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ATTACHMENT 6
LINDUM LEVEL CROSSING
TRANSPORT MODELLING REPORT
SHORT-TERM SIGNALISATION

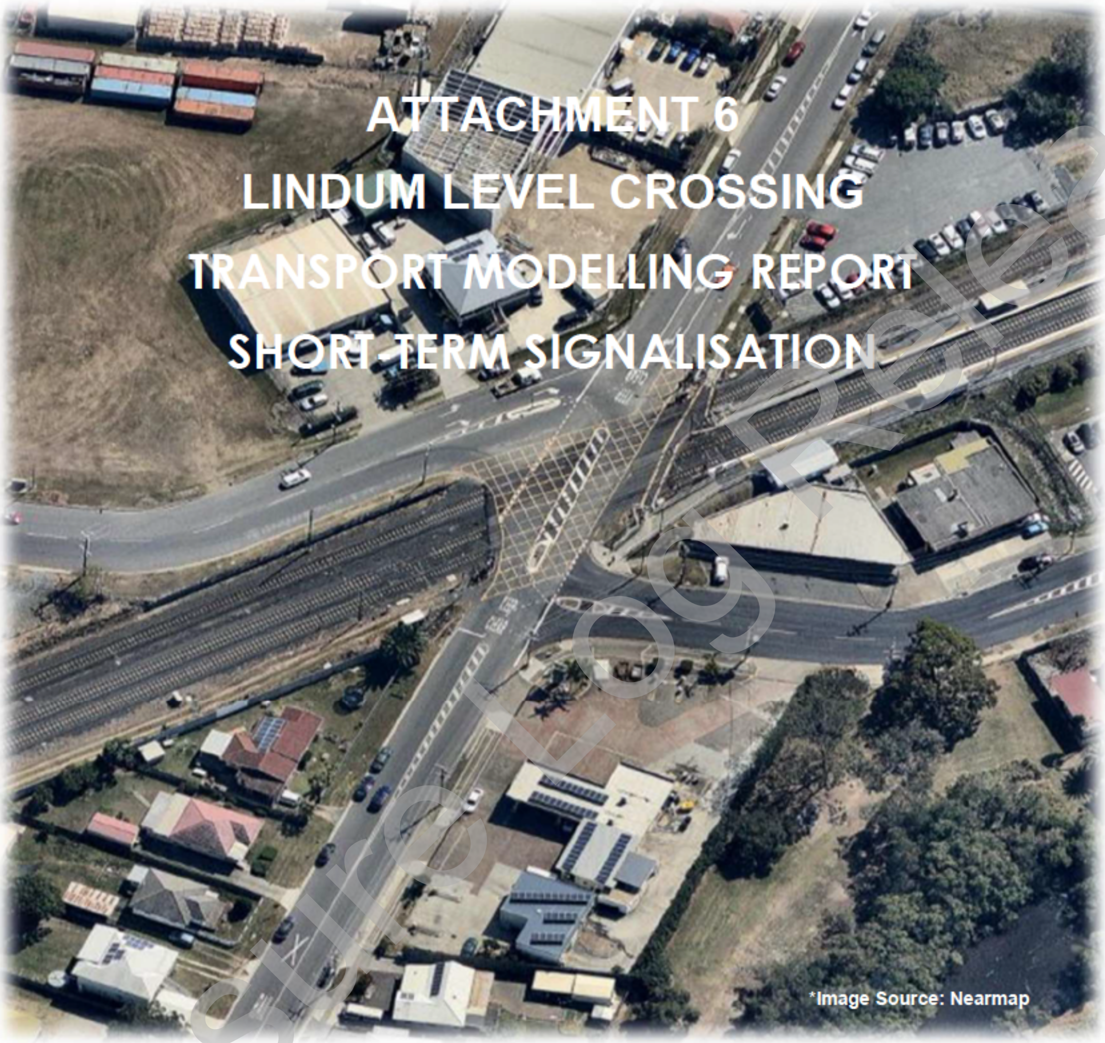

*Image Source: Nearmap

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1 INTRODUCTION

The Lindum Open Level Crossing (OLC) is located on the Kianawah Road - Lindum Road corridor which is an important arterial route that is bisected by the Cleveland rail line. The site is located in close proximity to the Port of Brisbane Motorway and serves as one of only three north-south access points to the Motorway to/from the Port of Brisbane industrial area.

The is being considered for interim upgrade to improve safety and predicted future congestion. City Projects Office (CPO - Brisbane Infrastructure) requested Brisbane City Council's Transport Engineering Studies Group (TEG) to undertake a transport investigation and assessment of the existing and future conditions within the study area. The purpose of this document is to summarise the findings of the Lindum OLC transport modelling investigations. The location of the study area and its surrounding environs is shown in **Figure 1-1**.

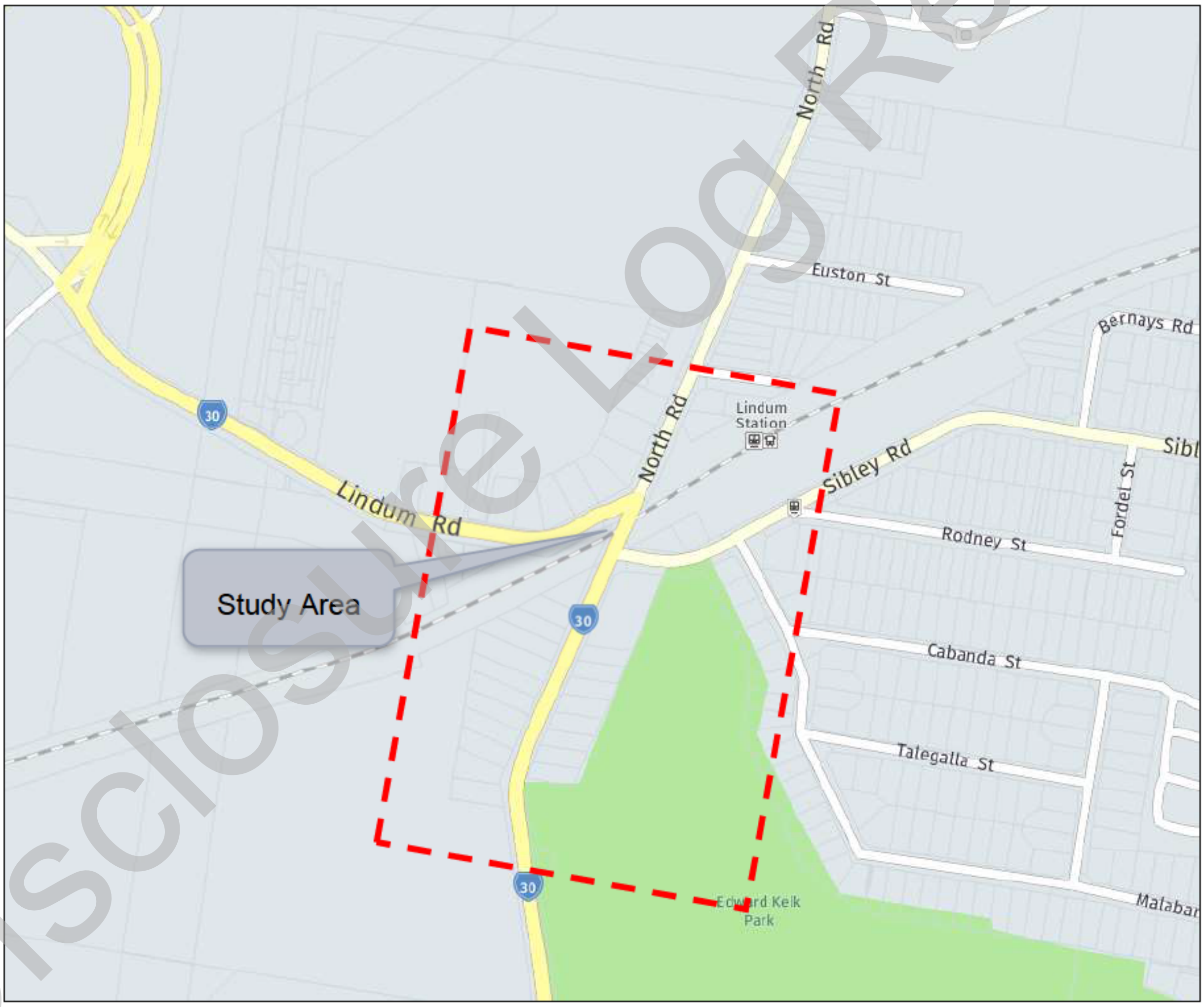

Figure 1-1: Subject Site and Surrounds

1.1 Purpose of this Report

This report sets out at an assessment of the transport implications of the proposed OLC upgrade, including consideration of the following:

1. Future traffic demands.
2. Design solutions to predicted changes in travel patterns.
3. Assessment of proposed future intersection options.
4. Project benefits evaluation for the preferred option.

2 ROAD NETWORK

2.1 Road Hierarchy

Lindum Road/ Kianawah Road corridor is an important arterial route that is bisected by the Cleveland rail line. The site is located in close proximity to the Port of Brisbane Motorway and serves as one of only three north-south access points to the Motorway to/from the Port of Brisbane industrial area.

By definition, an arterial route provides a major access route to a City with connections to major centres and facilitates important links in the public transport and freight networks. Lindum Road is currently a two-lane carriageway road between Lytton Road in the North-West and connects to North Road and Kianawah Road in the South-East. Kianawah Road achieves a major access route to the southern suburbs of Hemmant, Tingalpa, Wakerley and Gumdale.

North Road and Sibley Road are classified as District roads that connect to large residential districts north and east of the level crossing. North Road provides a main access connection to Iona College and Sandy Camp Road which is a main access route to Wynnum North. Sibley Road provides access to the Lindum Station Park and Ride and achieves a western connection to Wynnum State School and Wynnum. **Figure 2-1** shows current City Plan road hierarchy around the study area.

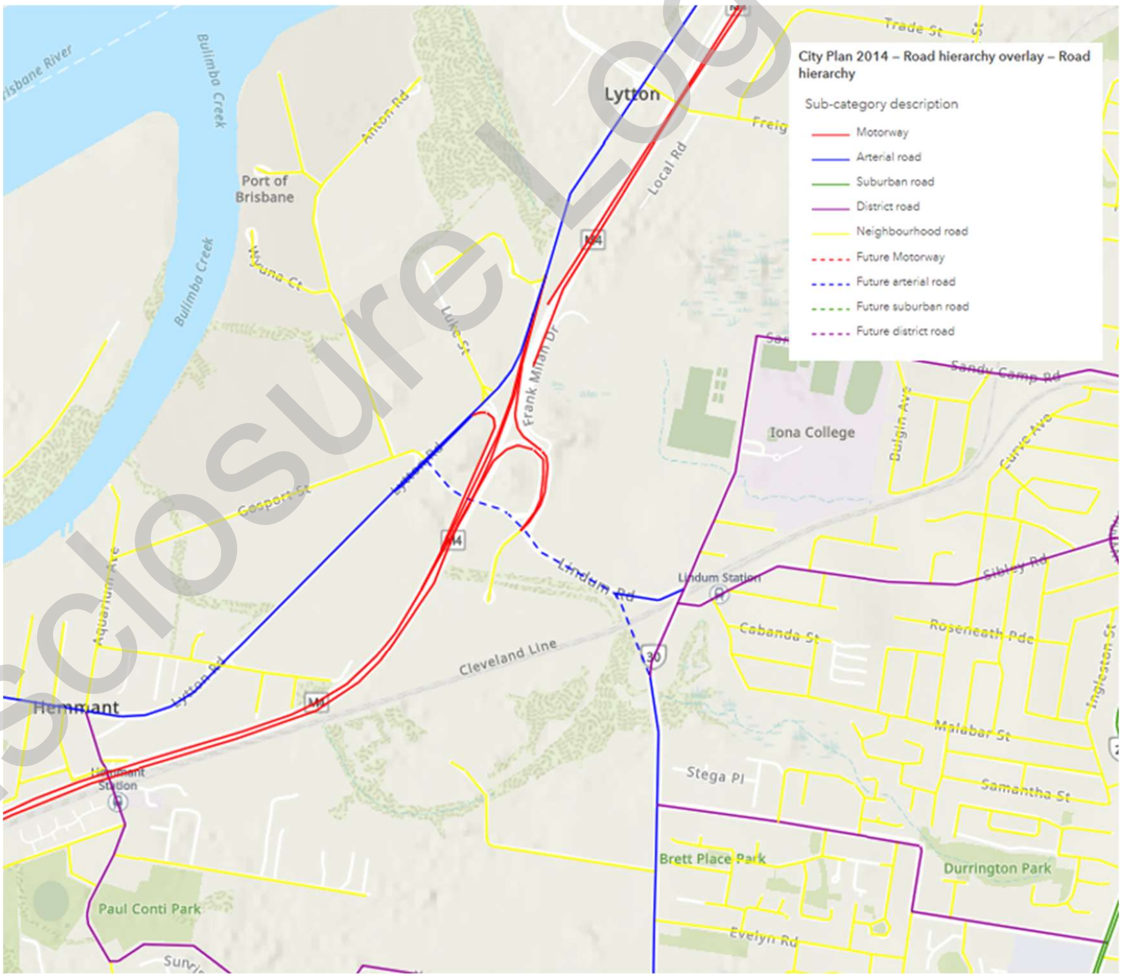

Figure 2-1: Current City Plan 2014 Road Hierarchy Overlay

2.2 Road Operations

The railway level crossing has busy priority controlled intersections closely spaced on the northern and southern sides of the crossing. The major movement via Lindum Road to Kianawah Road is controlled by a stop sign with very long queues and delays forming in peak hours.

Turn geometry between Lindum Road and Kianawah Road happens at an acute angle which reduces turn speeds and creates increased difficulty in navigation for heavy vehicles. Sibley Road approach south of the railway line is also controlled by a stop sign with poor geometry next to the railway crossing. This approach also experiences high delays while turning through long queues that form on Kianawah Road on the southern approach.

2.3 Base Year Volumes

A volume profile for Lindum Road OLC between 6:00am and 7:00pm was determined using traffic counts undertaken on 28 April 2021. This is illustrated in **Figure 2-2** and shows the average two-way volume by hour.

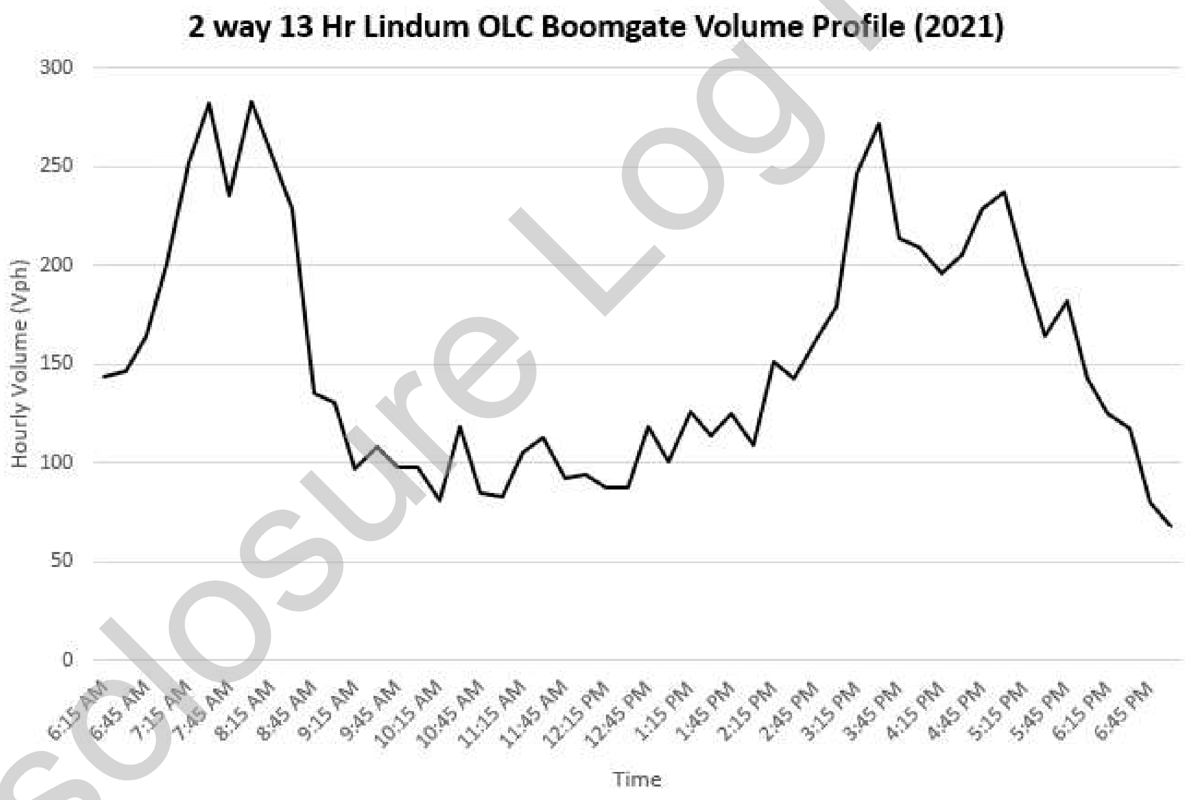

Figure 2-2 : Lindum Road OLC (two-way) 13Hr Volume Profile

The 13 hour profile shows that the PM peak hours extends from 3pm to 6:00pm with a dominant school peak occurring at 3pm prior to the later road peak at 5pm. The AM peak is higher and sharper peaking at 7:15am to 8:15am. The percentage of heavy vehicles at the Lindum OLC boomgate averages 3.6%.

A summary of Daily Traffic volumes by approach with Heavy Vehicle proportions is included in **Table 2-1.** Results from the 17^{h} July 2018 boom gate survey and the 28th April 2021 intersection and boomgate surveys are included. By comparison the volume of traffic crossing the Open Level Crossing has increased by 2000 vpd since 2018 based on the day of survey.

Table 2-1: Daily Two Way Traffic Volumes (rounded to the nearest 1,000)

Location	Wednesday, 28 April 2021	Tuesday, 17 July 2018
OLC	10,000 vpd (4%HV)	8,000 vpd (4% HV)
Lindum Rd	10,000 vpd (5%HV)	N/a
North Rd	7,000 vpd (3%HV)	N/a
Sibley Rd	6,000 vpd (3%HV)	N/a
Kianawah Rd	9,000 vpd (3%HV)	N/a

2.4 Cycling Routes

The City Plan transport overlay outlines existing and future active transport routes within the Lindum Road OLC study area. Future cycle routes are shown in **Figure 2-3**. There are no primary routes leading to the level crossing, however, secondary routes exist alongside the railway line and along Kianawah Road and North Road. Lindum Road and Sibley Road have designated local routes. It should be noted that no cycle infrastructure facilities currently exist in the study area.

Figure 2-3: Bicycle Hierarchy - City Plan 2014 (15 December 2017)

Figure 2-4 shows the cyclist movements based on the 13-hour survey data (28 April 2021). Generally very minimal cycle activity was observed. The highest movement observed was southbound on Kianawah Road from North Road.

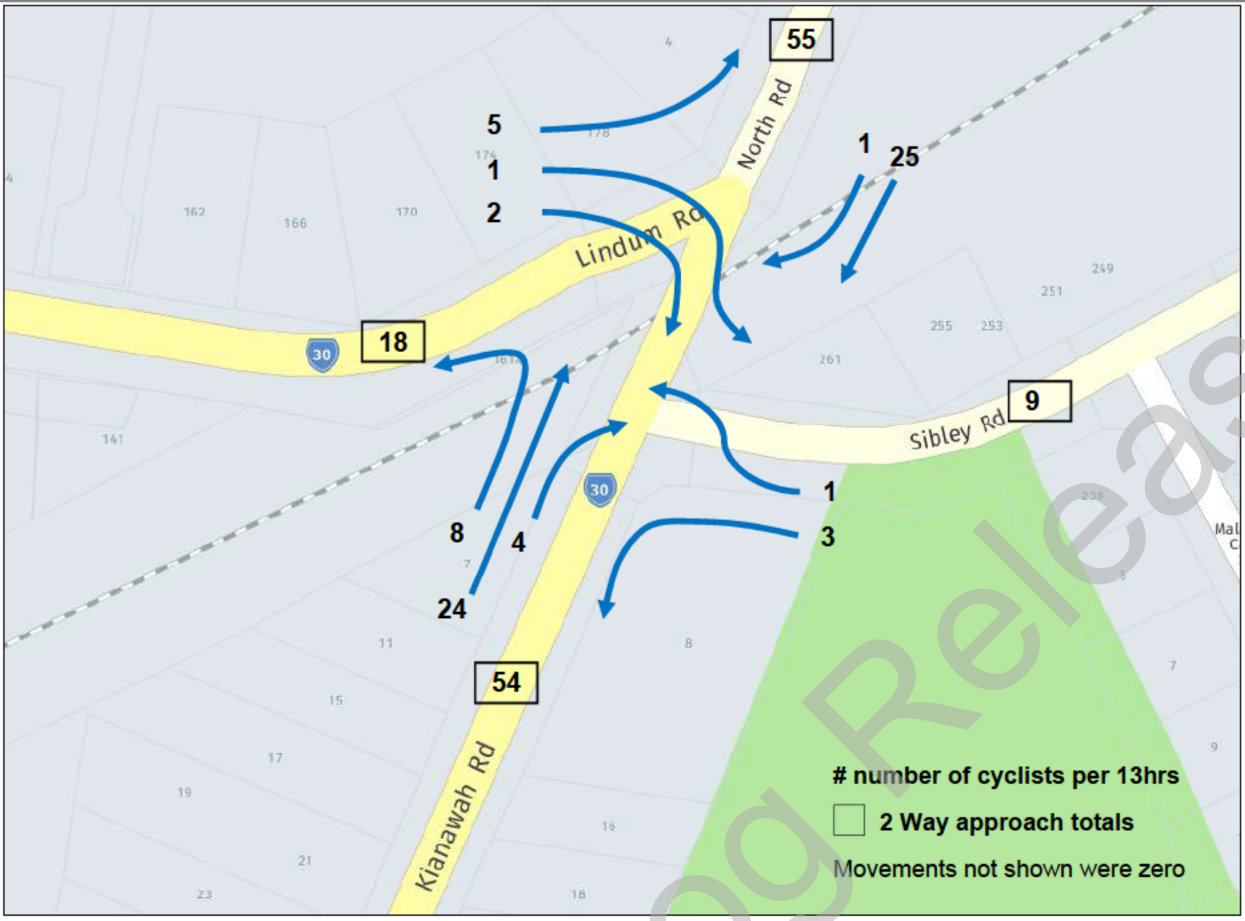

Figure 2-4: Cyclist Movements (28 April 2021 Survey)

2.5 Pedestrian Movements

Pedestrian movement surveys were conducted on 28 April 2021. The survey results for the road crossing are summarised in **Figure 2-5** for the morning peak, and **Figure 2-6** for the afternoon peak. **Figure 2-5** shows the busiest pedestrian movement in the morning is along the eastern side of North Road with 42 pedestrians during the peak hour. The second highest pedestrian movement appears in the eastern side of Kianawah Road towards Sibley Road. Both of these movements appear to be related to the Lindum Train Station. The number of pedestrians crossing the LLC is not shown because the existing pedestrian crossing near the station and the boom gate signals already cater for these movements.

