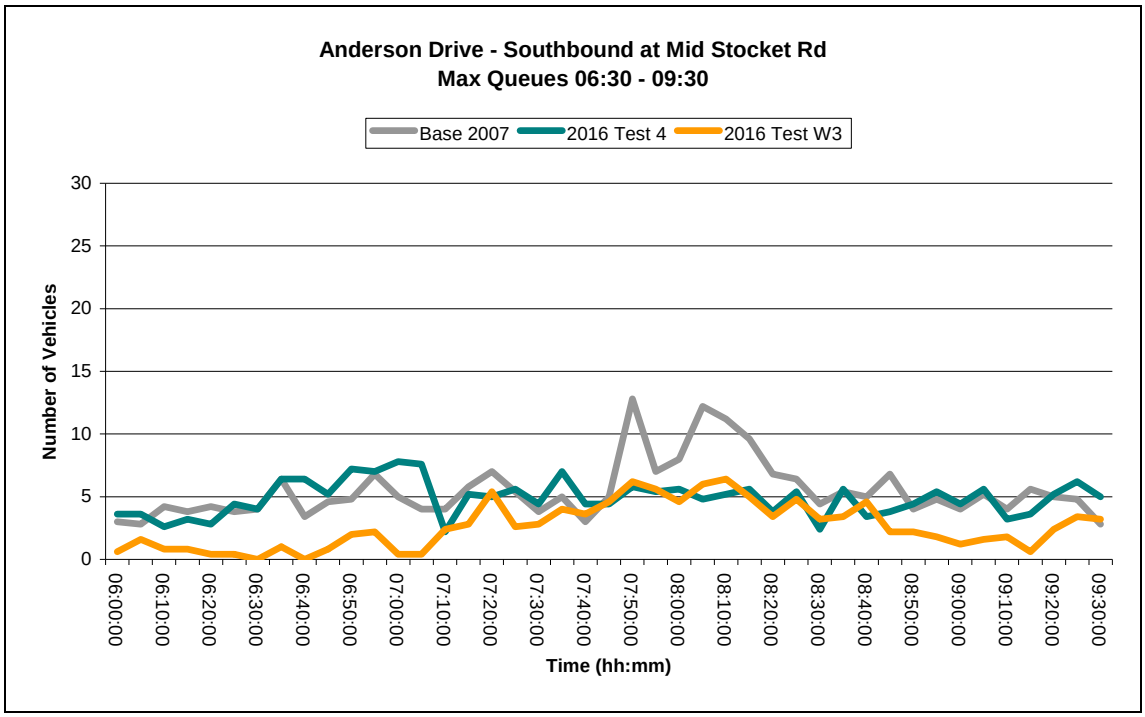


Figure C.9 : Anderson Drive – AM Peak Southbound at J3 Mid Stocket Road, Maximum Queue levels

