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29/11/2017

BARNESON BOULEVARD DETAILED DESIGN – TRAFFIC MODELLING ASSESSMENT

REVIEW OF JACOBS MEMORANDUM 27 MAY 2016 (MODELLING MEMO)

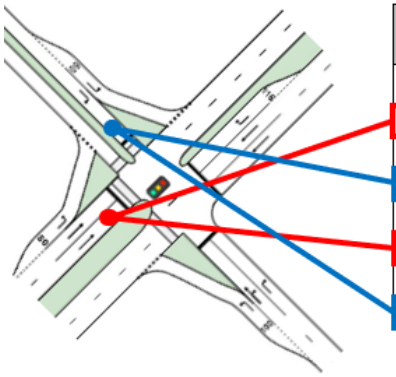
1 INTRODUCTION

This document has been prepared by myself (David Wilkins, Principal and Senior Traffic Engineer - i3 consultants WA (i3)) in response to the request to undertake a desktop review of the Barneson Boulevard Detailed Design – Traffic Modelling Assessment memorandum prepared by Jacobs dated 27 May 2016, hereinafter referred to as the Jacobs Modelling Memo.

In addition to the review of the Jacobs Modelling memo, the desktop review is to consider and analyse an alternate plan for Barneson Boulevard that terminate at McMinn Street with a roundabout. This desktop analysis is to include comparisons between the current design and the alternate design.

2 CURRENT DESIGN

The current design, i.e. the design used as the basis for the Jacobs Modelling Memo, is difficult to ascertain as this Memo includes different intersection design configurations for the VISSUM model and the SIDRA Intersection models. An example of this is that the SIDRA Intersection model shown on page 37 of the Jacobs Modelling Memo indicates there will not be any right turns from 'Barneson Blvd SW' into Tiger Brennan Dr or straight through movements from a new 'TBD NW' leg, due to the one-way carriageway of Tiger Brennan Drive. The VISSUM model allows for these movements, as shown in Figure 1 below.



Movement	Vehicles	Ave Delay (s)	LOS	Ave Q	Max Q
AM Peak: Barneson Boulevard/ Tiger Brennan Drive Western Intersection					
Barneson Blvd SW right	36	42	C	2	29
TBD NW left	0	0	A	0	0
TBD NW through	8	32	C	1	16
PM Peak: Barneson Boulevard/ Tiger Brennan Drive Western Intersection					
Barneson Blvd SW right	9	44	D	1	12
TBD NW left	0	0	A	0	0
TBD NW through	5	50	D	2	14

Figure 1 – Inconsistent VISSUM and SIDRA Model intersection configuration (Barneson Blvd/ TBD)

Another difficulty in ascertaining the base design for the models within the Jacobs Modelling Memo is the lack of SIDRA Intersection data and layout diagrams for key intersections other than on Barneson Boulevard, i.e. Daly St/ McMinn St/ Stuart Hwy and Bennett St/ McMinn St/ Tiger Brennan Dr. The VISSUM model allows for up 250 vehicles per hour to turn right from Daly St into McMinn street when this movement is currently prohibited. The Jacobs Modelling Memo indicates that the layout will be altered to allow this, i.e. Figure 4: (reproduced as Figure 2 below) but does not include a SIDRA intersection model that is network linked to the Barneson St SIDRA Intersection network model to reflect this. The same applies for the Bennett St/ McMinn St/ Tiger Brennan Dr intersection.

Figure 2 – VISSUM Model intersection configuration (Daly St/ McMinn St/ Stuart Hwy)

The SIDRA model within the Jacobs Modelling Memo is also inconsistent with the published proposed layout of Barneson Boulevard, as shown in Figure 3 below.

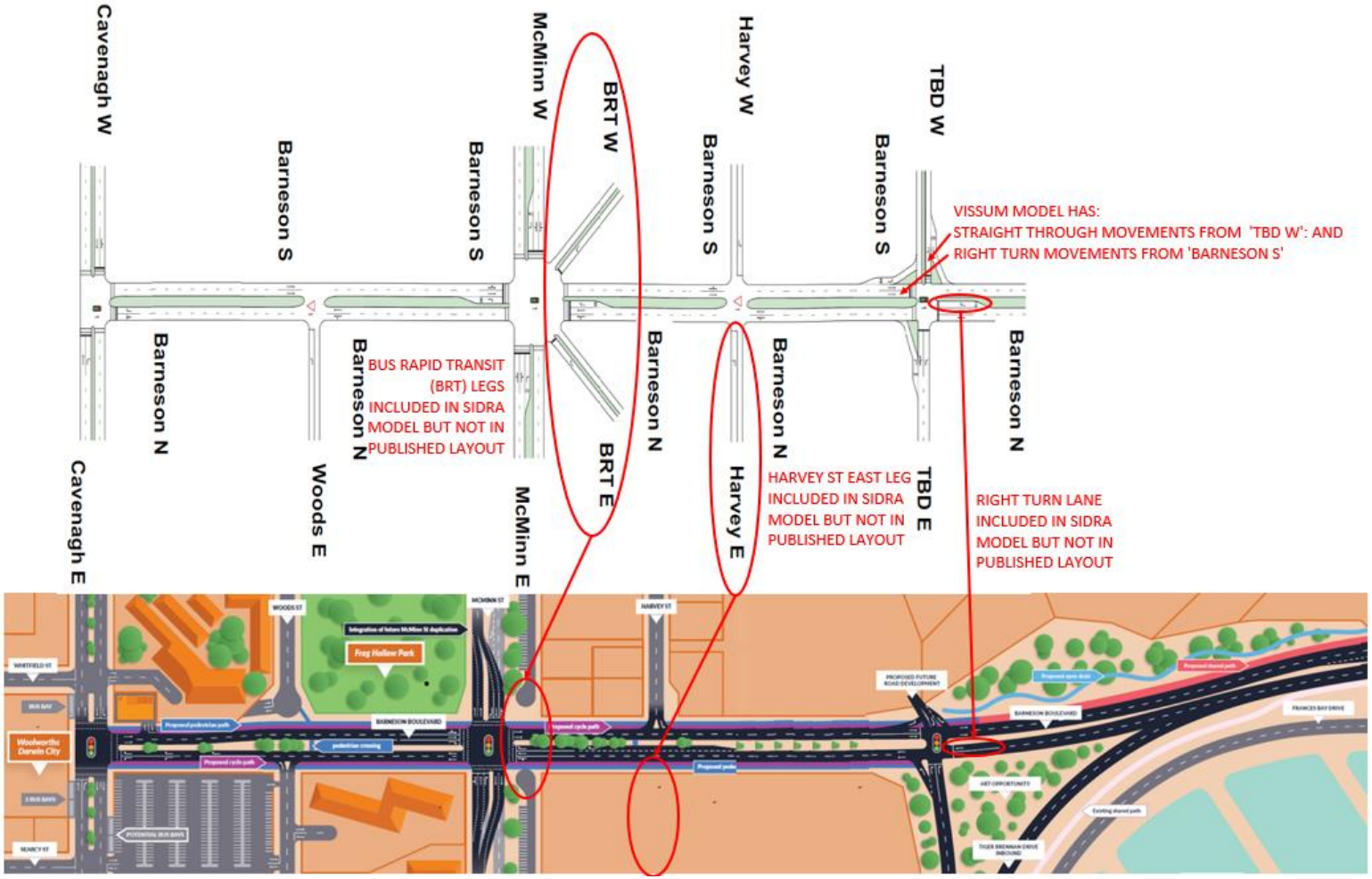


Figure 3 – Assessed inconsistencies between VISSUM, SIDRA and published layout of Barneson Street proposal

As indicated, it is difficult to determine a single layout configuration for this assessment due to assessed inconsistencies with layouts and indicated movements within the Jacobs Modelling Memo and the published layout. In order to meet the requested requirement for a comparative analysis of the alternate layout (i.e. termination and roundabout at Barneson/ McMinn) it is necessary to adopt 'base layouts' for Barneson Blvd and the road network. These adopted base layouts are:

- Jacobs Network Model Layout - Figure 4 below;
- Option 1 (Barneson terminates at McMinn with roundabout) - Figure 5 on the following page; and
- Option 2 (Barneson terminates at McMinn with traffic signals) - Figure 6 on the following page.

Note that Option 2 has been prepared to enable an assessment to be made of the impacts of roundabout control on the proposed Bus Rapid Transit route compared with traffic signal control. Turning prohibitions at each assessed Key intersection (Ki#) are shown in the individual assessments. The road colours reflect the current City of Darwin Road Classifications as shown in Figure 4 below. It is interesting to note that only McMinn St is classified as an arterial road and questions the desirability of an arterial road connection (i.e. Barneson St) between this road and Cavenagh Street – an unclassified CBD road.

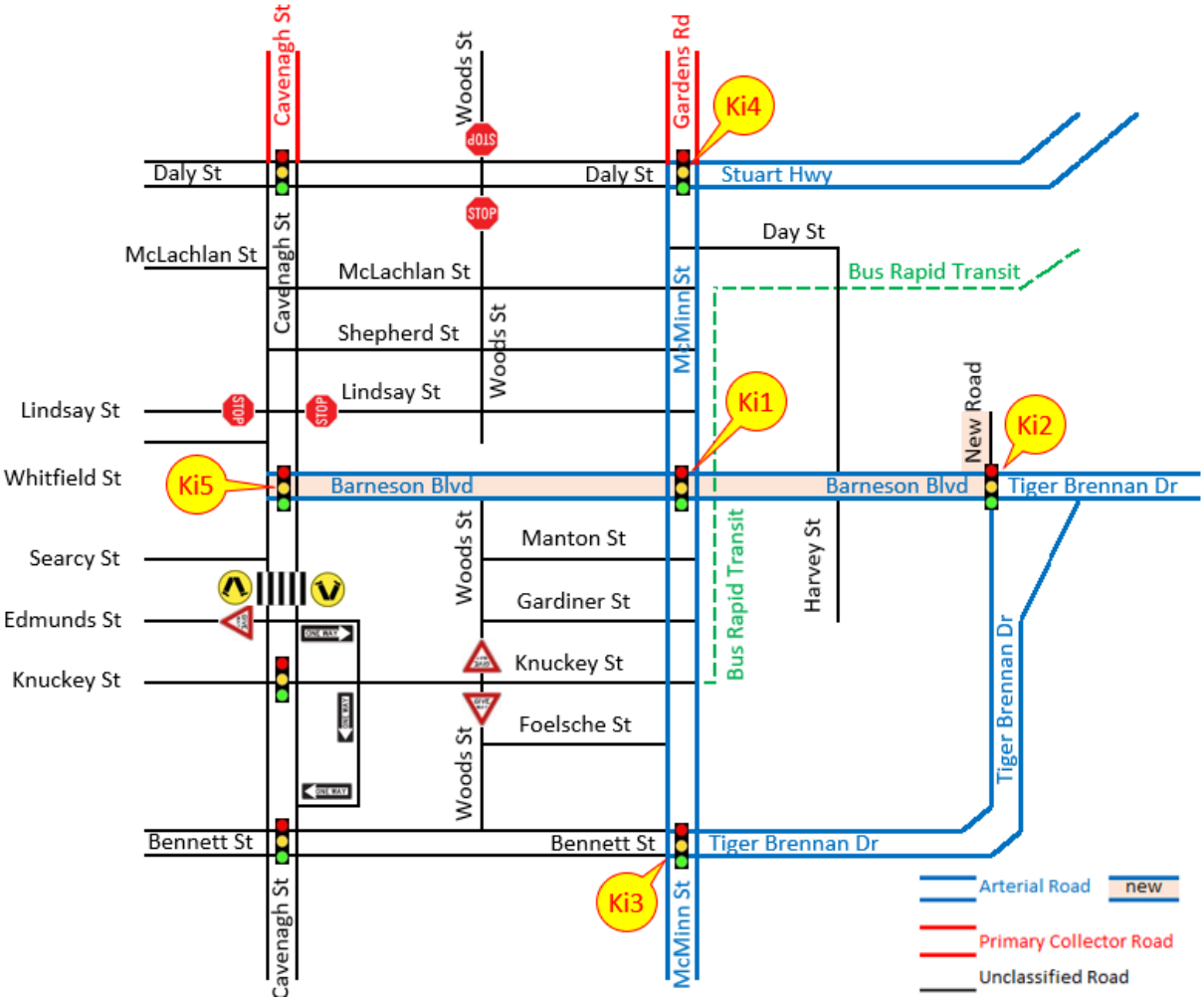


Figure 4 – Jacobs Network Model layout

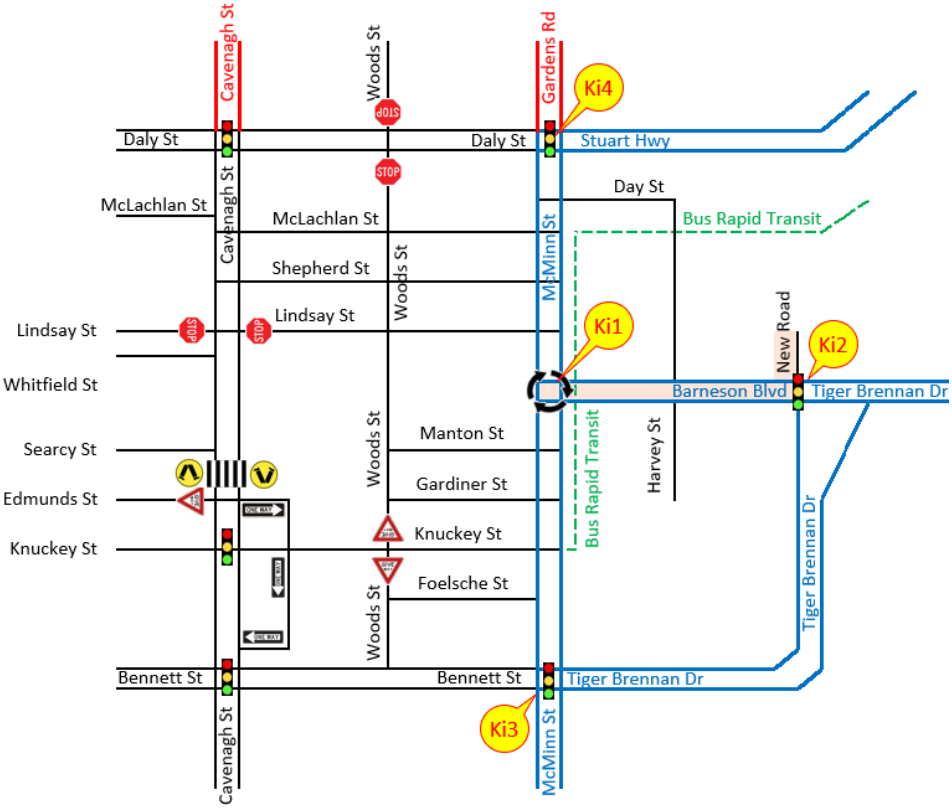


Figure 5 - Option 1 Network Model

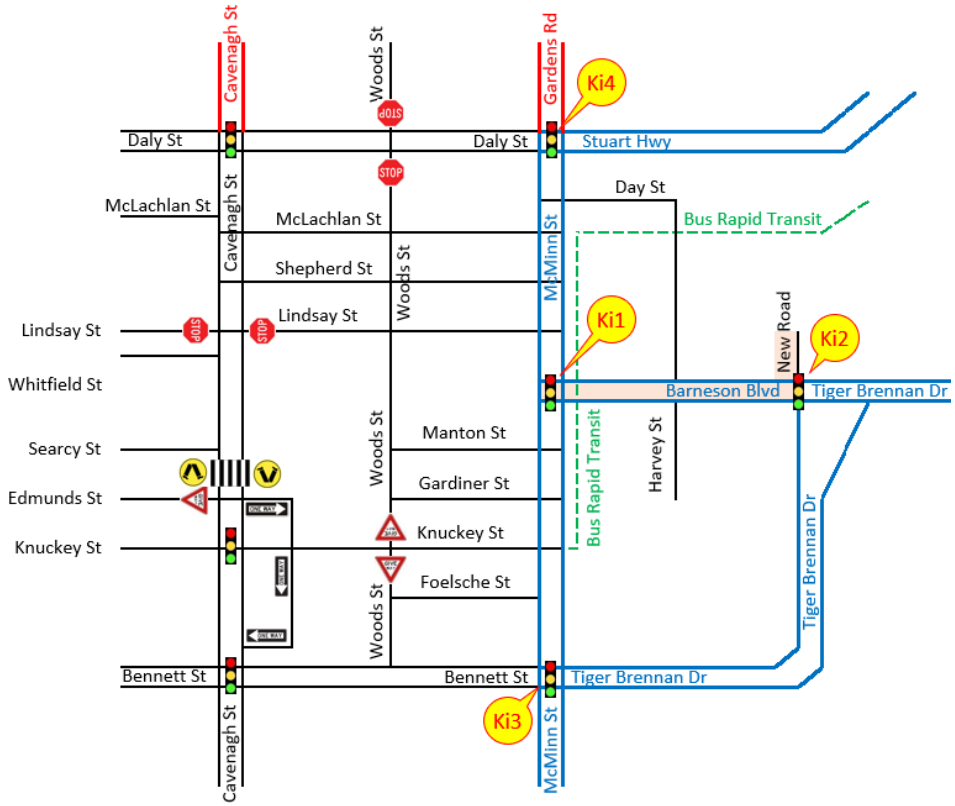


Figure 6 – Option 2 Network Model

3 TRIP ASSIGNMENTS

The assessed trip assignments for the Jacobs Model, based on the VISSUM data provided in Appendix B of the Jacobs Modelling Memo, is shown in Figure 7 below and Figure 8 on the following page for the AM and PM peak hours.

