Item 1

Steffany Ngu

Subject:	EBP traffic modelling review with Mott MacDonald
Location:	Microsoft Teams Meeting
Start:	Tue 11/02/2025 4:00 PM
End:	Tue 11/02/2025 5:00 PM
Show Time As:	Tentative
Recurrence:	(none)
Organizer:	John Harrison
Required Attendees:	Janice Buteux-wheeler; Colin Muir; Umesh Murdeshwar; Eric Wu; Howard Chan; Jo Kaya; Andrew Ha
Optional Attendees:	

Microsoft Teams meeting Need help?

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From: John Harrison
To: Janice Buteux-wheeler; Colin Muir; Umesh Murdeshwar; Eric Wu; Howard Chan; Jo Kaya; Andrew Ha; [redacted]
Cc: [redacted] Tanmila Islam; Nadi Tzannes; Peta Smith; Natasha Singerova; Dominic Leonard
Subject: TM030 TM032 RE: EBP traffic modeling review with Mott MacDonald
Date: Tuesday, 11 February 2025 5:35:21 PM
Attachments: image006.png
image007.png
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image012.png
image013.png
image014.png

Hi and thanks all for the meeting today whereby I note we discussed the following:-

TfNSW review of modelling noted in summary that (refer details in the email below):-

- 2039 "Do Minimum" (without project) scenario has not reported
- Calibration (SIDRA), coding and signal coordination issues (SIDRA and VISSM) identified
- Reporting does not provide an accurate assessment of the project's benefits or impacts, particularly regarding delay, queuing, and travel time. Indications are that Mott Macdonald results inaccurately indicated worse results. The REF may therefore be in error.

It was resolved that:-

1. TfNSW modelling team will provide their updated data to be passed onto Mott MacDonald
2. Mott Macdonald to review availability and timing to update their model and the REF findings.
3. Follow up meeting with Mott MacDonald and project team to confirm the actions to progress the matter – Colin – are you able to facilitate please?

May I suggest the above actions to be undertaken tomorrow 12/2/25 to allow the necessary modelling and REF updates to progress and resolved ASAP after that.

Thanks very much Howard and Eric for your prompt assistance to understand the issues.

[redacted] – for tracking, please refer to extracts from the TfNSW EBP Technical comments Register (TCR TM030 & TM032), below as these indirectly refer to these issues.

TM	30	19/4/24	Traffic Impact Assessment	10/2 - JH - noted advice - essential the modelling is accurate and record and ideally mitigate any impacts to the surrounding road network. Accordingly, it has been agreed that the project team will request VISSIM modelling to be done to accurately reflect the benefits and impacts of the project. And subsequently, the REF is to include mention of all of this and acknowledge any impacts to other intersections in the area, despite any further work not being included in the current scope of the project. 25/1-JH-awaiting on further VISSM model review by TfNSWW internal and SIDRA if required. 15/11/2024-TI- It is critical that it is clearly noted within key project documentation that traffic impacts are expected as a result of this project, however, those impacts are beyond project scope, etc. Unless NSS have seen that this has been included, we can't close this comment. 15/9-JH-will await updated ADC log 22/7-JH-will await updated ADC log and Traffic Impact Assessment Report 13/7/24-JH-designer to update ADC log accordingly - re project assumption / constraints 31/5 - TI - Agree with this approach. NSS understand the limitations, however, we need to tag this concern and any possible mitigations should be considered. 27/5-JH - to TI - suggest designer provide statement in requirement verification (RVTM) and ADC log that project satisfies Business Requirement and mitigated "downstream" impacts where possible within constraints of the project? 09/05/24 -TI- That is understood. However, those intersections are already heavily congested. Due to the town centre nature of the area and upcoming development, any further impact to these intersections would not only be detrimental for efficiency, but also add to safety concerns of all road users. Impacts should be aimed to be minimised as much as possible. 19/4-TI-Having a look at all the future year modelling results comparisons, it seems that there is expected to be a negative impact to the efficiency at certain intersection. For example certain approaches at the intersection of Carlingford/Ray Rd intersection as well as Epping Road and Essex Street. From a logical assessment, the proposed works should not have a negative impact to these intersections and we question what is causing these results?	20/12-JH-noted ADC log includes an entry (Item 77) that refers to this issue and transfers action to TfNSW to consider possible mitigations in future projects located on Carlingford Road and Ray Street. This is out of project scope. Note that comments on REF relate to this. Refer to these responses (such responses will refer to TfNSW for other actions as may be appropriate). 30/08/24 - EW - Traffic report issued, ADC to be submitted along with 100% resubmission 18/07/24 - EW - Added ADC77 12/07/24 - [redacted] - Consideration of possible mitigations are not part of our scope. The [redacted] issues fall outside the project boundaries. 24/05/24 - [redacted] - The capacity improvements at Blaxland Road and Epping Road have moved the westbound bottleneck west, to Carlingford Road and Ray Street. Additionally, the STFM model forecasts increased traffic growth in future years, particularly in the contra-peak directions. This increased traffic demand at intersections without upgrades, results in worsening intersection performance.
TM	32	19/4/24	Traffic Impact Assessment	10/2 - JH - noted advice - essential the modelling is accurate and record and ideally mitigate any impacts to the surrounding road network. Accordingly, it has been agreed that the project team will request VISSIM modelling to be done to accurately reflect the benefits and impacts of the project. And subsequently, the REF is to include mention of all of this and acknowledge any impacts to other intersections in the area, despite any further work not being included in the current scope of the project. 25/1-JH-awaiting on further VISSM model review by TfNSWW internal and SIDRA if required. 17/7-JH- TI please review 28/5/24 -TI - I don't think my comment has been understood. Happy to discuss over phone if needed. This isn't a holding point for the project, but consistency in the report is preferred. 8/05/24 - TI- This is understood, and the comment is not regarding the result of the 2039 scenario, but moreso in relation to the comparison that is made. Comparisons should be made between Do-Nothing vs Project scenarios in the same years to demonstrate the impacts/benefits of the proposal in each of those years. Comparing 2029 to2039 doesn't provide this. 19/4-TI-A conclusion has been derived that the 2039 Project scenario will operate much worse than the 2029. However, this is not a reasonable comparison as the road environment and traffic volume will change over the 10 years. Ideally a comparison of the 2039 Do nothing scenario with a 2039 Project scenario should be considered.	20/12-JH- Further review required by Tanmila and Peta if we want MM to adjust anything noting that there is no further modelling in project scope in this regard. 12/07/24 - [redacted] - The reviewer states this is not a hold point. The 2039 Do Minimum is an artificial and worthless comparison. Delay would never continue to build to those ridiculous levels. Drivers would change their behaviour. 24/05/24 - [redacted] - performance levels begin to drop again. Beyond a certain performance threshold, demand stabilises and travellers begin to change the time of departure (peak spreading), they change their route choice, or they change their mode.

Kind regards

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NSW GOVERNMENT Transport for NSW

OFFICIAL

From: John Harrison
Sent: Tuesday, 11 February 2025 10:00 AM
To: Janice Buteux-wheeler <Janice.Buteux-wheeler@transport.nsw.gov.au>; Colin Muir <Colin.Muir@transport.nsw.gov.au>; Umesh Murdeshwar <Umesh.Murdeshwar@transport.nsw.gov.au>; Eric Wu <Eric.Wu2@transport.nsw.gov.au>; Howard Chan <Howard.CHAN@transport.nsw.gov.au>; Jo Kaya <Joanna.Jarraldkaya@transport.nsw.gov.au>; Andrew Ha <Andrew.Ha@transport.nsw.gov.au>; [redacted] @mottmac.com>
Cc: [redacted] @mottmac.com>; [redacted] @mottmac.com>
Subject: RE: EBP traffic modelling review with Mott MacDonald

Hi [redacted] – latest review by TfNSW traffic modelling team is as follows for further discussion at the meeting today please…

(please also pass on / invite [redacted] as necessary)

"It has come to our attention that a 2039 "Do Minimum" (without project) scenario has not been modelled and results had been directly compared between 2029 and 2039 model results. This approach could not provide an accurate assessment of the project's benefits or impacts, particularly regarding delay, queuing, and travel time.

Based on our observations from previous modelling in both SIDRA and VISSIM, couple of deficiencies have been identified:

For SIDRA:

1. Calibration Issues:

The base model did not meet the calibration criteria, as the Degree of Saturation (DoS) exceeded 1 and did not align with the queue length survey data.

2. Coding Issues:

Various network coding issues were identified, including geometry, area factor, and saturation flow discrepancies.

3. Signal Coordination Issues:

Inefficient signal coordination was observed, contributing to delays.

Below are the SIDRA model results after we resolved the signal coordination issue and adjusted several network/parameter coding. The PM base model was recalibrated and validated to align with the survey data. These changes were then applied to the project case, and we also developed the 2039 "do minimum" model to analyse the impact and benefits with the project upgrade. The new TfNSW model project case results indicate that higher traffic volumes were able to enter the network with reasonable DoS and delay.

SIDRA PM - Sensitivity (TfNSW):

	2023 PM Base						2039 PM DM					2039 PM Bridge Upgrade				
	Total Arrival Flow (veh/hr)	DOS	Average Delay (sec)	LOS	95% back of Q (m)	Survey Q (m)	Total Arrival Flow (veh/hr)	DOS	Average Delay (sec)	LOS	95% back of Q (m)	Total Arrival Flow (veh/hr)	DOS	Average Delay (sec)	LOS	95% back of Q (m)
Carlingford / Ray/Rawson	2780	0.87	25	B	230	210	3110	0.96	41	C	365	3169	0.97	44	D	385
Carlingford / Beecroft	4671	1.03	36	C	310	210	5005	1.05	63	E	496	5145	1.09	77	F	534
Epping / Blaxland	5078	1.01	33	C	285	308	5468	0.98	31	C	321	5421	0.89	26	B	241
Epping / Essex	3306	0.95	42	C	221	252	3531	1.04	56	D	331	3507	1.03	57	E	287
Epping / High	4797	1.04	60	E	92	49	5271	1.54	>500	F	184	5231	0.72	6	A	35
Rawson / Bridge	1097	0.71	24	B	30	56	1340	1.14	>100	F	183	1347	1.02	76	F	103

SIDRA PM - Original (Mott McDonald):

	2023 PM Base						2039 PM DM					2039 PM Bridge Upgrade				
	Total Arrival Flow (veh/hr)	DOS	Average Delay (sec)	LOS	95% back of Q (m)	Survey Q (m)	Total Veh (veh/hr)	DOS	Average Delay (sec)	LOS	95% back of Q (m)	Total Arrival Flow (veh/hr)	DOS	Average Delay (sec)	LOS	95% back of Q (m)
Carlingford / Ray/Rawson	2831	1.934	67	F	137	210	Did not modelled					3156	2.72	161	F	378
Carlingford / Beecroft	4601	1.9	30	C	125	210						4936	1.26	68	E	327
Epping / Blaxland	5030	1.4	42	C	185	308						5323	0.81	25	B	128
Epping / Essex	3271	0.9	42	C	135	252						3449	0.89	46	D	130
Epping / High	4727	1.039	61	E	14	49						5115	0.676	5	A	41
Rawson / Bridge	1097	1.101	48	D	12	56						1288	1.282	97	F	25

VISSIM:

1. Signal Timing and Coordination:
   - Fixed time signals were implemented across all models, with identical phase times applied to both base and future year models. No adjustments or optimisations had been undertaken to accommodate future traffic demands or enhance intersection performance in the project case.
     Inefficient signal coordination was identified, resulting in increased delays and high level of latent demand while other location / direction have spare capacity.
2. 2039 "Do Minimum" Scenario:
   - Similar to the SIDRA modelling, a 2039 "Do Minimum" (without project) scenario was not modelled.
     The network results from Mott McDonald's original 2039 PM project model were significantly worse compared to our new created 2039 "Do Minimum" scenario. It is not make sense for the project case to have additional capacity but poorer in overall network performance.
3. Coding Issues:
   - Several coding issues, such as incorrect conflict markers, were found primarily in the project case, creating unnecessary delays or blockages.

Below are the VISSIM 2039 with and without project models (Both AM and PM) results after we resolved the signal coordination issue and adjusted several network/parameter coding.

Network Stats	2023 Base AM	2039 AM DM	2039 AM Project	
			Mott McDonald	TfNSW Sensitivity
Avg Delay (s)	112	129	121	114
Avg Speed (km/h)	26	24	25	26
VKT (km)	9651	10156	10115	10370
VHT (hr)	369	425	408	406
Total Veh	6119	6534	6509	6640
Latent Demand	5	289	310	30

Network Stats	2023 Base PM	2039 PM DM	2039 PM Project	
			Mott McDonald	TfNSW Sensitivity
Avg Delay (s)	98	216	240	197
Avg Speed (km/h)	28	16	15	17
VKT (km)	9563	10311	10015	10273
VHT (hr)	345	639	666	593
Total Veh	6252	6969	6752	6900
Latent Demand	0	90	419	166

Travel Time		2023 Base AM		2039 PM AM		2039 AM Project			
						Mott McDonald		TfNSW Sensitivity	
		Total Veh	Avg Travel Time (S)	Total Veh	Avg Travel Time (S)	Total Veh	Avg Travel Time (S)	Total Veh	Avg Travel Time (S)
Route 1	1: Beecroft Rd NB - R1_1	610	44.6	628	44.7	630	44.2	639	49.8
	2: Beecroft Rd NB - R1_2	470	55.3	486	54.7	486	55.6	463	88.9
	3: Beecroft Rd NB - R1_3	928	39.7	973	39.7	962	39.6	1004	39.6
	4: Beecroft Rd SB - R2_1	1280	63.8	1210	65.2	1211	65.3	1209	68.0
	5: Beecroft Rd SB - R2_2	346	154.0	365	158.6	359	69.3	369	73.5
	6: Beecroft Rd SB - R2_3	553	25.2	557	25.2	562	25.7	556	25.7
Route 2	7: Carlingford Rd/Epping EB - R3_1	1071	214.4	1075	218.5	1071	222.1	1057	83.5
	8: Carlingford Rd/Epping EB - R3_2	999	54.0	1023	56.6	1019	58.1	1003	60.5
	9: Carlingford Rd/Epping EB - R3_4	1776	47.8	1698	45.8	1696	44.4	1718	70.5
	10: Carlingford Rd/Epping WB - R4_1	667	92.0	746	92.2	754	85.8	726	98.0
	11: Carlingford Rd/Epping WB - R4_2	607	48.9	729	52.8	717	60.2	780	90.2
	12: Carlingford Rd/Epping WB - R4_3	687	45.8	808	48.0	797	47.4	866	43.9

Travel Time		2023 Base PM		2039 PM DM		2039 PM Project			
						Mott McDonald		TfNSW Sensitivity	
		Total Veh	Avg Travel Time (S)	Total Veh	Avg Travel Time (S)	Total Veh	Avg Travel Time (S)	Total Veh	Avg Travel Time (S)
Route 1	1: Beecroft Rd NB - R1_1	832	71.3	889	70.8	804	366.9	786	366.7
	2: Beecroft Rd NB - R1_2	665	57.4	727	65.5	663	69.3	642	79.6
	3: Beecroft Rd NB - R1_3	1262	39.5	1427	39.5	1395	39.4	1378	39.4
	4: Beecroft Rd SB - R2_1	890	53.9	914	61.5	920	61.2	914	60.0
	5: Beecroft Rd SB - R2_2	180	420.3	237	110.3	232	77.3	238	69.3
	6: Beecroft Rd SB - R2_3	267	25.1	330	25.3	325	25.9	330	25.8
Route 2	7: Carlingford Rd/Epping EB - R3_1	870	90.1	1009	299.0	870	427.3	1036	332.1
	8: Carlingford Rd/Epping EB - R3_2	584	40.5	591	42.7	521	39.8	608	43.1
	9: Carlingford Rd/Epping EB - R3_4	1035	41.8	992	28.0	928	39.5	1007	27.4
	10: Carlingford Rd/Epping WB - R4_1	1187	80.3	1136	211.2	1260	72.8	1250	55.4
	11: Carlingford Rd/Epping WB - R4_2	801	65.9	743	66.5	788	93.7	783	91.3
	12: Carlingford Rd/Epping WB - R4_3	860	46.0	805	45.1	837	47.4	840	44.6

Kind regards

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Transport for NSW

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MOTT MACDONALD

Base Year Model Technical Note

Epping Bridge Upgrade

TfNSW

Project:	Epping Bridge Replacement		
Our reference:	703100907	**Your reference:**	EBP150523-MOTTM-EPG-TP-RPT-000001 Rev C OFFICIAL
Prepared by:		**Date:**	25 July 2024
Approved by:		**Checked by:**	
Subject:	Base Year Model Calibration and Validation Report		

1 Introduction

1.1 Background

This draft technical note documents the development, calibration, and validation of the 2023 Base Case VISSIM and SIDRA models for the Epping Bridge project.

We seek TfNSW review, comment and/or agreement to their fitness for purpose, prior to commencement of the end state scenario modelling and construction staging work for the Concept Design phase.

Traffic modelling is required to demonstrate the potential impacts of the project on the transport network, during construction and at end state, for the Review of Environmental Factors (REF).

This Technical Note has been structured in line with TTD2017/001.

1.2 Project Objectives

The proposed project will replace and widen the existing Epping Bridge across the combined T9 and Metro rail corridor. It will include the following upgrades to Epping Road and Beecroft Road:

- an additional eastbound right turn lane from Epping Bridge into Blaxland Road
- an additional westbound lane across the bridge deck
- widening of the traffic lanes on the bridge deck, continuing around the sharp curve in the Beecroft Road alignment, immediately west of the bridge
- adjustments to the Beecroft Road access with Bridge Street and High Street
- improved active transport facilities along the southern footpath of the bridge
- relocation of existing Beecroft Road bus stops north of the pedestrian overbridge

1.3 Scope of Work

Mott MacDonald has been engaged to develop a Preliminary Design Review (Concept Design) and develop the Review of Environmental Factors (REF) which will be used to seek Planning Approval for the project. The Concept Design would then be used as the reference design for the next phase of procurement for the Detailed Design and Construction of the works.

The concept design will be built upon the work completed in 2021 by Future Rail for the Definition Design of the Epping Bridge Project. The Future Rail Definition Design assessed both a widening and replacement option which was used to prepare the Final Business Case, which is now complete.

The purpose of the VISSIM and SIDRA modelling is to:

- Provide traffic analysis for the Review of Environmental Factors (REF) of the Epping Bridge Replacement proposal. The modelling will need to compare traffic performance With and Without Project at opening year 2028 and 10-years after opening.
- Assess the travel delay impacts, if any, of key traffic staging arrangements during construction of the project, to inform the Road User Delay Management Strategy.

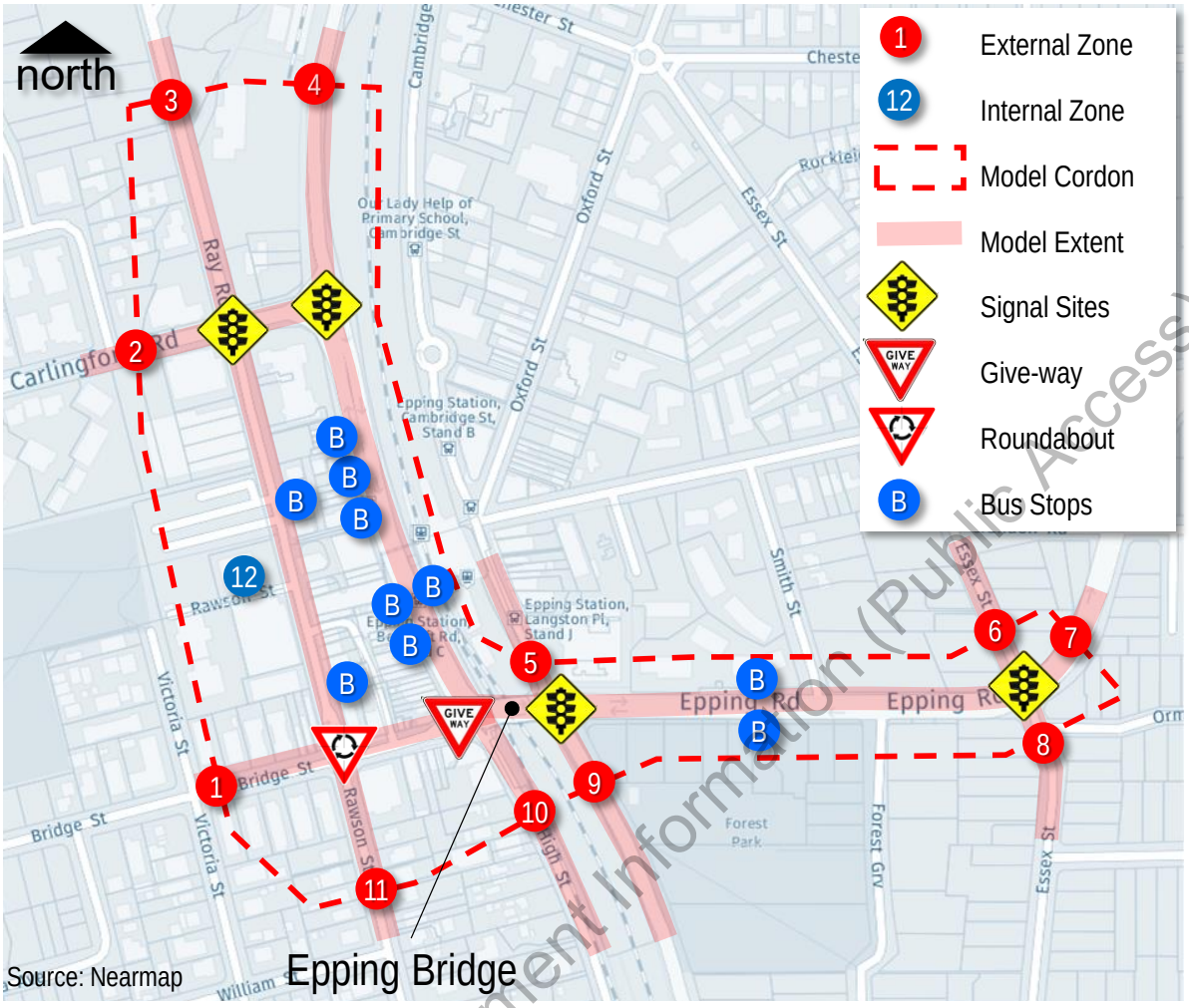
Whilst there may be minor design optimisation undertaken during the Concept Design phase, the design layouts were specified in the Concept Design brief. Optioneering and/or comparative assessments of alternate designs are not included in the Concept Design scope.

1.4 Study Area

The proposed extent of the VISSIM & SIDRA models is presented in **Figure 1-1** The 12x12 cordon zones, that were adopted for the previous VISSIM modelling during the Reference Design phase, are retained. The zone descriptions include:

1. Bridge Street (west)
2. Carlingford Road (west)
3. Ray Road (north)
4. Beecroft Road (north)
5. Langston Place (north)
6. Essex Street (south)
7. Epping Road (east)
8. Essex Street (north)
9. Rawson Street (south)
10. Blaxland Road (south)
11. High Street (south)
12. Rawson Street Carpark

Figure 1-1 Study Area



1.5 Report Outline

This report has been structured in accordance with TTD 2017/001 and includes:

Section 1 – Introduction

Section 2 – Existing Conditions

Section 3 – Model Development

Section 4 – Model Calibration and Validation

Section 5 – Summary and Conclusion

2 Existing Conditions

2.1 Traffic Surveys

The following data has been collected to undertake the development and calibration of the AM and PM peak Base Case models:

2.1.1 Traffic volume counts

- Classified Intersection Traffic Counts were obtained for following peak periods on Thursday 21/9/2023.
  - AM Peak Period (06:00-10:00)
  - PM Peak Period (15:00-19:00)
- Traffic data was collected at the following Intersections and details are given in **Appendix A.**
  - Epping Road and Essex Street
  - Epping Road, Langston Road and Blaxland Road
  - Epping Road, High Street and Bridge Street
  - Carlingford Road and Beecroft Road
  - Carlingford Road, Rawson Street and Ray Road
  - Bridge Street and Rawson Street

Based on traffic survey data, the following peak hours were identified in AM peak and PM peak:

- AM Peak Hour (07:30-08:30)
- PM Peak Hour (17:00-18:00)

2.1.2 SCATS Information

SCATS Signal operation data for 21/09/2024 was provided by TfNSW for the following signalised intersections:

- Carlingford Road / Ray Road/ Rawson Street (VV1015)
- Carlingford Road / Beecroft Road (VV0706)
- Epping Road / Langston Place/ Blaxland Road (VV0216)
- Epping Road / Essex Road (VV1338)

This SCATs information was analysed for the peak hours to understand the signal phasing times and cycle times. The signal phases given in the SCATS were coded in VISSIM including the alternate phases. The alternate phases were coded as a variable phase and some of these alternative phases were skipped based on the demand. The phases with green time have been retained in the modelling. It was observed that all signalised intersections in the study area are running with a cycle time of ~130 seconds. The user-given cycle time of approximately 130 seconds was adopted for all signalised intersections in the base case scenario.

2.1.3 Queue Length Survey

Intersection Queue Length Surveys at the same survey sites, on Thursday 21/9/2023, are presented in **Appendix B**. This queue length data was used for model validation.

A review of the queue length data revealed the following:

- IC01: Carlingford Road / Ray Road/ Rawson Street.
  - During the AM Peak, a substantial queue of 42 vehicles was observed on the west approach.
- IC02: Carlingford Road / Beecroft Road:

- In both the AM and PM peaks, a maximum of 30 vehicles were observed queuing on the South approach through lanes.

- IC03: Epping Road / Blaxland Road:
  - During both the AM and PM Peaks, there were 30-35 vehicles queuing to turn right from Beecroft Road's west approach onto Blaxland Road.
  - In the PM peak, a maximum of 40 vehicles were observed queuing to turn left from Blaxland Road's south approach into Beecroft Road.
- IC04: Epping Road / Essex Road:
  - In both the AM and PM Peaks, 13-15 vehicles were observed queuing on the North approach attempting to turn right into Epping Road.

2.1.4 Travel Time Survey

Travel time data was collected on 21/09/2023 during the 4-hour AM and PM peak periods using the floating car method. The Base Case models are validated using this travel time data. The routes for the travel time assessments were:

- Route 1: Beecroft Road and Blaxland Road (Northbound and Southbound)
- Route 2: Carlingford Road, Beecroft Road and Epping Road (Eastbound and Westbound)

In addition to the primary travel time surveys above, HERE travel time data was sourced for the same road segments during the same periods. A summary of the travel time data is presented in **Table 2.1** and travel time graphs are presented in **Appendix C**.

Table 2.1: Travel Time Data

No	Route	Section		AM Peak (07:30 - 08:30)		PM Peak (17:00 - 18:00)	
		From	To	Survey	HERE	Survey	HERE
1	Beecroft Rd NB	Maida Rd	Epping Rd	0:00:29	0:00:43	0:03:06	0:00:55
		Epping Rd	Carlingford Rd	0:01:26	0:01:08	0:01:23	0:01:11
		Carlingford Rd	Kandy Ave	0:00:42	0:00:54	0:00:40	0:00:29
2	Beecroft Rd SB	Kandy Ave	Carlingford Rd	0:01:04	0:00:52	0:01:18	0:01:35
		Carlingford Rd	Blaxland Rd	0:02:54	0:01:34	0:06:09	0:01:35
		Blaxland Rd	Maida Rd	0:00:25	0:00:32	0:00:25	0:00:46
3	Carlingford Rd/Epping EB	Kent St	Beecroft Rd	0:03:49	0:03:24	0:01:27	0:01:36
		Beecroft Rd	Blaxland Rd	0:01:10	0:01:30	0:00:45	0:01:07
		Blaxland Rd	Essex St	0:00:43	0:00:40	0:00:25	0:00:35
4	Carlingford Rd/Epping WB	Essex St	Blaxland Rd	0:01:33	0:00:56	0:02:28	0:01:29
		Blaxland Rd	Carlingford Rd	0:00:47	0:01:05	0:01:19	0:01:29
		Carlingford Rd	Kent St	0:00:47	0:00:42	0:00:50	0:00:48

2.1.5 Public Transport

Existing bus service timetables and frequencies were obtained from public timetables. The study area is currently serviced by 11 bus routes as summarised in **Table 2.2.**

Table 2.2: Bus Routes

Route Number	From/To
550	Macquarie Park to Parramatta via Epping; Parramatta to Macquarie Park via Epping.
630	Epping to Blacktown; Blacktown to Epping
541	Epping to Eastwood; Eastwood to Epping.
718w	Epping Station, Beecroft Rd to James Ruse High School.
651	Rouse Hill Station to Epping via Castle Hill; Epping to Rouse Hill Station via Castle Hill.
546	Parramatta to Epping via Oatlands & North Rocks; Epping to Parramatta via Oatlands & North Rocks.
549	Parramatta to Epping via North Rocks; Epping to Parramatta via North Rocks.
726w	Epping Station, Beecroft Rd to Mount Saint Benedict High.
732w	Epping Station, Beecroft Rd to Baulkham Hills High.
3013	Epping Station to Baulkham Hills HS.
3014	Epping Station to Baulkham Hills HS.

2.2 Site Visit

Site visits were undertaken on the following occasions:

- 25 October 2023, AM Peak
- 14 November 2023, PM Peak

Photos from the site visits are presented in **Appendix D**. The main observations from the site visits are listed below.

2.2.1 Congestion Locations

The main areas of congestion in the AM Peak include:

- Carlingford Road eastbound approaching Ray Street and Beecroft Road
- Ray Street and Rawson Street approaches to Carlingford Road
- Beecroft Road southbound approaching Carlingford Road due to large weave movement across to the right lane, to turn into Blaxland Road.
- Essex Street approaching Epping Road.
- The westbound left turn lane in Epping Road, approaching Blaxland Road, is underutilised, whilst the adjacent through lanes experienced extensive queuing. Buses making a passenger stop on this approach, found it very difficult to merge back into the through lanes before Blaxland Road.
- 30min parking is allowed on Beecroft Rd NB.

The main areas of congestion in the PM peak include:

- Ray Street and Rawson Street approaches to Carlingford Road
- Essex Street approaching Epping Road.
- Blaxland Road northbound approaching Epping Road
- Bridge Street westbound approaching the Rawson Street roundabout.
- Parking is restricted on Beecroft Rd NB.

No school zones within the study area

3 Model Development

3.1 Modelling Platform

The modelling analysis for this project is undertaken using VISSIM (Version 2023 SP02) and SIDRA Intersection analysis (Version 9.1).

3.2 Model Development

3.2.1 Road Types

The road network capacity and speeds are coded based on:

- Nearmap, spatially accurate aerial photography
- Roadway surveys
- Existing traffic signal layouts
- Existing speed limit zones including school zones, if any
- Site observations

3.2.2 Traffic Demands

Existing traffic demands and patterns for the network were derived from turning volumes. The traffic profile for the AM and PM peak periods are illustrated in **Figure 3.1** and **Figure 3.2** respectively. Based on these following peak hours for AM and PM peak hours were determined and used for VISSIM and SIDRA modelling.

- 7:30am to 8:30am
- 5:00pm to 6:00pm

The VISSIM model includes a warm-up and cool-down period along with the peak hours:

- a 60-minute warm-up period
- a 30-minute cool-down period.

Figure 3.1: AM Peak Traffic Profile

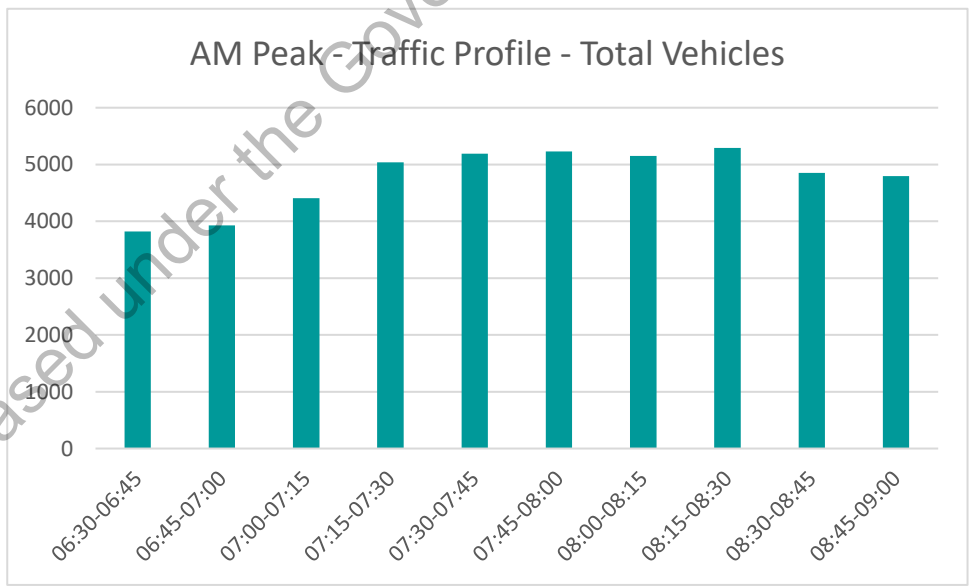
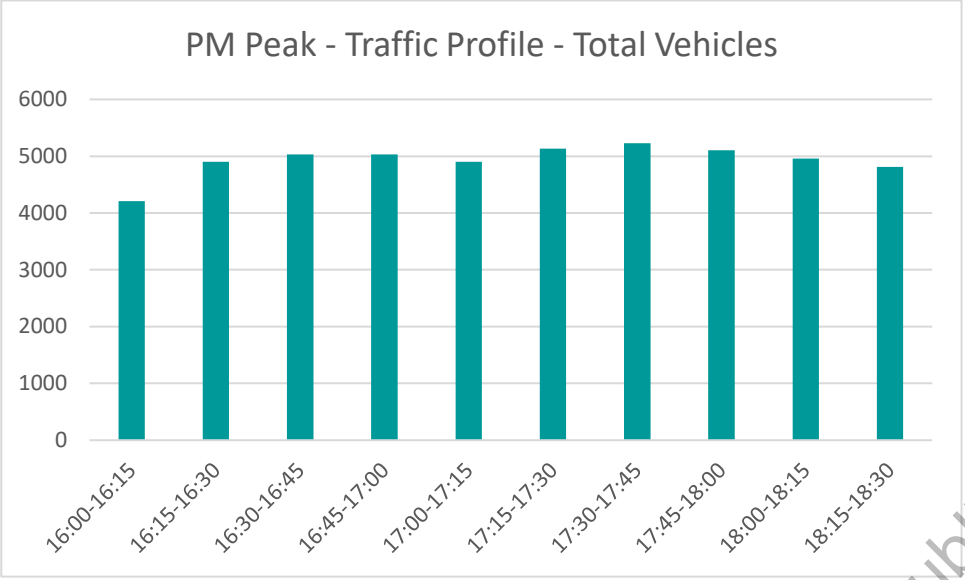


Figure 3.2: PM Peak Traffic Profile



3.2.3 Traffic Composition

The Base Case matrices were developed for the following vehicle types:

- Cars
- Trucks
- Buses

Additionally, pedestrian and cycle movements at crossing points are included in the VISSIM and SIDRA models.

The buses were modelled as a fixed route, as discussed in **Section 0**. The composition of vehicles in each peak hour is summarised in **Table 3.1**.

Table 3.1: Traffic Composition

Time Period	Cars	Trucks	Total
AM Peak			
07:30 -08:30	20,402	462	**20,864**
PM Peak			
17:00 -18:00	20,370	227	**20,370**

3.2.4 Speed Profiles

The models were developed using the VISSIM and SIDRA default values for driver behaviour and speed profiles for NSW, where available. Given that this is a low-speed environment, posted speed limits in the area are 60km/h or less, and the area is subject to congested traffic conditions, the respective default values in VISSIM and SIDRA are considered acceptable.

3.2.5 Traffic Signals

The VISSIM and SIDRA models were developed with fixed time signal operation. Signal timings, phases and offset data were derived from the SCATS data collected on the 21/9/2023. The SCATS timing data in **Appendix H** clearly shows that cycle and phase times remain very consistent during peak periods, so fixed time operation is justified.

SCATS detector Counts, SCATS signal data, SCATS History and Controller information are presented in **Appendices E, F, G** and **H**. Existing traffic signal drawings are presented in **Appendix I.** Phase and cycle time of each signal are presented in **Table 3.2.**

Table 3.2: Average Signal Phase Time (s) - AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)	PM Peak (17:00-18:00)
Carlingford Rd & Ray Rd & Rawson St	A	86	84
	B	44	46
	Total	**129**	**130**
Beecroft Rd & Carlingford Rd	A	47	57
	B	18	20
	C	64	52
	Total	**128**	**129**
Epping Rd & Blaxland Rd & Langston Pl	A	55	81
	B	23	23
	C	28	27
	D	24	-
	Total	**130**	**131**
Epping Rd & Essex St	A	82	79
	B	27	27
	C	21	23
	Total	**130**	**128**

3.2.6 Public Transport

Bus service arrivals and departures at Epping Station during the AM and PM peaks, to stands C, D, E, F and G were explicitly coded, based on service routes and timetables. Bus stands A and B, located in Cambridge Street on the east side of the station are excluded from the model.

The bus arrivals, dwell times and departure events are tabulated in **Appendix J.** The journey of each bus through the model was coded as a series of events (entries, bus stop dwells, layovers and/or exits).

3.2.7 Active Transport

Observed active transport crossing counts were included in all Base Case SIDRA and VISSIM models.

3.2.8 Matrix Estimation

Demand matrices for cars and trucks were generated at 15-minute intervals by applying the TFlowFuzzy methodology within the VISUM software. These matrices were derived from the observed turning traffic volumes (refer to Section 2.1.1), aiming to replicate the distribution of traffic demand and its changes throughout the modelling period. In this process, the 2021 STFM Base Case cordon matrices were utilized as the base travel pattern for the matrix estimation. The 2021 demand patterns are presented in **Appendix K.**

2023 Peak hour observed flows were coded directly into the Base case SIDRA models.

3.2.9 Assignment Type

Stochastic Route Choice was used to model the Epping Road in VISSIM. Given the lack of route choice available within the study area, the traffic assignment method effectively functions as ‘all or nothing’ assignment.

4 Model Calibration and Validation

4.1 Overview

The model calibration involves aligning observed traffic conditions with the modelled traffic conditions including vehicle behaviour observed on site. Turning counts and queue length, travel time have been selected as key performance indicators (KPI's) of model calibration for VISSIM Modelling and queue length for SIDRA modelling. Data collected from traffic surveys, as discussed in **Section 2.1** has been compared against model outputs. Furthermore, model stability has been tested against a set of criteria outlined below.

4.2 Model Calibration VISSIM Modelling

4.2.1 Model Calibration Criteria

This model is calibrated against the core area criteria:

- Core model tolerance criteria listed in **Table 4-1.**
- 100 per cent of observations to be within tolerance limits.
- R^2 value of observed versus modelled plots to be >0.95
- Average modelled cycle time for each 1-hour period to be within 10% of observed SCATS cycle time for the same period
- Total green-time over each 1-hour period to be within 10% of observed SCATS equivalent for each phase

Table 4-1 Core Area Tolerance Limits

Flow	Criteria
< 99	To be within 10 vehicles of observed
100-999	To be within 10% of observed
1000-1999	To be within 100 vehicles of observed
>2000	**To be within 5% of observed**

4.2.2 Turning Count Calibration Results

Table 4-1 describes the network wide criteria and measurement requirements set out by TfNSW in the Traffic Modelling Guidelines (2013) for turning and link counts.

The traffic flows for each modelled hour were calibrated against the observed turning counts. The calibration outcomes for the AM and PM peak periods are summarised in **Table 4.2** and **Table 4.3** respectively.

Table 4.2: Base Model Turning Flows Calibration - AM Peak

AM Peak (07:30-08:30) – Calibration Results	
Plot	**Results**
Percentage of turn/link volumes	75/77 (97%)
R-square value	1.00

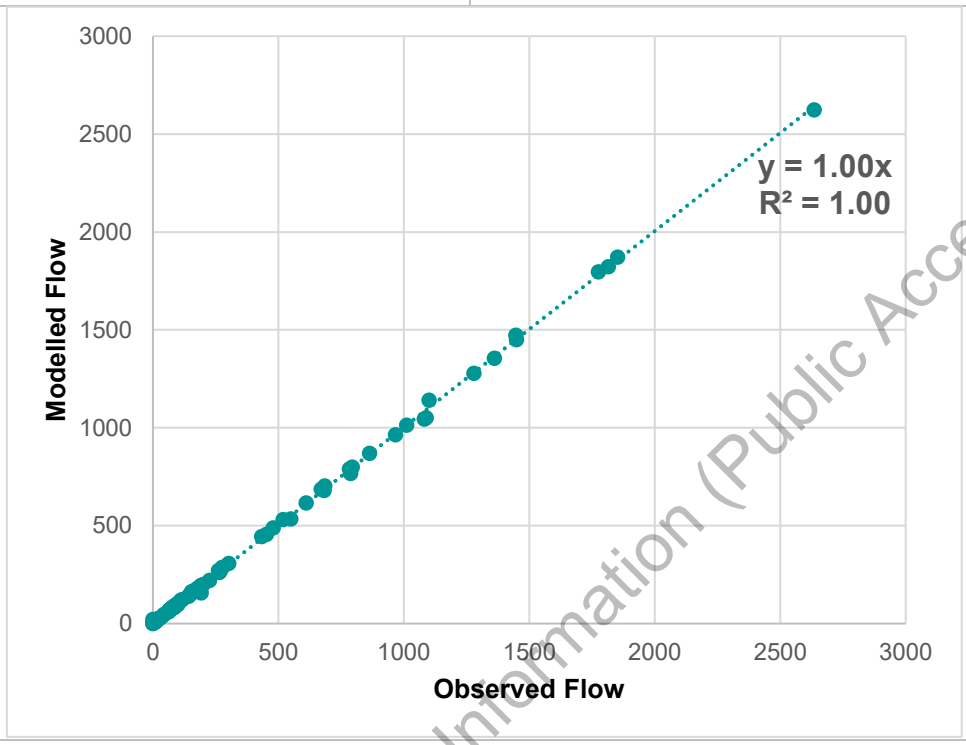
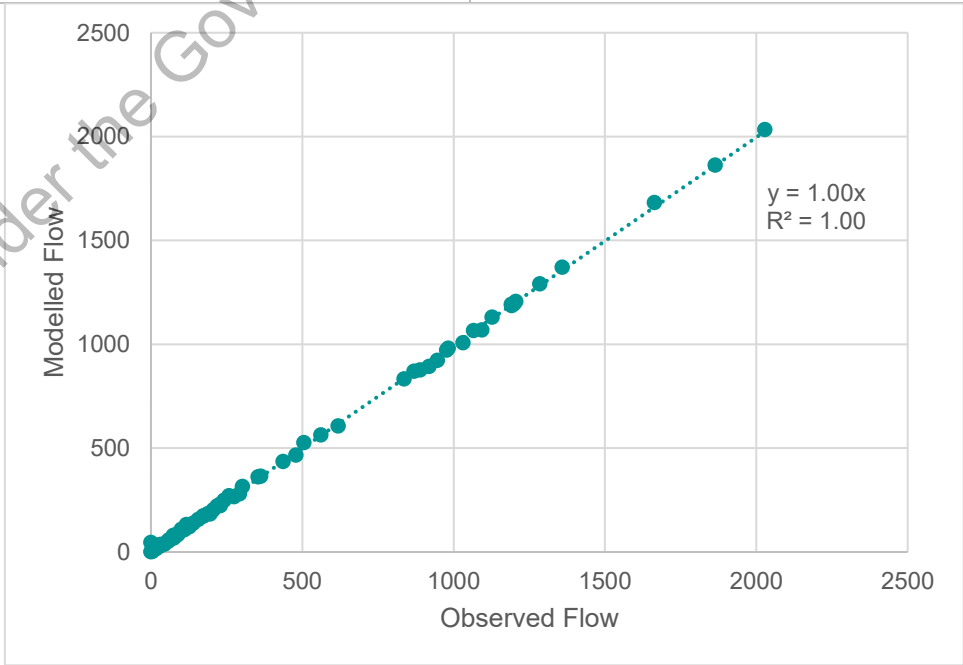


Table 4.3: Base Model Turning Flows Calibration - PM Peak

PM Peak (17:00-18:00) – Calibration Results	
Plot	**Results**
Percentage of turn/link volumes	75/77 (97%)
R-square value	1.00



Based on the above results, the Base Case models of Epping Road bridge were well calibrated using the turning movements at each intersection and all cordon entry/exit points against the observed traffic turning counts. However, there are two turning fail to meet the criteria due to traffic imbalances created by Hunts La street.

4.2.3 Signal Time Calibration Results

A comparison of observed and modelled signal times at each intersection is presented **Table 4-4.**

During the AM and PM peaks, the modelled average cycle time and phase times shows a good match with the observed times (within 10%).

Table 4-4 Signal Time Comparison – AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
		Observed	Modelled	Diff %	Observed	Modelled	Diff %
Carlingford Rd & Ray Rd & Rawson St	A	86	83	3%	84	84	0%
	B	44	47	-7%	46	46	0%
	Total	**129**	**130**	**-1%**	**130**	**130**	**0%**
Beecroft Rd & Carlingford Rd	A	47	47	0%	57	57	0%
	B	18	18	-3%	20	21	-8%
	C	64	64	-1%	52	52	0%
	Total	**128**	**129**	**-1%**	**129**	**130**	**-1%**
Epping Rd & Blaxland Rd & Langston Pl	A	55	55	1%	81	81	0%
	B	23	25	-7%	23	24	-2%
	C	28	29	-2%	27	26	6%
	D	24	23	6%	-	-	-
	Total	**130**	**130**	**0%**	**131**	**130**	**1%**
Epping Rd & Essex St	A	82	81	2%	79	77	3%
	B	27	29	-7%	27	29	-9%
	C	21	21	2%	23	25	-8%
	Total	**130**	**130**	**0%**	**128**	**130**	**-1%**

4.2.4 Model Stability

The model statistics for assessing calibration and validation were based on a median run selected from five model seed values (560, 28, 7771, 86524 and 2849). An analysis of VHT and VKT results for the five seed values was used to demonstrate model stability.

4.2.5 Demonstration of Model Stability

The ability of a model to produce consistent results for several seed values is referred to as model stability. The stability of the model is assessed by comparing the total vehicle hours travelled (VHT) network performance indicator between the five model seed runs undertaken for each period.

Based on this, and as indicated in the TfNSW Traffic Modelling Guidelines (2013), the representative seed run is selected (median VHT value). All results reported are based on this single representative seed run. As such, **Figure 4.1** and **Figure 4.2** illustrate the VHT during the AM and PM peak periods respectively.