Figure 2-6 shows the busiest pedestrian movement in the PM peak hour is along the eastern side of Kianawah Road south of Sibley Road with 28 pedestrians. The second highest pedestrian movement occurs on the northern side of Sibley Road leading to the train station and shops from North Road.

With the changes of signal control at this intersection, the existing pedestrian movements are expected to change.

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[redacted]

Figure 2-5: Pedestrian Movements (AM)

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[redacted]

Figure 2-6: Pedestrian Movements (PM)

2.6 Parking Origin-Destination (OD) Survey

An Origin Destination (OD) survey was conducted by Austraffic on 25 May 2021 to capture the origin and destination of travel paths through the intersections either side of the level crossing. Sites on all approach roads and Lindum Train Station car park access points were selected to track localised movements through the intersections through the focussed study area. **Figure 2-7** below shows the survey design and the cordon sites for capturing movements entering and exiting the survey area.

The survey period focused on three hours from 6:30am to 9:30am in the morning and four hours from 2:30pm to 6:30pm in the afternoon.

Figure 2-7: OD Survey Design

Figure 2-8 and **Figure 2-9** shows the OD traffic patterns relating to the two carpark entry and exit points for the Lindum Train Station car park on Sibley Road for AM and PM peak periods. Some observations from the AM peak period results show larger numbers on trips from:

- Kianawah Rd to Site 4: 52 trips
- Site 5 to Kianawah Rd: 24 trips
- Sibley Rd to Site 5: 21 trips
- Malabar St to Site 4: 18 trips

This indicates that the majority of trips to the Lindum Train Station car park south of the railway line travel to and from Kianawah Rd to the south.

The PM peak period results show the highest activity is to Site 5 to Sibley Rd with 17 trips.

The results for other travel paths through the intersection were used to adjust the AIMSUN Microsimulation Model for the Study area discussed later in this report.

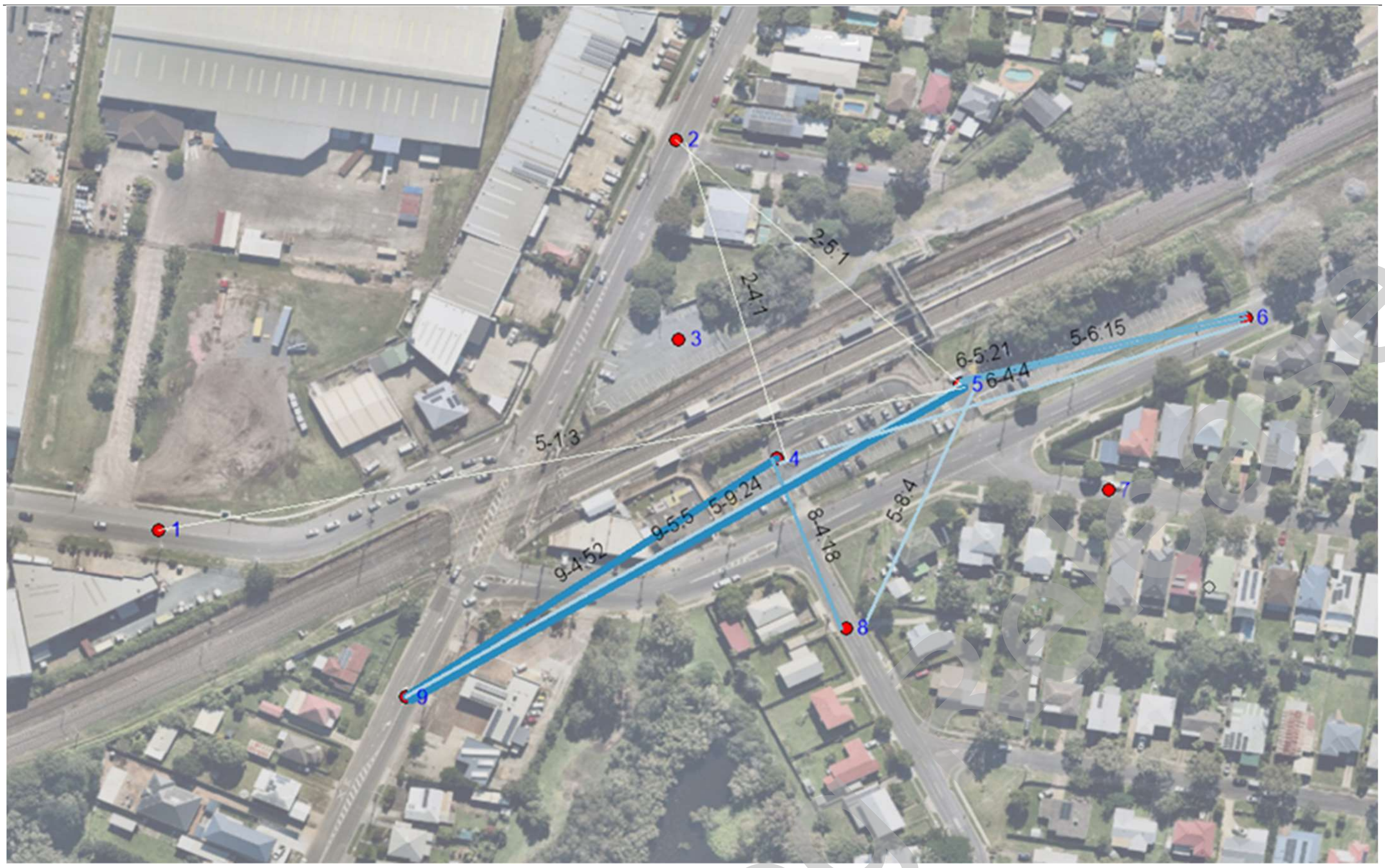


Figure 2-8: OD Survey (AM Peak)

Figure 2-9: OD Survey (PM Peak)

2.7 Traffic Crash History

A review of the traffic crash history for these road sections was undertaken using data from Transport and Main Road's (TMR) Crash Analysis Reporting System (CARS) for crashes occurring between 1st July 2016 and 30 June 2021. This is the most recent 5-year period of data available at the time of writing this report. A total of 6 crashes were reported around the Lindum OLC study area.

A summary of the severity of crashes is included **Table 2-2** and the relevant Crash Diagram can be found in **Figure 2-10.** The most common Crash Severity at this intersection is Hospitalisation that resulted in three of the six crashes. The most common Crash Nature is an Angle Crash that caused by through and right movements colliding. One fatal crash occurred in 2021 which involved a vehicle being struck by a train while attempting to cross when the crossing was closed. Other crashes involved angle collisions at the T-intersection on both sides of the level crossing.

Table 2-2 : Crash Severity by Year – Lindum OLC

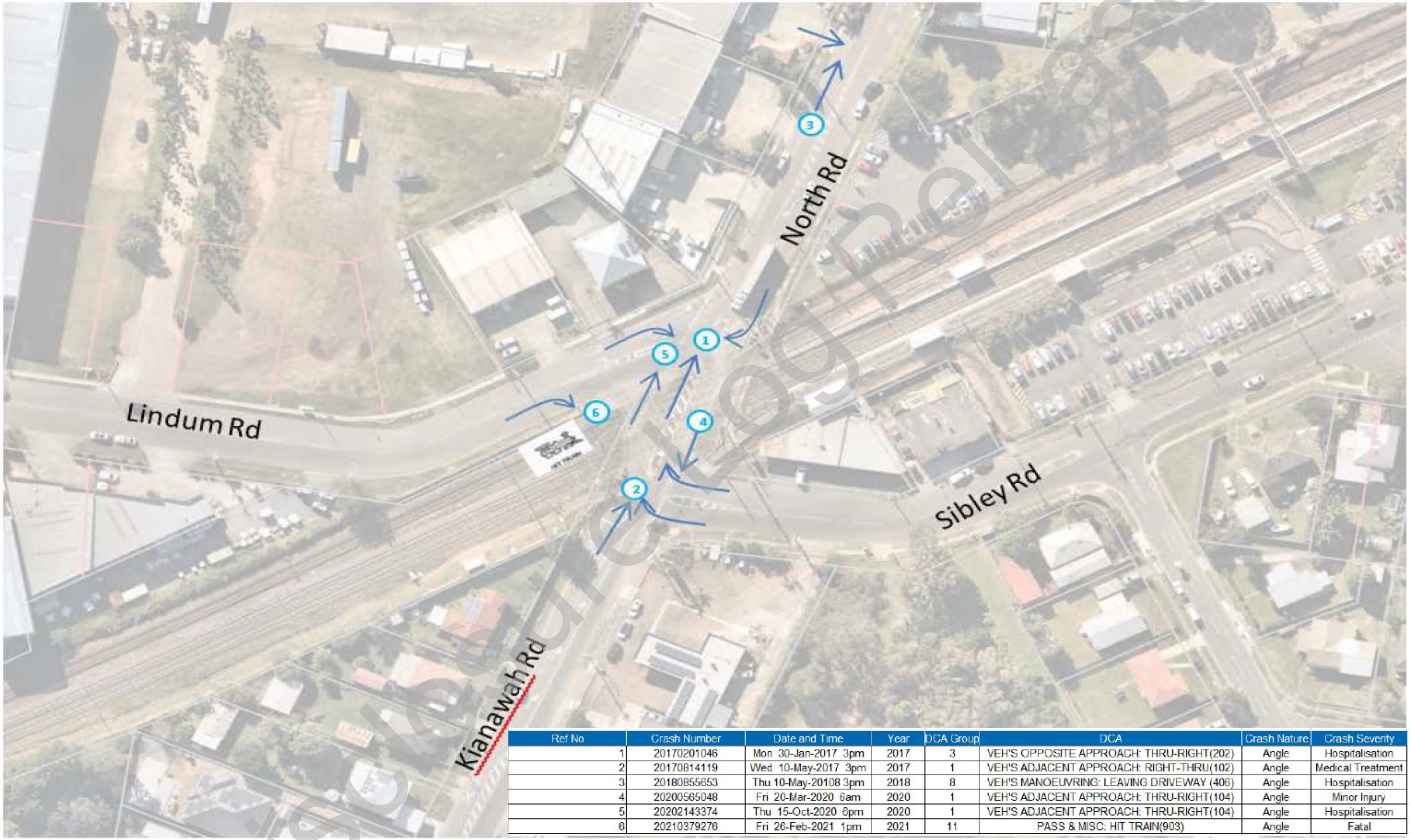
Severity	Year						TOTAL
	2016	2017	2018	2019	2020	2021	
Fatal	0	0	0	0	0	1	1
Hospitalisation	0	1	1	0	1	0	3
Medical Treatment	0	1	0	0	0	0	1
Minor Injury	0	0	0	0	1	0	1
TOTAL	0	2	1	0	2	1	6

It is noted that the above data from the CARS system does not include for a pedestrian fatality on the pedestrian level crossing in 2019.

2.8 Crash Cost

Australian research into the cost of crashes has been developed by Austroads in conjunction with Australian State Road Authorities. The cost of crashes considers the direct costs attributed to medicals, property, trauma, emergency services, legal, insurance and other quantifiable costs associated with road crashes.

The crash nature of an accident is further defined by the Definitions for Coding Accidents (DCA). As part of the federally funded Blackspot program, costs of crashes to the community associated with the crash nature (DCA code) have been developed by TMR and Austroads. A detailed description of the DCA group by crash nature is contained in **Appendix A**. The estimated cost of crashes per annum at the level crossing and both intersections is Sch4Pt3(15) [redacted] per annum.



Ref No	Crash Number	Date and Time	Year	DCA Group	DCA	Crash Nature	Crash Severity
1	20170201046	Mon 30-Jan-2017 3pm	2017	3	VEH'S OPPOSITE APPROACH: THRU-RIGHT(202)	Angle	Hospitalisation
2	20170814119	Wed 10-May-2017 3pm	2017	1	VEH'S ADJACENT APPROACH: RIGHT-THRU(102)	Angle	Medical Treatment
3	20180855653	Thu 10-May-20108 3pm	2018	8	VEH'S MANOEUVRING: LEAVING DRIVEWAY (406)	Angle	Hospitalisation
4	20200565048	Fri 20-Mar-2020 6am	2020	1	VEH'S ADJACENT APPROACH: THRU-RIGHT(104)	Angle	Minor Injury
5	20202143374	Thu 15-Oct-2020 6pm	2020	1	VEH'S ADJACENT APPROACH: THRU-RIGHT(104)	Angle	Hospitalisation
6	20210379276	Fri 26-Feb-2021 1pm	2021	11	PASS & MISC: HIT TRAIN(903)	Angle	Fatal

Figure 2-10 : Lindum OLC Crash Diagram

3 PUBLIC TRANSPORT

Both bus and rail are the major modes of public transport in the study area with rail providing the main role.

The Lindum train station is located on the northern side of Sibley Road between Malabar Street and Bernays Road. Passengers can also access the train platform from the northern side via the pedestrian overpass facility. There is also a bus station located outside the Park n Ride facility on the southern side of the rail line which two community bus services (223 and 224) service.

Translink through Brisbane Transport provides the main scheduled bus services in the area. A general overview of the existing bus routes servicing the study area has been undertaken. **Figure 3-1** illustrates the location the bus routes and stops servicing the study area and connecting roads. Route 819, 815, 5076 and 5077 are school bus services. **Figure 3-2** illustrates the stop locations and IDs.

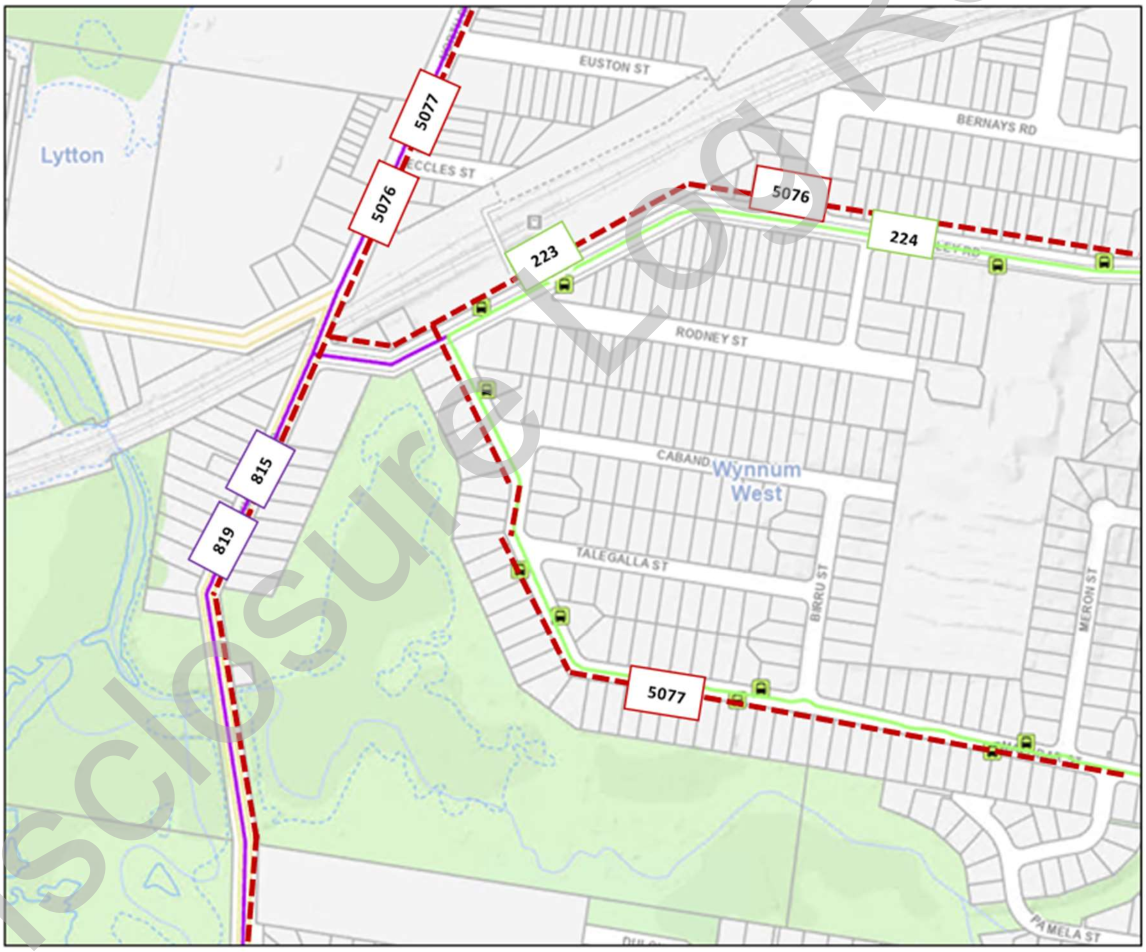


Figure 3-1: Existing Bus Routes and Bus Stops

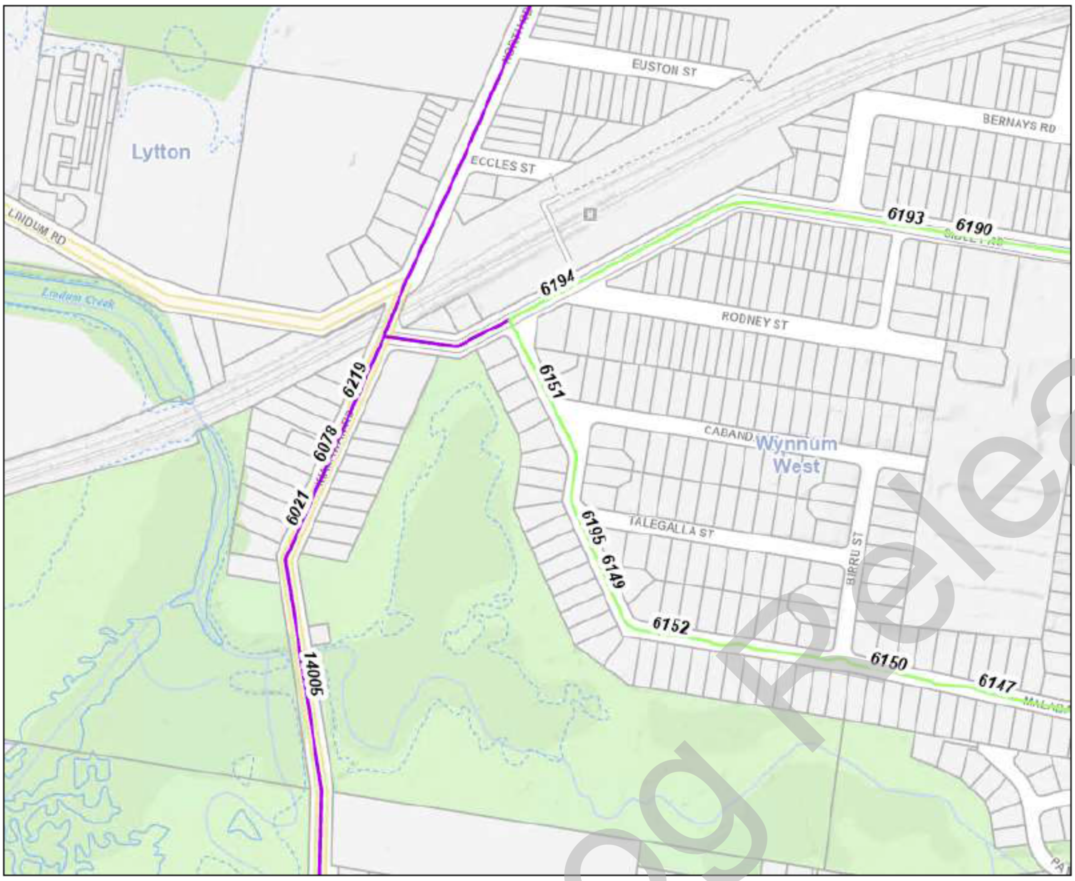


Figure 3-2: Bus Stop IDs

3.1 Rail and Boomgate Operation Summary

Table 3-1 summarises the daily rail service patterns at Lindum Station. There are 70 inbound and 65 outbound services in a typical Weekday. This includes 6 inbound express services in the morning and 5 outbound express services in the afternoon. However, the express services travel past Lindum Train Station.