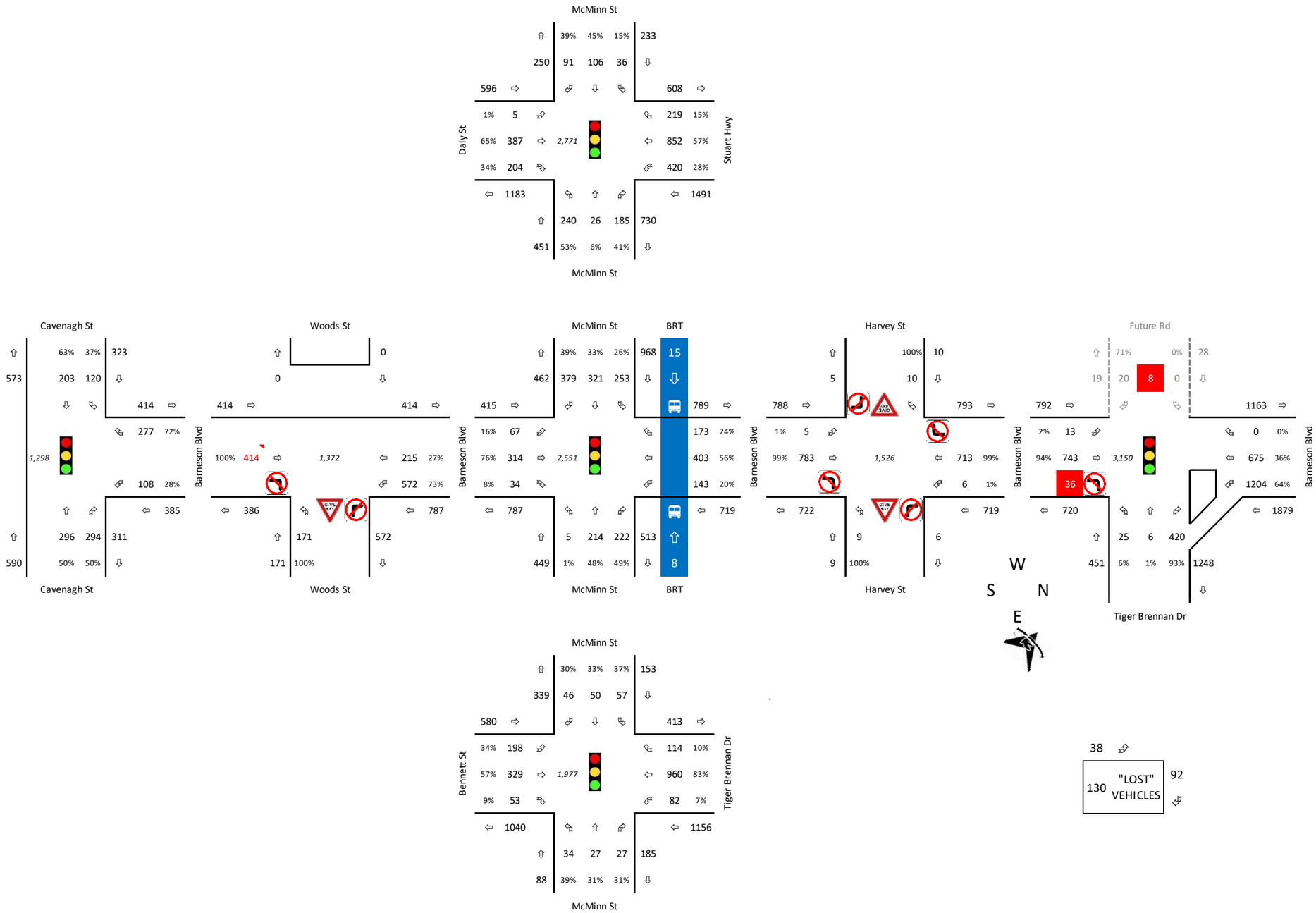


Figure 7 – Assessed Jacobs 2031 AM Peak Hour Model

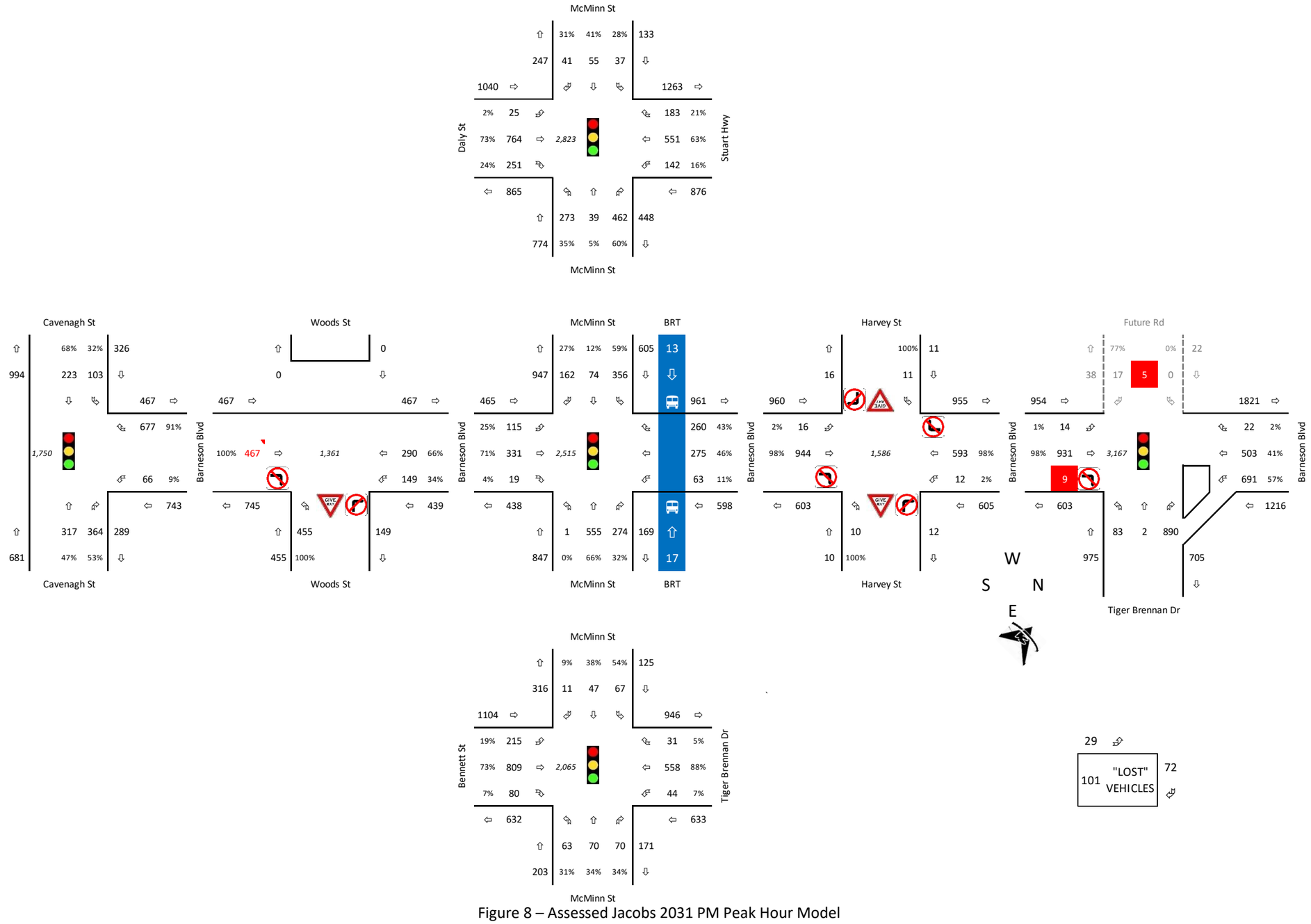


Figure 8 – Assessed Jacobs 2031 PM Peak Hour Model

Both the Jacobs models indicate a 'loss' of between 100 and 130 vehicles on Tiger Brennan Dr between Barneson Blvd and McMinn St/ Bennett St. As there are no intersections or developments here, this appears to be a modelling error.

The assessed trip assignments for the Options model based on the VISSUM data provided in Appendix B of the Jacobs Modelling Memo, is shown in Figure 9 below and Figure 10 on the following page for the AM and PM peak hours.

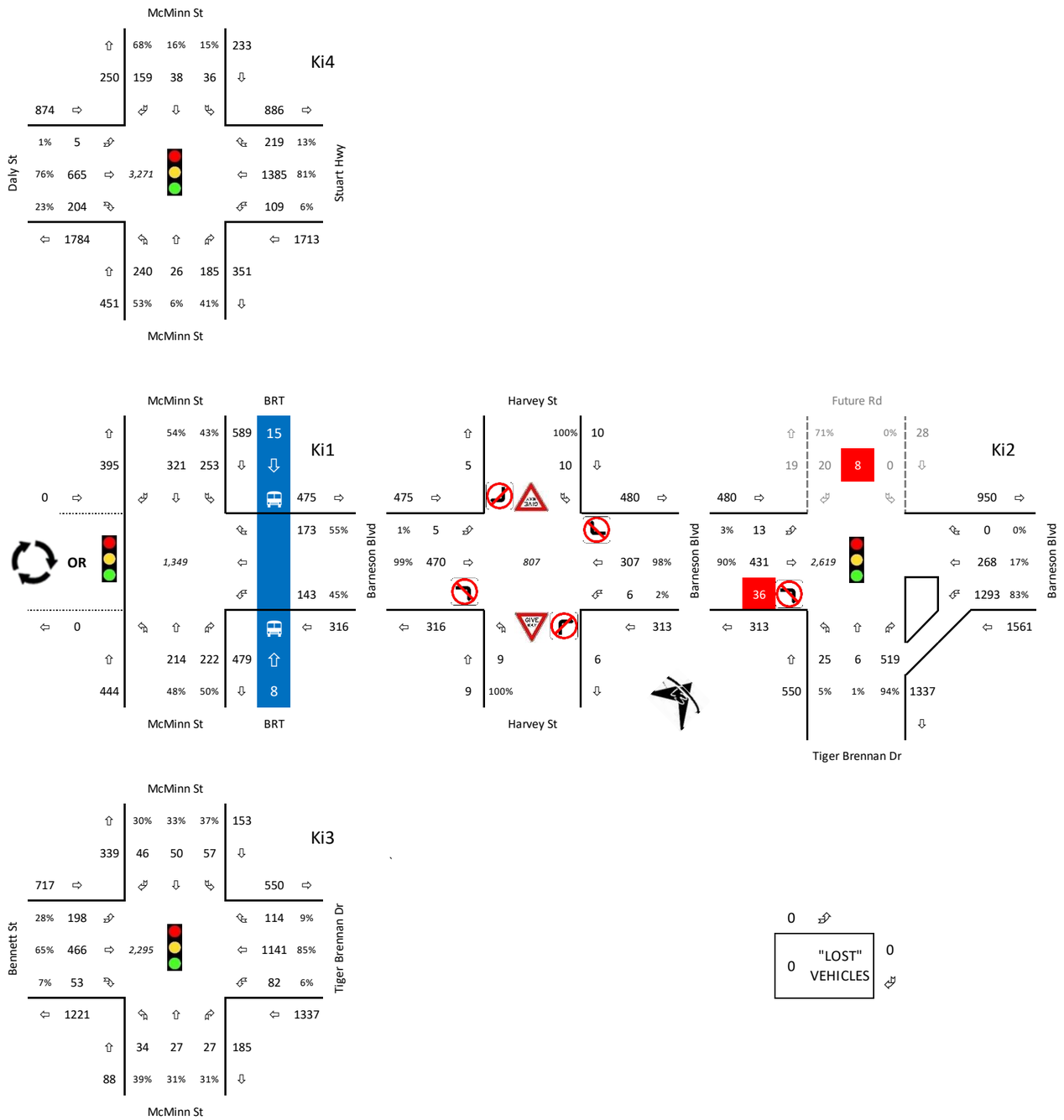


Figure 9 – Assessed Options 1&2 2031 AM Peak Hour Model

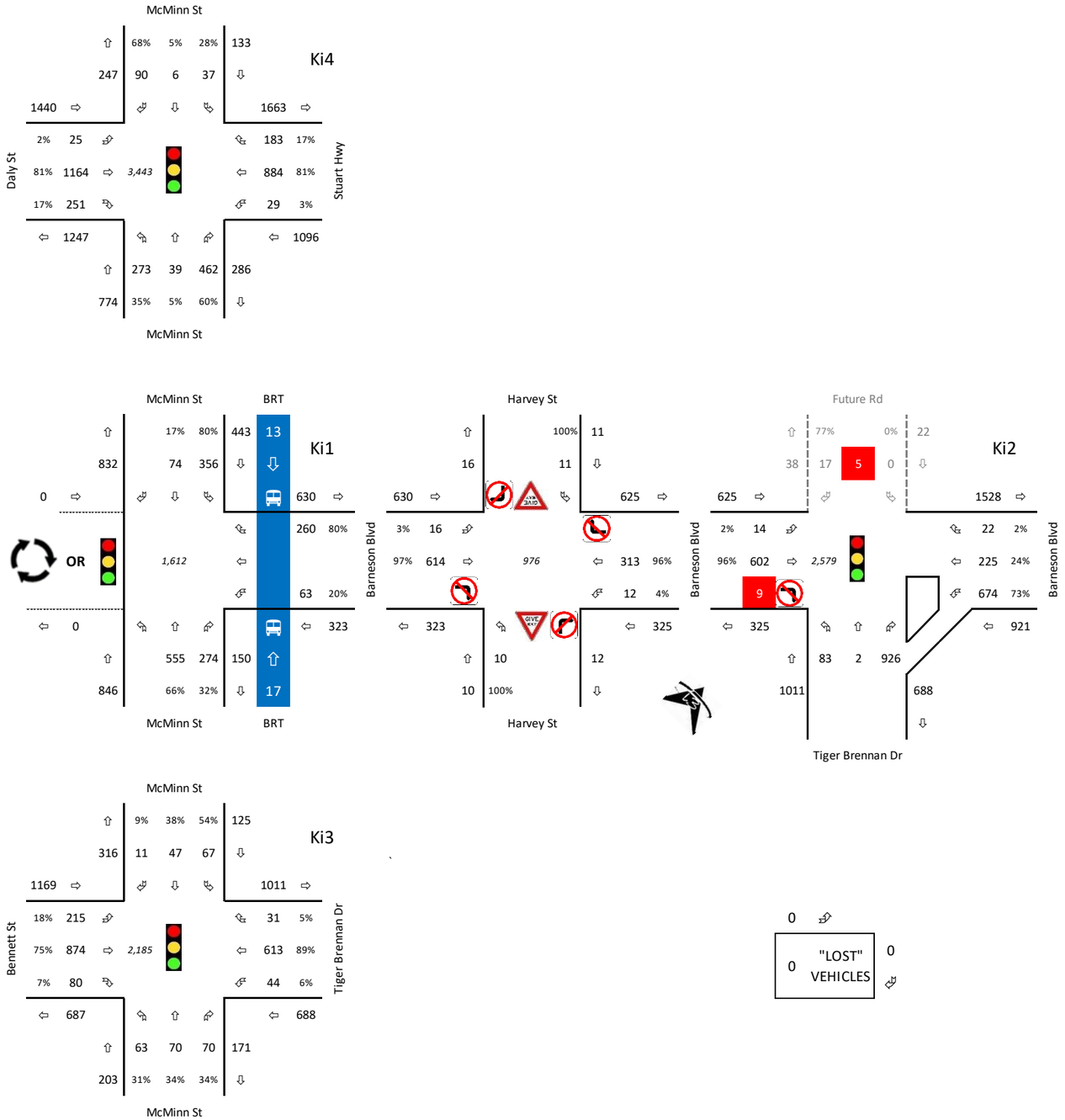


Figure 10 – Assessed Options 1&2 2031 PM Peak Hour Model

4 OPTIONS ASSESSMENTS

SIDRA Intersection models have been prepared for each Key intersection as shown in Figure 11 to Figure 15 below and on the following pages. Traffic signal phasing is included in **Appendix A.**