Figure 4.1: Total Vehicle Hours Travelled (VHT) - AM Peak

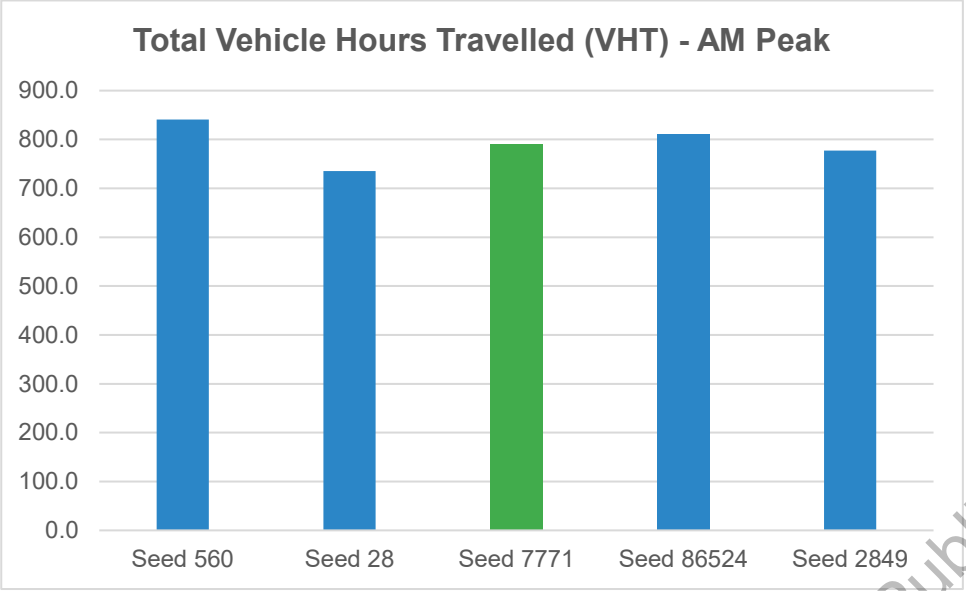
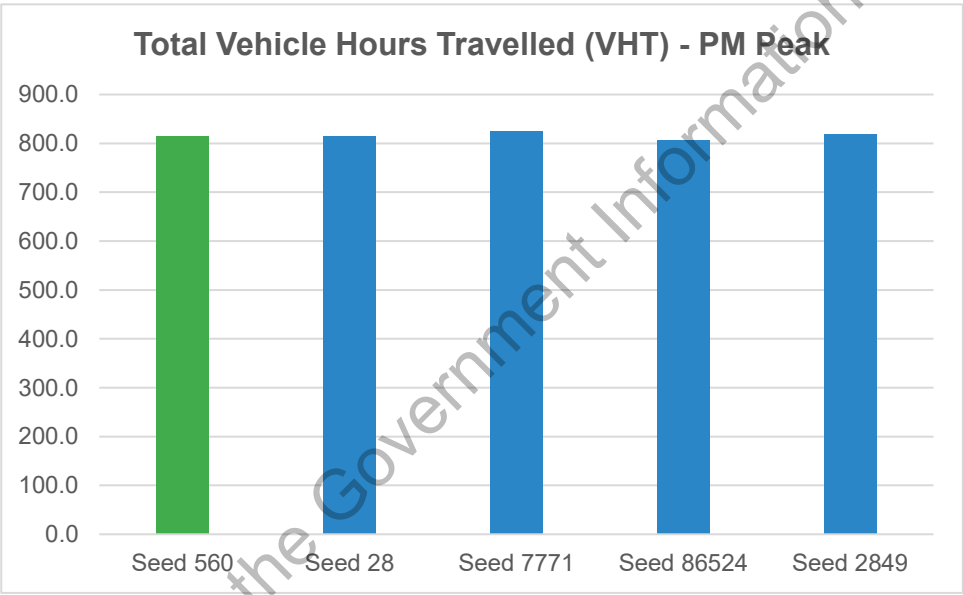


Figure 4.2: Total Vehicle Hours Travelled (VHT) - PM Peak



The difference between the results produced by each seed was within 7% and 1% in the AM and PM peaks compared to the respective median values. Hence, the AM and PM peak modelling show that both models are stable. The median seed value (in green) for AM Peak is 7771 and for PM Peak the median seed value is 560.

4.2.6 Model Validation

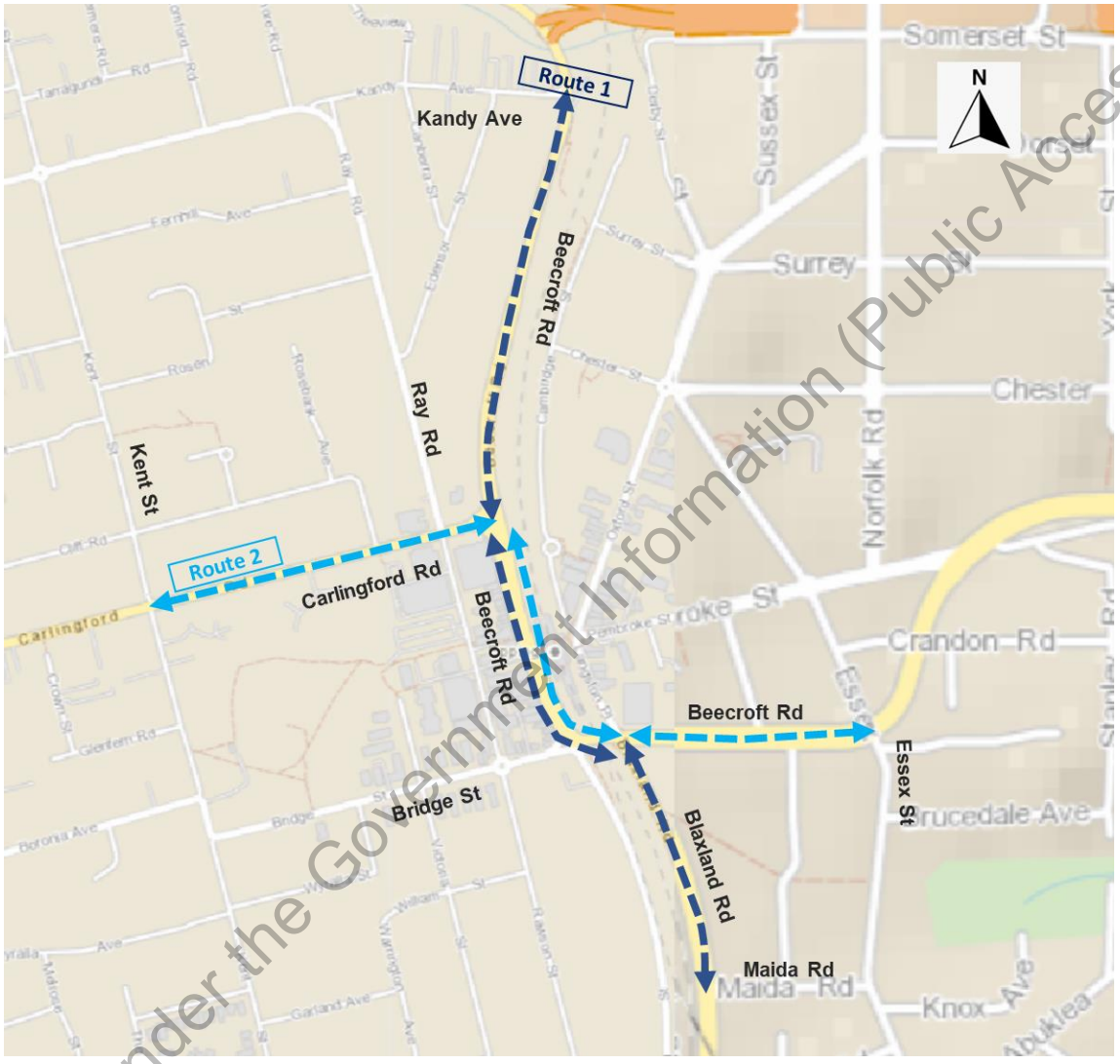
VISSIM Model validation has been undertaken using observed travel time data. The objective is to achieve modelled travel times within 15% of observed travels times, or within 1-minute, whichever is the highest.

4.2.7 Travel Time Validation

The model validation has been undertaken based on the observed travel time (Refer to **Section 2.1.4** for details). Travel time data has been collected during AM and PM peak periods for two routes within the model area which are shown in **Figure 4-3** and listed below:

- Route 1: Beecroft Road, Blaxland Road (Northbound and Southbound)
- Route 2: Carlingford Road, Beecroft Road and Epping Road (Eastbound and Westbound)

Figure 4-3 Travel Time Routes



The travel time comparison for the above-mentioned routes are provided in **Table 4-5**. Also, the cumulative travel time graphs for each route are provided in **Figure 4-4** to **Figure 4-11**.

Table 4-5 Travel Time Validation Results - AM and PM Peaks

Route	From	To	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
			Observed	Modelled	Diff %	Observed	Modelled	Diff %
Beecroft Rd (Northbound)	Maida Rd	Epping Rd	00:29	00:45	-53%	03:06	01:11	62%
	Epping Rd	Carlingford Rd	01:26	00:55	36%	01:23	00:57	31%
	Carlingford Rd	Kandy Ave	00:42	00:40	6%	00:40	00:40	2%
	Overall		**02:37**	**02:20**	**11%**	**05:10**	**02:48**	**46%**
Beecroft Rd (Southbound)	Kandy Ave	Carlingford Rd	01:04	01:04	1%	01:18	00:54	31%
	Carlingford Rd	Blaxland Rd	02:54	02:34	11%	06:09	07:00	-14%
	Blaxland Rd	Maida Rd	00:25	00:25	-1%	00:25	00:25	1%
	Overall		**04:23**	**04:03**	**8%**	**07:52**	**08:19**	**-6%**
Carlingford Rd/Epping Rd (Eastbound)	Kent St	Beecroft Rd	03:49	03:34	6%	01:27	01:30	-4%
	Beecroft Rd	Blaxland Rd	01:10	00:54	23%	00:45	00:40	11%
	Blaxland Rd	Essex St	00:43	00:48	-11%	00:25	00:42	-65%
	Overall		**05:42**	**05:16**	**8%**	**02:37**	**02:52**	**-10%**
Carlingford Rd/Epping Rd (Westbound)	Essex St	Blaxland Rd	01:33	01:32	1%	02:28	01:20	46%
	Blaxland Rd	Carlingford Rd	00:47	00:49	-3%	01:19	01:07	15%
	Carlingford Rd	Kent St	00:47	00:46	2%	00:50	00:46	8%
	Overall		**03:07**	**03:07**	**0%**	**04:36**	**03:13**	**30%**

Figure 4-4 Travel Time Plot - Beecroft Rd (Northbound) - AM Peak (07:30 - 08:30)

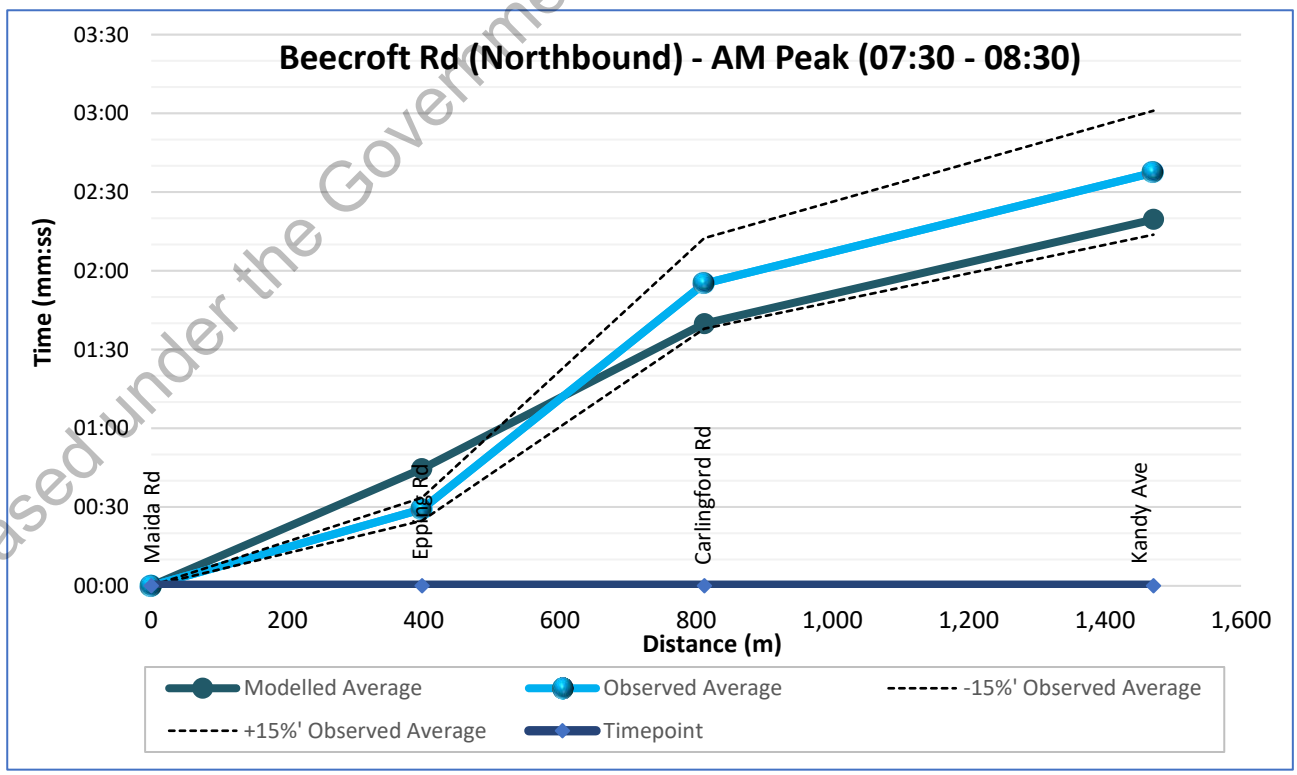


Figure 4-5 Travel Time Plot - Beecroft Rd (Southbound) - AM Peak (07:30 - 08:30)

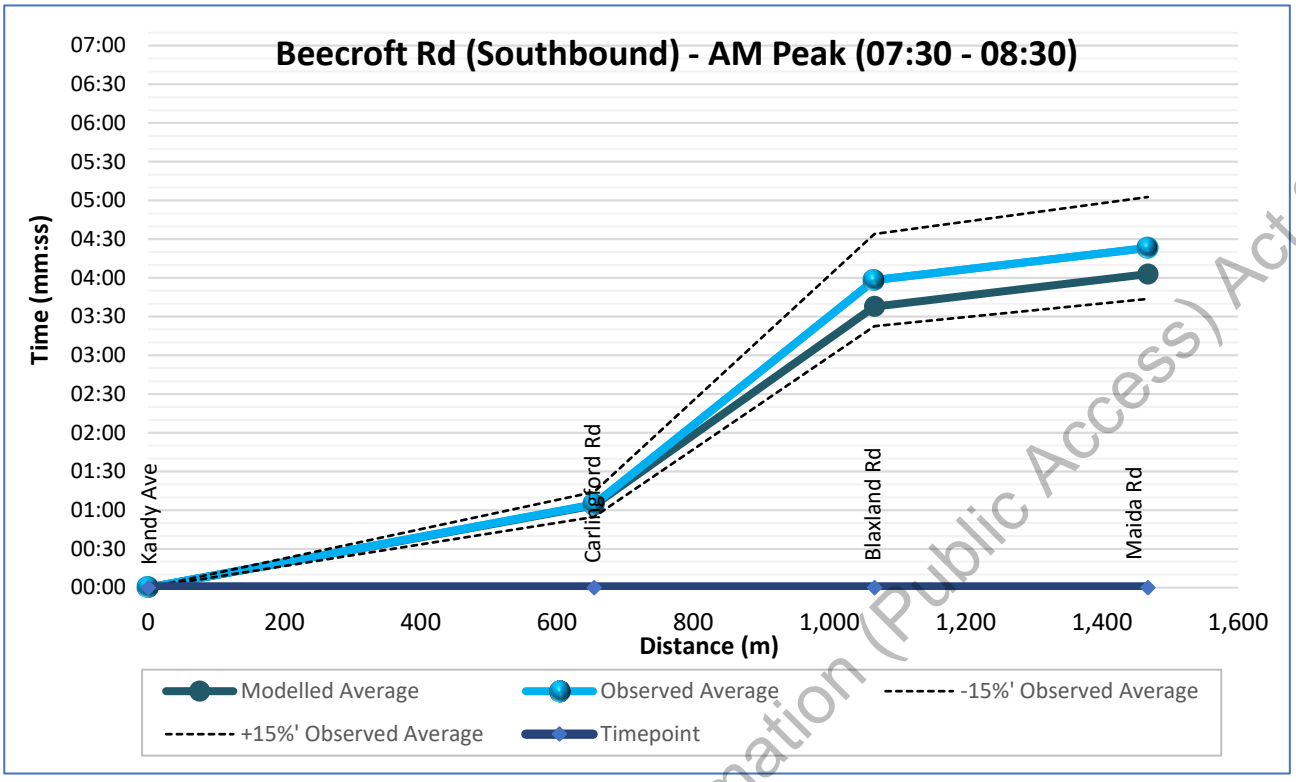


Figure 4-6 Travel Time Plot - Beecroft Rd (Northbound) - PM Peak (17:00 - 18:00)

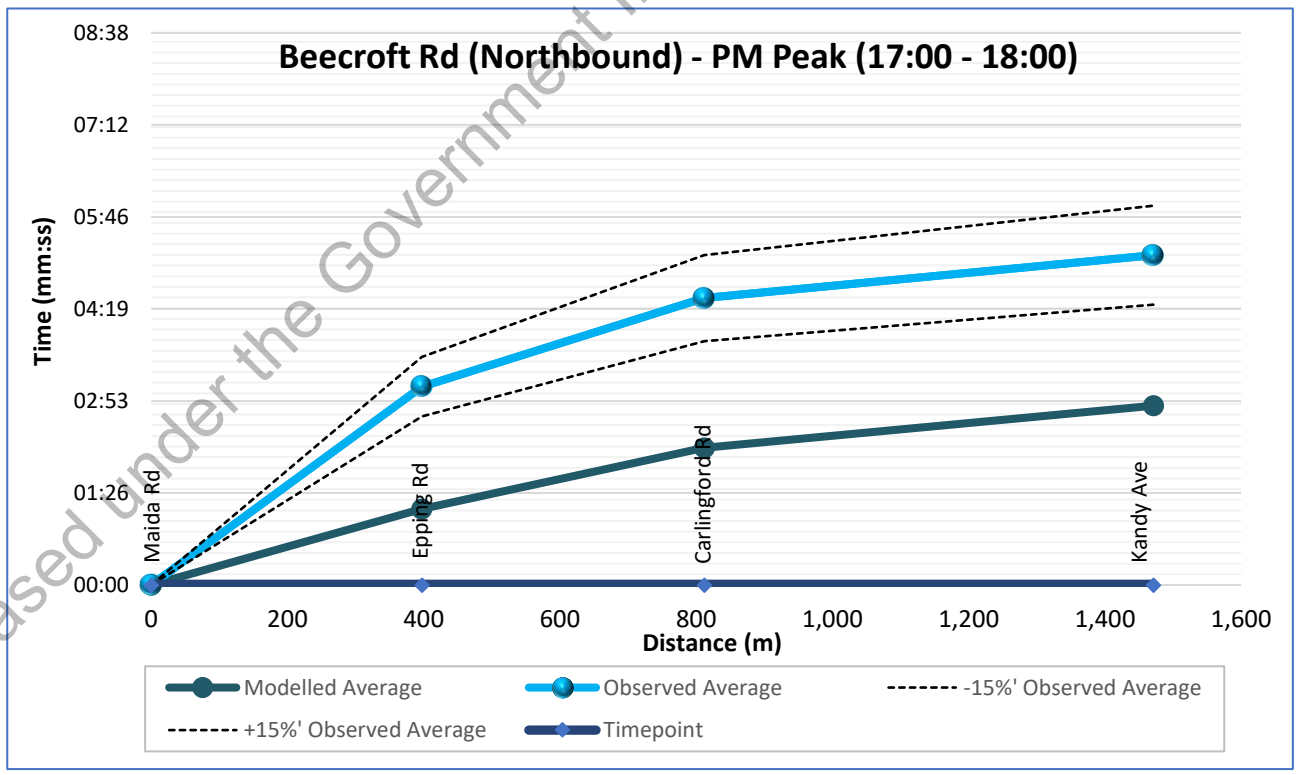


Figure 4-7 Travel Time Plot - Beecroft Rd (Southbound) - PM Peak (17:00 - 18:00)

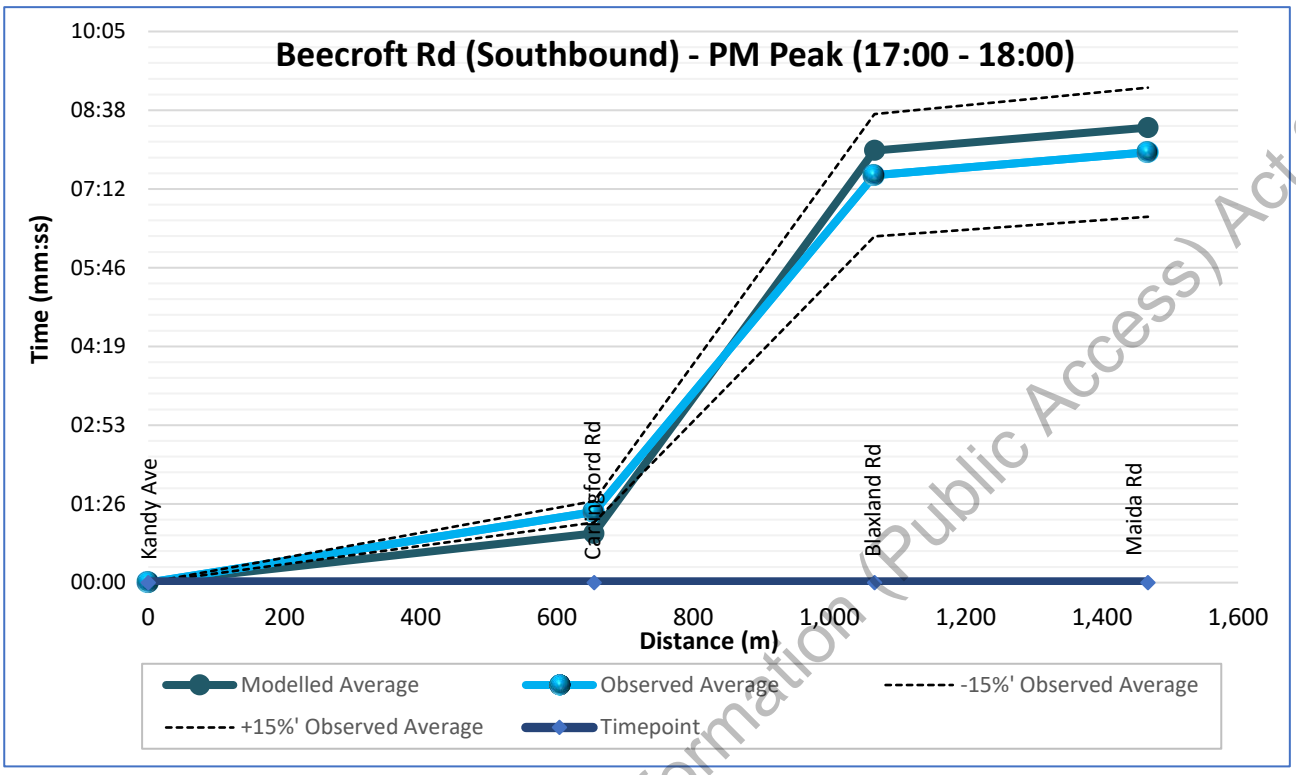


Figure 4-8 Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- AM Peak (07:30 - 08:30)

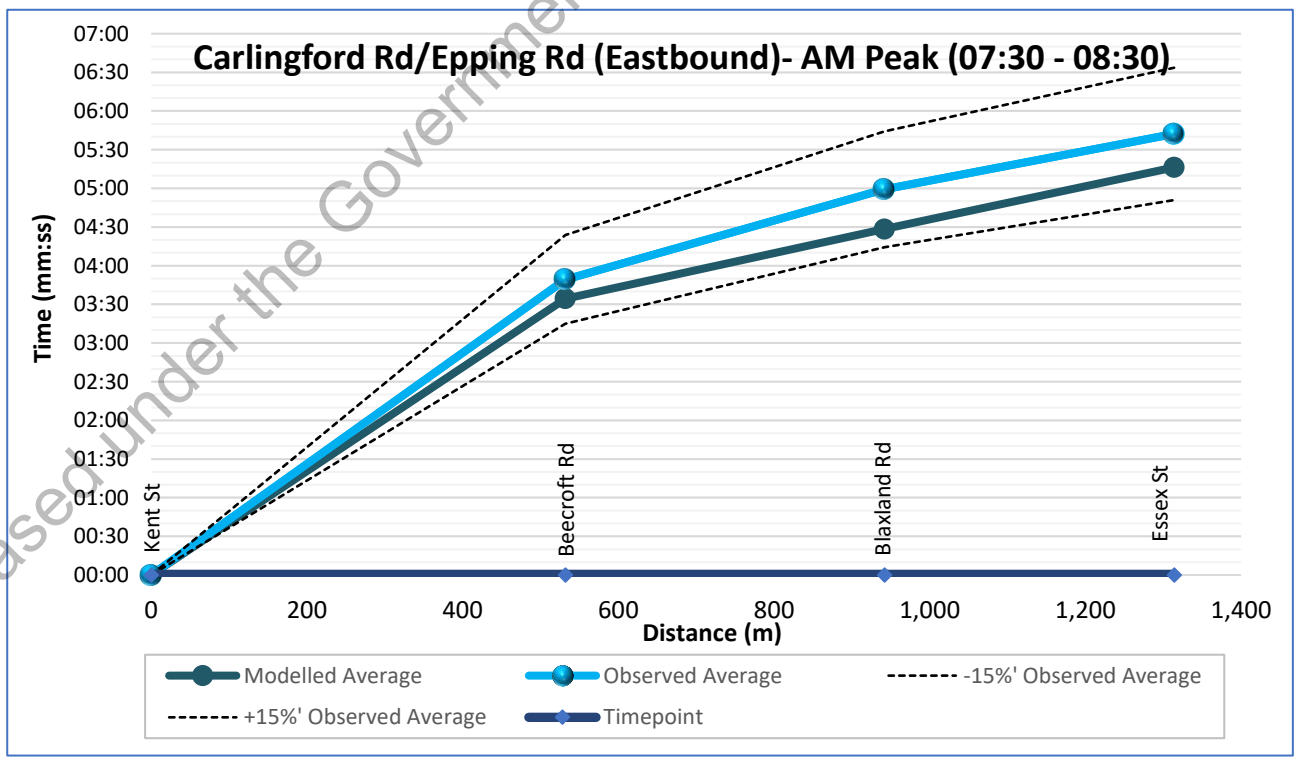


Figure 4-9 Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- AM Peak (07:30 - 08:30)

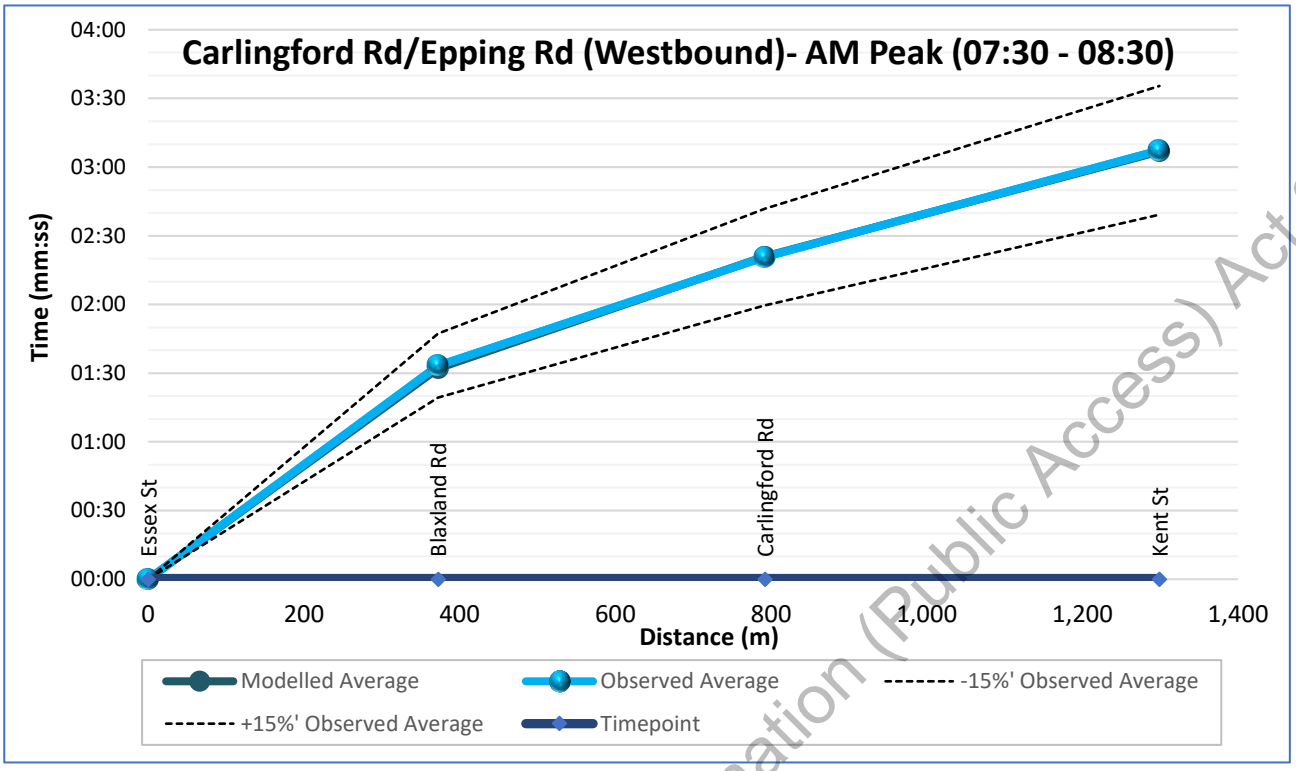


Figure 4-10 Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- PM Peak (17:00 - 18:00)

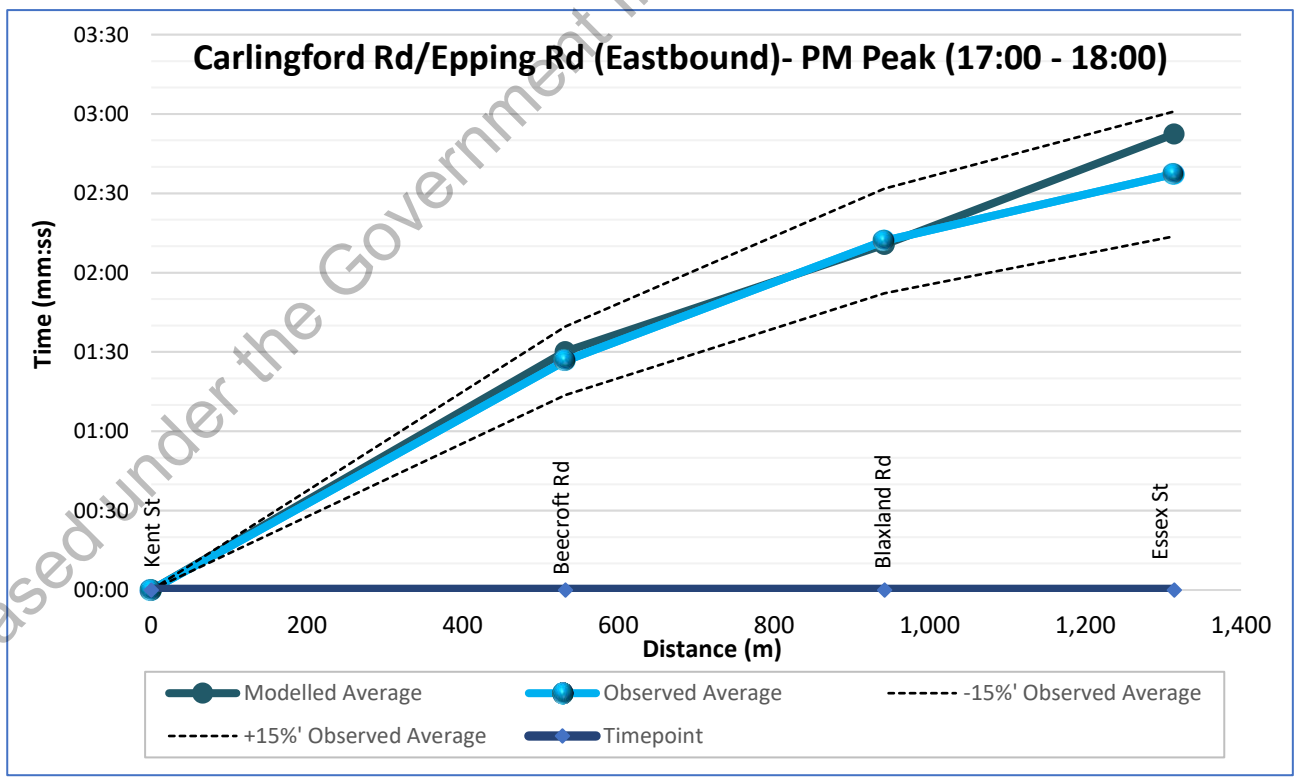
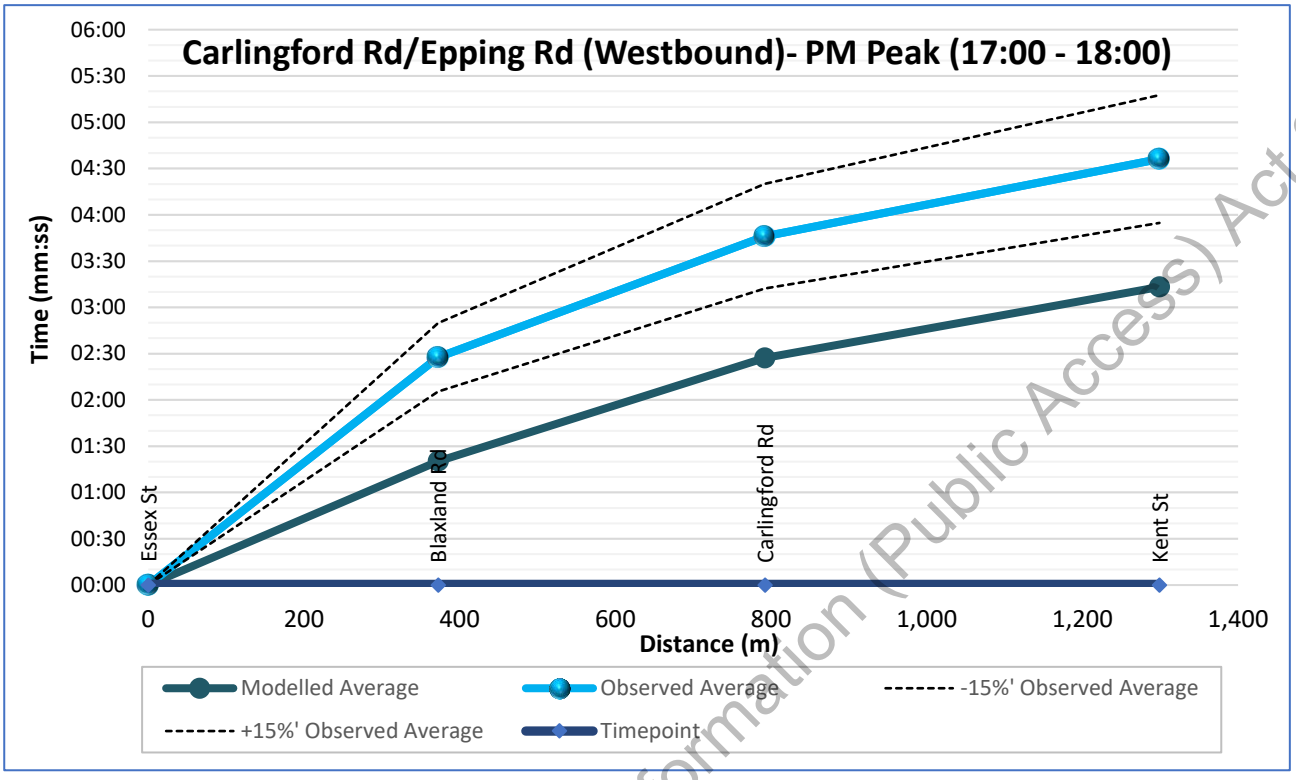


Figure 4-11 Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- PM Peak (17:00 - 18:00)



4.2.7.1 Key Finding

- The analysis reveals that most travel times align well with the observed data, with most sections differing by less than 15%. Instances where the threshold is exceeded typically involve differences of less than 25 seconds, mainly in shorter or relatively low travel time sections.
- During the PM peak, Beecroft Rd (Northbound) and Carlingford Rd/Epping Rd (Westbound) are noted as not meeting the criteria due to long observed travel times on individual sections within the overall survey route. The uncharacteristically long travel times in these segments seemed inconsistent with travel times in adjacent time periods, the observed traffic queueing and the short travel distances involved. Such inconsistencies can occur when the number of data samples is low. The data may have been influenced by a specific traffic event, data collection errors, or the behaviour of the surveyor (driver).
- To check the perceived inconsistencies in the floating car surveys, a secondary data source was used to check the validation. HERE data was sourced, for the same period, to check the segments in question. The HERE data provides a larger sample of travel times in those segments and confirmed that the floating car data was uncharacteristically high. The modelled flows were consistent with the HERE travel time data.
- Based on the review against multiple travel time validation data sources, the analysis confirmed that the modelled travel times are consistent with observed travel times and that the model is well calibrated and validated.

4.2.8 Queue Length Validation

A summary of modelled and observed average queue lengths (vehicles) for each approach are provided in **Table** 4-6.

Table 4-6 Average Queue Length (meters) Validation Summary - AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
		Observed	Modelled	Diff	Observed	Modelled	Diff
Carlingford Rd & Ray Rd & Rawson St	South	27	21	-6	77	17	-60
	East	40	11	-29	46	16	-30
	North	63	37	-26	67	34	-33
	West	292	234	-58	106	40	-66
Beecroft Rd & Carlingford Rd	South	97	25	-72	129	59	-70
	East	-	-	-	-	-	-
	North	62	24	-38	40	14	-26
	West	54	20	-34	60	19	-41
Beecroft Road / High Street / Bridge Street	South	5	0	-5	4	0	-4
	East	-	-	-	-	-	-
	North	-	-	-	-	-	-
	West	23	5	-18	26	7	-19
Bridge Street / Rawson Street	South	18	2	-16	18	4	-14
	East	23	1	-22	33	2	-31
	North	26	12	-14	21	4	-17
	West	23	8	-15	18	2	-16
Epping Rd & Blaxland Rd & Langston Pl	South	38	20	-18	244	42	-202
	East	113	75	-38	164	98	-66
	North	31	12	-19	30	13	-17
	West	145	157	12	204	165	-39
Epping Rd & Essex St	South	13	12	-1	22	15	-7
	East	10	7	-3	131	19	-112
	North	39	47	8	50	101	51
	West	88	74	-14	76	25	-51

4.2.8.1 Key Findings

- In the AM peak, the modelled queue lengths are generally a good match to the observed queue lengths. The largest AM Peak average queue length inconsistencies occurred on the southern approach to the Beecroft Rd / Carlingford Rd intersection. The modelled queues were slightly lower than modelled.
- In the PM peak, the modelled queue lengths are generally a good match to the observed in most of the approaches. The largest PM Peak average queue length inconsistencies occurred on the southern approach to Epping Road / Blaxland Road / Langston Place intersection. The modelled queues were lower than the observed.

4.2.9 Network Performance

The network performance statistics indicate the efficiency of road network. For instance, models showing a comparatively higher level of vehicle stops typically represent high levels of congestion, which generally reduce throughput and increase greenhouse emissions (due to the increased stop/start nature of the driving). Conversely, a comparatively low VHT typically represents a network with a relatively low level of congestion and is generally be correlated with a low level of vehicle stops.

Table 4-7 presents the key network performance parameters for the following:

- Total distance travelled by all vehicles within the modelled network (VKT);
- Total travel time by all vehicles within the modelled network (VHT); and
- The average speed of vehicle trips on all roads within the microsimulation model;
- The average delay of vehicle trips on all roads within the microsimulation model;
- The total completed vehicle trips on all roads within the microsimulation model;
- Unreleased trips (Latent Demand) – demand that could not be released in the peak hour;
- The average number of vehicle stops on all roads within the microsimulation models.

Table 4-7 Network Performance Summary - AM and PM Peaks

Model Performance Parameters	AM Peak (07:30-08:30)	PM Peak (17:00-18:00)
Vehicle kilometres travelled (VKT) km	9651	9563
Vehicle hours travelled (VHT) Hours	369	345
Average network speed (km/h)	26	28
Average network delay (s)	111.9	97.5
Completed trips	6119	6252
Unreleased trips	5	0
Number of vehicle stops Average	3.12	2.29

The average network speeds are comparatively lower in both AM and PM peaks. This indicates the increased congestion levels with the future demand growth.

4.2.10 Intersection Performance

Table 4.8 summarises approach and overall intersection performance in terms of Average queue, delay and LOS based on the TfNSW method, indicated below.

LOS	Delay (sec)	
	Low	High
A	0	14
B	15	28
C	29	42
D	43	56
E	57	70
F	>71	

Table 4.8: Intersection Performance – AM and PM Peak

		AM Peak (07:30-08:30)				PM Peak (17:00-18:00)			
Intersection	Approach	Traffic Volume	Delay (s)	LOS	Average Queue (m)	Traffic Volume	Delay (s)	LOS	Average Queue (m)
Carlingford Rd & Ray Rd & Rawson St	South	269	73	F	21	356	50	D	17
	East	876	9	A	11	1,184	8	A	16
	North	483	62	E	37	234	40	C	10
	West	1098	146	F	234	952	50	D	40
	Overall	**2,726**	**80**	**F**	**107**	**2,726**	**31**	**C**	**24**
Beecroft Rd & Carlingford Rd	South	1,668	31	C	25	2,168	34	C	59
	North	1,452	31	C	24	1,194	32	C	14
	West	1,410	10	A	20	1,061	14	A	19
	Overall	**4,530**	**25**	**B**	**23**	**4,423**	**28**	**B**	**37**
Bridge Street / Rawson Street	South	191	13	A	2	196	16	B	4
	East	198	9	A	1	369	8	A	2
	North	293	26	B	12	230	13	A	4
	West	305	15	B	8	174	9	A	2
	Overall	**987**	**41**	**C**	**12**	**969**	**45**	**D**	**4**
Beecroft Road / High Street / Bridge Street	South	24	9	A	0	17	11	A	0
	East	1716	1	A	0	2,500	1	A	0
	West	207	12	A	5	128	26	B	7
	Overall	**1,947**	**12**	**A**	**5**	**2,645**	**26**	**B**	**7**
Epping Rd & Blaxland Rd & Langston Pl	South	794	27	B	20	977	47	D	42
	East	1,118	54	D	75	1696	48	D	98
	North	265	49	D	12	242	54	D	13
	West	2,640	42	C	157	1,867	57	D	165
	Overall	**4,817**	**43**	**C**	**107**	**4,782**	**52**	**D**	**108**
Epping Rd & Essex St	South	185	57	E	12	293	53	D	15
	East	690	14	A	7	1,202	21	B	19
	North	519	74	F	47	562	120	F	101
	West	1843	25	B	74	1,121	20	B	25
	Overall	**3,237**	**32**	**C**	**52**	**3,178**	**41**	**C**	**35**

4.2.10.1 Key Finding

- All the intersections perform satisfactorily at LOS D or better in both AM and PM peaks except Carlingford Road / Ray Road / Rawson Street intersection, in the AM peak.
- The north approach at the Epping Road / Essex Street intersection is performing at LOS F in both AM and PM peaks, South approach in the AM peak operates with LOS E.

4.3 Model Calibration SIDRA Modelling

4.3.1 Calibration Process

The following parameters have been changed to calibrate the surveyed queue lengths recorded on-site.

Carlingford Road / Ray Road / Rawson Street

Blocking Calibration

- This includes filtering effects in the B phase where vehicles clear at the end of the phase.
- Blocking calibration to reduce queueing from Ray Road (0.2 and 1.8 for AM and PM respectively).
- Blocking calibration to reduce queueing from Rawson Street (0).
- Blocking calibration to increase queueing from the West (1.04).

Lane Utilisation

- 90% Lane Utilisation on the kerbside lane from the south approach.
- West appr adjusted coordination arrival type to 5 to reduce the blockage right turn from Beecroft Road.

Phase Timing

- SCATS History shows a fixed split plan configured during peaks.
- It is assumed a priority green split was locked given to Carlingford Road over the side streets.

Beecroft Road and Carlingford Road

Signal coordination calibration

- Increased the rating to 6 and 85% arrived during Green on the Southern approach (AM).
- Increased the rating to 6 and 86% arrived during Green on the Southern approach (PM).

Epping Road / Blaxland Road / Langston Place

Signal coordination calibration

- AM peak - increased the Arrival during Green to 70% on the east approach.
- PM peak - increase the Arrival during Green to 80% on the east approach.

Lane Capacity Adjustment

- Increased the south approach queue via capacity reduction, -58%. It is assumed that the queue did not dissipate before the PM peak due to the split plan locked from 3:15 pm

Phase Timing

- SCATS History shows a fixed split plan configured during peaks.
- It is assumed a priority green split was locked given to Epping Road over the side streets.

Epping Road / Essex Street

Signal coordination calibration

- AM peak - increased the rating to 6 with coordination on the west approach.

- PM Peak - increase the % arrival during green for westbound to 80% and reduced the arrival rating to 2 on the east approach.

Lane Utilisation

- Lane 1 utilisation east approach is adjusted with lane-by-lane queue length. 5%
- Lane 1 utilisation south approach is adjusted with lane-by-lane queue length. 95%

Beecroft Road / High Street / Bridge Street

Lane Capacity - The capacity on the High Street (left into Beecroft Road) was reduced to 70%. It is due to limited sight visibility and high speed on the main road.

4.3.2 Signal Time Calibration Results

Like VISSIM modelling, a comparison of observed and Sidra modelled signal times at each intersection is presented **Table 4-9**.

Table 4-9 Sidra Signal Time Comparison - AM and PM Peaks

Intersection	Phase	AM Peak (07:30-08:30)			PM Peak (17:00-18:00)		
		Observed	Modelled	Diff %	Observed	Modelled	Diff %
Carlingford Rd & Ray Rd & Rawson St	A	86	85	1%	84	85	-1%
	B	44	45	-2%	46	45	2%
	Total	**129**	**130**	**-1%**	**130**	**130**	**0%**
Beecroft Rd & Carlingford Rd	A	47	43	9%	57	58	-2%
	B	18	16	13%	20	20	0%
	C	64	71	-10%	52	52	0%
	Total	**128**	**130**	**-2%**	**129**	**130**	**-1%**
Epping Rd & Blaxland Rd & Langston Pl	A	55	56	2%	81	81	0%
	B	23	23	0%	23	23	0%
	C	28	28	0%	27	26	4%
	D	24	24	0%	-	-	-
	Total	**129**	**130**	**0%**	**131**	**130**	**1%**
Epping Rd & Essex St	A	82	80	2%	79	80	-1%
	B	27	27	0%	27	27	0%
	C	21	23	-9%	23	23	0%
	Total	**130**	**130**	**0%**	**128**	**130**	**-2%**

4.3.2.1 Key Findings

- During the AM and PM peaks, the modelled average cycle time and phase times shows a good match with the observed times (within 10%).
- The only exception is phase B during the AM Peak at Beecroft Road and Carlingford Road, where the absolute difference is only 2 seconds.
- The modelled signal timings are considered well calibrated with observed.

