11.0 CONCLUSION AND RECOMMENDATIONS

The following recommendations were based on consideration of:

- Statutory requirements under the *National Parks and Wildlife Act* 1974
- The results of the background research, site survey and assessment
- The interests of Aboriginal stakeholder groups
- The likely impacts of the proposed development

It was found that:

- No Aboriginal sites and/or places were located within the study area.
- The study area has been subject to significant ground disturbance
- The study area was assessed as demonstrating low archaeological potential.

It is therefore recommended that:

- The proposed 'Shepherd Street Precinct' development is able to proceed without the need for further archaeological and/or Aboriginal heritage assessment.
- If the project design should change or if areas not surveyed are added to the scope of proposed works, further archaeological assessment would be required.
- If Aboriginal objects are uncovered during works an archaeologist, the TLALC and OEH must be notified. Further investigation and approvals may be required.
- If human remains are identified during archaeological test excavation or during any stage of the proposed works, work should cease, the site should be secured and the NSW Police and the OEH should be notified. Further investigation and approvals may be required.
- A final copy of this report (with updated study area and proposed design) should be forwarded to TLALC for their records.

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13.0 APPENDICES

13.1 Appendix 1: Tharawal Local Aboriginal Land Council Report

THARAWAL LOCAL ABORIGINAL LAND COUNCIL
220 West Parade, Couridjah NSW 2571

Friday 2nd October 2015

Alex Timms
Artefact
Level 4, Building B, 35 Saunders Street
Pyrmont NSW 2009

RE: Shepherd Street, Liverpool NSW

Dear Alex,

Thank you for your invitation on this survey undertaken on Friday 21st August 2015. Nothing of Aboriginal Cultural Significance was located within this survey.

Tharawal LALC agrees with the Recommendations in the DRAFT report.

- The proposed 'Shepherd Street precinct' development is able to proceed without the need for further archaeological and/or Aboriginal heritage assessment.
- If the project design should change or if areas not surveyed are added to the scope of proposed works, further archaeological assessment would be required.
- If Aboriginal objects are uncovered during works and archaeologist, the TLALC and OEH must be notified. Further investigation and approvals may be required.
- If human remains are identified during archaeological test excavation or during any stage of the proposed works, work should cease, the site should be secured and the NSW Police, Tharawal LALC and OEH should be notified. Further investigation and approvals may be required

Yours Sincerely,

Abbi Whillock
Cultural Heritage Officer
Tharawal Local Aboriginal Land Council
M: 0448 002 042

PO Box 168
PICTON NSW 2571
Phone: 02 4681 0059 Fax: 02 4681 0866 ABN: 60 693 210 407
heritage@tharawal.com.au

artefact

Artefact Heritage
ABN 73 144 973 526
Level 4, Building B
35 Saunders Street
Pyrmont NSW 2009
Australia
+61 2 9518 8411
office@artefact.net.au
www.artefact.net.au

INROADS:GROUP

Planning Proposal, Shepherd Street, Liverpool

Addendum Traffic Report

Revision B
10 June 2016

Prepared by: **Anne Coutts**
Director, InRoads Group
BE Civil, MIEAust

InRoads Group
www.inroadsgroup.com.au
PO Box 596 | Potts Point NSW 1335
02 8035 3417
ABN: 25 608 559 897
ACN: 608 559 897

CONSULT AUSTRALIA
Member Firm

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Liverpool City Council Concept Plan – Woodbrook Road Underpass

InRoads Group has prepared this report solely for the benefit and use of its client. This report takes into account the particular instructions and requirements of the client. In preparing this report we assume that all information and documents provided to us by the client or its consultants were complete, accurate and current. InRoads Group will not be liable for any conclusion drawn resulting from omission or lack of full disclosure by the client or its consultants.

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1.0 Introduction

InRoads Group was engaged to undertake a Traffic Impact Assessment investigating the impacts of rezoning seven adjacent properties on Shepherd Street in Liverpool. The subject properties include all of those on the eastern side of Shepherd Street, south of Atkinson Street (i.e. 20, 26, 28, 32-24, and 31-33 Shepherd Street). These properties have a combined area of approximately 31,000m^2.

Whilst already zoned R4 high-density residential, an increase in the permitted height and floor space ratio is sought to increase the potential density of development on the subject sites from 787 apartments (under the current planning controls) to 1,201 apartments on the eastern side of Shepherd Street.

An overall Masterplan has been developed which assumes the redevelopment of all land parcels on Shepherd Street, i.e. also including the properties on the western side, i.e. 19, 21, 25, 27, 29 Shepherd Street (see **Figure 1.0** below). An overall yield of approximately 1,500 residential apartments is anticipated for all properties on Shepherd Street (east and west) under this Masterplan, compared with 1,085 apartments under the existing planning controls. The proposed yield has been reduced from 1,774 apartments under the previous proposal.

Whilst this Planning Proposal relates to the rezoning of the properties on the eastern side of Shepherd Street only (i.e. 20, 26, 28, 32-24, and 31-33 Shepherd Street), the traffic investigations undertaken consider the impact of the redevelopment of all properties on Shepherd Street, as requested by Council.

This report is an Addendum to the Traffic Report prepared by InRoads Group (dated 10 March 2016) which accompanied the original Planning Proposal, and therefore should be read in conjunction with that report. Considering the amended (reduced yield) scheme, this report provides the results of additional analyses and investigations as requested by Council, and suggests an approach towards considering the cumulative impact of the proposed development in the context of the significant growth and development anticipated in the Liverpool City Centre Precinct. This is discussed further in the following section.

Figure 1.0: Subject Land Parcels (Masterplan Area)

1.1 Background and Context

The original Planning Proposal sought an increase in the permitted height and floor space ratio to increase the potential density of development on the subject sites from 787 apartments (under the current planning controls) to 1,475 apartments on the eastern side of Shepherd Street. The current Planning Proposal is for a reduced yield scheme of 1,201 apartments. **Table 1.1** below summarises the indicative Floor Space Ratios and apartments yields under the existing controls, the original proposal, and the current (reduced yield) proposal.