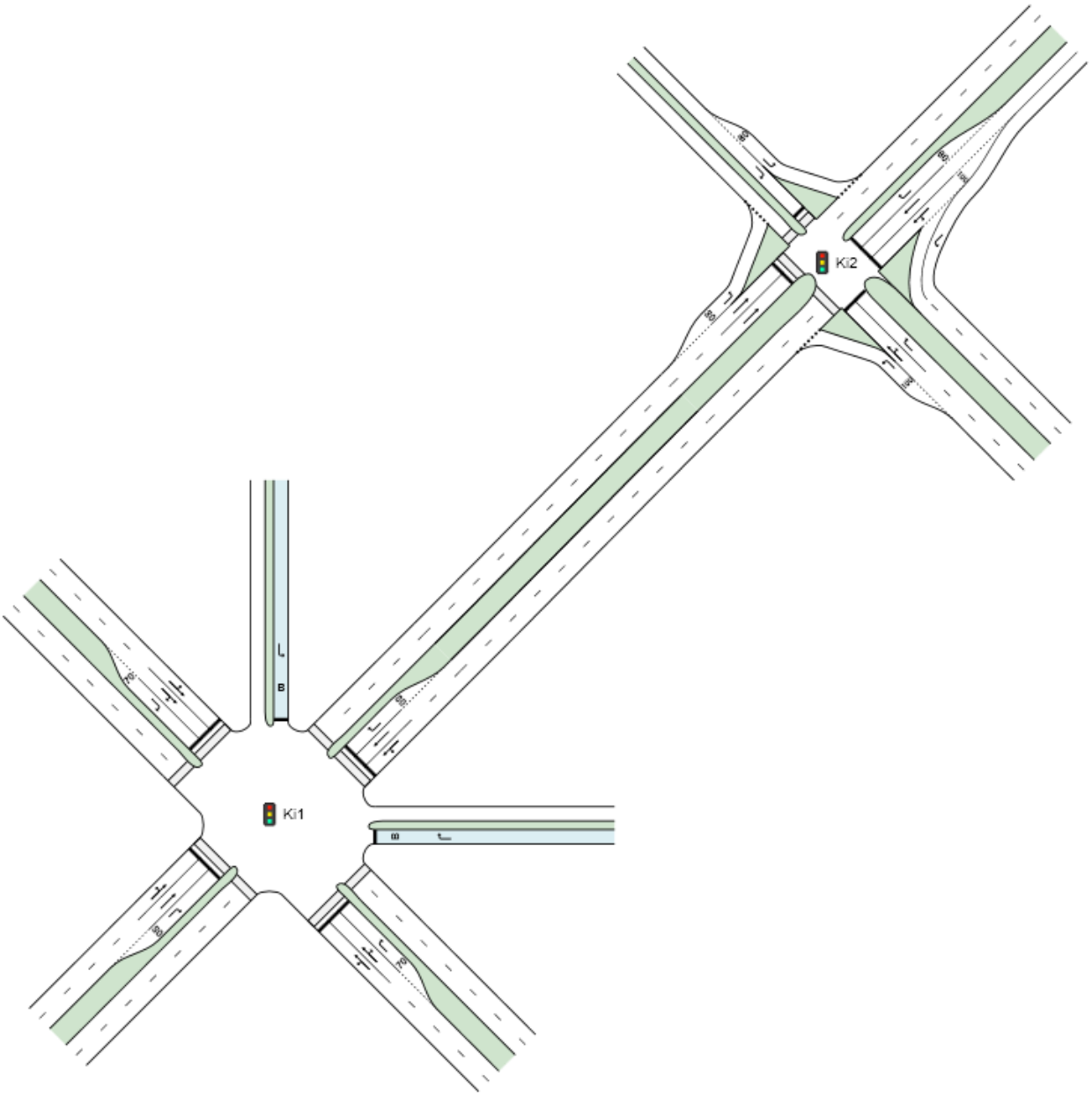


Figure 11 – Jacobs Model Network Ki1 – Ki2

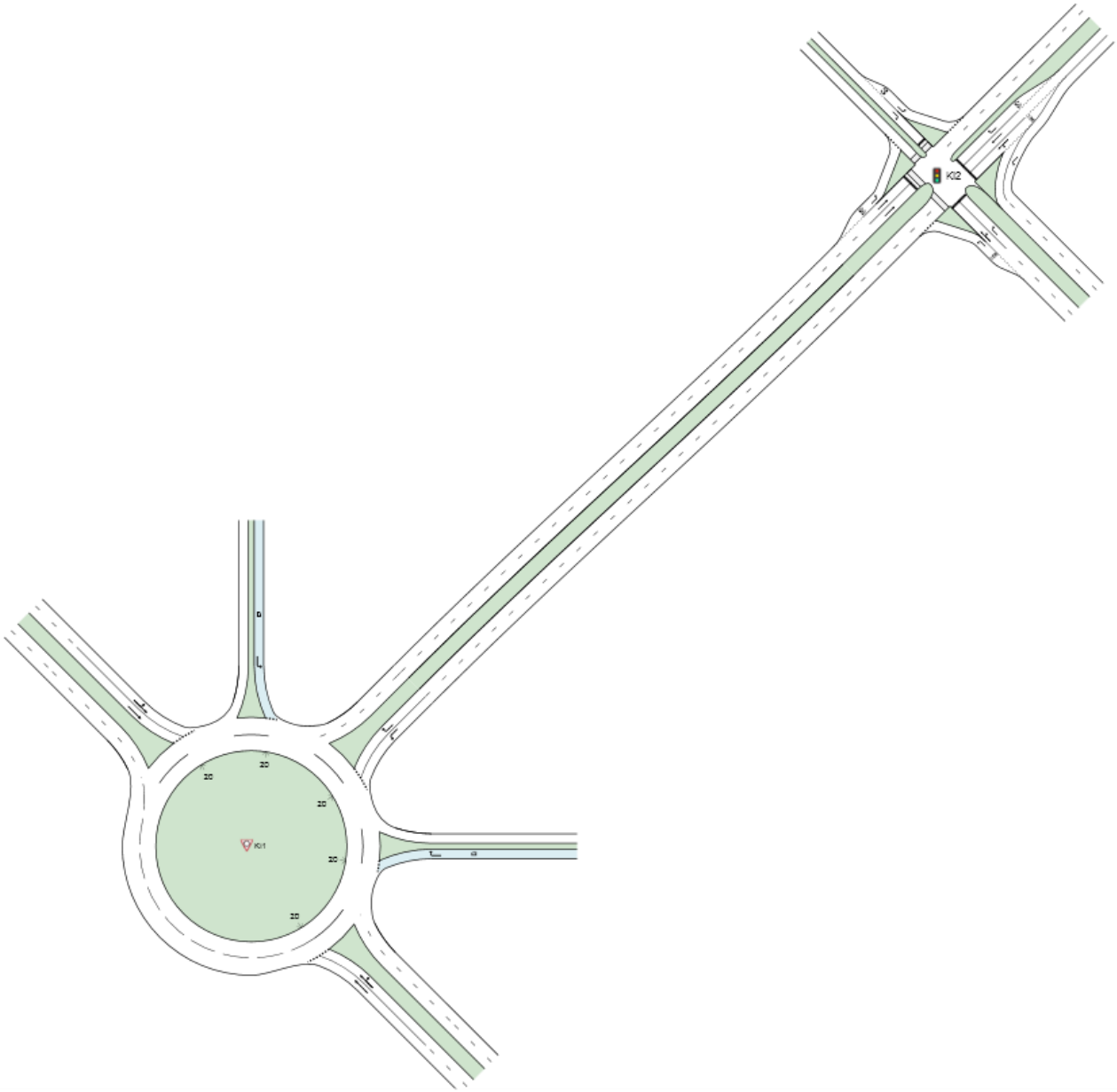


Figure 12 – Option 1 Model Network Ki1 – Ki2

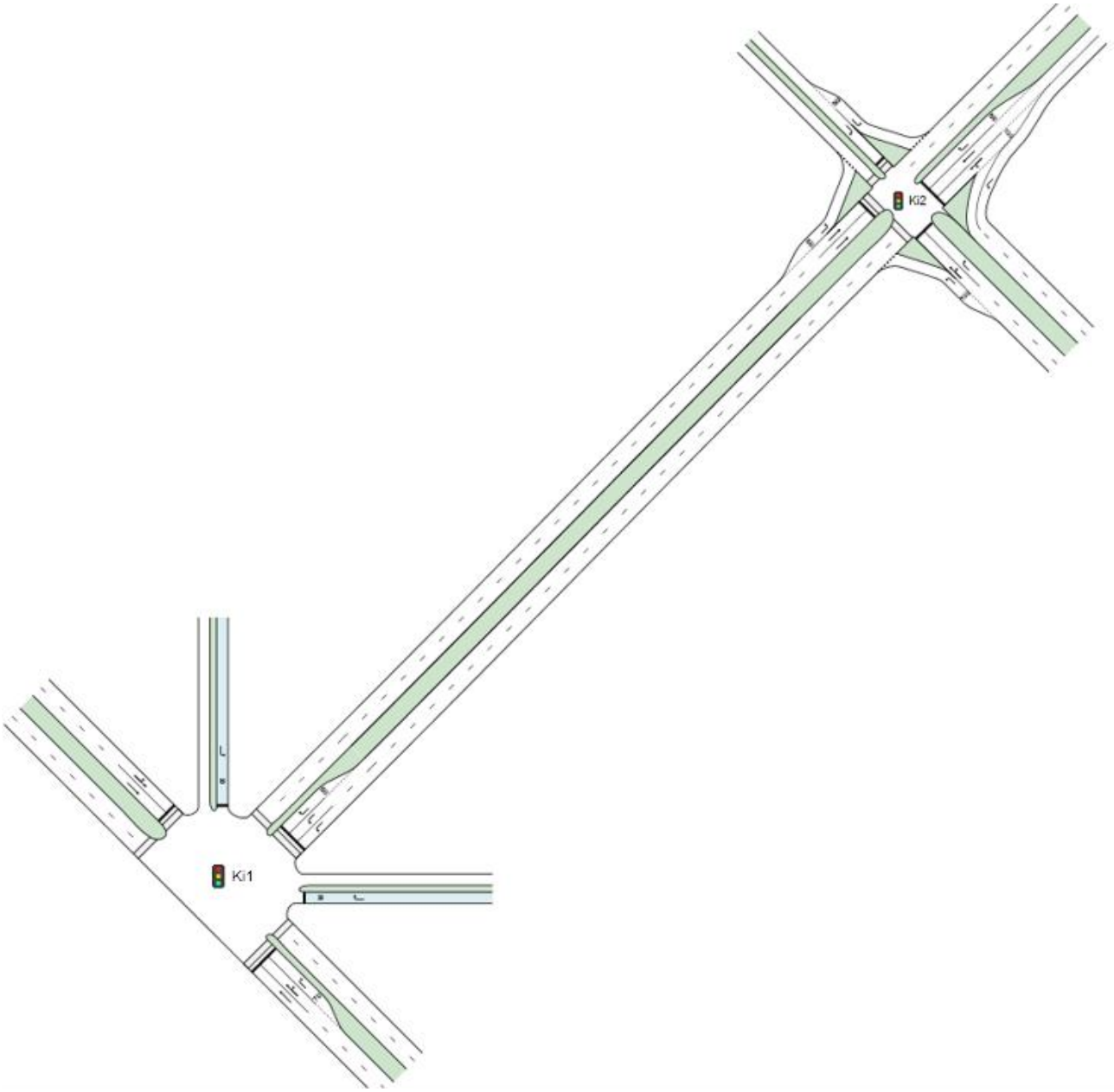


Figure 13 – Option 2 Model Network Ki1 – Ki2

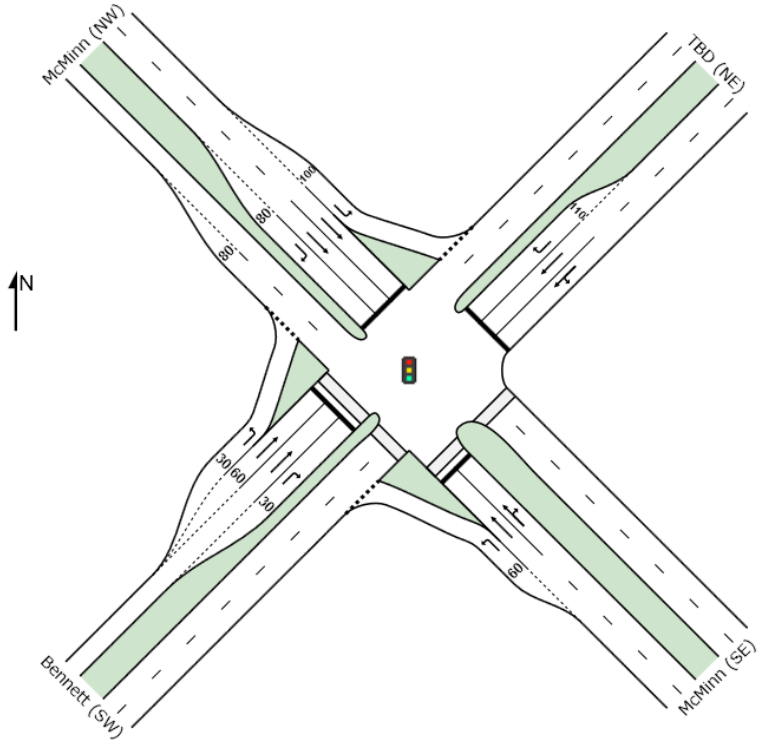


Figure 14 – Jacobs and Options 1 & 2 Model Ki3

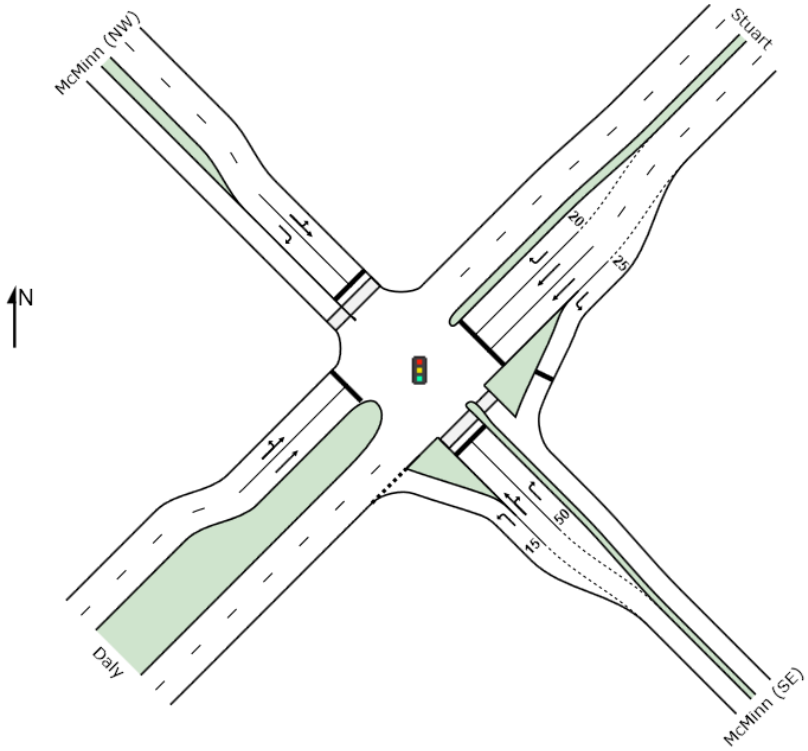


Figure 15 – Jacobs and Options 1 & 2 Model Ki4

The traffic data from the trip assignment models in **Section 3** was used as input data within each SIDRA Intersection model with the key performance indicators of 'Degree of Saturation", 'Average Delay', 'Level of Service' and '95% Back of Queue (m)' summarised for each intersection, movement and option and compared against the assessed Jacobs data.

An explanation of the various intersection performance criteria used is provided as Table 1 below.

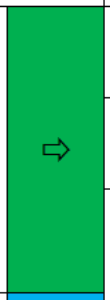
SIDRA v/c & colour code		LoS	Average Delay per vehicle (d) in seconds				v/c Range	Performance Comments
			Unsignalised intersections	Roundabouts	Signalised intersections	All (RTA)		
< 0.6		A	d ≤ 10	d ≤ 10	d ≤ 10	d ≤ 14.5	≤ 0.44	**Good operation and plenty of spare capacity** *Stable free flow conditions where drivers are able to select desired speeds and to easily manoeuvre within the traffic stream.*
		B	10 < d ≤ 15	10 < d ≤ 20	10 < d ≤ 20	14.5 < d ≤ 28.5		
		C	15 < d ≤ 25	20 < d ≤ 35	20 < d ≤ 35	28.5 < d ≤ 42.5	0.45 - 0.64	**Acceptable delays and spare capacity** *Stable flow but most drivers are restricted to some extent in their ability to select their desired speed and to manoeuvre within the traffic stream.*
0.6 - 0.7		D	25 < d ≤ 35	35 < d ≤ 50	35 < d ≤ 55	42.5 < d ≤ 56.5	0.65 - 0.84	**Acceptable delays** (Expected typical peak hour conditions) *Close to the limit of stable flow. All drivers are restricted in their ability to select their desired speed and to manoeuvre within the traffic stream. Small increases in traffic flow may cause operational problems.*
0.7 - 0.8								
0.8 - 0.9								
0.9 - 1.0		E	35 < d ≤ 50	50 < d ≤ 70	55 < d ≤ 80	56.5 < d ≤ 70.5	0.85 - 1.04	**Near capacity and senstive to disturbances in flows** *Traffic volumes are close to capacity and there is virtually no freedom to select desired speeds. Flow is unstable and minor disturbances within the traffic stream will cause breakdown leading to long queues and delays.*
> 1.0		F	50 < d	70 < d	80 < d	70.5 < d	> 1.25	**At Capacity** - Requires other control mode and/ or additional lanes *In the zone of forced flow where the amount of traffic approaching the point under consideration exceeds that which can pass. Flow breakdown occurs and extensive queues and delays result.*

Table 1 – Intersection performance criteria

The assessed Degree of Saturation performance criteria for each intersection and option for each peak hour is shown in the following sections. Degree of Saturation is defined as the ratio or arrival (or demand) flow to Capacity (also known as volume/ capacity, v/c ratio). Degrees of saturation above 1.o represent oversaturated conditions (demand flow exceeds capacity), and degrees of saturation below 1.0 represent undersaturated conditions (demand flow is below capacity). The Degree of Saturation is included in Column 1 of Table 1 above, as v/c.

4.1 KI1: BANESON BLVD/ MCMINN STREET & KI2: BARNESON BLVD/ TBD (NETWORK)

These two interactions have been assessed within a network model, as per the Jacobs Modelling Memo. The network model considers the influence of the operation of each intersection on the other intersection.

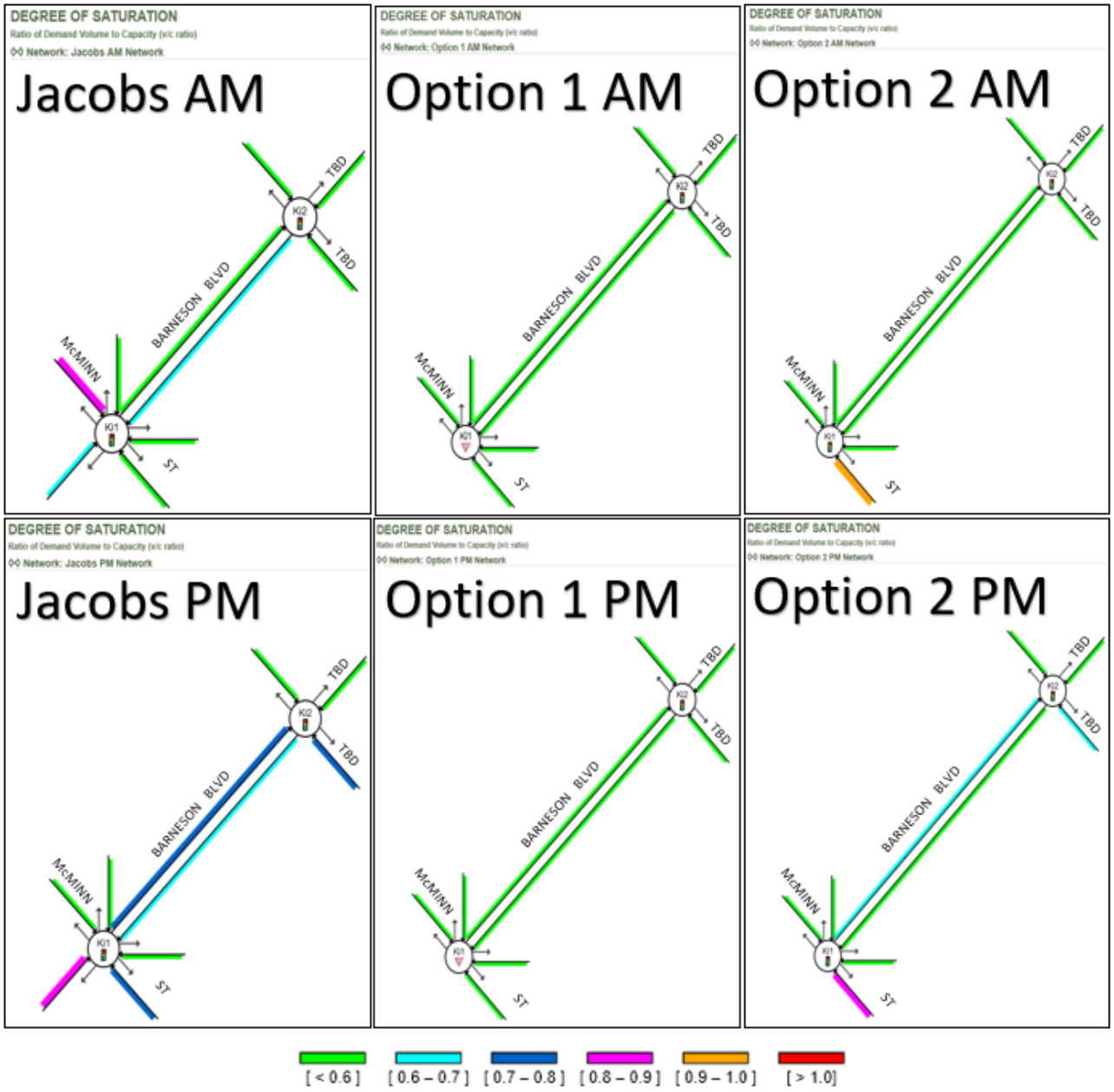


Figure 16 – Ki1 & Ki2 intersection assessment based on Degree of Saturation

A summary of the assessed 'Average Delay', 'Level of Service' and '95% Back of Queue (m) is shown in Table 2 and Table 3 on the following pages.

2031 AM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki1	**Barneson Blvd/ McMinn St**									
1	*McMinn neb left into Barneson*	51.5			D			86.9		
2	*McMinn neb straight ahead*	47.3	3.8	39.5	D	A	D	86.9	7.9	80.4
4	*McMinn neb right into Barneson*	62.1	8.3	60.1	E	A	E	51.6	7.9	48.6
5	*BRT nwb*	73.5	14.2	64.6	E	B	E	7.2	1.1	6.6
6	*Barneson swb left into McMinn*	41.2	4.7	40.7	D	A	D	99.4	5.5	24.6
7	*Barneson swb straight ahead*	36.6			D			102.0		
8	*Barneson swb right into McMinn*	42.5	8.8	43.3	D	A	D	63.2	6.1	63.8
9	*BRT seb*	74.6	11.1	65.4	E	B	E	13.7	2.4	12.5
10	*McMinn seb left into Barneson*	31.8	4.2	22.8	C	A	C	90.9	10.9	63.4
11	*McMinn seb straight ahead*	28.6	4.1	17.4	C	A	B	102.0	10.9	64.7
12	*McMinn seb right into Barneson*	42.7			D			114.1		
13	*Barneson neb left into McMinn*	57.1			E			82.0		
14	*Barneson neb straight ahead*	52.6			D			83.4		
15	*Barneson neb right into McMinn*	54.4			D			14.0		
All Vehicles		**42.9**	**5.6**	**35.5**	**D**	**A**	**D**	**114.1**	**10.9**	**80.4**

2031 PM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki1	**Barneson Blvd/ McMinn St**									
1	*McMinn neb left into Barneson*	44.7			D			133.9		
2	*McMinn neb straight ahead*	42.0	4.6	41.5	D	A	D	133.9	18.4	128.8
4	*McMinn neb right into Barneson*	53.4	9.3	52.4	D	A	D	106.9	18.1	113.2
5	*BRT nwb*	68.9	12.0	77.0	E	B	E	14.3	1.9	15.9
6	*Barneson swb left into McMinn*	29.9	3.9	28.3	C	A	C	47.6	2.7	8.6
7	*Barneson swb straight ahead*	25.3			C			48.4		
8	*Barneson swb right into McMinn*	34.8	7.8	32.3	C	A	C	81.7	8.0	83.1
9	*BRT seb*	68.4	10.1	76.3	E	B	E	10.9	1.9	12.1
10	*McMinn seb left into Barneson*	24.1	4.6	23.8	C	A	C	78.3	14.9	86.6
11	*McMinn seb straight ahead*	28.7	5.5	27.0	C	A	C	33.7	4.0	18.8
12	*McMinn seb right into Barneson*	47.4			D			43.5		
13	*Barneson neb left into McMinn*	54.8			D			91.1		
14	*Barneson neb straight ahead*	50.1			D			93.3		
15	*Barneson neb right into McMinn*	49.3			D			7.0		
All Vehicles		**39.8**	**6.1**	**37.4**	**D**	**A**	**D**	**93.3**	**18.4**	**128.8**

Table 2 – Ki1: Barneson Blvd/ McMinn St Average Delay, Level of Service & Queue Assessment

2031 AM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki2	**Barneson Blvd/ Tiger Brennan Dr**									
16	*TBD nwb left into Barneson*	8.6	7.4		A	A		0.3	1.8	
17	*TBD nwb straight into New Rd*	42.5	28.5		D	C		11.8	85.2	
18	*TBD nwb right into TBD*	48.1	34.1		D	C		11.8	85.2	
19	*TBD swb left into TBD*	9.6	5.7		A	A		17.3	0.0	
20	*TBD swb straight into Barneson*	18.2	28.3		B	C		17.9	86.4	
21	*TBD swb right into New Rd*	71.1	71.1		E	E		0.1	0.5	
22	*New Rd left into TBD*	11.3	9.6		B	A		0.0	0.1	
23	*New Rd right into Barneson*	74.1	74.1		E	E		1.4	9.7	
24	*Barneson left into New Rd*	5.9	5.9		A	A		0.0	0.3	
25	*Barneson straight into TBD neb*	25.8	36.9		C	D		16.7	78.2	
All Vehicles		**21.7**	**19.6**		C	B		**17.9**	**86.4**	

2031 PM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki2	**Barneson Blvd/ Tiger Brennan Dr**									
16	*TBD nwb left into Barneson*	7.6	6.9		A	A		6.5	5.1	
17	*TBD nwb straight into New Rd*	38.0	28.9		D	C		178.7	162.9	
18	*TBD nwb right into TBD*	43.7	34.5		D	C		179.9	162.9	
19	*TBD swb left into TBD*	8.4	12.1		A	B		86.7	63.9	
20	*TBD swb straight into Barneson*	24.1	29.5		C	C		87.8	63.9	
21	*TBD swb right into New Rd*	74.3	74.3		E	E		10.7	10.7	
22	*New Rd left into TBD*	21.6	16.0		C	B		0.2	0.2	
23	*New Rd right into Barneson*	73.9	73.9		E	E		8.2	8.2	
24	*Barneson left into New Rd*	6.0	6.0		A	A		0.3	0.3	
25	*Barneson straight into TBD neb*	37.9	43.7		D	D		187.3	122.6	
All Vehicles		**30.4**	**29.9**		C	C		**187.3**	**162.9**	

Table 3 – Ki2: Barneson Blvd/ Tiger Brennan Dr Average Delay, Level of Service & Queue Assessment

The intersection performance assessment data indicates that there are significant improvements to the assessed delays with Option 1, i.e. terminating Barneson Boulevard at McMinn Street and providing a dual lane roundabout at this intersection. The overall average delay with the current Jacobs 4-way traffic signal controlled layout is assessed as around 40 seconds in the SIDRA Model prepared by i3 consultants for this review and between 45-50 seconds in the Jacobs Modelling Memo SIDRA report. The assessed overall average delay with Barneson Blvd terminating at McMinn St is 6 seconds with roundabout control and between 35 and 40 seconds with traffic signal control.