4.3.3 Queue Length Calibration Results

A summary of modelled and observed average queue lengths (in metres) for each approach is provided in **Table 4-10.** The modelled queue lengths for both peaks show a good match with the observed queues.

It is noted that the observed queue length comparison for VISSIM models are different because the approach queue length is an average across all the lanes. In contrast the SIDRA's approach queue length is taken from the maximum queue length of all the lanes. The observed queue length calculation is consistent with SIDRA outputs.

Table 4-10 Sidra Output - Averaged Queue Length Comparison (metres)

Intersection	Approach	AM Peak (07:30-08:30)		PM Peak (17:00-18:00)	
		Observed	Modelled	Observed	Modelled
Carlingford Rd & Ray Rd & Rawson St	South	35	49	91	75
	East	42	49	49	40
	North	84	92	98	91
	West	294	257	119	137
Beecroft Rd & Carlingford Rd	South	98	87	147	125
	East	-	-	-	-
	North	63	105	49	74
	West	56	50	63	50
Beecroft Road / High Street / Bridge Street	South	7	0	7	0
	East	-	-	-	-
	North	-	-	-	-
	West	21	9	28	20
Bridge Street / Rawson Street	South	21	11	28	12
	East	28	11	49	24
	North	21	19	28	12
	West	21	18	28	6
Epping Rd & Blaxland Rd & Langston Pl	South	49	52	252	185
	East	112	127	182	137
	North	35	45	35	43
	West	126	183	203	139
Epping Rd & Essex St	South	35	22	35	47
	East	21	35	210	136
	North	49	82	63	82
	West	84	69	77	51

4.3.4 Intersection Performance

The Sidra outputs of the base model, AM and PM peaks, are shown in **Table 4.11**.

Table 4.11: Intersection Performance – AM and PM Peak

Intersection	Approach	AM Peak (07:30-08:30)				PM Peak (17:00-18:00)			
		Traffic Volume	Delay (s)	LOS	Avg Queue (m)	Traffic Volume	Delay (s)	LOS	Avg Queue (m)
Carlingford Rd & Ray Rd & Rawson St	South	267	53	D	58	350	170	F	53
	East	898	6	A	38	1200	3	A	40
	North	494	83	F	52	229	372	F	37
	West	1064	107	F	213	933	36	C	137
	Overall	**2723**	**64**	**E**	**213**	**2711**	**67**	**E**	**137**
Beecroft Rd & Carlingford Rd	South	1695	9	A	120	2189	10	A	137
	North	1467	41	C	43	1199	46	D	74
	West	1413	48	D	50	1070	44	D	50
	Overall	**4575**	**31**	**C**	120	**4458**	**28**	**B**	137
Bridge Street / Rawson Street	South	196	18	B	**m**	191	20	B	12
	East	222	18	B	15	377	120	F	24
	North	344	20	B	14	288	6	A	13
	West	326	10	A	12	190	5	A	6
	Overall	**1088**	**18**	**B**	**14**	**1047**	**49**	**D**	**24**
Beecroft Road / High Street / Bridge Street	South	26	5	A	0	18	6	A	0
	East	1701	4	NA	0	2530	4	NA	0
	North	2582	6	NA	109	1875	6	NA	76
	West	156	19	B	8	146	64	E	20
	Overall[1]	**4468**	**19**	**B**	**8**	**4570**	**64**	**E**	**20**
Epping Rd & Blaxland Rd & Langston Pl	South	803	31	C	49	976	106	F	38
	East	1165	20	B	123	1731	10	A	137
	North	264	59	E	42	262	58	E	43
	West	2650	48	D	172	1881	43	C	139
	Overall	**4881**	**36**	**C**	**123**	**4850**	**42**	**C**	**185**
Epping Rd & Essex St	South	183	74	F	26	280	103	F	15
	East	712	15	B	30	1203	34	C	136
	North	536	93	F	72	569	91	F	82
	West	1874	5	A	70	1098	8	A	51
	Overall	**3307**	**25**	**B**	**72**	**3149**	**42**	**C**	**136**

[1] Level of Service (LOS) of worst movement

4.3.4.1 Key Findings

- All the intersections perform satisfactorily at LOS D or better in both peaks except for the intersection of Carlingford Road, Ray Road and Rawson Street intersection.
- The poor performance of Carlingford Road, Ray Road and Rawson Street, with LOS E for both peaks, is caused by the congestion at Beecroft Road and Carlingford Road.
- Intersection performance in the SIDRA models is consistent with the VISSIM models despite the software packages applying different approaches to calculating delay. The calibrated SIDRA models will be used to generate the signal timing for future scenarios, which in turn used as a starting point in VISSIM.

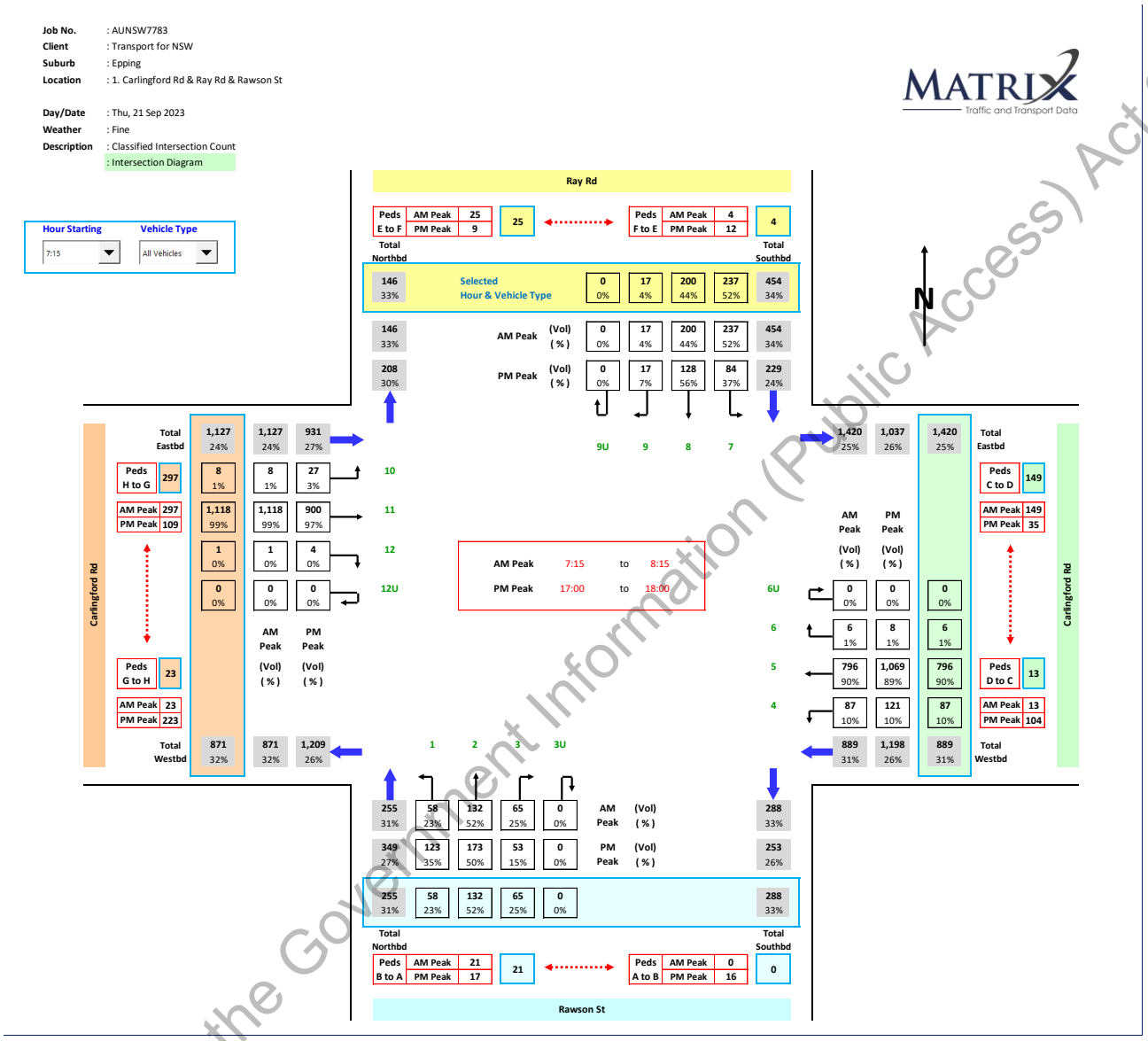
5 Summary and Conclusion

The purpose of this modelling was to develop a calibrated and validated 2023 base model for VISSIM and SIDRA models for the Epping Bridge project. The base model was developed to represent the typical 2023 weekday AM and PM peak periods.

The AM and PM peak models are suitably calibrated for the 2023 weekday AM and weekday PM peak periods. Comparing the turning movement counts in the VISSIM model to the observed counts, it was concluded that the models conform with the calibration criteria set out in the TfNSW Traffic Modelling Guidelines (2013) for microsimulation models.

The queue lengths and travel times are satisfactorily validated against the observed queues recorded on site for VISSIM modelling. The SIDRA Model was validated against observed queue lengths, and it found to be satisfactory. The 2023 AM and PM Peak base models were therefore considered fit-for-purpose for use in end state scenario testing.

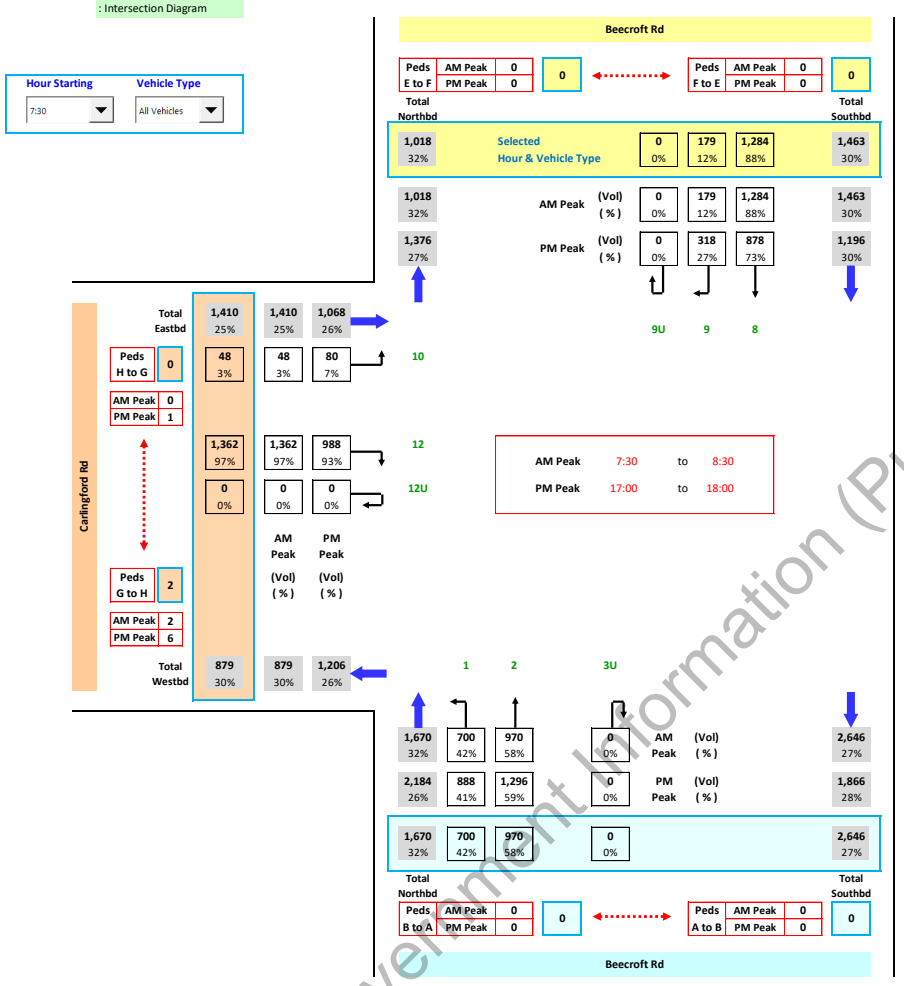
A. Classified Intersection Traffic Counts (21/9/2023)



Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 2. Carlingford Rd & Beecroft Rd

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

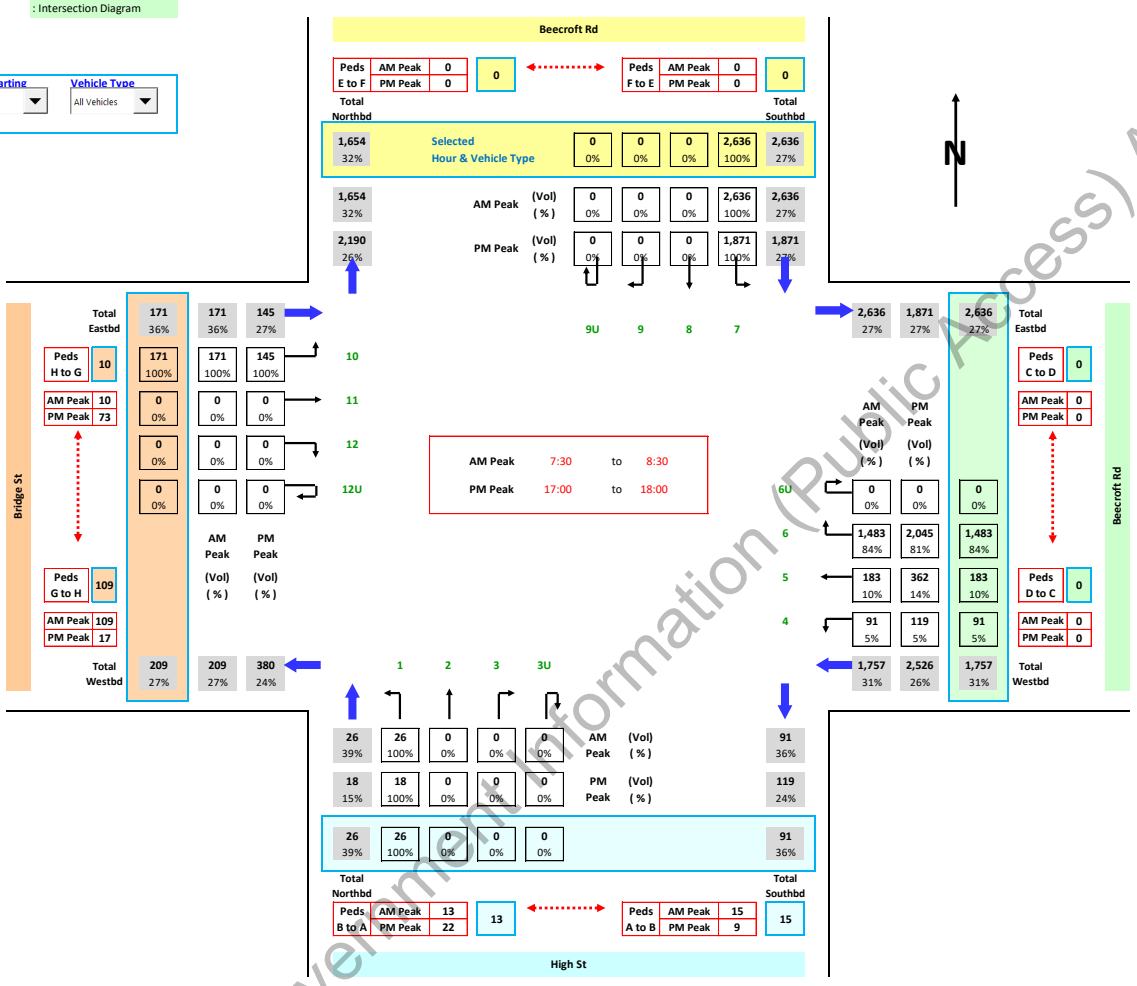


Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 3. High St & Bridge St & Beecroft Rd

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

Hour Starting 7:30 | Vehicle Type All Vehicles

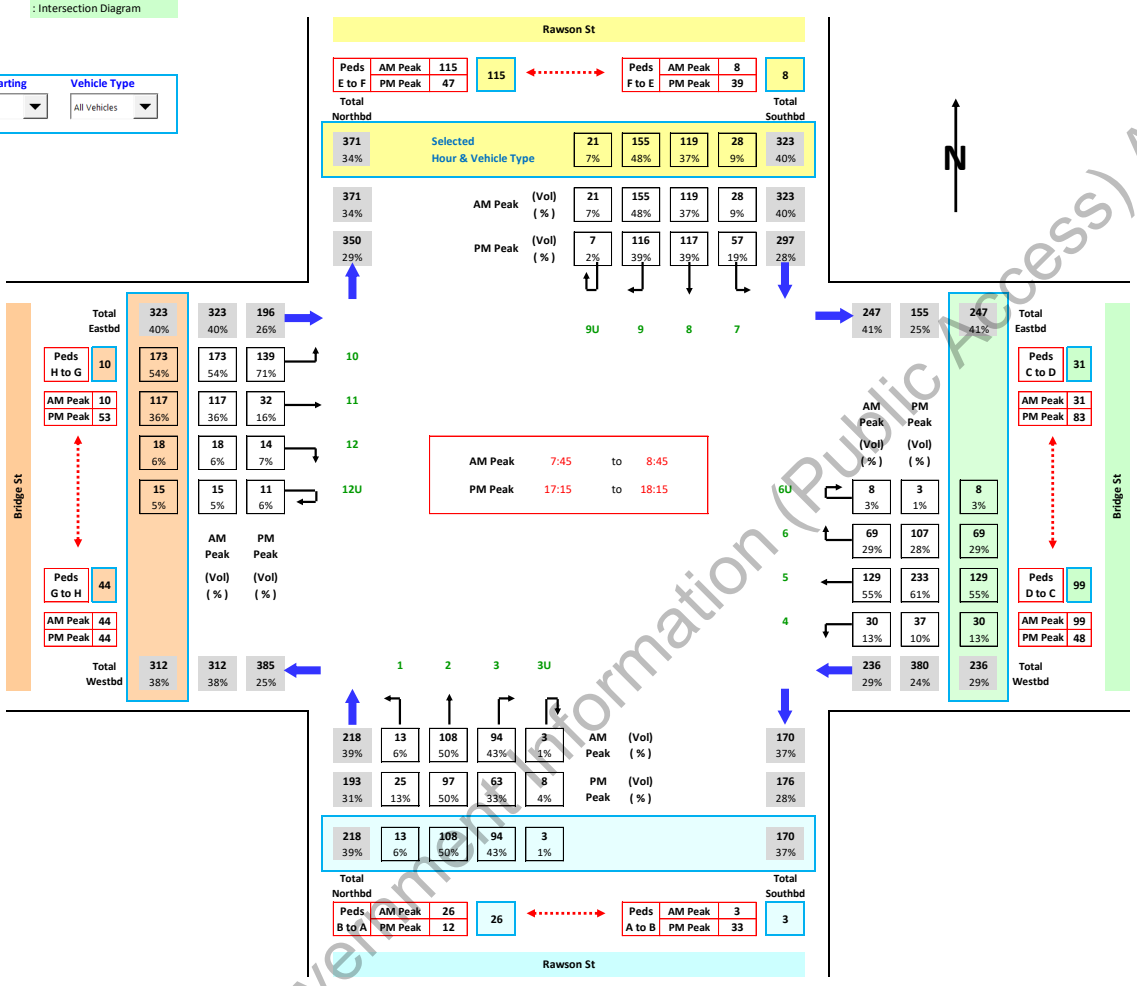


Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 4. Bridge St & Rawson St

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

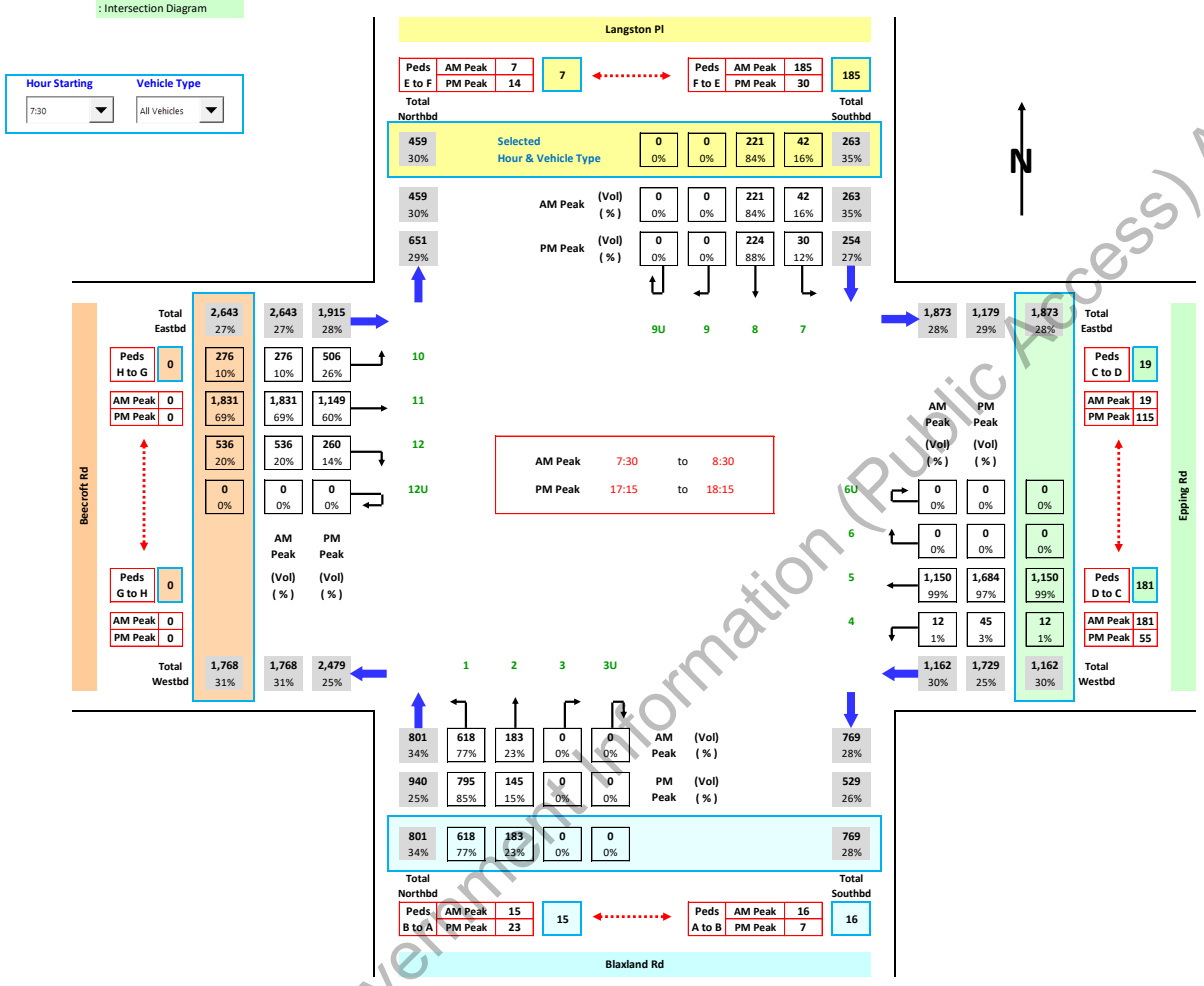
Hour Starting 7:45 **Vehicle Type** All Vehicles



Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 5. Epping Rd & Blaxland Rd & Langston Pl & Beecroft Rd

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

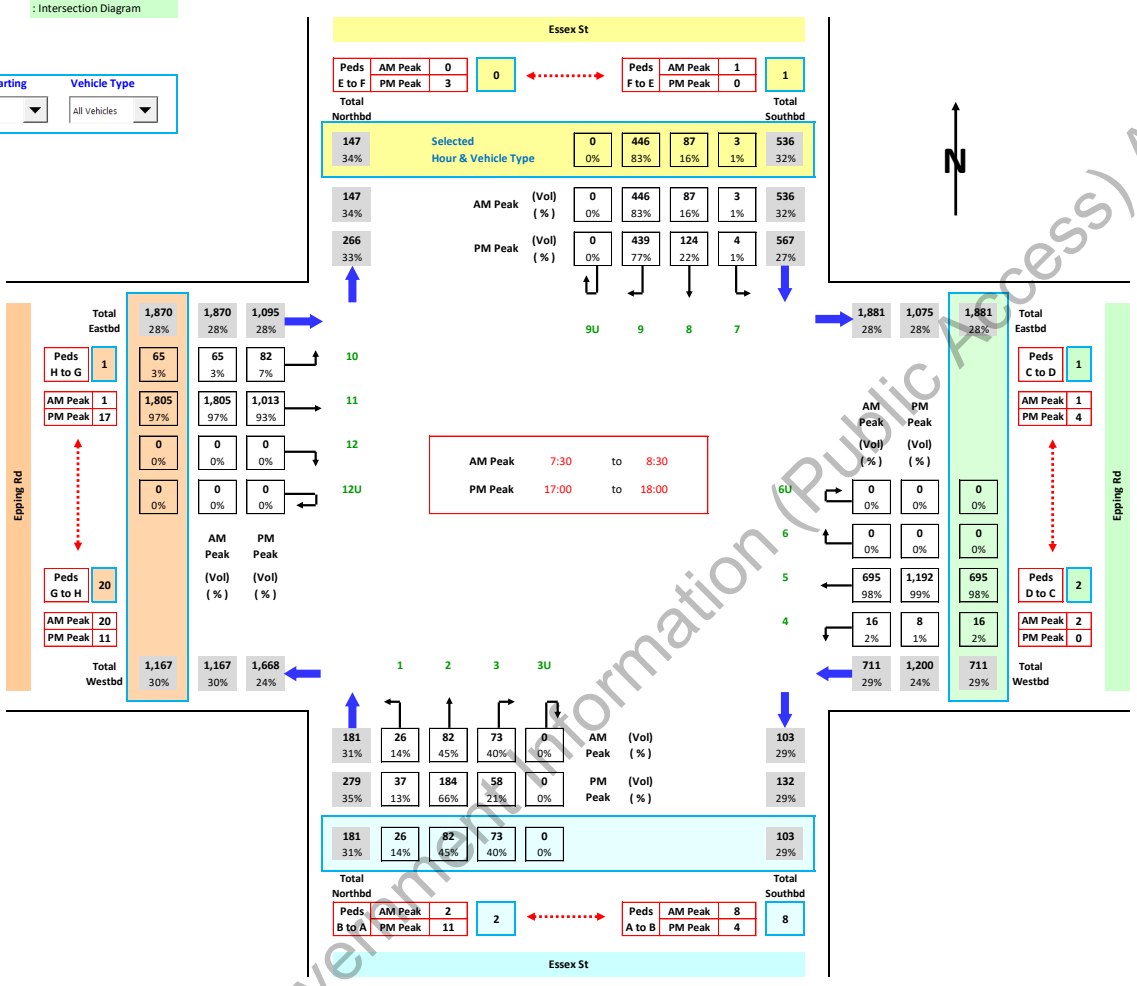


Job No. : AUNSW7783
Client : Transport for NSW
Suburb : Epping
Location : 6. Epping Rd & Essex St

Day/Date : Thu, 21 Sep 2023
Weather : Fine
Description : Classified Intersection Count
: Intersection Diagram

MATRIX Traffic and Transport Data

Hour Starting 7:30 **Vehicle Type** All Vehicles



B. Average Queue Length Data (21/9/2023)

Table B1: Carlingford Road, Ray Road and Rawson Street, Average Queue Length (Vehicles)

15-min Period Starting	Rawson Street (S)		Carlingford Road (E)		Ray Road (N)		Carlingford Road (W)	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
6:30	1	2	2	1	3	2	10	10
6:45	2	3	2	2	4	2	12	10
7:00	3	3	2	2	4	3	10	10
7:15	4	4	5	4	6	5	18	19
7:30	4	3	7	7	9	7	40	38
7:45	6	3	6	6	11	7	40	42
8:00	6	4	6	6	11	7	47	49
8:15	5	5	7	5	17	6	40	39
8:30	6	10	8	6	21	6	33	30
8:45	5	5	7	6	19	7	17	16
16:00	10	14	6	7	9	4	7	6
16:15	8	14	6	6	9	3	11	8
16:30	7	14	7	7	6	4	9	6
16:45	8	14	6	6	5	2	10	9
17:00	11	14	7	7	15	4	23	20
17:15	7	14	6	6	20	6	17	12
17:30	9	12	7	8	17	6	15	12
17:45	8	14	8	6	8	4	14	11
18:00	7	14	7	8	14	4	15	11
18:15	9	14	7	7	17	5	11	7

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B2: Carlingford Road and Beecroft Road, Average Queue Length (Vehicles)

15-min Period Starting	Beecroft Road (S)				Beecroft Road (N)					Carlingford Road (W)		
	Lane 1	Lane 2	Lane 3	Lane 4	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 1	Lane 2	Lane 3
6:30	1	1	9	8	8	9	9	2	1	1	7	7
6:45	1	1	8	7	7	7	9	2	1	1	8	8
7:00	1	1	8	8	8	10	12	2	2	1	8	7
7:15	1	1	12	12	9	9	11	4	3	0	8	8
7:30	1	1	13	12	9	10	11	3	3	0	8	9
7:45	1	1	10	10	8	9	9	4	3	0	8	8
8:00	1	1	20	20	7	8	11	5	4	0	7	8
8:15	1	1	14	15	8	9	11	5	3	1	9	8
8:30	2	1	12	13	7	8	10	6	5	0	9	8
8:45	1	1	9	10	7	9	8	5	4	0	9	8
16:00	3	4	14	17	4	4	4	6	3	1	9	9
16:15	2	3	22	25	4	3	2	5	4	1	9	9
16:30	3	3	20	23	4	3	3	6	5	0	9	9
16:45	4	3	19	24	5	4	5	7	5	0	9	8
17:00	4	4	16	21	4	3	4	7	5	0	9	9
17:15	3	3	17	21	5	4	4	6	5	0	9	9
17:30	4	4	18	24	7	5	8	8	6	1	9	9
17:45	4	4	15	19	4	4	6	8	4	1	9	9
18:00	2	3	13	16	4	4	3	5	3	0	9	9
18:15	2	2	12	15	5	5	4	4	3	1	9	8

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B3: High Street, Beecroft Road & Bridge Street, Average Queue Length (Vehicles)

15-min Period Starting	High Street (S)	Bridge Street (W)
	Lane 1	Lane 1
6:30	0	1
6:45	0	1
7:00	1	2
7:15	0	4
7:30	1	4
7:45	1	4
8:00	1	3
8:15	1	5
8:30	1	4
8:45	1	2
16:00	1	4
16:15	1	4
16:30	1	4
16:45	1	4
17:00	1	4
17:15	1	5
17:30	1	3
17:45	0	5
18:00	2	4
18:15	2	3

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B4: Rawson Street and Bridge Street, Average Queue Length (Vehicles)

15-min Period Starting	Rawson Street (S)	Bridge Street (E)	Rawson Street (N)	Bridge Street (W)
	Lane 1	Lane 1	Lane 1	Lane 1
6:30	1	0	1	1
6:45	1	1	1	1
7:00	2	2	1	2
7:15	2	2	6	3
7:30	2	2	4	2
7:45	3	2	5	3
8:00	2	3	4	5
8:15	4	7	4	4
8:30	3	2	2	3
8:45	2	4	3	3
16:00	9	6	4	9
16:15	3	4	3	5
16:30	7	8	7	8
16:45	2	6	3	2
17:00	3	4	4	2
17:15	3	4	3	3
17:30	2	7	2	2
17:45	4	5	4	4
18:00	4	5	3	5
18:15	2	4	2	3

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

Table B5: Epping Road, Blaxland Road and Langston Place, Average Queue Length (Vehicles)

15-min Period Starting	Blaxland Road (S)			Epping Road (E)			Langston Place (N)		Beecroft Road (W)			
	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 1	Lane 2	Lane 3	Lane 4
6:30	3	2	4	1	4	3	1	2	2	6	5	11
6:45	5	1	2	1	11	8	1	3	1	4	5	6
7:00	4	3	3	0	12	7	2	3	0	11	5	13
7:15	5	2	5	1	20	14	3	5	1	16	11	31
7:30	7	4	4	1	16	11	2	4	1	23	22	28
7:45	8	5	5	1	20	13	5	6	6	23	23	27
8:00	6	3	7	1	20	15	4	8	12	10	10	15
8:15	7	5	7	1	22	16	3	7	4	10	9	14
8:30	8	5	5	1	14	11	4	4	5	12	12	26
8:45	7	3	5	1	10	8	2	4	7	20	17	20
16:00	37	36	4	1	31	26	3	4	4	5	4	25
16:15	36	36	4	1	24	17	3	4	4	6	6	27
16:30	23	20	4	1	26	21	3	4	4	4	4	28
16:45	37	34	4	2	25	22	5	5	1	6	7	32
17:00	40	37	3	1	26	20	3	5	3	4	3	26
17:15	43	43	4	2	25	20	4	6	5	4	5	31
17:30	41	38	5	2	29	23	4	6	8	7	9	28
17:45	22	20	5	2	25	23	4	6	5	9	7	33
18:00	15	11	3	3	23	15	2	5	7	4	5	31
18:15	12	7	4	1	14	7	2	4	4	7	7	13

Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm.

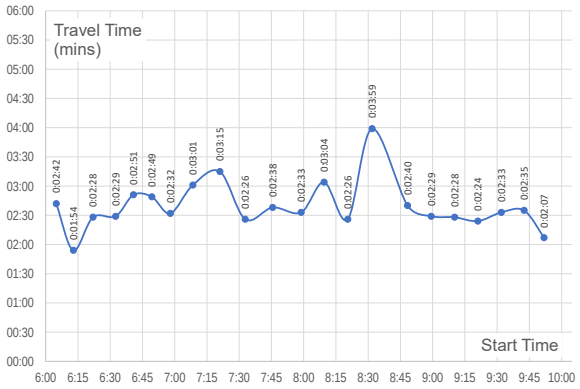
Table B6: Epping Road and Essex Street, Average Queue Length (Vehicles)

15-min Period Starting	Essex Street (S)			Epping Road (E)			Essex Street (N)			Epping Road (W)	
	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2
6:30	1	1	2	1	3	3	1	3	3	12	12
6:45	1	1	1	0	3	2	2	4	4	13	12
7:00	1	1	3	1	2	2	1	5	6	12	13
7:15	1	1	3	1	3	3	2	9	10	14	13
7:30	1	1	3	1	2	1	2	6	8	14	14
7:45	2	1	4	1	3	2	1	9	8	14	13
8:00	1	2	5	1	3	2	2	9	9	12	13
8:15	1	2	4	1	4	3	2	9	8	13	12
8:30	1	3	6	1	3	3	3	7	7	10	13
8:45	1	3	5	1	4	4	3	7	7	11	12
16:00	1	2	4	2	31	28	2	10	9	12	11
16:15	2	2	4	1	30	27	4	6	8	12	12
16:30	3	1	3	1	31	27	4	7	7	12	12
16:45	2	2	5	1	30	29	2	8	7	12	12
17:00	1	3	4	1	32	27	3	12	13	11	12
17:15	1	4	6	0	31	27	2	6	6	11	11
17:30	2	5	7	1	30	28	5	10	11	12	12
17:45	1	3	5	1	29	24	4	10	8	11	11
18:00	1	2	4	1	22	18	2	11	11	10	9
18:15	1	2	4	1	8	7	2	6	5	6	6

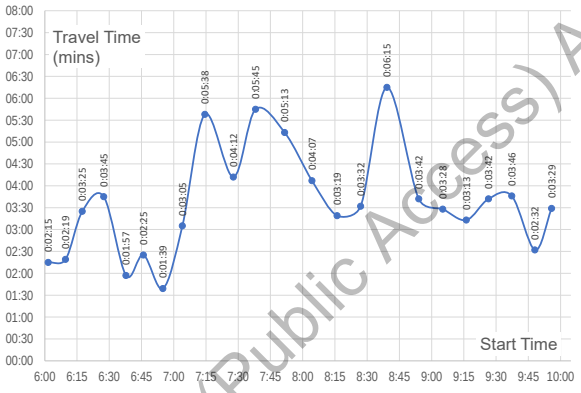
Source: Matrix, Traffic & transport Data, 21/9/2023, 6am-10am and 3pm-7pm

C. Travel Time Data (21/9/2023)

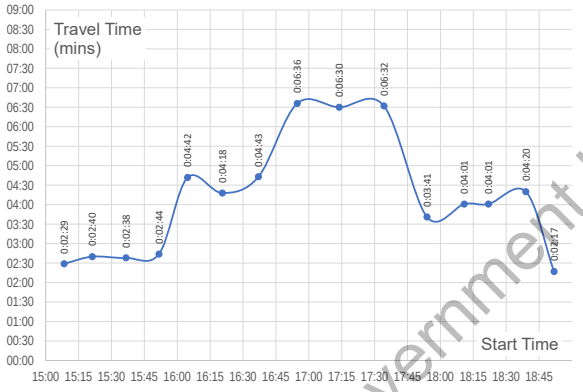
Beecroft Road, Epping Road and Blaxland Road, Northbound Travel Time



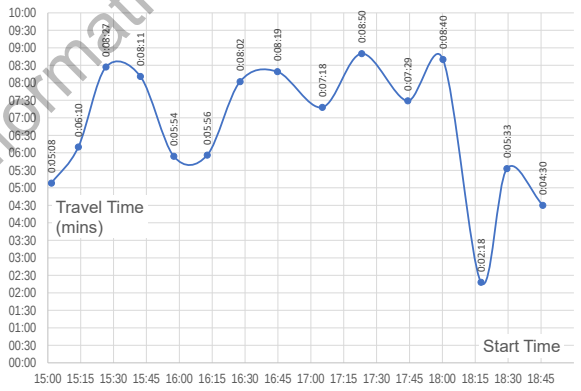
Beecroft Road, Epping Road and Blaxland Road, Southbound Travel Time



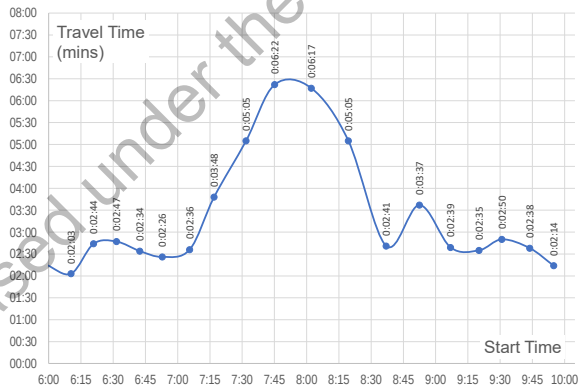
Beecroft Road, Epping Road and Blaxland Road, Northbound Travel Time



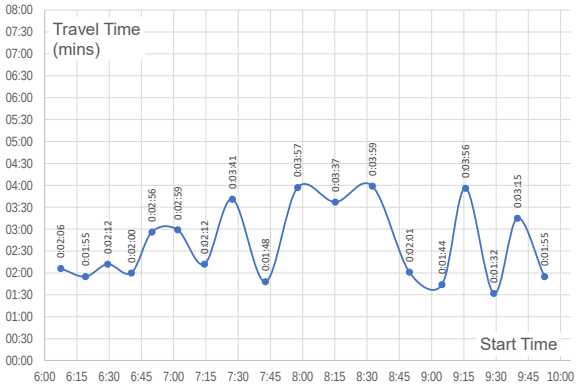
Beecroft Road, Epping Road and Blaxland Road, Southbound Travel Time



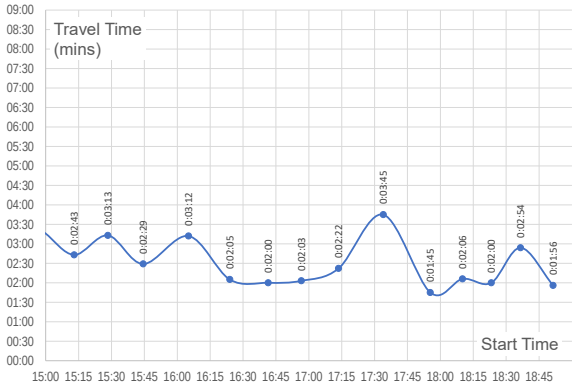
Carlingford Road, Beecroft Road and Epping Road, Eastbound Travel Time



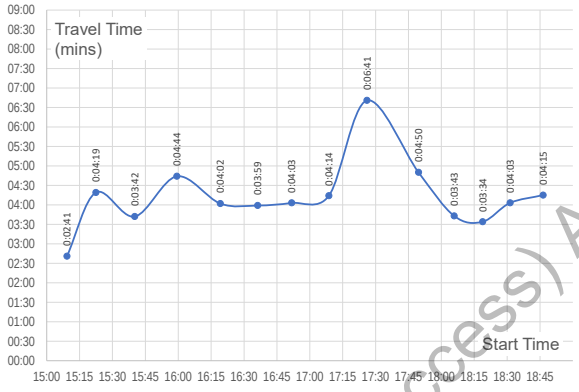
Carlingford Road, Beecroft Road and Epping Road, Westbound Travel Time



Carlingford Road, Beecroft Road and Epping Road, Eastbound Travel Time

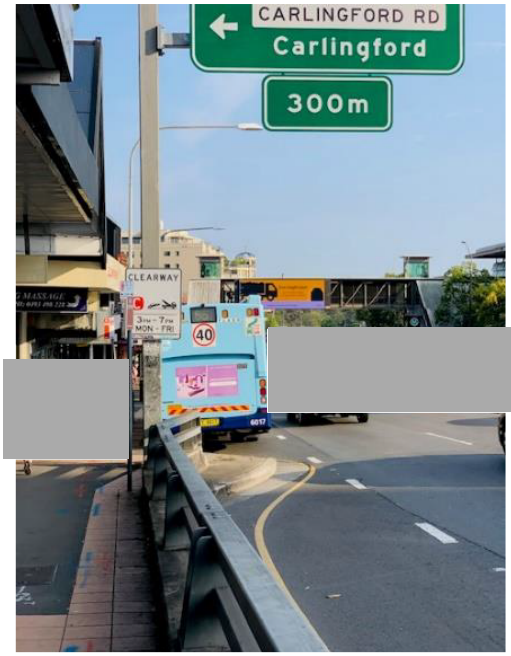


Carlingford Road, Beecroft Road and Epping Road, Westbound Travel Time



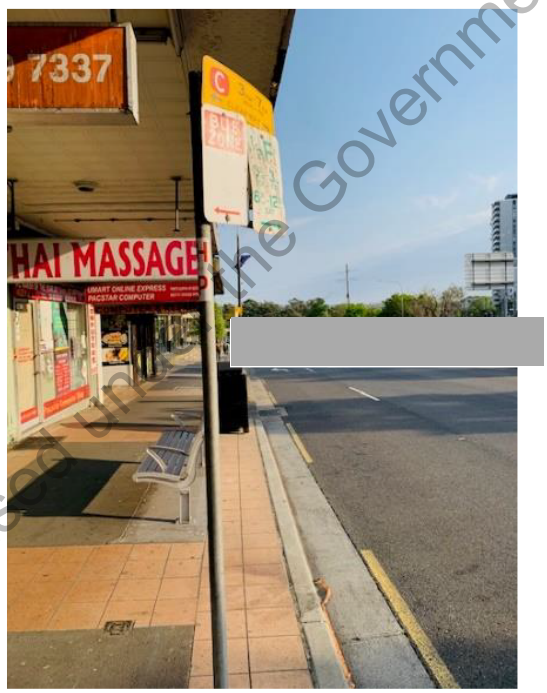
D. Site Visit Photographs

Beecroft Road NB at Carlingford Rd / Beecroft Road Intersection

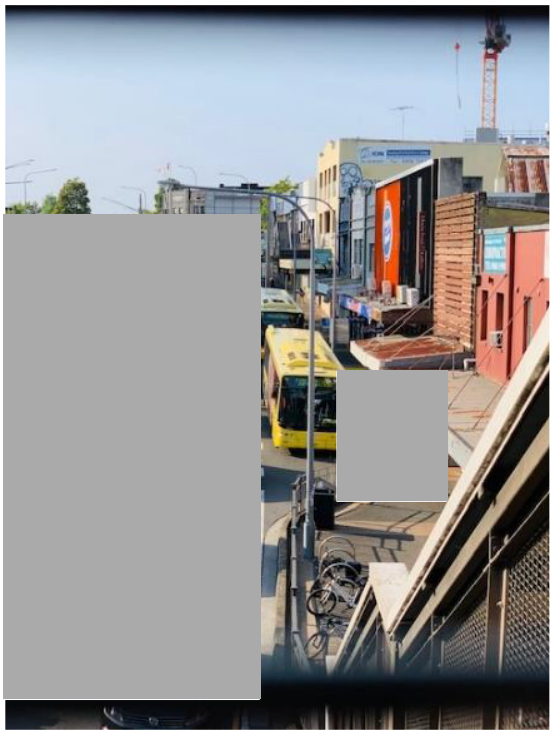


Bus Stop Stand on Beecroft Road

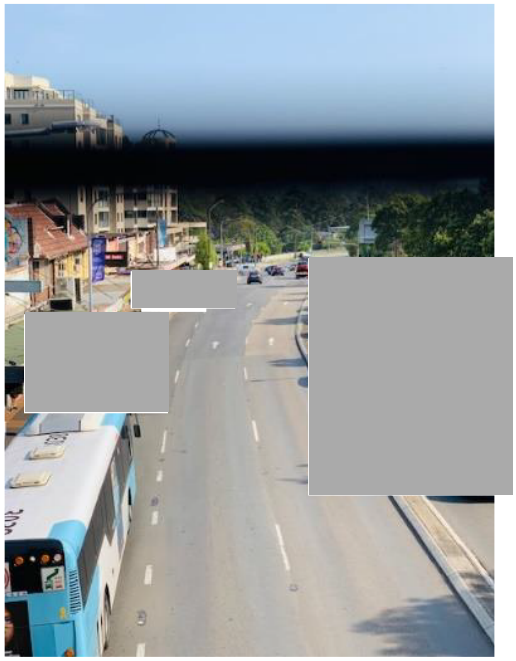
Beecroft Road NB at Carlingford Rd / Beecroft Road Intersection



Midblock location on Beecroft Road



Midblock location on Beecroft Road



E. SCATS Traffic Count Data (21/9/2023)

Table E1: TCS216, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
6:30	3	98	73	204	248	56	26	115	22	8	15	868
6:45	2	113	82	186	232	62	25	129	20	7	17	875
7:00	1	125	101	208	249	65	32	121	26	13	24	965
7:15	5	145	137	207	277	76	40	139	32	19	39	1116
7:30	4	148	143	217	286	94	51	133	36	12	36	1160
7:45	4	149	123	202	276	102	64	136	40	17	45	1158
8:00	4	137	140	198	274	97	51	134	55	23	56	1169
8:15	3	152	156	205	264	97	55	120	50	16	52	1170
8:30	10	129	124	191	235	78	44	125	38	19	39	1032
8:45	6	134	110	190	256	111	48	132	29	14	32	1062

Table E2: TCS216, PM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
17:00	8	206	211	119	147	103	95	65	39	21	32	1046
17:15	13	209	215	139	164	104	118	70	41	20	32	1125
17:30	9	203	215	132	157	109	115	61	38	18	33	1090
17:45	10	214	204	140	175	101	109	67	33	22	46	1121
18:00	8	231	221	107	151	101	111	62	30	20	38	1080
18:15	10	208	214	131	170	94	108	60	33	24	48	1100
18:30	12	199	204	170	196	100	106	65	31	28	37	1148
18:45	13	205	204	157	187	103	102	61	44	19	44	1139
19:00	17	219	214	149	150	95	80	58	35	17	34	1068
19:15	3	198	179	136	147	106	84	78	37	12	23	1003