Table 1.1: Indicative Yields

	Eastern Precinct		Overall Precinct	
	Floor Space Ratio	**No. of Apartments**	**Floor Space Ratio**	**No. of Apartments**
Existing Controls	2.5 : 1	787	2.5 : 1	1,085
Original Scheme	4.5 : 1	1,475	4.5 : 1	1,774
Amended (Current) Scheme	**3.45 : 1**	**1,201**	**3.45 : 1**	**1,500**

As previously discussed, this report is an Addendum to the Traffic Report prepared by InRoads Group (dated 10 March 2016) which accompanied the original Planning Proposal, and therefore should be read in conjunction with that report. It documents the results of additional traffic analyses / investigations requested by Council, based upon the reduced potential overall yield of 1,500 residential apartments.

Reference should also be made to the 'Strategic Integrated Transport Assessment' for the precinct undertaken by Smyth Consulting, which provides a strategic-level assessment of the transport opportunities and constraints affecting the precinct, and identifies a set of initiatives that can deliver appropriate levels of access while minimising impacts upon the traffic and transport network.

It is acknowledged that Council has recently requested that transport network modelling (both strategic modelling and local microsimulation modelling) be undertaken by the Applicant, to assess the cumulative impact of development in Liverpool (i.e. of the Shepherd Street precinct in addition to other substantial development proposed/approved in and around the Liverpool CBD).

However as discussed with Council, this modelling would be a significant exercise potentially taking many months to complete, and would require a detailed understanding of the planning and development proposals which have been submitted to Council, other land-use changes in the south-west growth centre and the Western Sydney Airport in particular, and local and State government planning for both the road and the public transport system.

Furthermore, it is important to note that the proposal is largely consistent with the current high density zoning of the precinct in terms of overall traffic impact. The proposed apartment yield is expected to generate only an additional approximately 100 vehicles per hour in the peak periods (compared with the apartment yield achievable under the current planning controls), which, when distributed across various arrival and departure routes, is not considered to be significant from a traffic planning perspective.

Finally, it is noted that Council is in the process of engaging a consultant to undertake this substantial modelling exercise for the broader Liverpool City Centre Precinct (RFQ PQ2561), given that Council has submitted a planning proposal to the NSW Department of Planning and Environment to amend the Liverpool Local Environmental Plan 2008 to permit B4 mixed-use developments in the existing B3 zoning in the city centre, which is estimated to result in an additional 7,500 residential dwellings in this area.

However as discussed with Council, the Applicant proposes to fund a 'variation' to the modelling to be undertaken by Council's consultant, to assess the impact of the Planning Proposal for the Shepherd Street precinct upon the broader road network at the 2026 and 2036 design horizon. As opposed to an approach whereby the Applicant and Council's consultant development similar strategic and microsimulation models in parallel, the proposed approach will minimise duplication of, and potentially redundant work, and facilitate consistency in the modelling.

It is assumed that this modelling would compare the performance of the road network under the current planning controls (i.e. 1,085 apartments in the Shepherd Street precinct as the future baseline scenario), to the 1,500 apartments in the Shepherd Street precinct which are being assessed under this planning proposal. This modelling will allow Council and the Applicant to finalise the commitments required to ensure traffic impacts of the proposal are appropriately addressed.

In addition to the network analyses proposed to be undertaken, additional local (SIDRA) intersection modelling has been undertaken, to support the proposal. The results of the additional traffic analyses / investigations requested by Council are outlined in the following sections.

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2.0 Amended Proposal – Intended Development Outcomes

The current Concept Masterplan is included for reference as **Appendix A**.

This amended Planning Proposal seeks to vary the planning controls of the Liverpool Local Environmental Plan 2008 for the subject sites, to facilitate residential development with the indicative yields as outlined in **Table 2.0** below.

Table 2.0: Indicative Yields by Property

Site	Property Description	Area	Indicative Yield
Properties which are the subject of this Planning Proposal			
20 Shepherd Street	Lot 1 on DP247485	9,908 m^2	309 apartments
26 - 28 Shepherd Street	Lot 22 and 23 on DP859055	8,721 m^2	375 apartments
32-34 Shepherd Street	Lot 3 and Lot 4 on DP247485	3,988 m^2	178 apartments
31-33 Shepherd Street	Lot 5 and Lot 6 on DP247485	8,427 m^2	339 apartments
Sub-total		**31,044 m^2**	**1,201 apartments**
Additional properties within Masterplan Area			
19 Shepherd Street	SP70274	2,128 m^2	50 apartments
21 Shepherd Street	SP30264	2,090 m^2	49 apartments
25 Shepherd Street	Lot 11 on DP1131075	3,948 m^2	102 apartments
27 Shepherd Street	Lot 8 on DP247485	2,123 m^2	61 apartments
29 Shepherd Street	Lot 7 on DP247485	2,086 m^2	37 apartments
Sub-total		**12,375 m^2**	**299 apartments**

It is reiterated that whilst this Planning Proposal relates to the rezoning of the properties on the eastern side of Shepherd Street only (i.e. 1,201 apartments on 20, 26, 28, 32-24, and 31-33 Shepherd Street), the traffic investigations undertaken consider the impact of the redevelopment of all properties on Shepherd Street (i.e. 1,500 apartments), as requested by Council.

The following sections summarise the results of the additional analyses and investigations undertaken.

3.0 Additional Traffic Analyses

The Traffic Report which accompanied the original Planning Proposal included the results of analyses of the following intersections (see **Figure 3.0** below):

1. Shepherd Street / Atkinson Street
2. Shepherd Street / Riverpark Drive
3. Shepherd Street / Speed Street
4. Speed Street / Mill Road

Figure 3.0: Key Intersections Previously Analysed

The results of the traffic modelling undertaken revealed that there is substantial spare capacity at all four intersections modelled during the critical AM and PM peak hours to accommodate the traffic expected to be generated by the previous (higher yield) scheme (i.e. 1,750 apartments), at the 2035 design horizon. Under all design scenarios, these intersections were modelled to perform well within acceptable capacity limits.

The four (4) intersections identified above were selected for assessment given their proximity to the precinct, and the fact that all traffic accessing the precinct would necessarily travel through Intersections 1, 2, and 3, as this is the only route to/from the catchment.