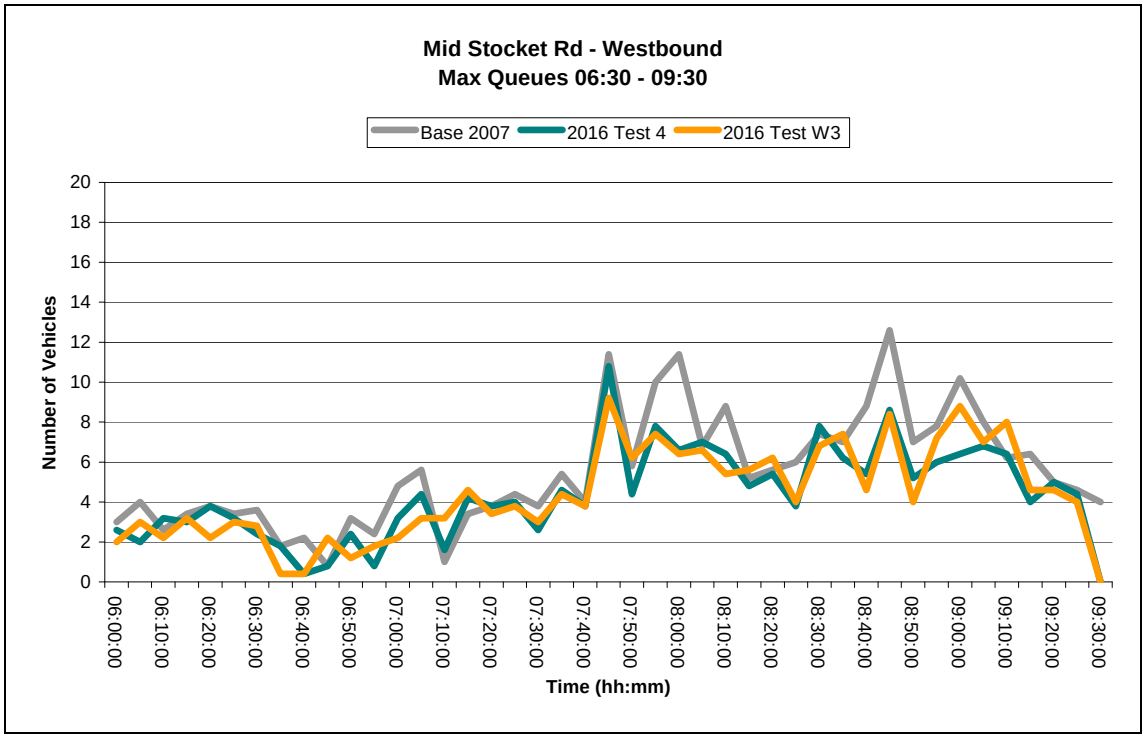


Figure C.10 : Mid Stocket Road – AM Peak Westbound at J3, Maximum Queue levels

D WESTBURN ROAD MODEL – PM PEAK QUEUE LENGTH GRAPHS

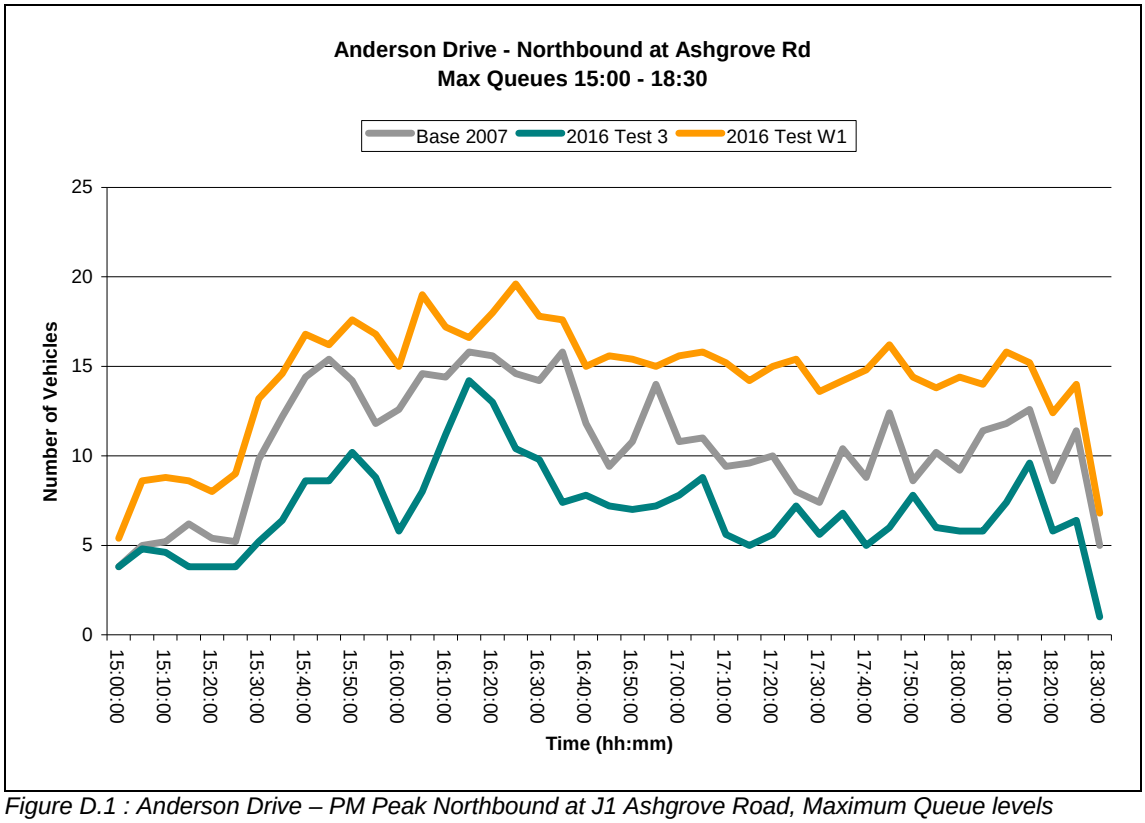


Figure D.1 : Anderson Drive – PM Peak Northbound at J1 Ashgrove Road, Maximum Queue levels