Table 3-1 : Lindum Train Station Daily Rail Activity

Service Type	Inbound	Outbound	Total
Normal (all stations)	59	57	116
Express	6	4	10
Guardian	5	6	11
Freight (6am – 7pm)			7
Total	70	67	144

Table 3-2 summarises boom gate activity recorded from the Traffic Surveys that were completed at the Level Crossing on 28th April 2021 and 17th July 2018. The surveys recorded activity over 13 hours from 6am to 7pm. The number of closures have increased since 2018. However, the closure durations have reduced equating to an overall reduction in the time that the boomgates are closed during peak hours and across the whole day.

Table 3-2 : Lindum OLC Boom Gate Activity

Boom Gate	Activity	Wednesday 28 April 2021	Tuesday 17 July 2018
Train Frequency (6am – 7pm)	Passenger	102	Not Classified
	Freight	7	Not Classified
	Closure Frequency 13 hours	95	86
	AM Peak Hr % Closed	21%	27%
Closure Patterns	PM Peak Hr % Closed	15%	22%
	13 Hr % Closed	16%	18%
	Max Closure Duration	2 min 48 sec	4 min 58sec

4 TRANSPORT MODELLING METHODOLOGY

In 2014 a mesoscopic road network model was developed in the SATURN software covering the Hemmant Lytton Neighbourhood Plan Area. It was refreshed with the latest infrastructure updates and extended the latest forecast year from 2021 to 2041. The model development relies on other available transport models at the Macro, Strategic Level, the Mesoscopic Road Network simulation level and the Microscopic vehicular base modelling. **Figure 4-1** below summarises the stages of modelling methodology in this study.

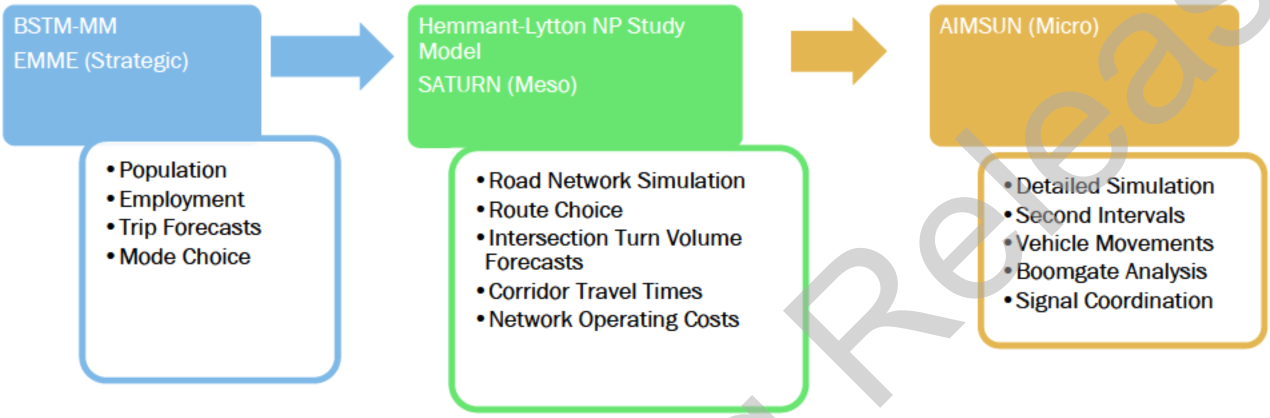


Figure 4-1: Modelling Methodology

Traffic modelling began at the strategic level using the Brisbane Strategic Transport Model (BSTM-MMv2.1) in the EMME software. This is a 4 step trip generation and multi-modal trip assignment model that is used for future travel forecasts. Future road based trip demands identified by the BSTM-MM were used as an initial starting point prior to more detailed local area road network modelling.

Cordoned outputs from the BSTM-MMv2.1 were used as the prior trip matrices for the refreshed Hemmant-Lytton NP Study Model. This is a mesoscopic road network simulation model developed in the SATURN software and covers the study area. The SATURN Model for the study area operates as a full simulation and assignment model and was used for forecasting intersection movements. It is a useful tool for considering the influences of road or intersection upgrades on the wider road network and provides statistical outputs and still graphical summaries of road network operation that are useful for economic evaluation of road network operation.

Analysis of the project traffic demands was undertaken at the mesoscopic (meso) level. This allowed the performance of the road network and the project area to be analysed across the different scenarios with greater accuracy and detail in hourly time intervals.

Evaluation of boomgate impacts on the OLC performance was considered at the Micro level with the Aimsun software. Time analysis was detailed to the second-by-second level and individual vehicles were simulated using car following methods. This allowed the performance of the OLC area to be analysed across the different proposed layouts with greater accuracy and details under the influence of Boomgate operations. Boom gate closures were simulated based on the boomgate open and close times recorded in the traffic surveys.

5 ROAD NETWORK MODEL DEVELOPMENT

Lindum OLC is located in the hub of Lindum area connecting the two areas that are seperated by the rail line. Travel times delays at this OLC could influence the route choice in the surrounding networks. Available road network models provide an informative means of considering the effects that upgrades might have on wider travel paths. BSTM-MM was adopted in the macro level to derive trip matrices from demographic and background data these trip demands were loaded and assigned in the meso level model using the SATURN Software.

The SATURN model has a smaller coverage area but contains more detailed network information than the BSTM strategic trip forecasting model. This allows finer and more sensitive consideration of route choices. A couple of turn-ban scenarios at the OLC were tested to consider wider network impacts and those traffic demands were then used for more detailed consideration at the micro level of modelling in the AIMSUN software. **Figure 5-1** below illustrates the modelling process that was followed in this study.

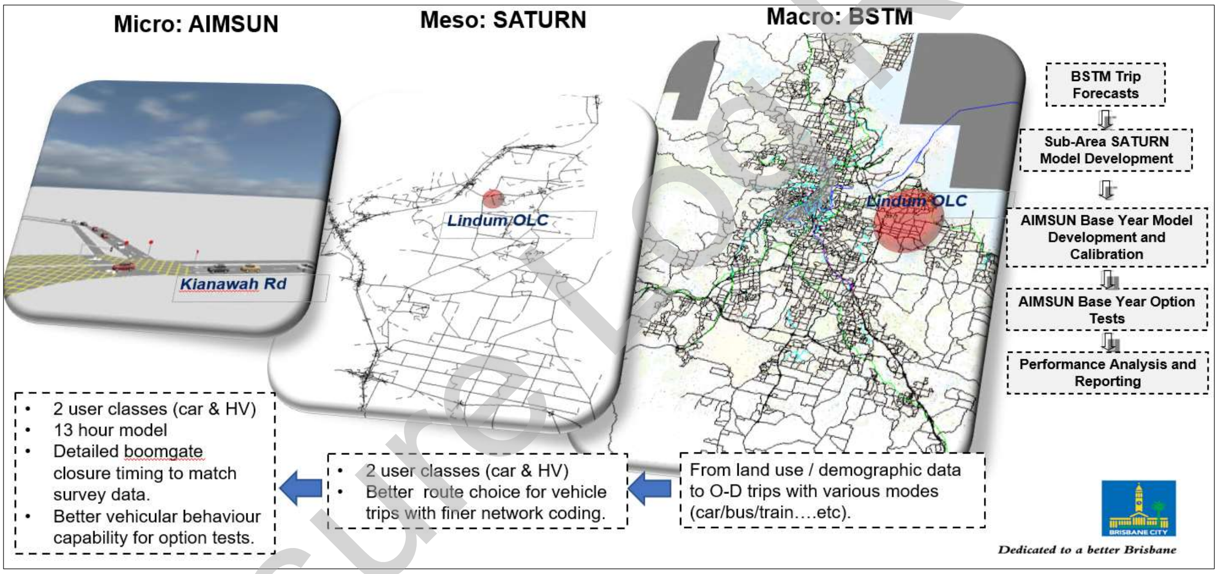


Figure 5-1: Model Structure

5.1 SATURN MODEL SCENARIOS

The SATURN models are developed and used to identify forecast travel paths at the Open Level Crossing. In addition to the base case, two extra road network scenarios were developed and considered in SATURN to identify the travel demand changes around the OLC intersections. This mainly included consideration of the effects of banning right turns to and from Sibley Road. **Figure 5-2** shows the turn-ban movements in the 1Ban and 2Ban scenarios which focussed on Sibley Road approach to Kianawah Road. The 1Ban scenario bans the right-turn from Sibley Road to Kianawah Road and the 2 Ban scenarios also bans the right-turn from the southern approach. Both scenarios assumed that U-turn facilities are provided further south of Kianawah Road to provide alternative routes for the right turn ban from Sibley Road.

A U-turn pocket south of Sibley Road on Kianawah Road is proposed in options that included a right turn ban from Sibley Road, This would enable motorists to turn left from Sibley Road and proceed south along Kianawah Road before doing a u-turn at the u-turn facility to proceed north across the OLC.

Figure 5-2: SATURN Test Scenarios

Figure 5-3 shows the predicted displacement in travel paths or shift in volume triggered by the 1Ban option. This compares the 1ban scenario with the Base case. **Figure 5-4** shows the volume difference between 2Ban and Base case in 2021. In general, the 1Ban and 2Ban options have reduced demands using this intersection as they are forced to displace to alternative routes. The displacement is quite widespread and the main observations are:

- Kianawah Road to Sibley Road trips shift to Wynnum Road
- An increase in trips travelling via Crawford Road to the south instead of via Sibley Rd
- An increase in trips crossing the railway line via Wynnum Road north and Pritchard Street rather than Kianawah Road.

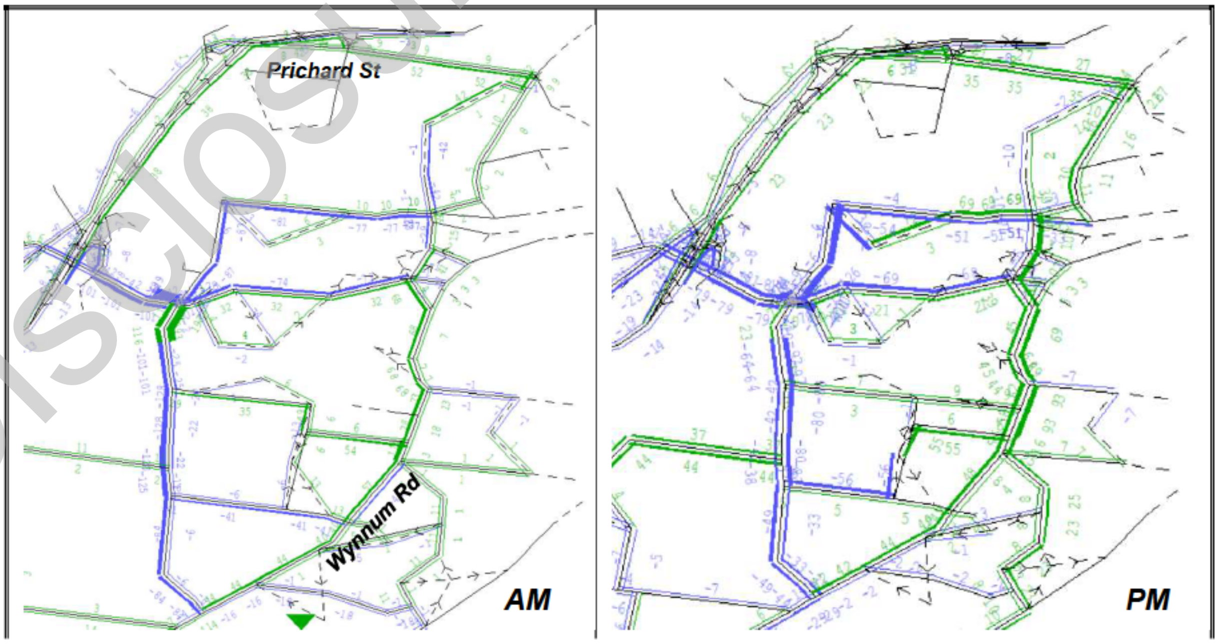


Figure 5-3: SATURN Base vs 1Ban (2021)

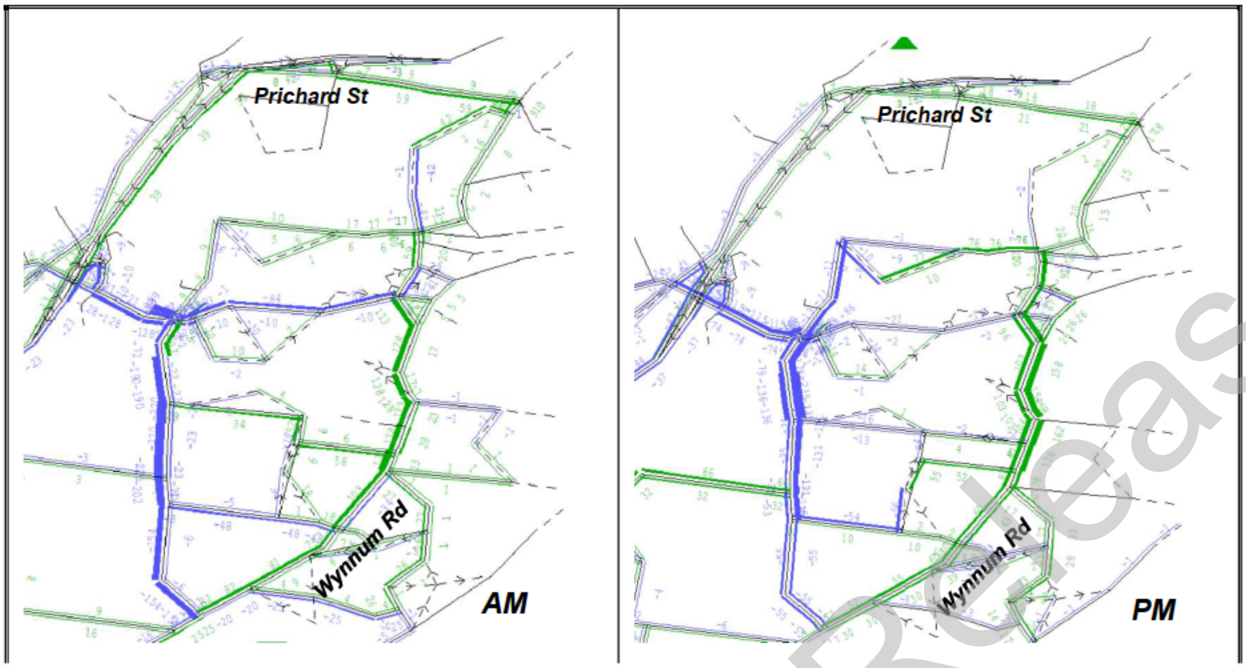
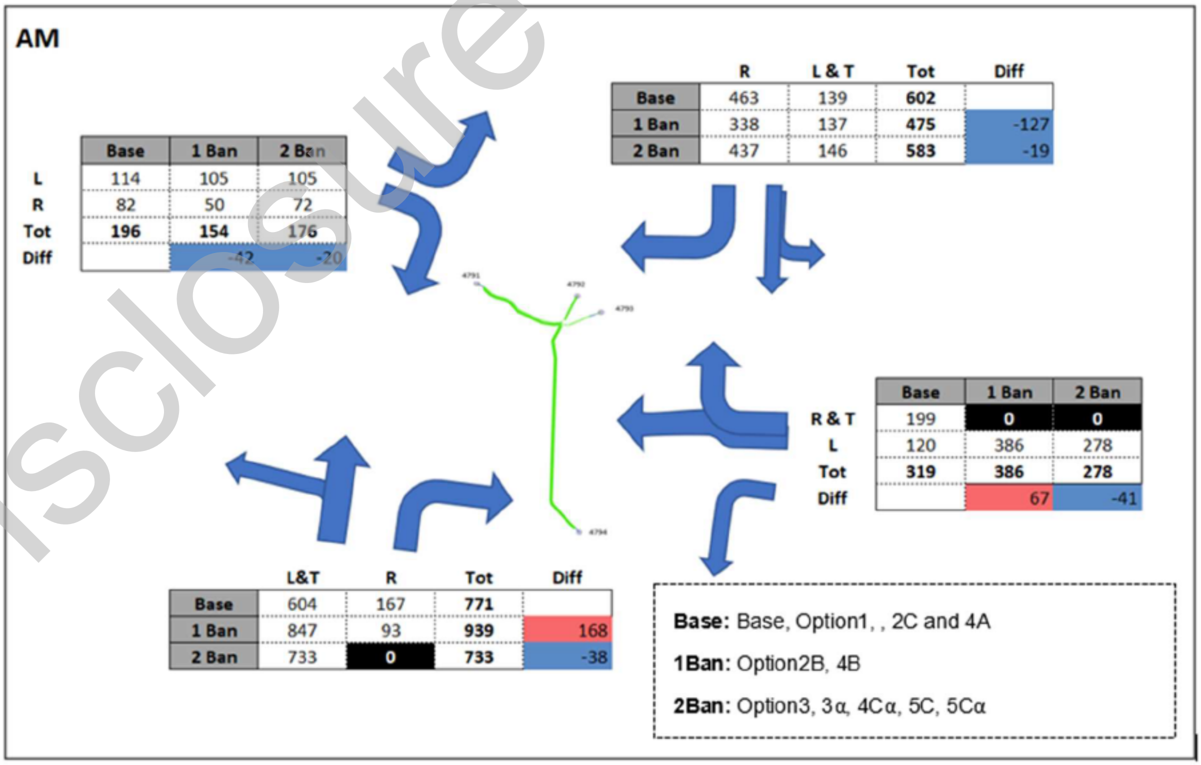


Figure 5-4: SATURN Base vs 2Ban (2021)

5.2 SATURN MODEL CORDON MATRICES 2021

Figure 5-5 below summarises the AM peak trip demands at the intersection movement level from the SATURN models. This information was used in the trip assignments for the detailed AIMSUN model simulation. **Figure 5-6** shows the predicted intersection demands with different scenarios for the PM peak periods.



	Base	1 Ban	2 Ban
L	114	105	105
R	82	50	72
Tot	196	154	176
Diff		-42	-20

	R	L & T	Tot	Diff
Base	463	139	602	
1 Ban	338	137	475	-127
2 Ban	437	146	583	-19

	Base	1 Ban	2 Ban
R & T	199	0	0
L	120	386	278
Tot	319	386	278
Diff		67	-41

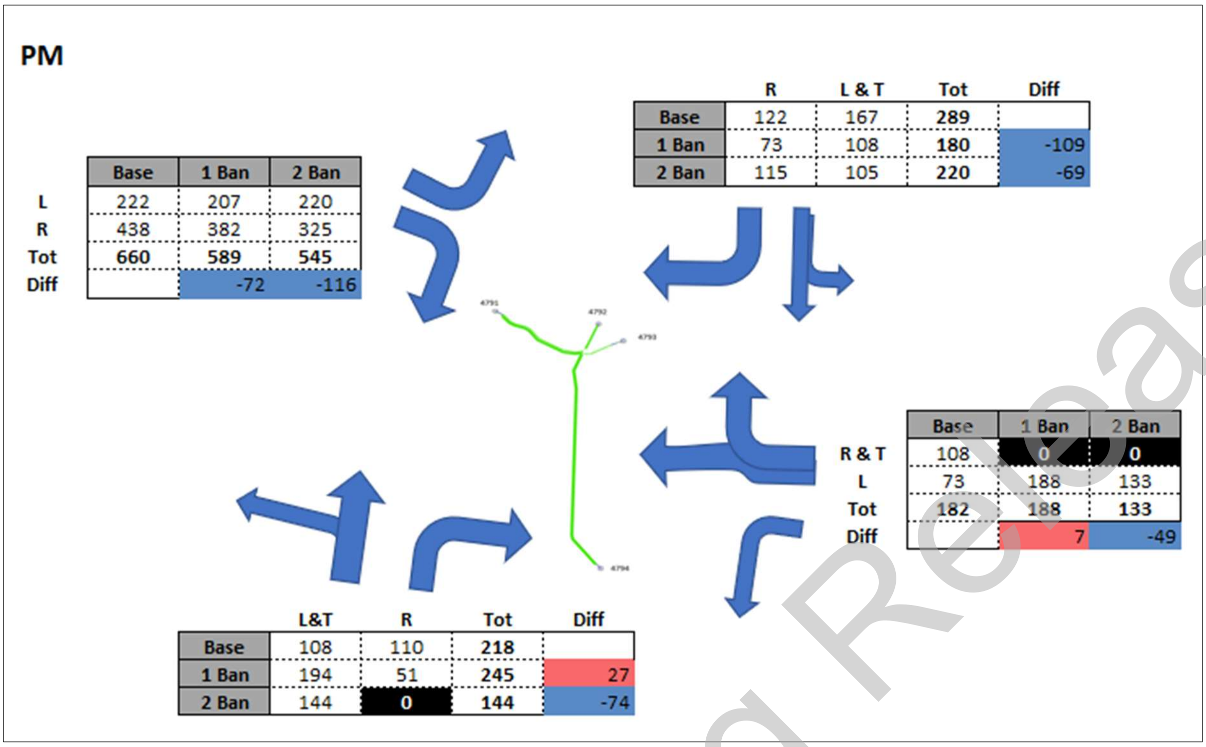
	L&T	R	Tot	Diff
Base	604	167	771	
1 Ban	847	93	939	168
2 Ban	733	0	733	-38

Base: Base, Option1, , 2C and 4A

1Ban: Option2B, 4B

2Ban: Option3, 3α, 4Cα, 5C, 5Cα

Figure 5-5: SATURN AM Matrices



	Base	1 Ban	2 Ban
L	222	207	220
R	438	382	325
Tot	660	589	545
Diff		-72	-116

	R	L & T	Tot	Diff
Base	122	167	289	
1 Ban	73	108	180	-109
2 Ban	115	105	220	-69

	Base	1 Ban	2 Ban
R & T	108	0	0
L	73	188	133
Tot	182	188	133
Diff		7	-49

	L&T	R	Tot	Diff
Base	108	110	218	
1 Ban	194	51	245	27
2 Ban	144	0	144	-74

Figure 5-6: SATURN PM Matrices

5.3 AIMSUN MODEL DEVELOPMENT AND VALIDATION

The AIMSUN microsimulation model plays a detailed level of investigation for this study. Second by second micro-simulation software packages are the only effective tools available for evaluating both Boomgate impacts and signal coordination together. **Figure 5-7** below shows typical boomgate closures recorded in seconds for a duration of 13 hours. The variation in the start of closure time and duration of closure are the key challenges to be considered that cannot be accurately assessed by peak hour models. This study adopts the recorded boomgate operation time at a second by second level to mimic the OLC in the real environment.