Figure 16, Table 2 and Table 3 above indicates that all layouts and options would perform at an acceptable level and that Option 2 performs at the best level, i.e. “Good operation and plenty of spare capacity”.

4.2 KI3: BENNETT ST/ MCMINN ST

This intersection has been modelled as a standalone intersection. Options 1 & 2 reflect the forecast changed traffic volumes and movements associated with the removal of the Barneson Blvd section between McMinn St and Cavanaugh St, as indicated in **Section 3** of this assessment.

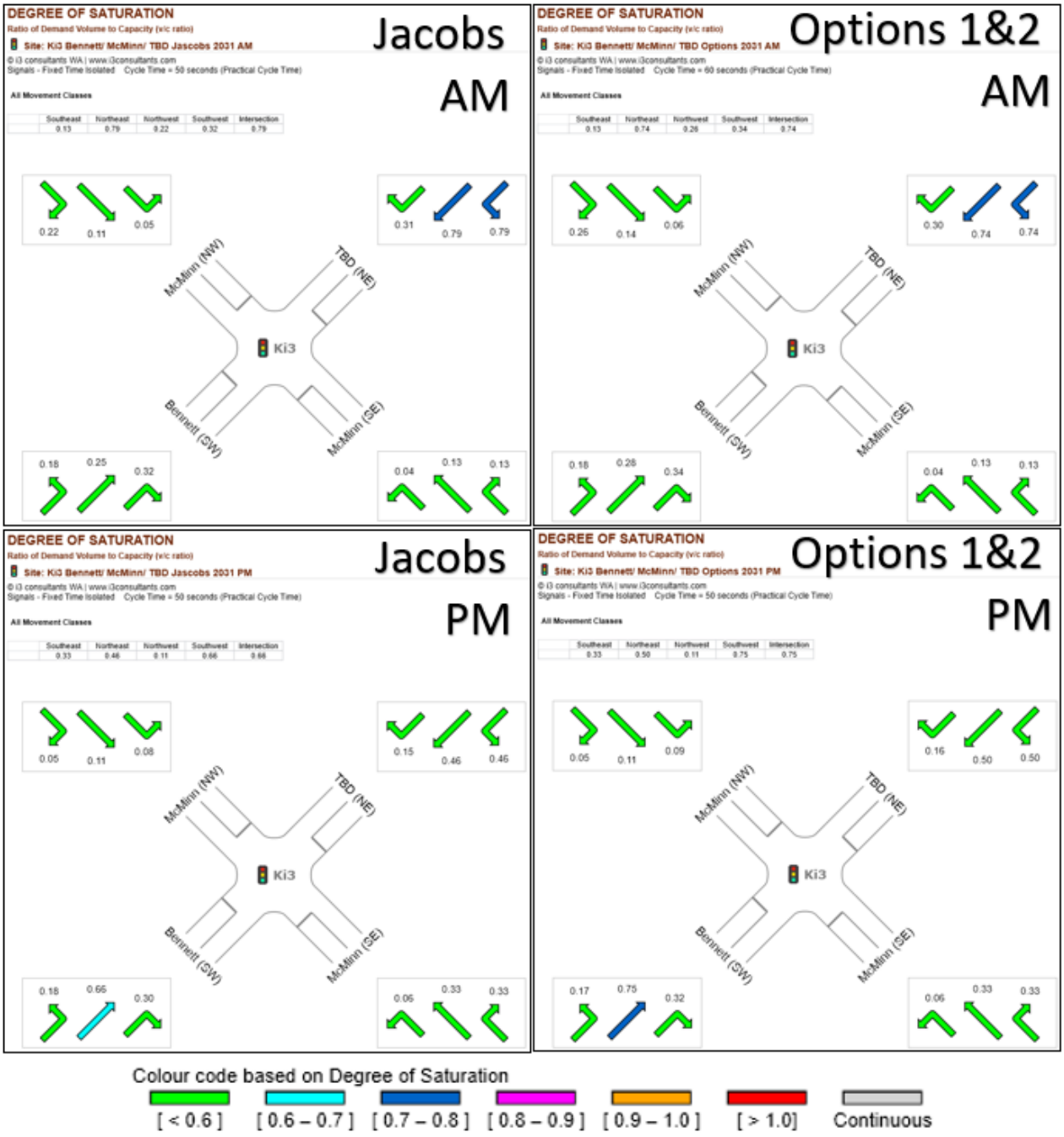


Figure 17 – Ki3 intersection assessment based on Degree of Saturation

A summary of the assessed 'Average Delay', 'Level of Service' and '95% Back of Queue (m) is shown in Table 4 on the following page.

2031 AM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki3	**Bennett St/ Tiger Brennan Dr/ McMinn St**									
26	*McMinn nwb left into Bennett*	10.1	10.9		B	B		2.4	3.0	
27	*McMinn nwb straight ahead*	20.1	24.6		C	C		5.9	7.1	
28	*McMinn nwb right into TBD*	26.0	30.5		C	C		5.9	7.1	
29	*TBD left into McMinn*	24.8	21.7		C	C		97.3	116.5	
30	*TBD straight into Bennett*	19.2	16.2		B	B		98.0	117.1	
31	*TBD right into McMinn*	20.9	20.1		C	C		16.8	18.1	
32	*McMinn seb left into TBD*	7.0	6.9		A	A		1.9	2.2	
33	*McMinn seb straight ahead*	22.5	28.2		C	C		4.3	5.3	
34	*McMinn seb right into Bennett*	28.6	34.5		C	C		8.1	10.0	
35	*Bennett left into McMinn*	7.1	7.0		A	A		7.5	8.3	
36	*Bennett straight into TBD*	12.4	11.3		B	B		21.4	32.2	
37	*Bennett right into McMinn*	29.4	30.8		C	C		9.7	11.0	
All Vehicles		**17.4**	**15.7**		B	B		**98.0**	**32.2**	

2031 PM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki3	**Bennett St/ Tiger Brennan Dr/ McMinn St**									
26	*McMinn nwb left into Bennett*	7.7	7.7		A	A		2.9	2.9	
27	*McMinn nwb straight ahead*	20.8	20.8		C	C		15.9	15.9	
28	*McMinn nwb right into TBD*	26.9	26.9		C	C		15.9	15.9	
29	*TBD left into McMinn*	19.1	19.4		B	B		42.8	47.7	
30	*TBD straight into Bennett*	13.6	13.8		B	B		43.1	48.0	
31	*TBD right into McMinn*	25.6	26.7		C	C		5.1	5.2	
32	*McMinn seb left into TBD*	9.0	9.4		A	A		4.2	4.4	
33	*McMinn seb straight ahead*	22.4	22.4		C	C		4.0	4.0	
34	*McMinn seb right into Bennett*	27.8	27.8		C	C		1.9	1.9	
35	*Bennett left into McMinn*	6.9	6.9		A	A		6.6	6.6	
36	*Bennett straight into TBD*	15.1	17.2		B	B		64.5	76.4	
37	*Bennett right into McMinn*	23.6	23.8		C	C		12.8	12.9	
All Vehicles		**14.8**	**15.7**		B	B		**64.5**	**76.4**	

Table 4 – Ki3: Bennett St/ Tiger Brennan Dr/ McMinn St Average Delay, Level of Service & Queue Assessment

Figure 17 and Table 4 above indicates the performance of this intersection would not be adversely affected by the alternate design and will continue to operate with acceptable delays on Bennett Street.

The provision of the Barneson Blvd link provides an opportunity to review the need for right turns at this intersection due to the available alternative routes which in turn would reduce overall delays through this intersection.

4.3 KI4: DALY ST/ MCMINN ST/ STUART HWY

This intersection has been modelled as a standalone intersection. Options 1 & 2 reflect the forecast changed traffic volumes and movements associated with the removal of the Barneson Blvd section between McMinn St and Cavanaugh St, as indicated in **Section 3** of this assessment but without right turns from Daly St into McMinn St due to modeling based on the current layout.

Figure 18 – Ki4 intersection assessment based on Degree of Saturation

A summary of the assessed 'Average Delay', 'Level of Service' and '95% Back of Queue (m) is shown in Table 5 on the following page.

2031 AM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki4	**Daly St/ McMinn St/ Stuart Hwy**									
38	*McMinn nwb left into Daly*	10.2	23.1		B	C		19.3	53.0	
39	*McMinn nwb straight ahead*	24.1	42.0		C	D		19.6	32.8	
40	*McMinn nwb right into Stuart*	29.7	47.6		C	D		19.6	32.8	
41	*Stuart left into McMinn*	10.2	8.7		B	A		36.4	8.7	
42	*Stuart straight into Daly*	21.3	28.2		C	C		82.2	255.9	
43	*Stuart right into McMinn*	21.1	41.4		C	D		34.7	69.0	
44	*McMinn seb left into Stuart*	27.8	39.7		C	D		27.4	20.9	
45	*McMinn seb straight ahead*	25.3	37.3		C	D		27.4	20.9	
46	*McMinn seb right into Daly*	26.2	45.7		C	D		16.6	51.0	
47	*Daly left into McMinn*	16.6	15.0		B	B		24.3	50.1	
48	*Daly straight into Stuart*	11.1	9.4		B	A		24.3	50.1	
All Vehicles		**18.0**	**26.4**		B	C		**82.2**	**255.9**	

2031 PM Peak Hour		Average Delay (s)			Level of Service			95% Back of Queue (m)		
		Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2	Jacobs	Option 1	Option 2
Ki4	**Daly St/ McMinn St/ Stuart Hwy**									
38	*McMinn nwb left into Daly*	8.0	16.9		A	B		18.5		
39	*McMinn nwb straight ahead*	30.2	204.5		C	F		41.5		
40	*McMinn nwb right into Stuart*	36.3	131.7		D	F		88.5		
41	*Stuart left into McMinn*	8.3	7.4		A	A		9.9		
42	*Stuart straight into Daly*	15.4	18.4		B	B		60.7		
43	*Stuart right into McMinn*	86.2	448.8		F	F		83.5		
44	*McMinn seb left into Stuart*	38.7	59.0		D	E		24.6		
45	*McMinn seb straight ahead*	36.3	56.6		D	E		24.6		
46	*McMinn seb right into Daly*	37.0	64.5		D	E		10.5		
47	*Daly left into McMinn*	22.2	24.1		C	C		75.3		
48	*Daly straight into Stuart*	16.6	18.6		B	B		75.5		
All Vehicles		**24.8**	**63.5**		B	B		**88.5**		

Table 5– Ki4: Daly St/ McMinn St/ Stuart Hwy Average Delay, Level of Service & Queue Assessment

Figure 17 and Table 5 above indicates that the layout of this intersection requires modifications as per that shown and used in the VISSUM model (i.e. Figure 2 on page 2) to accommodate the changed traffic movements and volumes indicated in the VISSUM model. Refer **Section 5** for further comment on these forecast volumes.

The PM peak hour assessment indicates that the Daly St/ McMinn St/ Stuart Hwy intersection would exceed acceptable capacity levels (i.e. Level of Service F) for the McMinn Street westbound right and straight-ahead movements as well as the Stuart Hwy straight ahead movement into Daly St.

The layout of this intersection has been modelled 'as is'. On a like for like basis, this is a shortcoming of the alternate recommendation to terminate Barneson at McMinn. Note however such pressures are not uncommon when considering a network in isolation. It is highly likely that modelling of this intersection as per the VISSUM model layout in the Jacobs Modelling Memo would address this.

Similar to the model of inter-connected review of Ki1 & Ki2, it is recommended that an interconnected review of Ki4 with Daily & Cavanagh St is considered, noting that should Ki4 become congested, drivers have the choice of a less disrupted journey via Cavanagh St or alternatively linking with Barneson Blvd and exiting to the City's northwest via Woolner Rd.

It is beyond the scope of this initial desktop study to prepare and design detailed traffic signal models for these intersections, particularly as these details are not included in the Jacobs Modelling memo.

A comparison between the current layout and VISSUM model layout is provided as Figure 19 below.

Figure 19 – Ki4: Daly St/ McMinn St/ Stuart Hwy Existing Layout v VISSUM layout

SIDRA Intersection summary reports are included in **Appendix A**.

4.4 KI5: BARNESON BLVD/ CAVENAGH ST

This intersection has been modelled as part of this assessment as it is not an intersection in the alternate design, i.e. Barneson Boulevard terminates at McMinn Street and does not extend to Cavenagh St.

The VISUM model within the Jacobs Modelling Memo indicates expected average delays of 0 and 1 second for through traffic on Cavanaugh Street during peak hours, as shown in the extract provided as Table 6 below.

Movement	Vehicles	Ave Delay (s)	LOS	Ave Q	Max Q
AM Peak Hour	**Barneson Boulevard/ Cavenagh Street**				
Barneson Blvd NE left	108	22	B	9	50
Barneson Blvd NE right	277	24	B	9	50
Cavenagh St NW left	120	10	A	3	35
Cavenagh St NW through	203	1	A	0	0
Cavenagh St SE through	296	0	A	0	0
Cavenagh St SE right	294	15	B	20	29
Overall LOS	**1299**		A		
PM Peak Hour	**Barneson Boulevard/ Cavenagh Street**				
Barneson Blvd NE left	66	36	C	14	79
Barneson Blvd NE right	677	19	B	14	79
Cavenagh St NW left	103	22	B	10	38
Cavenagh St NW through	223	1	A	0	0
Cavenagh St SE through	317	0	A	0	0
Cavenagh St SE right	364	7	A	10	29
Overall LOS	**1750**		A		

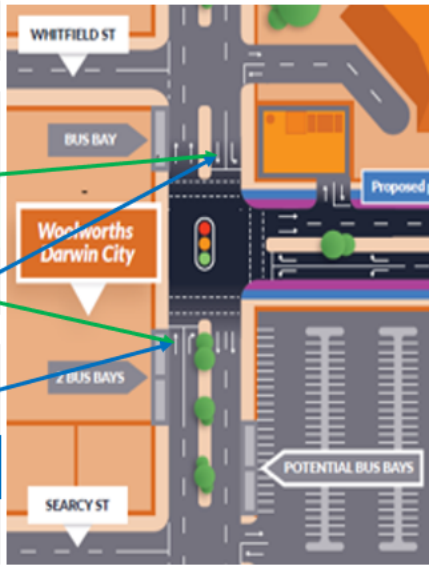


Table 6 – Jacobs VISSUM model intersection outputs for Ki5: Barneson Blvd/ Cavenagh St

It is difficult to associate the above 'Average Delay' data (and hence all other data) with the proposal to introduce traffic signals at this location, particularly as it is proposed to provide pedestrian phases across Cavenagh St. This suggests that delays associated with pedestrian movements in the CBD have not been considered within the VISSUM model and hence further questions the 'robustness' of this model for this proposal.

5 FORECASTING TRIP VOLUMES

This Jacobs Modelling Memo does not provide any details indicating how traffic generation to and from the Darwin CBD is assigned to the three major access roads, i.e. Stuart Hwy, Tiger Brennan Drive and the new Barneson Boulevard link, other than to refer to previous VISSUM models.

The Jacobs Modelling Memo indicates that 2031 volumes were obtained by applying 1.5% per annum growth to the previous 2027 model. It does not indicate whether the same simplistic approach was applied to obtaining the previous 2027 volumes.

Forecasting traffic volumes beyond the current 5-year period (i.e. beyond 2023) is fraught with danger due to the introduction of autonomous vehicles in this time frame. Researchers argue that the disruption brought about by autonomous vehicles, including mobility-as-a-service could double or triple road capacity due to its ability to operate synchronously and with greatly-reduced spacing compared to manually-driven vehicles (Mulligan C. (2014) ICT & the Future of Transport: part 2/8 industry).

In addition to the advent of disruptive autonomous vehicles, the use of straight line growth projections with no regard for limits of capacity of the selected routes and the resulting attractiveness of alternative routes is also fraught with danger. For example, applying straight line growth of 1.5% per annum to the recorded daily traffic volumes on Stuart Hwy and Tiger Brennan Drive at the nearest data collection points to the CBD in 1994 results in a significant over-estimation of traffic volumes on Stuart Hwy and under-estimation of traffic volumes on Tiger Brennan Drive for 2016, as shown in Figure 20 below. This is further complicated by the fact that traffic growth is applied to peak hour volumes and there is much greater flexibility in managing peak hour volumes than there is in managing daily volumes.

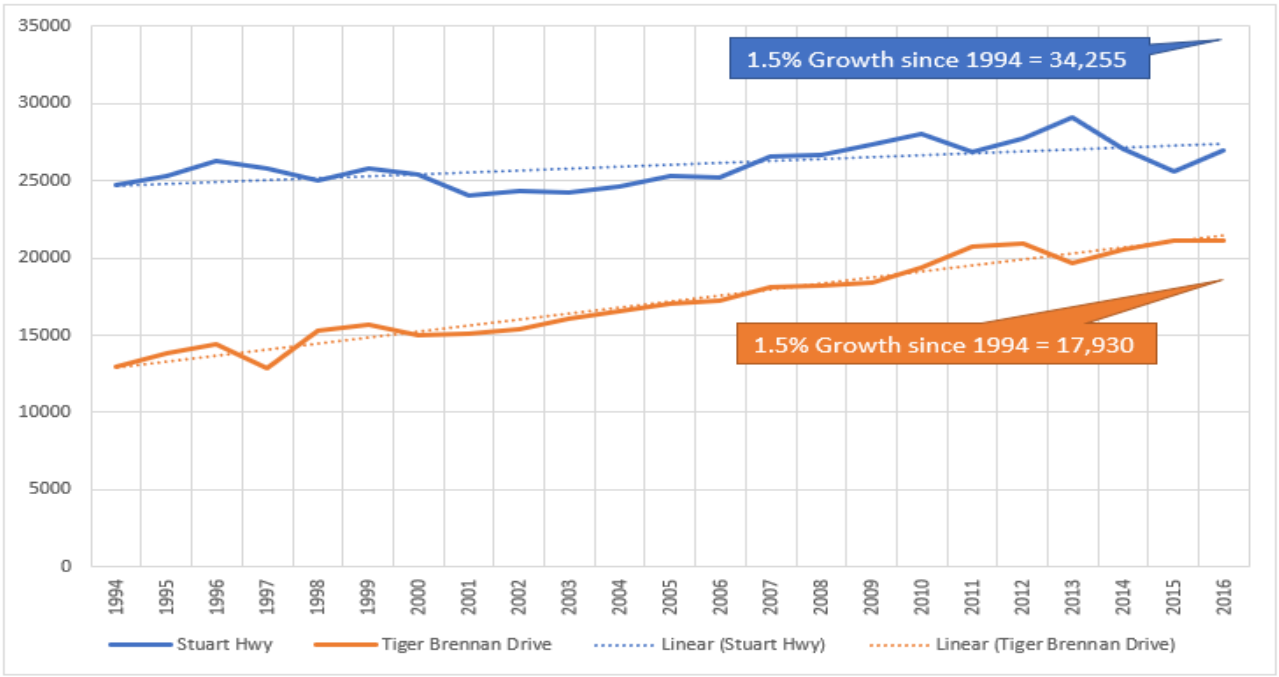


Figure 20 – Actual daily traffic volumes on Stuart Hwy and TBD north of the CBD since 1994

A further factor to consider in forecasting volumes is the influence of induced demand. This is particularly relevant to the Barneson Boulevard proposal as it is designed to accommodate higher volumes of traffic into and out of the CBD. This in turn is likely to encourage higher volumes of traffic into and out of the CBD as those drivers who previously found it difficult to access the CBD and used alternative forms of transport, or simply avoided peak hours, will now find it more attractive to drive to and from the CBD during peak hours.