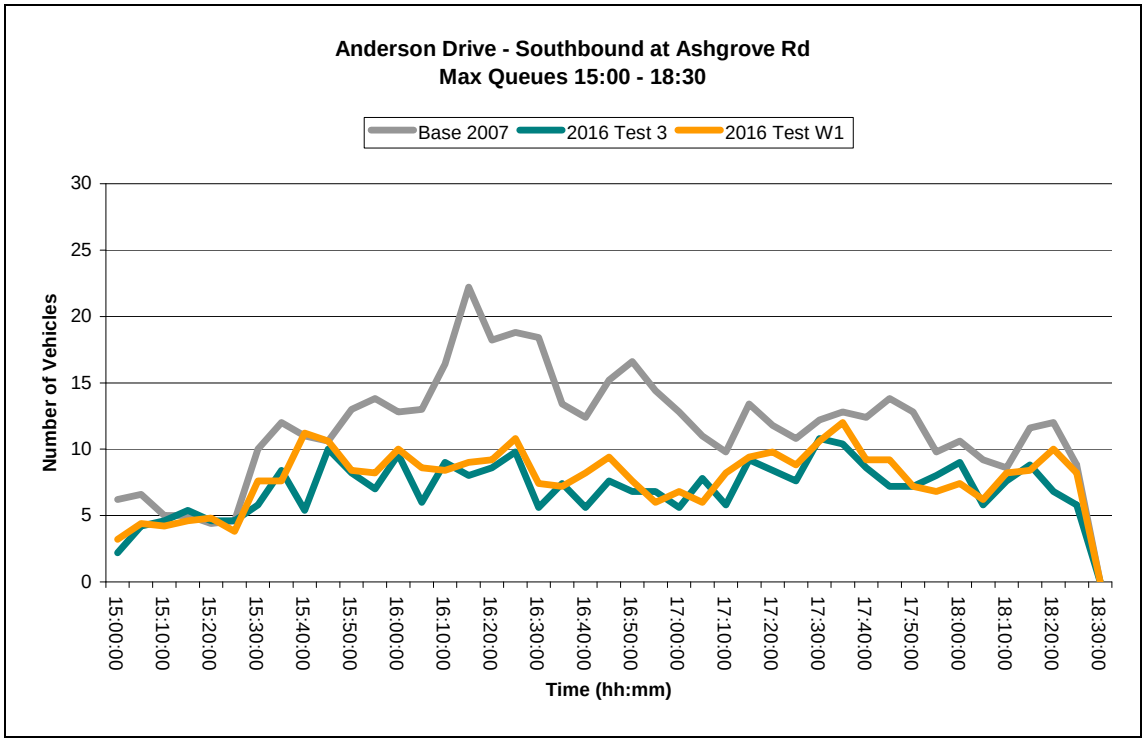


Figure D.2 : Anderson Drive – PM Peak Southbound at J1 Ashgrove Road, Maximum Queue levels