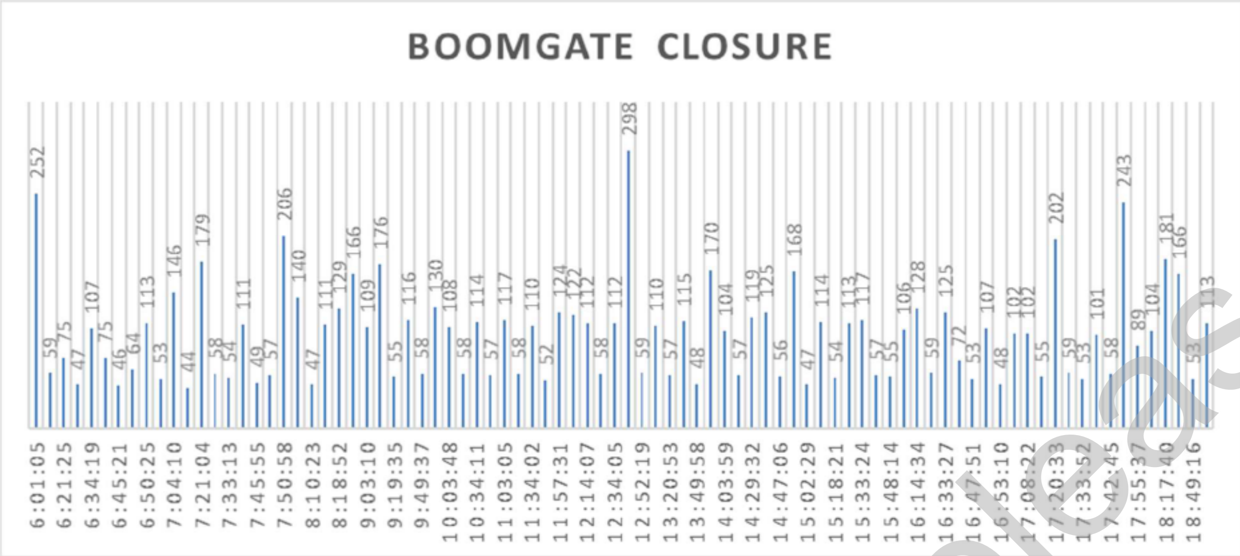


Figure 5-7: Boomgate Closure (seconds)

Figure 5-8 shows the AIMSUN model extents. The model covers west from Lytton Road, north from Sandy Camp Road, east to Wynnum North Road and south to Wynnum Road. This model purely focuses on the level crossing and signalised intersection operation independently of wider road network effects.

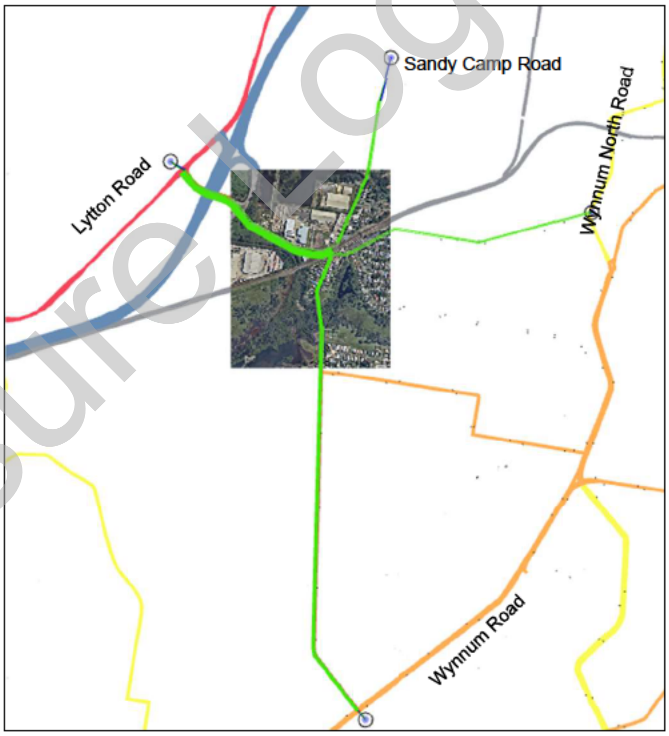


Figure 5-8: AIMSUN Model Extents

5.3.1 AIMSUN Model Development

There are number of key essential components in micro-simulation models including:

- **Networks**: The network geometry uses the latest aerial images as a reference to cover the latest updates.

- **Boomgate**: Recorded boomgate operation timing data was adopted.
- **Traffic Signals**: The signal phases and timing in proposed options were designed according to the boomgate operations, signal coordination and safety factors. The assumptions made are attached and included in **Appendix B**.
- **Traffic Counts**: Traffic survey data was used to derive the 13-hour demand profiles.
- **Model Matrices**: Model trip matrices were derived from the upper level SATURN models which consider wider network impacts with various turn-ban scenarios.
- **Behaviour Factors**: The decision making delays from side streets are longer than default parameters in this study due to sharper turning angles. Driving behaviour factors were reviewed and adjusted to match the local characteristics.

5.3.2 Model Calibration and Validation

Key modelling parameters were reviewed against measured data to check the model quality and accuracy prior to further scenario tests. The evaluation parameters are:

- Traffic Counts
- Maximum Queue
- Average Delays by movement

5.3.2.1 Traffic Counts

As a rule of thumb, in comparing assigned volumes with observed volumes a GEH parameter of 5 or less would indicate an acceptable fit to a traffic modeller, whether it was a difference of 325 to 4,000 or 120 in 500, while links with GEH parameters greater than 10 require closer attention.

The developed AIMSUN model is a 13 hour model covering the period from 06:00AM to 19:00 PM. The model calibration was based on the traffic survey data (peak hours) that was collected on 28 April 2021. **Table 5-1** shows both AM and PM models have achieved 100 percent of movements with a GEH value less than 5. This result shows a very good match to the real traffic environment.

Table 5-1 : Model Calibration – Turning Volumes

Movements	AM Peak			PM Peak		
	Survey	Model	GEH	Survey	Model	GEH
Lindum-SB	159	160	0.1	165	175	0.8
Sibley-NBR	88	95	0.8	107	107	0.0
Lindum-NBL	341	367	1.4	132	142	0.9
Sibley-SBT	145	157	1.0	271	292	1.2
Lindum-SBR	193	207	1.0	65	70	0.6
Lindum-EBL	104	115	1.0	202	226	1.6
Sibley-NBT	398	414	0.8	105	107	0.2
Sibley-WBR	111	128	1.6	73	83	1.1
Sibley-SBL	77	75	0.3	220	221	0.1
Lindum-NBT	168	176	0.6	46	47	0.2
Lindum-EBR	63	72	1.1	326	338	0.6
Sibley-WBL	82	92	1.1	132	130	0.1
					*GEH<5% AM:100%; PM:100%	

5.3.2.2 Maximum Queue

The modelled maximum queue results were compared to the survey data. **Figure 5-9** demonstrates the simulated maximum queue for each approach at the OLC. The data is collected from one-minute modelling intervals over 5 model replications. The blue (AM) and red (PM) dashed lines are the maximum queue recorded during the peak hours of the survey day. The comparison shows similar queuing patterns in all approaches showing a good match between modelled and real queues.

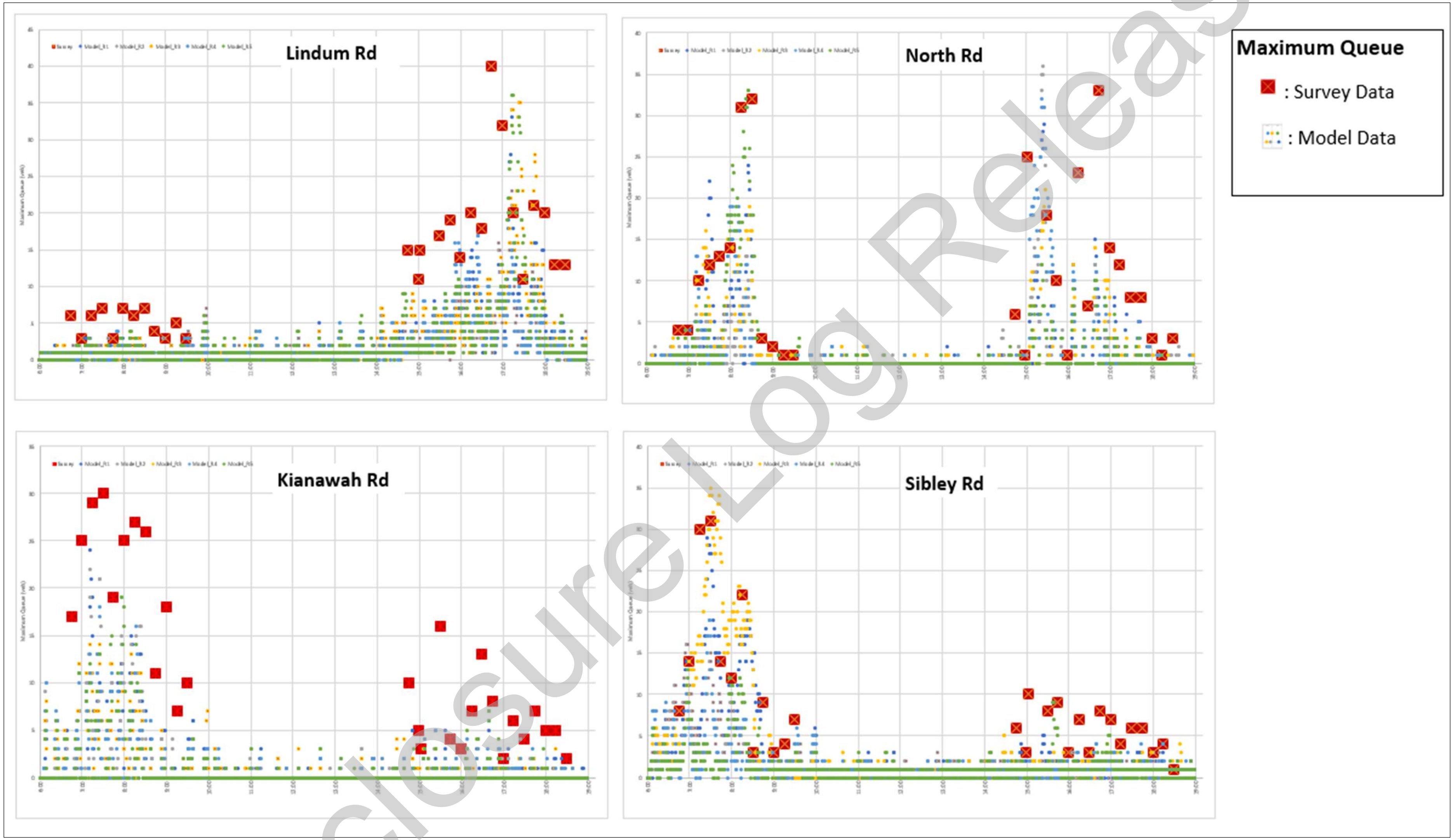


Figure 5-9: Model Calibration – 13 Hrs Maximum Queue (Approaches)

Figure 5-10 and **Figure 5-11** show the simulated maximum queue for each lane at the OLC. The simulation data was collected in 15-minute intervals over 5 modelling replications during both AM and PM modelling periods. The bar charts show the maximum queue data from the model (blue) and the survey (red). The comparison shows similar queuing patterns in most approach lanes indicating a good match between modelled and real queues.

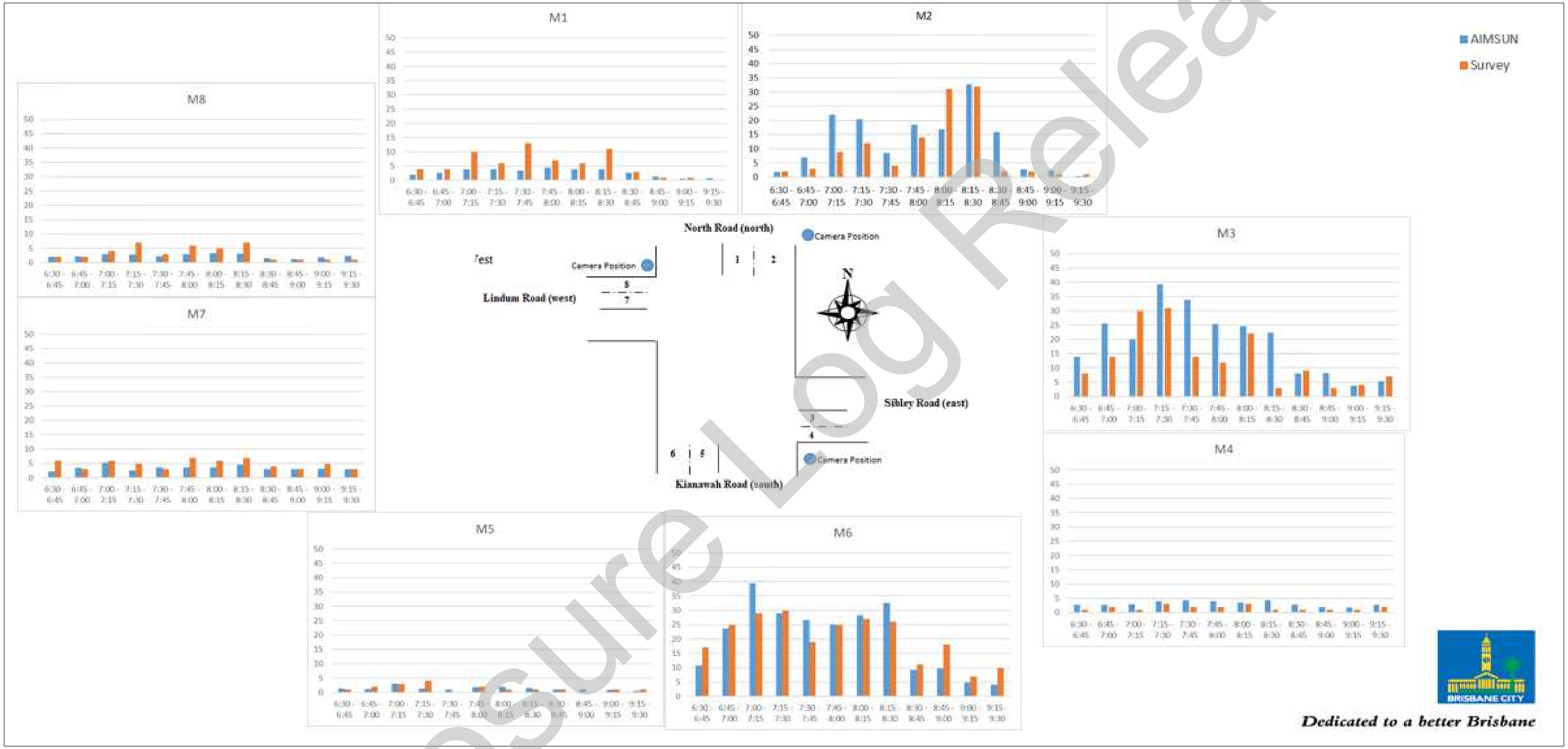


Figure 5-10: Model Calibration – AM Maximum Queue (Lanes)

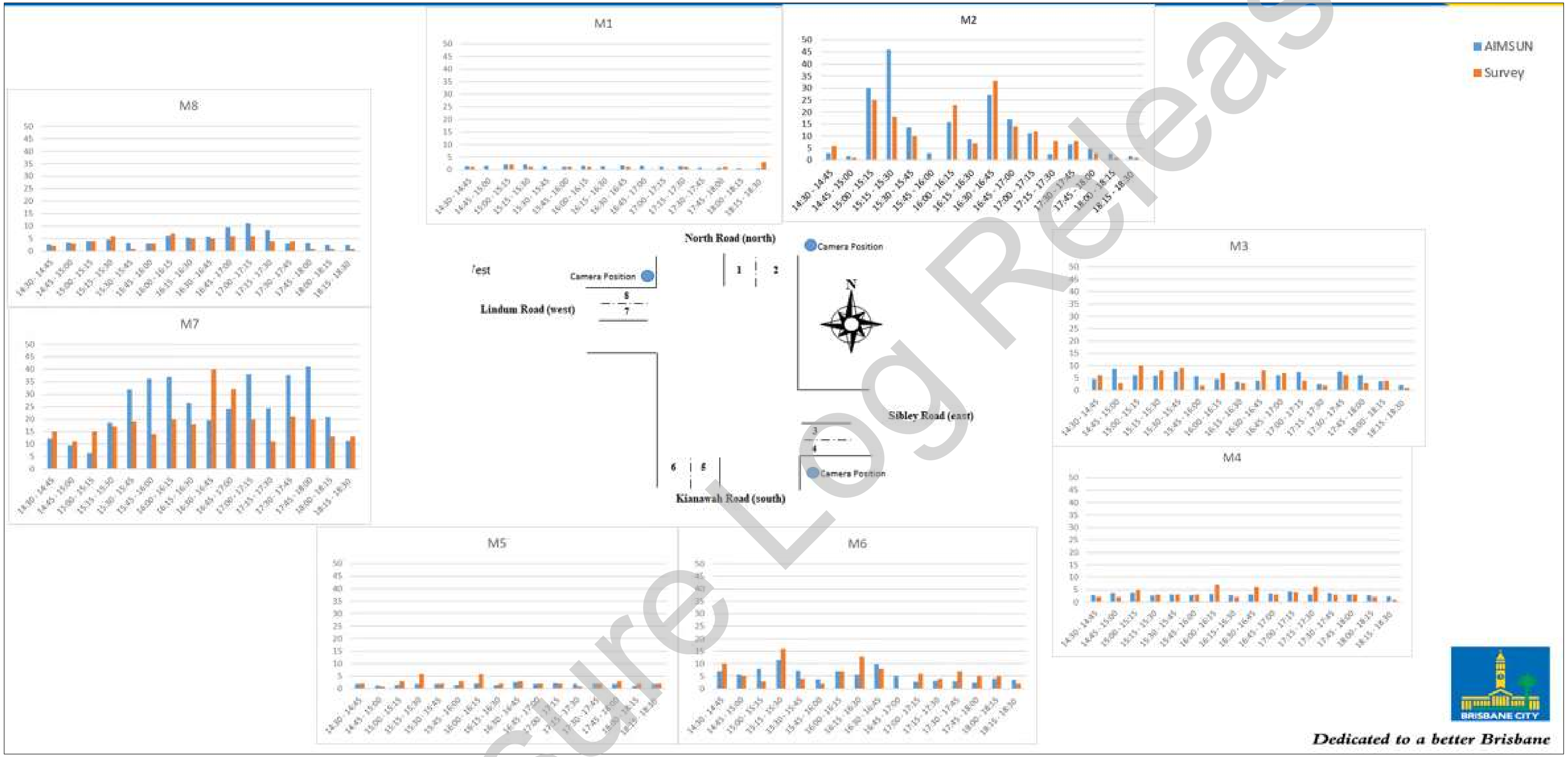


Figure 5-11: Model Calibration – PM Maximum Queue (Lanes)

5.3.2.3 Queuing Delays

Figure 5-12 summarises the simulated queuing delays for each approach at the OLC. This data is collected in one-minute intervals over 5 replications though the 13-hour modelling period. The blue (AM) and red (PM) dashed lines are the queuing delays from the survey. The comparison shows similar queuing delay results for the modelled and actual delays on all approaches during the modelling periods.

In summary, the developed AIMSUN model simulations provide a very good match to the survey data and are considered appropriate for further option tests.