Page 8 of the Jacobs Modelling Memo indicates that a 60%/ 40% split has been used for inbound traffic on Tiger Brennan Drive as it approaches Barneson Boulevard, i.e. 60% continue left towards Bennett St/ McMinn St and 40% turn into Barneson Blvd. There is no indication how this split was determined.

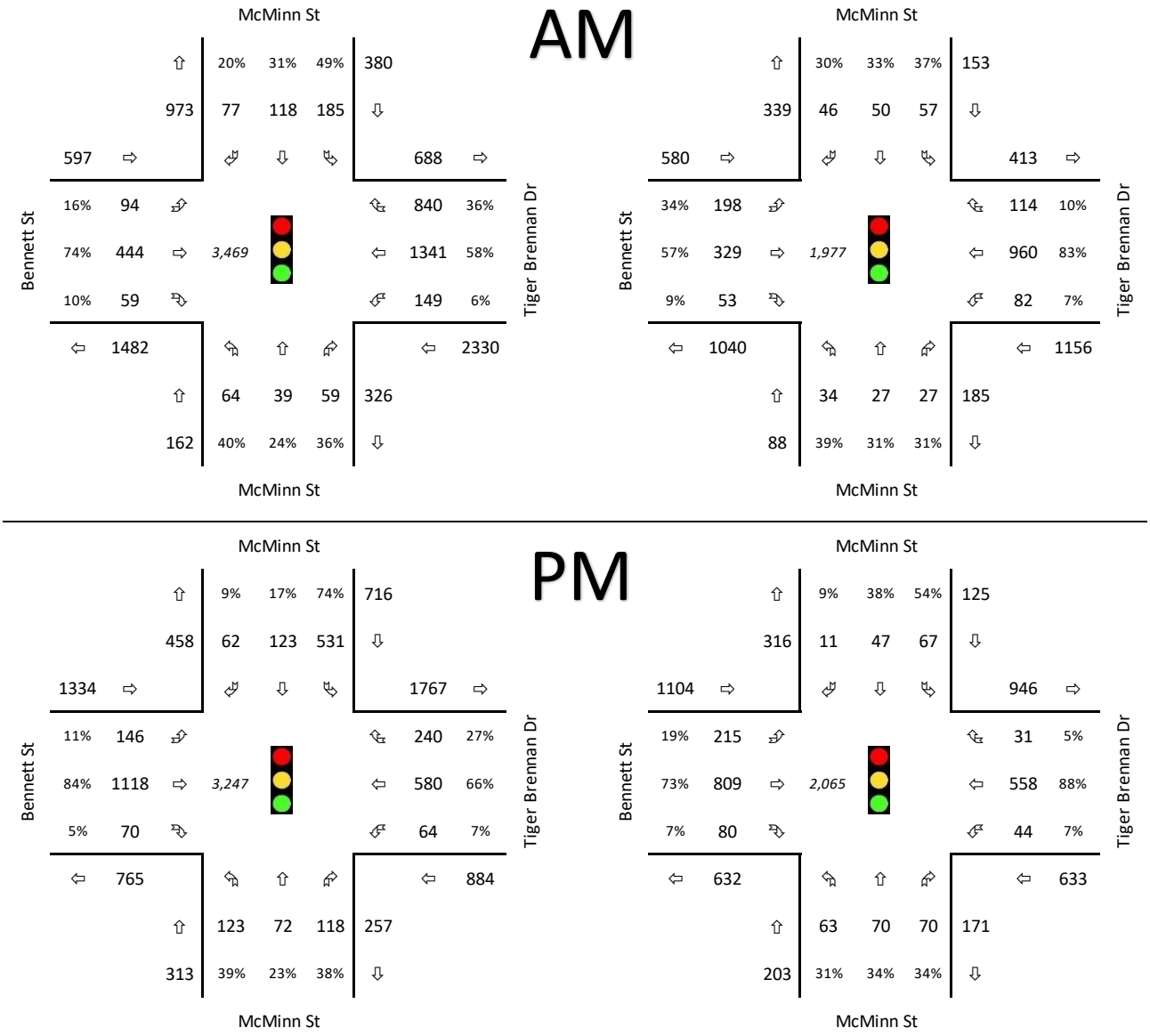
In June 2013, Tonkin Consulting published a comprehensive "Darwin CBD Parking Strategy" Report. This report included origin-destination data based on 1,000 vehicle number plates. This data would assist in determining the attractiveness of each route into the City and may provide a better estimate of the 60%/ 40% split used.

A review of a previous traffic models for the Bennett St/ McMinn St/ Tiger Brennan Drive intersection has revealed significant differences in forecast traffic volumes that raises concerns with the validity of the following statements in Section 2.4 of the Jacobs Modelling Memo:

"The 2012 Base Year Darwin CBD VISSIM model was calibrated and validated to a high level against observed traffic data and conditions, providing a robust base for the future scenario assessment undertaken for this study. The good level of calibration achieved gives confidence that the model provides good replication of travel conditions and driver behaviour, and that the traffic assignment through the network is sensible."

"The 2031 forecast model was developed based on known planned development for the CBD as well as travel demands from the Darwin Strategic Traffic model, which itself is based on up-to-date land use and planning data forecasts for Greater Darwin."

Earlier models, as well as SCATS data and manual traffic surveys undertaken in Bennett Street, indicate higher traffic volumes in this street than indicated in the 2031 VISSUM model. It is acknowledged that the provision of the Barneson Boulevard link will draw some traffic away from the TBD approach to this intersection, however, the traffic generators on Bennett St (the extension of TBD over McMinn St) have not diminished and the current proposal to develop a 450-space car park in Civic Square as well as other traffic generating developments at this end of the CBD will result in an increase in traffic to and from Bennett Street, not a decrease. A comparison between an earlier model and the VISSUM model is provided as Figure 21 on the following page.



TTM 6 Carey St Traffic and Transport Assessment Report 2024 Volumes

Jacobs Modelling Memo VISSUM 2031 Volumes

Figure 21 – Comparison of Ki3 (Bennett St/ McMinn St/ TBD) intersection models

In addition to the preceding modelling issues, there is a proposal for a link road to be provided between Bagot Road and Tiger Brennan Dr that would significantly change the proportion of traffic using each access route. This proposal is known as the Snell St link and is shown, along with the Barneson Blvd link, in Figure 22 below.

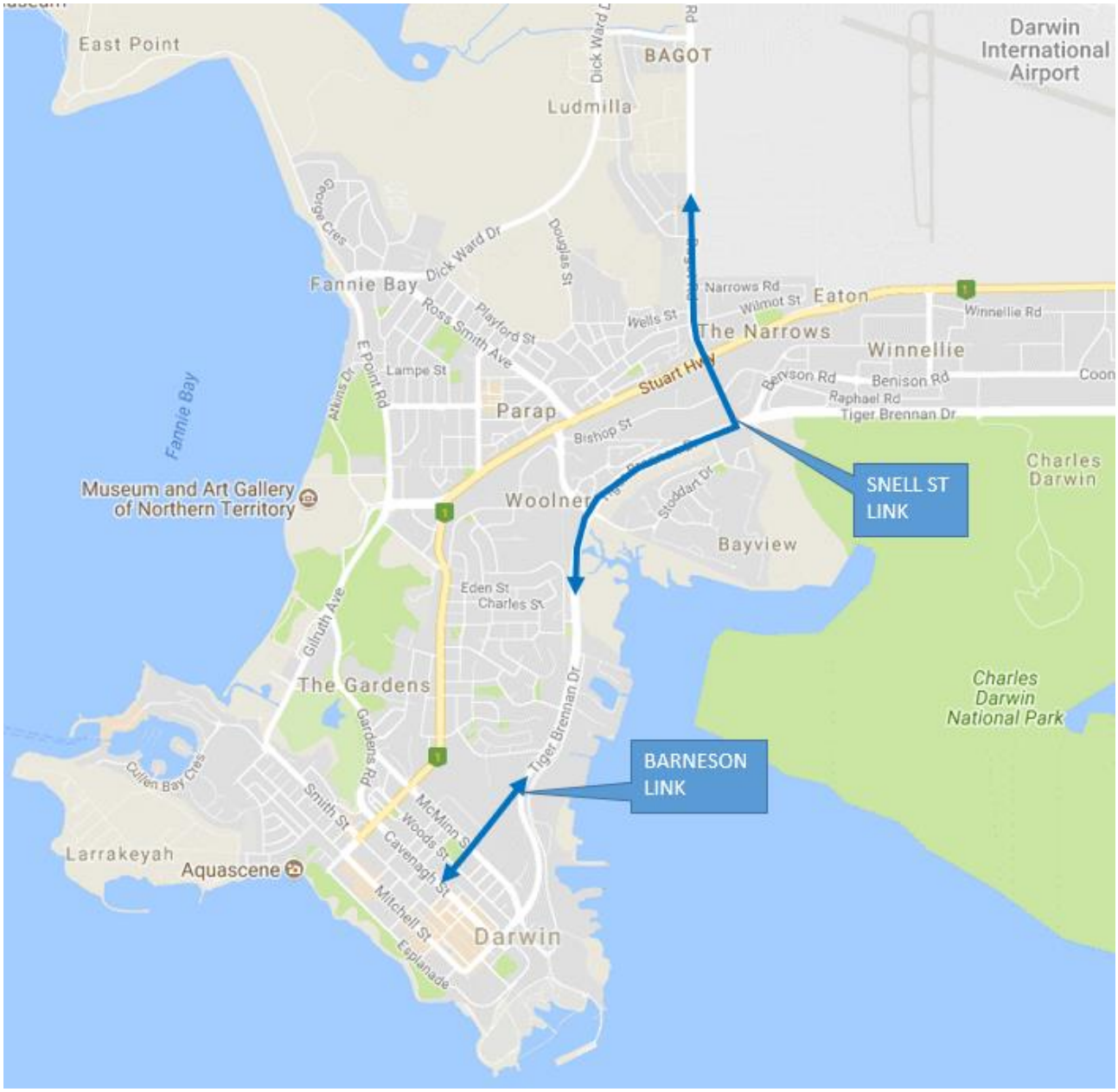


Figure 22 – Barneson Link & Snell St Link

6 WOODS STREET

Woods Street currently carries traffic between Daly Street and Bennett Street. The Barneson Boulevard project will result in Woods Street being separated into two sections with a cul-de-sac on the northwest side and restricted left-in/ left-out only turns on the southeast side of Barneson Boulevard, as shown in the composite plan provided as Figure 23 below.

Figure 23 – Composite proposal plan showing Woods Street treatment

In addition to reducing activity in Woods Street, there will be a reduction in connectivity and accessibility and a need to review each side road connection with Woods Street to ensure that priority is given to the prevalent flow. For example, the intersection of Lindsay St/ Woods St in Figure 23 above would require a change in the STOP control so that Lindsay Street becomes the through road.

The Jacobs Modelling Memo includes a VISSUM model diagram showing "PM Peak left turn from Woods Street into Barneson Boulevard" (page 24) that redirects approximately 450 vehicles in an hour from Woods Street southeast of Barneson Boulevard into Barneson Boulevard (left turn) and then a right turn into Cavenagh Street. This model is reproduced as Figure 24 on the following page. The Jacobs Modelling Memo

does not assess the impact of these significant changes on the road network other than in terms of traffic volumes, i.e.:

"There is a relatively high volume of traffic turning right from Barneson Boulevard onto Cavenagh Street (around 700 vehicles). Of this traffic, around 60% originates from Woods Street (developments of Woods Street and areas to the east of Woods Street) and the remainder from areas north of Barneson Boulevard."

The above statement confirms that the proposal will have a significant impact on both Woods Street and Cavenagh Street. The alternate proposal to terminate Barneson Boulevard at McMinn Street would have little or no impact on Woods Street or Cavenagh Street.

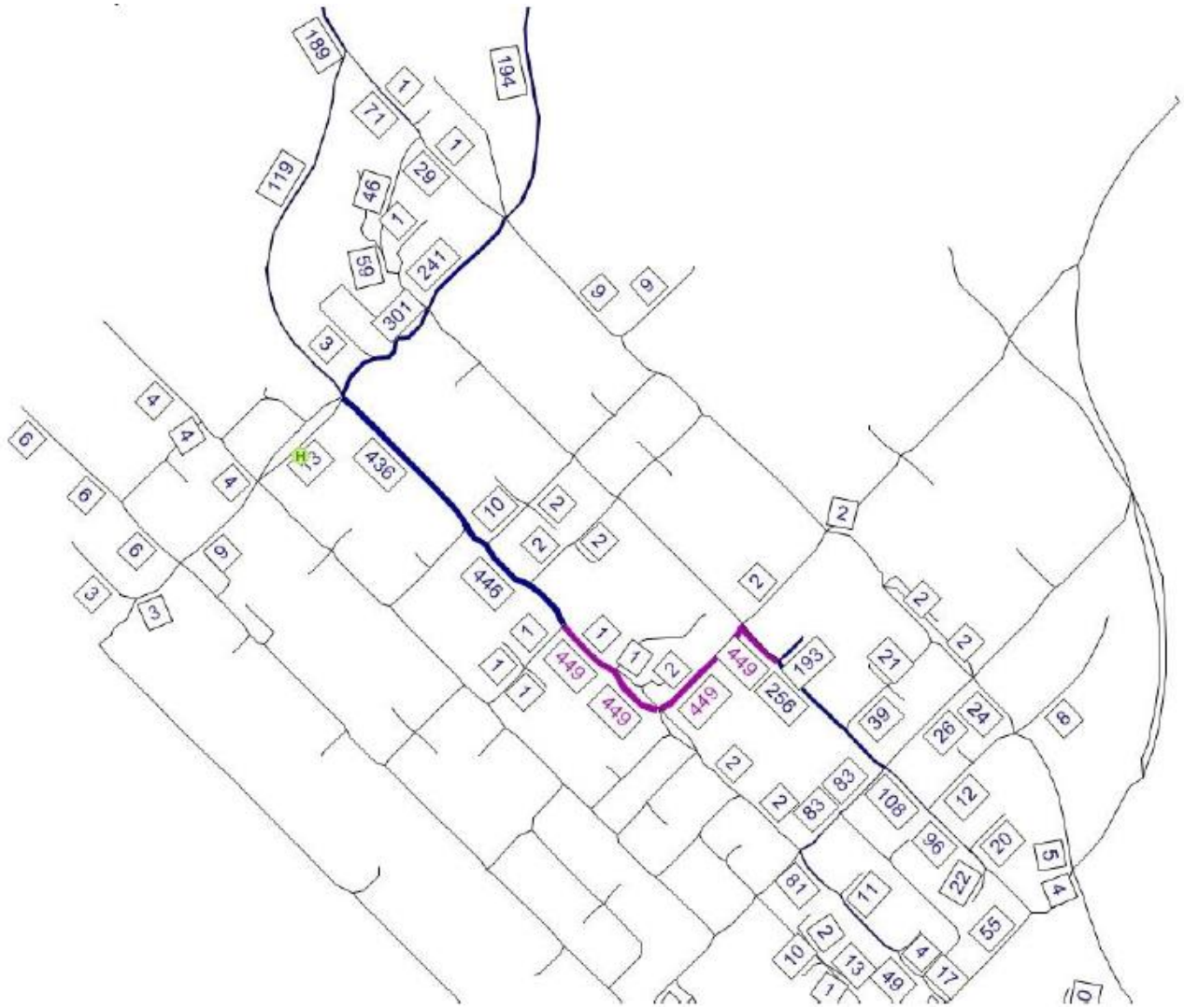


Figure 24 – PM peak left turn from Woods Street onto Barneson Boulevard (Jacobs Modelling Memo extract)

7 PUBLIC TRANSPORT

Public transport to and from the CBD is an integral part of any CBD traffic study. Whilst page 10 of the Jacobs Modelling Memo discusses concepts for dedicated right and left turn lanes at some signalised intersections and the provision of segregated bus lanes, referred to as Bus Rapid Transit (RPT) in the Memo, there is no mention of the proposal to relocate current bus terminus points on Cavenagh St (near Woolworths) and the Bus Interchange from the Civic Precinct to a location close to the proposed Cavenagh St/ Barneson Blvd intersection and the impact this will have on pedestrian movements in this area as well as travel times and inner city traffic flows.

8 FINDINGS

This review note has identified and documented a number of concerns with the information and data included and used in the Jacobs Modelling Memo and considers it appropriate that a more detailed and comprehensive modelling report is prepared for what is a significant transport infrastructure project.

The principal areas of concern are:

- Inconsistencies between the VISSUM model, the SIDRA models and the proposed layout;
- 'Lost' traffic within the model on sections of streets without development (e.g. TBD between Barneson & McMinn);
- Lack of an integrated comparison of impacts on Cavanaugh St traffic within the Goyder grid;
- The use of 1.5% linear traffic growth per annum to the year 2031 without considering:
    - capacity limits of streets and intersections;
    - the disruptive impact of autonomous vehicles within the next 5 years (i.e. by 2023); and
    - significant traffic generating developments within the CBD.
- The adoption of generic 60%/ 40 % trip assignment without considering:
    - recent CBD origin/ destination parking survey data;
    - the need to ensure that this does not result in a reduction on CBD streets where the traffic generators have not reduced (e.g. Bennett Street); and
    - that current parking supply is known to be 1,343 (assuming that the 450 underground Civic Centre car park simply replaces the existing Parliament & Supreme court above ground provisions);
- The apparent lack of inclusion of pedestrian crossing demands and associated delays in the VISSUM model (e.g. Ki 5);
- The lack of assessment of the proposal to relocate current bus terminus points on Cavenagh St (near Woolworths) and the Bus Interchange from near the Civic Centre to a location close to the Cavenagh St/ Barneson Blvd intersection and the impact this will have on pedestrian movements in this area as well as travel times and inner-city traffic flows;
- The lack of consideration of induced traffic (i.e. encouraging more vehicles into the CBD instead of encouraging greater use of alternative modes such as cycling and public transport; and
- The lack of consideration of the impact of other road network proposals (e.g. Snell St link);

In addition to the above, the report only assesses the impact of a given design and hence does not allow for the comparative assessment of other options such as:

- Terminating Barneson Boulevard at McMinn Street (connecting to the arterial road network and negating the need to impact on Woods Street and Cavenagh St);

- Providing roundabout control instead of traffic signal control at Barneson Blvd/ McMinn Street (reducing delays and accommodating the desire for U turns generated by developments on both sides of Barneson Blvd);
- Changing the alignment of Barneson Blvd at Tiger Brennan Drive so that it is the terminating road (reflecting the assessed higher demand for through traffic on Tiger Brennan Drive).

Although this is a fairly basic preliminary assessment due to limited data and resources, it has identified that there are benefits to be had in adopting the 'alternate' design, namely reduced delays on the road network, reduced travel times, reduced impact on Woods Street and Cavenagh Street and a more logical arterial road network that accommodates traffic to and from the CBD but does not encourage it to travel through the CBD.

In summary, a more comprehensive modelling report of various options and layouts is considered warranted for such a significant transport infrastrucute project than the failry brief Jacobs Modelling Memo that assesses a single design option.