The analyses previously undertaken did not extend to intersections which are more remote from the precinct, for the following key reasons:

- whilst it was acknowledged that the proposal was for development of a reasonable scale, residential land uses are inherently low traffic generators on a per square meter basis (particularly when located in walking distance of a CBD centre or public transport services). The overall net traffic impact of the proposal was therefore not considered to be substantial, particularly in light of the following considerations:
    - the traffic generation of the existing and historic industrial developments within the precinct, which generated reasonable volumes of heavy vehicle traffic but would be removed under the proposal; and
    - the anticipated and planned increase in mode share to public and active transport modes, and the resulting reduced reliance upon private vehicle expected over the next 10 - 20 years;
- traffic from the network, upon reaching Speed Street, would disperse towards the arterial road network (e.g. the Hume Highway, Newbridge Road/Terminus Street, Bigge Street) via various routes depending upon its destination. That is, whilst is was acknowledged that traffic increases at more remote intersections would occur, these increases would be diluted as distance from the Masterplan area increases, such that the overall impact upon their performance was considered likely to be marginal; and
- importantly, the proposal did not involve substantially more development than anticipated under the existing planning controls (for which it was assumed separate traffic and transport planning would necessarily have been undertaken). That is, the proposal was largely consistent with the current high density zoning of the precinct, in terms of overall traffic impact.

Notwithstanding the above, additional intersections analyses have been undertaken, as requested by Council. The following sections summarise the results of these additional analyses.

3.1 Intersection Overview

The following additional intersections have been analysed, to assess their future operation and the expected impact of the proposal:

5. Speed Street / Bigge Street / Pirie Street
6. Newbridge Road / Speed Street
7. Terminus Street / Pirie Street

These intersections are located approximately 600m to the north of the subject site.

Newbridge Road / Terminus Street forms part of State Road MR 512, which connects from the Princes Highway (HW1) near Heathcote to the east of Liverpool City Centre, via Heathcote Road, Newbridge Road, Terminus Street and Macquarie Street to Copeland Street (Hume Highway HW2) to the west of the Liverpool City Centre. Newbridge Road carries in the order of 36,000vpd (2015 Average Annual Daily Count) at the bridge over the Georges River. Accordingly, the intersections along this road currently carry high volumes of traffic.

Furthermore, due to the fact that Bigge Street forms a primary access route between Newbridge Road and the Liverpool City Centre and other key destinations such as Liverpool Hospital (via the underpass of Newbridge Road), the traffic volumes at the Speed Street / Bigge Street / Pirie Street intersection during the peak periods are relatively substantial.

These intersections are discussed in further detail in the following sections.

Figure 3.1: Additional Intersections Analysed

3.1.1 Speed Street / Bigge Street / Pirie Street

The Speed Street / Bigge Street / Pirie Street Intersection is a four-way signalised intersection, as shown in **Figure 3.1.1** below.

This intersection was recently upgraded from a priority-controlled intersection to a signalised intersection, to better cater for the significant turning movement volumes between the northern and eastern approaches in particular (due to the fact that Bigge Street forms a primary access route between Newbridge Road and the Liverpool City Centre and other key destinations such as Liverpool Hospital, via the underpass of Newbridge Road, as previously discussed).

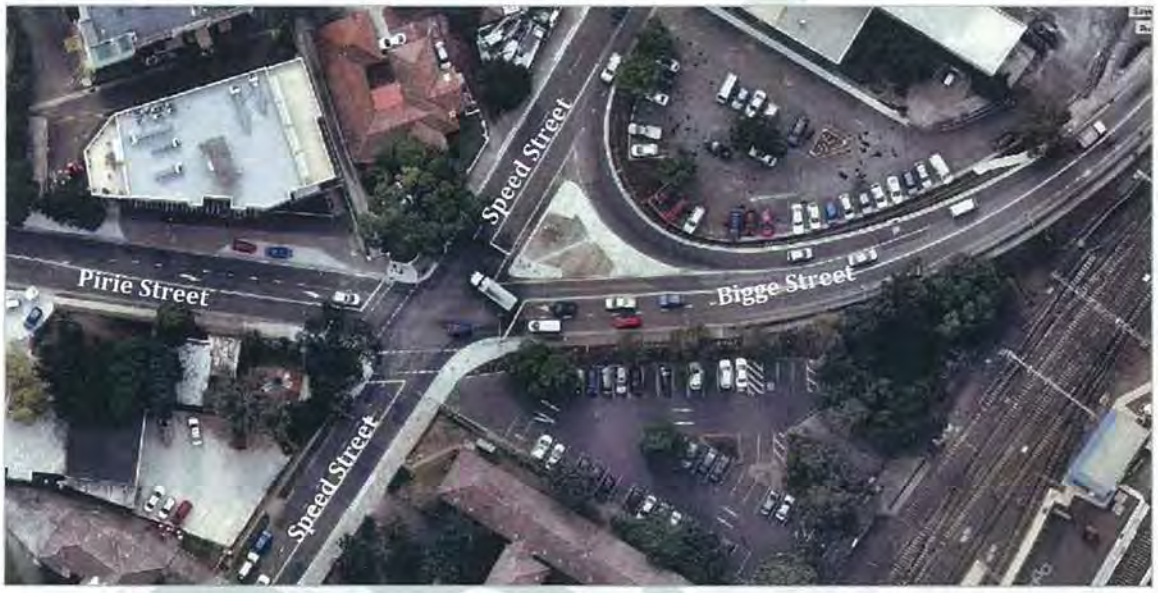

Figure 3.1.1: Speed Street / Bi

gge Street / Pirie Street Intersection

3.1.2 Newbridge Road / Speed Street Intersection

The Newbridge Road / Speed Street intersection is a four-way signalised intersection, as shown in **Figure 3.1.2a** below. The northern approach of the intersection is a bus only lane.

It is understood that as part of the refurbishment of the development on the south-east corner of the intersection (2 – 4 Speed Street), the pedestrian footbridge over Newbridge Road is to be demolished, and Newbridge Road and Speed Street are to be widened on the corner of the intersection to better accommodate the left turn manoeuvre from east to south (see **Figure 3.1.2b** below). This should enable the left turn movement from Newbridge Road into Speed Street to run concurrently with the right turn movement from Speed Street, in the phasing sequence.