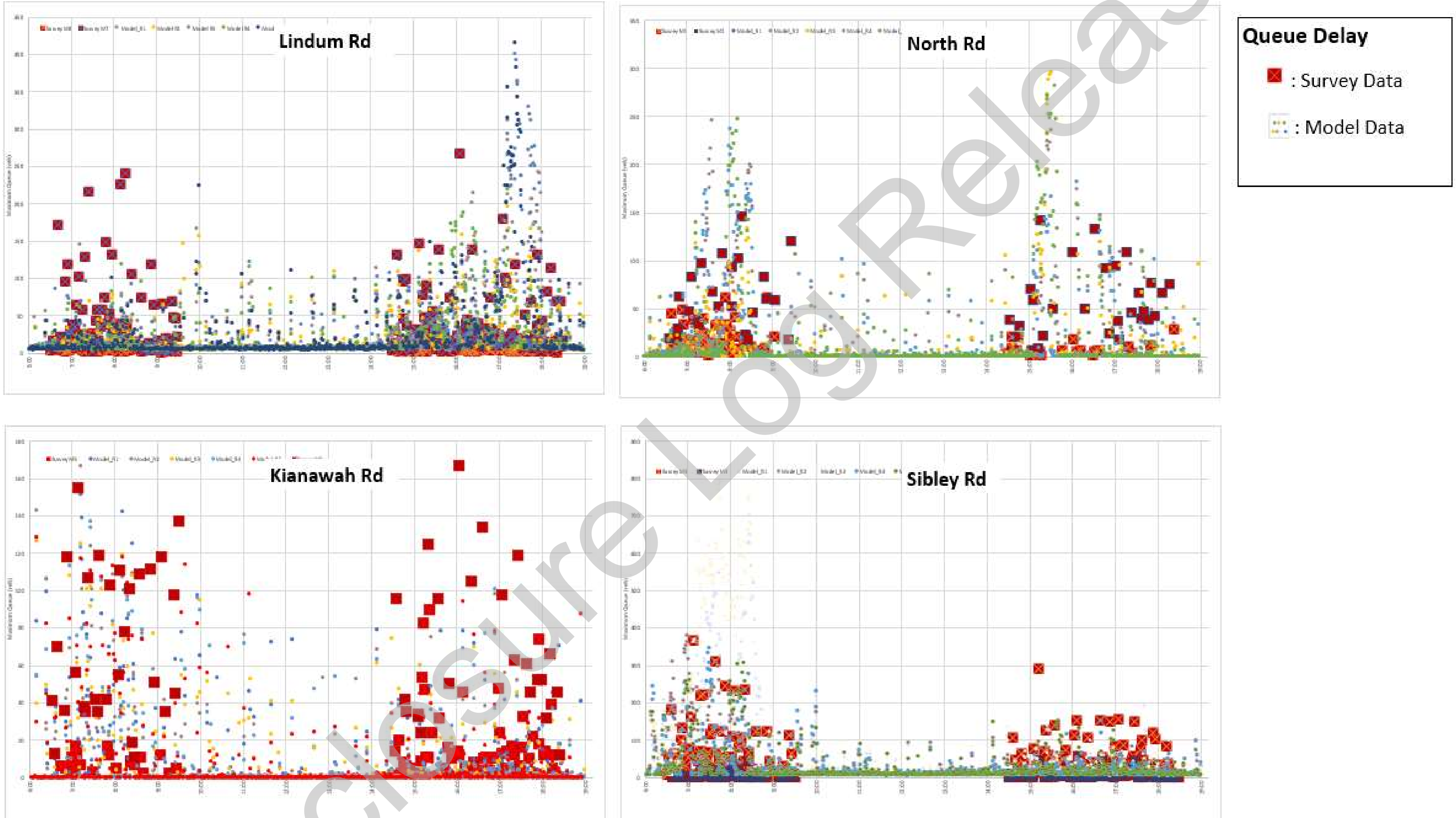


Figure 5-12: Model Calibration – Queuing Delays

6 BASE YEAR AIMSUN OPTION TESTS

After preliminary studies, 12 short list proposed options were tested and reported in the report. The detailed intersection layouts and traffic signal phasing assumptions are attached in **Appendix B**.

6.1 AIMSUN Options

Table 6-1 below summarises the options considered and shows the key difference between each option including number of lanes, turning movement assumptions, and the control types at the Sibley Road approach.

Table 6-1 : Option Table

Option Name	Kianawah Rd Approach Lanes	North Rd Approach Lanes	All Movements	Only Ban of RT From Sibley Rd	Banned RT To & From Sibley Rd	Banned RTs To Sibley Rd (Buses Excepted)	Signalise Sibley Rd LT Out
Option 1	2 Lanes: L & Shared TR	3 Lanes: L T R	✓	✗	✗	✗	✓
Option 2	3 Lanes: L T R	3 Lanes: L T R	✓	✗	✗	✗	✓
Option 2B	3 Lanes: L T R	3 Lanes: L T R	✗	✓	✗	✗	✓
Option 2Bα	3 Lanes: L T R	3 Lanes: L T R	✗	✓	✗	✗	✗
Option 2C	3 Lanes: L T R	3 Lanes: L T R	✓	✗	✗	✗	✓
Option 3	2 Lanes: L & T	3 Lanes: L T R	✗	✗	✓	✗	✓
Option 3α	2 Lanes: L & T	3 Lanes: L T R	✗	✗	✓	✗	✗
Option 4Aα	3 Lanes: L T R(s)	2 Lanes: L T	✓	✗	✗	✗	✗
Option 4Cα	2 Lanes: L T (s)	2 Lanes: L T	✗	✗	✓	✗	✗
Option 4Bα	3 Lanes: L T R(s)	2 Lanes: L T	✗	✓	✗	✗	✗
Option 5C	2 Lanes: L T (s)	2 Lanes: L R	✗	✗	✓	✗	✓
Option 5Cα	2 Lanes: L T (s)	2 Lanes: L R	✗	✗	✓	✗	✗

The option labelling was developed to recognise certain elements of the option based on the naming. The structure of the option naming is as follows:

- Option 1 – signals on existing, all movements, no widening
- Option 2 – signals on existing, all movements, with widening for right turns
- Option 2C – same as Option 2 with alternative phasing
- Option 3 – signals on existing, no widening with banned right turns
- Option 4 – signals with off-line OLC
- Option 5 – signals on existing with controlled left turns from Sibley Rd
- A – all right turns
- B – banned right turns from Sibley Rd
- C – no right turns to and from Sibley Rd
- α – left turn lane from Sibley Rd, give way controlled.

6.2 Modelling Results

This section describes modelling results including:

- Turning Delays,
- 95th Percentile Queue for each approach
- Global Level: Delay Time, Mean Speed and Mean Queue.

6.2.1 Turning Delays

Table 6-2 summarises the turning delay results for each movement under each option during AM peak periods. Movements with high delays and very poor levels of service are coloured red. The existing Base case has high delays from the Sibley Road approach due to the "Stop" control set up for this approach which takes a long time to clear after boom gates reopen.

The tested options, Option1, Option2, Option2B, Option2C, Option3, Option4α and Option5C introduce greater turning delays (>100s) in one of the movements.

Option 2Bα, Option3α, Option4Bα, Option4Cα and Option5Cα all appear to introduce lower turning delays than the existing intersection configuration.

Table 6-2 : Turning Delay (AM)

Delays (sec)		AM												
Approach	Path	Base	Opt1	Opt2	Opt2B	Opt2Bα	Opt2C	Opt3	Opt3α	Opt4Aα	Opt4Bα	Opt4Cα	Opt5C	Opt5Cα
West	L	14	25	36	40	27	26	24	24	26	26	19	24	24
	T	49	147	97	91	69	87	93	78	103	75	91	96	78
	R	51	150	93	86	69	92	96	84	97	72	83	98	84
North	L	38	91	32	34	32	41	26	29	101	39	32	37	31
	T	46	220	55	43	45	88	35	33	103	50	36	40	34
	R	43	56	115	100	76	73	91	46	64	63	39	99	46
East	L	220	81	101	186	11	57	162	8	11	9	7	167	8
	T	270	205	200	Ban	Ban	127	Ban	Ban	87	Ban	Ban	Ban	Ban
	R	299	167	152	Ban	Ban	105	Ban	Ban	83	Ban	Ban	Ban	Ban
South	L	47	268	65	41	53	76	39	44	315	48	58	43	44
	T	46	315	70	38	60	109	59	59	413	53	70	61	59
	R	46	282	95	49	65	64	Ban	Ban	405	71	Ban	Ban	Ban

Average of 5 Replications

Table 6-3 shows the turning delays for each movement under each option during PM peak periods. Again, the existing Base case has very high turning delays from the Lindum Road approach.

In this period the tested options, Option1, Option2, Option2C, Option3 and Option4Aα and Option5C again have greater turning delays (>100s) in one of the movements during the PM period.

Option2B,Option 2Bα, Option3α, Option4Bα, Option4Cα and Option5Cα appear to be a group of options that achieve lower turning delays than the existing intersection configuration.

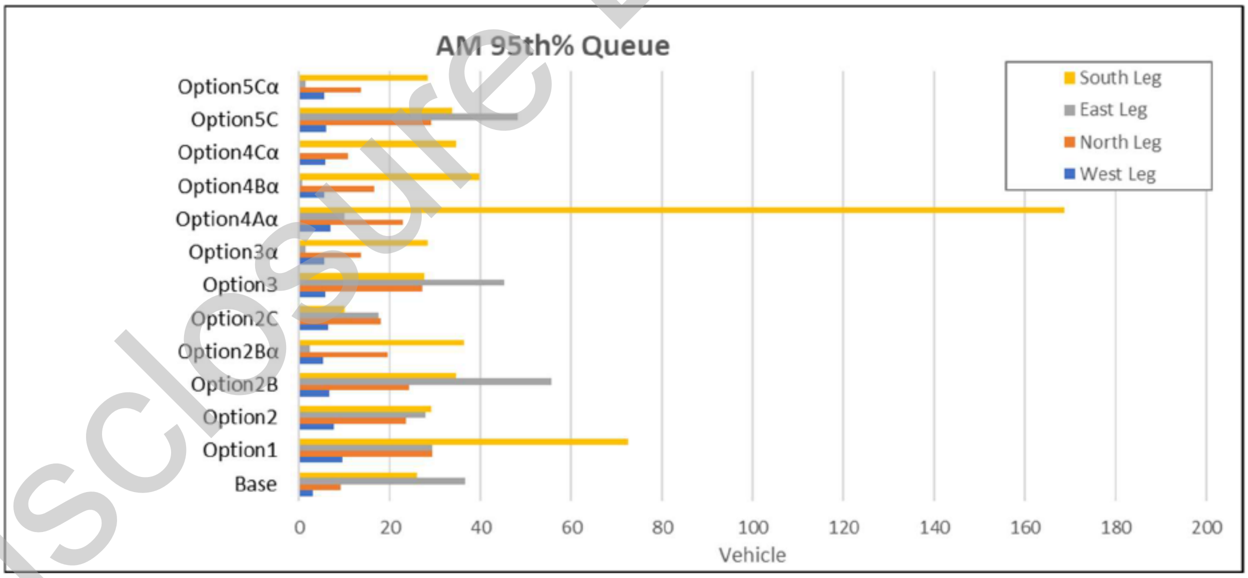
Table 6-3 : Turning Delay (PM)

Delays (sec)		PM												
Approach	**Path**	**Base**	**Opt1**	**Opt2**	**Opt2B**	**Opt2Bα**	**Opt2C**	**Opt3**	**Opt3α**	**Opt4Aα**	**Opt4Bα**	**Opt4Cα**	**Opt5C**	**Opt5Cα**
West	L	38	29	27	24	15	16	13	12	15	10	17	13	14
	T	130	143	71	63	59	69	65	54	100	77	64	66	54
	R	129	146	77	63	58	70	64	53	98	78	61	65	53
North	L	30	70	49	63	47	62	42	49	80	61	44	55	51
	T	38	124	74	76	67	106	43	47	87	75	47	50	48
	R	31	26	123	36	47	39	47	36	38	29	49	51	36
East	L	27	48	55	83	10	43	104	7	8	8	6	104	7
	T	49	144	144	Ban	Ban	93	Ban	Ban	109	Ban	Ban	Ban	Ban
	R	38	109	107	Ban	Ban	86	Ban	Ban	73	Ban	Ban	Ban	Ban
South	L	17	34	31	26	26	35	36	26	188	35	26	26	26
	T	20	154	64	75	68	136	72	68	442	71	53	72	68
	R	11	130	134	42	50	64	Ban	Ban	471	51	Ban	Ban	Ban

Average of 5 Replications

6.2.2 95th% Queue

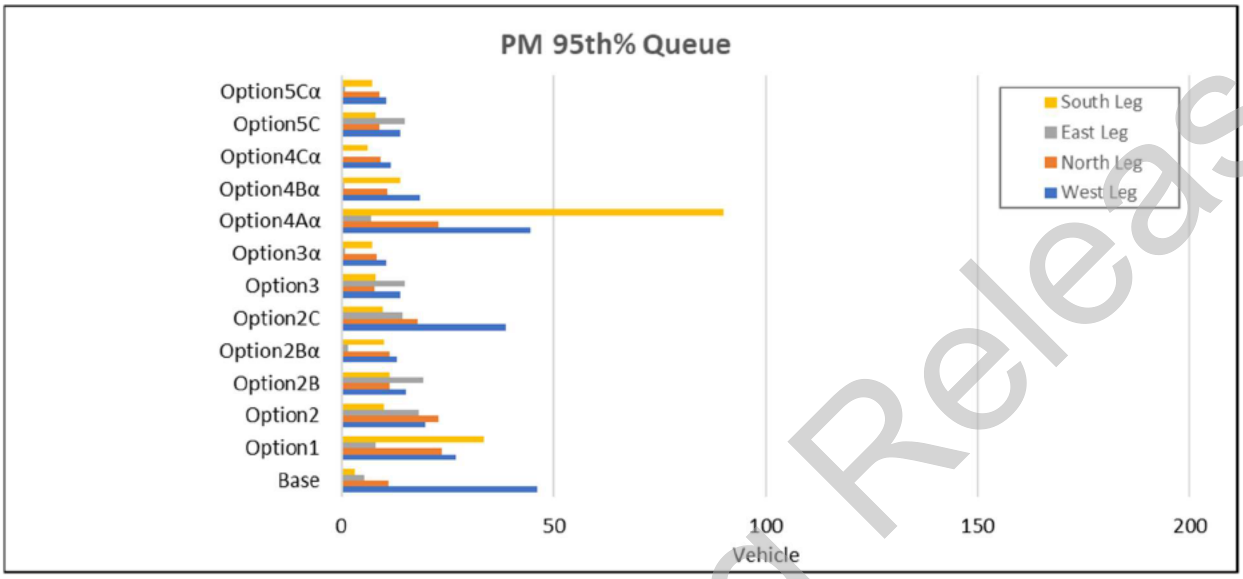
Figure 6-1 below shows the 95th percentile vehicle queue for each approach by option during the AM peak period. The outputs show Option4Aα has a significant long queue in the southern approach. This option caters for all movements and achieves the level crossing alignment off-line but has more complex signal phasing that leads to the high delay. The result concluded the exclusion of Option4Aα as a shortlisted option. Option1 returned the 2nd worst result in terms of 95th percentile queue.



	AM		AM 95th% Queue											
end 8:15	Base	Option1	Option2	Option2B	Option2Bα	Option2C	Option3	Option3α	Option4Aα	Option4Bα	Option4Cα	Option5C	Option5Cα
West Leg	3	9	8	7	5	6	6	5	7	5	6	6	5
North Leg	9	29	23	24	19	18	27	14	23	16	11	29	14
East Leg	37	29	28	56	2	18	45	1	10	1	0	48	1
South Leg	26	72	29	35	36	10	28	28	169	40	35	34	28

Figure 6-1: 95th% Queue (veh) - AM

Figure 6-2 below shows the 95th percentile vehicle queue during the PM peak periods. The ouputs show Option4Aα again has a significantly long queue on the southern approach. The western approach has a consistantly long queue in the Base, Option2C and Option4Aα that reflects the higher trip demands from the western approach during PM peaks.



	PM		PM 95th% Queue											
end 17:15	Base	Option1	Option2	Option2B	Option2Bα	Option2C	Option3	Option3α	Option4Aα	Option4Bα	Option4Cα	Option5C	Option5Cα
West Leg	46	27	20	15	13	39	14	11	45	19	12	14	11
North Leg	11	24	23	11	11	18	8	8	23	11	9	9	9
East Leg	6	8	18	19	2	14	15	1	7	0	0	15	1
South Leg	3	33	10	11	10	10	8	7	90	14	6	8	7

Figure 6-2: 95th% Queue (veh) - PM

6.2.3 Global Statistics

Global statistics are useful ouputs to compare options overall and this provides a preliminary indication of an option that might return the highest economic result. **Table 6-4** shows the forecast global performance outputs, including Delay time, Mean Speed and Mean Queue, for all options in three different time intervals.

Table 6-4 : Global Performance Statistics

13 Hrs

Time Series	Base	Opt1	Opt2	Opt2B	Opt2Bα	Opt2C	Opt3	Opt3α	Opt4Aα-NBRT_25m	Opt4Bα-NBRT_25m	Option4Cα	Opt5C	Opt5Cα	Units
Delay Time - All	17.14	41.06	28.56	19.31	13.61	24.73	22.36	12.92	44.70	14.37	16.00	23.90	13.09	*sec/km*
Mean Speed - All	46.26	35.39	40.35	45.40	48.90	42.15	43.44	49.02	34.16	48.39	47.06	42.65	48.91	*km/h*
Mean Queue - All	10.21	27.98	16.84	12.54	7.52	15.16	13.52	6.28	29.63	8.57	7.68	14.50	6.37	*veh*

**** Colour Scales for each Item***

AM

Time Series	Base	Opt1	Opt2	Opt2B	Opt2Bα	Opt2C	Opt3	Opt3α	Opt4Aα-NBRT_25m	Opt4Bα-NBRT_25m	Option4Cα	Opt5C	Opt5Cα	Units
Delay Time - All	24.42	61.36	34.53	26.19	16.69	29.35	24.90	14.92	62.46	16.72	19.63	26.70	15.01	*sec/km*
Mean Speed - All	43.17	31.00	39.83	43.13	47.81	40.84	43.77	48.74	31.22	47.81	45.82	42.94	48.69	*km/h*
Mean Queue - All	26.92	76.39	32.65	33.48	15.86	29.43	28.32	14.58	72.99	12.49	19.44	30.29	14.70	*veh*

**** Colour Scales for each Item***

PM

Time Series	Base	Opt1	Opt2	Opt2B	Opt2Bα	Opt2C	Opt3	Opt3α	Opt4Aα-NBRT_25m	Opt4Bα-NBRT_25m	Option4Cα	Opt5C	Opt5Cα	Units
Delay Time - All	21.10	32.30	28.07	18.89	13.60	22.29	18.20	12.48	37.27	14.52	14.92	18.68	12.86	*sec/km*
Mean Speed - All	44.88	39.69	41.30	46.06	49.45	44.18	46.16	49.76	37.86	49.00	48.38	45.87	49.51	*km/h*
Mean Queue - All	18.57	33.26	25.67	17.79	11.60	22.17	14.28	8.28	45.45	13.31	9.49	14.61	8.59	*veh*

**** Colour Scales for each Item***

During the AM peak period, Option3α was forecast to have the best performance followed by Option5Cα and then Option4Bα.

During the PM peak period, Option3α was forecast to have the best performance following by Option5Cα and then Option2Bα.

For the daily 13-hour modelling period, Option3α was forecast to achieve the best performance followed by Option5Cα, Option2Bα, Option4Cα and Option4Bα.

Considering Option 3α includes 2 banned right turns that impact on accessibility to the Lindum Train Station and Sibley Road, and Option 4Bα does not. Option 4Bα is considered to be the better performing solution.

7 DISCUSSION

The key purpose of this study is to seek an interim solution to improve the safety of the OLC before the ultimate upgrades occur at a later date. The interim upgrade should desirably improve or minimise performance impacts with the primary aim of improving safety of operation.

In the aspect of traffic performance, the following options are compared further with consideration to safety and accessibility at the level crossing:

- Option2Bα
- Option3α
- Option4Bα
- Option4Cα
- Option5Cα

Safety considerations in the option layout include

- Boom Gate length to minimise movements bypassing the gate
- Safety of filtering right turns
- Movements blocking shared lanes
- Pedestrian crossings and vehicle turning conflicts
- Swept paths for larger vehicles.

Option2Bα, Option3α and Option5Cα are all based on the existing alignment which requires longer boomgates to provide required safety protection to the OLC. **Figure 7-1** shows the coverage limitation of a standard boomgate (10m) and the exposure risk that exits gaps at the OLC. Option4Bα and Option4Cα are located on a new alignment 30 metres west of the existing level crossing location. This creates a more conventional T-intersection geometry and enables standard boomgates to provide required protection to the OLC.

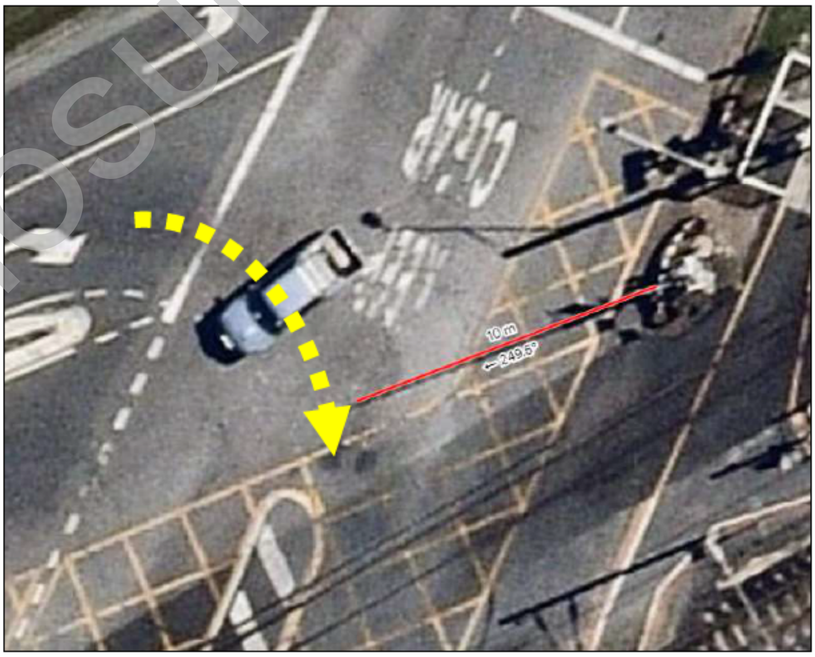


Figure 7-1: Standard Boomgate Coverage (10m)

The safety of right turns can be improved by either banning the turns or controlling with full signal protection. Although banning movements could potentially contribute to performance improvement, this would be a less favourable solution due the impact on accessibility in the road network. Option4Cα was forecast to have slightly better performance results than Option4Bα at the crossing because both right turns to and from Sibley Road were removed. However, Option4Bα was forecast to be the better overall option than Option4Cα due to the accessibility advantage created by retaining the right turn into Sibley Road. This reduced travel distances and travel times overall by minimising the displacement of right turns (including for vehicle access to Lindum Station including bus replacement services).