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APPENDIX A SIDRA DATA AND REPORTS

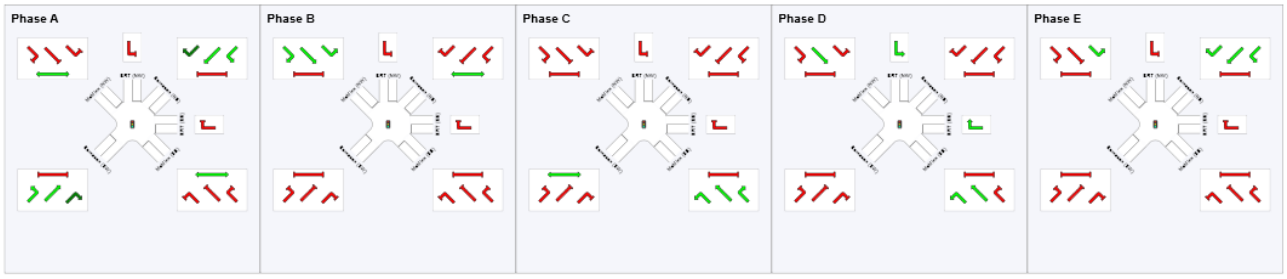

Figure 25 – Ki1 Barneson/ McMinn traffic signal phases

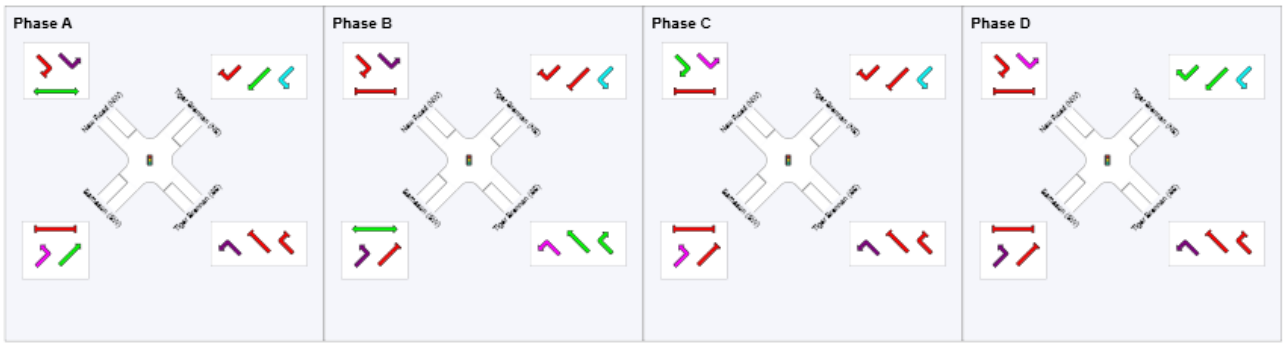

Figure 26 – Ki2 Barneson/ Tiger Brennan traffic signal phases

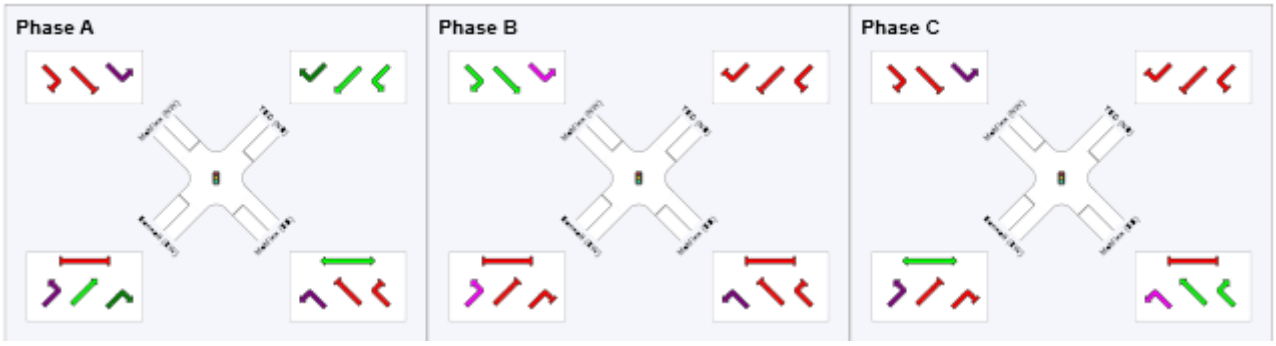

Figure 27 – Ki3 Bennett/ McMinn/ Tiger Brennan traffic signal phases

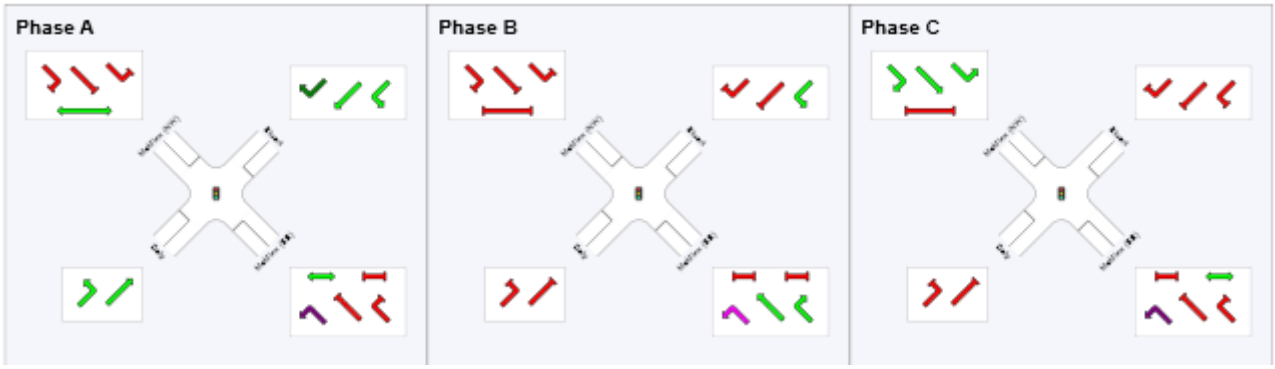

Figure 28 – Ki4 Daly/ McMinn/ Stuart traffic signal phases

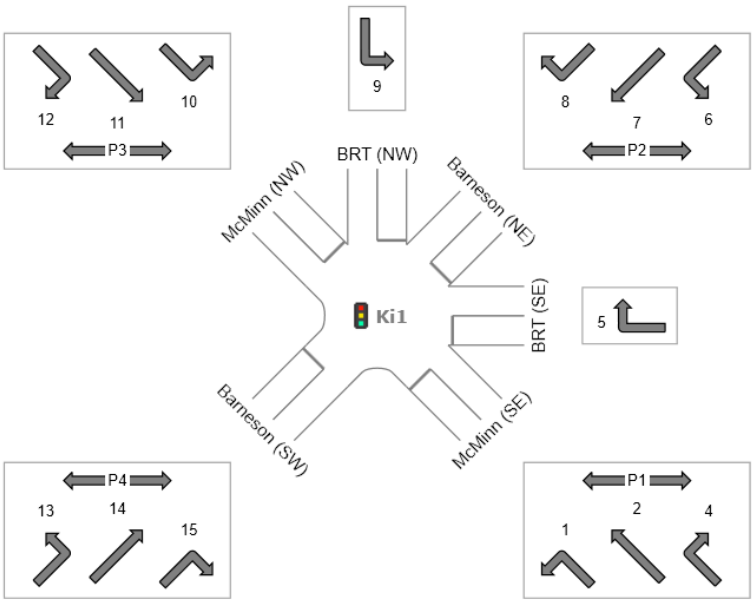

Figure 29 – Ki1 Model Movement IDs

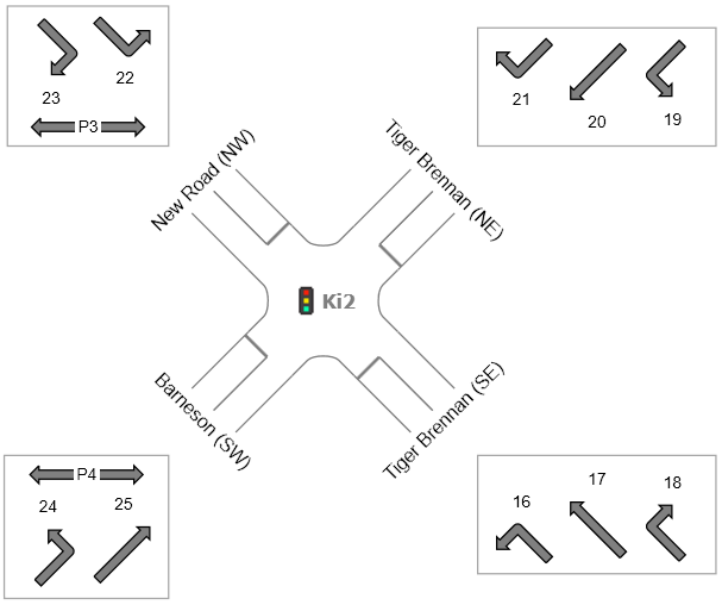

Figure 30 – Ki2 Model Movement IDs

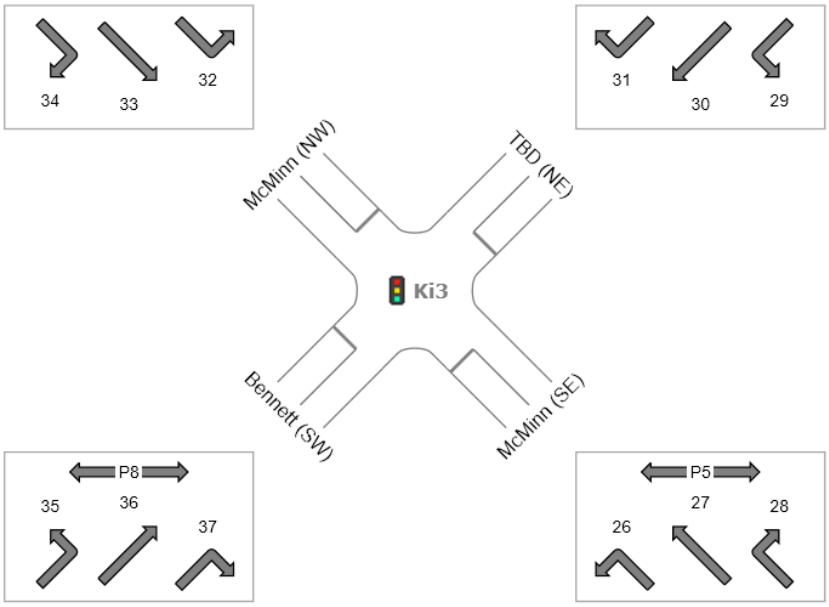

Figure 31 – Ki3 Model Movement IDs

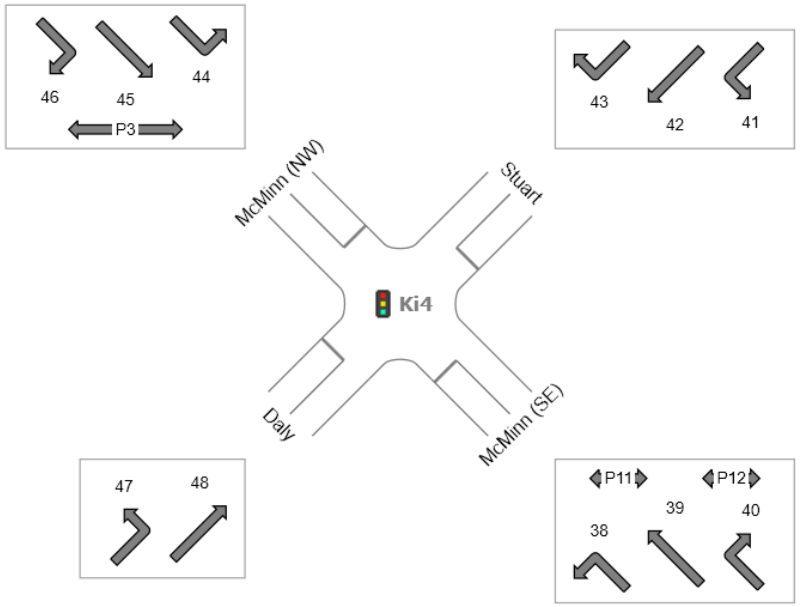

Figure 32 – Ki4 Model Movement IDs

MOVEMENT SUMMARY

Site: Ki1 Barneson/ McMinn Jacobs 2031 AM

Network: Jacobs AM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: McMinn (SE)													
1	L2	5	1.0	5	1.0	0.340	30.3	LOS C	8.3	58.5	0.78	0.66	35.2
2	T1	225	1.0	225	1.0	0.340	25.8	LOS C	8.3	58.5	0.78	0.66	37.8
4	R2	234	1.0	234	1.0	0.422	47.3	LOS D	5.3	37.7	0.95	0.78	23.2
Approach		464	1.0	464	1.0	0.422	36.7	LOS D	8.3	58.5	0.87	0.72	31.1
East: BRT (SE)													
5	R2	8	100.0	8	100.0	0.055	46.7	LOS D	0.4	4.8	0.89	0.68	31.1
Approach		8	100.0	8	100.0	0.055	46.7	LOS D	0.4	4.8	0.89	0.68	31.1
NorthEast: Barneson (NE)													
6	L2	151	1.0	151	1.0	0.501	19.8	LOS B	7.1	50.0	0.54	0.59	38.7
7	T1	424	1.0	424	1.0	0.501	14.9	LOS B	7.1	50.3	0.53	0.49	37.0
8	R2	182	1.0	182	1.0	0.689	30.8	LOS C	6.8	48.0	0.91	0.79	33.2
Approach		757	1.0	757	1.0	0.689	19.7	LOS B	7.1	50.3	0.63	0.58	36.2
North: BRT (NW)													
9	L2	16	100.0	16	100.0	0.104	47.3	LOS D	0.7	9.2	0.90	0.70	31.2
Approach		16	100.0	16	100.0	0.104	47.3	LOS D	0.7	9.2	0.90	0.70	31.2
NorthWest: McMinn (NW)													
10	L2	266	1.0	266	1.0	0.899	52.5	LOS D	16.7	118.0	1.00	1.13	22.0
11	T1	338	1.0	338	1.0	0.899	45.6	LOS D	17.0	119.7	1.00	1.11	31.4
12	R2	399	1.0	399	1.0	0.899	58.1	LOS E	17.0	119.7	1.00	1.05	25.9
Approach		1003	1.0	1003	1.0	0.899	52.4	LOS D	17.0	119.7	1.00	1.09	27.1
SouthWest: Barneson (SW)													
13	L2	71	1.0	71	1.0	0.696	50.5	LOS D	9.7	68.5	1.00	0.86	28.1
14	T1	331	1.0	331	1.0	0.696	45.9	LOS D	9.9	69.6	1.00	0.86	16.7
15	R2	36	1.0	36	1.0	0.211	46.7	LOS D	1.6	11.4	0.91	0.73	28.5
Approach		437	1.0	437	1.0	0.696	46.7	LOS D	9.9	69.6	0.99	0.85	20.6
All Vehicles		2685	1.9	2685	1.9	0.899	39.5	LOS D	17.0	119.7	0.87	0.84	28.9

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	SouthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P2	NorthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P3	NorthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P4	SouthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		211	44.3	LOS E			0.94	0.94

MOVEMENT SUMMARY

Site: Ki2 Barneson/ TBD Jacobs 2031 AM

Network: Jacobs AM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Tiger Brennan (SE)													
16	L2	26	1.0	26	1.0	0.028	8.5	LOS A	0.3	2.0	0.30	0.61	51.1
17	T1	6	1.0	6	1.0	0.506	35.9	LOS D	9.6	67.9	0.92	0.81	35.8
18	R2	442	1.0	442	1.0	0.506	41.5	LOS D	9.6	67.9	0.92	0.81	38.5
Approach		475	1.0	475	1.0	0.506	39.6	LOS D	9.6	67.9	0.88	0.80	38.8
NorthEast: Tiger Brennan (NE)													
19	L2	1078	1.0	1078	1.0	0.462	8.8	LOS A	13.9	98.3	0.14	0.56	54.1
20	T1	711	1.0	711	1.0	0.462	15.8	LOS B	14.2	100.4	0.67	0.62	37.7
21	R2	1	1.0	1	1.0	0.010	54.5	LOS D	0.0	0.4	0.96	0.59	24.9
Approach		1789	1.0	1789	1.0	0.462	11.6	LOS B	14.2	100.4	0.35	0.58	49.9
NorthWest: New Road (NW)													
22	L2	1	1.0	1	1.0	0.001	12.3	LOS B	0.0	0.1	0.42	0.58	45.2
23	R2	21	1.0	21	1.0	0.190	56.8	LOS E	1.0	7.3	0.98	0.70	11.2
Approach		22	1.0	22	1.0	0.190	54.7	LOS D	1.0	7.3	0.95	0.70	12.4
SouthWest: Barneson (SW)													
24	L2	14	1.0	14	1.0	0.009	5.9	LOS A	0.0	0.2	0.10	0.57	49.0
25	T1	782	1.0	782	1.0	0.505	36.6	LOS D	18.6	131.3	0.99	0.86	33.5
Approach		796	1.0	796	1.0	0.505	36.0	LOS D	18.6	131.3	0.98	0.86	33.6
All Vehicles		3082	1.0	3082	1.0	0.506	22.5	LOS C	18.6	131.3	0.60	0.69	42.9

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P3	NorthWest Full Crossing	53	21.8	LOS C	0.1	0.1	0.66	0.66
P4	SouthWest Full Crossing	53	41.5	LOS E	0.1	0.1	0.91	0.91
All Pedestrians		105	31.7	LOS D			0.79	0.79

MOVEMENT SUMMARY

Site: Ki1 Barneson/ McMinn Jacobs 2031 PM

Network: Jacobs PM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: McMinn (SE)													
1	L2	1	1.0	1	1.0	0.751	42.5	LOS D	18.3	129.4	0.98	0.89	31.0
2	T1	584	1.0	584	1.0	0.751	40.0	LOS D	18.3	129.4	0.98	0.89	33.3
4	R2	288	1.0	288	1.0	0.751	51.3	LOS D	13.4	94.4	1.00	0.89	22.5
Approach		874	1.0	874	1.0	0.751	43.8	LOS D	18.3	129.4	0.99	0.89	30.3
East: BRT (SE)													
5	R2	18	100.0	18	100.0	0.275	58.8	LOS E	0.9	12.1	0.99	0.71	28.4
Approach		18	100.0	18	100.0	0.275	58.8	LOS E	0.9	12.1	0.99	0.71	28.4
NorthEast: Barneson (NE)													
6	L2	66	1.0	66	1.0	0.244	17.5	LOS B	3.6	25.3	0.44	0.48	40.2
7	T1	289	1.0	289	1.0	0.244	10.9	LOS B	3.6	25.3	0.38	0.36	39.8
8	R2	274	1.0	274	1.0	0.696	32.1	LOS C	10.2	71.9	0.97	0.84	32.8
Approach		629	1.0	629	1.0	0.696	20.8	LOS C	10.2	71.9	0.65	0.58	36.0
North: BRT (NW)													
9	L2	14	100.0	14	100.0	0.210	58.3	LOS E	0.7	9.2	0.98	0.70	28.7
Approach		14	100.0	14	100.0	0.210	58.3	LOS E	0.7	9.2	0.98	0.70	28.7
NorthWest: McMinn (NW)													
10	L2	375	1.0	375	1.0	0.598	20.3	LOS C	9.3	65.5	0.88	0.82	33.2
11	T1	78	1.0	78	1.0	0.366	21.8	LOS C	3.8	26.9	0.91	0.74	38.6
12	R2	171	1.0	171	1.0	0.366	38.9	LOS D	5.1	35.8	0.92	0.77	30.8
Approach		623	1.0	623	1.0	0.598	25.6	LOS C	9.3	65.5	0.90	0.79	33.3
SouthWest: Barneson (SW)													
13	L2	121	1.0	121	1.0	0.818	55.1	LOS E	12.2	85.8	1.00	0.97	26.8
14	T1	348	1.0	348	1.0	0.818	50.5	LOS D	12.4	87.9	1.00	0.97	15.6
15	R2	20	1.0	20	1.0	0.102	45.4	LOS D	0.9	6.2	0.89	0.70	28.9
Approach		489	1.0	489	1.0	0.818	51.4	LOS D	12.4	87.9	1.00	0.96	20.0
All Vehicles		2647	2.2	2647	2.2	0.818	35.6	LOS D	18.3	129.4	0.89	0.80	30.2