Figure 3.1.2a: Shepherd Street / Riverpark Drive Intersection

Figure 3.1.2b: Approved Plan (DA1097/2013)

3.1.3 Terminus Street / Pirie Street Intersection

The Terminus Street / Pirie Street intersection is a four-way signalised intersection, as shown in **Figure 3.1.3** below.

Figure 3.1.3: Terminus Street / Pirie Street Intersection

3.2 Intersection Modelling

3.2.1 Background Traffic Volumes

For the purpose of the additional traffic analyses, turning movement counts were undertaken at the three (3) subject intersections on Tuesday 31 May 2016, between the hours of 7:00am – 9:00am and 3:00pm – 6:00pm. The traffic volumes recorded during the peak hours are included for reference as **Appendix B.**

As requested by Council, the 2026 and 2036 design horizons have been assessed for the additional intersection modelling undertaken. In order to establish future year background traffic volumes, data from the RMS Emme Strategic Traffic Assignment Model has been used. This data (7-9 AM, 4-6 PM (2 hour Peak)) is provided for reference as **Appendix C**, and the traffic volumes presented in this data for Newbridge Road (east of Speed Street) are summarised in **Table 3.2.1** below. The observed 2016 traffic volumes are included for the purpose of comparison, and the compound growth rates implied by the RMS data are also summarised in **Table 3.2.1**, by travel direction.

Table 3.2.1: Forecast Two Hour Traffic Volumes from RMS Emme Strategic Traffic Assignment Model (Newbridge Road, East of Speed Street)

	Eastbound			Westbound		
	2 Hour Volume	Growth Factor (from 2015)	Compound Growth Rate (from 2015)	2 Hour Volume	Growth Factor (from 2015)	Compound Growth Rate (from 2015)
Observed AM (2016 Count)	2,939	-	-	3,058	-	-
2015 AM	3,070	-	-	3,507	-	-
2026 AM	3,653	1.19	1.59%	4,510	1.29	2.31%
2036 AM	3,960	1.29	1.22%	5,002	1.43	1.71%
Observed PM (2016 Count)	3,285	-	-	3,524	-	-
2015 PM	3,478	-	-	3,333	-	-
2026 PM	4,390	1.26	2.14%	4,180	1.25	2.08%
2036 PM	4,924	1.42	1.67%	4,706	1.41	1.66%

The above data reveals that the RMS data indicates a forecast compound growth rate of between approximately 1.2% and 2.2% on existing volumes, for traffic on Newbridge Road.

With a view to maintaining a conservative approach, a 2% compound growth factor has been applied to the remaining traffic movements at the intersections analysed, in order to forecast 2026 and 2036 turning movement volumes at the three (3) subject intersections. The resulting forecast traffic volumes are shown in **Appendix D.**

3.2.2 Masterplan Traffic Generation

The RMS Guide to Traffic Generating Developments provides a peak hour trip rate of 0.29 vehicle trips / dwelling for High density residential flat buildings in Metropolitan Sub-Regional Centres. The application of this rate to the 1,500 apartments provides a forecast traffic generation of 435 vehicle trips in the AM and PM peak hours.

Based upon investigations undertaken by Smyth Consulting (as documented in the 'Strategic Integrated Transport Assessment'), it is assumed that over time, people's travel behaviour will change as a result of a number of factors. This will result in a reduced dependence upon private vehicle, and an increase in mode share to public transport and active travel models. In light of the estimate of future mode share for the precinct presented in Table 2 of the Smyth Consulting report, the following assumptions have been made:

- By 2026, there will be a 10% reduction in mode share to private vehicle (i.e. a trip generation rate of 0.261 trips per dwelling will apply); and
- By 2036, there will be a 20% reduction in mode share to private vehicle (i.e. a trip generation rate of 0.232 trips per dwelling will apply).

The resulting predicted peak hour trip generation volumes are therefore 392 vehicle trips in 2026, and 348 vehicle trips in 2036.

Assuming an 80% / 20% departure / arrival profile in the AM peak hour, and a 70% / 30% arrival / departure profile in the PM peak hour, the forecast traffic generation associated with the 1,500 residential apartments is as outlined in **Table 3.2.2** below.

Table 3.2.2: Forecast Masterplan Traffic Generation

	2026			2036		
	Arrivals	Departures	Total	Arrivals	Departures	Total
AM Peak Hour	78	313	392	70	278	348
PM Peak Hour	274	117	392	244	104	348

3.2.3 Masterplan Traffic Distribution

The distribution of traffic generated by the precinct has been estimated considering the likely travel routes to and from key destinations (i.e. local trips) and arterial roads (i.e. more regional trips), as follows:

- Liverpool Hospital – Medical Precinct
- Westfield Liverpool
- Local Primary Schools and High Schools
- Warwick Farm Railway Station Commuter Carpark
- Proposed Eat Street (Macquarie St)
- The Hume Highway
- Newbridge Road (Light Horse Bridge)
- The M5 Motorway
- Cumberland Highway

The figures included as **Appendix E** show the most direct routes to the above destinations, from the Shepherd Street precinct. The resulting assumptions applied in order to assign the traffic generated by the precinct to the broader road network, are as follows:

- 40% of traffic will travel to/from Bigge Street (i.e. the CBD / Liverpool Hospital – Medical Precinct);
- 20% of traffic will travel to/from the Hume Highway south / M5 Motorway (inbound);
- 20% of traffic will travel to/from Pirie Street (i.e. south/west of CBD, Hume Highway north / Cumberland Highway);
- 10% of traffic will travel to/from Newbridge Road / M5 Motorway (outbound); and
- 10% of traffic will travel to/from Hoxton Park Road.

The resulting predicted increase in traffic volumes at the three (3) additional intersections assessed, are shown in **Appendix F.**

3.2.4 Design Volumes

The design volumes for the 2026 and 2036 design horizons (i.e. the forecast background traffic volumes plus the additional traffic expected to be generated by the 1,500 apartments) at the three (3) additional intersections assessed, are shown in **Appendix G.**

It should be noted that the analyses undertaken include a reasonable degree of conservatism, as the traffic currently generated by existing developments (which would be demolished and replaced in order to deliver the residential developments proposed), has not been discounted.