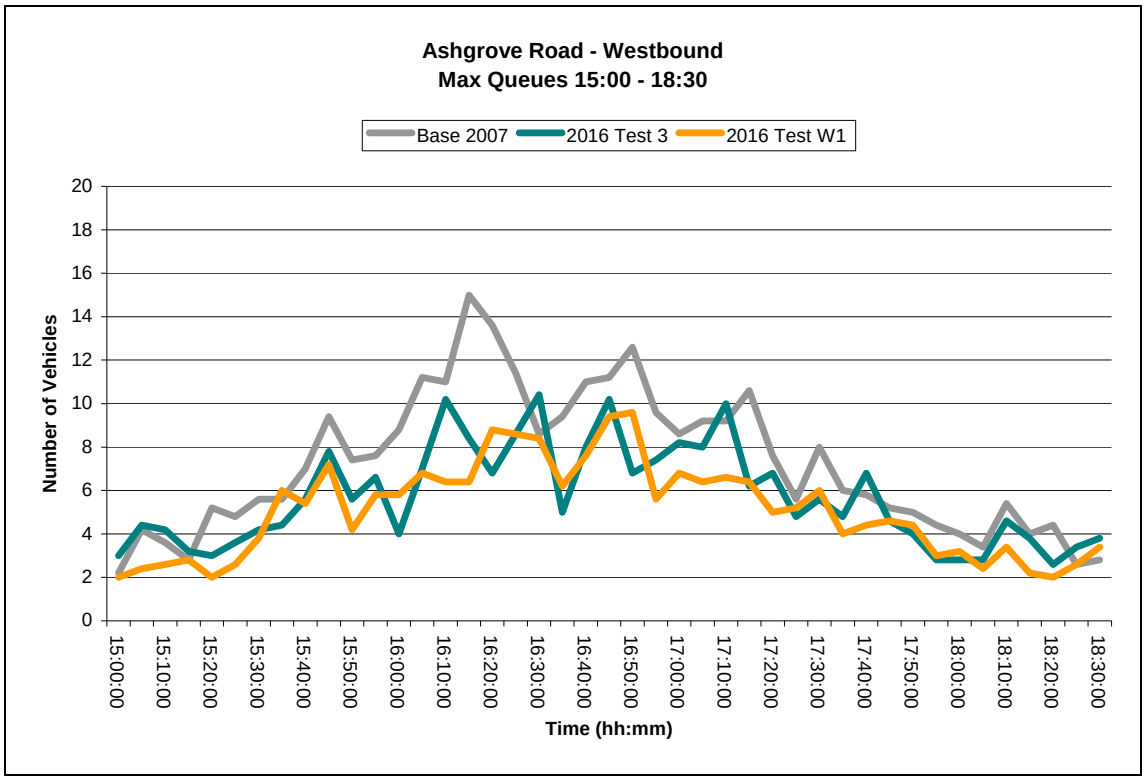


Figure D.3 : Ashgrove Road – PM Peak Westbound at J1, Maximum Queue levels

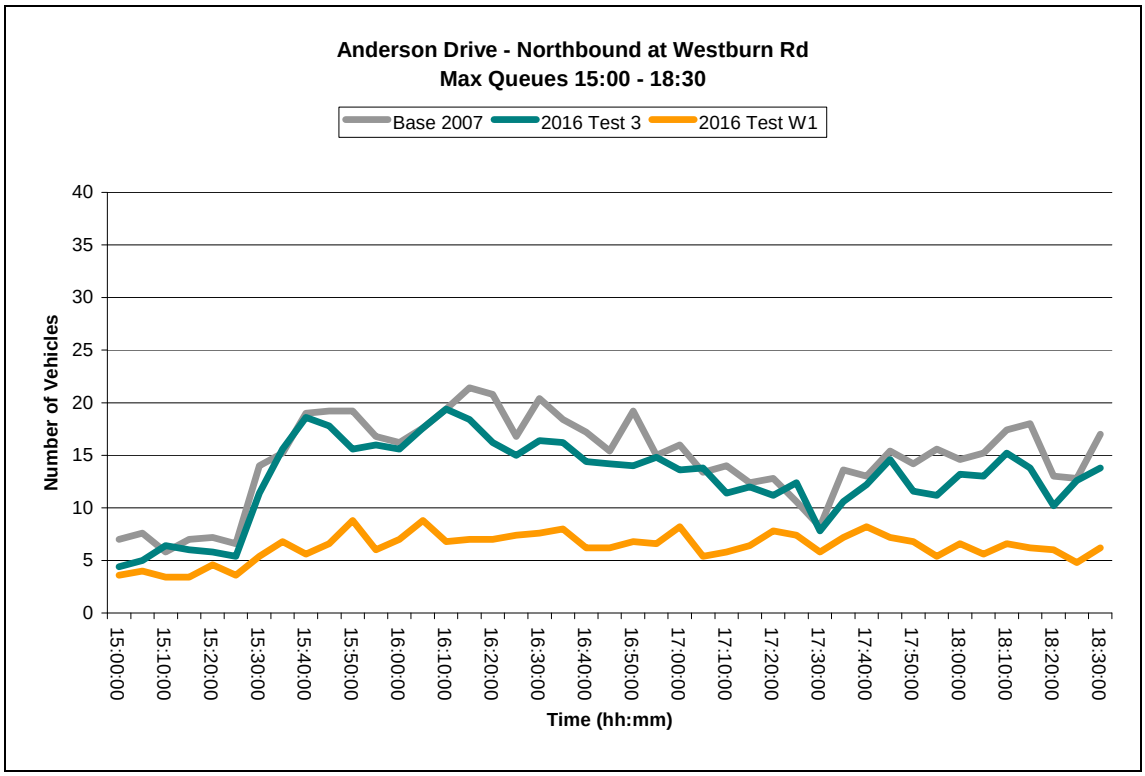


Figure D.4 : Anderson Drive – PM Peak Northbound at J2 Westburn Road, Maximum Queue levels