Option with shared lanes yielded worse performance results because these options required more complex phasing to manage the impact created by blocking. This is demonstrated in the results returned for Option 1.

In all options the added pedestrian crossings offer a vast improvement in pedestrian safety and protection. The α (alpha) series of options returned improved performance, however there was no pedestrian protection provided across the left turn lane on Sibley Rd with Give Way onto a splitter island.

The design needs to provide for wider swept paths required by larger articulated vehicles turning at acute angles. This issue is worsened in the Options 1, 2, 3 and 5 series that retain the level crossing alignment at its current location.

Option 4Bα addresses most of these issues while still being rated one of the better performing options.

8 PROJECT BENEFIT CALCULATIONS

8.1 Methodology

The brief methodology used in the benefit calculation was as follows:

1. Determine crash cost benefits for the OLC assessed.
2. Extract vehicle operating costs from SATURN and AIMSUN for assessed.
3. Determine vehicle cost benefits between Benefits Base and Option at 2021 and 2031.

This section details the calculation of project benefits from crash reductions and operation improvements over a 10 year project benefit period in Net Present Value (NPV). The calculations follow the process recommended by the Federal Government for a Project Proposal Report (PPR). As a sensitivity test, a treasury discount rates of 4% and 7% has been adopted. Option4Bα is selected as the preferred option for the project benefit calculations based on the overall benefits it is expected to return considering a number of factors with the primary influences being operating performance and safety.

A layout for Option 4Bα is shown in **Figure 8-1**. The option is based on a new level crossing on an improved alignment with signalised intersections that include a right turn into Sibley Rd with no right turn out of Sibley Rd.

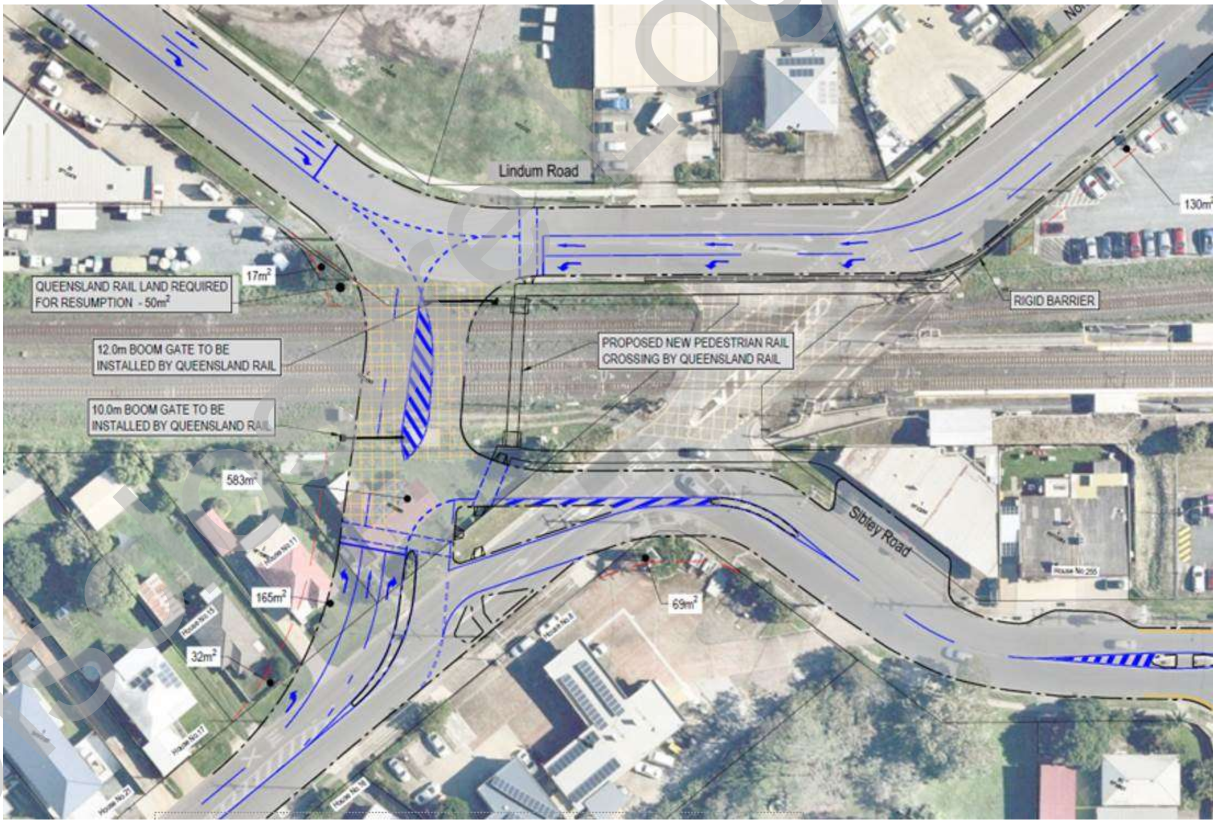


Figure 8-1: Option 4Bα Layout

8.2 Crash Reduction Benefits

Traffic crash reductions were initially calculated using the Federal Government Guidelines for the Blackspot Program. The methodology is set out in a spreadsheet process that is distributed and updated annually by Department of Transport and Main Roads (TMR) each year. As part of the process, a treatment crash reduction matrix has been developed which outlines expected crash reductions for various treatments depending on the crash type. The reduction factors have been developed following many years of research into the effectiveness of crash treatments.

Crash costs were calculated based Crash DCA types over a 5 year crash history. Crash reduction factors are based on the safety treatments introduced by the project. The relevant treatments introduced by this project varied depending on the corridor scheme.

The service life for crash reduction treatments is asumed to be 30 years in this analysis. The crash reduction benefits gained, based on 4% and 7% discount rates over 30 years, are summarised in **Table 8-1** and **Table 8-2**. Sch4Pt3(15) [redacted]

It is noted the crash reduction benefits do not include for the pedestrian fatality on the pedestrian level crossing in 2019, for which the preferred option can be expected to contribute towards a future reduction.

Table 8-1 : Crash Reduction Benefits – 4% discount rate

	Net Present Values		
Year	Crash Benefits	Project Cost	Recurring Costs
1	Sch4Pt3(15) [redacted]		
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
Total			
10 Year			

Table 8-2 : Crash Reduction Benefits – 7% discount rate

Year	Net Present Values
	Sch4Pt3(15) [redacted]
1	[redacted]
2	[redacted]
3	[redacted]
4	[redacted]
5	[redacted]
6	[redacted]
7	[redacted]
8	[redacted]
9	[redacted]
10	[redacted]
11	[redacted]
12	[redacted]
13	[redacted]
14	[redacted]
15	[redacted]
16	[redacted]
17	[redacted]
18	[redacted]
19	[redacted]
20	[redacted]
21	[redacted]
22	[redacted]
23	[redacted]
24	[redacted]
25	[redacted]
26	[redacted]
27	[redacted]
28	[redacted]
29	[redacted]
30	[redacted]
Total	[redacted]
10 Year	[redacted]

8.3 Total Project Benefits

The extra capacity created by upgrading the OLC is predicted to reduce congestion and improve (reduce) the vehicle operation costs. The benefits are assumed to be capped beyond 2031. This is because the interim option is predicted to reach capacity by 2031 and no further benefits can be realised beyond the capacity limitation. Based on the SATURN and AIMSUN models outputs and the operation cost model, the 2021 to 2051 operational and crash reduction benefits for the upgrade scheme are illustrated in **Figure 8-2** and **Figure 8-3** with different discount rates (4% and 7%).

Lindum OLC Upgrade

Scheme : Option4Bα (2021-2051)

Table 1: BCR Calculation

Operation Benefits (Source: NCR_Cost Analysis)	4% Treasury Discount Rate
Sum of Annual Vehicle Operating Benefits 2021 - 2051	Sch4Pt3(15) [redacted]
Crash Benefits	[redacted]
NPV of all intersections	[redacted]
Total Benefits	[redacted]
Total Benefits 2021 to 2051	[redacted]
Total Costs	[redacted]
Total Project Costs	[redacted]
Benefit/Cost Ratio	[redacted]
BCR	[redacted]

Table 2: NPV Operation Benefit (2021 - 2051)

Sch4Pt3(15)

[redacted]

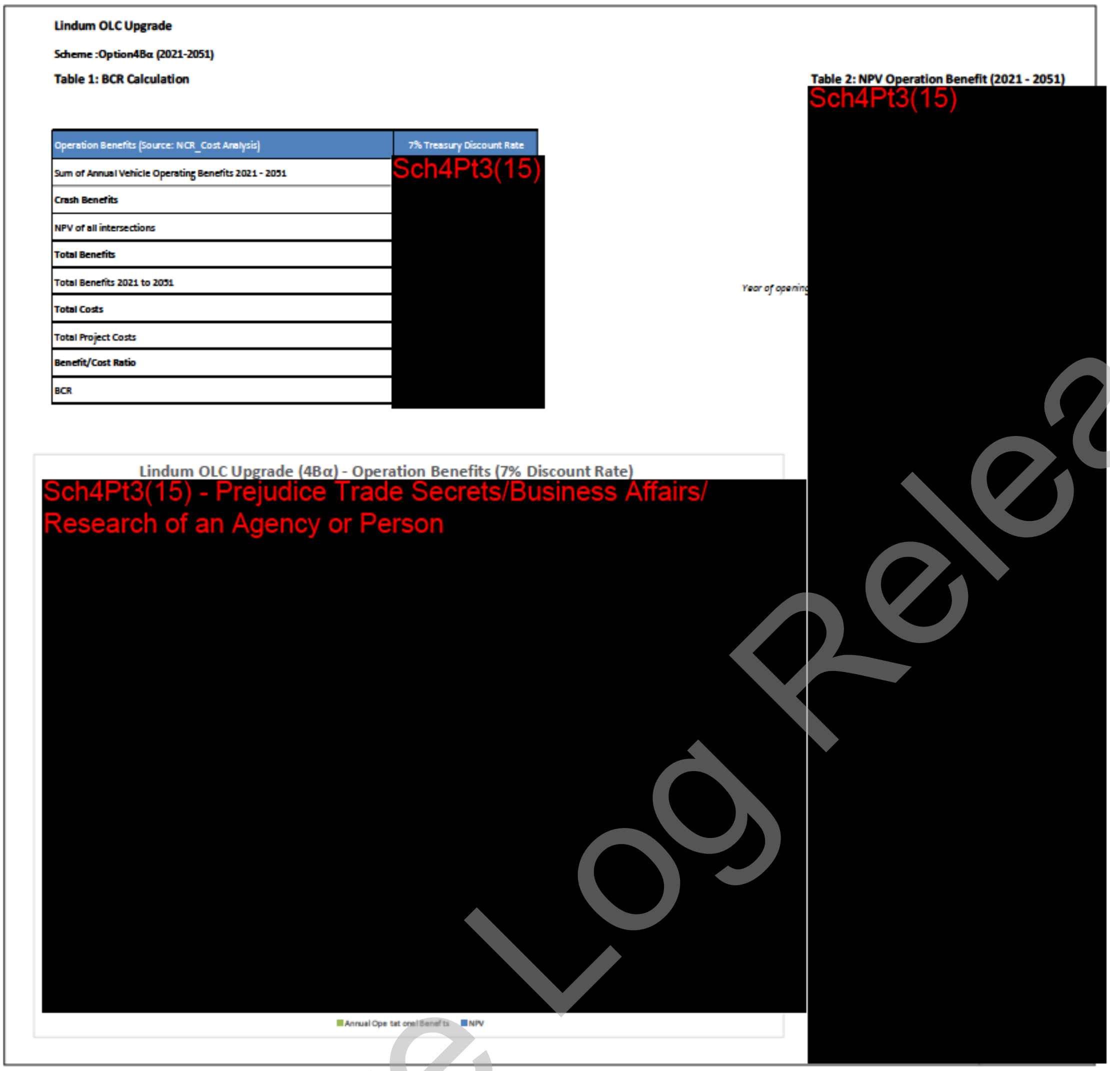
Lindum OLC Upgrade (4Bα) - Operation Benefits (4% Discount Rate)

Sch4Pt3(15) - Prejudice Trade Secrets/Business Affairs/ Research of an Agency or Person

[redacted]

Annual Operational Benefits NPV

Figure 8-2 : Total Benefit Summary (4% Discount Rate)



[redacted]

Figure 8-3 : Total Benefit Summary (7% Discount Rate)

Although results show that there are initially some negative benefits, upgrades to the OLC are quickly realised by 2031 in response to forecast travel growth.

Sch4Pt3(15) [redacted]

9 CONCLUSIONS

Based on the analysis and discussions presented in this report, the following main points are provided as a summary:

- Several levels of transport modelling were undertaken to investigate interim upgrade options for the Lindum Open Level Crossing.
- Long term trip forecasting was undertaken at the Macro Level using the BSTM (Brisbane Strategic Transport Model).
- Road Network simulation modelling was undertaken at the Mesoscopic level using the Hemmant Lytton Gumdale Road Network model in the SATURN software to consider the effects of turn bans and changes to congestion levels.
- Detailed Microscopic assessment of Boom Gate operation in partnership with signalisation options has been undertaken using AIMSUN to consider the operation of solutions in finer detail. A 13 hour assessment was considered at this level.
- Models were validated to measure travel characteristics that included volume, delay and queue and very good matches were achieved.
- The AIMSUN model adopted real boomgate data and has achieved a good match to current traffic environment and is very suitable for scenario testing.
- 12 proposed options were tested initially with further refinement analysis of Option2Bα, Option3α, Option4Bα, Option4Cα and Option5Cα due to their improved operational performance and safety.
- The options ranged from signals on existing, signals on existing with widening for right turns, banning right turns to simplify phasing to improve safety and performance, and providing a new level crossing with signals on an alternative improved geometric alignment.
- Option2Bα, Option3α, and Option5Cα have safety concerns that couldn't be resolved with a standard boomgate and would require upgraded infrastructure solutions.
- Option4Bα and Option4Cα are all based on a new level crossing on an improved geometric alignment. They were further considered due to the improved alignment and safety and operating performance, however Option 4Bα retains a protected right turn from Kianawah Road to Sibley Road.
- Sch4Pt3(15) - Prejudice Trade Secrets/Business Affairs/Research of an Agency or Person [redacted]
- [redacted]
- A layout for the preferred option 4Bα is shown in **Figure 8-1**.

Appendix A

DCA Code

DCA Group by Crash Nature/Crash DCA Description

DCA Group	Crash DCA Description
1	Vehicles adjacent approach : through/right/left (101/101/102/103/104/105/106/107/108/109) Vehicles adjacent approach : other (100)
2	Vehicles opposite approach : head on (201) Vehicles overtaking : head on (501)
3	Vehicles opposite approach : through/right/left (202/203/204/205)
4	Vehicles same direction : rear (301) Vehicles same direction : left/right rear (302/303)
5	Vehicles same direction : lane change right/ left (306/307) Vehicles same direction : lane side swipe (305) Vehicles overtaking : cutting in (504)
6	Vehicles same direction : right/left side swipe (308/309)
7	Vehicles opposite approach : u-turn (207) Vehicles same direction : u-turn (304)
8	Vehicles manoeuvring : leaving driveway (406) Vehicles manoeuvring : leaving parking (401) Vehicles manoeuvring : entering from footway (408)
9	Vehicles overtaking : pulling out (503) Vehicles overtaking : pulling out rear end (505) Vehicles overtaking : overtake right turn (506)
10	Vehicles manoeuvring : parking (402) Vehicles manoeuvring : reversing (402) Vehicles on path : parked (601) Vehicles on path : car door (604) Vehicles on path : accident or broken down (608)
11	Passengers & miscellaneous : hit train (903)
12	Pedestrian : near side vehicle hit from right (001) Pedestrian : hit emerging behind vehicle (002) Pedestrian : far side vehicle hit from left (003) Pedestrian : play/work/stand/lie on carriageway (004) Pedestrian : hit walking/facing with traffic (005/006) Pedestrian : hit by vehicle entering/leaving driveway (007) Pedestrian : on footway hit by vehicle on footway (008) Pedestrian : hit while boarding/alighting (009)
13	Vehicles on path : permanent obstruction
14	Passengers & miscellaneous : hit animal (609)
15	Vehicles overtaking : out of control (502) Off path-straight : left/right off carriageway (701/702) Off path-straight : left/right turn (706/707)
16	Off path-straight : left/right off carriageway (703/704) Off path-straight : mounts traffic island (708) Passengers & miscellaneous : hit railway crossing furniture (904)
17	Off path-straight : out of control on carriageway (705)
18	Off path-curve : off carriageway right/left bend (801/802) Off path-curve : mounts traffic island (808)
19	Off path-curve : off carriageway right/left bend hit object (803/804)
20	Off path-curve : out of control on carriageway (805) Vehicle left/right-turning at intersection or driveway (806/807)

Appendix B

Crash Benefits

4% Discount Rate

Benefit-Cost Ratio Calculation

Benefits

Crash History												
				Treatment 1			Treatment 3			Treatment 2		
DCA Group	Cost per crash	Total No. of Crashes	Crashes Cost per year	No. of Crashes	Reduction Rate(%)	Reduced Cost per year	No. of Crashes	Reduction Rate(%)	Reduced Cost per year	No. of Crashes	Reduction Rate(%)	Reduced Cost per year
1	Sch4Pt3(15) [redacted]											
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
Totals		6	[redacted]	6		Sch4Pt3(15) [redacted]						
Savings Per Treatment												
Total Recurring Costs					$ -							
Service Life in years												

Traffic Growth Rate	2%
Discount Rate	4%
Assessment Period	20

Total Benefits (NPV)	[redacted]
Total Costs (NPV)	

7% Discount Rate

Benefit-Cost Ratio Calculation

Benefits

Crash History

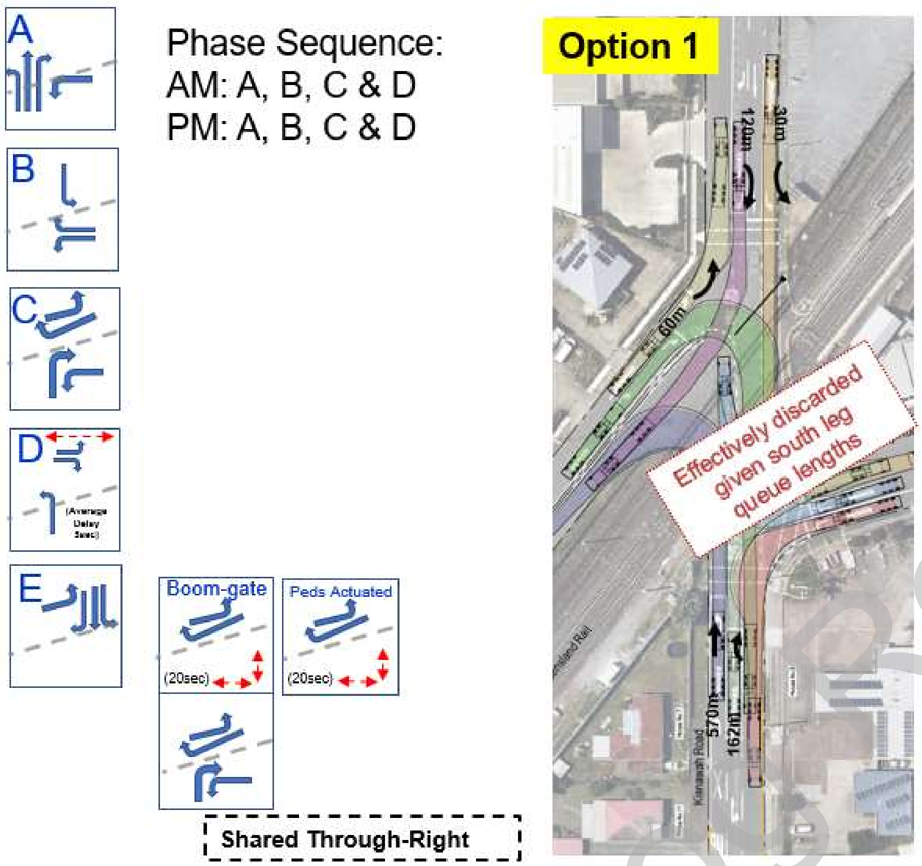
DCA Group	Cost per crash	Total No. of Crashes	Crashes Cost per year	Treatment 1 No. of Crashes	Treatment 1 Reduction Rate(%)	Treatment 1 Reduced Cost per year	Treatment 3 No. of Crashes	Treatment 3 Reduction Rate(%)	Treatment 3 Reduced Cost per year	Treatment 2 No. of Crashes	Treatment 2 Reduction Rate(%)	Treatment 2 Reduced Cost per year
1	Sch4Pt3(15) [redacted]											
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												