The intersections were analysed using the SIDRA computer program to determine the intersection performance characteristics under the 'without masterplan' and 'with masterplan' design future design scenarios. The SIDRA modelling package produces a range of outputs, the most useful of which are the Degree of Saturation (DOS) and Average Vehicle Delay (AVD). The AVD is in turn related to a level of service (LOS) criteria. These performance measures can be interpreted using the following explanations:

Degree of Saturation (DOS) - the DOS is a measure of the operational performance of individual intersections. Both queue length and delay increase rapidly as DOS approaches 1.

Average Vehicle Delay (AVD) - the AVD for individual intersections provides a measure of the operational performance of an intersection. In general, levels of acceptability of AVD for individual intersections depend on the time of day (motorists generally accept higher delays during peak commuter periods) and the road system being modelled (motorists are more likely to accept longer delays on side streets than on the main road system).

Level of Service (LOS) - this is a comparative measure which provides an indication of the operating performance of an intersection using the guidelines in **Table 3.2.4** below.

Table 3.2.4: Level of Service Performance Criteria (Traffic Signals)

Level of Service	Average Delay per Vehicle	Performance
A	<14 seconds	Good operation
B	15 – 28 seconds	Good with acceptable delays and spare capacity
C	29 – 42 seconds	Satisfactory
D	43 – 56 seconds	Operating near capacity
E	57 – 70 seconds	At capacity, requires other control mode
F	> 71 seconds	At capacity, requires other control mode

The results of the analyses undertaken at the Speed Street / Bigge Street / Pirie Street intersection, the Newbridge Road / Speed Street intersection, and the Terminus Street / Pirie Street intersection, are outlined in the following sections.

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3.2.5 Modelling Results

3.2.5.1 Intersection 5 – Speed Street / Bigge Street / Pirie Street intersection

Based upon the aforementioned information and assumptions, the modelling results for the 2026 and 2036 design horizons without the additional traffic forecast to be generated by the Shepherd Street precinct (i.e. based upon forecast future background traffic volumes) at the Speed Street / Bigge Street / Pirie Street intersection are as outlined in **Appendix H**, and summarised in the following table.

Table 3.2.5.1a: Intersection Performance (Without Development)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2016 Observed Volumes			
AM Peak	0.583	10.5 secs	LOS A
PM Peak	0.634	10.9 secs	LOS A
2026 Design Horizon			
AM Peak	0.730	10.9 secs	LOS A
PM Peak	0.795	13.8 secs	LOS A
2036 Design Horizon			
AM Peak	0.711	12.2 secs	LOS A
PM Peak	**1.032**	33.7 secs	LOS C

The above results demonstrate that the Speed Street / Bigge Street / Pirie Street intersection is expected to be approaching acceptable operational capacity limits by the 2036 design horizon, without the additional traffic forecast to be generated by the Shepherd Street precinct. This is largely due to the heavy right turn volume from Bigge Street onto Speed Street (northbound) which is anticipated during the PM peak.

Given Liverpool's City Council's planning for an additional 7,500 residential dwellings in the CBD, and the additional pressure this would place on this intersection, it is anticipated that Council may have plans for a future upgrade to the Speed Street / Bigge Street / Pirie Street intersection. Notwithstanding this, option testing has been undertaken in order to determine an appropriate treatment to increase the capacity of this intersection. It has been determined that the provision of a short additional stand-up lane on the eastern approach (i.e. a 20m long left turn lane) would facilitate acceptable operation at the 2036 design horizon, as outlined in **Appendix I**, and as summarised in **Table 3.2.5.1b** below.

Table 3.2.5.1b: Intersection Performance (Without Development, with Upgrade)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2036 Design Horizon			
AM Peak	0.711	12.1 secs	LOS A
PM Peak	0.850	15.4 secs	LOS B

Considering the impact of the additional traffic expected to be generated by the Shepherd Street precinct, the results of the intersection analyses both without and with the proposed development are as outlined in **Appendix J**, and as summarised in **Table 3.2.5.1c** below.

Table 3.2.5.1c: Comparative Intersection Performance (Without and With Development)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2026 Design Horizon (Existing Intersection Configuration)			
AM Peak	0.730	10.9 secs	LOS A
AM Peak With Development	**0.777**	**13.5 secs**	**LOS A**
PM Peak	0.795	13.8 secs	LOS A
PM Peak With Development	**0.963**	**25.7 secs**	**LOS B**
2036 Design Horizon (Upgraded Intersection Configuration)			
AM Peak	0.711	12.1 secs	LOS A
AM Peak With Development	**0.921**	**16.6 secs**	**LOS B**
PM Peak	0.850	15.4 secs	LOS B
PM Peak With Development	**0.947**	**22.3 secs**	**LOS B**

The above results demonstrate that the Speed Street / Bigge Street / Pirie Street intersection:

- is expected to operate generally within acceptable limits at the 2026 design horizon, with the additional traffic forecast to be generated by the Shepherd Street precinct, under its existing configuration; and
- is expected to operate generally within acceptable limits at the 2036 design horizon, with the additional traffic forecast to be generated by the Shepherd Street precinct, assuming the upgraded intersection configuration required to cater for the higher forecast background traffic volumes.

Notwithstanding the above, it is acknowledged that the traffic generated by the Shepherd Street precinct will have an impact upon the performance of this intersection, and may bring forward the need for ameliorative works at the intersection.

As such, it is suggested that the Applicant make a partial contribution towards future upgrades to this intersection, to be used by Council as and when required.

It may be more cost-effective to direct such funds towards a higher capacity intersection treatment which may be identified as part of the broader traffic study currently being undertaken on behalf of Council, rather than piecemeal (minimal) upgrade works as identified as part of these analyses.

3.2.5.2 Intersection 6 – Newbridge Road / Speed Street intersection

Based upon the aforementioned information and assumptions, the modelling results for the 2026 and 2036 design horizons without the additional traffic forecast to be generated by the Shepherd Street precinct (i.e. based upon forecast future background traffic volumes) at the Newbridge Road / Speed Street intersection are as outlined in **Appendix K**, and summarised in the following table.