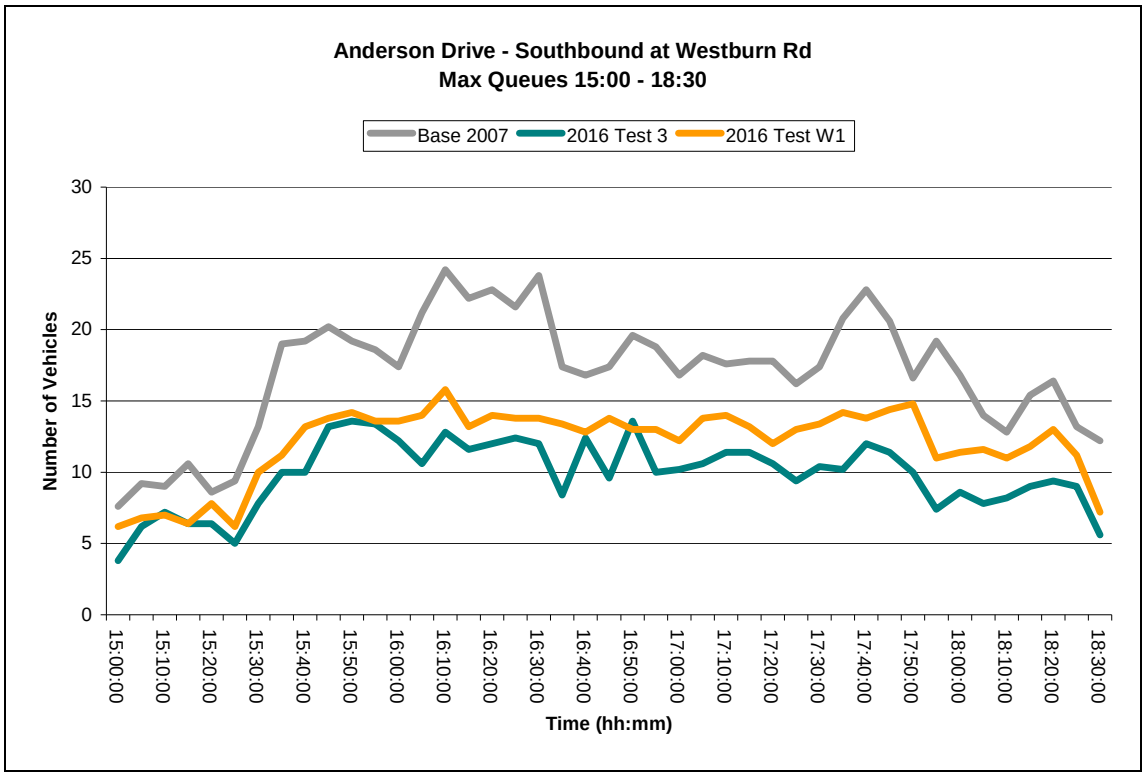


Figure D.5 : Anderson Drive – PM Peak Southbound at J2 Westburn Road, Maximum Queue levels