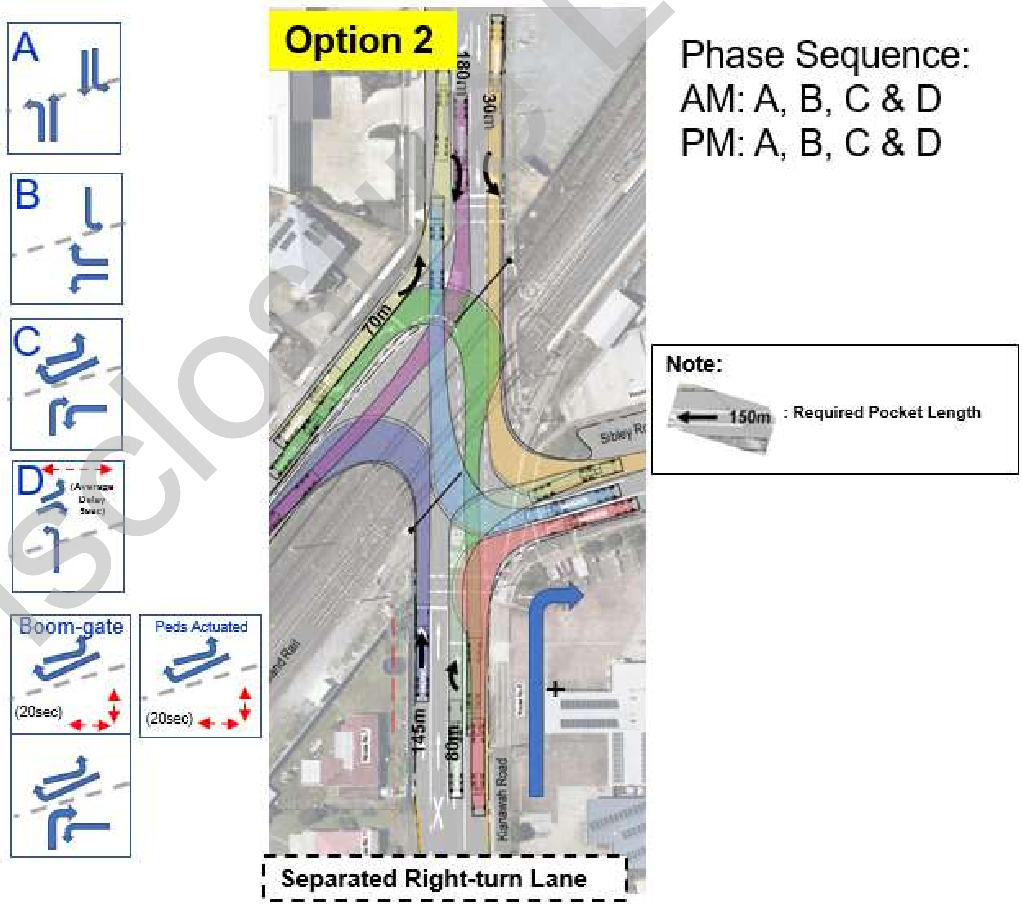
Savings Per Treatment			Sch4Pt3(15) [redacted]
Total Recurring Costs		$ -	
Service Life in years			

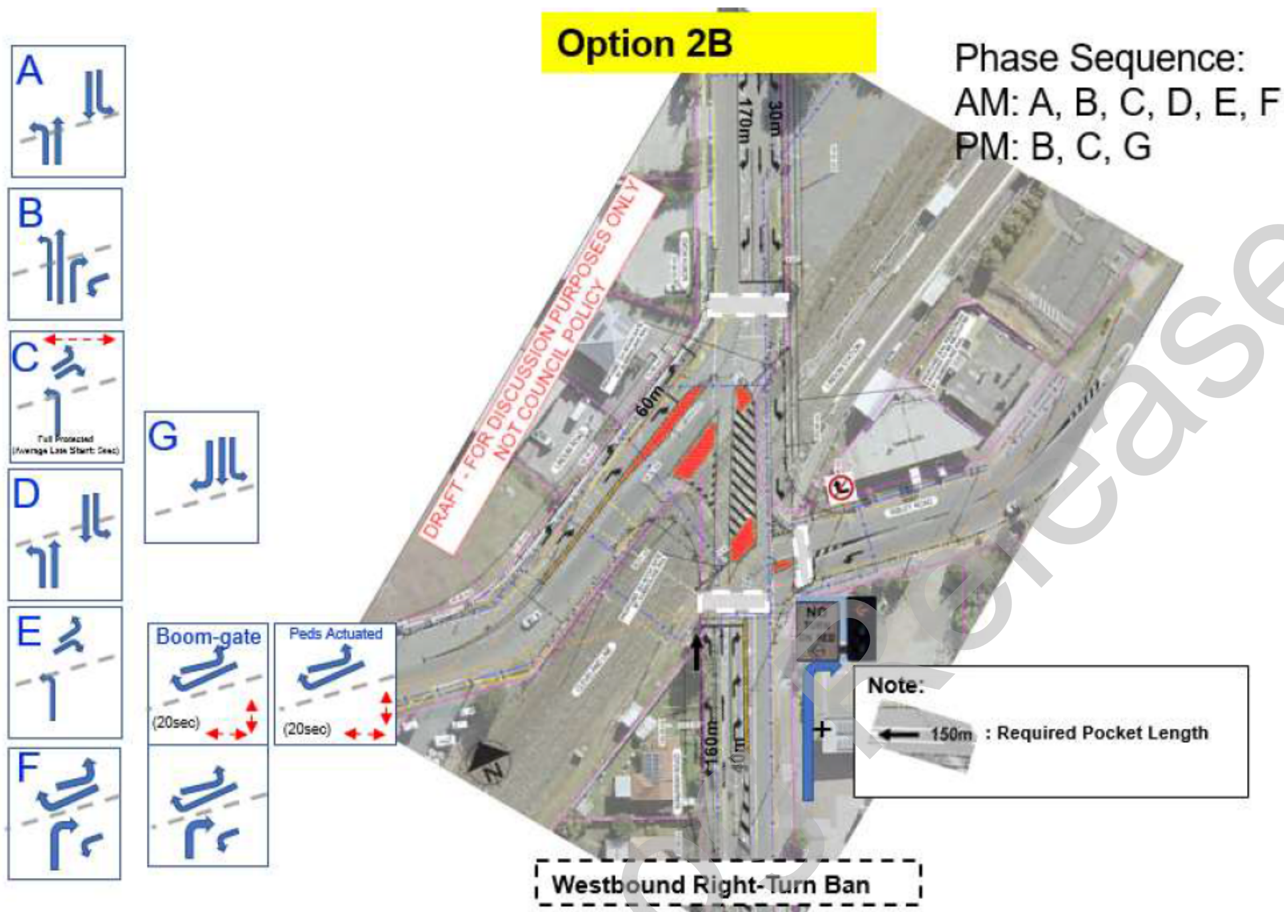
Traffic Growth Rate	2%
Discount Rate	7%
Assessment Period	20

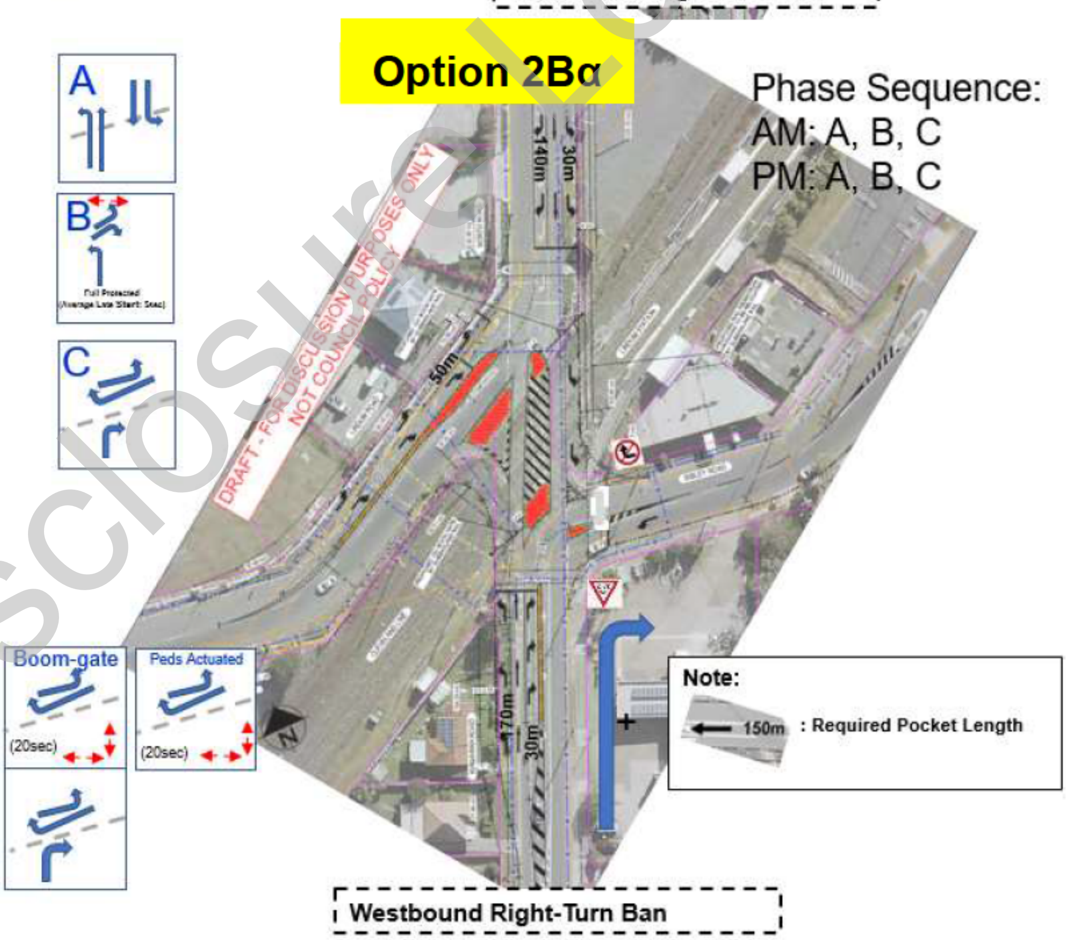
Appendix C

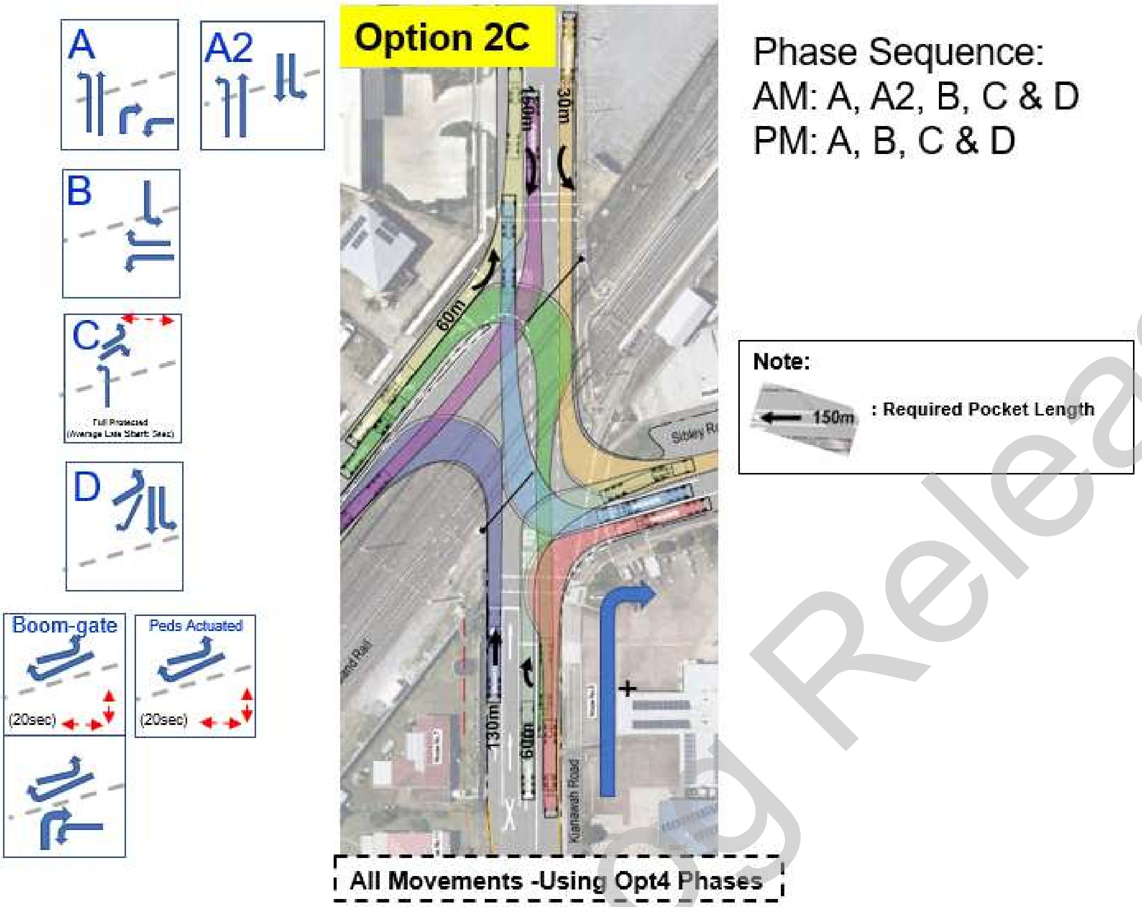
Option Layouts

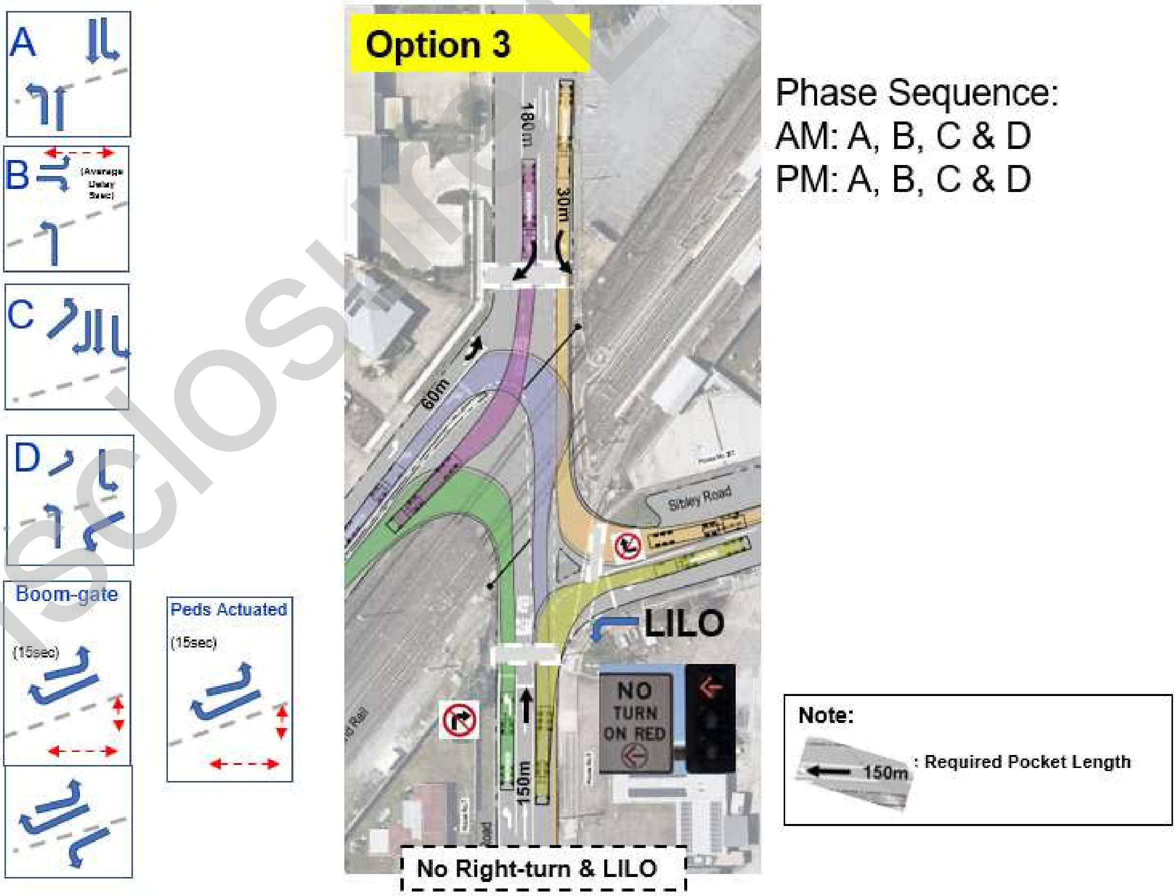

Option 1
Phase Sequence:
AM: A, B, C & D
PM: A, B, C & D
A
B
C
D
E
Boom-gate
(20sec)
Peds Actuated
(20sec)
Shared Through-Right
120m
30m
60m
570m
162m
Effectively discarded given south leg queue lengths


Option 2
Phase Sequence:
AM: A, B, C & D
PM: A, B, C & D
A
B
C
D
Boom-gate
(20sec)
Peds Actuated
(20sec)
180m
30m
70m
145m
80m
Note:
150m : Required Pocket Length
Separated Right-turn Lane

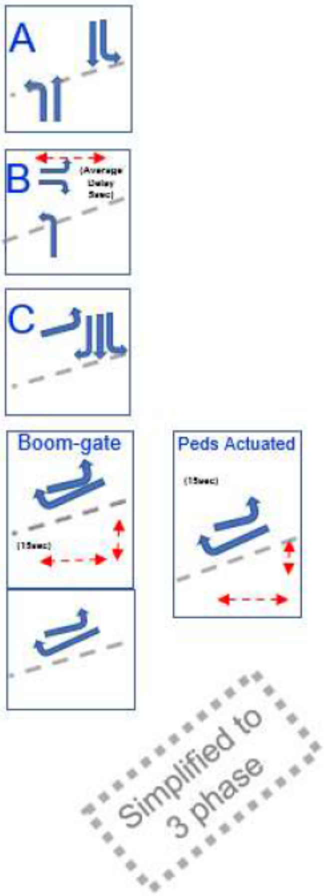

Option 2B
Phase Sequence:
AM: A, B, C, D, E, F
PM: B, C, G
A
B
C
Full Protected (Average Lane Start: 5sec)
D
E
F
G
Boom-gate
(20sec)
Peds Actuated
(20sec)
DRAFT - FOR DISCUSSION PURPOSES ONLY
NOT COUNCIL POLICY
170m
30m
60m
160m
40m
Note:
150m : Required Pocket Length
Westbound Right-Turn Ban


Option 2Bα
Phase Sequence:
AM: A, B, C
PM: A, B, C
A
B
Full Protected (Average Lane Start: 5sec)
C
Boom-gate
(20sec)
Peds Actuated
(20sec)
DRAFT - FOR DISCUSSION PURPOSES ONLY
NOT COUNCIL POLICY
140m
30m
50m
170m
30m
Note:
150m : Required Pocket Length
Westbound Right-Turn Ban


Option 2C
A
A2
B
C
Full Protected (Average Late Start: 5sec)
D
Boom-gate
(20sec)
Peds Actuated
(20sec)
150m
30m
60m
130m
60m
Sibley Rd
Kianawah Road
All Movements -Using Opt4 Phases
Phase Sequence:
AM: A, A2, B, C & D
PM: A, B, C & D
Note:
150m
: Required Pocket Length


Option 3
A
B
(Average Delay 5sec)
C
D
Boom-gate
(15sec)
Peds Actuated
(15sec)
180m
30m
60m
Sibley Road
LILO
NO TURN ON RED
150m
No Right-turn & LILO
Phase Sequence:
AM: A, B, C & D
PM: A, B, C & D
Note:
150m
: Required Pocket Length