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	SouthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P2	NorthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P3	NorthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P4	SouthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		211	44.3	LOS E			0.94	0.94

MOVEMENT SUMMARY

Site: Ki2 Barneson/ TBD Jacobs 2031 PM

Network: Jacobs PM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Tiger Brennan (SE)													
16	L2	87	1.0	87	1.0	0.078	7.5	LOS A	0.8	5.5	0.26	0.62	52.0
17	T1	2	1.0	2	1.0	0.796	36.9	LOS D	22.4	158.0	0.98	0.91	35.4
18	R2	937	1.0	937	1.0	0.796	42.5	LOS D	22.4	158.0	0.98	0.91	38.2
Approach		1026	1.0	1026	1.0	0.796	39.5	LOS D	22.4	158.0	0.92	0.88	38.8
NorthEast: Tiger Brennan (NE)													
19	L2	727	1.0	727	1.0	0.354	7.6	LOS A	9.6	67.6	0.07	0.54	54.8
20	T1	529	1.0	529	1.0	0.354	19.6	LOS B	9.7	68.4	0.70	0.62	35.0
21	R2	23	1.0	23	1.0	0.209	56.9	LOS E	1.1	8.1	0.98	0.71	24.3
Approach		1280	1.0	1280	1.0	0.354	13.5	LOS B	9.7	68.4	0.35	0.58	48.3
NorthWest: New Road (NW)													
22	L2	1	1.0	1	1.0	0.002	21.5	LOS C	0.0	0.2	0.61	0.59	38.5
23	R2	18	1.0	18	1.0	0.162	56.6	LOS E	0.9	6.2	0.98	0.69	11.2
Approach		19	1.0	19	1.0	0.162	54.6	LOS D	0.9	6.2	0.96	0.69	12.6
SouthWest: Barneson (SW)													
24	L2	15	1.0	15	1.0	0.010	5.9	LOS A	0.0	0.2	0.08	0.56	49.2
25	T1	980	1.0	980	1.0	0.791	42.5	LOS D	24.8	174.9	0.98	0.90	31.2
Approach		995	1.0	995	1.0	0.791	42.0	LOS D	24.8	174.9	0.96	0.89	31.3
All Vehicles		3320	1.0	3320	1.0	0.796	30.3	LOS C	24.8	174.9	0.71	0.77	39.3

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P3	NorthWest Full Crossing	53	27.4	LOS C	0.1	0.1	0.74	0.74
P4	SouthWest Full Crossing	53	34.5	LOS D	0.1	0.1	0.83	0.83
All Pedestrians		105	31.0	LOS D			0.79	0.79

MOVEMENT SUMMARY

Site: Ki1 Barneson/ McMinn Option 1 2031 AM

Network: Option 1 AM Network

Roundabout

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Arrival Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)													
2	T1	225	1.0	225	1.0	0.203	3.8	LOS A	1.2	8.4	0.40	0.43	48.1
4	R2	234	1.0	234	1.0	0.203	8.3	LOS A	1.2	8.4	0.40	0.60	41.4
Approach		459	1.0	459	1.0	0.203	6.1	LOS A	1.2	8.4	0.40	0.52	45.5
East: BRT (SE)													
5	R2	8	100.0	8	100.0	0.020	13.8	LOS B	0.1	1.1	0.62	0.73	44.0
Approach		8	100.0	8	100.0	0.020	13.8	LOS B	0.1	1.1	0.62	0.73	44.0
NorthEast: Barneson (NE)													
6	L2	151	1.0	151	1.0	0.161	4.7	LOS A	0.7	4.7	0.41	0.55	46.5
8	R2	182	1.0	182	1.0	0.175	8.8	LOS A	0.7	5.2	0.40	0.67	45.3
Approach		333	1.0	333	1.0	0.175	7.0	LOS A	0.7	5.2	0.40	0.61	45.8
North: BRT (NW)													
9	L2	16	100.0	16	100.0	0.047	11.1	LOS B	0.2	2.4	0.67	0.77	44.0
Approach		16	100.0	16	100.0	0.047	11.1	LOS B	0.2	2.4	0.67	0.77	44.0
NorthWest: McMinn (NW)													
10	L2	266	1.0	266	1.0	0.279	4.2	LOS A	1.5	10.9	0.45	0.52	44.4
11	T1	338	1.0	338	1.0	0.279	4.1	LOS A	1.5	10.9	0.46	0.48	48.0
Approach		604	1.0	604	1.0	0.279	4.2	LOS A	1.5	10.9	0.46	0.49	46.9
All Vehicles		1420	2.7	1420	2.7	0.279	5.6	LOS A	1.5	10.9	0.43	0.53	46.1

MOVEMENT SUMMARY

Site: Ki2 Barneson/ TBD Options 2031 AM

Network: Option 1 AM Network

Signals - Fixed Time Isolated Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Tiger Brennan (SE)													
16	L2	26	1.0	26	1.0	0.021	7.4	LOS A	0.3	1.8	0.21	0.59	52.1
17	T1	6	1.0	6	1.0	0.367	28.5	LOS C	12.1	85.2	0.74	0.78	38.6
18	R2	546	1.0	546	1.0	0.367	34.1	LOS C	12.1	85.2	0.74	0.78	41.1
Approach		579	1.0	579	1.0	0.367	32.9	LOS C	12.1	85.2	0.72	0.77	41.3
NorthEast: Tiger Brennan (NE)													
19	L2	1361	1.0	1361	1.0	0.369	5.7	LOS A	0.0	0.0	0.00	0.53	55.8
20	T1	282	1.0	282	1.0	0.357	28.3	LOS C	12.2	86.4	0.74	0.63	29.9
21	R2	1	1.0	1	1.0	0.012	71.1	LOS E	0.1	0.5	0.97	0.59	21.2
Approach		1644	1.0	1644	1.0	0.369	9.6	LOS A	12.2	86.4	0.13	0.55	52.5
NorthWest: New Road (NW)													
22	L2	1	1.0	1	1.0	0.001	9.6	LOS A	0.0	0.1	0.29	0.57	47.5
23	R2	21	1.0	21	1.0	0.247	74.1	LOS E	1.4	9.7	1.00	0.70	8.9
Approach		22	1.0	22	1.0	0.247	71.0	LOS E	1.4	9.7	0.96	0.70	10.0
SouthWest: Barneson (SW)													
24	L2	14	1.0	14	1.0	0.009	5.9	LOS A	0.0	0.3	0.10	0.57	49.1
25	T1	454	1.0	454	1.0	0.371	36.9	LOS D	11.1	78.2	0.82	0.69	33.4
Approach		467	1.0	467	1.0	0.371	36.0	LOS D	11.1	78.2	0.80	0.69	33.6
All Vehicles		2713	1.0	2713	1.0	0.371	19.6	LOS B	12.2	86.4	0.38	0.62	46.0

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P3	NorthWest Full Crossing	53	34.8	LOS D	0.1	0.1	0.73	0.73
P4	SouthWest Full Crossing	53	32.6	LOS D	0.1	0.1	0.71	0.71
All Pedestrians		105	33.7	LOS D			0.72	0.72

MOVEMENT SUMMARY

Site: Ki1 Barneson/ McMinn Option 1 2031 PM

Network: Option 1 PM Network

Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Arrival Flows Total veh/h	Arrival Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: McMinn (SE)													
2	T1	584	1.0	584	1.0	0.409	4.7	LOS A	2.8	19.9	0.56	0.56	47.3
4	R2	288	1.0	288	1.0	0.409	9.4	LOS A	2.8	19.5	0.56	0.65	41.8
Approach		873	1.0	873	1.0	0.409	6.3	LOS A	2.8	19.9	0.56	0.59	46.1
East: BRT (SE)													
5	R2	18	100.0	18	100.0	0.035	11.7	LOS B	0.1	1.9	0.54	0.68	45.0
Approach		18	100.0	18	100.0	0.035	11.7	LOS B	0.1	1.9	0.54	0.68	45.0
NorthEast: Barneson (NE)													
6	L2	66	1.0	66	1.0	0.084	3.9	LOS A	0.3	2.4	0.26	0.44	46.9
8	R2	274	1.0	274	1.0	0.212	7.8	LOS A	1.0	7.0	0.23	0.59	45.7
Approach		340	1.0	340	1.0	0.212	7.0	LOS A	1.0	7.0	0.24	0.56	46.0
North: BRT (NW)													
9	L2	14	100.0	14	100.0	0.038	10.1	LOS B	0.1	1.9	0.64	0.74	44.5
Approach		14	100.0	14	100.0	0.038	10.1	LOS B	0.1	1.9	0.64	0.74	44.5
NorthWest: McMinn (NW)													
10	L2	375	1.0	375	1.0	0.355	4.6	LOS A	2.1	14.9	0.55	0.60	44.1
11	T1	78	1.0	78	1.0	0.124	5.5	LOS A	0.6	4.0	0.52	0.56	47.7
Approach		453	1.0	453	1.0	0.355	4.8	LOS A	2.1	14.9	0.54	0.59	45.1
All Vehicles		1697	2.8	1697	2.8	0.409	6.1	LOS A	2.8	19.9	0.49	0.58	45.8

MOVEMENT SUMMARY

Site: Ki2 Barneson/ TBD Options 2031 PM

Network: Option 1 PM Network

Signals - Fixed Time Isolated Cycle Time = 130 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Tiger Brennan (SE)													
16	L2	87	1.0	87	1.0	0.064	6.9	LOS A	0.7	5.1	0.19	0.60	52.6
17	T1	2	1.0	2	1.0	0.594	28.9	LOS C	23.1	162.9	0.81	0.83	38.4
18	R2	975	1.0	975	1.0	0.594	34.5	LOS C	23.1	162.9	0.81	0.83	40.9
Approach		1064	1.0	1064	1.0	0.594	32.2	LOS C	23.1	162.9	0.76	0.81	41.4
NorthEast: Tiger Brennan (NE)													
19	L2	709	1.0	709	1.0	0.279	12.1	LOS B	9.1	63.9	0.18	0.58	51.9
20	T1	237	1.0	237	1.0	0.279	29.5	LOS C	9.1	63.9	0.73	0.64	29.0
21	R2	23	1.0	23	1.0	0.272	74.3	LOS E	1.5	10.7	1.00	0.71	20.7
Approach		969	1.0	969	1.0	0.279	17.8	LOS B	9.1	63.9	0.34	0.60	46.9
NorthWest: New Road (NW)													
22	L2	1	1.0	1	1.0	0.002	16.0	LOS B	0.0	0.2	0.44	0.59	42.3
23	R2	18	1.0	18	1.0	0.210	73.9	LOS E	1.2	8.2	0.99	0.70	9.0
Approach		19	1.0	19	1.0	0.210	70.6	LOS E	1.2	8.2	0.96	0.69	10.2
SouthWest: Barneson (SW)													
24	L2	15	1.0	15	1.0	0.010	6.0	LOS A	0.0	0.3	0.10	0.57	49.0
25	T1	634	1.0	634	1.0	0.591	43.7	LOS D	17.4	122.6	0.92	0.79	30.8
Approach		648	1.0	648	1.0	0.591	42.9	LOS D	17.4	122.6	0.90	0.78	31.0
All Vehicles		2701	1.0	2701	1.0	0.594	29.9	LOS C	23.1	162.9	0.64	0.73	40.6

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P3	NorthWest Full Crossing	53	38.5	LOS D	0.1	0.1	0.77	0.77
P4	SouthWest Full Crossing	53	29.2	LOS C	0.1	0.1	0.67	0.67
All Pedestrians		105	33.9	LOS D			0.72	0.72

MOVEMENT SUMMARY

Site: Ki1 Barneson/ McMinn Option 2 2031 AM

Network: Option 2 AM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: McMinn (SE)													
2	T1	225	1.0	225	1.0	0.581	39.8	LOS D	10.2	71.7	0.96	0.79	33.5
4	R2	234	1.0	234	1.0	0.905	67.5	LOS E	6.8	47.7	1.00	1.05	18.9
Approach		459	1.0	459	1.0	0.905	53.9	LOS D	10.2	71.7	0.98	0.92	26.4
East: BRT (SE)													
5	R2	8	100.0	8	100.0	0.111	55.9	LOS E	0.4	5.4	0.96	0.68	29.0
Approach		8	100.0	8	100.0	0.111	55.9	LOS E	0.4	5.4	0.96	0.68	29.0
NorthEast: Barneson (NE)													
6	L2	151	1.0	151	1.0	0.146	19.3	LOS B	1.7	12.3	0.42	0.64	37.8
8	R2	182	1.0	182	1.0	0.353	17.2	LOS B	3.5	24.6	0.41	0.65	38.7
Approach		333	1.0	333	1.0	0.353	18.2	LOS B	3.5	24.6	0.42	0.64	38.3
North: BRT (NW)													
9	L2	16	100.0	16	100.0	0.208	56.7	LOS E	0.8	10.4	0.97	0.70	29.0
Approach		16	100.0	16	100.0	0.208	56.7	LOS E	0.8	10.4	0.97	0.70	29.0
NorthWest: McMinn (NW)													
10	L2	266	1.0	266	1.0	0.394	17.1	LOS B	6.0	42.2	0.76	0.75	35.3
11	T1	338	1.0	338	1.0	0.394	12.8	LOS B	7.3	51.5	0.75	0.64	43.0
Approach		604	1.0	604	1.0	0.394	14.7	LOS B	7.3	51.5	0.75	0.69	40.5
All Vehicles		1420	2.7	1420	2.7	0.905	28.9	LOS C	10.2	71.7	0.75	0.76	34.0

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	SouthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P2	NorthEast Full Crossing	53	32.9	LOS D	0.1	0.1	0.81	0.81
P3	NorthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		158	40.5	LOS E			0.90	0.90

MOVEMENT SUMMARY

Site: Ki2 Barneson/ TBD Options 2031 AM

Network: Option 2 AM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Tiger Brennan (SE)													
16	L2	26	1.0	26	1.0	0.021	7.4	LOS A	0.2	1.6	0.24	0.60	52.1
17	T1	6	1.0	6	1.0	0.416	25.9	LOS C	10.2	71.7	0.80	0.79	39.7
18	R2	546	1.0	546	1.0	0.416	31.5	LOS C	10.2	71.7	0.80	0.79	42.0
Approach		579	1.0	579	1.0	0.416	30.4	LOS C	10.2	71.7	0.78	0.78	42.3
NorthEast: Tiger Brennan (NE)													
19	L2	1361	1.0	1361	1.0	0.369	5.7	LOS A	0.0	0.0	0.00	0.53	55.8
20	T1	282	1.0	282	1.0	0.364	22.6	LOS C	9.6	67.9	0.75	0.64	33.3
21	R2	1	1.0	1	1.0	0.010	54.5	LOS D	0.0	0.4	0.96	0.59	24.9
Approach		1644	1.0	1644	1.0	0.369	8.6	LOS A	9.6	67.9	0.13	0.55	53.2
NorthWest: New Road (NW)													
22	L2	1	1.0	1	1.0	0.001	9.4	LOS A	0.0	0.1	0.33	0.57	47.8
23	R2	21	1.0	21	1.0	0.190	56.8	LOS E	1.0	7.3	0.98	0.70	11.2
Approach		22	1.0	22	1.0	0.190	54.5	LOS D	1.0	7.3	0.95	0.70	12.5
SouthWest: Barneson (SW)													
24	L2	14	1.0	14	1.0	0.009	6.2	LOS A	0.1	0.5	0.21	0.58	48.4
25	T1	454	1.0	454	1.0	0.418	31.8	LOS C	9.1	64.1	0.84	0.71	35.5
Approach		467	1.0	467	1.0	0.418	31.0	LOS C	9.1	64.1	0.83	0.70	35.7
All Vehicles		2713	1.0	2713	1.0	0.418	17.5	LOS B	10.2	71.7	0.39	0.63	47.2

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P3	NorthWest Full Crossing	53	30.5	LOS D	0.1	0.1	0.78	0.78
P4	SouthWest Full Crossing	53	31.3	LOS D	0.1	0.1	0.79	0.79
All Pedestrians		105	30.9	LOS D			0.79	0.79

MOVEMENT SUMMARY

Site: Ki1 Barneson/ McMinn Option 2 2031 PM

Network: Option 2 PM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: McMinn (SE)													
2	T1	584	1.0	584	1.0	0.893	53.4	LOS D	23.4	165.1	1.00	1.09	30.0
4	R2	288	1.0	288	1.0	0.893	62.9	LOS E	14.8	104.7	1.00	1.05	19.9
Approach		873	1.0	873	1.0	0.893	56.5	LOS E	23.4	165.1	1.00	1.08	27.2
East: BRT (SE)													
5	R2	18	100.0	18	100.0	0.275	58.8	LOS E	0.9	12.1	0.99	0.71	28.4
Approach		18	100.0	18	100.0	0.275	58.8	LOS E	0.9	12.1	0.99	0.71	28.4
NorthEast: Barneson (NE)													
6	L2	66	1.0	66	1.0	0.043	18.4	LOS B	0.8	5.8	0.44	0.63	38.2
8	R2	274	1.0	274	1.0	0.353	15.8	LOS B	5.4	38.3	0.43	0.67	39.4
Approach		340	1.0	340	1.0	0.353	16.3	LOS B	5.4	38.3	0.43	0.66	39.2
North: BRT (NW)													
9	L2	14	100.0	14	100.0	0.210	58.3	LOS E	0.7	9.2	0.98	0.70	28.7
Approach		14	100.0	14	100.0	0.210	58.3	LOS E	0.7	9.2	0.98	0.70	28.7
NorthWest: McMinn (NW)													
10	L2	375	1.0	375	1.0	0.549	18.7	LOS B	8.5	59.8	0.84	0.80	34.1
11	T1	78	1.0	78	1.0	0.183	20.2	LOS C	2.2	15.4	0.85	0.65	40.0
Approach		453	1.0	453	1.0	0.549	18.9	LOS B	8.5	59.8	0.84	0.78	35.6
All Vehicles		1697	2.8	1697	2.8	0.893	38.5	LOS D	23.4	165.1	0.84	0.91	30.6

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	SouthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P2	NorthEast Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P3	NorthWest Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		158	44.3	LOS E			0.94	0.94

MOVEMENT SUMMARY

Site: Ki2 Barneson/ TBD Options 2031 PM

Network: Option 2 PM Network

Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Arrival Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: Tiger Brennan (SE)													
16	L2	87	1.0	87	1.0	0.067	6.9	LOS A	0.6	4.5	0.22	0.61	52.5
17	T1	2	1.0	2	1.0	0.662	26.4	LOS C	19.5	137.5	0.88	0.84	39.4
18	R2	975	1.0	975	1.0	0.662	32.0	LOS C	19.5	137.5	0.88	0.84	41.9
Approach		1064	1.0	1064	1.0	0.662	29.9	LOS C	19.5	137.5	0.82	0.82	42.3
NorthEast: Tiger Brennan (NE)													
19	L2	709	1.0	709	1.0	0.280	10.5	LOS B	7.0	49.6	0.18	0.58	52.9
20	T1	237	1.0	237	1.0	0.280	23.3	LOS C	7.0	49.6	0.74	0.64	32.4
21	R2	23	1.0	23	1.0	0.209	56.9	LOS E	1.1	8.1	0.98	0.71	24.3
Approach		969	1.0	969	1.0	0.280	14.7	LOS B	7.0	49.6	0.33	0.60	48.7
NorthWest: New Road (NW)													
22	L2	1	1.0	1	1.0	0.002	15.3	LOS B	0.0	0.2	0.49	0.59	42.8
23	R2	18	1.0	18	1.0	0.162	56.6	LOS E	0.9	6.2	0.98	0.69	11.2
Approach		19	1.0	19	1.0	0.162	54.3	LOS D	0.9	6.2	0.95	0.69	12.6
SouthWest: Barneson (SW)													
24	L2	15	1.0	15	1.0	0.010	5.7	LOS A	0.0	0.1	0.02	0.55	49.5
25	T1	634	1.0	634	1.0	0.681	32.8	LOS C	14.7	104.1	0.92	0.79	35.1
Approach		648	1.0	648	1.0	0.681	32.2	LOS C	14.7	104.1	0.90	0.78	35.2
All Vehicles		2701	1.0	2701	1.0	0.681	25.2	LOS C	19.5	137.5	0.67	0.73	42.7