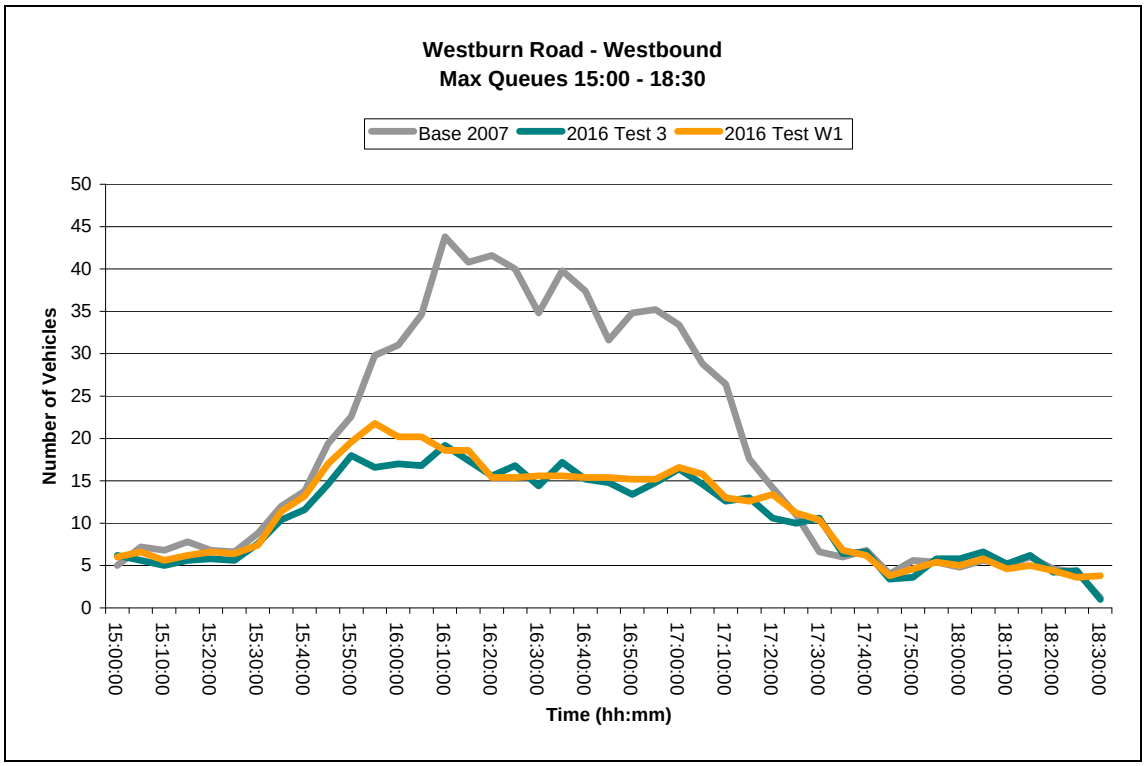


Figure D.6 : Westburn Road – PM Peak Westbound at J2, Maximum Queue levels

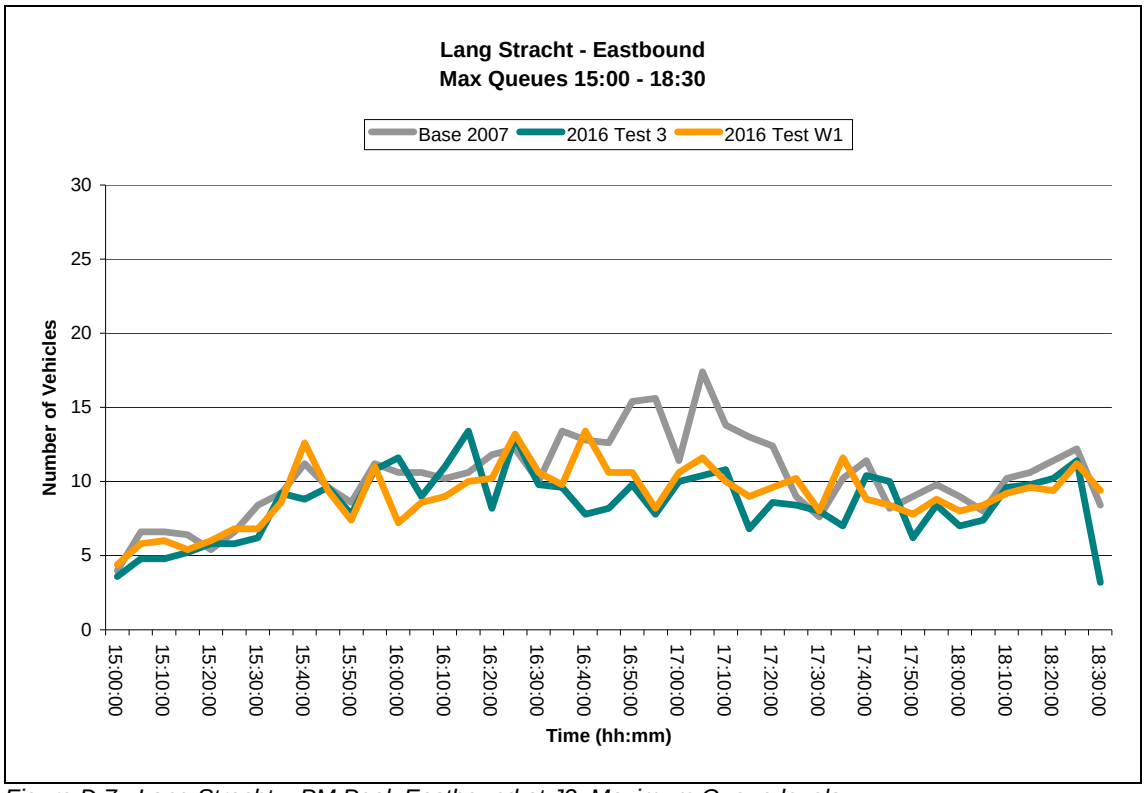