Table 3.2.5.2a: Intersection Performance (Without Development)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2016 Observed Volumes			
AM Peak	0.825	18.0 secs	LOS B
PM Peak	0.855	28.4 secs	LOS B
2026 Design Horizon			
AM Peak	0.867	16.9 secs	LOS B
PM Peak	0.980	61.6 secs	**LOS E**

The above results demonstrate that the Newbridge Road / Speed Street intersection is expected to be approaching acceptable operational capacity limits by the 2026 design horizon, without the additional traffic forecast to be generated by the Shepherd Street precinct. This is largely due to the increase in through traffic on Newbridge Road.

Given RMS' forecast traffic growth on Newbridge Road and the additional pressure this would place on this intersection, it is anticipated that RMS may have plans for a future upgrade to the Newbridge Road / Speed Street intersection. Notwithstanding this, option testing has been undertaken in order to determine an appropriate treatment to increase the capacity of this intersection.

It has been determined that the provision of a short additional stand-up lane on the eastern approach (i.e. a 60m long left turn lane) would facilitate acceptable operation at the 2026 design horizon, as outlined in **Appendix L**, and as summarised in **Table 3.2.5.2b** below. However the modelling results suggest that an additional upgrade may be required by the 2036 design horizon.

Table 3.2.5.2b: Intersection Performance (Without Development, with Upgrade)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2026 Design Horizon			
AM Peak	0.845	17.7 secs	LOS B
PM Peak	0.916	30.6 secs	LOS C
2036 Design Horizon			
AM Peak	0.844	22.0 secs	LOS B
PM Peak	0.997	61.0 secs	**LOS E**

In any case, the Shepherd Street precinct is expected to prompt only a very marginal increase in turning movement volumes at this intersection, as suggested by the results of the intersection analyses both without and with the proposed development which are provided in **Appendix M**, and summarised in **Table 3.2.5.2c** below.

Table 3.2.5.2c: Comparative Intersection Performance (Without and With Development)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2026 Design Horizon (Upgraded Intersection Configuration)			
AM Peak	0.845	17.7 secs	LOS B
AM Peak With Development	**0.845**	**18.0 secs**	**LOS B**
PM Peak	0.916	30.6 secs	LOS C
PM Peak With Development*	**0.902**	**29.4 secs**	**LOS C**
2036 Design Horizon (Upgraded Intersection Configuration)			
AM Peak	0.842	22.0 secs	LOS B
AM Peak With Development	**0.844**	**22.1 secs**	**LOS B**
PM Peak	0.997	61.0 secs	**LOS E**
PM Peak With Development	**1.002**	**70.0 secs**	**LOS E**

* Note: modelling results indicate an improvement under the 'with development' scenario, as the signal phase timings have been optimised in the modelling program and the program is running a longer cycle time under the 'with development' scenario.

In light of the above modelling results and the marginal impact of the traffic generated by the Shepherd Street precinct upon the performance of the intersection, as well as the broader planning which we understand is being undertaken by Council / RMS to address traffic growth on key roads in the Liverpool area, no ameliorative works are considered to be warranted at the Newbridge Road / Speed Street intersection to support the proposal.

It is considered that the Section 94 contributions levied against the development would represent an appropriate contribution towards any future upgrade works which may be required at this intersection.

3.2.5.3 Intersection 7 – Terminus Street / Pirie Street intersection

Based upon the aforementioned information and assumptions, the modelling results for the 2026 and 2036 design horizons without the additional traffic forecast to be generated by the Shepherd Street precinct (i.e. based upon forecast future background traffic volumes) at the Terminus Street / Pirie Street intersection are as outlined in **Appendix N**, and summarised in the following table.

Table 3.2.5.3a: Intersection Performance (Without Development)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2016 Observed Volumes			
AM Peak	0.608	28.5 secs	LOS B
PM Peak	0.452	23.4 secs	LOS B
2026 Design Horizon			
AM Peak	0.732	30.0 secs	LOS C
PM Peak	0.568	24.3 secs	LOS B
2036 Design Horizon			
AM Peak	0.811	32.3 secs	LOS C
PM Peak	0.639	25.1 secs	LOS B

The above results demonstrate that the Terminus Street / Pirie Street intersection is expected to operate within acceptable limits at the 2036 design horizon, without the traffic generated by the Shepherd Street precinct.

Considering the impact of the additional traffic expected to be generated by the Shepherd Street precinct, the results of the intersection analyses both without and with the proposed development are as outlined in **Appendix O**, and as summarised in **Table 3.2.5.3b** below.

Table 3.2.5.3b: Comparative Intersection Performance (Without and With Development)

	Degree of Saturation (DOS)	Average Vehicle Delay (AVD)	Intersection Level of Service (LOS)
2026 Design Horizon			
AM Peak	0.732	30.0 secs	LOS C
AM Peak With Development	**0.738**	**30.6 secs**	**LOS C**
PM Peak	0.568	24.3 secs	LOS B
PM Peak With Development	**0.644**	**26.0 secs**	**LOS B**
2036 Design Horizon			
AM Peak	0.811	32.3 secs	LOS C
AM Peak With Development	**0.811**	**32.9 secs**	**LOS C**
PM Peak	0.639	25.1 secs	LOS B
PM Peak With Development	**0.711**	**26.3 secs**	**LOS B**

The above table demonstrates that the Terminus Street / Pirie Street intersection is expected to operate within acceptable limits at the 2036 design horizon, with the traffic generated by the Shepherd Street precinct. Furthermore, the traffic generated by the precinct is expected to have a marginal impact upon the performance of the intersection.

As a consequence, no upgrade works at this intersection are considered to be required to support the proposal.

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4.0 Woodbrook Road Underpass

During recent discussions with Council surrounding the subject Planning Proposal, Council has suggested that Transport for NSW and the Australian Rail Track Corporation (ARTC) be approached, with a view to reopening the underpass of the rail line to re-establish the vehicular connection from Powerhouse Road to Woodbrook Drive.

This underpass is currently closed off by way of concrete barriers and fencing, as shown in **Figure 4.0** below.