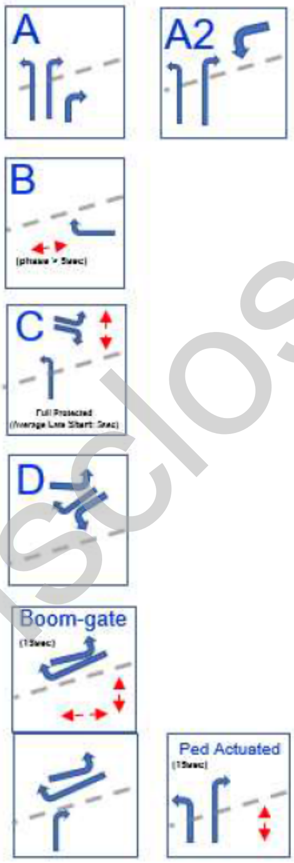
Option 3α

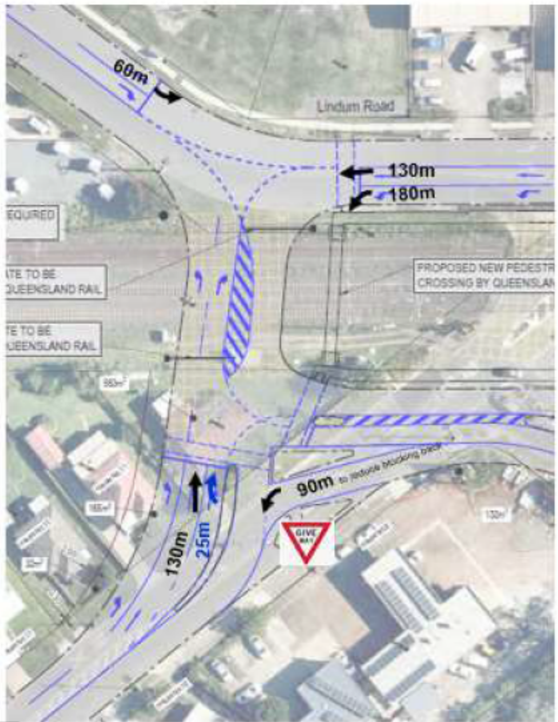


Phase Sequence:
AM: A, B & C
PM: A, B & C

Note:
150m : Required Pocket Length

Option 4Aα

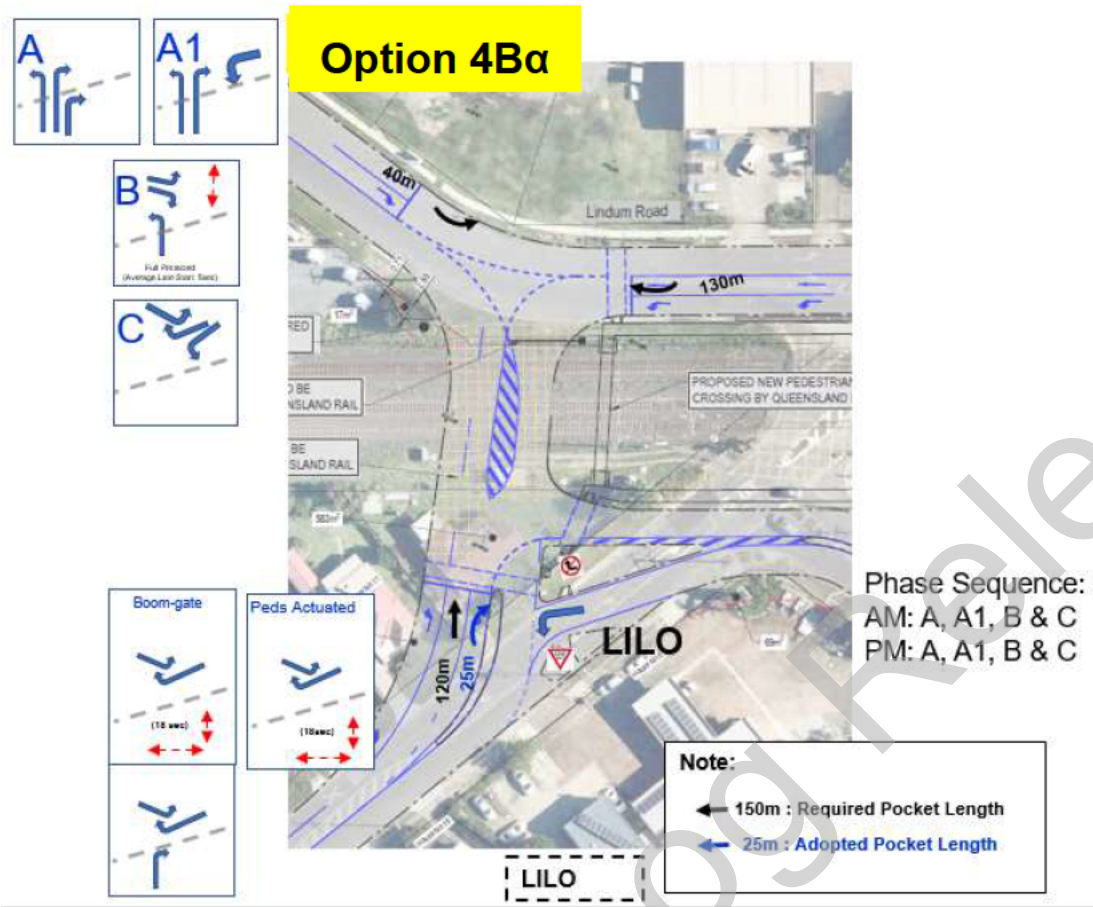


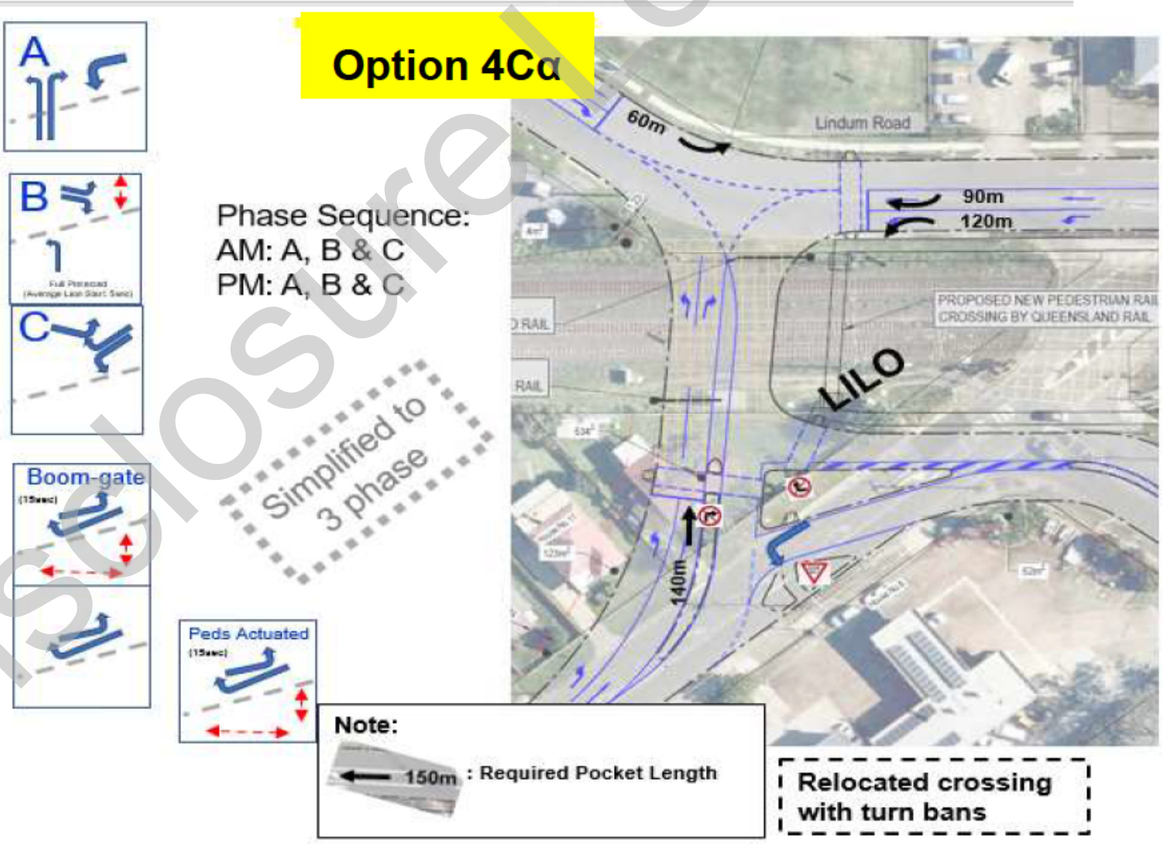


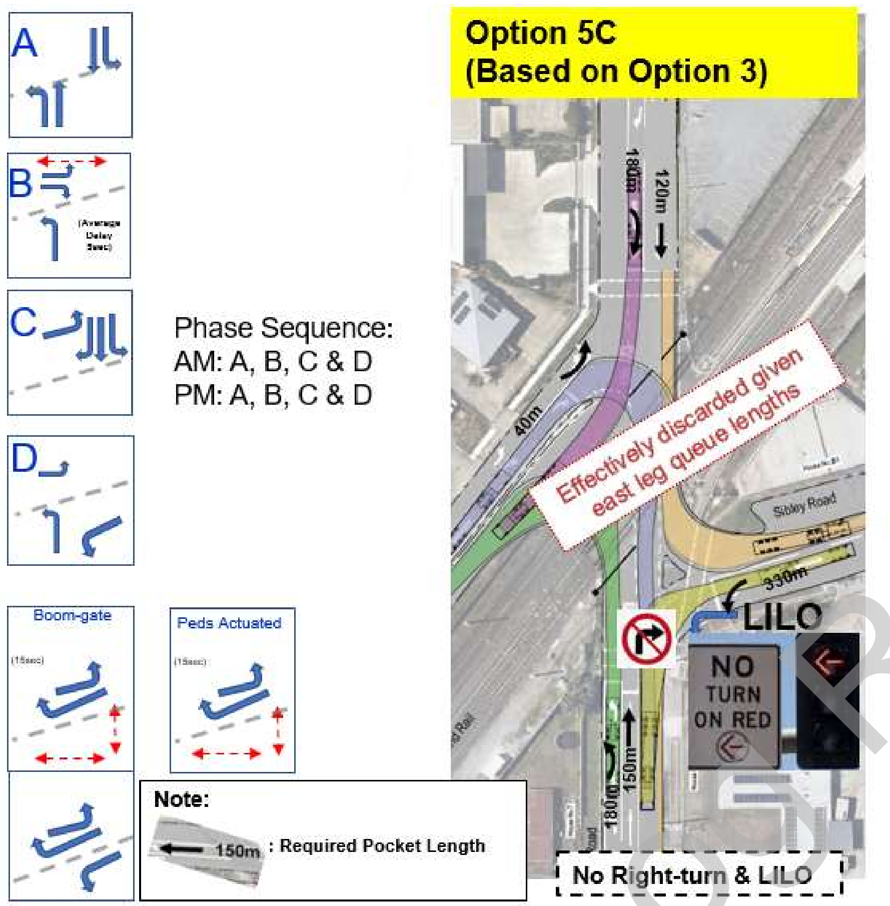
Phase Sequence:
AM: A, A2, B, D & C
PM: A2, A, C, B & D

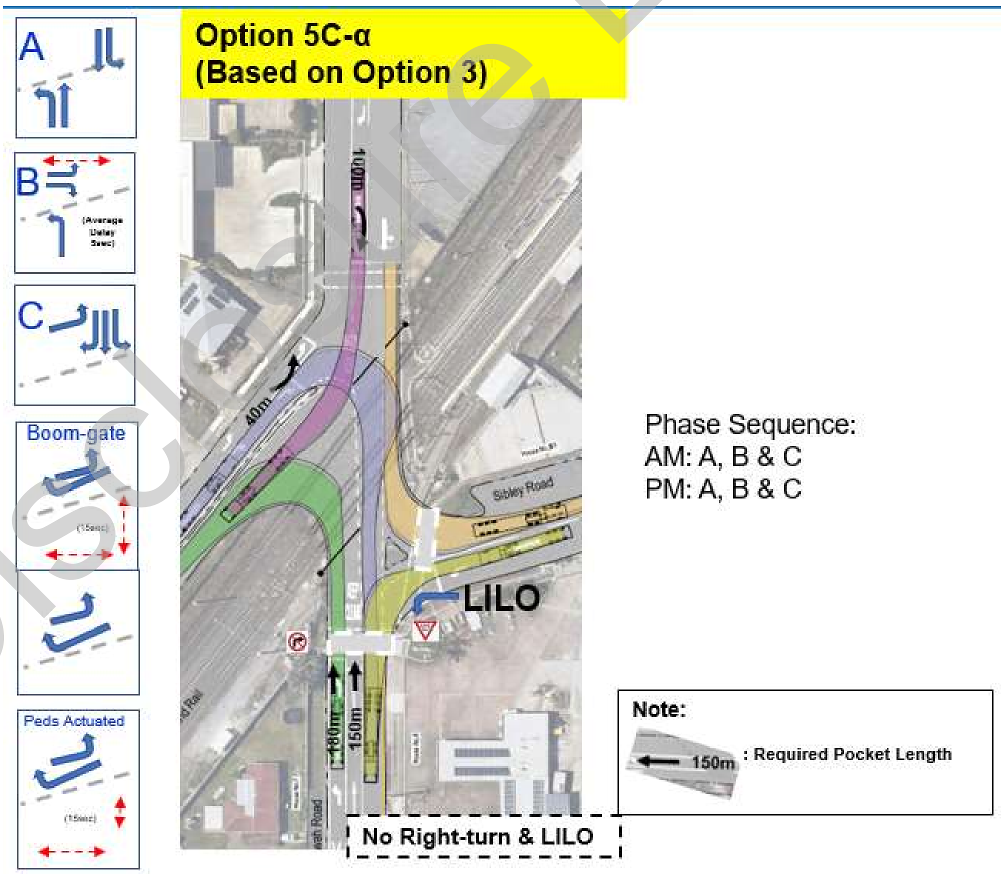
Note:
150m : Required Pocket Length
25m : Adopted Pocket Length

Relocated crossing


Option 4Bα
A
A1
B
C
40m
Lindum Road
130m
PROPOSED NEW PEDESTRIAN CROSSING BY QUEENSLAND
Boom-gate
Peds Actuated
120m
25m
LILO
Phase Sequence:
AM: A, A1, B & C
PM: A, A1, B & C
Note:
150m : Required Pocket Length
25m : Adopted Pocket Length
LILO


Option 4Cα
A
B
C
Phase Sequence:
AM: A, B & C
PM: A, B & C
60m
Lindum Road
90m
120m
PROPOSED NEW PEDESTRIAN RAIL CROSSING BY QUEENSLAND RAIL
LILO
Simplified to 3 phase
Boom-gate
(15sec)
Peds Actuated
(15sec)
140m
Note:
150m : Required Pocket Length
Relocated crossing with turn bans

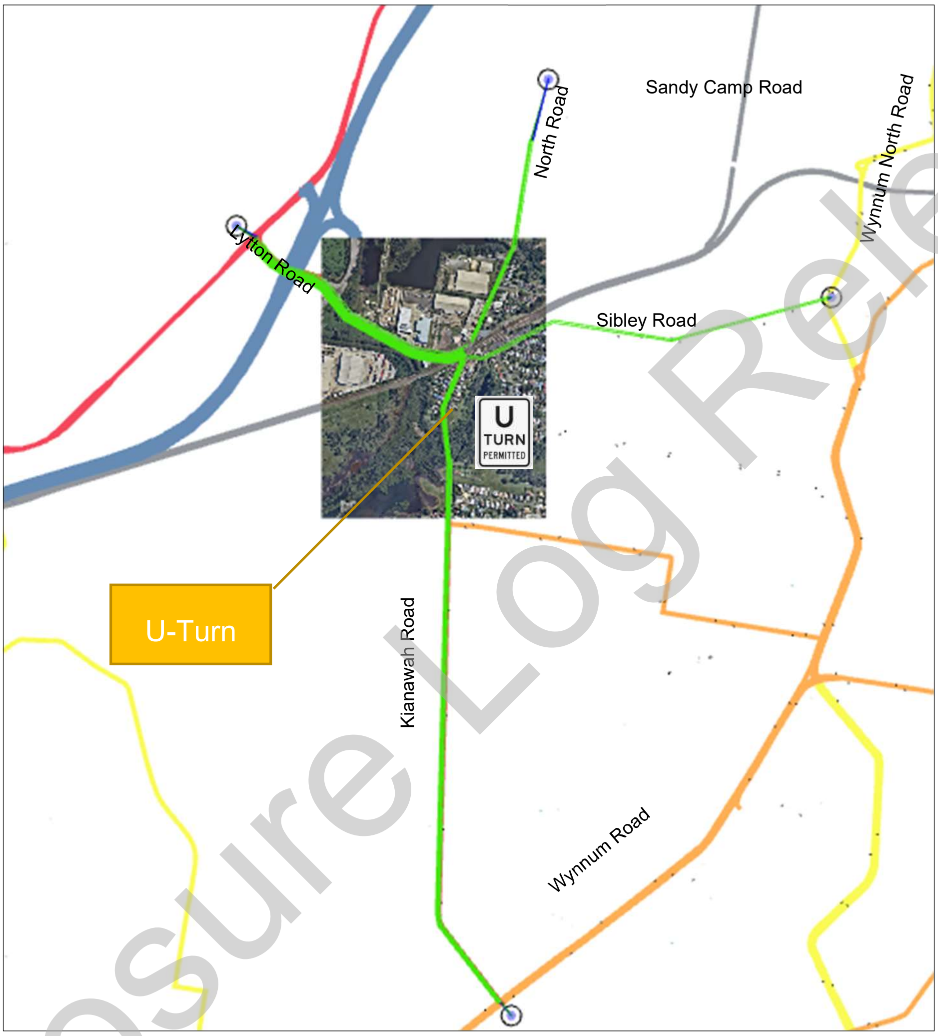

Option 5C
(Based on Option 3)
A
B
(Average Delay 5sec)
C
D
Phase Sequence:
AM: A, B, C & D
PM: A, B, C & D
Boom-gate
(15sec)
Peds Actuated
(15sec)
Note:
150m : Required Pocket Length
180m
120m
40m
Effectively discarded given east leg queue lengths
Sibley Road
330m
LILO
NO TURN ON RED
150m
180m
No Right-turn & LILO


Option 5C-α
(Based on Option 3)
A
B
(Average Delay 5sec)
C
Boom-gate
(15sec)
Peds Actuated
(15sec)
100m
40m
Sibley Road
LILO
180m
150m
No Right-turn & LILO
Phase Sequence:
AM: A, B & C
PM: A, B & C
Note:
150m : Required Pocket Length

1.1 U-turn Facility Analysis

Figure-1 shows the AIMSUN model extents and the location of the proposed U-Turn facility. The proposed U-Turn facility approximately locates at 300 metre south from the intersection of Sibley Road and Kianawah Road intersection.

Figure-1: AIMSUN Model Extents and U-Turn Facility Location



The 95 and 100 percentile queue length are derived from 5 model replications that each replication has maximum queue length in every 1 minute intervals. **Figure-2** below show the layout of the U-turn facility and **Table 1** shows the 95 and 100 percentile queue distances during the AM and PM peaks.

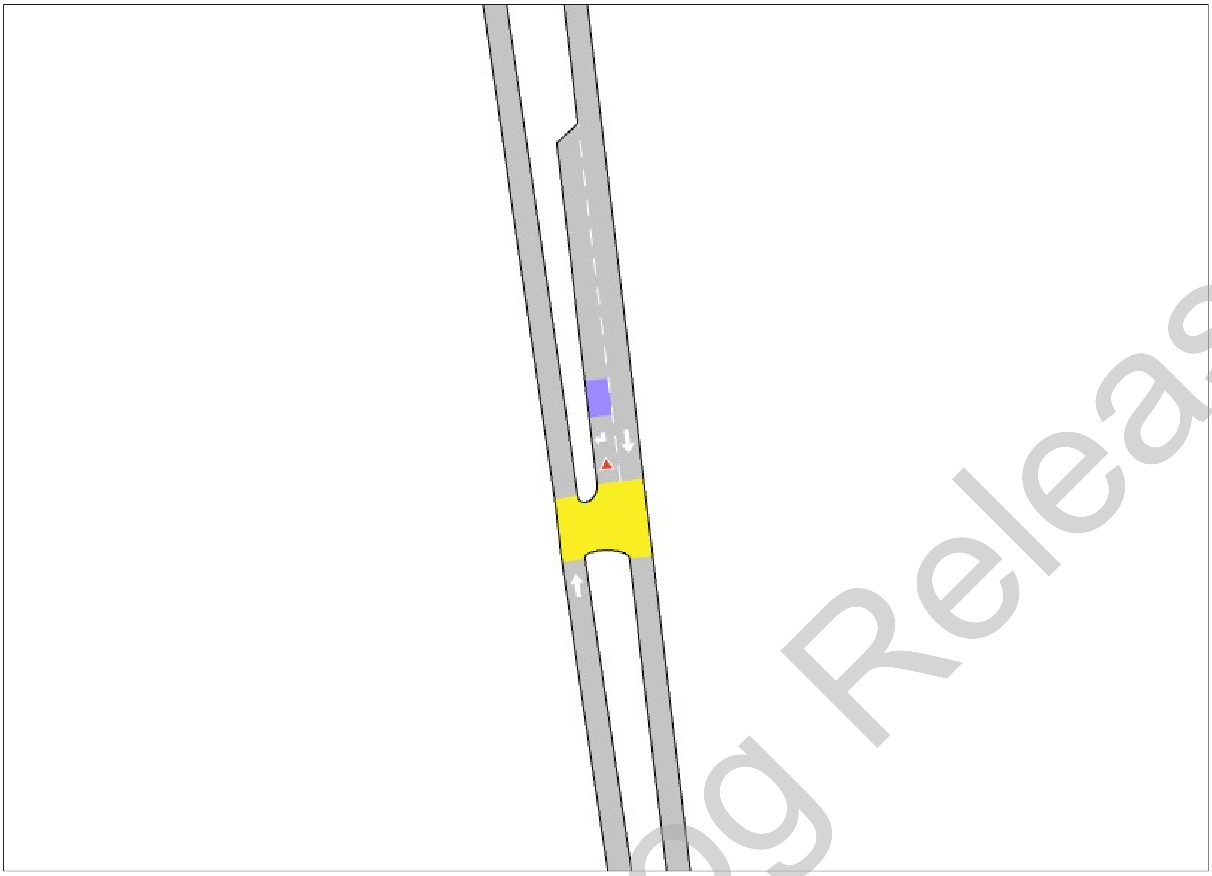


Figure-2: U-Turn Facility Layout

Table 1: 95%tile Queue and 100%tile Queue

Kianawah Rd U-Turn	95% Queue (m)	100% Queue (m)
AM Peak	19	36
PM Peak	6	12