Table E3: TCS706, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	TOTAL
6:30	62	75	76	72	85	45	58	14	3	167	208	23	888
6:45	67	68	62	76	98	56	80	8	8	157	185	24	889
7:00	64	89	100	94	110	60	81	11	9	159	199	30	1006
7:15	86	107	108	104	111	76	97	25	17	167	204	21	1123
7:30	100	123	100	122	136	86	127	23	17	152	179	10	1175
7:45	102	118	89	96	113	84	116	21	16	163	191	12	1121
8:00	118	147	101	111	101	72	74	29	21	142	179	12	1107
8:15	121	141	93	118	102	84	94	27	19	159	180	19	1157
8:30	96	121	92	120	113	65	98	41	32	159	176	10	1123
8:45	94	101	88	96	93	55	84	36	20	159	166	11	1003

Table E4: TCS706, PM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	TOTAL
17:00	124	168	53	63	62	112	124	36	22	115	125	25	1029
17:15	158	193	56	77	67	110	109	36	25	115	124	27	1097
17:30	152	183	52	79	65	119	119	37	40	116	138	15	1115
17:45	161	183	73	73	59	104	113	36	31	117	127	20	1097
18:00	152	187	61	64	52	120	120	39	34	102	122	30	1083
18:15	155	186	74	80	64	104	117	41	36	108	125	20	1110
18:30	140	172	96	122	49	85	123	48	45	120	127	23	1150
18:45	148	183	72	91	57	106	122	40	31	132	138	11	1131
19:00	139	179	64	69	45	107	114	30	23	113	133	15	1031
19:15	116	149	60	65	50	107	112	32	18	124	132	11	976

Table E5: TCS1015, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	Total
6:30	170	186	56	62	22	10	5	11	522
6:45	151	167	70	84	27	17	12	18	546
7:00	162	178	69	85	32	21	19	19	585
7:15	163	169	90	113	44	39	31	18	667
7:30	125	139	114	136	65	44	32	17	672
7:45	122	144	103	125	60	55	45	15	669
8:00	114	134	94	101	64	48	45	19	619
8:15	122	136	106	114	62	51	43	17	651
8:30	117	130	101	124	52	41	43	13	621
8:45	123	123	88	107	62	48	39	20	610

Table E6: TCS1015, PM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	Total
16:00	118	108	144	150	21	32	61	7	641
16:15	116	101	153	128	16	24	55	10	603
16:30	121	105	153	148	23	31	48	6	635
16:45	117	109	131	146	28	14	55	14	614
17:00	114	98	157	157	7	23	77	10	643
17:15	125	107	136	153	8	43	59	7	638
17:30	114	111	147	149	15	35	71	8	650
17:45	136	109	145	141	31	37	57	6	662
18:00	119	113	136	128	7	28	62	11	604
18:15	122	114	129	126	27	35	50	8	611

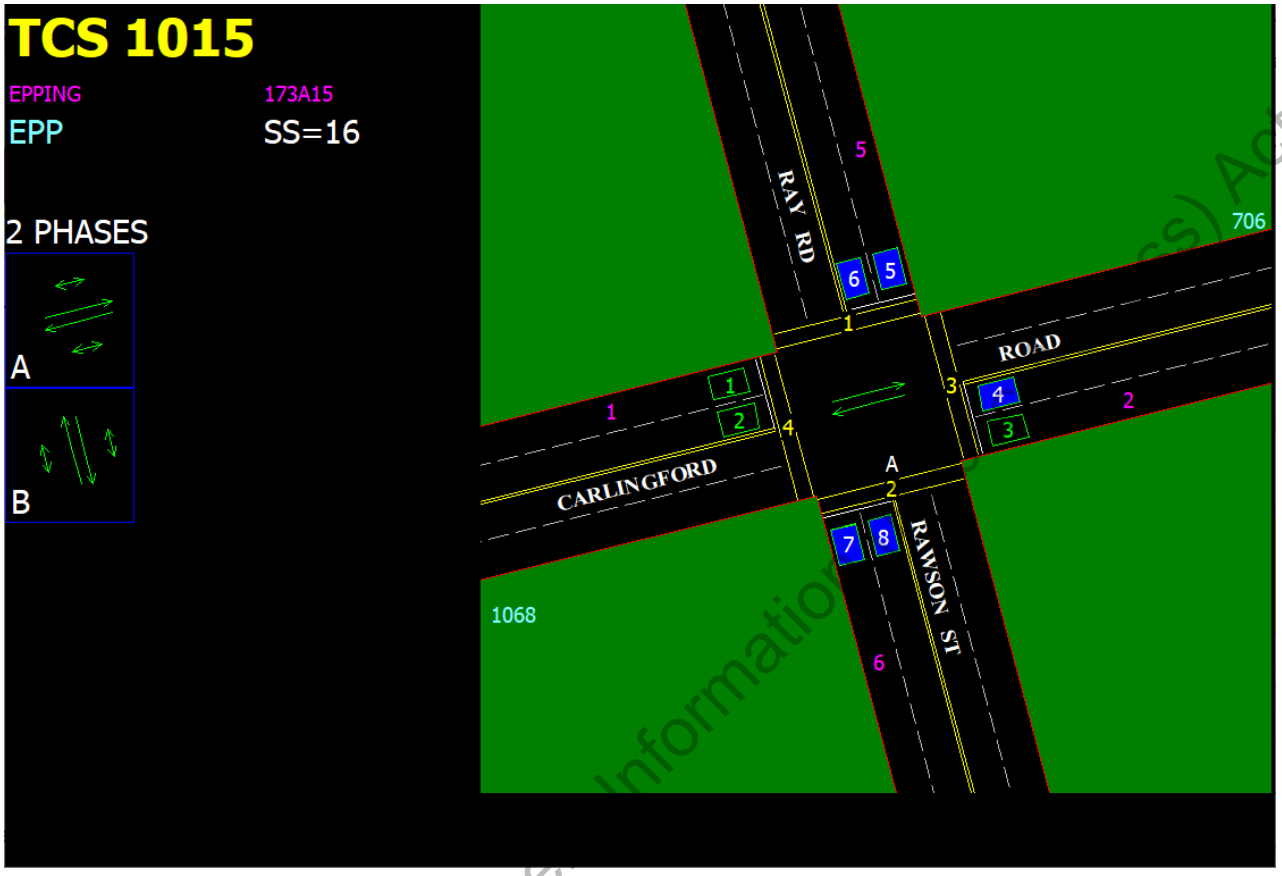
Table E7: TCS1338, AM Peak, 15-min Detector Counts (Vehicles)

15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
6:30	193	231	4	72	53	8	19	19	2	4	12	617
6:45	202	205	1	81	52	9	24	25	2	2	8	611
7:00	212	224	3	83	54	10	36	49	4	8	15	698
7:15	218	234	7	92	88	22	52	59	4	8	24	808
7:30	242	248	5	97	86	26	40	50	3	6	22	825
7:45	221	232	6	97	68	15	52	54	7	10	31	793
8:00	222	234	5	91	73	20	50	57	8	13	36	809
8:15	229	227	8	97	78	24	58	63	6	12	28	830
8:30	206	198	6	87	72	28	35	45	6	14	48	745
8:45	217	211	12	69	61	24	39	46	4	16	39	738

Table E8: TCS1338, PM Peak, 15-min Detector Counts (Vehicles)

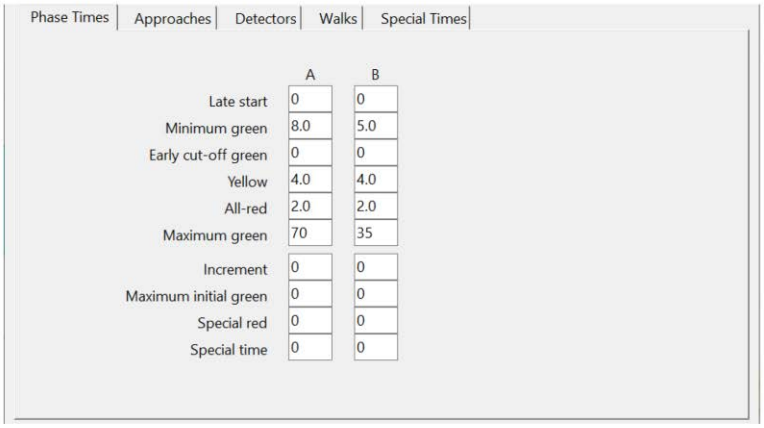
15-min Period Starting	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	Total
16:00	124	103	13	130	159	26	47	58	2	13	27	702
16:15	131	132	13	146	180	29	40	52	9	16	28	776
16:30	120	122	18	149	175	29	37	47	16	8	27	748
16:45	134	138	9	133	159	20	48	48	12	15	32	748
17:00	127	105	10	134	163	31	58	79	9	18	30	764
17:15	132	116	12	138	172	22	33	43	11	20	41	740
17:30	148	158	9	109	142	35	47	72	10	33	42	805
17:45	153	147	9	136	146	35	43	52	4	19	39	783
18:00	131	114	16	139	157	28	55	60	2	15	31	748
18:15	136	106	10	147	148	22	36	40	5	14	29	693

F. SCATS Intersection and Subsystem Data

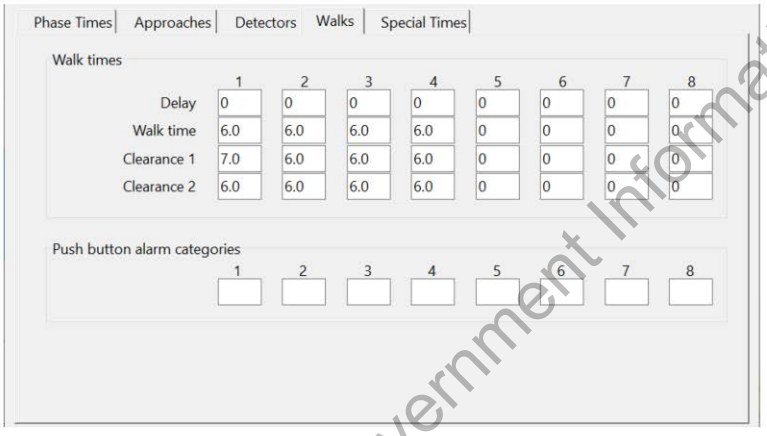


TCS 1015

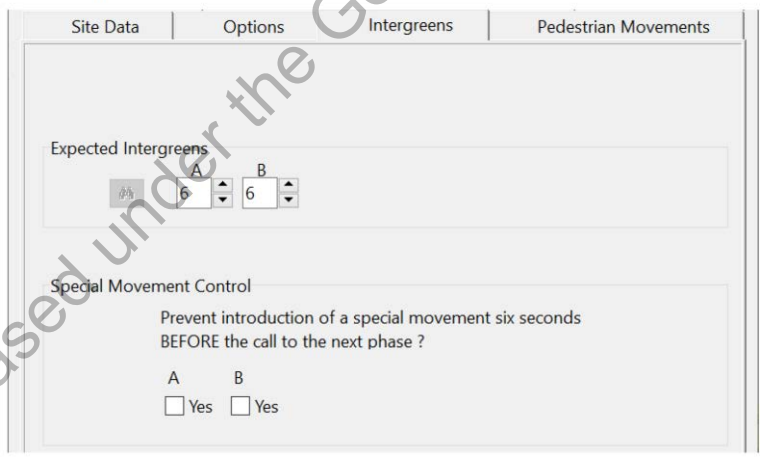
1. Phase Times

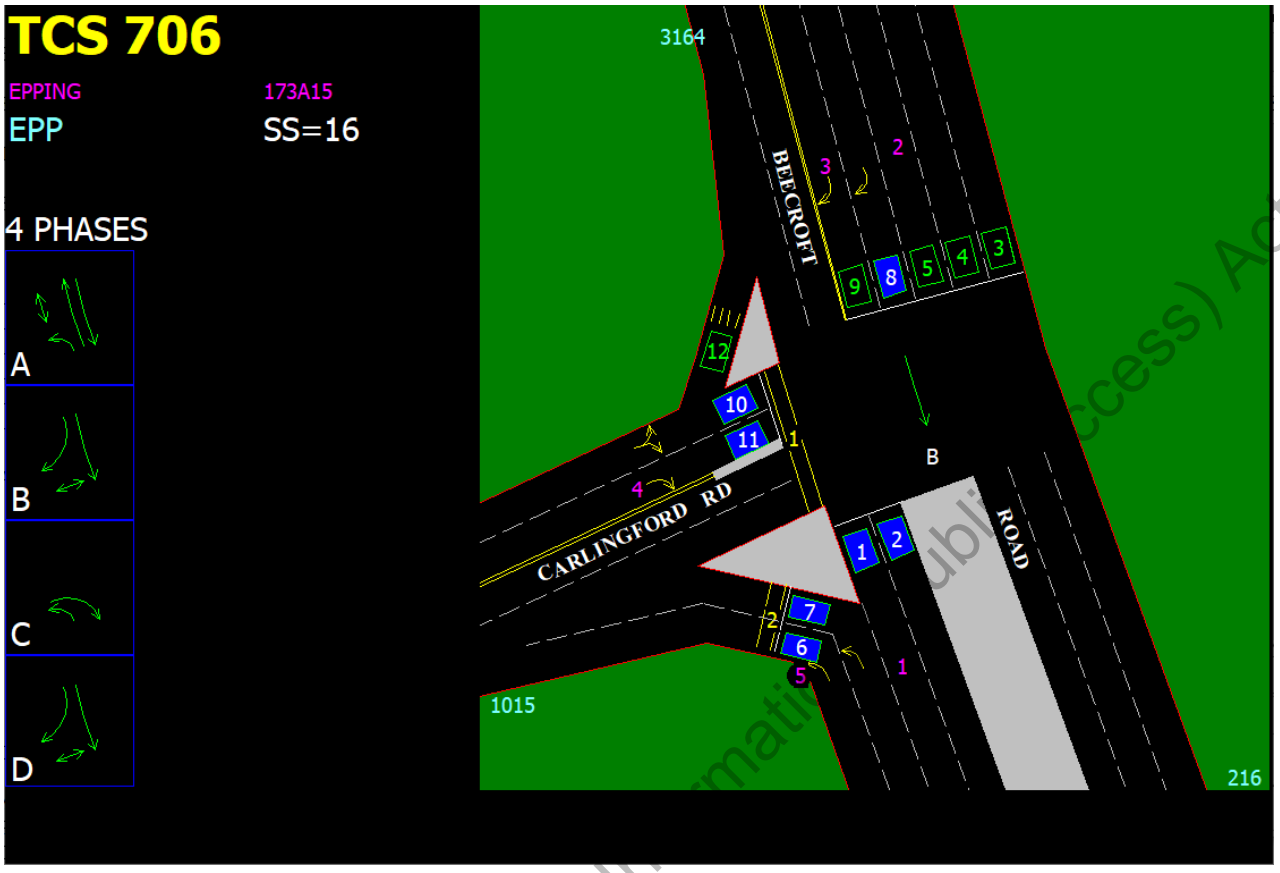


2. Walk Times



3. Intergreens





TCS 706

1. Phase Times

Phase Times | Approaches | Detectors | Walks | Special Times

	A	B	C	D
Late start	0	0	0	0
Minimum green	8.0	8.0	8.0	8.0
Early cut-off green	0	0	0	0
Yellow	4.0	4.0	4.0	4.0
All-red	2.0	2.0	2.0	2.0
Maximum green	60	20	70	20
Increment	0	0	0	0
Maximum initial green	0	0	0	0
Special red	0	0	0	0
Special time	0	0	0	0

2. Walk Times

Phase Times | Approaches | Detectors | Walks | Special Times

Walk times

	1	2	3	4	5	6	7	8
Delay	0	0	0	0	0	0	0	0
Walk time	6.0	6.0	0	0	0	0	0	0
Clearance 1	8.0	1.0	0	0	0	0	0	0
Clearance 2	6.0	6.0	0	0	0	0	0	0

Push button alarm categories

1	2	3	4	5	6	7	8

3. Intergreens

Site Data | Options | Intergreens | Pedestrian Movements

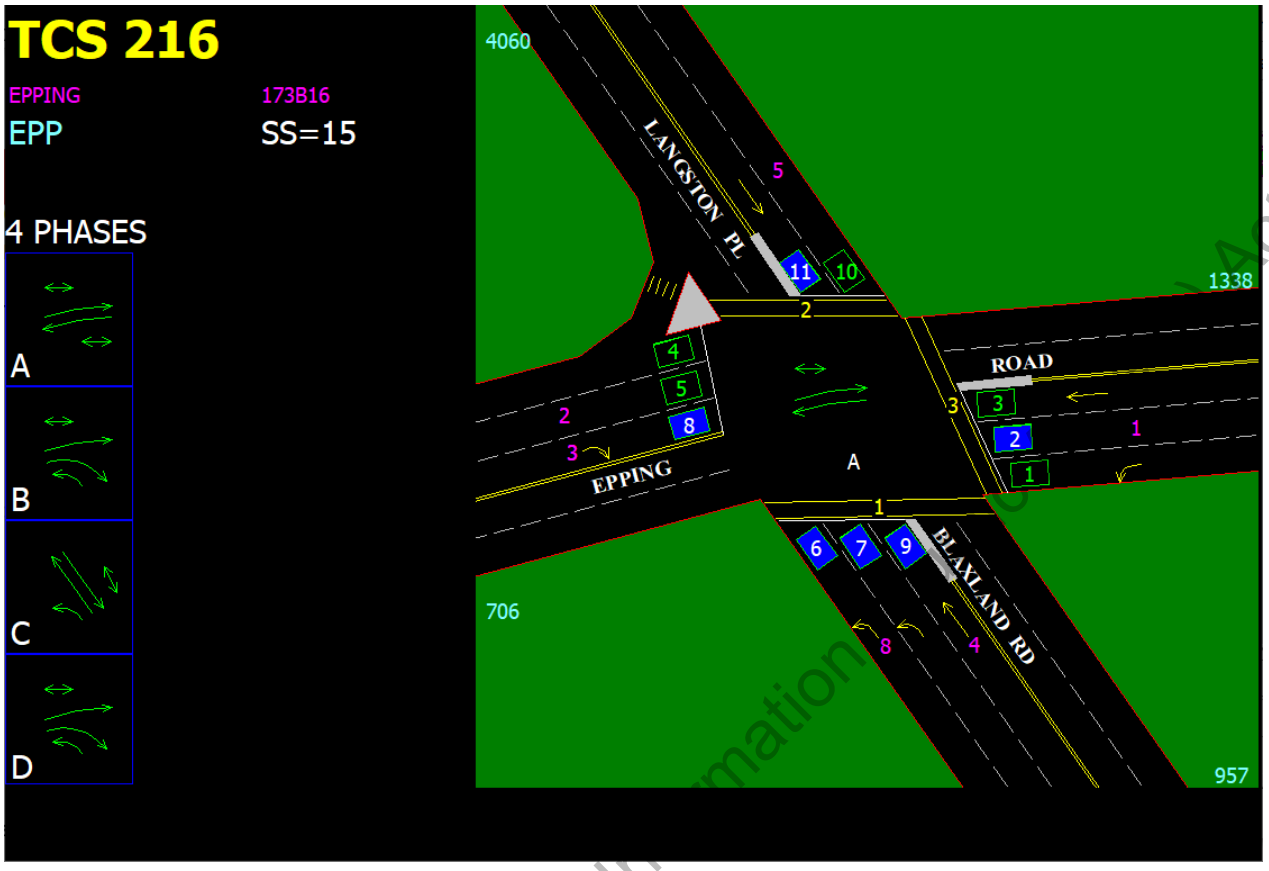
Expected Intergreens

A	B	C	D
6	6	6	6

Special Movement Control

Prevent introduction of a special movement six seconds BEFORE the call to the next phase ?

A	B	C	D
☐ Yes	☐ Yes	☐ Yes	☐ Yes



TCS 216

1. Phase Times

Phase Times | Approaches | Detectors | Walks | Special Times

	A	B	C	D
Late start	0	0	0	0
Minimum green	8.0	8.0	5.0	8.0
Early cut-off green	0	0	0	0
Yellow	4.0	4.0	4.0	4.0
All-red	2.5	2.5	3.0	2.5
Maximum green	80	50	15	20
Increment	0	0	0	0
Maximum initial green	0	0	0	0
Special red	0	0	0	0
Special time	0	0	0	0

2. Walk Times

Phase Times | Approaches | Detectors | Walks | Special Times

Walk times

	1	2	3	4	5	6	7	8
Delay	0	0	0	0	0	0	0	0
Walk time	6.0	6.0	6.0	0	0	0	0	0
Clearance 1	13	4.0	12	0	0	0	0	0
Clearance 2	6.0	6.0	7.0	0	0	0	0	0

Push button alarm categories

1	2	3	4	5	6	7	8

3. Intergreens

Site Data | Options | Intergreens | Pedestrian Movements

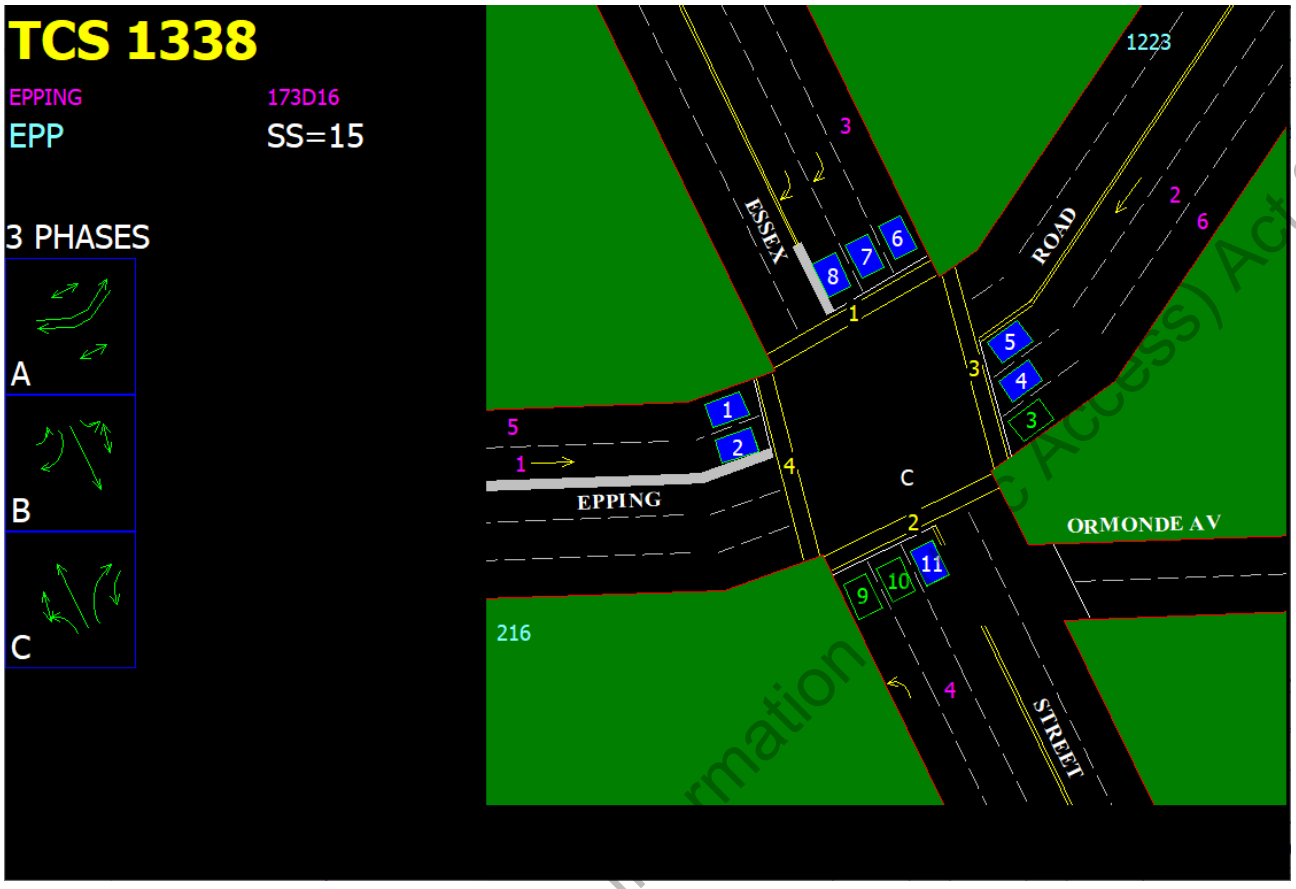
Expected Intergreens

A	B	C	D
7	7	7	7

Special Movement Control

Prevent introduction of a special movement six seconds BEFORE the call to the next phase ?

A	B	C	D
☐ Yes	☐ Yes	☐ Yes	☐ Yes



TCS 1338

1. Phase Times

Phase Times | Approaches | Detectors | Walks | Special Times

	A	B	C
Late start	0	0	0
Minimum green	8.0	5.0	5.0
Early cut-off green	0	0	0
Yellow	4.0	4.0	4.0
All-red	2.5	2.5	2.5
Maximum green	80	30	30
Increment	0	0	0
Maximum initial green	0	0	0
Special red	0	0	0
Special time	0	0	0

2. Walk Times

Phase Times | Approaches | Detectors | Walks | Special Times

Walk times

	1	2	3	4	5	6	7	8
Delay	0	0	0	0	0	0	0	0
Walk time	6.0	6.0	6.0	6.0	0	0	0	0
Clearance 1	10	7.0	11	11	0	0	0	0
Clearance 2	6.0	6.0	6.0	6.0	0	0	0	0

Push button alarm categories

1	2	3	4	5	6	7	8

3. Intergreens

Site Data | Options | Intergreens | Pedestrian Movements

Expected Intergreens

A	B	C
7	7	7

Special Movement Control

Prevent introduction of a special movement six seconds BEFORE the call to the next phase ?

A ☐ Yes B ☐ Yes C ☐ Yes

G. SCATS Region LX File

[Site 1338 has the same Subsystem with 216, coordinated with offset plans. Both 706 and 1015 are linked to 216].

1338

SLOT15=3,1,4!INT=1338!VC=6.1!CS=16!PK=/ZSL=0! [Controller and software Information – No subsystem data is assigned to this site]
COM=DO,P,1:4,H!BPS=1200!PH=0298686232!DD=0!CTYPE=C29V6.1R20S18!
LS=ON!
IK=!
S#=15!LM=MF^!RMN=0!DCL=0!
VOLS=1-24!
AT=7!BT=7!CT=7!
W1=6!W1T=16!W1F=!W2=6!W2T=13!W2F=! [Pedestrian Walk and Clearance]
W3=6!W3T=17!W3F=!W4=6!W4T=17!W4F=!
PP1=22,22^A!PP2=-8,-13^A! [Offset Plan data]
PP3=39,9^A!PP4=17,22^A!
VAR1=47!VAR1.0=!
VAR1.1=2!VAR1.2=136!VAR1.3=20!VAR1.4=0!
VAR2=47!VAR2.0=!
VAR2.1=3!VAR2.2=128!VAR2.3=20!VAR2.4=0!
VAR3=10!VAR3.0=!
VAR4=75!VAR4.0=!
VAR4.1=1287!

I=1338!PLAN=1!SF=!XSF=0! [Split plan data]
A=0PDFGC!
C=20FGB!
B=20TGA!

1015

SLOT18=2,1,4!INT=1015!VC=6.1!CS=354!PK=/ZSL=0! [Controller and Software Information]
COM=DO,P,3:2,H!BPS=1200!PH=0298770813!DD=0!CTYPE=C29V6.1R20S18!
LS=ON!
IK=!
S#=16!LM=MF^!RMN=0!DCL=0! [Subsystem 16 assigned to this site]
VOLS=1-24!
AT=6!BT=6! [Phase intergreen]
W1=8!W1T=13!W1F=!W2=8!W2T=12!W2F=! [Pedestrian Walk and Clearance]
W3=6!W3T=12!W3F=!W4=6!W4T=12!W4F=!

PP1=-7,-7A!PP2=-7,-7A! [Offset Plan Data]
PP3=-7,-7A!PP4=-7,-7A!
VAR1=47!VAR1.0=!
VAR1.1=2!VAR1.2=142!VAR1.3=30!VAR1.4=30!
VAR2=75!VAR2.0=!
VAR2.1=1283!

I=1015!PLAN=1!SF=!XSF=0! [Split plan data]
A=0PDFGB!
B=35A!

SS=16!LCL=40!HCL=130!SCL=72,0!KCL=0!ZSS=0! [Subsystem Data assigned to Site 1015, with Min / Max Cycle Length = 40 seconds / 130 seconds. Stopper 1 = 72 seconds]

SK=NSDDNAOVIFBF!
XCL=110!SZ=88,94!SMX=/ [Stretch Cycle Time and its cycle length calibration factors]
FCL=30,40,45,50,60,70,75,80,90,100,110,115,120,125,130,140!
PS1=40^,72!PS2=82,110!PS3=82,110!PS4=82,110!

LP1=-24,-24^D216! [Link Plan Data – Site 1015 is linked to Site 216]
LP2=30,16^A216!
LP3=9,3^D216!
LP4=8,39^D216!

706

SLOT17=4,4,2!INT=706!VC=5!CS=21!PK=/ZSL=0!
COM=NET,H!CTYPE=C18V5R20S24!
LS=ON!
IK=!
S#=16!LM=MF^!RMN=0!DCL=0! [Subsystem assigned to this site.
VOLS=1-24!
AT=6!BT=6!CT=6!DT=6! [Phase intergreen]
W1=6!W1T=14!W1F=!W2=6!W2T=7!W2F=! [Pedestrian Walk and Clearance]
PP1=0,0^B!PP2=0,0^B! [Offset Plan data]
PP3=0,0^B!PP4=0,0^B!
VAR1=35!VAR1.0=!
VAR1.1=1!VAR1.2=3!VAR1.3=0!VAR1.4=0!VAR1.5=0!
VAR1.6=0!VAR1.7=0!VAR1.8=0!VAR1.9=37!VAR1.10=147!
VAR1.11=0!VAR1.12=0!VAR1.13=0!
VAR2=11!VAR2.0=!
VAR2.1=127!VAR2.2=10!VAR2.3=0!VAR2.4=19!VAR2.5=0!
VAR3=3!VAR3.0=!
VAR3.1=0!VAR3.2=1!
VAR4=49!VAR4.0=!
VAR4.1=65!VAR4.2=0!
VAR5=10!VAR5.0=!
VAR6=11!VAR6.0=!
VAR6.1=383!VAR6.2=7!VAR6.3=0!VAR6.4=19!VAR6.5=0!
VAR7=90!VAR7.0=!
VAR7.1=1!
VAR8=10!VAR8.0=!
VAR9=75!VAR9.0=!
VAR9.1=1295!

I=706!PLAN=1!SF=!XSF=0! [Split plan data]
A=49TGC!
C=0PDFGB!
B=15FGA!
D=1A!

I=706!PLAN=2!SF=!XSF=0!
A=45TGC!
C=0PDFGB!
B=15FGA!
D=1A!

I=706!PLAN=3!SF=!XSF=0!
A=41TGC!
C=0PDFGB!
B=15FGA!
D=1A!

I=706!PLAN=4!SF=!XSF=0!
A=37TGC!
C=0PDFGB!
B=15FGA!
D=1A!

SS=16!LCL=40!HCL=130!SCL=72,0!KCL=0!ZSS=0! [Subsystem Data assigned to Site 706, with Min / Max Cycle Length = 40 seconds / 130 seconds. Stopper 1 = 72 seconds]
SK=NSDDNAOVIFBF!
XCL=110!SZ=88,94!SMX=/ [Stretch Cycle Time and its cycle length calibration factors]
FCL=30,40,45,50,60,70,75,80,90,100,110,115,120,125,130,140!
PS1=40^,72!PS2=82,110!PS3=82,110!PS4=82,110!
LP1=-24,-24^D216! [Link Plan Data Site 706 is linked to Site 216]
LP2=30,16^A216!

LP3=9,3^D216!
LP4=8,39^D216!

216

SLOT16=4,8,3!INT=216!VC=6.1!CS=345!PK=/ZSL=0! [Controller and Software Information]
COM=NET,H!CTYPE=C29V6.1R20S18!
LS=ON!
IK=!
S#=15!LM=MI^!RMN=0!DCL=80! [Subsystem 15 Assigned to this Site]
VOLS=1-24!
AT=7!BT=7!CT=7!DT=7! [Phase intergreen]
W1=6!W1T=19!W1F=!W2=0ABD!W2T=10!W2F=! [Pedestrian Walk and clearance]
W3=6!W3T=19!W3F=!
PP1=0,0^D!PP2=0,0^A! [Offset plan data]
PP3=0,0^D!PP4=0,0^D!

VAR1=35!VAR1.0=!
VAR1.1=1!VAR1.2=2!VAR1.3=3!VAR1.4=0!VAR1.5=0!
VAR1.6=4!VAR1.7=0!VAR1.8=0!VAR1.9=158!VAR1.10=19!
VAR1.11=145!VAR1.12=0!VAR1.13=107!
VAR2=14!VAR2.0=!
VAR2.1=0!VAR2.2=15!
VAR3=14!VAR3.0=!
VAR3.1=0!VAR3.2=7!
VAR4=19!VAR4.0=!
VAR5=14!VAR5.0=!
VAR5.1=0!VAR5.2=3!
VAR6=36!VAR6.0=!
VAR6.1=300!VAR6.2=301!
VAR7=10!VAR7.0=!
VAR8=11!VAR8.0=!
VAR8.1=383!VAR8.2=7!VAR8.3=0!VAR8.4=19!VAR8.5=0!
VAR9=90!VAR9.0=!
VAR9.1=2!
VAR10=75!VAR10.0=!
VAR10.1=1311!

I=216!PLAN=1!SF=!XSF=0! [Split plan data]
A=0PDFGB!
B=19FGC!
C=17A!
D=1A!

I=216!PLAN=2!SF=!XSF=0!
A=0PDFGB!
B=22FGC!
C=17A!
D=1A!

I=216!PLAN=3!SF=!XSF=0!
A=0PDFGB!
B=25FGC!
C=17A!
D=1A!

I=216!PLAN=4!SF=!XSF=0!
A=0PDFGB!
B=28FGC!
C=17A!
D=1A!

I=216!PLAN=5!SF=Z+!XSF=0!
A=0PDFGB!

B=14FGC!
C=17D!
D=17TGA!

I=216!PLAN=6!SF=Z+!XSF=0!
A=0PDFGB!
B=17FGC!
C=17D!
D=17TGA!

I=216!PLAN=7!SF=Z+!XSF=0!
A=0PDFGB!
B=17FGC!
C=17D!
D=20TGA!

I=216!PLAN=8!SF=Z+!XSF=0!
A=0PDFGB!
B=20FGC!
C=17D!
D=20TGA!

SS=15!LCL=40!HCL=130!SCL=72,0!KCL=0!ZSS=0! [Subsystem Data assigned to Site 216, with Min / Max Cycle Length = 40 seconds / 130 seconds. Stopper 1 = 72 seconds]
SK=NSDDNAOVIF!
XCL=110!SZ=88,94!SMX=/ [Stretch Cycle Time and its cycle length calibration factors]
FCL=30,40,45,50,60,70,75,80,90,100,110,115,120,125,130,140!
PS1=40^,72!PS2=82,110!PS3=82,110!PS4=82,110!

LP1=0! [Link Plan Data]
LP2=0!
LP3=0!
LP4=0!

H. SCATS History Files

Periodic statistics for TCS sites 216, 706, 1015 and 1338, at 15-min intervals from Thursday, 21 September 2023, 12:00 AM AEST to Thursday, 21 September 2023, 11:59:59 PM AEST.

TCS 216	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	55	47	55	53	55	54	52	58	55	53
B-phase	31	35	27	26	23	23	23	23	23	26
C-phase	24	24	24	25	26	26	27	26	26	26
D-phase	20	22	23	23	24	25	25	22	24	24
Cycle Length	129	125	127	130	130	130	130	132	130	130

TCS 216	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	81	81	81	80	81	80	81	81	81	73
B-phase	23	23	23	23	23	23	23	23	23	30
C-phase	25	25	26	26	25	25	25	26	25	25
D-phase	-	-	-	-	-	-	-	-	-	-
Cycle Length	129	129	130	130	129	130	130	130	130	129

TCS 706	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	32	32	37	41	48	46	47	47	43	43
B-phase	14	15	15	16	17	18	18	17	19	19
C-phase	82	77	78	70	63	65	63	63	66	67
Cycle Length	130	124	129	130	129	127	129	127	128	129

TCS 706	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	60	60	57	57	58	59	56	56	59	52
B-phase	19	19	19	19	20	19	20	19	18	19
C-phase	50	50	52	52	50	49	54	54	52	58
Cycle Length	129	130	129	132	129	128	130	130	130	128

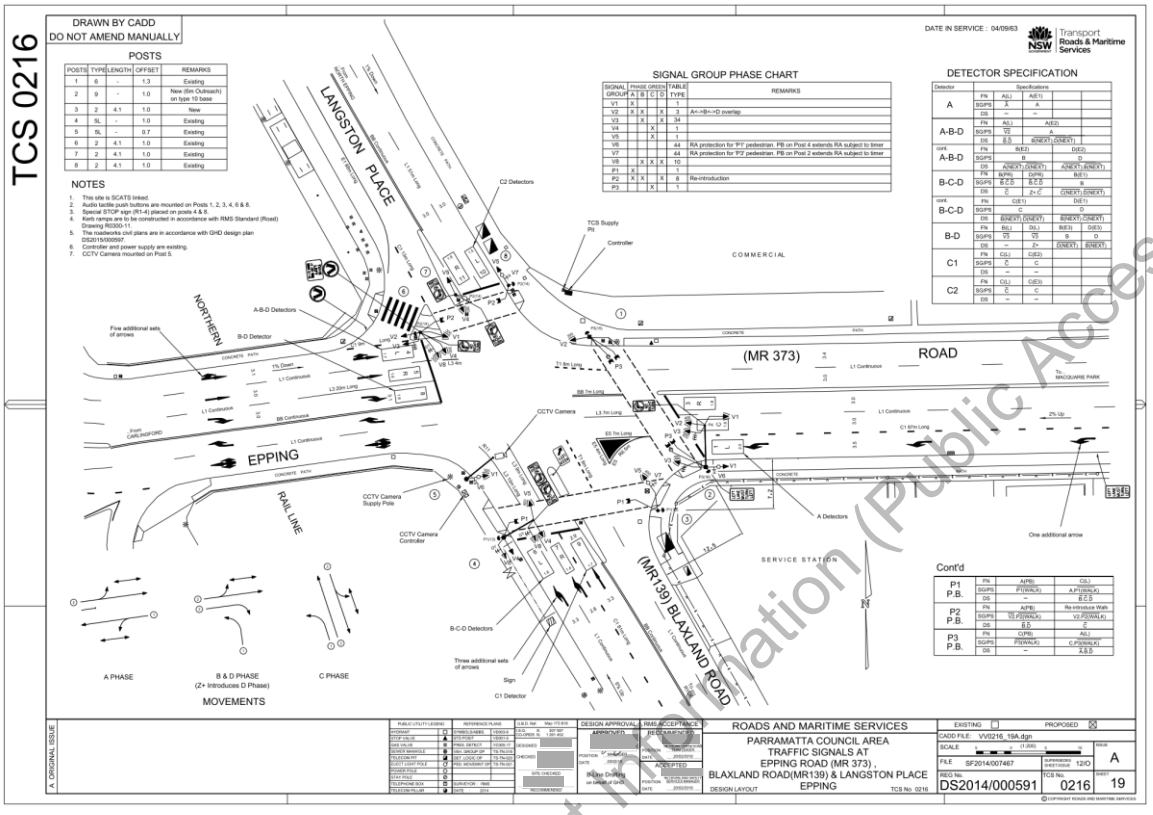
TCS 1015	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	104	96	100	91	87	86	85	84	84	84
B-phase	24	28	28	37	43	43	44	45	46	46
Cycle Length	129	124	132	128	131	129	129	130	130	130

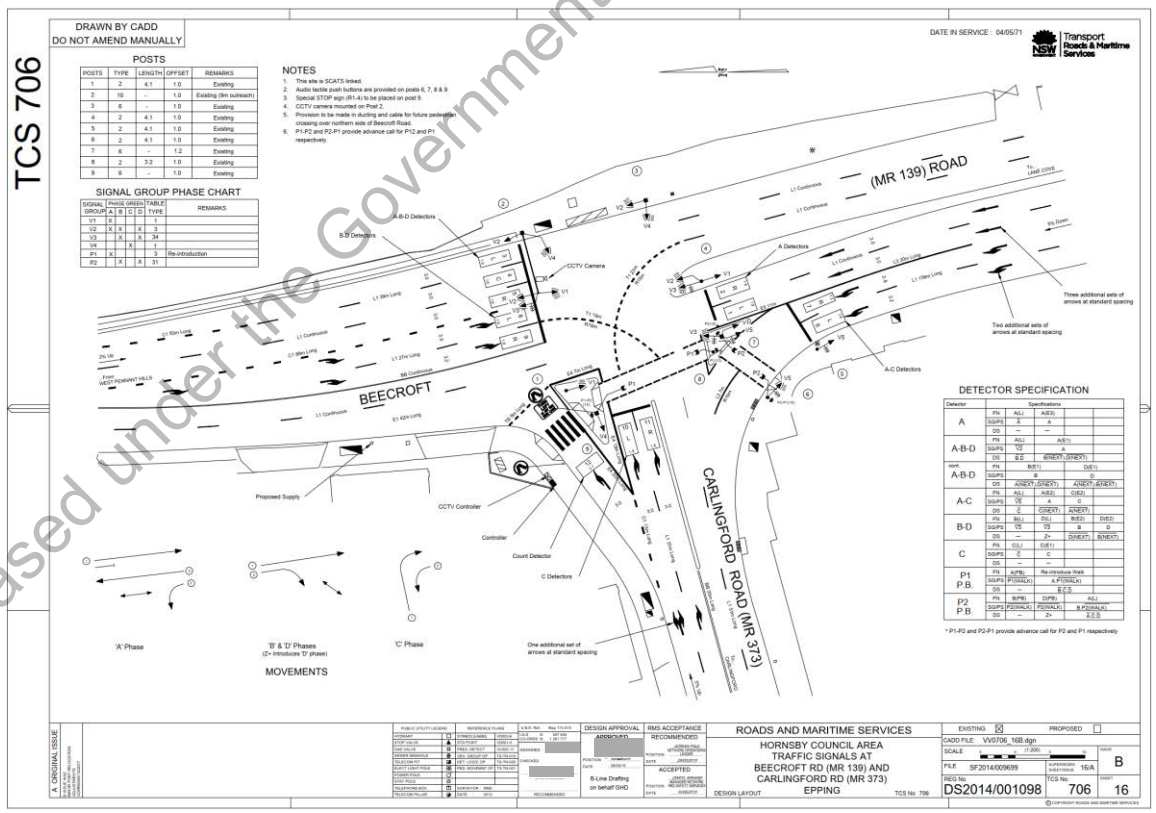
TCS 1015	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	84	84	84	84	84	84	84	85	84	84
B-phase	46	46	46	46	46	46	46	45	46	46
Cycle Length	130	130	130	130	130	130	130	130	130	130

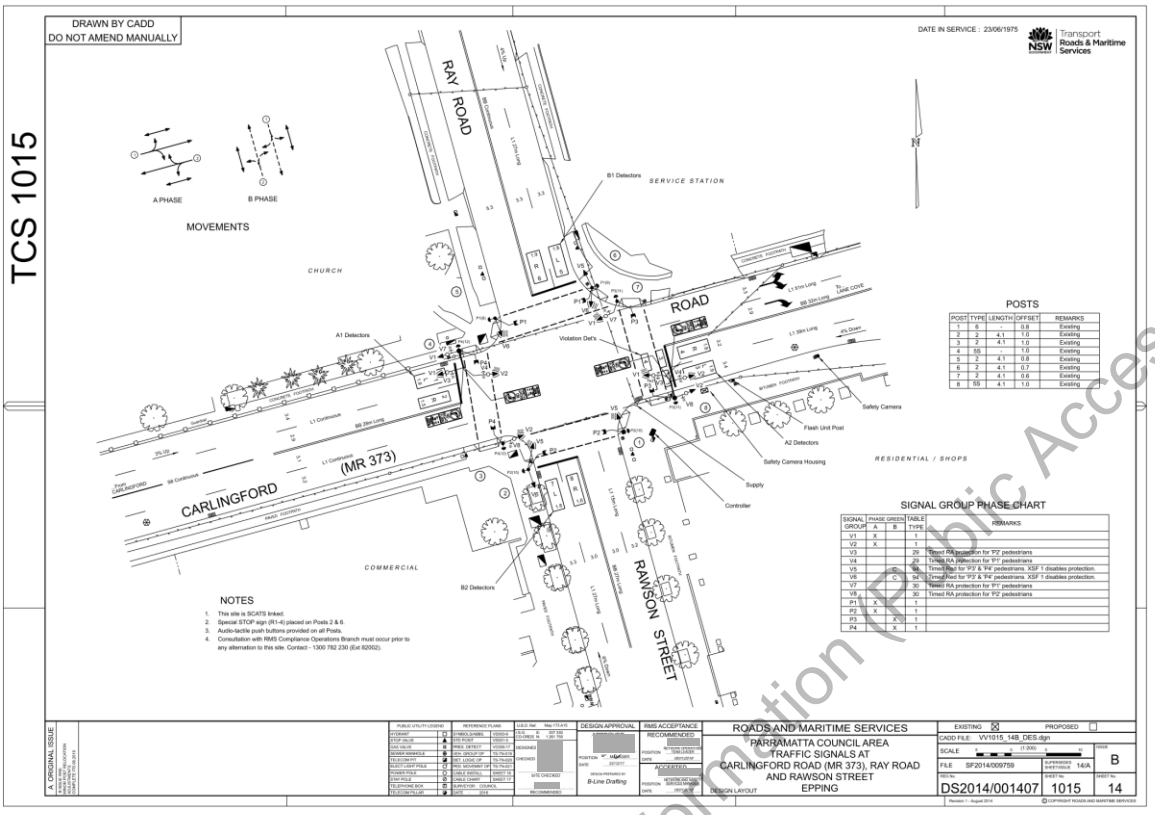
TCS 1338	Observed Average Phase Times (secs) for the 15-min period starting									
	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45
A-phase	95	94	85	81	87	80	81	79	80	80
B-phase	18	19	25	28	26	27	26	29	25	26
C-phase	16	15	18	21	19	22	22	21	24	22
Cycle Length	130	127	129	131	129	130	130	129	130	130