Figure 4.0: Woodbrook Road Underpass (looking from Powerhouse Road, toward east)

It is understood that Council has previously investigated the option of re-opening this underpass as part of the Georges River Casula Parklands Master Plan (as a gated entry for emergency vehicles and special events at the Casula Powerhouse), and also as a two-way, one-lane connection for all vehicles (under 3.6m in height), as shown in the plan included as **Appendix P.**

Council has recently requested that the Applicant:

1. Review the traffic demand generated by the Shepherd Street precinct expected to use this underpass;
2. Identify traffic calming devices which may be required; and
3. Obtain in principal approval from Transport for NSW and ARTC for the reopening of this connection.

In response to each of the above:

1. The underpass would provide a connection from the Shepherd Street precinct to a small residential catchment bounded by the Hume Highway to the west, the M5 to the north, and the rail line to the east. It would not offer a particularly direct or convenient route to any arterial roads, or any significant local destinations. Whilst there may be a small demand for this route from the Hume Highway (south) or the M5 (westbound) to the precinct, the development of the precinct does not, in our view, trigger the need to re-open this connection. Importantly, the analyses undertaken do not rely upon the re-establishment of this connection, and assume that all traffic to/from the precinct travels via alternative (existing) routes. Notwithstanding this, the proponent has committed to working with Council and the RMS with a view to reopening the underpass, and will commence discussions with the relevant state agencies to facilitate this.
2. On the basis of (1) above, no traffic calming devices are considered to be required. However should this connection be re-opened at some point in the future and it be determined that traffic calming devices are required in the local residential catchment to control vehicle speeds, it is anticipated that these would simply involve platform or sinusoidal road humps (depending upon on-road cyclist arrangements), or chicanes, which are low cost treatments.
3. Notwithstanding the above, as previously mentioned, the proponent has committed to working with Council and the RMS with a view to reopening the underpass, and will commence discussions with the relevant state agencies to facilitate this.

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5.0 Summary and Recommendations

In summary:

- The proposal seeks the of rezoning seven adjacent properties on Shepherd Street in Liverpool. The subject properties include all of those on the eastern side of Shepherd Street, south of Atkinson Street. Whilst currently zoned R4 high-density residential, an increase in the permitted height and floor space ratio is sought, to allow 1,201 residential apartments to be delivered on the subject properties (rather than 787 under the current planning controls).
- An overall Masterplan has been developed which assumes the redevelopment of all land parcels on Shepherd Street, i.e. also including the properties on the western side. An overall yield of approximately 1,500 residential apartments is anticipated for all properties on Shepherd Street (east and west) under this Masterplan, compared with 1,085 apartments under the existing planning controls. The proposed yield has been reduced from 1,774 apartments under the previous proposal.
- Whilst this Planning Proposal relates to the rezoning of the properties on the eastern side of Shepherd Street only, the traffic investigations undertaken considered the impact of the redevelopment of all properties on Shepherd Street, as requested by Council.
- Council has recently requested that transport network modelling (both strategic modelling and local microsimulation modelling) be undertaken by the Applicant, to assess the cumulative impact of development in Liverpool (i.e. of the Shepherd Street precinct in addition to other substantial development proposed/approved in and around the Liverpool CBD). Accordingly, the Applicant proposes to fund a 'variation' to the modelling to be undertaken by Council's consultant, to assess the impact of the Planning Proposal for the Shepherd Street precinct upon the broader road network at the 2026 and 2036 design horizon.
- A 'Strategic Integrated Transport Assessment' for the precinct has been undertaken by Smyth Consulting. This provides a strategic-level assessment of the transport opportunities and constraints affecting the precinct, and identifies a set of initiatives that can deliver appropriate levels of access while minimising impacts upon the traffic and transport network.
- In addition to the above, additional local (SIDRA) intersection modelling has been undertaken, to support the proposal. The results of the additional traffic analyses / investigations requested by Council can be summarised as follows:
    - **Speed Street / Bigge Street / Pirie Street intersection** - it is acknowledged that the Shepherd Street precinct will have an impact upon the performance of this intersection, and is therefore suggested that the Applicant make a partial contribution towards a minor upgrade to this intersection, to accommodate this additional traffic. It may however be more cost-effective to direct such funds towards a higher capacity intersection treatment which may be identified as part of the broader traffic study currently being undertaken on behalf of Council, rather than piecemeal (minimal) upgrade works as identified as part of these analyses.
    - **Newbridge Road / Speed Street intersection** - the Shepherd Street precinct is expected to have a marginal impact upon the performance of the intersection. Given the broader planning which we understand is being undertaken by Council / RMS to address traffic growth on key

roads in the Liverpool area, no ameliorative works are considered to be warranted at the Newbridge Road / Speed Street intersection to support the proposal. It is considered that the Section 94 contributions levied against the development would represent an appropriate contribution towards any future upgrade works which may be required at this intersection.

- **Terminus Street / Pirie Street intersection** – this intersection is expected to operate within acceptable limits at the 2026 and 2036 design horizons, with the additional traffic generated by the Shepherd Street precinct. The traffic generated by the precinct is expected to have a marginal impact upon the performance of the intersection. As a consequence, no upgrade works at this intersection are considered to be required to support the proposal.

- Whilst the development of the precinct does not, in our view, trigger the need to re-open the rail underpass connecting from Powerhouse Road to Woodbrook Road, and the analyses undertaken do not rely upon the re-establishment of this connection, the Applicant has committed to engaging with Transport for NSW and ARTC, in order to discuss the possibility of re-establishing this connection, as requested by Council.

In light of the information contained within this report, we consider that the proposal is satisfactory from a traffic operations perspective, and recommend that the Planning Proposal be approved from a traffic engineering perspective.

5.1 Qualifications

This report has been approved by Anne Coutts, Director (BE Civil, MIEAust, MAITPM).