Figure D.7 : Lang Stracht – PM Peak Eastbound at J2, Maximum Queue levels

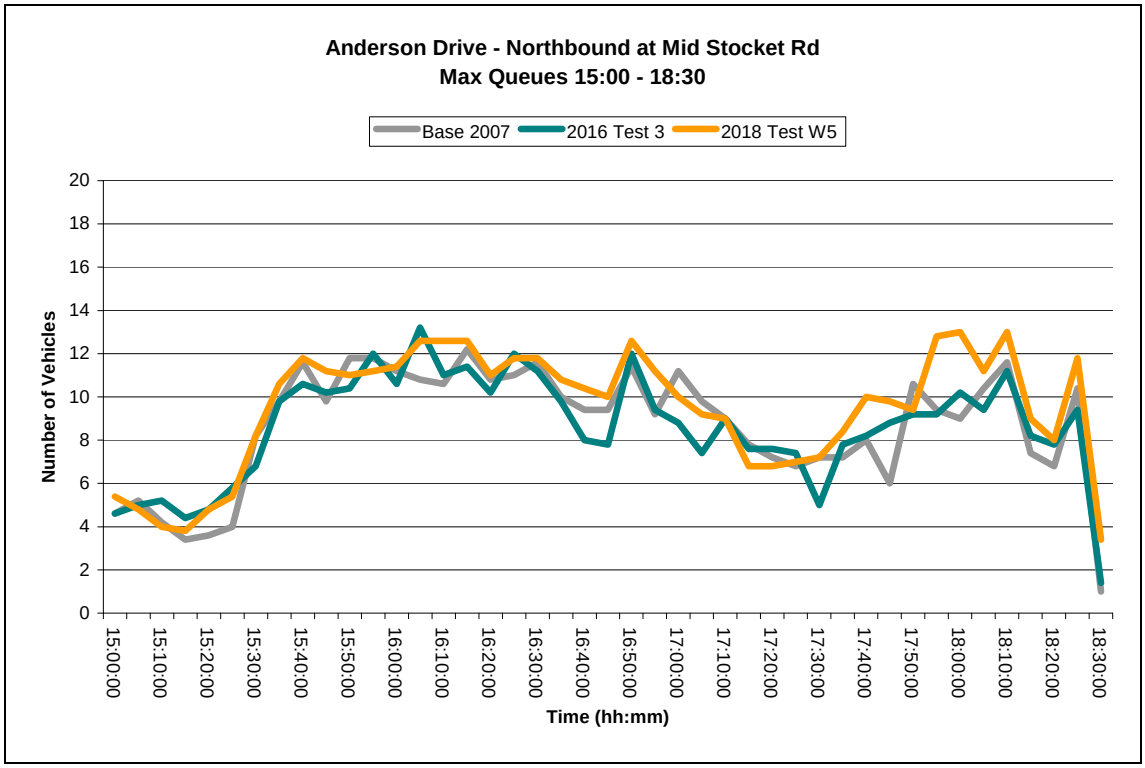


Figure D.8 : Anderson Drive – PM Peak Northbound at J3 Mid Stocket Road, Maximum Queue levels