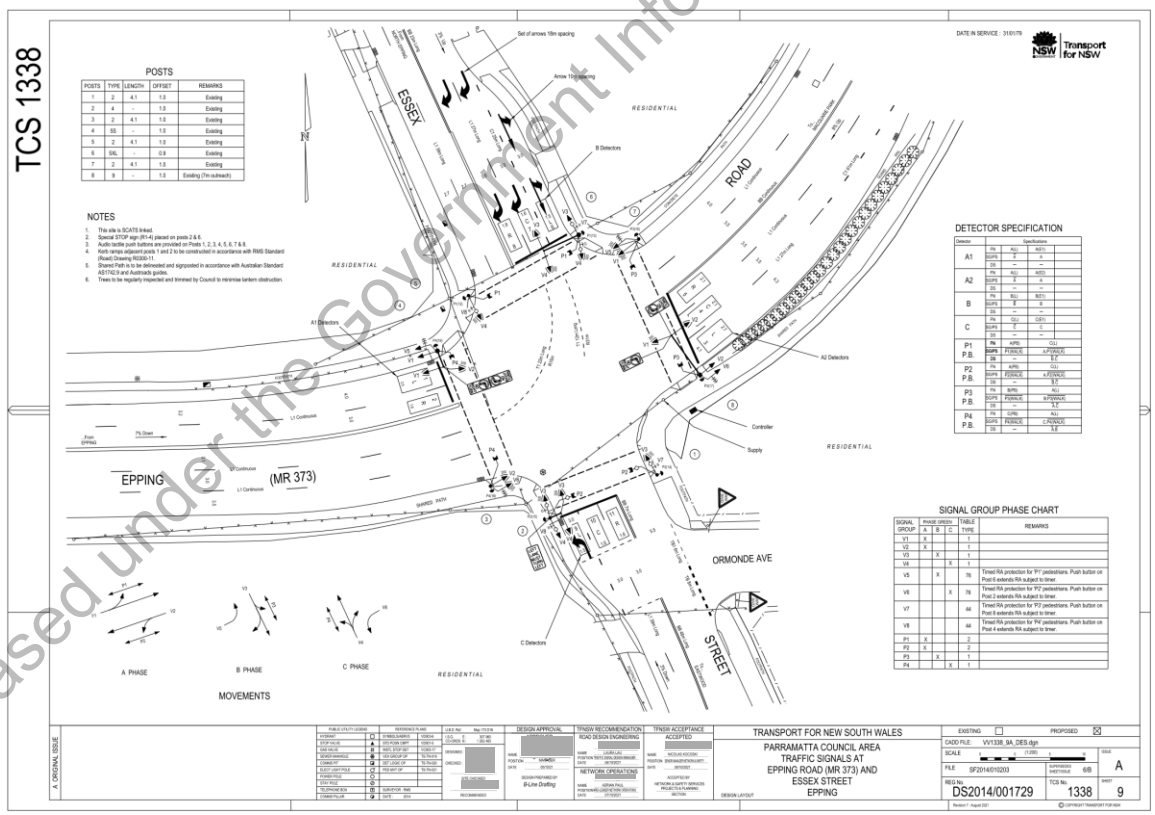
TCS 1338	Observed Average Phase Times (secs) for the 15-min period starting									
	16:00	16:15	16:30	16:45	17:00	17:15	17:30	17:45	18:00	18:15
A-phase	81	81	82	79	78	81	78	79	80	83
B-phase	26	26	25	26	29	24	27	26	27	26
C-phase	22	20	20	22	21	23	24	23	21	21
Cycle Length	130	127	128	129	129	131	130	130	130	130

I. Existing Traffic Signal Plans









J. 2023 Bus Service Coding Summary

Table J1: AM Peak Bus Services

Route	Start		Event 1		Event 2		Event 3		Event 4		Event 5		Event 6		End
	Start Time	Cordon Entry	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Cordon Exit
541	06:47	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541 (EB)	07:35	1	212112	300	212114	-	-	-	-	-	-	-	0	0	1
541	08:02	1	212112	240	212114	300	212190	10	212115	10	-	-	0	0	1
541	08:54	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541 (WB)	07:28	1	212114	300	212190	10	212115	10	-	-	-	-	0	0	1
546	06:37	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	07:05	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	07:35	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	08:21	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	08:54	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (NB)	06:44	3	212140	300	2121163	10	-	-	-	-	-	-	-	-	3
549	06:52	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (NB)	07:14	3	212140	300	2121163	10	-	-	-	-	-	-	-	-	3
549	07:20	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	07:49	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	08:05	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	08:38	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (SB)	08:58	3	2121155	10	212190	10	212115	10	212112	300	-	-	0	0	3
550 (EB)	06:54	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:03	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:15	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:25	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:47	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	07:57	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:10	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:20	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:31	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:41	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	08:53	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (WB)	06:35	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	06:46	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	06:56	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:06	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:14	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:25	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:37	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	07:49	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:01	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:11	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:22	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:44	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	08:53	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
630 (WB)	06:32	2	212114	300	212129	10	-	-	-	-	-	-	0	0	2
630	07:20	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	07:50	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	08:36	2	212123	10	212190	10	212115	10	212114	540	212129	10	-	-	2
651 (NB)	06:30	4	212113	300	-	-	-	-	-	-	-	-	0	0	4
651	06:47	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	07:10	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	07:35	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	08:03	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651 (SB)	08:25	4	212190	10	212115	10	212113	300	0	0	0	0	0	0	4
651	08:50	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
718w	08:25	1	212114	300	212190	10	212115	10	-	-	-	-	0	0	1
726w	07:33	2	212114	300	212129	10	-	-	-	-	-	-	0	0	2
732w	07:50	2	212114	300	212129	10	-	-	-	-	-	-	0	0	2
3013	08:02	2	212114	300	-	-	-	-	-	-	-	-	0	0	2
3014	07:57	2	212114	300	-	-	-	-	-	-	-	-	0	0	2

Table J2: PM Peak Bus Services

Route	Start		Event 1		Event 2		Event 3		Event 4		Event 5		Event 6		End
	Start Time	Cordon Entry	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Bus Stop	Dwell (sec)	Cordon Exit
541	16:22	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541	17:07	1	212112	300	212114	-	-	-	-	-	-	-	0	0	1
541	17:37	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
541	18:24	1	212112	300	212114	300	212190	10	212115	10	-	-	0	0	1
546	16:23	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	16:53	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	17:23	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546	17:53	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
546(SB)	18:23	3	2121155	10	212190	10	212115	10	212112	300	-	-	0	0	3
549	16:08	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	16:38	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	17:08	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549	17:38	3	2121155	10	212190	10	212115	10	212112	300	212140	300	2121163	10	3
549 (NB)	18:00	3	212140	300	2121163	10	-	-	-	-	-	-	-	-	3
549	18:08	3	2121155	10	212190	10	212115	10	212112	120	212140	300	2121163	10	3
550 (EB)	16:17	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:26	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:36	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:46	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	16:56	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	17:16	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	17:37	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	17:57	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (EB)	18:17	2	2121213	10	212111	300	2121214	10	-	-	-	-	0	0	7
550 (WB)	16:00	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:24	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:36	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:46	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	16:56	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	17:16	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	17:37	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	17:57	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
550 (WB)	18:17	7	212138	10	212126	10	212154	300	212190	10	-	-	0	0	1
630 (EB)	16:25	2	212123	10	212190	10	212115	10	212114	300	-	-	0	0	2
630 (EB)	16:55	2	212123	10	212190	10	212115	10	212114	300	-	-	0	0	2
630	17:25	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	17:55	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
630	18:25	2	212123	10	212190	10	212115	10	212114	300	212129	10	-	-	2
651 (NB)	16:00	4	212113	300	-	-	-	-	-	-	-	-	0	0	4
651	16:17	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	16:43	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651	17:12	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651 (NB)	17:40	4	212113	300	-	-	-	-	-	-	-	-	0	0	4
651	17:41	4	212190	10	212115	10	212113	300	-	-	-	-	0	0	4
651 (SB)	18:11	4	212190	10	212115	10	212113	300	0	0	0	0	0	0	4
733	16:14	1	212114	300	-	-	-	-	-	-	-	-	0	0	4

K. 2021 AM & PM STFM Link Flow Plots & Cordon Matrices

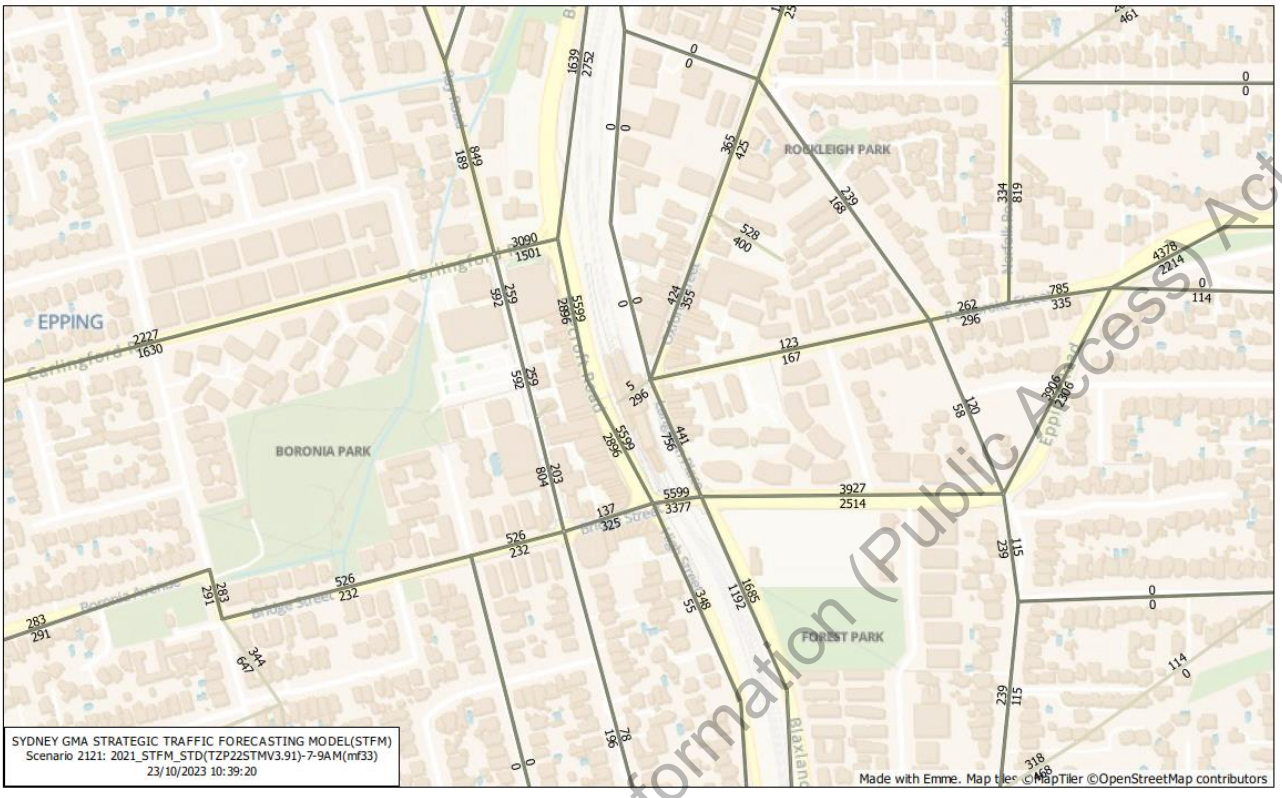
Table K1: STFM 2021 AM Peak 2-hour Cordon Matrices (Vehicles)

ID	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1		743	59	46	1684		6		119	89	5		2752
2	698		37	72				1	318	36		30	1192
3	106	94			144		1		24	142		15	526
4	30	152			1793		7		207			38	2227
5	585	11	86	1096			93	337		57		41	2306
6	51		6	51				3		5		4	120
7	70		8	82		58		7		9		5	239
8	55												55
9		437					4						441
10	31	21	16	40	27		1		7		31	13	187
11		2			46		1		32	73		44	196
12	14	224	19	243	211		2		51	44	42		849
TOTAL	1639	1685	232	1630	3906	58	115	348	756	455	78	189	11091

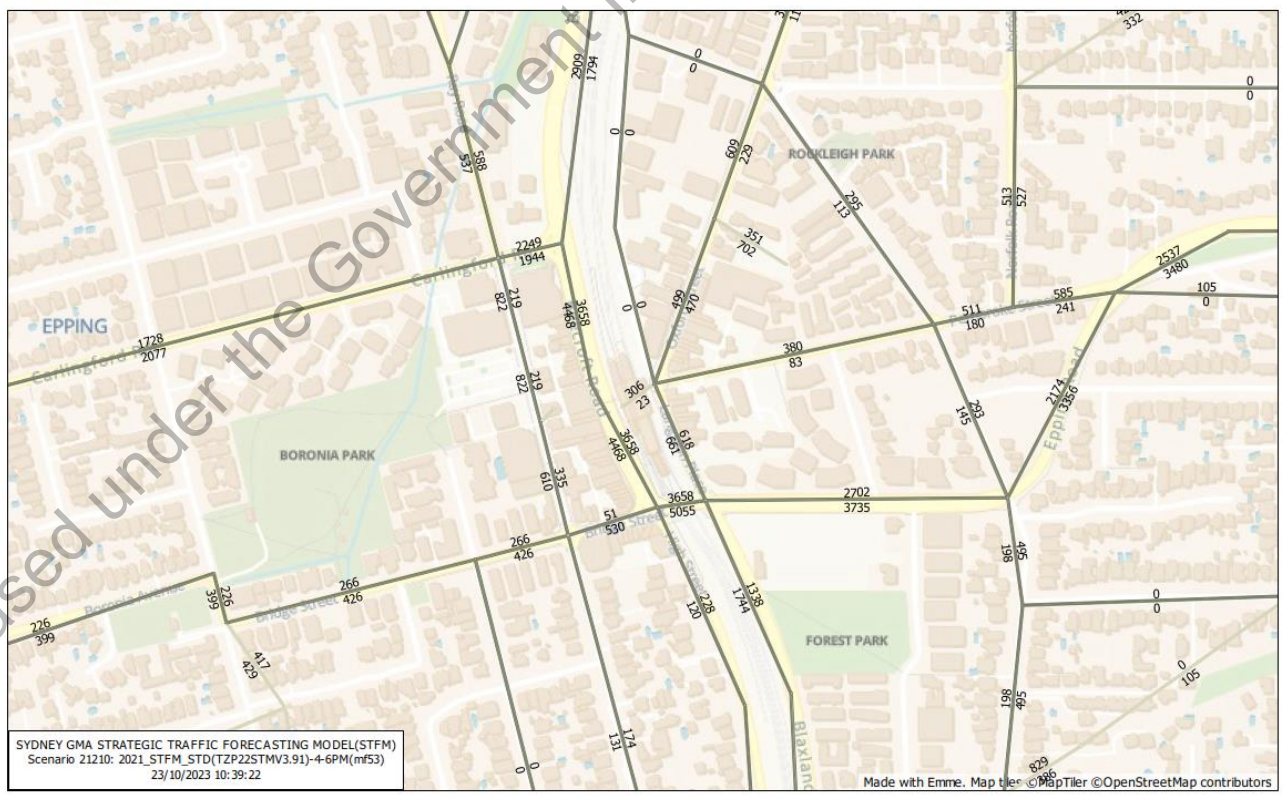
Table K2: STFM 2021 PM Peak 2-hour Cordon Matrices (Vehicles)

ID	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
1		619	43	74	680	44	173		94	36	31		1794
2	896		165	140				3	424	24		92	1744
3	16	16			115	4	17		8	70		21	266
4	102	65			1040	38	132		100			251	1728
5	1511		92	1479				199		23		52	3356
6	87		37	116				23		5		24	293
7	43		8	24	70	41		4		4		4	198
8	120												120
9		512					107						618
10	114	39	59	94	81	6	28		12		80	42	554
11		2			27	1	4		5	41		51	131
12	21	85	23	149	161	10	36		17	23	63		588
TOTAL	2909	1338	426	2077	2174	145	495	228	661	226	174	537	11390

2021 AM Peak



2021 PM Peak



L. TfNSW Operational Transport Forecasting Team Review Comments on Draft Issue

MOTT MACDONALD

Options Testing Technical Note

Epping Bridge Upgrade

TfNSW

Project:	Epping Bridge Replacement		
Our reference:	703100907	**Your reference:**	EBP150523-MOTTM-EPG-TF-RPT-000004 Rev E OFFICIAL
Prepared by:		**Date:**	9 April 2025
Approved by:		**Checked by:**	
Subject:	Options Testing Technical Note		

1 Introduction

1.1 Background

This technical note documents the end-state and construction staging models developed using VISSIM and SIDRA for the Concept Design phase of the Epping Bridge project. This note serves as a supplement to our previously submitted Base Year Technical Note on February 29, 2024.

Traffic modelling is required to demonstrate the operational impacts of the project on the transport network, during construction and at end state, for the Review of Environmental Factors (REF).

This Technical Note has been structured in line with TTD2017/001.

1.2 Project Objectives

The proposed project will replace and widen the existing Epping Bridge across the combined T9 and Metro rail corridor. It will include the following upgrades to Epping Road and Beecroft Road:

- an additional eastbound right turn lane from Epping Bridge into Blaxland Road.
- an additional westbound lane across the bridge deck.
- widening of the traffic lanes on the bridge deck, continuing around the sharp curve in the Beecroft Road alignment, immediately west of the bridge.
- adjustments to the Beecroft Road access with Bridge Street and High Street.
- improved active transport facilities along the southern footpath of the bridge.
- relocation of existing Beecroft Road bus stops north of the pedestrian overbridge.

1.3 Scope of Work

Mott MacDonald has been engaged to develop a Preliminary Design Review (Concept Design) and develop the Review of Environmental Factors (REF) which will be used to seek Planning Approval for the project. The Concept Design would then be used as the reference design for the next phase of procurement for the Detailed Design and construction of the works.

The concept design will be built upon the work completed in 2021 by Future Rail for the Definition Design of the Epping Bridge Project. The Future Rail Definition Design assessed both a widening and replacement option which was used to prepare the Final Business Case, which is now complete.

The purpose of the VISSIM and SIDRA modelling is to:

- Provide traffic analysis for the Review of Environmental Factors (REF) of the Epping Bridge Replacement proposal. The modelling will need to compare traffic performance With and Without Project at opening year 2029 and With Project 10-years after opening.
- Assess the travel delay impacts of key traffic staging arrangements during construction of the project, to inform the Road User Delay Management Strategy.

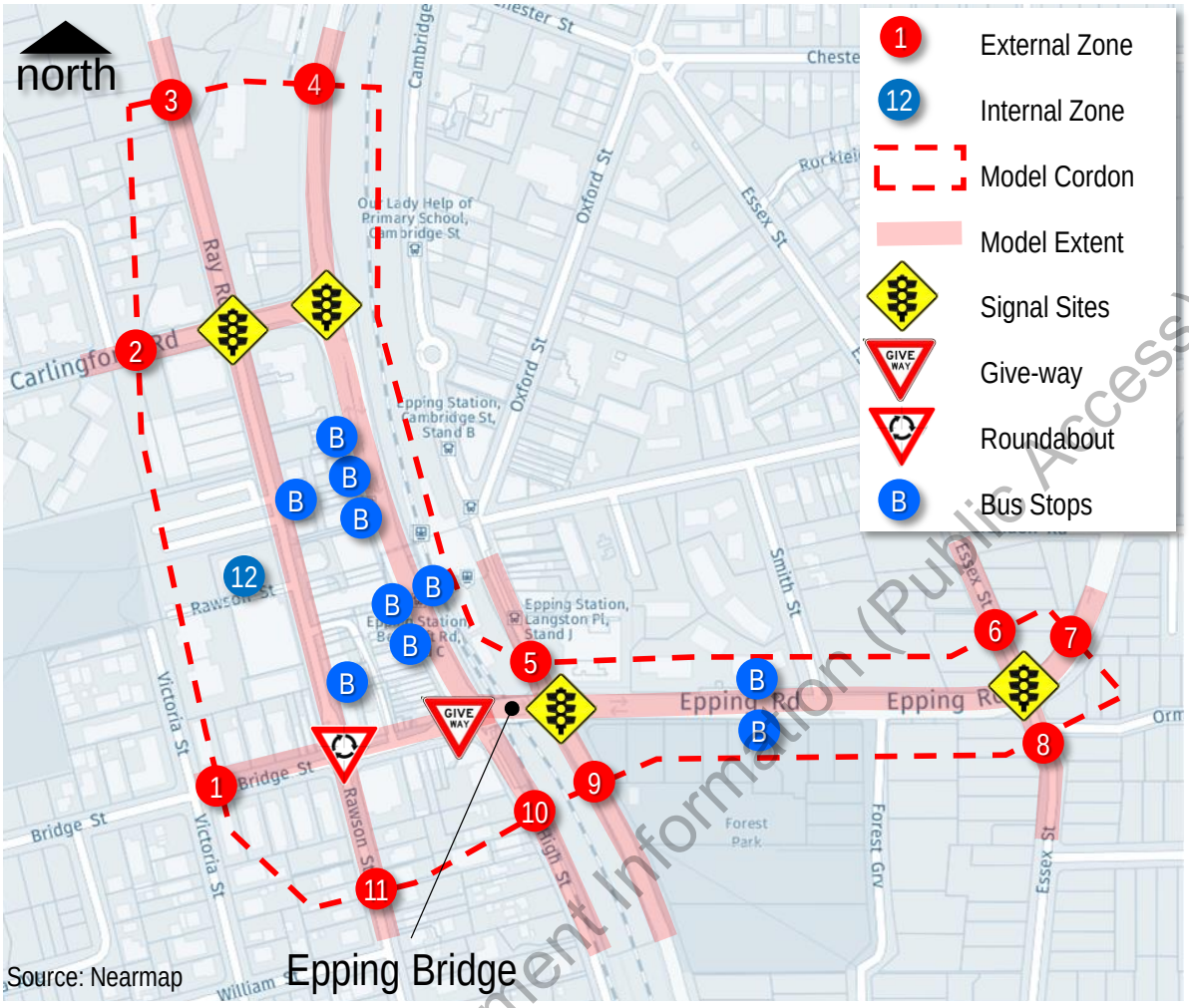
Whilst there may be minor design optimisation undertaken during the Concept Design phase, the design layouts were specified in the Concept Design brief. Optioneering and/or comparative assessments of alternate designs was not included in the Concept Design scope.

1.4 Study Area

The proposed extent of the VISSIM and SIDRA models is presented in Figure 1-1. The 12x12 cordon zones, that were adopted for the previous VISSIM modelling during the Reference Design phase, are retained. The zone descriptions include:

1. Bridge Street (west)
2. Carlingford Road (west)
3. Ray Road (north)
4. Beecroft Road (north)
5. Langston Place (north)
6. Essex Street (south)
7. Epping Road (east)
8. Essex Street (north)
9. Rawson Street (south)
10. Blaxland Road (south)
11. High Street (south)
12. Rawson Street Carpark

Figure 1-1 Study Area



1.5 Report Outline

This report has been structured in accordance with TTD 2017/001 and includes:

Section 1 – Introduction

Section 2 – Construction Scenario Testing

Section 3 – Future Options Testing

Section 4 – Summary and Conclusion

1.6 This revision

This revision of the technical note updates the SIDRA modelling following calibration refinements to the Base Case SIDRA models. The SIDRA analysis in Sections 2.3.4, 3.3.5 and 3.3.6 have all been updated.

Additionally, a series of alternate signal optimisation strategies have been applied to the 'With Project' scenarios, in both the VISSIM and SIDRA models, to maximise project benefits.

Both updates were undertaken in response to TfNSW comments raised on 11 February 2025.

2 Construction Scenario Testing

The objective of construction scenario modelling is to assess the potential impacts of construction works on road users and identify opportunities to minimise road user delays during construction (PS251.07). The performance of the road network during the construction traffic stages was assessed using the VISSIM and SIDRA modelling software.

2.1 Scenario Descriptions

The following construction traffic stages were modelled:

- Stage 1A
- Stage 4A
- Stage 5B
- Stage 5B (80% Demand)
- Stage 6

These stages were selected for analysis, as they represented a significant change in layout or capacity, compared to a previous stage.

Stage 5B was modelled with normal demand and haulage then again with 80% demand, to reflect the lower demand experienced over the Christmas and New Year shut-down periods.

A review of permanent count data (Site: 74453) on the Epping Bridge over Christmas 2017, revealed that daily traffic demand dropped to 80% of normal flow over the 4-week period commencing 18 December 2017.

2.1.1 Stage 1A

It is important to maintain three lanes on the northbound Blaxland Road approach to TCS216 during construction of the retaining wall and bridge abutments on the south-west corner of the site. This will be achieved by shifting the three lanes east and reducing the southbound carriageway of Blaxland Road to a single lane.

On the northern side of the intersection, the Langston Place approach will need to be reconfigured to a dedicated left lane and a single through lane. The alignment of the southbound movement from Langston Place to Blaxland Road may be problematic due to the reverse curves through the intersection. Capacity for through movements on the Langston Place approach will be reduced during this stage.

It is understood that all signalised pedestrian crossings will be maintained during this stage.

The construction staging 1A drawing is presented in **Appendix A-1.**

2.1.2 Stage 4A

The Blaxland Road approach to TCS216 is shifted west into its ultimate configuration. The Langston Place approach is also changed to its ultimate configuration and the two departure lanes on Blaxland Road are re-opened.

The westbound Epping Road approach is realigned and A-detectors 2 and 3 relocated.

It is understood that all signalised pedestrian crossings will be maintained during this stage.

The construction staging 4A drawing is presented in **Appendix A-2.**

2.1.3 Stage 5B

Stage 5B reduces Epping Road eastbound capacity significantly over the Christmas Break.

The eastbound shared through and left will be impacted by the closure of the left turn slip lane into Langston Place. Instead, this movement will be delayed by the left turn pedestrian protection.

The eastbound shared through and right lane will be blocked by right turn traffic in A-phase.

The only way to make this work efficiently and maximise the available capacity would be to operate Epping Road as split approaches phases.

All the eastbound left, through and right movements operate at the same time in a new A-phase.

All the westbound through and left movements then operate in an existing A-phase, at the same time. The Langston Place crossing is added to this B-phase. Given that there is no right turn conflict – it has little or no impact on the phase.

C-phase for Langston Place movements would operate as normal.

These signal modifications would help to minimise the impact and maximise the available lane capacities.

It is understood that all signalised crossings will be maintained during this stage.

The construction Stage 5B layout drawing is presented in **Appendix A-3.**

2.1.4 Stage 5B (80% Demand)

Same as 5B but modelled with 80% demand to reflect the lower demand experienced over the Christmas and New Year shut-down periods.

2.1.5 Stage 6

The Blaxland Road approach is in its end-state configuration. The Langston Place approach is adjusted to its end-state configuration.

The Epping Road eastern approach maintains two westbound lanes on the new alignment. The median lane provides a buffer to median construction works.

The Epping Road western approach maintains two through lanes and right turn lane on the new bridge approach vertical alignment.

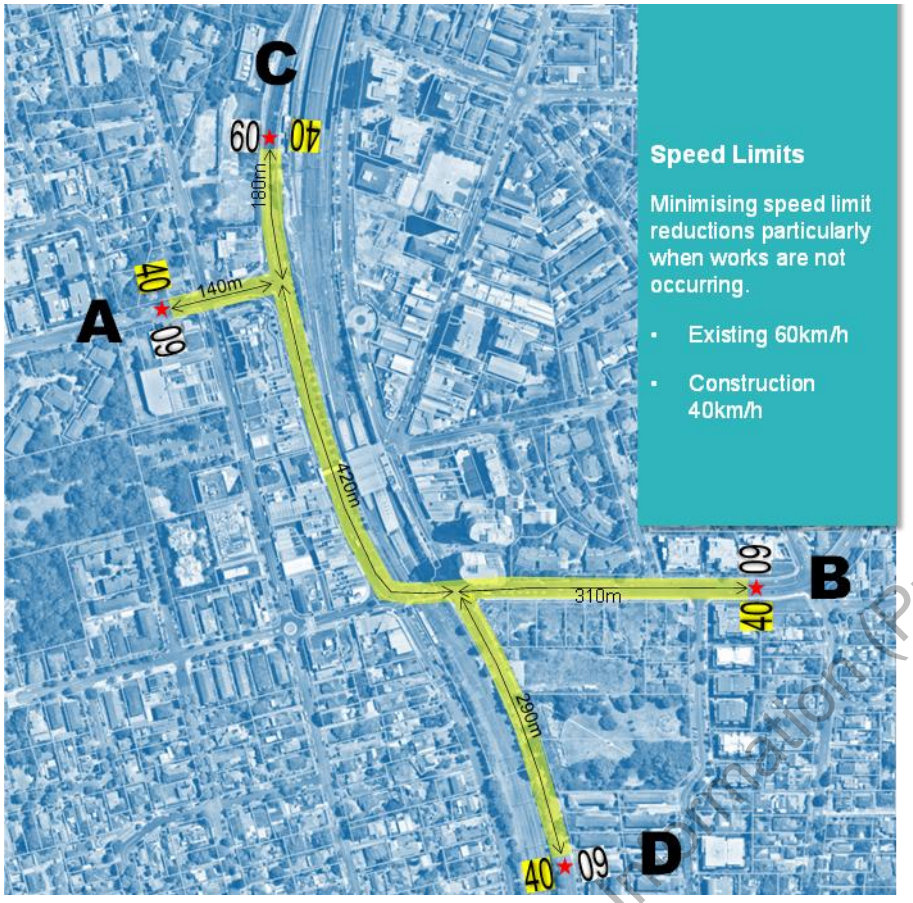
The construction staging 6A drawing is presented in **Appendix A-4.**

2.2 Assumptions

2.2.1 Speed Limits

The speed limits are reduced to 40km/h from the existing 60km/h in the project area during construction. The indicative extent of 40km/h construction speed limits are presented in Figure 2-1.

Figure 2-1 Extent of Construction Speed Zones

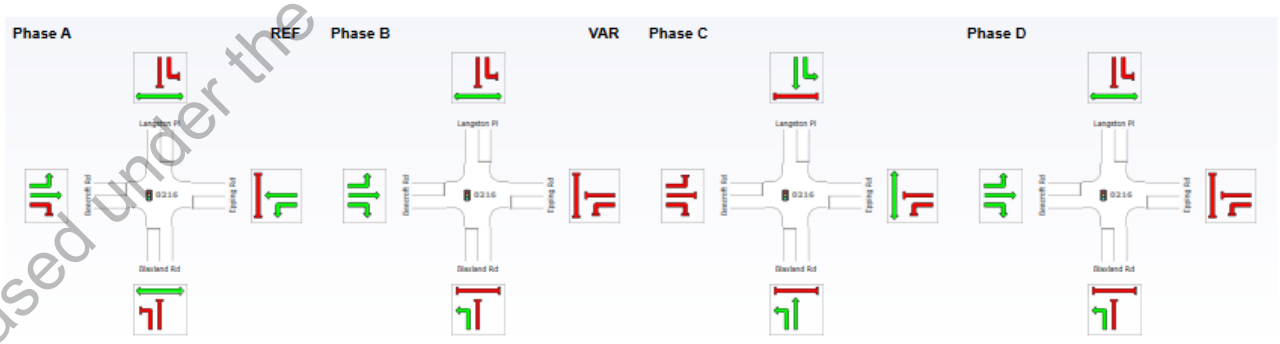


2.2.2 Signal Phasing

All existing signal phases are retained except in scenario 5B. In this 5B scenario the A, B and C phasing was adopted as shown in the Figure 2-2.

A staged pedestrian crossing is proposed on the eastern approach to the signalised intersection of Epping Road and Blaxland Road and Langston intersection place in construction stages 4A and 6.

Figure 2-2 Signal Phasing at Epping Rd / Blaxland Rd / Langston Pl



2.2.3 Traffic Demand

The traffic demand data for the year 2023 was utilized for all construction scenarios , except for Stage 5B. For Stage 5B, the scenario was also modelled using 80% of the demand to account for the reduced traffic typically experienced during the Christmas and New Year shut-down periods.

2.3 Construction Scenario Results

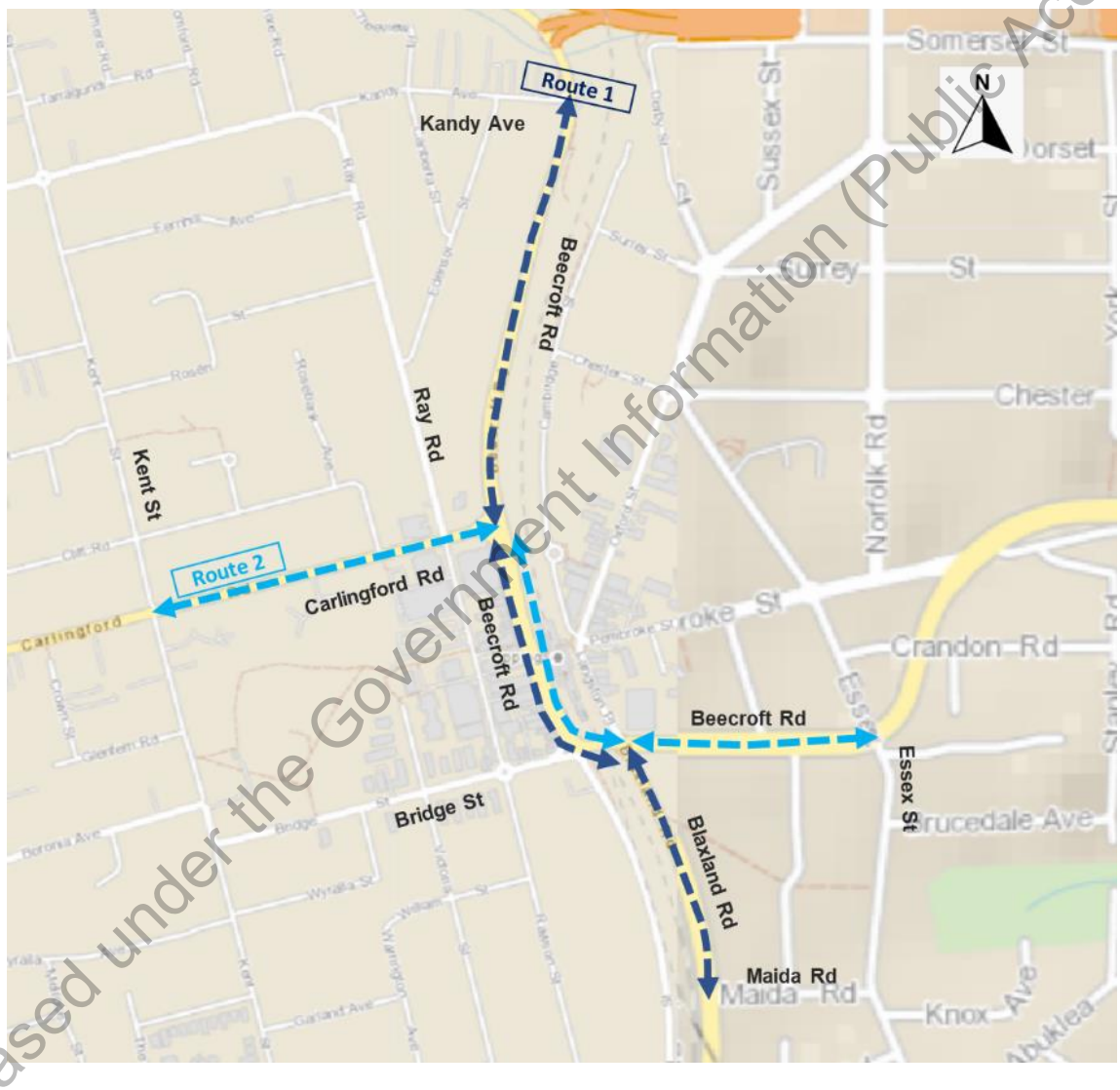
This section details the model performance in terms of travel time, network statistics, intersection performances including vehicle delay and Level of Service for all construction stages including 2023 base case.

2.3.1 VISSIM Travel Time Comparison

Travel times have been extracted for all the construction stages during AM and PM peak periods for two routes within the model area which are shown in Figure 2-3 and listed below:

- Route 1: Beecroft Road, Blaxland Road (Northbound and Southbound)
- Route 2: Carlingford Road, Beecroft Road and Epping Road (Eastbound and Westbound)

Figure 2-3 Travel Time Routes



The travel time comparison for the above-mentioned routes are provided in **Table 2-1**. Also, the cumulative travel time graphs for each route are provided in **Figure 2-4** to **Figure 2-11**.

Table 2-1 Construction Stages Travel Time Summary - AM and PM Peaks

Route	From	To	2023 Base Year	Stage 1A	Stage 4A	Stage 5B	Stage5B(80 %Demand)	Stage 6
AM Peak (07:30-08:30)								
Beecroft Rd (Northbound)	Maida Rd	Epping Rd	00:45	00:50	00:49	00:44	00:44	00:48
	Epping Rd	Carlingford Rd	00:55	01:04	01:07	01:16	01:14	01:06
	Carlingford Rd	Kandy Ave	00:40	00:46	00:46	00:46	00:46	00:46
	Overall		**02:20**	**02:40**	**02:41**	**02:46**	**02:44**	**02:40**
Beecroft Rd (Southbound)	Kandy Ave	Carlingford Rd	01:04	01:08	01:08	01:12	01:07	01:08
	Carlingford Rd	Blaxland Rd	02:34	02:36	02:31	02:17	01:11	02:10
	Blaxland Rd	Maida Rd	00:25	00:35	00:35	00:34	00:34	00:35
	Overall		**04:03**	**04:19**	**04:14**	**04:03**	**02:51**	**03:53**
Carlingford Rd/Epping Rd (Eastbound)	Kent St	Beecroft Rd	03:34	03:26	04:27	08:08	01:16	02:25
	Beecroft Rd	Blaxland Rd	00:54	00:57	00:57	01:32	01:15	00:56
	Blaxland Rd	Essex St	00:48	00:51	00:49	00:43	00:38	00:50
	Overall		**05:16**	**05:15**	**06:13**	**10:23**	**03:09**	**04:11**
Carlingford Rd/Epping Rd (Westbound)	Essex St	Blaxland Rd	01:32	01:47	01:46	02:52	01:20	01:33
	Blaxland Rd	Carlingford Rd	00:49	00:50	00:55	01:02	01:00	00:55
	Carlingford Rd	Kent St	00:46	00:51	00:51	00:43	00:41	00:52
	Overall		**03:07**	**03:29**	**03:32**	**04:38**	**03:00**	**03:20**
PM Peak (17:00-18:00)								
Beecroft Rd (Northbound)	Maida Rd	Epping Rd	01:11	01:18	01:26	01:12	01:04	01:14
	Epping Rd	Carlingford Rd	00:57	01:00	01:01	01:03	01:00	01:00
	Carlingford Rd	Kandy Ave	00:40	00:46	00:46	00:46	00:46	00:46
	Overall		**02:48**	**03:04**	**03:13**	**03:01**	**02:50**	**03:00**
Beecroft Rd (Southbound)	Kandy Ave	Carlingford Rd	00:54	00:57	00:57	00:58	00:58	00:57
	Carlingford Rd	Blaxland Rd	07:00	07:22	08:42	01:58	01:26	07:16
	Blaxland Rd	Maida Rd	00:25	00:35	00:35	00:34	00:34	00:35
	Overall		**08:19**	**08:54**	**10:14**	**03:30**	**02:57**	**08:48**
Carlingford Rd/Epping Rd (Eastbound)	Kent St	Beecroft Rd	01:30	01:32	01:39	01:38	01:22	01:42
	Beecroft Rd	Blaxland Rd	00:40	00:44	00:44	01:22	01:07	00:44
	Blaxland Rd	Essex St	00:42	00:44	00:44	00:48	00:43	00:44
	Overall		**02:52**	**03:00**	**03:06**	**03:48**	**03:12**	**03:10**
Carlingford Rd/Epping Rd (Westbound)	Essex St	Blaxland Rd	01:20	01:40	01:35	01:27	01:16	01:22
	Blaxland Rd	Carlingford Rd	01:07	01:09	01:09	01:09	01:03	01:09
	Carlingford Rd	Kent St	00:46	00:50	00:50	00:51	00:44	00:49
	Overall		**03:13**	**03:39**	**03:35**	**03:27**	**03:03**	**03:20**

Figure 2-4 Construction Stage Travel Time Plot - Beecroft Rd (Northbound) - AM Peak (07:30 - 08:30)

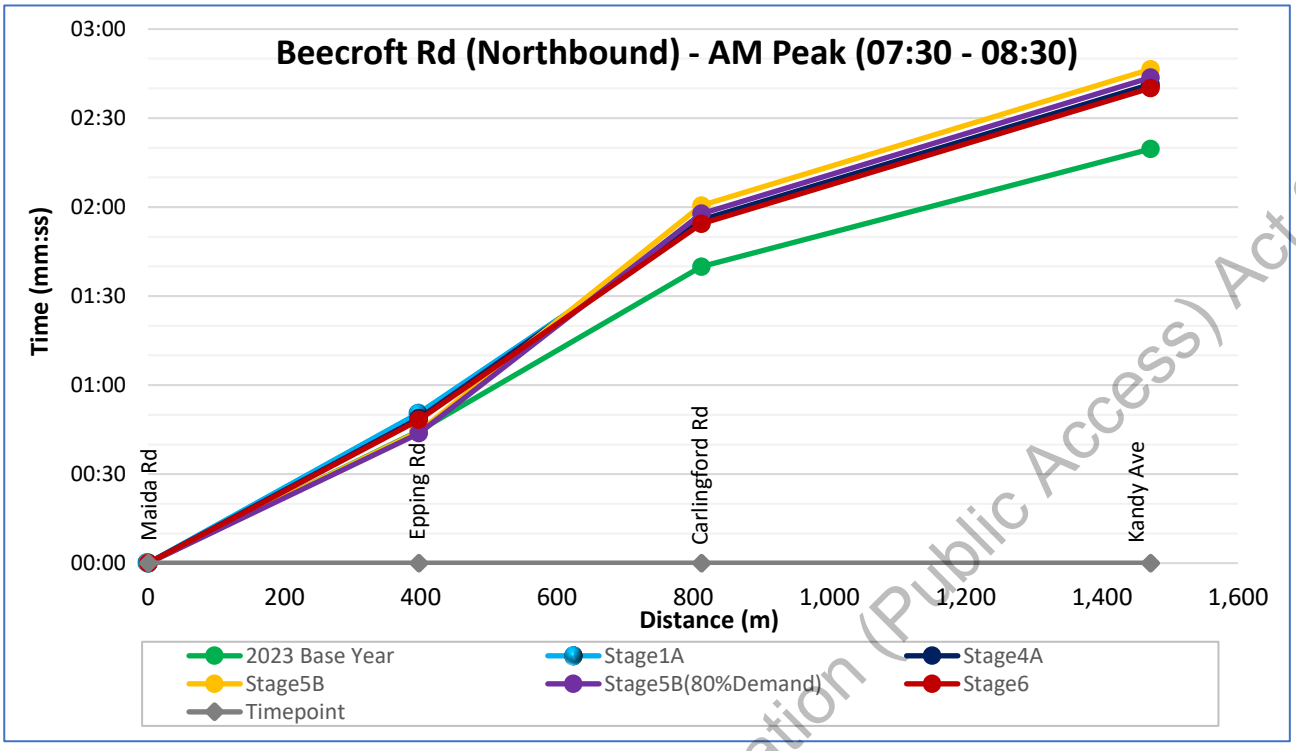


Figure 2-5 Construction Stage Travel Time Plot - Beecroft Rd (Southbound) - AM Peak (07:30 - 8:30)

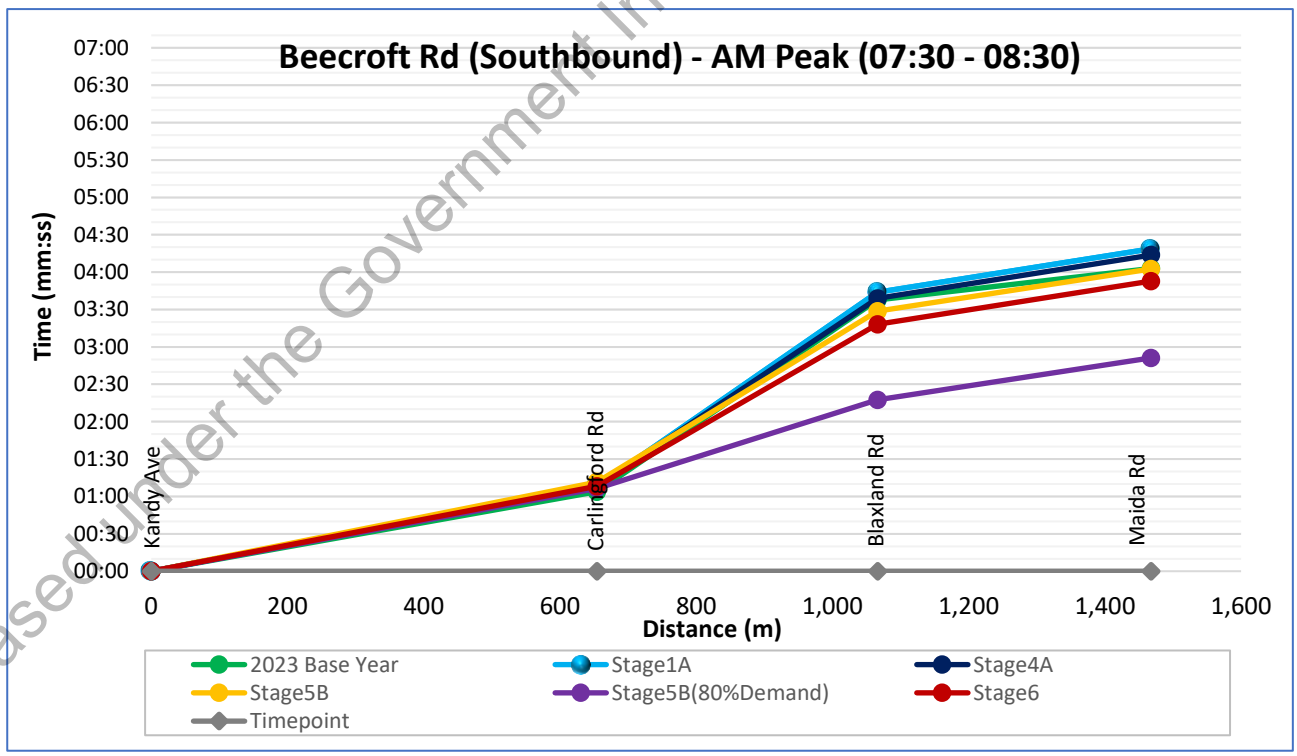


Figure 2-6 Construction Stage Travel Time Plot - Beecroft Rd (Northbound) - PM Peak (17:00 - 18:00)