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P3	NorthWest Full Crossing	53	33.7	LOS D	0.1	0.1	0.82	0.82
P4	SouthWest Full Crossing	53	28.2	LOS C	0.1	0.1	0.75	0.75
All Pedestrians		105	30.9	LOS D			0.79	0.79

MOVEMENT SUMMARY

Site: Ki3 Bennett/ McMinn/ TBD Jascobs 2031 AM

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
26	L2	36	1.0	0.042	10.1	LOS B	0.3	2.4	0.53	0.65	43.8
27	T1	28	1.0	0.126	20.1	LOS C	0.8	5.9	0.88	0.64	42.2
28	R2	28	1.0	0.126	26.0	LOS C	0.8	5.9	0.89	0.70	43.0
Approach		93	1.0	0.126	18.0	LOS B	0.8	5.9	0.75	0.66	42.9
NorthEast: TBD (NE)											
29	L2	86	1.0	0.789	24.8	LOS C	13.8	97.3	0.96	0.94	45.0
30	T1	1011	1.0	0.789	19.2	LOS B	13.9	98.0	0.96	0.94	45.5
31	R2	120	1.0	0.307	20.9	LOS C	2.4	16.8	0.81	0.76	47.3
Approach		1217	1.0	0.789	19.8	LOS B	13.9	98.0	0.94	0.92	45.6
NorthWest: McMinn (NW)											
32	L2	60	1.0	0.054	7.0	LOS A	0.3	1.9	0.33	0.62	54.7
33	T1	53	1.0	0.113	22.5	LOS C	0.6	4.3	0.92	0.66	41.7
34	R2	48	1.0	0.219	28.6	LOS C	1.1	8.1	0.94	0.73	36.5
Approach		161	1.0	0.219	18.5	LOS B	1.1	8.1	0.70	0.66	45.6
SouthWest: Bennett (SW)											
35	L2	208	1.0	0.176	7.1	LOS A	1.1	7.5	0.36	0.65	51.0
36	T1	346	1.0	0.248	12.4	LOS B	3.0	21.4	0.74	0.60	49.9
37	R2	56	1.0	0.320	29.4	LOS C	1.4	9.7	0.95	0.74	29.5
Approach		611	1.0	0.320	12.1	LOS B	3.0	21.4	0.63	0.63	48.5
All Vehicles		2081	1.0	0.789	17.4	LOS B	13.9	98.0	0.82	0.81	46.3

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P5	SouthEast Full Crossing	53	19.4	LOS B	0.1	0.1	0.88	0.88
P8	SouthWest Full Crossing	53	19.4	LOS B	0.1	0.1	0.88	0.88
All Pedestrians		105	19.4	LOS B			0.88	0.88

MOVEMENT SUMMARY

Site: Ki3 Bennett/ McMinn/ TBD Jascobs 2031 PM

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
26	L2	66	1.0	0.063	7.7	LOS A	0.4	2.9	0.39	0.64	46.5
27	T1	74	1.0	0.327	20.8	LOS C	2.2	15.9	0.91	0.69	41.9
28	R2	74	1.0	0.327	26.9	LOS C	2.2	15.9	0.93	0.75	42.6
Approach		214	1.0	0.327	18.8	LOS B	2.2	15.9	0.75	0.70	43.0
NorthEast: TBD (NE)											
29	L2	46	1.0	0.456	19.1	LOS B	6.1	42.8	0.81	0.70	48.2
30	T1	587	1.0	0.456	13.6	LOS B	6.1	43.1	0.81	0.69	48.9
31	R2	33	1.0	0.149	25.6	LOS C	0.7	5.1	0.87	0.72	45.3
Approach		666	1.0	0.456	14.5	LOS B	6.1	43.1	0.82	0.70	48.6
NorthWest: McMinn (NW)											
32	L2	71	1.0	0.083	9.0	LOS A	0.6	4.2	0.48	0.66	53.5
33	T1	49	1.0	0.106	22.4	LOS C	0.6	4.0	0.92	0.65	41.7
34	R2	12	1.0	0.052	27.8	LOS C	0.3	1.9	0.91	0.67	36.9
Approach		132	1.0	0.106	15.7	LOS B	0.6	4.2	0.68	0.66	48.3
SouthWest: Bennett (SW)											
35	L2	226	1.0	0.175	6.9	LOS A	0.9	6.6	0.34	0.64	51.1
36	T1	852	1.0	0.665	15.1	LOS B	9.1	64.5	0.87	0.77	48.2
37	R2	84	1.0	0.300	23.6	LOS C	1.8	12.8	0.86	0.76	32.6
Approach		1162	1.0	0.665	14.1	LOS B	9.1	64.5	0.77	0.75	47.7
All Vehicles		2174	1.0	0.665	14.8	LOS B	9.1	64.5	0.78	0.72	47.6

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P5	SouthEast Full Crossing	53	19.4	LOS B	0.1	0.1	0.88	0.88
P8	SouthWest Full Crossing	53	19.4	LOS B	0.1	0.1	0.88	0.88
All Pedestrians		105	19.4	LOS B			0.88	0.88

MOVEMENT SUMMARY

Site: Ki3 Bennett/ McMinn/ TBD Options 2031 AM

Signals - Fixed Time Isolated Cycle Time = 60 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
26	L2	36	1.0	0.044	10.9	LOS B	0.4	3.0	0.52	0.65	43.0
27	T1	28	1.0	0.135	24.6	LOS C	1.0	7.1	0.89	0.65	39.8
28	R2	28	1.0	0.135	30.5	LOS C	1.0	7.1	0.90	0.70	41.0
Approach		93	1.0	0.135	21.1	LOS C	1.0	7.1	0.75	0.67	41.1
NorthEast: TBD (NE)											
29	L2	86	1.0	0.741	21.7	LOS C	16.5	116.5	0.89	0.83	46.7
30	T1	1201	1.0	0.741	16.2	LOS B	16.6	117.1	0.89	0.83	47.3
31	R2	120	1.0	0.301	20.1	LOS C	2.6	18.1	0.74	0.75	47.7
Approach		1407	1.0	0.741	16.8	LOS B	16.6	117.1	0.87	0.82	47.3
NorthWest: McMinn (NW)											
32	L2	60	1.0	0.058	6.9	LOS A	0.3	2.2	0.29	0.61	54.7
33	T1	53	1.0	0.136	28.2	LOS C	0.7	5.3	0.94	0.67	38.7
34	R2	48	1.0	0.263	34.5	LOS C	1.4	10.0	0.96	0.73	33.9
Approach		161	1.0	0.263	22.2	LOS C	1.4	10.0	0.70	0.67	43.7
SouthWest: Bennett (SW)											
35	L2	208	1.0	0.175	7.0	LOS A	1.2	8.3	0.32	0.64	51.1
36	T1	491	1.0	0.281	11.3	LOS B	4.6	32.2	0.67	0.56	50.7
37	R2	56	1.0	0.339	30.8	LOS C	1.6	11.0	0.91	0.76	28.8
Approach		755	1.0	0.339	11.6	LOS B	4.6	32.2	0.59	0.60	49.3
All Vehicles		2416	1.0	0.741	15.7	LOS B	16.6	117.1	0.77	0.73	47.4

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P5	SouthEast Full Crossing	53	19.2	LOS B	0.1	0.1	0.80	0.80
P8	SouthWest Full Crossing	53	24.4	LOS C	0.1	0.1	0.90	0.90
All Pedestrians		105	21.8	LOS C			0.85	0.85

MOVEMENT SUMMARY

Site: Ki3 Bennett/ McMinn/ TBD Options 2031 PM

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
26	L2	66	1.0	0.063	7.7	LOS A	0.4	2.9	0.39	0.64	46.5
27	T1	74	1.0	0.327	20.8	LOS C	2.2	15.9	0.91	0.69	41.9
28	R2	74	1.0	0.327	26.9	LOS C	2.2	15.9	0.93	0.75	42.6
Approach		214	1.0	0.327	18.8	LOS B	2.2	15.9	0.75	0.70	43.0
NorthEast: TBD (NE)											
29	L2	46	1.0	0.497	19.4	LOS B	6.8	47.7	0.83	0.72	48.1
30	T1	645	1.0	0.497	13.8	LOS B	6.8	48.0	0.83	0.71	48.7
31	R2	33	1.0	0.160	26.7	LOS C	0.7	5.2	0.89	0.72	44.8
Approach		724	1.0	0.497	14.8	LOS B	6.8	48.0	0.83	0.71	48.4
NorthWest: McMinn (NW)											
32	L2	71	1.0	0.085	9.4	LOS A	0.6	4.4	0.50	0.66	53.3
33	T1	49	1.0	0.106	22.4	LOS C	0.6	4.0	0.92	0.65	41.7
34	R2	12	1.0	0.052	27.8	LOS C	0.3	1.9	0.91	0.67	36.9
Approach		132	1.0	0.106	15.9	LOS B	0.6	4.4	0.70	0.66	48.2
SouthWest: Bennett (SW)											
35	L2	226	1.0	0.174	6.9	LOS A	0.9	6.6	0.34	0.64	51.1
36	T1	920	1.0	0.748	17.2	LOS B	10.8	76.4	0.89	0.85	46.9
37	R2	84	1.0	0.321	23.8	LOS C	1.8	12.9	0.86	0.76	32.5
Approach		1231	1.0	0.748	15.8	LOS B	10.8	76.4	0.79	0.80	46.7
All Vehicles		2300	1.0	0.748	15.7	LOS B	10.8	76.4	0.79	0.76	47.0

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P5	SouthEast Full Crossing	53	19.4	LOS B	0.1	0.1	0.88	0.88
P8	SouthWest Full Crossing	53	19.4	LOS B	0.1	0.1	0.88	0.88
All Pedestrians		105	19.4	LOS B			0.88	0.88

MOVEMENT SUMMARY

Site: Ki4: Daly/ McMinn/ Stuart Jacobs 2031 AM

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
38	L2	253	1.0	0.335	10.2	LOS B	2.7	19.3	0.60	0.72	52.4
39	T1	27	1.0	0.499	24.1	LOS C	2.8	19.6	0.98	0.77	41.2
40	R2	195	1.0	0.499	29.7	LOS C	2.8	19.6	0.98	0.77	48.4
Approach		475	1.0	0.499	19.0	LOS B	2.8	19.6	0.78	0.75	49.7
NorthEast: Stuart											
41	L2	442	1.0	0.375	10.2	LOS B	5.2	36.4	0.51	0.71	55.2
42	T1	897	1.0	0.844	21.3	LOS C	11.6	82.2	0.83	0.91	47.8
43	R2	231	1.0	0.573	21.1	LOS C	4.9	34.7	0.87	0.81	45.2
Approach		1569	1.0	0.844	18.2	LOS B	11.6	82.2	0.75	0.84	50.1
NorthWest: McMinn (NW)											
44	L2	38	1.0	0.651	27.8	LOS C	3.9	27.4	1.00	0.84	42.7
45	T1	112	1.0	0.651	25.3	LOS C	3.9	27.4	1.00	0.84	42.3
46	R2	96	1.0	0.433	26.2	LOS C	2.4	16.6	0.97	0.76	23.6
Approach		245	1.0	0.651	26.0	LOS C	3.9	27.4	0.99	0.81	37.7
SouthWest: Daly											
47	L2	5	1.0	0.266	16.6	LOS B	3.4	24.3	0.71	0.59	11.5
48	T1	407	1.0	0.266	11.1	LOS B	3.4	24.3	0.71	0.59	53.0
Approach		413	1.0	0.266	11.1	LOS B	3.4	24.3	0.71	0.59	52.4
All Vehicles		2702	1.0	0.844	18.0	LOS B	11.6	82.2	0.77	0.78	49.6

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P11	SouthEast Stage 1	5	11.6	LOS B	0.0	0.0	0.68	0.68
P12	SouthEast Stage 2	5	19.4	LOS B	0.0	0.0	0.88	0.88
P3	NorthWest Full Crossing	5	13.7	LOS B	0.0	0.0	0.74	0.74
All Pedestrians		16	14.9	LOS B			0.77	0.77

MOVEMENT SUMMARY

Site: Ki4: Daly/ McMinn/ Stuart Jacobs 2031 PM

Signals - Fixed Time Isolated Cycle Time = 70 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
38	L2	287	1.0	0.278	8.0	LOS A	2.6	18.5	0.39	0.67	53.7
39	T1	41	1.0	0.784	30.2	LOS C	5.9	41.5	0.88	0.90	38.6
40	R2	486	1.0	0.784	36.3	LOS D	12.5	88.5	0.96	0.92	46.4
Approach		815	1.0	0.784	26.0	LOS C	12.5	88.5	0.75	0.83	47.8
NorthEast: Stuart											
41	L2	149	1.0	0.109	8.3	LOS A	1.4	9.9	0.30	0.63	56.0
42	T1	580	1.0	0.462	15.4	LOS B	8.6	60.7	0.74	0.63	50.7
43	R2	193	1.0	0.994	86.2	LOS F	11.8	83.5	1.00	1.35	26.2
Approach		922	1.0	0.994	29.1	LOS C	11.8	83.5	0.72	0.78	44.9
NorthWest: McMinn (NW)											
44	L2	39	1.0	0.595	38.7	LOS D	3.5	24.6	1.00	0.80	38.1
45	T1	58	1.0	0.595	36.3	LOS D	3.5	24.6	1.00	0.80	37.5
46	R2	43	1.0	0.273	37.0	LOS D	1.5	10.5	0.97	0.73	19.2
Approach		140	1.0	0.595	37.2	LOS D	3.5	24.6	0.99	0.78	34.0
SouthWest: Daly											
47	L2	26	1.0	0.518	22.2	LOS C	10.7	75.3	0.80	0.70	10.9
48	T1	804	1.0	0.518	16.6	LOS B	10.7	75.5	0.80	0.69	50.0
Approach		831	1.0	0.518	16.8	LOS B	10.7	75.5	0.80	0.69	48.7
All Vehicles		2707	1.0	0.994	24.8	LOS C	12.5	88.5	0.77	0.77	46.5

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P11	SouthEast Stage 1	5	14.5	LOS B	0.0	0.0	0.64	0.64
P12	SouthEast Stage 2	5	29.3	LOS C	0.0	0.0	0.91	0.91
P3	NorthWest Full Crossing	5	16.5	LOS B	0.0	0.0	0.69	0.69
All Pedestrians		16	20.1	LOS C			0.75	0.75

MOVEMENT SUMMARY

Site: Ki4: Daly/ McMinn/ Stuart Options 2031 AM

Signals - Fixed Time Isolated Cycle Time = 80 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
SouthEast: McMinn (SE)											
38	L2	253	1.0	0.597	23.1	LOS C	7.5	53.0	0.86	0.81	45.8
39	T1	27	1.0	0.683	42.0	LOS D	4.6	32.8	1.00	0.84	34.4
40	R2	195	1.0	0.683	47.6	LOS D	4.6	32.8	1.00	0.84	43.5
Approach		475	1.0	0.683	34.3	LOS C	7.5	53.0	0.92	0.83	44.0
NorthEast: Stuart											
41	L2	115	1.0	0.084	8.7	LOS A	1.2	8.7	0.30	0.63	55.8
42	T1	1458	1.0	0.892	28.2	LOS C	36.3	255.9	0.77	0.89	44.9
43	R2	231	1.0	0.851	41.4	LOS D	9.8	69.0	0.77	0.98	36.9
Approach		1803	1.0	0.892	28.6	LOS C	36.3	255.9	0.74	0.88	44.7
NorthWest: McMinn (NW)											
44	L2	38	1.0	0.366	39.7	LOS D	3.0	20.9	0.97	0.75	37.7
45	T1	40	1.0	0.366	37.3	LOS D	3.0	20.9	0.97	0.75	37.0
46	R2	167	1.0	0.807	45.7	LOS D	7.2	51.0	1.00	0.92	16.7
Approach		245	1.0	0.807	43.4	LOS D	7.2	51.0	0.99	0.87	25.4
SouthWest: Daly											
47	L2	5	1.0	0.317	15.0	LOS B	7.1	50.1	0.56	0.49	11.7
48	T1	700	1.0	0.317	9.4	LOS A	7.1	50.1	0.56	0.48	53.9
Approach		705	1.0	0.317	9.5	LOS A	7.1	50.1	0.56	0.48	53.6
All Vehicles		3228	1.0	0.892	26.4	LOS C	36.3	255.9	0.75	0.79	45.2

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P11	SouthEast Stage 1	5	9.0	LOS A	0.0	0.0	0.48	0.48
P12	SouthEast Stage 2	5	33.3	LOS D	0.0	0.0	0.91	0.91
P3	NorthWest Full Crossing	5	10.5	LOS B	0.0	0.0	0.51	0.51
All Pedestrians		16	17.6	LOS B			0.63	0.63

LANE SUMMARY

Site: Ki4: Daly/ McMinn/ Stuart Options 2031 PM

Signals - Fixed Time Isolated Cycle Time = 110 seconds (Practical Cycle Time)

Lane Use and Performance

	Demand Flows		Cap.	Deg. Satn	Lane Util.	Average Delay	Level of Service	95% Back of Queue		Lane Config	Lane Length	Cap. Adj.	Prob. Block.
	Total	HV						Veh	Dist				
	veh/h	%	veh/h	v/c	%	sec			m		m	%	%
SouthEast: McMinn (SE)													
Lane 1	287	1.0	722[1]	0.398	100	16.9	LOS B	8.1	57.5	Short	15	0.0	NA
Lane 2	146	1.0	146[1]	1.004	100	208.5	LOS F	12.8	90.4	Full	1000	0.0	0.0
Lane 3	381	1.0	379[1]	1.004	100	110.0	LOS F	31.4	221.5	Short	50	0.0	NA
Approach	815	1.0		1.004		94.9	LOS F	31.4	221.5				
NorthEast: Stuart													
Lane 1	31	1.0	1525	0.020	100	7.4	LOS A	0.3	2.0	Short	25	0.0	NA
Lane 2	683	1.0	1003[1]	0.681	100	19.4	LOS B	25.9	183.1	Full	1100	0.0	0.0
Lane 3	248	1.0	364[1]	0.681	100	15.6	LOS B	7.2	51.1	Full	1100	0.0	0.0
Lane 4	193	1.0	138[1]	1.398	100	448.8	LOS F	36.4	256.7	Short	20	0.0	NA
Approach	1154	1.0		1.398		90.0	LOS F	36.4	256.7				
NorthWest: McMinn (NW)													
Lane 1	45	1.0	118	0.383	100	58.7	LOS E	2.5	17.5	Full	14	0.0	25.4
Lane 2	95	1.0	117	0.807	100	64.5	LOS E	5.6	39.6	Full	16	0.0	90.2
Approach	140	1.0		0.807		62.6	LOS E	5.6	39.6				
SouthWest: Daly													
Lane 1	625	1.0	1037	0.603	100	18.8	LOS B	22.7	160.4	Full	280	0.0	0.0
Lane 2	626	1.0	1039	0.603	100	18.6	LOS B	22.8	160.7	Full	280	0.0	0.0
Approach	1252	1.0		0.603		18.7	LOS B	22.8	160.7				
Intersection	3360	1.0		1.398		63.5	LOS E	36.4	256.7				

1 Reduced capacity due to a short lane effect. Short lane queues may extend into the adjacent full-length lanes. Some upstream delays at entry to short lanes are not included.

ABOUT THE AUTHOR

David Wilkins is an RTA NSW Certified Level 3 Lead Auditor (RSA-08-0178) and Main Roads Western Australia (MRWA) accredited Senior Road Safety Auditor (SRSA 0101). In addition to this, David is an MRWA accredited Crash Investigation Team Leader and Roadworks Traffic Manager (MRWA-RTM-10-RTM20). David has undertaken 83 road safety audits in the last five years and 205 road safety audits since 2001 across the full range of stages from feasibility through to pre-opening, including roadworks, existing roads, schools and mine sites.

David's specialist skills are in the management and development of transport infrastructure and planning, particularly with respect to road safety engineering, roadworks traffic management, traffic engineering, crash investigation, road safety audits, alternative transport systems (TravelSmart, shared paths, cycle facilities), transport statements, transport assessments, parking demand management, local area traffic management, speed management, accessible environments and innovation.

David specialises in undertaking and preparing traffic impact assessments in accordance with the Austroads 'Guide to Traffic Management Part 12: Traffic Impacts of Developments'.