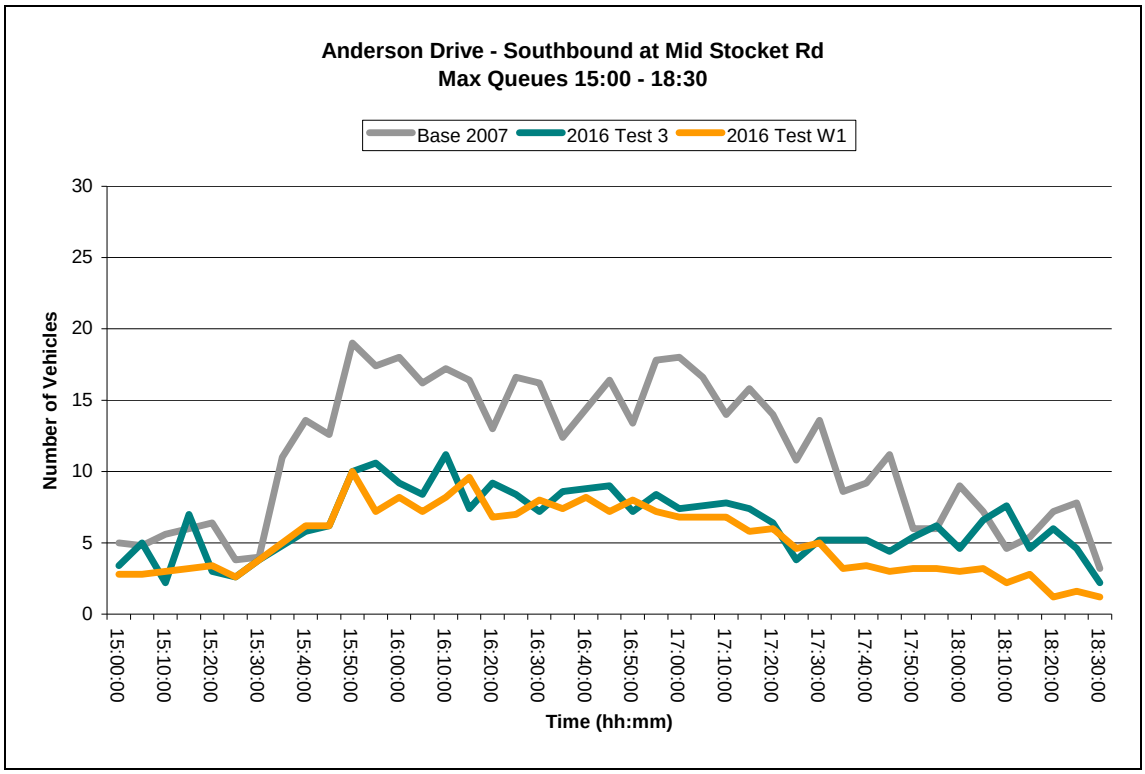


Figure D.9 : Anderson Drive – PM Peak Southbound at J3 Mid Stocket Road, Maximum Queue levels

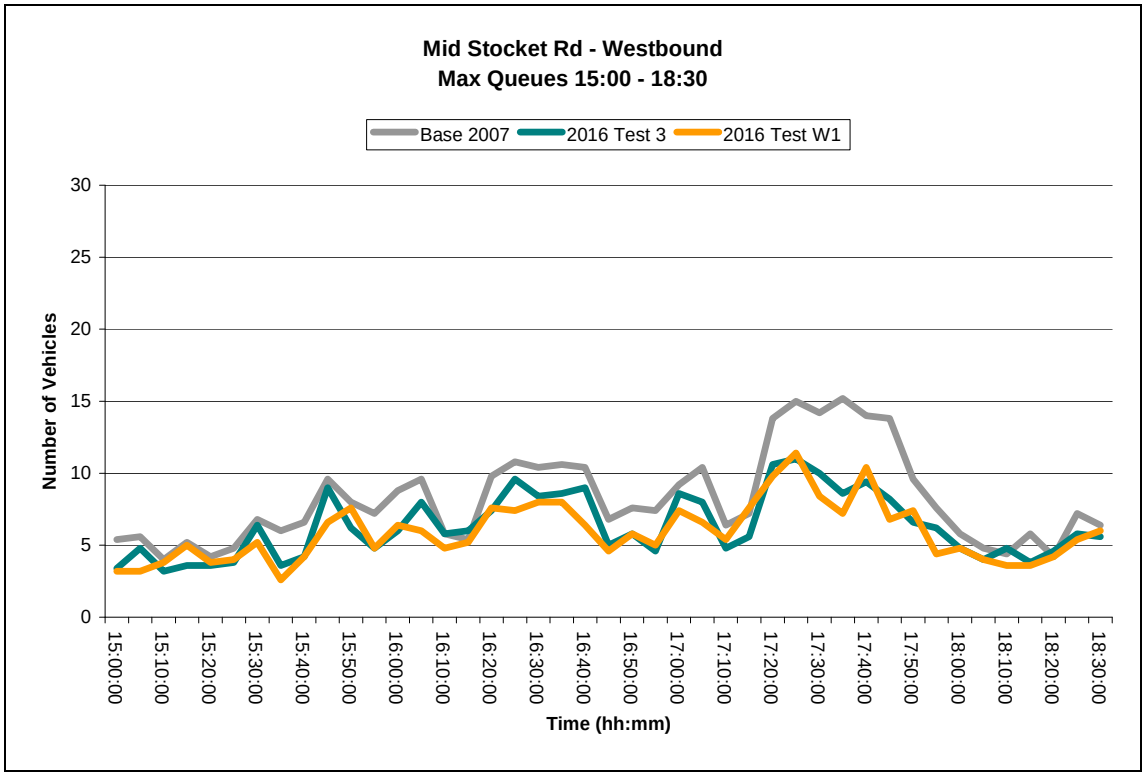


Figure D.10 : Mid Stocket Road – PM Peak Westbound at J3, Maximum Queue levels