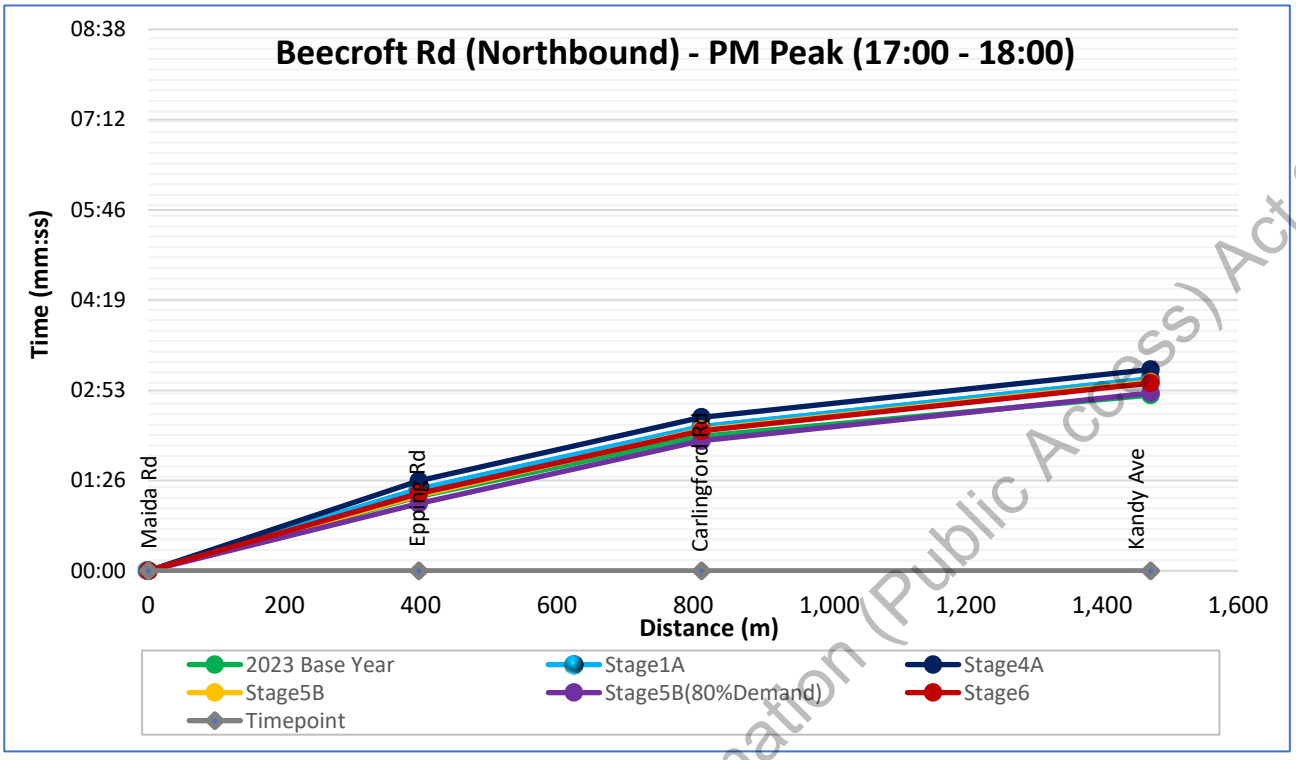


Figure 2-7 Construction Stage Travel Time Plot - Beecroft Rd (Southbound) - PM Peak (17:00 - 18:00)

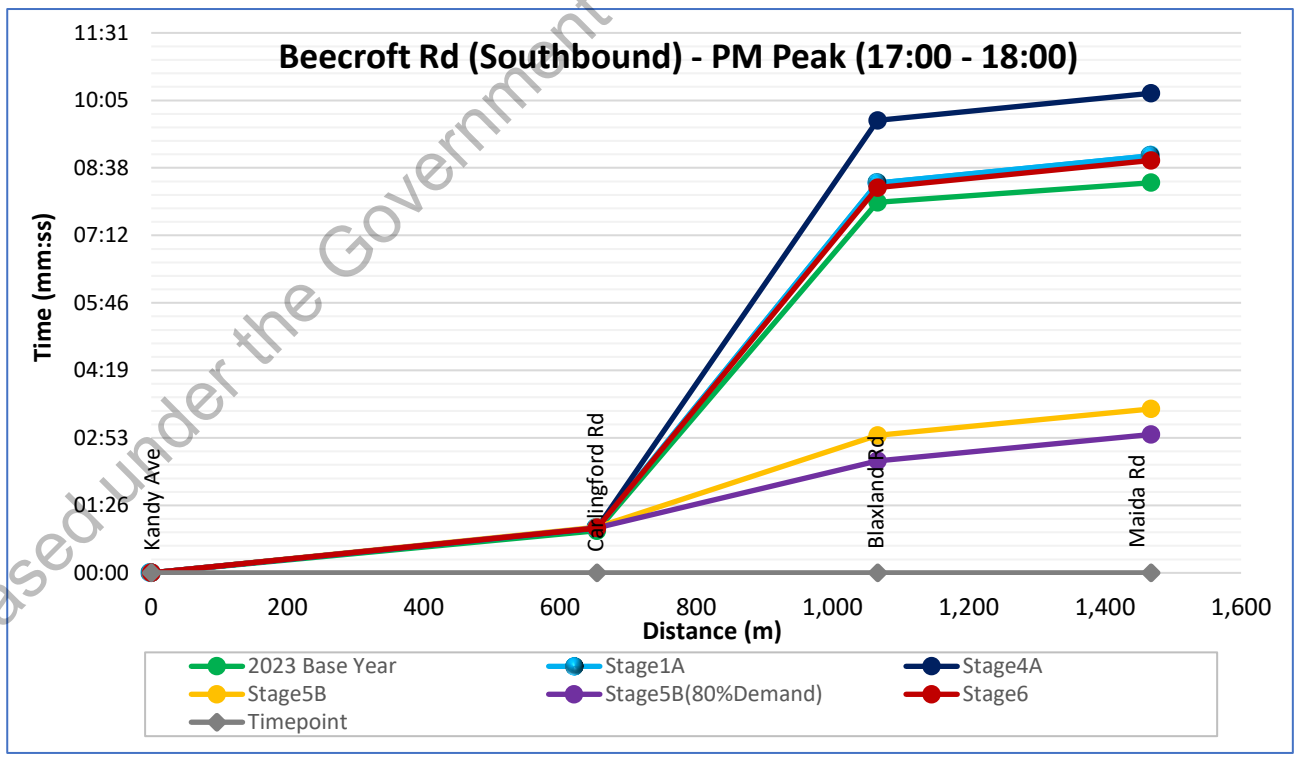


Figure 2-8 Construction Stage Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- AM Peak (07:30 - 08:30)

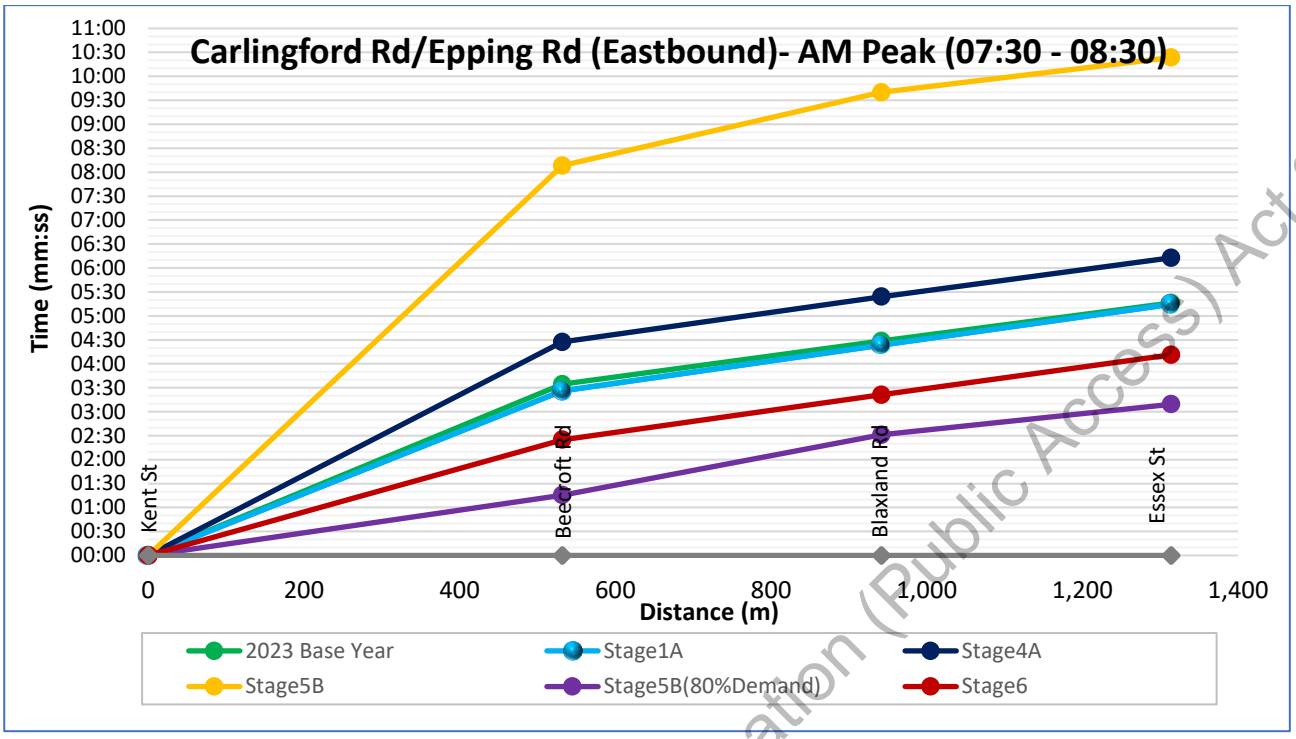


Figure 2-9 Construction Stage Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- AM Peak (07:30 - 08:30)

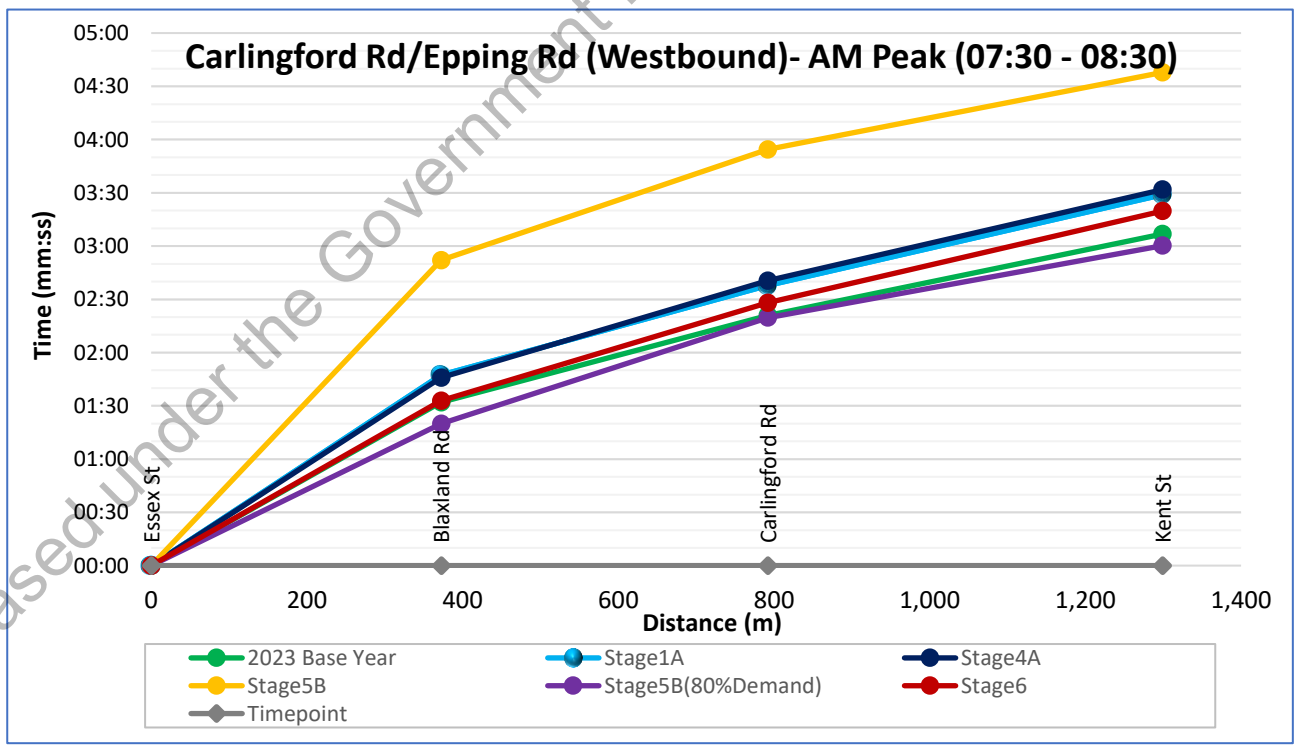


Figure 2-10 Construction Stage Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- PM Peak (17:00 - 18:00)

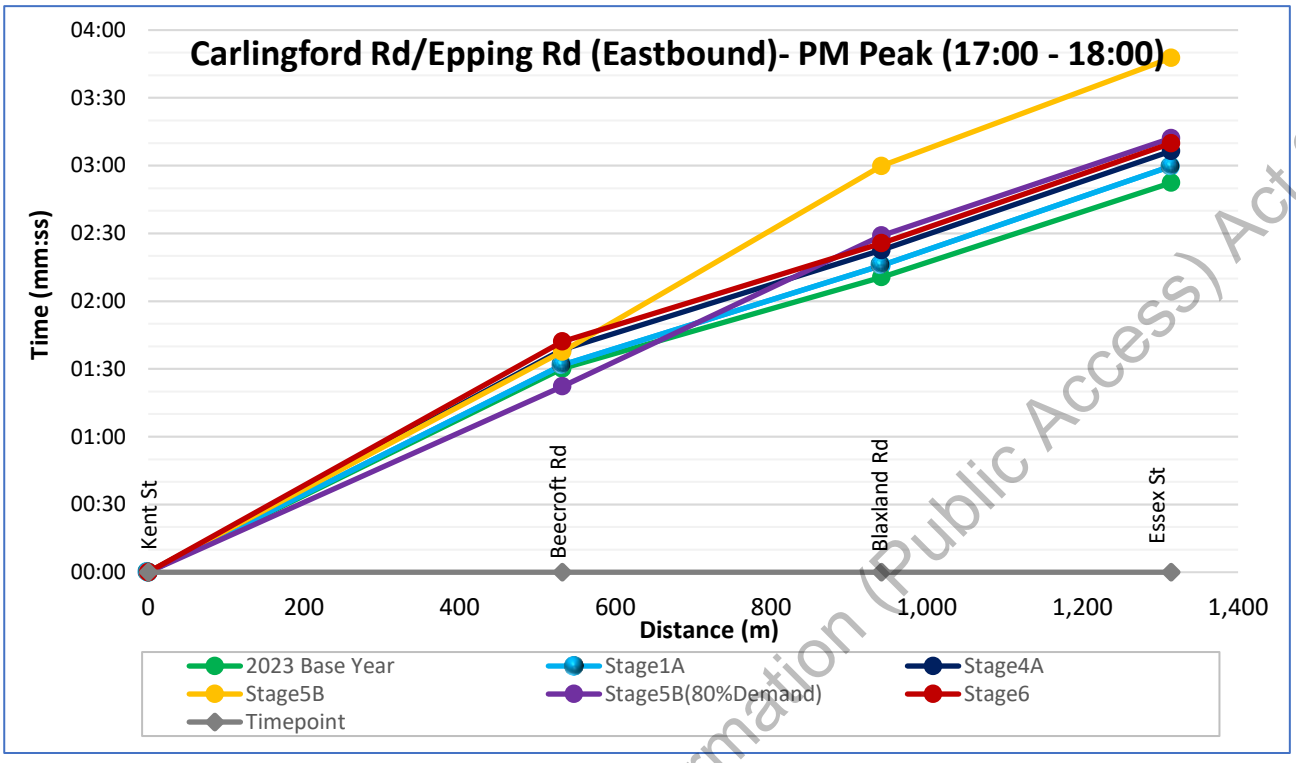
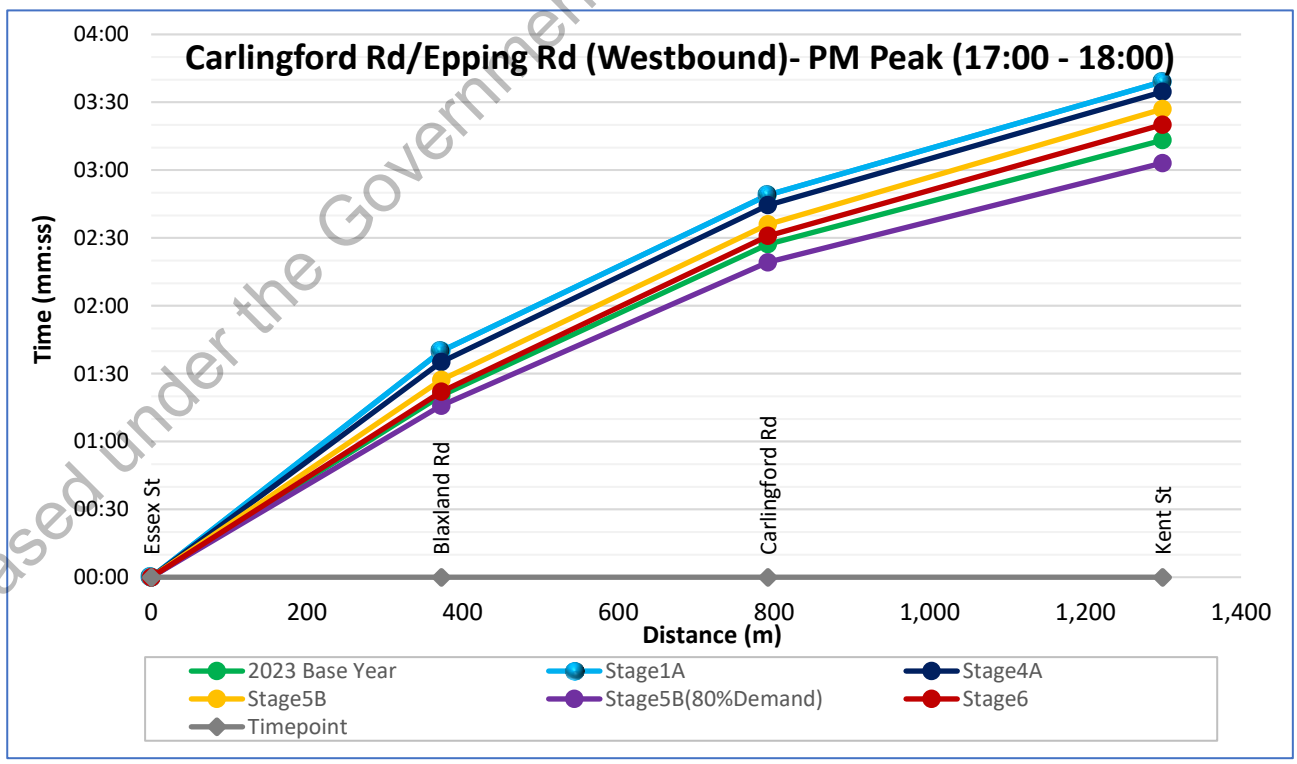


Figure 2-11 Construction Stage Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- PM Peak (17:00 - 18:00)



The key observations from the AM Peak hour VISSIM construction staging analysis include:

- The travel times along Beecroft Road northbound and southbound are approximately 10 to 30 seconds higher in all the construction stages compared to the 2023 base year except Stage 5B.
- The travel times along Carlingford Rd/Epping Rd eastbound are higher (approximately 60 seconds to 120 seconds in all the construction stages compared to the 2023 base year except Stage 1A and Stage 5B. In Stage 5B it yields 300 seconds due to a reduction in lane capacity (no dedicated right tun lane onto Blaxland Road) along Epping Bridge.
- The travel times along Carlingford Rd/Epping Rd westbound are slightly higher(approximately 10 seconds to 25 seconds) higher in all the construction stages compared to the 2023 base year except Stage 5B, which yields approximately 100 seconds.
- As expected, the travel times experienced in Stage 5B (80% Demand) are generally similar or lower than the 2023 base year.

The key observations from the PM Peak hour VISSIM construction staging analysis include:

- The travel times along Beecroft Road northbound are slightly higher (approximately 10 seconds to 25 seconds) higher in all the construction stages compared to the 2023 base year except Stage 5B.
- The travel times along Beecroft Road southbound are approximately 120 seconds higher in Stage 4A and approximately 30 seconds higher in Stage 6. All other scenarios show reduced travel times when compared to the 2023 base year.
- The travel times along Carlingford Rd/Epping Rd eastbound are slightly higher (approximately 10 seconds to 25 seconds) higher in all the construction stages compared to the 2023 base year except Stage 5B, which yields approximately 60 seconds.
- The travel times along Carlingford Rd/Epping Rd westbound are approximately 10 to 25 seconds higher in all the construction stages compared to the 2023 base year.
- As expected, the travel times experienced in Stage 5B (80% Demand) are generally similar or lower than the 2023 base year.

2.3.2 VISSIM Network Performance Summary

The network performance statistics indicate the efficiency of road network. For instance, models showing a comparatively higher level of vehicle stops typically represent high levels of congestion, which generally reduce throughput and increase greenhouse emissions (due to the increased stop/start nature of the driving). Conversely, a comparatively low VHT typically represents a network with a relatively low level of congestion and is generally be correlated with a low level of vehicle stops.

Table 2-2 presents the key network performance parameters for the following:

- Total distance travelled by all vehicles within the modelled network (VKT);
- Total travel time by all vehicles within the modelled network (VHT); and
- The average speed of vehicle trips on all roads within the microsimulation model;
- The average delay of vehicle trips on all roads within the microsimulation model;
- The total completed vehicle trips on all roads within the microsimulation model;
- Unreleased trips (Latent Demand) – demand that could not be released in the peak hour;
- The average number of vehicle stops on all roads within the microsimulation models.

The key observations from VISSIM assessment of network performance include:

- The average network speeds are comparatively lower in both AM and PM peaks for all construction scenarios compared to the 2023 base year except Stage 5B (80% Demand). This is due to reduced speed limits in construction scenarios and network alignments mentioned in the scenario description.
- All the construction stages yield similar or slightly higher average delays when compared to the 2023 base year except Stage 5B (80% Demand).
- In the AM peak, during the construction Stage 5B there are unreleased trips due to the removal of dedicated right turn lane on to Blaxland Road at Epping Rd/ Blaxland Rd/Langston Place intersection.

Table 2-2 Construction Stages - Network Performance Summary - AM and PM Peaks

Model Performance Parameters	2023 Base Year	Stage1A	Stage4A	Stage5B	Stage5B(80%Demand)	Stage6
AM Peak (07:30-08:30)						
Vehicle kilometres travelled (VKT) km	9651	9684	9601	9046	7755	9645
Vehicle hours travelled (VHT) Hours	369	387	404	572	263	361
Average network speed (km/h)	26	25	24	16	29	27
Average network delay (s)	111.9	102.9	113.2	217.2	71.3	89.4
Completed trips	6119	6154	6073	5759	4901	6122
Unreleased trips	5	3	5	300	0	4
Average Number of vehicle-stops	3.12	3.04	3.51	7.54	2.14	2.67
PM Peak (17:00-18:00)						
Vehicle kilometres travelled (VKT) km	9563	9610	9568	9579	7706	9570
Vehicle hours travelled (VHT) Hours	345	376	383	365	254	370
Average network speed (km/h)	28	26	25	26	30	26
Average network delay (s)	97.5	96.3	100.5	91.6	65.2	94.0
Completed trips	6252	6305	6247	6246	5041	6266
Unreleased trips	0	0	0	0	0	0
Average Number of vehicle-stops	2.29	2.48	2.52	2.65	1.83	2.50

2.3.3 VISSIM Intersection Performance

Table 2-3 summarises the overall intersection performance in terms of delay and LOS based on the TfNSW method, indicated below. **Appendix B** shows detailed results of each movement and approach wise performances.

LOS	Delay (sec)	
	Low	High
A	0	14
B	15	28
C	29	42
D	43	56
E	57	70
F	>71	

The key observations from the AM Peak Hour VISSIM intersection performance assessment during construction staging, include:

- Carlingford Road / Ray Road / Rawson Street intersection yields LOS F across all scenarios except Stage 5B (80% Demand) and Stage 6, in Stage 6 it operates with LOS E.
- Bridge Street / Rawson Street and Epping Rd / Blaxland Rd / Langston Pl intersections performs at LOS E, with all other scenarios yielding LOS D or better.
- Other than above mentioned all the intersections perform satisfactorily at LOS D or better.

The key observations from the PM Peak Hour VISSIM intersection performance assessment during construction staging, include:

- Bridge Street / Rawson Street intersection performs at LOS F in Stage 5B and LOS E in Stage 6, with all other scenarios yielding LOS D or better.
- Beecroft Road / High Street / Bridge Street intersection perform at LOS F in both Stage 5B and Stage 6, with all other scenarios yielding LOS D or better.
- In Stage 4A, Epping Rd / Blaxland Rd / Langston Pl intersection performs at LOS E, with all other scenarios yielding LOS D or better.
- Other than above mentioned all the intersections perform satisfactorily at LOS D or better.

Table 2-3: Intersection Performance Comparison - Construction Stages - AM and PM Peak (VISSIM)

Intersection Name	2023 Base Year			Stage1A			Stage4A			Stage5B			Stage5B(80%Demand)			Stage6		
	Total vehicles	Avg. Delay (S)	LoS	Total vehicles	Avg. Delay (S)	LoS	Total vehicles	Avg. Delay (S)	LoS	Total vehicles	Avg. Delay (S)	LoS	Total vehicles	Avg. Delay (S)	LoS	Total vehicles	Avg. Delay (S)	LoS
AM Peak (07:30 - 08:30)																		
Carlingford Rd & Ray Rd & Rawson St	2,726	79.8	F	2,756	75.2	F	2,702	88.5	F	2,417	112.9	F	2,166	29.7	C	2,739	65.7	E
Beecroft Rd & Carlingford Rd	4,530	24.5	B	4,564	22.1	B	4,498	22.8	B	4,213	32.7	C	3,610	25.3	B	4,543	22.8	B
Bridge Street / Rawson Street	987	40.7	C	985	39.5	C	982	54.2	D	975	66.0	E	804	29.7	C	986	46.8	D
Beecroft Road / High Street / Bridge Street	1,947	12.0	A	1,947	16.8	B	1,929	15.7	B	1,904	19.4	B	1,590	14.4	A	1,948	17.4	B
Epping Rd & Blaxland Rd & Langston Pl	4,817	42.8	C	4,844	41.1	C	4,781	40.1	C	4,442	60.1	E	3,849	36.3	C	4,829	34.0	C
Epping Rd & Essex St	3,237	32.3	C	3,267	28.0	B	3,223	27.1	B	2,994	27.5	B	2,599	18.8	B	3,255	27.7	B
PM Peak (17:00 - 18:00)																		
Carlingford Rd & Ray Rd & Rawson St	2,726	30.6	C	2,748	31.0	C	2,729	33.8	C	2,711	34.2	C	2,180	25.2	B	2,732	33.8	C
Beecroft Rd & Carlingford Rd	4,423	28.5	B	4,458	25.7	B	4,432	24.9	B	4,414	25.8	B	3,548	23.3	B	4,433	24.5	B
Bridge Street / Rawson Street	969	45.2	D	976	46.2	D	970	39.9	C	985	91.9	F	786	33.5	C	975	61.7	E
Beecroft Road / High Street / Bridge Street	2,645	26.3	B	2,682	55.4	D	2,646	40.9	C	2,651	77.5	F	2,141	17.5	B	2,653	85.5	F
Epping Rd & Blaxland Rd & Langston Pl	4,782	51.5	D	4,822	54.8	D	4,784	57.4	E	4,745	43.4	D	3,826	31.6	C	4,787	48.1	D
Epping Rd & Essex St	3,178	40.9	C	3,187	37.2	C	3,181	37.7	C	3,166	38.7	C	2,551	25.4	B	3,184	35.8	C

2.3.4 SIDRA Intersection Performance

The forecast effects of the lane configuration changes during the critical construction stages was modelled in SIDRA. The SIDRA performance results for each stage, during the AM and PM peak hours, are presented in Table 2-4 and Table 2-5. The SIDRA analysis provides a sensitivity check for the VISSIM analysis.

Table 2-4 AM Peak Hour Intersection Performance During Construction

Stages	Performance Criteria	Carlingford Rd & Ray Rd & Rawson St	Beecroft Rd & Carlingford Rd	Bridge St & Rawson St	Beecroft Rd & High St	Epping Rd & Blaxland Rd	Epping Rd & Essex St
2023 (Base)	DoS	1.0	0.9	0.8	0.9	1.1	0.9
	LoS	E	C	B	B	C	B
	95th% Q (veh)	58	24	8	3	29	19
Stage 1A	DoS	1.0	1.1	0.8	0.9	1.0	1.0
	LoS	E	C	B	B	B	B
	95th% Q (veh)	36	15	3	1	23	15
Stage 4A	DoS	1.0	1.1	0.8	0.9	1.0	1.0
	LoS	E	C	B	B	B	B
	95th% Q (veh)	36	15	3	1	27	15
Stage 5B	DoS	1.0	1.2	0.8	1.0	1.1	0.9
	LoS	E	F	B	D	E	B
	95th% Q (veh)	36	37	3	3	33	14
Stage 5B (80%)	DoS	0.8	0.7	0.6	0.6	1.0	0.7
	LoS	B	B	A	A	B	B
	95th% Q (veh)	13	10	2	1	18	8
Stage 6	DoS	1.0	1.1	0.8	0.9	1.0	1.0
	LoS	E	C	B	B	C	C
	95th% Q (veh)	36	15	3	1	29	15

Table 2-5 PM Peak Hour Intersection Performance During Construction

Stages	Performance Criteria	Carlingford Rd & Ray Rd & Rawson St	Beecroft Rd & Carlingford Rd	Bridge St & Rawson St	Beecroft Rd & High St	Epping Rd & Blaxland Rd	Epping Rd & Essex St
2023 (Base)	DoS	1.0	1.0	0.7	1.0	1.2	0.9
	LoS	C	C	A	E	C	C
	95th% Q (veh)	31	26	10	7	43	31
Stage 1A	DoS	0.9	1.0	0.9	1.0	0.9	0.9
	LoS	C	C	A	C	C	C
	95th% Q (veh)	22	20	5	2	27	19
Stage 4A	DoS	0.9	1.0	0.7	1.8	0.9	1.0
	LoS	C	C	A	F	C	D
	95th% Q (veh)	22	18	5	10	31	19
Stage 5B	DoS	0.9	1.1	0.7	1.1	1.0	1.4
	LoS	C	E	A	F	C	F
	95th% Q (veh)	22	43	4	5	36	28
Stage 5B (80%)	DoS	0.9	0.7	0.5	0.7	0.9	0.9
	LoS	B	B	A	A	B	C
	95th% Q (veh)	16	7	3	1	17	12
Stage 6	DoS	0.9	1.0	0.7	1.0	0.9	1.1
	LoS	C	D	A	C	C	D
	95th% Q (veh)	22	40	4	2	31	20

The key observations from the SIDRA intersection performance assessment during construction staging include:

- The Carlingford Road, Ray Road and Rawson St intersection shows very little effects caused by the roadwork. The intersection LOS change from E to B in Stage 5B where 20% flow reduction is expected during the Christmas break.
- The left turn traffic from Bridge Street has a better level of service during the construction. The gap acceptance improved due to lower operation speed on Beecroft Road from 60km/hr to 40km/hr.
- In Option 5B with the lane reduction to two lanes on the west approach of the Blaxland Road intersection, the queue extends back to the Carlingford Road and Beecroft Road intersection in the morning peak. In the PM peak, the queue extends from Blaxland Road to Essex Road intersection with the tidal flow westbound.
- The operation becomes acceptable to schedule Stage 5B during the Christmas break with 20% flow reduction. The LOS B, or better, in the AM peak and LOS C in the PM peak.

3 Future Options Testing

The objective of future scenarios is to assess the traffic performance With and Without project at opening year 2029 and 10-years after opening. The future performance was assessed using the VISSIM and SIDRA modelling software.

3.1 Scenario Description

The following AM and PM peak scenarios were assessed along with the base case model:

- 2029 Without Project
  - Existing road network and optimised signal times
- 2029 With Project Case
  - Network upgrades
    - An additional westbound traffic lane across bridge deck
    - An additional right turn lane southbound onto Blaxland Road
    - A wider pedestrian and bicycle shared path
    - Stagged pedestrian crossing on the eastern approach of Epping Road, Blaxland Road and Langston Place intersection
  - Signal optimisation
- 2039 Without Project
  - Existing road network and optimised signal times
- 2039 With Project
  - Network upgrades same as 2029 Project Case
  - Signal optimisation

The project case drawing is presented in **Appendix C.**

3.2 Assumptions

3.2.1 Future Traffic Demand

The future traffic growth has been estimated based on available STFM outputs for the study area. To develop demand forecasts for 2029 and 2039, STFM's future zone to zone growth rates are applied to the existing travel patterns. This method ensures that zone-to-zone growth is considered, providing an accurate representation of the travel patterns.

3.2.2 Future Active Transport Demand

- A factor of 1.08 for 2029 and 1.18 for 2039 is applied to existing pedestrian flows.
- A factor of 1.07 for 2029 and 1.19 for 2039 is applied to existing cycles.

3.2.3 Signal Phasing

Signal optimization was tested for all future scenarios in the SIDRA models. The updated signal offsets and green splits were initially adopted in the VISSIM models as a starting point, and then refined. A key strategy to maximising network benefits was to favour inbound (eastbound) coordination along Carlingford Road and Beecroft Road, even during the PM peak. Outbound coordination was less effective due to the downstream bottleneck at Carlingford Road, Ray Road and Rawson Street. Additionally, some of the intersections were further optimized to balance traffic congestion in the network wherever applicable.

3.3 Future Year Results

This section details the model performance in terms of travel time, network statistics, intersection performances including delay and LOS for all future year scenarios including 2023 base case.

3.3.1 VISSIM Travel Time Comparison

Travel times have been extracted for all the future year scenarios during AM and PM peak periods for two routes and provided in Table 3-1 and Table 3-2**.** Also, the cumulative travel time graphs for each route are provided in Figure 3-1 to Figure 3-8.

Table 3-1 Future Year Scenarios Travel Time Summary - AM Peaks

Route	From	To	2023 Base Year	2029 Without Project	2029 With Project	2039 Without Project	2039 With Project
Beecroft Rd (Northbound)	Maida Rd	Epping Rd	00:45	00:45	00:44	00:45	00:44
	Epping Rd	Carlingford Rd	00:55	00:55	00:54	00:57	00:55
	Carlingford Rd	Kandy Ave	00:40	00:40	00:40	00:40	00:40
		Total	**02:20**	**02:19**	**02:17**	**02:21**	**02:19**
Beecroft Rd (Southbound)	Kandy Ave	Carlingford Rd	01:04	01:04	01:05	01:05	01:06
	Carlingford Rd	Blaxland Rd	02:34	02:47	01:11	02:21	01:10
	Blaxland Rd	Maida Rd	00:25	00:25	00:25	00:25	00:25
		Total	**04:03**	**04:16**	**02:41**	**03:51**	**02:41**
Carlingford Rd/Epping Rd (Eastbound)	Kent St	Beecroft Rd	03:34	05:02	01:27	04:25	01:27
	Beecroft Rd	Blaxland Rd	00:54	00:55	00:56	00:56	00:58
	Blaxland Rd	Essex St	00:48	00:49	00:42	00:47	01:13
		Total	**05:16**	**06:46**	**03:05**	**06:08**	**03:39**
Carlingford Rd/Epping Rd (Westbound)	Essex St	Blaxland Rd	01:32	01:31	01:33	01:36	01:38
	Blaxland Rd	Carlingford Rd	00:49	00:53	00:49	00:51	00:54
	Carlingford Rd	Kent St	00:46	00:48	00:45	00:48	00:46
		Total	**03:07**	**03:12**	**03:07**	**03:15**	**03:18**

Table 3-2 Future year Scenario travel Time Summary – PM Peaks

Route	From	To	2023 Base Year	2029 Without Project	2029 With Project	2039 Without Project	2039 With Project
Beecroft Rd (Northbound)	Maida Rd	Epping Rd	01:11	01:09	01:04	03:01	01:35
	Epping Rd	Carlingford Rd	00:57	01:00	00:56	01:12	01:12
	Carlingford Rd	Kandy Ave	00:40	00:40	00:40	00:39	00:39
		Total	**02:48**	**02:49**	**02:39**	**04:52**	**03:27**
Beecroft Rd (Southbound)	Kandy Ave	Carlingford Rd	00:54	01:05	00:56	03:26	00:59
	Carlingford Rd	Blaxland Rd	07:00	09:49	01:05	12:31	01:08
	Blaxland Rd	Maida Rd	00:25	00:25	00:25	00:25	00:25
		Total	**08:19**	**11:18**	**02:26**	**16:22**	**02:33**
Carlingford Rd/Epping Rd (Eastbound)	Kent St	Beecroft Rd	01:30	03:59	01:38	07:16	06:11
	Beecroft Rd	Blaxland Rd	00:40	00:43	00:44	00:47	00:43
	Blaxland Rd	Essex St	00:42	00:38	00:29	00:34	00:28
		Total	**02:52**	**05:21**	**02:51**	**08:37**	**07:22**
Carlingford Rd/Epping Rd (Westbound)	Essex St	Blaxland Rd	01:20	01:23	00:43	02:39	00:47
	Blaxland Rd	Carlingford Rd	01:07	01:03	00:59	01:34	01:19
	Carlingford Rd	Kent St	00:46	00:44	00:45	00:49	00:49
		Total	**03:13**	**03:10**	**02:27**	**05:03**	**02:54**

Figure 3-1 Future Scenario Travel Time Plot - Beecroft Rd (Northbound) - AM Peak (07:30 - 08:30)

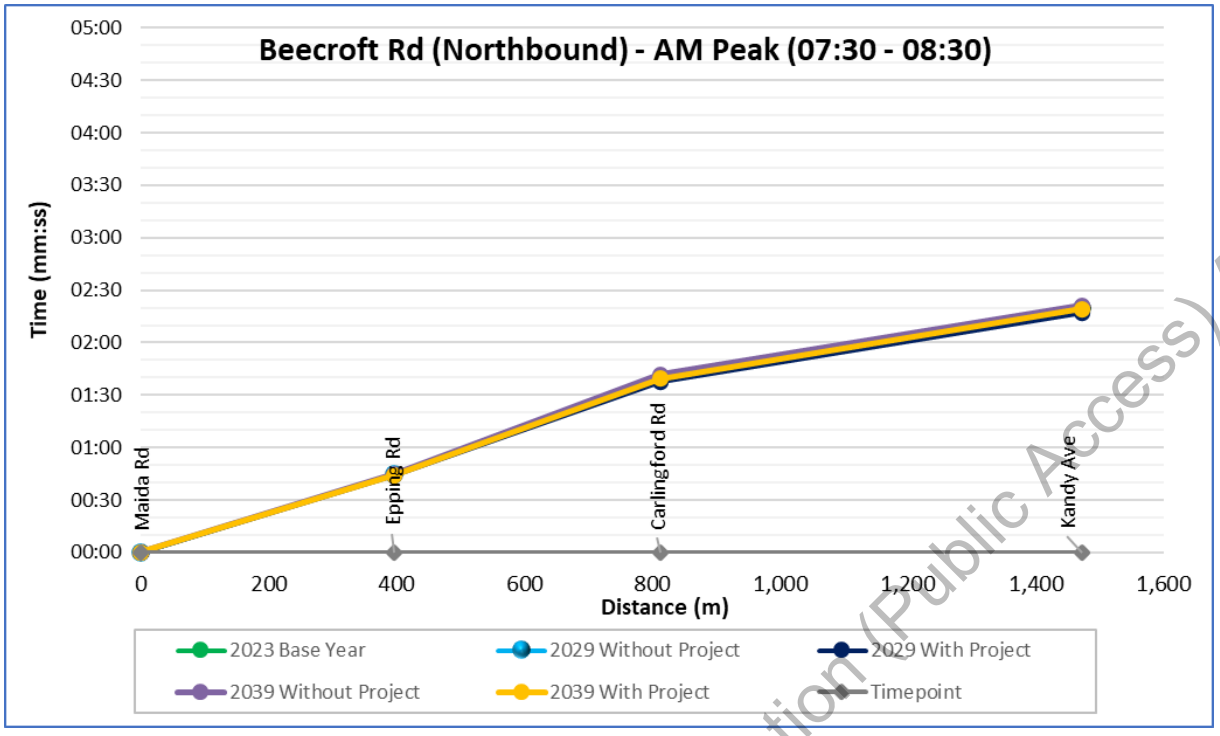


Figure 3-2 Future Scenario Travel Time Plot - Beecroft Rd (Southbound) - AM Peak (07:30 - 08:30)

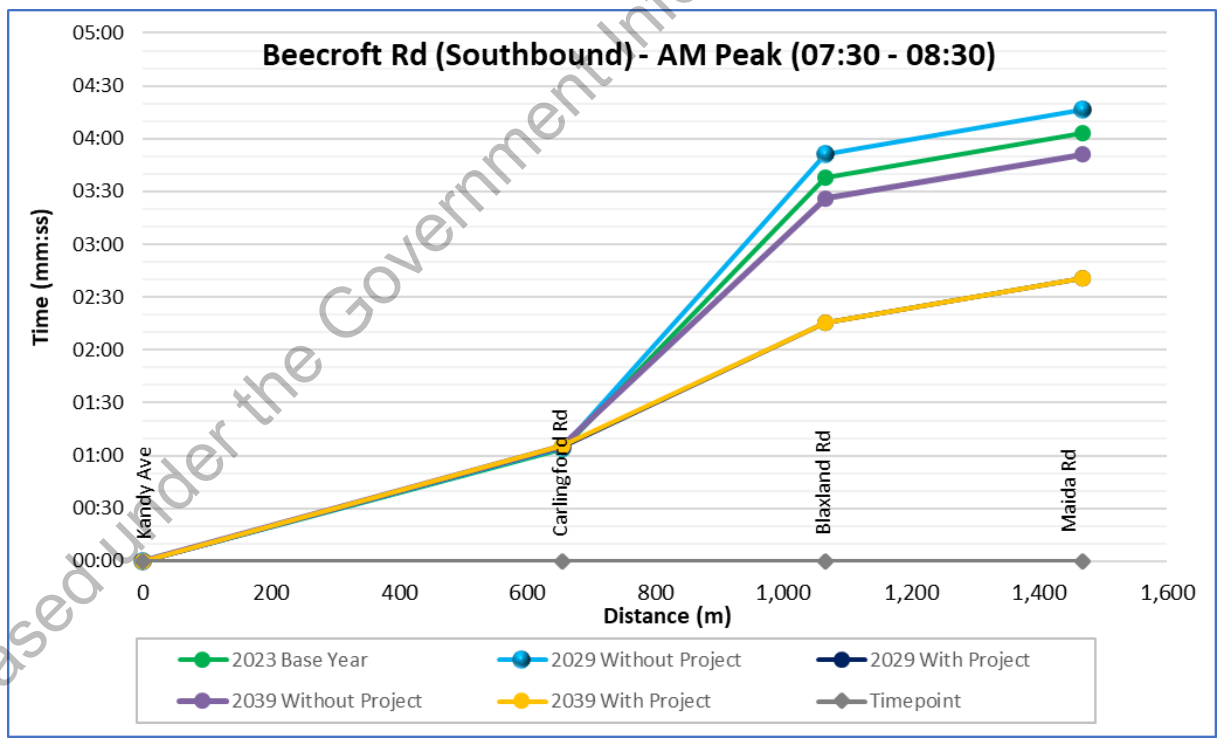


Figure 3-3 Future Scenario Travel Time Plot - Beecroft Rd (Northbound) - PM Peak (17:00 - 18:00)

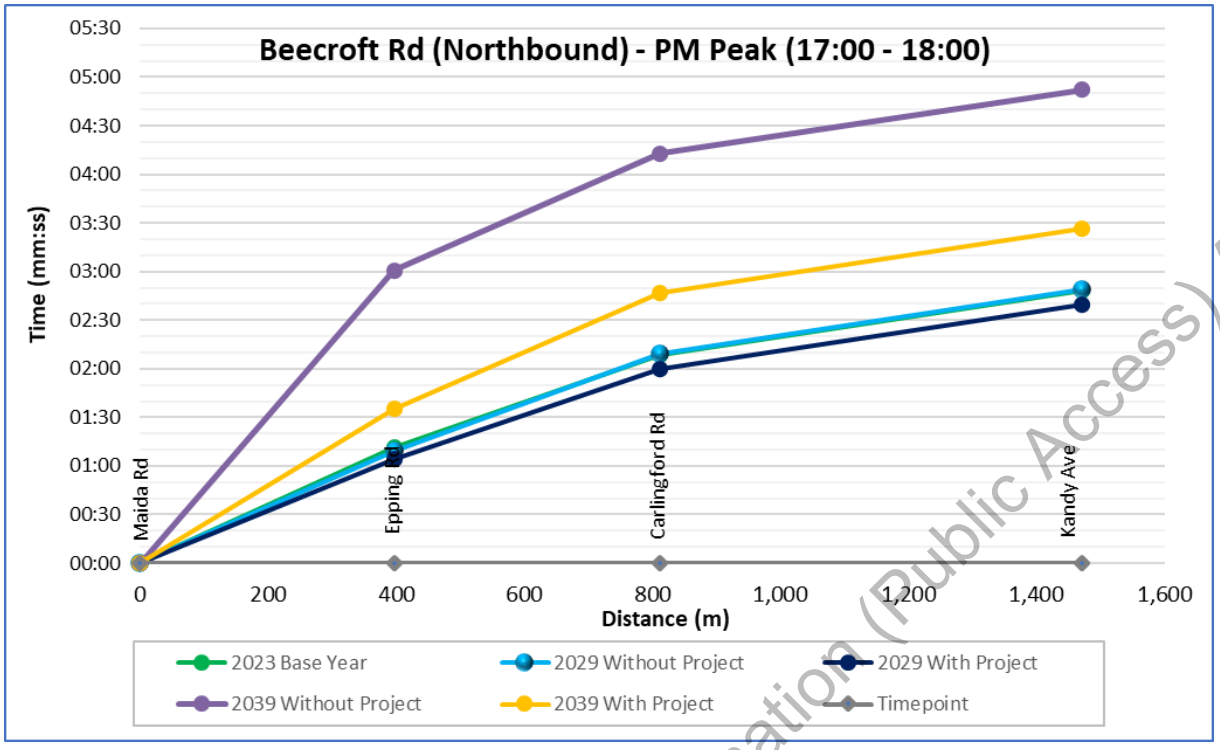


Figure 3-4 Future Scenario Travel Time Plot - Beecroft Rd (Southbound) - PM Peak (17:00 - 18:00)

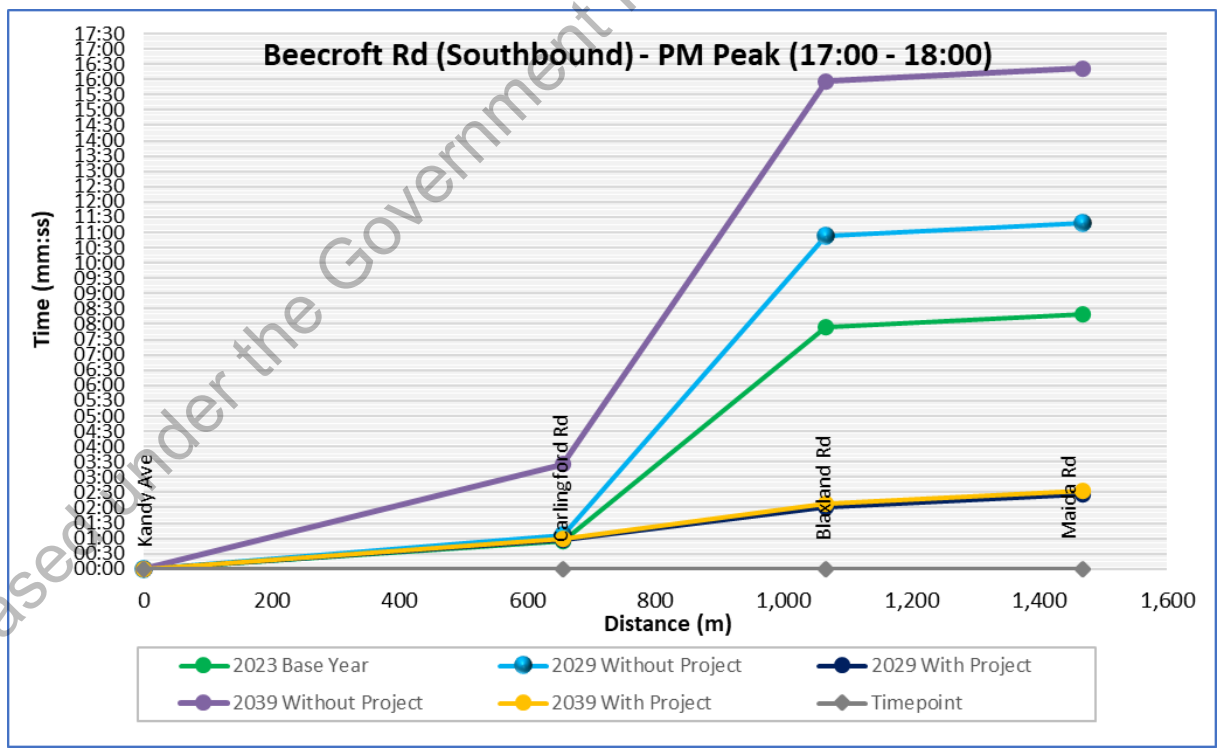


Figure 3-5 Future Scenario Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- AM Peak (07:30 - 08:30)

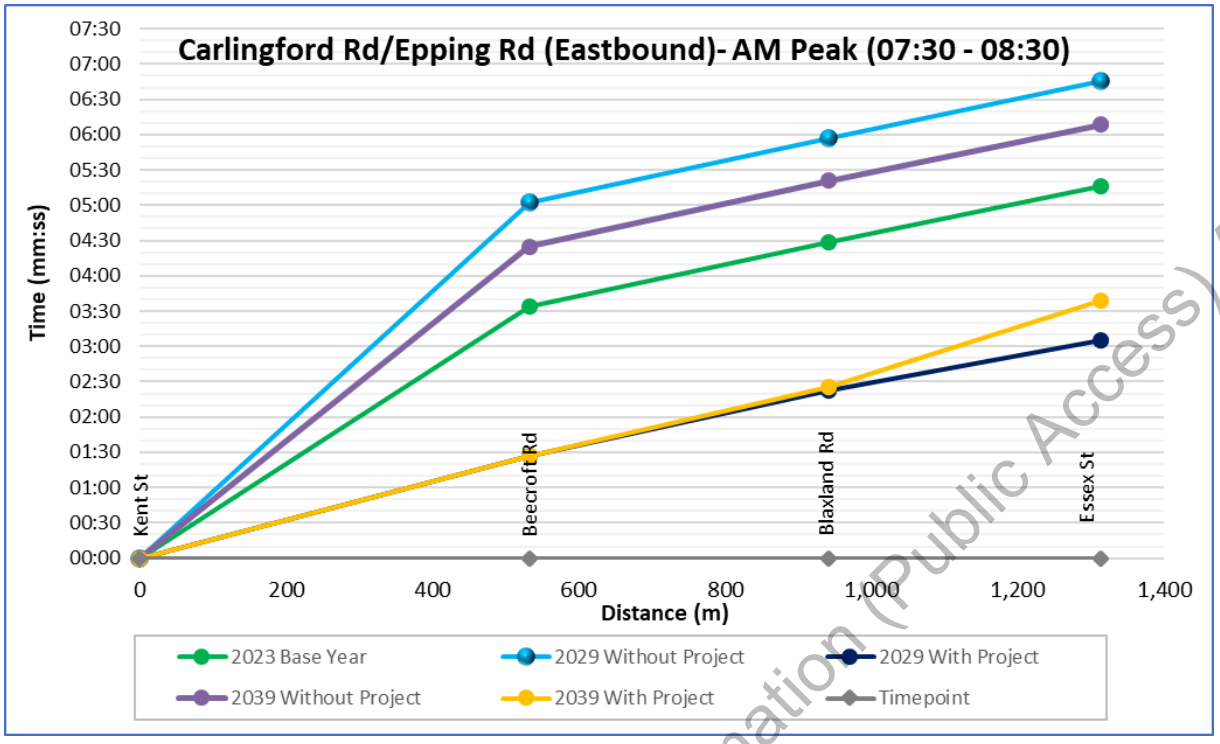


Figure 3-6 Future Scenario Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- AM Peak (07:30 - 08:30)

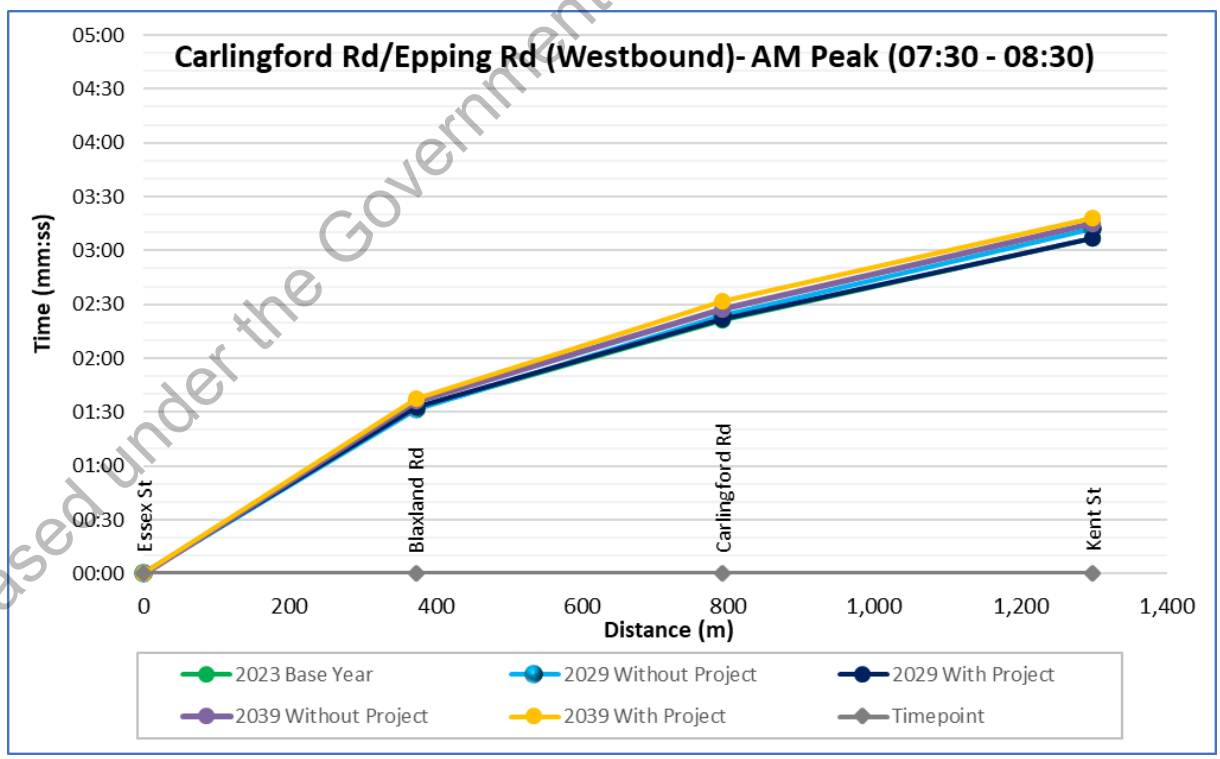


Figure 3-7 Future Scenario Travel Time Plot - Carlingford Rd/Epping Rd (Eastbound)- PM Peak (17:00 - 18:00)

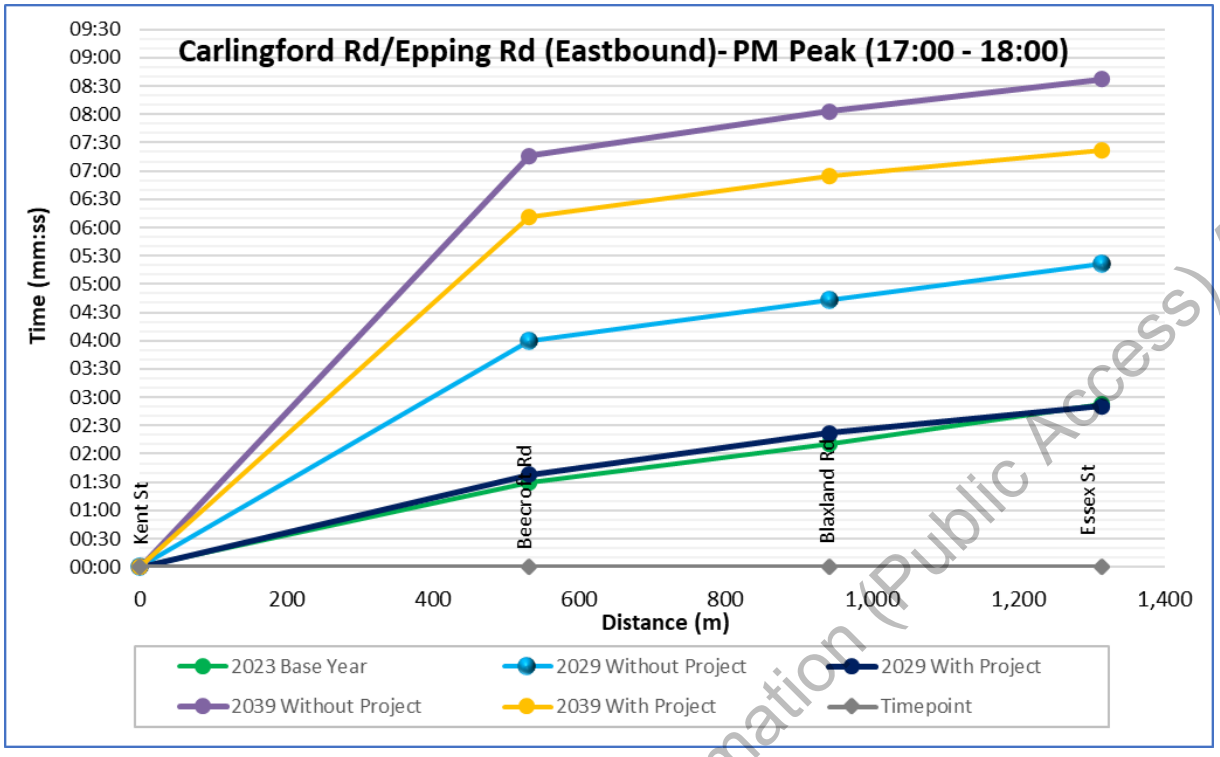
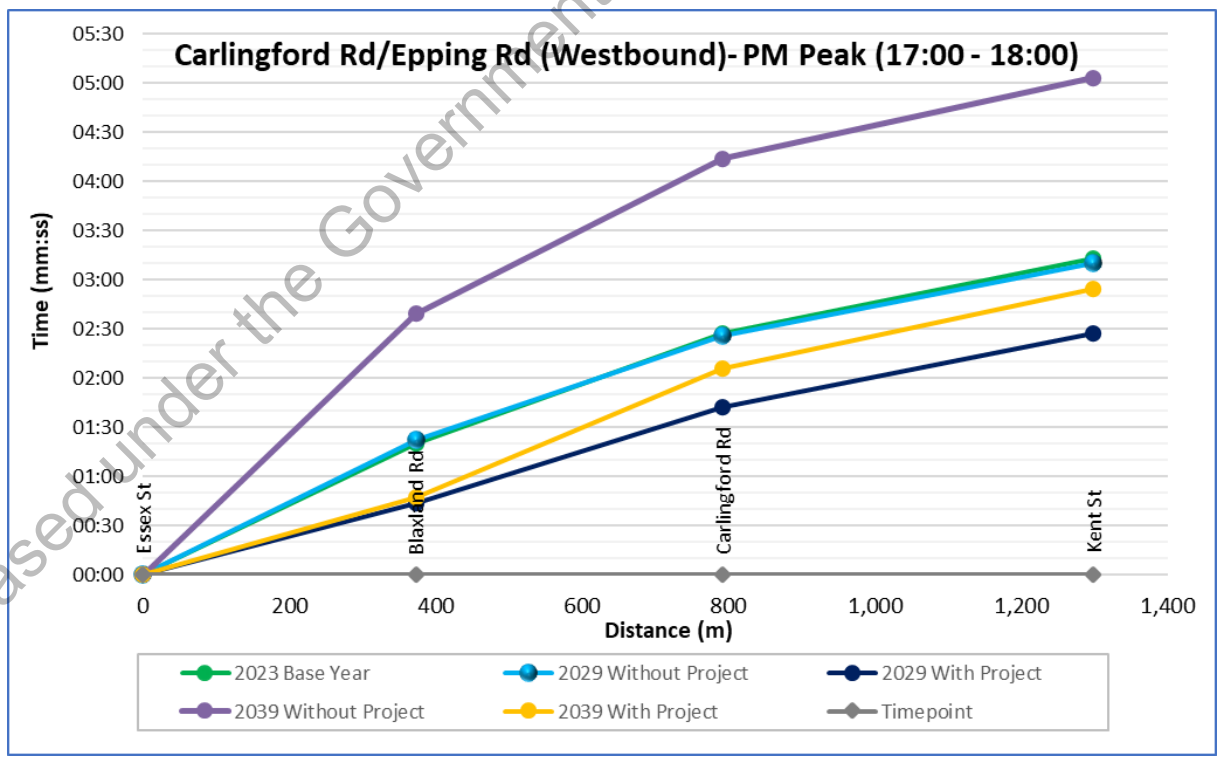


Figure 3-8 Future Scenario Travel Time Plot - Carlingford Rd/Epping Rd (Westbound)- PM Peak (17:00 - 18:00)



The key observations from AM Peak VISSIM travel time analysis include:

- Travel times along Beecroft Road northbound are similar between the 'Without Project' and 'With Project' case scenarios for the years 2029 and 2039.
- Beecroft Road southbound travel times have improved by approximately one minute and 30 seconds in 2029 and by one minute in 2039 in the 'With Project' case scenarios compared to the 'Without Project' case scenarios.
- Carlingford Road and Epping Road eastbound travel times have improved by approximately three minutes and 30 seconds in 2029 and by two minutes and 30 seconds in 2039 in the 'With Project' case scenarios compared to the 'Without Project' case scenarios.
- Travel times along Carlingford Road and Epping Road westbound are similar between the 'Without Project' and 'With Project' case scenarios for the years 2029 and 2039.

The key observations from the PM Peak VISSIM travel time analysis include:

- Travel times along Beecroft Road northbound are similar between the 'Without Project' and 'With Project' scenarios for the years 2029 and 2039.
- Beecroft Road southbound travel times have improved by approximately nine minutes in 2029 and by 13 minutes and 30 seconds in 2039 in the 'With Project' case scenarios compared to the 'Without Project' case scenarios.
- Carlingford Road and Epping Road eastbound travel times have improved by approximately two minutes 30 seconds in 2029 and by one minute in 2039 in the 'With Project' case scenarios compared to the 'Without Project' case scenarios.
- Carlingford Road and Epping Road westbound travel times have improved by approximately one minute in 2029 and by two minutes in 2039 in the 'With Project' case scenarios compared to the 'Without Project' case scenarios.

3.3.2 VISSIM Network Performance

The key network performance statistics, during AM and PM peak hours, were extracted from the VISSIM models and are presented in Table 3-3 and Table 3-4 below.

Table 3-3 Forecast AM Peak Hour Network Performance

Model Performance Parameters	2023 Base Year	2029 Without Project	2029 With Project	2039 Without Project	2039 With Project
Vehicle Kilometres Travelled (km)	9651	9882	9952	10153	10437
Vehicle Hours Travelled (hours)	369	432	333	440	380
Average Speed (km/h)	26	23	30	23	27
Average Vehicle Delay (seconds)	111.9	139.5	85.9	136.1	100.7
Completed trips	6119	6290	6348	6525	6710
Unreleased trips	5	105	27	295	36
Average Number of Vehicle-stops	3.12	3.98	2.31	3.98	2.70

Table 3-4 Forecast PM Peak Hour Network Performance

Model Performance Parameters	2023 Base Year	2029 Without Project	2029 With Project	2039 Without Project	2039 With Project
Vehicle Kilometres Travelled (km)	9563	9887	9925	9687	10389
Vehicle Hours Travelled (hours)	345	422	313	875	535
Average Speed (km/h)	28	23	32	11	19
Average Vehicle Delay (seconds)	97.5	128.9	73.5	343.5	168.8
Completed trips	6252	6518	6555	6466	6965
Unreleased trips	0	0	0	515	40
Average Number of Vehicle-stops	2.29	3.10	1.85	11.75	6.37

The key observations from the VISSIM network performance analysis include:

- The average network speeds show improvement during both the AM and PM peak periods in the ‘With Project’ case scenarios compared to the ‘Without Project’ case scenarios for the years 2029 and 2039.
- The average network delay is significantly lower during both the AM and PM peak periods in the ‘With Project’ case scenarios compared to the ‘Without Project’ case scenarios for the years 2029 and 2039.
- Additionally, the number of unreleased trips is lower during both the AM and PM peak periods in the ‘With Project’ case scenarios compared to the ‘Without Project’ case scenarios for the years 2029 and 2039.
- This indicates that the proposed project will enhance traffic flow and reduce congestion during peak hours.

3.3.3 SIDRA Network Performance

The key network performance statistics, during AM and PM peak hours, were extracted from the SIDRA models and are presented in Table 3-5 and Table 3-6. The SIDRA analysis provides a sensitivity check for the VISSIM analysis.

Table 3-5 Forecast AM Peak Hour Network Performance

Model Performance Parameters	2023 Base Year	2029 Without Project	2029 With Project	2039 Without Project	2039 With Project
Network Capacity (veh/hr)	23506	23652	23818	24622	24757
Average Vehicle Speeds (km/h)	27.8	25.1	27.3	19.3	20.8
Total travel Time (Veh-h/h)	365	404	387	550	512
Average Control Delay (sec)	26.8	32.7	28.6	51.0	45.4

Table 3-6 Forecast PM Peak Hour Network Performance

Model Performance Parameters	2023 Base Year	2029 Without Project	2029 With Project	2039 Without Project	2039 With Project
Network Capacity (veh/hr)	22994	24010	24106	25034	25155
Average Vehicle Speeds (km/h)	27.7	27.1	28.1	19.1	21.9
Total travel Time (Veh-h/h)	362	387	371	572	497
Average Control Delay (sec)	27.7	29.0	26.7	53.0	42.2

The key observations from the SIDRA network performance assessments include:

- In both peaks, the 'With Project' scenarios all provide better network performance than the 'Without Project' scenarios.
- 'Without Pproject', the network will deteriorate over time. Vehicle delay will almost double and travel speeds will slow by up to 9km/h.
- In 2029, the SIDRA analysis estimates that the project will reduce network delay by up to 13% and 8%, in the AM and PM peak, respectively.
- By 2039, the benefits of the project are even greater with the bridge widening reducing network delay by up to 11% and 20%, in the AM and PM peaks, respectively.

3.3.5 VISSIM Forecast Peak Hour Intersection Performance

The VISSIM forecast intersection performance for the AM and PM peak hours are summarised in Table 3-7 and Table 3-8. **Appendix D** provides an additional breakdown of intersection performance by intersection approach.

Table 3-7: Forecast AM Peak Hour Intersection Performance

Year	Performance Criteria	Carlingford Rd & Ray Rd & Rawson St	Beecroft Rd & Carlingford Rd	Bridge Street / Rawson Street	Beecroft Road / High Street / Bridge Street	Epping Rd & Blaxland Rd & Langston Pl	Epping Rd & Essex St
2023	Total Vehicles	2726	4530	987	1947	4817	3237
	Ave Delay (sec)	79.8	24.5	16.7	2.2	42.8	32.3
	Level of Service	F	B	B	A	C	C
2029 Without Project	Total Vehicles	2882	4607	1081	2031	4880	3270
	Ave Delay (sec)	83.5	25.3	24.0	2.7	43.9	50.6
	Level of Service	F	B	B	A	D	D
2029 With Project	Total Vehicles	2917	4659	1085	2088	4891	3332
	Ave Delay (sec)	43.5	23.8	17.4	3.3	33.1	34.3
	Level of Service	D	B	B	A	C	C
2039 Without Project	Total Vehicles	3077	4653	1196	2112	4962	3297
	Ave Delay (sec)	86.6	25.7	35.6	2.8	46.0	49.5
	Level of Service	F	B	C	A	D	D
2039 With Project	Total Vehicles	3120	4785	1231	2296	5097	3492
	Ave Delay (sec)	50.5	24.7	27.1	4.7	37.0	44.2
	Level of Service	D	B	B	A	C	D

The key observations from the AM Peak hour VISSIM intersection performance analysis include:

- In the 'Without Project' scenarios for the years 2029 and 2039, the intersection at Carlingford Road, Ray Road, and Rawson Street operates at LOS F. However, in the 'With Project' scenarios, this intersection improves to LOS D or better.
- All intersections in the ‘With Project’ case scenarios for the years 2029 and 2039 show improvements compared to the ‘Without Project’ case scenarios for the same years
- Additionally, all intersections perform satisfactorily at LOS D or better in both the ‘Without Project’ case and ‘With Project’ case scenarios for the years 2029 and 2039.

Table 3-8 Forecast PM Peak Hour Intersection Performance

Year	Performance Criteria	Carlingford Rd & Ray Rd & Rawson St	Beecroft Rd & Carlingford Rd	Bridge Street / Rawson Street	Beecroft Road / High Street / Bridge Street	Epping Rd & Blaxland Rd & Langston Pl	Epping Rd & Essex St
2023	Total Vehicles	2726	4423	969	2645	4782	3178
	Ave Delay (sec)	30.6	28.5	11.2	2.7	51.5	40.9
	Level of Service	C	B	A	A	D	C
2029 Without Project	Total Vehicles	2851	4557	1043	2737	4915	3201
	Ave Delay (sec)	77.4	35.6	13.6	3.3	53.9	38.5
	Level of Service	F	C	A	A	D	C
2029 With Project	Total Vehicles	2897	4594	1042	2717	4948	3219
	Ave Delay (sec)	35.9	26.4	13.6	2.1	25.1	34.0
	Level of Service	C	B	A	A	B	C
2039 Without Project	Total Vehicles	2642	4422	1084	2808	4878	3142
	Ave Delay (sec)	113.0	70.2	263.9	13.9	89.6	54.9
	Level of Service	F	F	F	A	F	D
2039 With Project	Total Vehicles	2985	4799	1210	2901	5135	3269
	Ave Delay (sec)	83.6	35.0	119.7	11.4	33.3	34.8
	Level of Service	F	C	F	A	C	C

The key observations from the PM Peak hour VISSIM intersection performance analysis include:

- The intersections at Carlingford Road, Ray Road, and Rawson Street intersection, perform at LOS F in both the 'Without Project' and 'With Project' scenarios for the years 2029 and 2039, except for the 2029 'With Project' scenario. However, the 'With Project' scenarios show improvements in terms of delays compared to the 'Without Project' scenarios.
- The Bridge Street and Rawson Street intersection perform at LOS F in both the 'Without Project' and 'With Project' scenarios in the year 2039.
- The Epping Road, Blaxland Road and Langston Place, along with Beecroft Road and Carlingford Road intersection, perform at LOS F in 'Without Project' case scenarios for the year 2039. However, the 'With Project' case scenarios show improvements in terms of delays.
- Other than the intersections mentioned above, all other intersections perform satisfactorily at LOS D or better in both the 'Without Project' and 'With Project' case scenarios for the years 2029 and 2039.

3.3.6 SIDRA Forecast Peak Hour Intersection Performance

The SIDRA forecast intersection performance for the AM and PM peak hours are summarised in Table 3-9 and Table 3-10. The SIDRA analysis provides a sensitivity check for the VISSIM analysis.

Table 3-9: Forecast AM Peak Hour Intersection Performance

Year	Performance Criteria	Carlingford Rd & Ray Rd & Rawson St	Beecroft Rd & Carlingford Rd	Bridge St & Rawson St	Beecroft Rd & High St & Bridge St	Epping Rd & Blaxland Rd	Epping Rd & Essex St
2023	DoS	1.0	0.9	0.8	0.9	1.1	0.9
	LoS	E	C	B	B	C	B
	95th Q (veh)	58	24	8	3	29	19
2029 Without Project	DoS	1.1	0.9	0.9	1.1	1.0	1.1
	LoS	F	B	B	F	B	D
	95th Q (veh)	42	13	5	7	29	22
2029 With Project	DoS	1.1	0.9	0.9	0.6	0.9	1.0
	LoS	F	C	B	A	B	D
	95th Q (veh)	42	13	6	1	9	22
2039 Without Project	DoS	1.2	1.1	1.0	1.3	1.1	1.4
	LoS	F	C	E	F	C	F
	95th Q (veh)	37	31	11	10	26	38
2039 With Project	DoS	1.2	1.1	1.0	0.6	0.9	1.4
	LoS	F	D	E	A	B	F
	95th Q (veh)	37	33	12	1	10	40

Table 3-10 Forecast PM Peak Hour Intersection Performance (SIDRA)

Year	Performance Criteria	Carlingford Rd & Ray Rd & Rawson St	Beecroft Rd & Carlingford Rd	Bridge St & Rawson St	Beecroft Rd & High St & Bridge St	Epping Rd & Blaxland Rd	Epping Rd & Essex St
2023	DoS	1.0	1.0	0.7	1.0	1.2	0.9
	LoS	C	C	A	E	C	C
	95th Q (veh)	31	26	10	7	43	31
2029 Without Project	DoS	0.9	1.0	1.1	1.3	0.9	0.9
	LoS	C	D	B	F	B	D
	95th Q (veh)	40	62	17	24	42	34
2029 With Project	DoS	0.9	1.0	0.9	0.4	0.9	0.9
	LoS	C	D	B	A	B	D
	95th Q (veh)	40	65	12	1	28	34
2039 Without Project	DoS	1.0	1.1	1.2	2.7	1.0	0.9
	LoS	D	E	E	F	C	D
	95th Q (veh)	63	69	38	25	45	37
2039 With Project	DoS	1.0	1.1	1.0	0.7	0.9	0.9
	LoS	E	F	C	A	B	D
	95th Q (veh)	65	76	17	2	34	37

The key observations from the SIDRA intersection performance analysis include:

- Carlingford Road, Ray Road and Rawson Street becomes LOS F in all future year AM Peak scenarios. The LOS becomes E in the 2039 PM peak. The intersection does not benefit from the upgrade due to the constraint of limited spaced to Beecroft Road and Carlingford Road intersection.
- Beecroft Road & Carlingford Road will reach its capacity in 2029, as show in the PM peak Table 3-10. The LOS deteriorates to F in 2039 PM peak in the project scenario due to higher northbound arrival flows from the upgraded intersection of Epping Road, Blaxland Road and Langston Place.
- With the bridge upgrade in 2039, the overall intersection performance at Epping Road, Blaxland Road and Langston Place improves from LOS C to B in both peaks, compared to the 'Without Project' scenario. The biggest performance improvements are experienced by the eastbound right turn from Epping Bridge into Blaxland Road, during the AM Peak, where movement performance improves from LOS F to B.
- Despite the overall western approach of Epping Road, at Blaxland Road, operating at LOS C 'Without Project' in the 2029 AM and PM peaks, this performance is a little misleading. The heavy eastbound right turn movement from Epping Bridge into Blaxland Road is operating at LOS F.
- The model also shows Essex Street intersection will reach its capacity in 2029. The LOS deteriorates to F in 2039 AM peak suggests an upgrade is required.
- The delay on the priority control left turn from Bridge Street to Beecroft Road becomes very high (LOS F) if no bridge upgrade takes place. The opposing traffic will be too busy to find a suitable gap to proceed. This also caused queue back to the Beecroft Road, High Street and Bridge Street roundabout in 2039, which would operate at LOS E for both peaks.
- With the project upgrades, the traffic from Bridge Street can proceed with the additional short lane on Beecroft Road merge with the main road traffic. This reduces the delay significantly to less than six seconds (LOS A). This in turn releases the gridlock on Bridge St in the PM peak and improves the roundabout operation from LOS E to C.

4 Summary and Conclusion

This technical note details and summarised the traffic assessment undertaken for construction stages and project scenarios of the proposed Epping Bridge widening.

Based on the analysis and discussions presented within this report, the following is a summary of the modelling outcomes:

4.1 Travel Times

Construction Stages:

- All the construction stages yield similar or slightly increased travel times along both routes compared to the 2023 base year in both peaks.
- Beecroft Road southbound movements experienced increase in the travel time approximately by 120 seconds in the PM peak in Stage 4A compared to the 2023 base year.
- Carlingford Rd & Epping Rd eastbound movements experienced increase in the travel time approximately by 120 seconds in the AM peak in Stage 1A and Stage 5B compared to the 2023 base year.
- The travel times experienced in Stage 5B (80% Demand) are generally similar or lower than the 2023 base year.

Future Year Scenarios:

- Travel times along Beecroft Road northbound remain consistent across both AM and PM peak periods in the 'Without Project' and 'With Project' scenarios for the years 2029 and 2039.
- Beecroft Road southbound travel times have improved by approximately one minute and 30 seconds in 2029 and by one minute in 2039 in the 'With Project' scenarios compared to the 'Without Project'

scenarios during the AM peak period. During the PM peak period, Beecroft Road southbound travel times have improved by nine minutes in 2029 and by 13 minutes and 30 seconds in 2039 in the 'With Project' case scenarios compared to the 'Without Project' scenarios.

- Travel times along Carlingford Road and Epping Road eastbound have improved by approximately three minutes and 30 seconds in 2029 and by two minutes and 30 seconds in 2039 in the 'With Project' scenarios compared to the 'Without Project' scenarios during the AM peak period. During the PM peak period, Carlingford Road and Epping Road eastbound travel times have improved by two minutes 30 seconds in 2029 and by one minute in 2039 in the 'With Project' case scenarios compared to the 'Without Project' scenarios.
- Travel times along Carlingford Road and Epping Road westbound are similar between the 'Without Project' and 'With Project' scenarios for the years 2029 and 2039 in the AM peak period. During the PM peak period, Carlingford Road and Epping Road westbound travel times have improved by approximately one minute in 2029 and by two minutes in 2039 in the 'With Project' case scenarios compared to the 'Without Project' scenarios.

4.2 Network Performance

Construction Stages:

- All construction scenarios except Stage 5B (80% Demand) yield lower average network speeds and slightly higher average network delays compared to the 2023 base year in both peaks.
- In the AM peak, during the construction Stage 5B there are unreleased trips due to the eastbound lane closure at Epping Rd / Blaxland Rd / Langston Pl intersection.

Future Year Scenarios:

- The average network speeds show improvement during both the AM and PM peak periods in the 'With Project' scenarios compared to the 'Without Project' scenarios for the years 2029 and 2039.
- The average network delay is significantly lower during both the AM and PM peak periods in the 'With Project' scenarios compared to the 'Without Project' scenarios for the years 2029 and 2039.
- Additionally, the number of unreleased trips is lower during both the AM and PM peak periods in the 'With Project' scenarios compared to the 'Without Project' scenarios for the years 2029 and 2039.
- This indicates that the proposed project will enhance traffic flow and reduce congestion during peak hours.

4.3 Intersections Performance

Construction Stages:

- Carlingford Road / Ray Road / Rawson Street intersection yields LOS F across all construction stages except Stage 5B (80% Demand) in the AM peak, in Stage 6 it operates with LOS E.
- Bridge Street / Rawson Street and Epping Rd / Blaxland Rd / Langston Pl intersections performs at LOS E, with all other scenarios yielding LOS D or better in the AM peak.
- Bridge Street / Rawson Street intersection performs at LOS F in Stage 5B and LOS E in Stage 6, with all other scenarios yielding LOS D or better in the PM peak.
- In Stage 4A, Epping Rd / Blaxland Rd / Langston Pl intersection performs at LOS E, with all other scenarios yielding LOS D or better in the PM peak.
- Other than above mentioned all the intersections perform satisfactorily at LOS D or better in both peaks.

Future Year Scenarios:

- During the AM peak periods, all other intersections perform satisfactorily at LOS D or better in both the 'Without Project' and 'With Project' scenarios for the years 2029 and 2039, except for the Carlingford Road, Ray Road, and Rawson Street intersection in the 2039 'Without Project' case scenario.
- The intersections at Carlingford Road, Ray Road, and Rawson Street perform at LOS F in both the 'Without Project' and 'With Project' case scenarios for the years 2029 and 2039 during the PM peak,

except for the 2029 'With Project' scenario. However, the 'With Project' scenarios show improvements in terms of delays compared to the 'Without Project' scenarios.

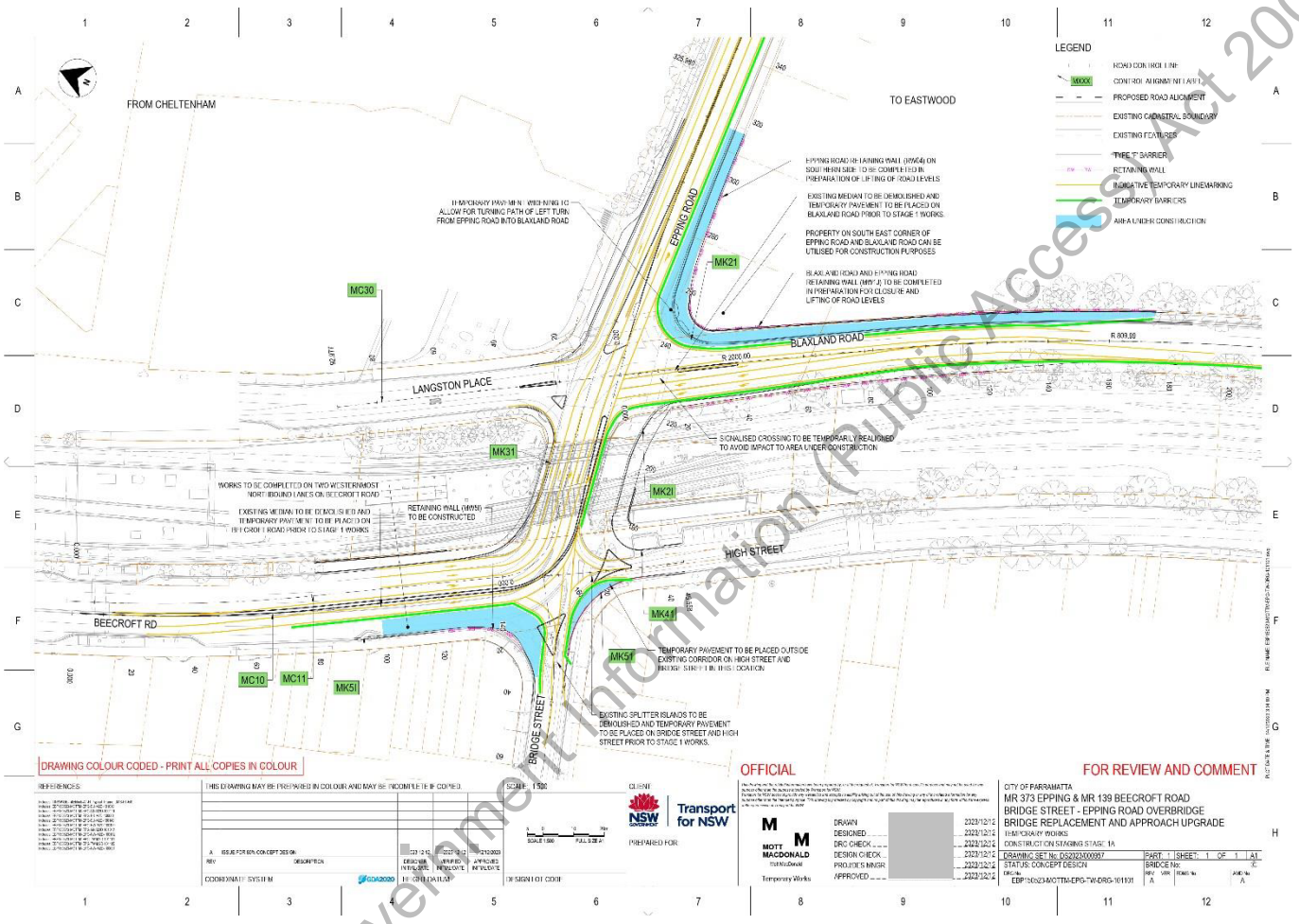
- The Bridge Street and Rawson Street intersection also performs at LOS F in both scenarios in 2039 during the PM peak. Additionally, the intersections at Epping Road, Blaxland Road, and Langston Place, along with Beecroft Road and Carlingford Road intersection, perform at LOS F in the 'Without Project' scenarios for 2039. However, the 'With Project' scenarios show improvements in terms of delays.
- Other than above mentioned, all intersections in the project scenarios for the years 2029 and 2039 show improvements compared to the ‘Without Project’ scenarios for the same years.

Also, SIDRA analysis has been carried out during the construction stages and project scenarios in line with VISSIM analysis and detailed in the respective sections.

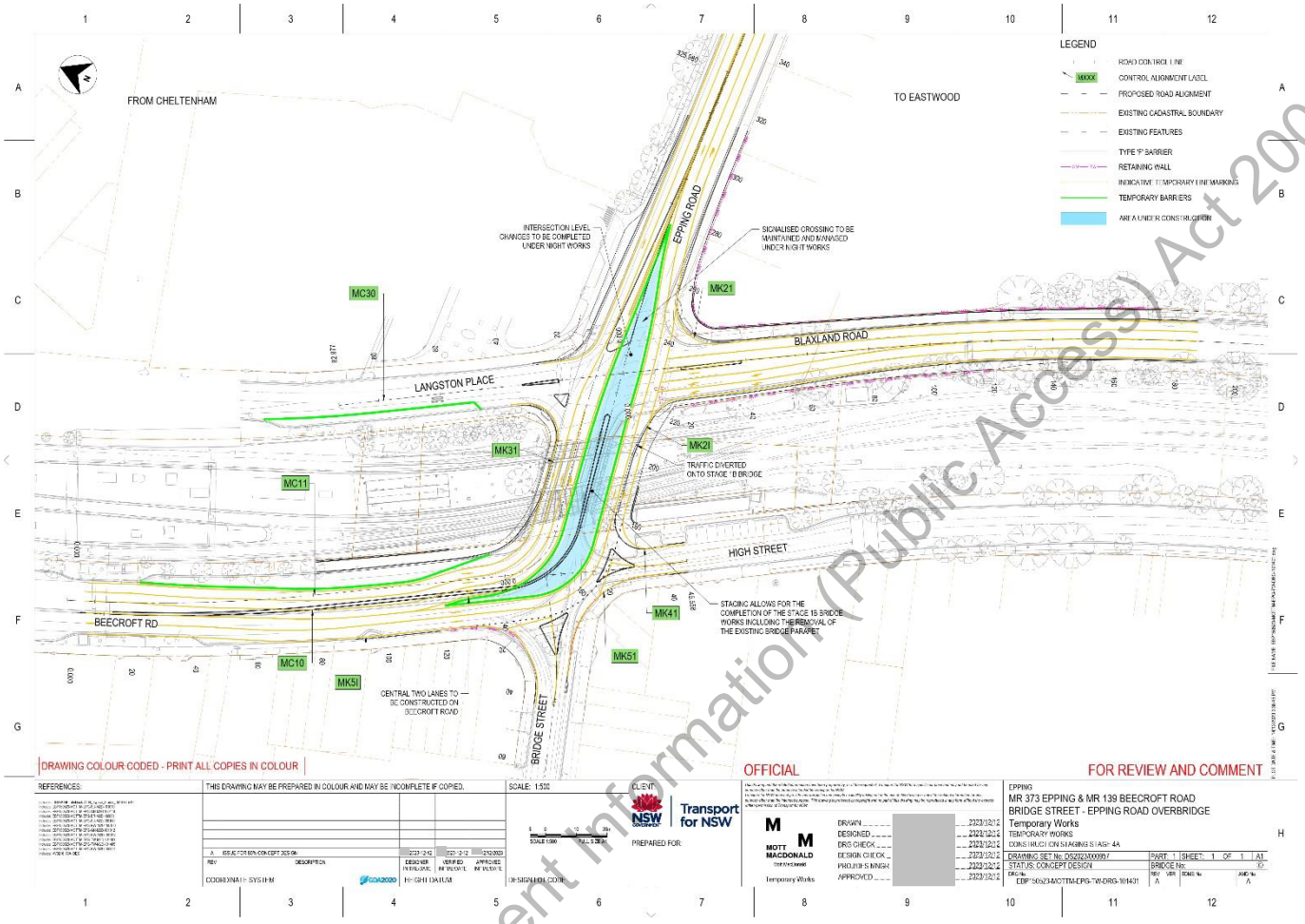
In summary, the widening of the Epping Bridge in the project scenarios shows improved network performance and travel times compared to the ‘Without Project’ scenarios.

A. Construction Staging Drawings

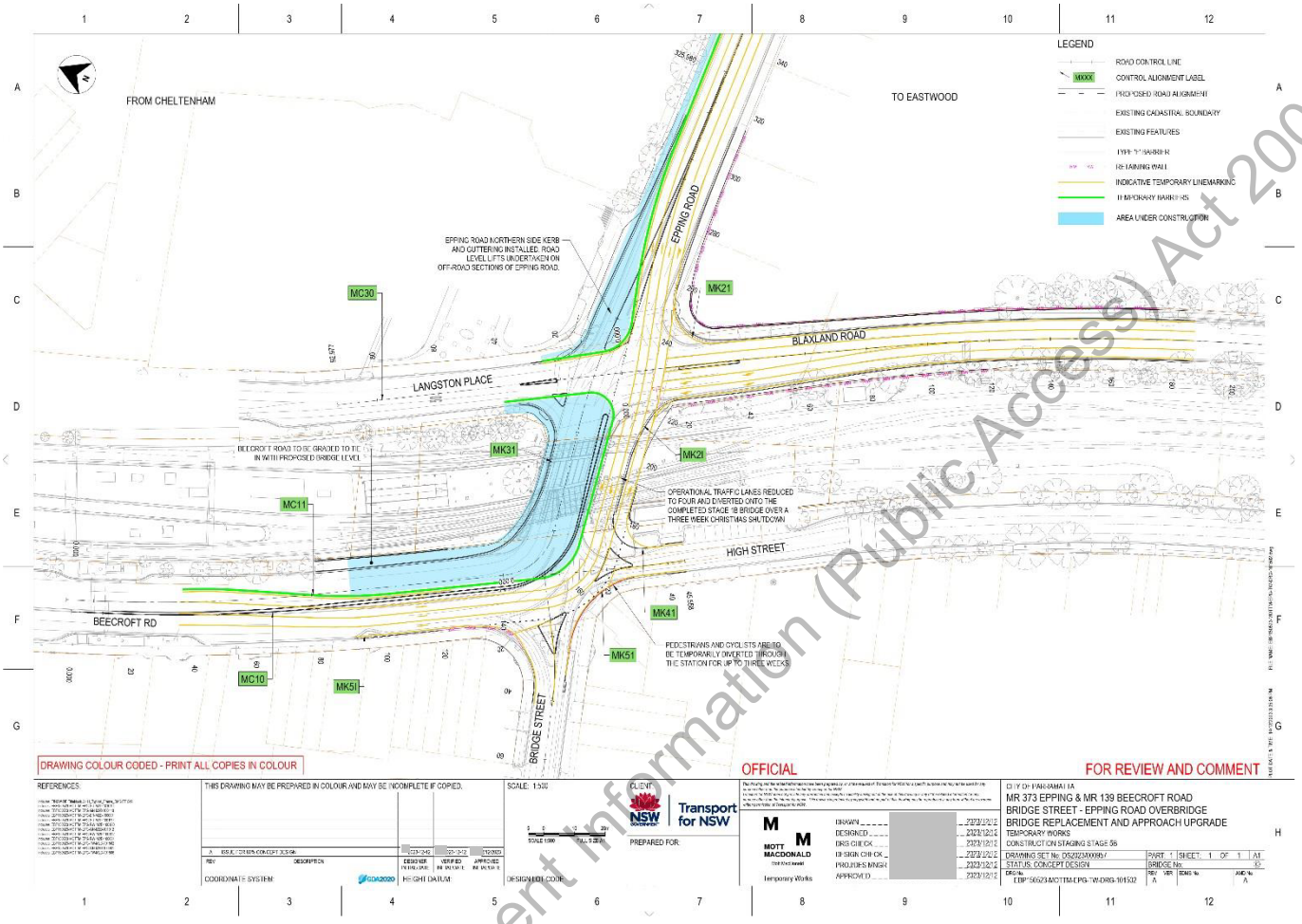
A.1 Stage 1A



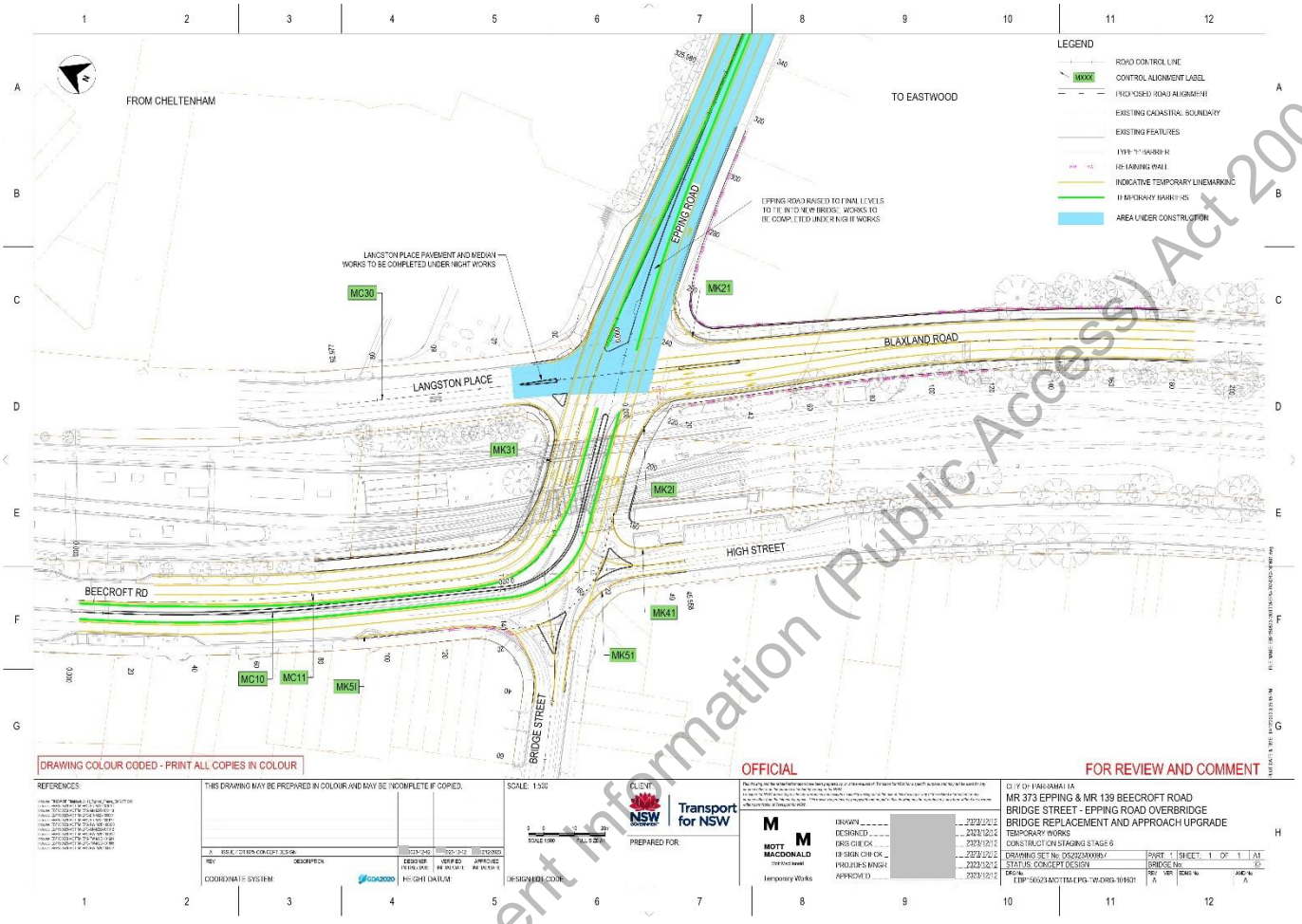
A.2 Stage 4A



A.3 Stage 5B



A.4 Stage 6



B. Intersection Performance - Construction Stages

B.1 AM Peak

Intersection Name	Approach Name	Movement Name	2023 Base Year								Stage1A								Stage4A							
			Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	44	21	D	63	269	73	21	F	42	18	C	63	269	63	18	E	45	21	D	63	269	73	21	F
		Thru	45	21	D	141					42	18	C	141					47	21	D	141				
		Right	162	21	F	65					131	18	E	65					156	21	F	65				
	East	Left	3	9	A	84	876	9	11	A	3	11	A	84	877	10	13	A	4	12	A	84	867	10	14	A
		Thru	10	11	A	788					11	14	A	787					11	14	A	777				
		Right	45	11	D	4					13	13	A	6					25	13	B	6				
	North	Left	78	37	F	261	483	62	37	E	73	34	F	267	489	59	34	E	89	41	F	266	488	67	41	E
		Thru	41	37	C	204					42	34	C	204					41	41	C	204				
		Right	52	37	D	18					50	34	D	18					51	41	D	18				
	West	Left	137	234	F	7	1098	146	234	F	138	224	F	7	1121	136	224	F	167	313	F	7	1078	165	313	F
		Thru	146	234	F	1086					136	224	F	1109					165	313	F	1066				
		Right	176	234	F	5					152	224	F	5					212	313	F	5				
Beecroft Rd & Carlingford Rd	South	Left	17	2	B	699	1668	31	25	C	11	1	A	702	1675	25	24	B	13	2	A	691	1655	27	25	B
		Thru	42	42	C	969					36	40	C	973					36	41	C	964				
	North	Thru	27	26	B	1279	1452	31	24	C	27	30	B	1278	1451	31	28	C	27	29	B	1278	1451	30	28	C
		Right	62	14	E	173					59	13	E	173					58	13	E	173				
	West	Left	13	0	A	45	1410	10	20	A	15	0	B	45	1438	10	20	A	10	0	A	43	1392	10	20	A
		Right	10	20	A	1365					10	21	A	1393					10	20	A	1349				
Bridge Street / Rawson Street	South	Left	11	2	A	12	191	13	2	A	11	2	A	12	190	10	2	A	13	2	A	12	190	11	2	A
		Thru	11	2	A	99					9	2	A	99					9	2	A	99				
		Right	15	2	A	80					11	2	A	79					12	2	A	79				
	East	Left	7	1	A	22	198	9	1	A	6	1	A	22	199	9	1	A	7	1	A	22	196	10	1	A
		Thru	9	1	A	111					8	1	A	111					10	1	A	108				
		Right	8	1	A	65					10	1	A	66					10	1	A	66				
	North	Left	41	12	C	12	293	26	12	B	39	13	C	11	289	27	13	B	54	16	D	11	291	33	16	C
		Thru	23	12	B	117					25	13	B	116					30	16	C	117				
		Right	27	12	B	164					28	13	B	162					35	16	C	163				
	West	Left	15	8	B	175	305	15	8	B	14	8	A	176	307	14	8	A	14	7	A	175	305	14	7	A
		Thru	16	8	B	115					15	8	A	115					15	7	A	115				
		Right	15	8	A	15					11	8	A	16					8	7	A	15				
Beecroft Road / High Street / Bridge Street	South	Left	9	0	A	24	24	9	0	A	13	0	A	24	24	13	0	A	6	0	A	24	24	6	0	A
	East	Left	1	0	A	87	1716	1	0	A	1	0	A	86	1716	1	0	A	1	1	A	87	1699	1	0	A
		Thru	1	0	A	178					0	0	A	176					1	0	A	174				
		Right	1	0	A	1451					1	0	A	1454					1	0	A	1438				
	West	Left	12	5	A	207	207	12	5	A	17	4	B	207	207	17	4	B	16	7	B	206	206	16	7	B
Epping Rd & Blaxland Rd & Langston Pl	South	Left	18	20	B	611	794	27	20	B	18	19	B	616	800	25	19	B	18	19	B	615	799	25	19	B
		Thru	57	20	E	183					50	19	D	184					50	19	D	184				
	East	Left	49	75	D	12	1118	54	75	D	73	104	F	12	1114	64	106	E	79	102	F	12	1096	62	102	E
		Thru	54	75	D	1106					64	106	E	1102					62	102	E	1084				
	North	Left	54	12	D	39	265	49	12	D	49	18	D	39	265	50	18	D	45	11	D	39	265	47	11	D
		Thru	48	12	D	226					50	18	D	226					48	11	D	226				
	West	Left	26	63	B	270	2640	42	157	C	24	86	B	273	2665	35	166	C	21	72	B	265	2621	35	159	C
		Thru	21	167	B	1820					14	175	A	1838					13	169	A	1805				
		Right	122	167	F	550					113	175	F	554					110	169	F	551				
Epping Rd & Essex St	South	Left	53	12	D	26	185	57	12	E	53	12	D	26	185	57	12	E	53	12	D	26	185	57	12	E
		Thru	63	12	E	85					63	12	E	85					63	12	E	85				
		Right	52	12	D	74					52	12	D	74					52	12	D	74				
	East	Left	9	2	A	14	690	14	7	A	11	7	A	14	690	14	7	A	11	7	A	14	690	14	7	A
		Thru	14	7	A	676					14	7	A	676					14	7	A	676				
	North	Left	126	47	F	2	519	74	47	F	71	47	F	2	522	73	47	F	126	47	F	2	519	74	47	F
		Thru	72	47	F	83					74	47	F	84					72	47	F	82				
		Right	74	47	F	434					73	47	F	436					74	47	F	435				
	West	Left	34	74	C	62	1843	25	74	B	30	65	C	62	1870	18	65	B	27	58	B	62	1829	16	58	B
		Thru	25	74	B	1781					17	65	B	1808					16	58	B	1767				

Intersection Name	Approach Name	Movement Name	Stage5B								Stage5B(80%Demand)								Stage6							
			Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	46	22	D	63	272	77	22	F	40	10	C	51	221	44	10	D	49	27	D	63	270	84	27	F
		Thru	44	22	D	142					38	10	C	113					45	27	D	141				
		Right	177	22	F	67					58	10	E	57					201	27	F	66				
	East	Left	2	4	A	85	859	6	5	A	2	2	A	69	696	3	3	A	2	12	A	84	875	10	14	A
		Thru	6	5	A	768					4	3	A	621					11	14	A	785				
		Right	22	5	B	6					14	3	A	6					13	13	A	6				
	North	Left	166	77	F	254	476	109	77	F	59	22	E	214	397	50	22	D	94	44	F	260	482	70	44	F
		Thru	42	77	C	204					38	22	C	166					41	44	C	204				
		Right	52	77	D	18					47	22	D	17					51	44	D	18				
	West	Left	204	487	F	4	810	241	487	F	27	27	B	6	852	38	27	C	119	134	F	7	1112	103	134	F
		Thru	241	487	F	800					38	27	C	841					103	134	F	1100				
		Right	323	487	F	6					36	27	C	5					131	134	F	5				
Beecroft Rd & Carlingford Rd	South	Left	16	11	B	682	1645	34	33	C	14	6	A	554	1342	33	25	C	14	1	A	700	1664	27	24	B
		Thru	48	49	D	963					47	38	D	788					36	40	C	964				
	North	Thru	32	45	C	1275	1448	36	41	C	25	27	B	1022	1159	29	25	C	27	29	B	1278	1451	30	28	C
		Right	62	12	E	173					59	12	E	137					59	14	E	173				
	West	Left	16	0	B	46	1120	26	28	B	11	0	A	42	1109	12	18	A	13	1	A	45	1428	10	20	A
		Right	27	29	B	1074					12	18	A	1067					10	21	A	1383				
Bridge Street / Rawson Street	South	Left	12	2	A	12	190	12	2	A	3	2	A	10	153	12	2	A	10	2	A	12	190	12	2	A
		Thru	10	2	A	99					12	2	A	79					11	2	A	99				
		Right	14	2	A	79					14	2	A	64					14	2	A	79				
	East	Left	9	1	A	22	184	10	1	A	6	1	A	19	169	9	1	A	4	1	A	22	198	7	1	A
		Thru	9	1	A	101					9	1	A	90					7	1	A	110				
		Right	12	1	A	61					9	1	A	60					9	1	A	66				
	North	Left	66	26	E	12	294	49	26	D	30	5	C	11	242	15	5	B	47	11	D	11	291	24	11	B
		Thru	45	26	D	117					14	5	A	96					23	11	B	117				
		Right	51	26	D	165					16	5	B	135					23	11	B	163				
	West	Left	13	7	A	176	307	13	7	A	6	2	A	138	240	7	2	A	15	9	B	176	307	16	9	B
		Thru	15	7	A	115					8	2	A	91					18	9	B	115				
		Right	9	7	A	16					6	2	A	11					13	9	A	16				
Beecroft Road / High Street / Bridge Street	South	Left	15	0	A	23	23	15	0	A	6	0	A	20	20	6	0	A	13	0	A	24	24	13	0	A
	East	Left	0	0	A	84	1674	1	0	A	0	0	A	72	1405	0	0	A	0	0	A	87	1717	1	0	A
		Thru	0	0	A	166					0	0	A	149					0	0	A	179				
		Right	1	0	A	1424					0	0	A	1184					1	0	A	1451				
	West	Left	19	9	B	207	207	19	9	B	14	5	A	165	165	14	5	A	17	8	B	207	207	17	8	B
Epping Rd & Blaxland Rd & Langston Pl	South	Left	14	31	A	606	787	30	31	C	13	17	A	488	632	22	17	B	17	19	B	615	799	25	19	B
		Thru	87	31	F	181					54	17	D	144					50	19	D	184				
	East	Left	153	197	F	12	1083	130	197	F	65	72	E	10	930	61	72	E	66	74	E	12	1112	47	74	D
		Thru	130	197	F	1071					61	72	E	920					47	74	D	1100				
	North	Left	69	14	E	39	265	60	14	E	59	11	E	32	203	55	11	D	47	12	D	39	265	48	12	D
		Thru	58	14	E	226					55	11	D	171					48	12	D	226				
	West	Left	24	309	B	221	2307	38	309	C	18	96	B	213	2084	28	96	B	22	63	B	273	2653	30	133	C
		Thru	32	309	C	1582					25	96	B	1438					13	141	A	1835				
		Right	60	309	E	504					42	96	C	433					91	141	F	545				
Epping Rd & Essex St	South	Left	53	12	D	26	185	57	12	E	64	9	E	22	144	58	9	E	53	12	D	26	185	57	12	E
		Thru	63	12	E	85					57	9	D	64					63	12	E	85				
		Right	52	12	D	74					57	9	D	58					52	12	D	74				
	East	Left	11	7	A	14	690	14	7	A	12	6	A	13	556	14	6	A	11	7	A	14	690	14	7	A
		Thru	15	7	A	676					14	6	A	543					14	7	A	676				
	North	Left	131	56	F	2	506	85	56	F	121	23	F	1	423	56	23	D	126	46	F	2	520	73	46	F
		Thru	86	56	F	81					52	23	D	68					71	46	F	83				
		Right	84	56	F	423					56	23	D	354					73	46	F	435				
	West	Left	29	20	C	62	1613	12	20	A	19	9	B	50	1476	6	9	A	29	60	C	62	1860	17	60	B
		Thru	11	20	A	1551					6	9	A	1426					17	60	B	1798				

B.2 PM Peak

Intersection Name	Approach Name	Movement Name	2023 Base Year								Stage1A								Stage4A							
			Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	54	17	D	123	356	50	17	D	58	18	E	123	356	51	18	D	62	19	E	123	356	55	19	D
		Thru	45	17	D	174					43	18	D	174					47	19	D	174				
		Right	54	17	D	59					59	18	E	59					63	19	E	59				
	East	Left	1	13	A	109	1184	8	16	A	2	16	A	109	1206	8	19	A	1	15	A	109	1186	8	16	A
		Thru	8	16	A	1068					8	19	A	1089					9	16	A	1069				
		Right	19	15	B	7					22	17	B	8					12	15	A	8				
	North	Left	41	10	C	85	234	40	10	C	41	12	C	85	233	44	12	D	41	10	C	85	233	40	10	C
		Thru	37	10	C	132					43	12	D	131					36	10	C	131				
		Right	56	10	D	17					68	12	E	17					60	10	E	17				
	West	Left	53	40	D	28	952	50	40	D	56	41	D	29	953	50	41	D	63	48	E	28	954	56	48	D
		Thru	50	40	D	922					49	41	D	922					56	48	D	924				
		Right	62	40	E	2					76	41	F	2					68	48	E	2				
Beecroft Rd & Carlingford Rd	South	Left	31	12	C	880	2168	34	59	C	26	11	B	899	2198	30	64	C	25	12	B	880	2171	28	56	B
		Thru	36	91	C	1288					32	102	C	1299					30	86	C	1291				
	North	Thru	17	10	B	889	1194	32	14	C	16	11	B	890	1195	29	14	C	17	11	B	890	1195	29	14	C
		Right	75	26	F	305					68	25	E	305					66	24	E	305				
	West	Left	11	2	A	74	1061	14	19	A	13	2	A	74	1065	14	19	A	12	3	A	74	1066	14	19	A
		Right	14	21	A	987					14	20	A	991					14	21	A	992				
Bridge Street / Rawson Street	South	Left	11	4	A	29	196	16	4	B	21	4	B	29	196	19	4	B	18	4	B	29	196	19	4	B
		Thru	17	4	B	91					17	4	B	91					17	4	B	91				
		Right	18	4	B	76					22	4	B	76					23	4	B	76				
	East	Left	7	2	A	34	369	8	2	A	6	2	A	35	378	9	2	A	8	2	A	34	371	9	2	A
		Thru	8	2	A	229					9	2	A	234					9	2	A	231				
		Right	10	2	A	106					10	2	A	109					10	2	A	106				
	North	Left	45	4	D	9	230	13	4	A	46	5	D	9	228	16	5	B	40	3	C	9	229	12	3	A
		Thru	12	4	A	111					15	5	A	109					10	3	A	110				
		Right	12	4	A	110					15	5	B	110					12	3	A	110				
	West	Left	8	2	A	118	174	9	2	A	8	2	A	118	174	9	2	A	8	2	A	118	174	9	2	A
		Thru	10	2	A	44					13	2	A	44					11	2	A	44				
		Right	9	2	A	12					10	2	A	12					9	2	A	12				
Beecroft Road / High Street / Bridge Street	South	Left	11	0	A	17	17	11	0	A	15	0	A	17	17	15	0	A	7	0	A	17	17	7	0	A
	East	Left	0	0	A	115	2500	1	0	A	1	1	A	114	2538	1	1	A	1	1	A	113	2499	1	0	A
		Thru	2	0	A	354					1	1	A	359					1	0	A	355				
		Right	1	0	A	2031					1	1	A	2065					1	0	A	2031				
	West	Left	26	7	B	128	128	26	7	B	55	11	D	127	127	55	11	D	41	12	C	130	130	41	12	C
Epping Rd & Blaxland Rd & Langston Pl	South	Left	45	42	D	837	977	47	42	D	46	43	D	840	980	47	43	D	56	53	D	845	988	56	53	D
		Thru	58	42	E	140					52	43	D	140					61	53	E	143				
	East	Left	38	98	C	29	1696	48	98	D	72	136	F	31	1729	57	140	E	69	144	E	28	1683	58	144	E
		Thru	49	98	D	1667					57	140	E	1698					58	144	E	1655				
	North	Left	70	13	F	23	242	54	13	D	71	27	F	23	242	69	27	E	68	13	E	23	242	54	13	D
		Thru	52	13	D	219					69	27	E	219					52	13	D	219				
	West	Left	9	10	A	479	1867	57	165	D	6	5	A	478	1871	55	175	D	6	6	A	480	1871	58	212	E
		Thru	8	218	A	1130					4	233	A	1131					4	283	A	1130				
		Right	357	218	F	258					364	233	F	262					388	283	F	261				
Epping Rd & Essex St	South	Left	48	15	D	46	293	53	15	D	48	15	D	46	293	53	15	D	48	15	D	46	293	53	15	D
		Thru	53	15	D	188					53	15	D	188					53	15	D	188				
		Right	56	15	D	59					56	15	D	59					56	15	D	59				
	East	Left	12	7	A	7	1202	21	19	B	11	18	A	7	1206	21	18	B	11	18	A	7	1203	20	18	B
		Thru	21	19	B	1195					21	18	B	1199					20	18	B	1196				
	North	Left	171	101	F	4	562	120	101	F	145	96	F	4	562	116	96	F	146	100	F	4	560	120	100	F
		Thru	122	101	F	121					121	96	F	121					124	100	F	119				
		Right	119	101	F	437					115	96	F	437					119	100	F	437				
	West	Left	17	25	B	87	1121	20	25	B	11	15	A	89	1126	11	15	A	10	15	A	89	1125	11	15	A
		Thru	20	25	B	1034					12	15	A	1037					12	15	A	1036				

Intersection Name	Approach Name	Movement Name	Stage5B								Stage5B(80%Demand)								Stage6							
			Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S)	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	58	19	E	123	357	54	19	D	53	13	D	99	285	47	13	D	55	17	D	123	355	49	17	D
		Thru	48	19	D	175					42	13	C	139					44	17	D	173				
		Right	65	19	E	59					48	13	D	47					54	17	D	59				
	East	Left	5	16	A	109	1187	9	18	A	2	4	A	93	945	6	5	A	4	14	A	109	1195	8	16	A
		Thru	9	18	A	1070					6	5	A	844					8	16	A	1078				
		Right	12	16	A	8					37	6	C	8					6	14	A	8				
	North	Left	40	12	C	85	233	46	12	D	43	8	C	70	188	38	8	C	41	9	C	85	233	38	9	C
		Thru	48	12	D	131					36	8	C	105					34	9	C	131				
		Right	61	12	E	17					32	8	C	13					51	9	D	17				
	West	Left	64	48	E	27	934	56	48	D	35	22	C	21	762	38	22	C	67	52	E	28	949	60	52	E
		Thru	56	48	D	905					38	22	C	739					60	52	E	919				
		Right	66	48	E	2					35	22	C	2					92	52	F	2				
Beecroft Rd & Carlingford Rd	South	Left	24	11	B	882	2172	29	54	C	18	10	B	694	1747	25	25	B	24	12	B	887	2178	27	47	B
		Thru	33	84	C	1290					30	35	C	1053					29	72	C	1291				
	North	Thru	17	15	B	890	1195	30	17	C	16	11	B	701	947	27	13	B	16	11	B	890	1195	29	14	C
		Right	67	24	E	305					57	17	E	246					68	24	E	305				
	West	Left	13	1	A	74	1047	14	19	A	8	0	A	60	854	16	18	B	12	1	A	74	1060	14	19	A
		Right	14	21	A	973					16	19	B	794					14	20	A	986				
Bridge Street / Rawson Street	South	Left	23	6	B	29	198	27	6	B	7	1	A	22	153	9	1	A	44	12	D	29	196	49	12	D
		Thru	22	6	B	91					10	1	A	70					40	12	C	91				
		Right	33	6	C	78					10	1	A	61					62	12	E	76				
	East	Left	14	4	A	34	374	11	4	A	6	1	A	28	301	7	1	A	13	5	A	34	376	16	5	B
		Thru	10	4	A	233					7	1	A	187					16	5	B	235				
		Right	13	4	A	107					7	1	A	86					17	5	B	107				
	North	Left	92	33	F	10	236	74	33	F	34	2	C	9	189	10	2	A	58	20	E	9	229	51	20	D
		Thru	82	33	F	115					9	2	A	89					60	20	E	110				
		Right	64	33	E	111					7	2	A	91					42	20	C	110				
	West	Left	12	4	A	119	177	19	4	B	7	2	A	95	143	8	2	A	16	6	B	118	174	24	6	B
		Thru	38	4	C	46					11	2	A	38					43	6	C	44				
		Right	18	4	B	12					7	2	A	10					29	6	B	12				
Beecroft Road / High Street / Bridge Street	South	Left	17	0	B	17	17	17	0	B	17	0	B	14	14	17	0	B	25	0	B	17	17	25	0	B
	East	Left	0	1	A	113	2499	1	0	A	0	0	A	98	2017	0	0	A	1	1	A	115	2505	1	0	A
		Thru	1	0	A	357					0	0	A	287					1	0	A	358				
		Right	1	0	A	2029					0	0	A	1632					1	0	A	2032				
	West	Left	78	29	F	135	135	78	29	F	18	5	B	110	110	18	5	B	85	38	F	131	131	85	38	F
Epping Rd & Blaxland Rd & Langston Pl	South	Left	41	41	C	886	976	44	41	D	34	27	C	669	779	37	27	C	43	41	D	840	980	45	41	D
		Thru	62	41	E	140					59	27	E	110					53	41	D	140				
	East	Left	62	116	E	28	1691	50	116	D	48	66	D	24	1368	35	66	C	56	97	D	29	1698	42	97	C
		Thru	50	116	D	1663					34	66	C	1344					42	97	C	1669				
	North	Left	82	14	F	23	242	62	14	E	60	11	E	19	198	59	11	E	69	13	E	23	242	54	13	D
		Thru	60	14	E	219					59	11	E	179					53	13	D	219				
	West	Left	14	117	A	474	1836	34	117	C	10	49	A	375	1481	22	49	B	6	5	A	476	1867	55	172	D
		Thru	32	117	C	1094					19	49	B	888					4	229	A	1128				
		Right	76	117	F	268					56	49	D	218					362	229	F	263				
Epping Rd & Essex St	South	Left	48	15	D	46	293	53	15	D	55	11	D	32	230	51	11	D	48	15	D	46	293	53	15	D
		Thru	53	15	D	188					50	11	D	150					53	15	D	188				
		Right	56	15	D	59					51	11	D	48					56	15	D	59				
	East	Left	11	18	A	7	1205	20	18	B	16	12	B	6	966	18	13	B	11	18	A	7	1204	20	18	B
		Thru	20	18	B	1198					18	13	B	960					20	18	B	1197				
	North	Left	145	97	F	4	562	116	97	F	30	22	C	3	463	54	22	D	115	89	F	4	563	109	89	F
		Thru	120	97	F	121					54	22	D	99					113	89	F	122				
		Right	115	97	F	437					54	22	D	361					107	89	F	437				
	West	Left	21	18	B	86	1106	16	18	B	20	10	B	74	892	12	10	A	10	15	A	89	1124	12	15	A
		Thru	15	18	B	1020					11	10	A	818					12	15	A	1035				

C. Project Case Drawing

D. Intersection Performance - Future Year Scenarios

D.1 AM Peak

AM PEAK PERIOD MOVEMENT DELAY

2023 Base Year

Intersection Name	Approach Name	Movement Name	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	44	21	D	63	269	73	21	F
		Thru	45	21	D	141				
		Right	162	21	F	65				
	East	Left	3	9	A	84	876	9	11	A
		Thru	10	11	A	788				
		Right	45	11	D	4				
	North	Left	78	37	F	261	483	62	37	E
		Thru	41	37	C	204				
		Right	52	37	D	18				
	West	Left	137	234	F	7	1098	146	234	F
		Thru	146	234	F	1086				
		Right	176	234	F	5				
Beecroft Rd & Carlingford Rd	South	Left	17	2	B	699	1668	31	25	C
		Thru	42	42	C	969				
	North	Thru	27	26	B	1279	1452	31	24	C
		Right	62	14	E	173				
	West	Left	13	0	A	45	1410	10	20	A
		Right	10	20	A	1365				
Bridge Street / Rawson Street	South	Left	11	2	A	12	191	13	2	A
		Thru	11	2	A	99				
		Right	15	2	A	80				
	East	Left	7	1	A	22	198	9	1	A
		Thru	9	1	A	111				
		Right	8	1	A	65				
	North	Left	41	12	C	12	293	26	12	B
		Thru	23	12	B	117				
		Right	27	12	B	164				
	West	Left	15	8	B	175	305	15	8	B
		Thru	16	8	B	115				
		Right	15	8	A	15				
Beecroft Road / High Street / Bridge Street	South	Left	9	0	A	24	24	9	0	A
	East	Left	1	0	A	87	1716	1	0	A
		Thru	1	0	A	178				
		Right	1	0	A	1451				
	West	Left	12	5	A	207	207	12	5	A
Epping Rd & Blaxland Rd & Langston Pl	South	Left	18	20	B	611	794	27	20	B
		Thru	57	20	E	183				
	East	Left	49	75	D	12	1118	54	75	D
		Thru	54	75	D	1106				
	North	Left	54	12	D	39	265	49	12	D
		Thru	48	12	D	226				
	West	Left	26	63	B	270	2640	42	157	C
		Thru	21	167	B	1820				
		Right	122	167	F	550				
Epping Rd & Essex St	South	Left	53	12	D	26	185	57	12	E
		Thru	63	12	E	85				
		Right	52	12	D	74				
	East	Left	9	2	A	14	690	14	7	A
		Thru	14	7	A	676				
	North	Left	126	47	F	2	519	74	47	F
		Thru	72	47	F	83				
		Right	74	47	F	434				
	West	Left	34	74	C	62	1843	25	74	B
		Thru	25	74	B	1781				

Year 2029 Do Min

Intersection Name	Approach Name	Movement Name	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	49	18	D	68	291	62	18	E
		Thru	50	18	D	161				
		Right	106	18	F	62				
	East	Left	1	12	A	108	949	10	14	A
		Thru	11	15	A	837				
		Right	46	14	D	4				
	North	Left	89	45	F	280	542	67	45	E
		Thru	43	45	D	242				
		Right	46	45	D	20				
	West	Left	139	385	F	8	1100	161	385	F
		Thru	161	385	F	1087				
		Right	209	385	F	5				
Beecroft Rd & Carlingford Rd	South	Left	20	4	B	750	1745	32	25	C
		Thru	41	41	C	995				
	North	Thru	27	25	B	1236	1433	32	24	C
		Right	65	17	E	197				
	West	Left	9	1	A	48	1429	10	20	A
		Right	10	20	A	1381				
Bridge Street / Rawson Street	South	Left	28	4	B	12	203	19	4	B
		Thru	18	4	B	110				
		Right	18	4	B	81				
	East	Left	14	2	A	23	211	12	2	A
		Thru	11	2	A	112				
		Right	11	2	A	76				
	North	Left	56	19	D	12	353	30	19	C
		Thru	27	19	B	147				
		Right	31	19	C	194				
	West	Left	25	17	B	182	314	29	17	C
		Thru	33	17	C	117				
		Right	50	17	D	15				
Beecroft Road / High Street / Bridge Street	South	Left	8	0	A	26	26	8	0	A
	East	Left	0	0	A	86	1798	1	0	A
		Thru	1	0	A	183				
		Right	1	0	A	1529				
	West	Left	16	7	B	207	207	16	7	B
Epping Rd & Blaxland Rd & Langston Pl	South	Left	18	20	B	608	802	27	20	B
		Thru	57	20	E	194				
	East	Left	63	78	E	6	1199	51	79	D
		Thru	51	79	D	1193				
	North	Left	49	11	D	39	275	44	11	D
		Thru	43	11	D	236				
	West	Left	26	65	B	275	2604	46	178	D
		Thru	21	191	B	1779				
		Right	134	191	F	550				
Epping Rd & Essex St	South	Left	57	13	E	27	195	59	13	E
		Thru	60	13	E	92				
		Right	59	13	E	76				
	East	Left	10	2	A	17	712	14	8	A
		Thru	14	8	A	695				
	North	Left	0	164	A	0	561	172	164	F
		Thru	176	164	F	74				
		Right	172	164	F	487				
	West	Left	36	74	C	60	1802	26	74	B
		Thru	26	74	B	1742				

Year 2029 Project Case

Intersection Name	Approach Name	Movement Name	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	47	23	D	68	298	74	23	F
		Thru	44	23	D	163				
		Right	171	23	F	67				
	East	Left	1	8	A	108	985	7	10	A
		Thru	8	10	A	870				
		Right	19	10	B	7				
	North	Left	103	51	F	278	541	75	51	F
		Thru	44	51	D	243				
		Right	54	51	D	20				
	West	Left	42	55	C	7	1093	53	55	D
		Thru	53	55	D	1081				
		Right	76	55	F	5				
Beecroft Rd & Carlingford Rd	South	Left	13	1	A	796	1803	28	24	B
		Thru	40	42	C	1007				
	North	Thru	28	25	B	1234	1429	33	24	C
		Right	65	17	E	195				
	West	Left	8	0	A	47	1427	10	18	A
		Right	10	18	A	1380				
Bridge Street / Rawson Street	South	Left	23	5	B	12	203	18	5	B
		Thru	17	5	B	110				
		Right	20	5	B	81				
	East	Left	13	2	A	23	217	11	2	A
		Thru	12	2	A	118				
		Right	10	2	A	76				
	North	Left	48	16	D	11	352	28	16	B
		Thru	25	16	B	147				
		Right	29	16	B	194				
	West	Left	9	3	A	182	313	10	3	A
		Thru	10	3	A	117				
		Right	13	3	A	14				
Beecroft Road / High Street / Bridge Street	South	Left	4	0	A	26	26	4	0	A
	East	Left	1	0	A	87	1855	2	0	A
		Thru	1	0	A	190				
		Right	2	0	A	1578				
	West	Left	14	5	A	207	207	14	5	A
Epping Rd & Blaxland Rd & Langston Pl	South	Left	19	22	B	616	810	28	22	B
		Thru	56	22	D	194				
	East	Left	71	46	F	5	1239	47	46	D
		Thru	47	46	D	1234				
	North	Left	55	12	D	39	277	45	12	D
		Thru	44	12	D	238				
	West	Left	32	117	C	267	2565	26	131	B
		Thru	22	132	B	1746				
		Right	36	132	C	552				
Epping Rd & Essex St	South	Left	51	12	D	26	186	59	12	E
		Thru	63	12	E	88				
		Right	58	12	E	72				
	East	Left	14	3	A	17	714	16	8	B
		Thru	16	8	B	697				
	North	Left	181	81	F	1	627	88	81	F
		Thru	93	81	F	82				
		Right	88	81	F	544				
	West	Left	34	55	C	60	1805	20	55	B
		Thru	20	55	B	1745				

Year 2039 Project Case

Intersection Name	Approach Name	Movement Name	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	47	26	D	74	310	74	26	F
		Thru	49	26	D	183				
		Right	202	26	F	53				
	East	Left	3	11	A	114	1088	8	13	A
		Thru	8	13	A	968				
		Right	28	13	B	6				
	North	Left	185	104	F	278	628	109	104	F
		Thru	47	104	D	331				
		Right	51	104	D	19				
	West	Left	47	54	D	10	1094	53	54	D
		Thru	53	54	D	1079				
		Right	81	54	F	5				
Beecroft Rd & Carlingford Rd	South	Left	15	3	B	901	1975	29	27	C
		Thru	41	47	C	1074				
	North	Thru	28	29	B	1206	1397	34	28	C
		Right	70	18	F	191				
	West	Left	8	0	A	48	1413	9	17	A
		Right	10	17	A	1365				
Bridge Street / Rawson Street	South	Left	12	9	A	12	216	28	9	B
		Thru	30	9	C	124				
		Right	27	9	B	80				
	East	Left	15	4	B	23	247	16	4	B
		Thru	16	4	B	142				
		Right	18	4	B	82				
	North	Left	48	32	D	11	450	39	32	C
		Thru	38	32	C	222				
		Right	40	32	C	217				
	West	Left	17	9	B	184	318	18	9	B
		Thru	19	9	B	118				
		Right	21	9	B	16				
Beecroft Road / High Street / Bridge Street	South	Left	2	0	A	26	26	2	0	A
	East	Left	1	0	A	99	2061	3	1	A
		Thru	1	1	A	218				
		Right	3	1	A	1744				
	West	Left	22	9	B	209	209	22	9	B
Epping Rd & Blaxland Rd & Langston Pl	South	Left	20	23	B	639	841	28	23	B
		Thru	55	23	D	202				
	East	Left	0	58	A	0	1407	53	58	D
		Thru	53	58	D	1407				
	North	Left	60	15	E	38	308	52	15	D
		Thru	51	15	D	270				
	West	Left	43	118	C	271	2541	29	134	C
		Thru	25	136	B	1718				
		Right	36	136	C	552				
Epping Rd & Essex St	South	Left	45	12	D	29	198	56	12	D
		Thru	58	12	E	97				
		Right	56	12	D	72				
	East	Left	17	5	B	20	760	21	12	B
		Thru	21	12	B	740				
	North	Left	80	74	F	2	760	63	74	E
		Thru	68	74	E	82				
		Right	63	74	E	676				
	West	Left	54	129	D	62	1774	45	129	D
		Thru	44	129	D	1712				

Year 2039 Do Min

Intersection Name	Approach Name	Movement Name	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	50	29	D	75	316	83	29	F
		Thru	45	29	D	186				
		Right	257	29	F	55				
	East	Left	2	14	A	114	1009	10	16	A
		Thru	10	16	A	891				
		Right	38	15	C	4				
	North	Left	144	81	F	283	634	91	81	F
		Thru	48	81	D	332				
		Right	53	81	D	19				
	West	Left	138	320	F	11	1118	155	320	F
		Thru	155	320	F	1102				
		Right	213	320	F	5				
Beecroft Rd & Carlingford Rd	South	Left	19	2	B	811	1814	31	25	C
		Thru	41	43	C	1003				
	North	Thru	28	29	B	1208	1401	35	28	C
		Right	80	21	F	193				
	West	Left	12	0	A	51	1438	10	19	A
		Right	10	20	A	1387				
Bridge Street / Rawson Street	South	Left	11	6	A	12	219	23	6	B
		Thru	25	6	B	126				
		Right	21	6	B	81				
	East	Left	18	3	B	23	216	15	3	B
		Thru	14	3	A	118				
		Right	16	3	B	75				
	North	Left	66	50	E	11	453	54	50	D
		Thru	50	50	D	222				
		Right	57	50	D	220				
	West	Left	31	22	C	179	308	33	22	C
		Thru	34	22	C	114				
		Right	49	22	D	15				
Beecroft Road / High Street / Bridge Street	South	Left	11	0	A	26	26	11	0	A
	East	Left	1	0	A	93	1878	1	0	A
		Thru	2	0	A	192				
		Right	1	0	A	1593				
	West	Left	16	7	B	208	208	16	7	B
Epping Rd & Blaxland Rd & Langston Pl	South	Left	18	21	B	630	832	28	21	B
		Thru	58	21	E	202				
	East	Left	0	103	A	0	1247	64	104	E
		Thru	64	104	E	1247				
	North	Left	63	14	E	38	308	51	14	D
		Thru	49	14	D	270				
	West	Left	36	71	C	282	2575	43	152	C
		Thru	22	162	B	1737				
		Right	110	162	F	556				
Epping Rd & Essex St	South	Left	65	14	E	32	208	60	14	E
		Thru	60	14	E	102				
		Right	59	14	E	74				
	East	Left	9	2	A	20	760	13	7	A
		Thru	14	7	A	740				
	North	Left	0	164	A	0	557	173	164	F
		Thru	186	164	F	68				
		Right	171	164	F	489				
	West	Left	34	67	C	61	1772	25	67	B
		Thru	25	67	B	1711				

D.2 PM Peak

PM PEAK PERIOD MOVEMENT DELAY

Intersection Name	Approach Name	Movement Name	Control Type	2023 Base Year								Year 2029 Do Min							
			Base Year	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	Signalised	54	17	D	123	356	50	17	D	55	20	D	128	402	53	20	D
		Thru	Signalised	45	17	D	174					51	20	D	209				
		Right	Signalised	54	17	D	59					52	20	D	65				
	East	Left	Signalised	1	13	A	109	1184	8	16	A	1	10	A	122	1209	7	12	A
		Thru	Signalised	8	16	A	1068					8	12	A	1079				
		Right	Signalised	19	15	B	7					20	10	B	8				
	North	Left	Signalised	41	10	C	85	234	40	10	C	43	11	D	105	265	41	11	C
		Thru	Signalised	37	10	C	132					39	11	C	142				
		Right	Signalised	56	10	D	17					37	11	C	18				
	West	Left	Signalised	53	40	D	28	952	50	40	D	180	240	F	28	975	185	240	F
		Thru	Signalised	50	40	D	922					185	240	F	946				
		Right	Signalised	62	40	E	2					203	240	F	1				
Beecroft Rd & Carlingford Rd	South	Left	Signalised	31	12	C	880	2168	34	59	C	25	8	B	882	2233	34	65	C
		Thru	Signalised	36	91	C	1288					40	102	C	1351				
	North	Thru	Signalised	17	10	B	889	1194	32	14	C	39	36	C	884	1210	55	35	D
		Right	Signalised	75	26	F	305					99	33	F	326				
	West	Left	UNSIGNALISED	11	2	A	74	1061	14	19	A	11	2	A	79	1114	17	20	B
		Right	Signalised	14	21	A	987					18	21	B	1035				
Bridge Street / Rawson Street	South	Left	UNSIGNALISED	11	4	A	29	196	16	4	B	16	4	B	28	219	17	4	B
		Thru	UNSIGNALISED	17	4	B	91					15	4	B	115				
		Right	UNSIGNALISED	18	4	B	76					20	4	B	76				
	East	Left	UNSIGNALISED	7	2	A	34	369	8	2	A	10	3	A	35	374	9	3	A
		Thru	UNSIGNALISED	8	2	A	229					9	3	A	221				
		Right	UNSIGNALISED	10	2	A	106					9	3	A	118				
	North	Left	UNSIGNALISED	45	4	D	9	230	13	4	A	40	4	C	9	243	12	4	A
		Thru	UNSIGNALISED	12	4	A	111					11	4	A	120				
		Right	UNSIGNALISED	12	4	A	110					12	4	A	114				
	West	Left	UNSIGNALISED	8	2	A	118	174	9	2	A	20	7	B	127	207	20	7	B
		Thru	UNSIGNALISED	10	2	A	44					19	7	B	68				
		Right	UNSIGNALISED	9	2	A	12					13	7	A	12				
Beecroft Road / High Street / Bridge Street	South	Left	UNSIGNALISED	11	0	A	17	17	11	0	A	10	0	A	17	17	10	0	A
	East	Left	UNSIGNALISED	0	0	A	115	2500	1	0	A	1	0	A	131	2568	2	1	A
		Thru	UNSIGNALISED	2	0	A	354					2	1	A	357				
		Right	UNSIGNALISED	1	0	A	2031					2	1	A	2080				
	West	Left	UNSIGNALISED	26	7	B	128	128	26	7	B	31	10	C	152	152	31	10	C
Epping Rd & Blaxland Rd & Langston Pl	South	Left	Signalised	45	42	D	837	977	47	42	D	43	40	D	844	1000	45	40	D
		Thru	Signalised	58	42	E	140					58	40	E	156				
	East	Left	Signalised	38	98	C	29	1696	48	98	D	48	109	D	30	1754	52	109	D
		Thru	Signalised	49	98	D	1667					52	109	D	1724				
	North	Left	Signalised	70	13	F	23	242	54	13	D	65	12	E	22	249	47	12	D
		Thru	Signalised	52	13	D	219					45	12	D	227				
	West	Left	UNSIGNALISED	9	10	A	479	1867	57	165	D	10	10	A	565	1912	61	235	E
		Thru	Signalised	8	218	A	1130					7	329	A	1077				
		Right	Signalised	357	218	F	258					384	329	F	270				
Epping Rd & Essex St	South	Left	Signalised	48	15	D	46	293	53	15	D	54	18	D	51	339	56	18	D
		Thru	Signalised	53	15	D	188					56	18	D	219				
		Right	Signalised	56	15	D	59					54	18	D	69				
	East	Left	Signalised	12	7	A	7	1202	21	19	B	20	8	B	7	1212	22	20	B
		Thru	Signalised	21	19	B	1195					22	20	B	1205				
	North	Left	Signalised	171	101	F	4	562	120	101	F	99	87	F	2	583	102	87	F
		Thru	Signalised	122	101	F	121					101	87	F	119				
		Right	Signalised	119	101	F	437					102	87	F	462				
	West	Left	Signalised	17	25	B	87	1121	20	25	B	16	19	B	74	1067	17	19	B
		Thru	Signalised	20	25	B	1034					17	19	B	993				

Intersection Name	Approach Name	Movement Name	Year 2029 Project Case								Year 2039 Project Case								Year 2039 Do Min							
			Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS	Avg. Delay (S	Avg. Queue (m)	LoS	Tot Vehicles	Approach Volume	Approach Delay (S)	Approach Avg. Queue (m)	Approach LoS
Carlingford Rd & Ray Rd & Rawson St	South	Left	61	22	E	128	401	58	22	E	71	32	F	136	453	72	32	F	133	77	F	98	354	150	77	F
		Thru	55	22	D	209					65	32	E	240					120	77	F	186				
		Right	62	22	E	64					93	32	F	77					255	77	F	70				
	East	Left	2	10	A	125	1207	7	11	A	1	14	A	122	1171	8	15	A	48	31	D	93	1083	13	32	A
		Thru	7	11	A	1073					9	15	A	1040					10	32	A	983				
		Right	11	11	A	9					18	14	B	9					6	19	A	7				
	North	Left	46	14	D	105	267	48	14	D	39	19	C	123	318	49	19	D	69	36	E	122	311	120	36	F
		Thru	49	14	D	144					56	19	D	177					152	36	F	171				
		Right	60	14	E	18					55	19	D	18					170	36	F	18				
	West	Left	60	59	E	28	1022	58	59	E	171	480	F	31	1043	184	480	F	201	493	F	26	894	217	493	F
		Thru	58	59	E	992					184	480	F	1010					217	493	F	865				
		Right	88	59	F	2					210	480	F	2					265	493	F	3				
Beecroft Rd & Carlingford Rd	South	Left	23	10	B	877	2220	29	40	B	33	14	C	863	2364	45	123	D	52	48	D	830	2283	53	135	D
		Thru	33	60	C	1343					51	186	D	1501					53	185	D	1453				
	North	Thru	19	11	B	881	1210	34	16	C	22	26	B	914	1224	38	27	C	119	393	F	833	1082	155	312	F
		Right	75	27	F	329					82	28	F	310					277	40	F	249				
	West	Left	11	1	A	74	1164	13	19	A	15	2	B	61	1211	14	21	A	19	2	B	58	1057	21	30	B
		Right	13	20	A	1090					14	22	A	1150					21	31	B	999				
Bridge Street / Rawson Street	South	Left	28	6	B	27	218	21	6	B	33	18	C	28	235	56	18	D	220	101	F	29	232	256	101	F
		Thru	22	6	B	115					49	18	D	130					235	101	F	127				
		Right	18	6	B	76					76	18	F	77					305	101	F	76				
	East	Left	12	4	A	35	373	10	4	A	14	5	A	34	376	16	5	B	44	30	D	35	386	49	30	D
		Thru	10	4	A	220					15	5	A	202					47	30	D	208				
		Right	11	4	A	118					19	5	B	140					55	30	D	143				
	North	Left	40	5	C	9	243	14	5	A	71	25	F	10	272	54	25	D	448	234	F	10	265	338	234	F
		Thru	11	5	A	120					56	25	D	141					343	234	F	144				
		Right	15	5	B	114					51	25	D	121					321	234	F	111				
	West	Left	12	3	A	127	208	11	3	A	306	408	F	141	327	339	408	F	563	415	F	77	201	587	415	F
		Thru	10	3	A	69					371	408	F	173					605	415	F	119				
		Right	8	3	A	12					275	408	F	13					530	415	F	5				
Beecroft Road / High Street / Bridge Street	South	Left	3	0	A	17	17	3	0	A	3	0	A	18	18	3	0	A	16	0	B	18	18	16	0	B
	East	Left	1	0	A	128	2546	1	0	A	1	0	A	151	2619	4	2	A	2	2	A	146	2594	4	4	A
		Thru	1	0	A	355					1	3	A	360					8	4	A	360				
		Right	1	0	A	2063					5	3	A	2108					4	4	A	2088				
	West	Left	17	5	B	154	154	17	5	B	86	63	F	264	264	86	63	F	142	96	F	196	196	142	96	F
Epping Rd & Blaxland Rd & Langston Pl	South	Left	40	41	C	865	1023	43	41	C	71	76	F	896	1062	75	76	F	134	177	F	913	1083	135	177	F
		Thru	59	41	E	158					94	76	F	166					139	177	F	170				
	East	Left	15	26	B	29	1713	19	26	B	20	30	B	31	1755	23	30	B	80	274	F	30	1708	95	275	F
		Thru	19	26	B	1684					23	30	B	1724					95	275	F	1678				
	North	Left	58	13	E	21	249	51	13	D	66	13	E	23	266	51	13	D	67	13	E	24	270	50	13	D
		Thru	50	13	D	228					50	13	D	243					48	13	D	246				
	West	Left	13	19	A	573	1963	18	32	B	14	24	A	696	2052	18	37	B	9	11	A	627	1817	63	250	E
		Thru	11	37	A	1090					10	44	A	1025					4	376	A	925				
		Right	52	37	D	300					53	44	D	331					398	376	F	265				
Epping Rd & Essex St	South	Left	53	18	D	50	338	55	18	D	72	28	F	50	402	66	28	E	72	26	F	51	403	64	26	E
		Thru	56	18	D	219					64	28	E	269					62	26	E	269				
		Right	54	18	D	69					72	28	F	83					65	26	E	83				
	East	Left	19	8	B	7	1215	21	20	B	18	8	B	8	1280	20	19	B	31	13	C	8	1254	52	45	D
		Thru	21	20	B	1208					20	19	B	1272					52	46	D	1246				
	North	Left	99	84	F	2	575	100	84	F	124	72	F	4	564	97	72	F	126	88	F	4	549	127	88	F
		Thru	99	84	F	116					107	72	F	124					119	88	F	122				
		Right	100	84	F	457					94	72	F	436					129	88	F	423				
	West	Left	13	7	A	74	1091	7	7	A	16	6	B	56	1023	7	6	A	18	11	B	53	936	13	11	A
		Thru	7	7	A	1017					6	6	A	967					12	11	A	883				

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