DRAFT

APPENDIX A

Concept Masterplan

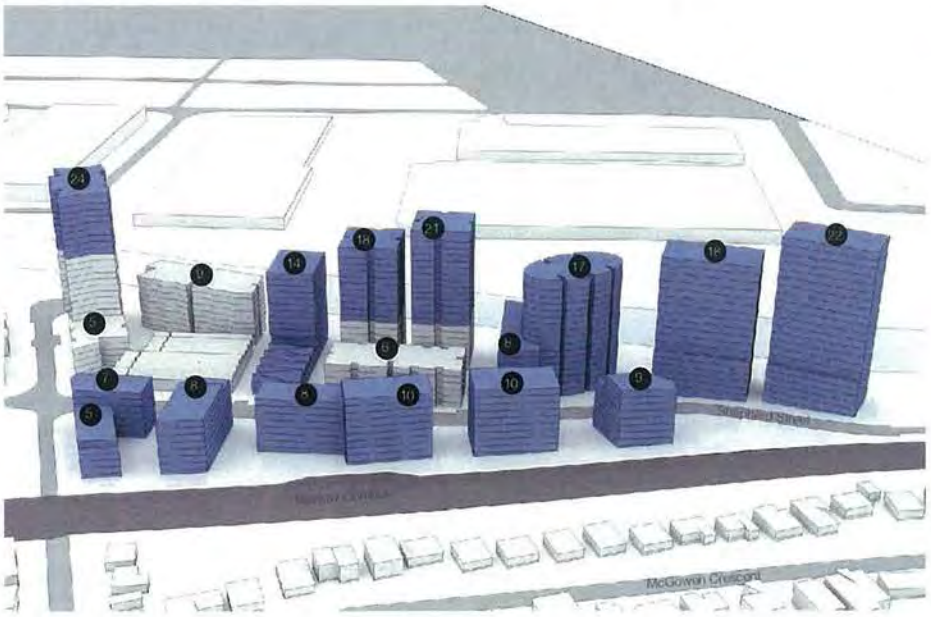
1.1 Preferred Concept - Plan

Lot	Storey	GFA	FSR	Dwellings	Height
Paper Mill	24	31,783m²	3.22	309	75.8m
22-23	6-20	31,870m²	3.67:1	375	67.3m
3+4	17	16,050m²	3.53:1	178	55.7m
5+6	18-22	28,820m²	3.44:1	339	76.9m
7	9	3,299m²	1.63	37	28.4m
8	10	5,497m²	2.72	61	31.9m
11	8-10	9,141m²	2.37	102	31m
SP-30264	8	4,447m²	2.2	49	25.5m
SP-70274	5-7	4,472m²	2.2	50	22.4m

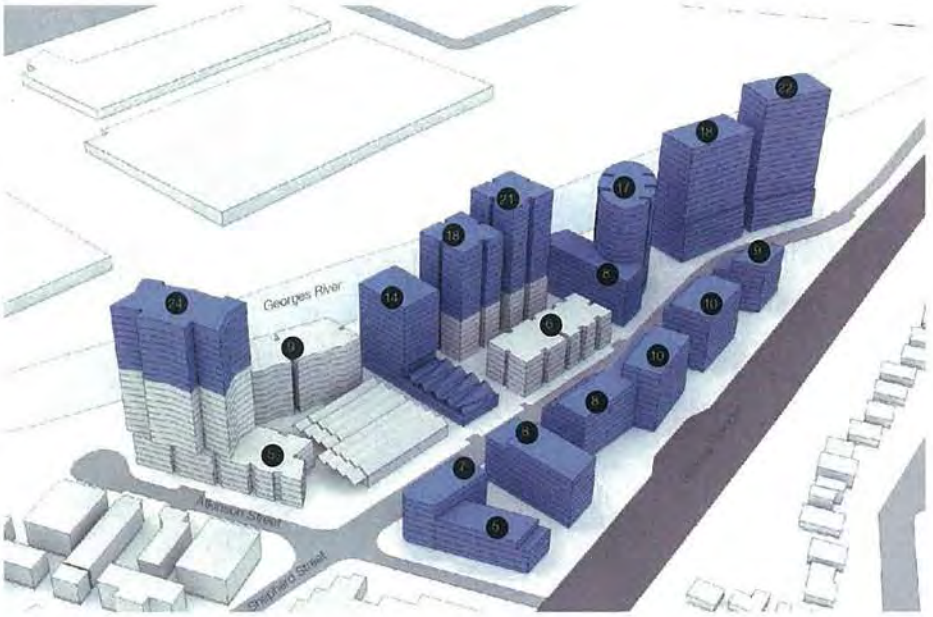
Key

- Site Boundary
- Proposed
- Open Space
- Approved

1.2 Preferred Concept Massing



View 01

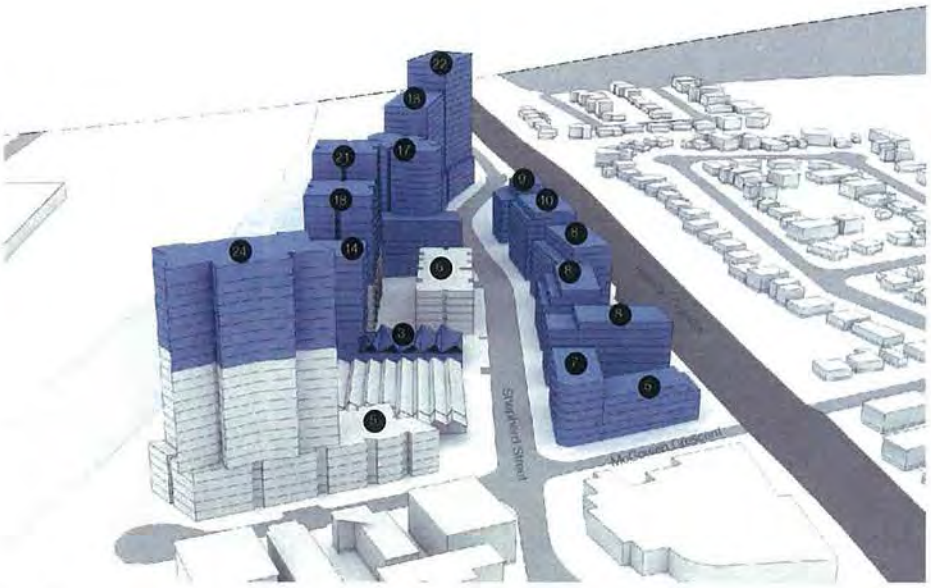


View 02

Key

- Site Boundary
- Proposed Allowable
- Approved

1.3 Preferred Concept Massing



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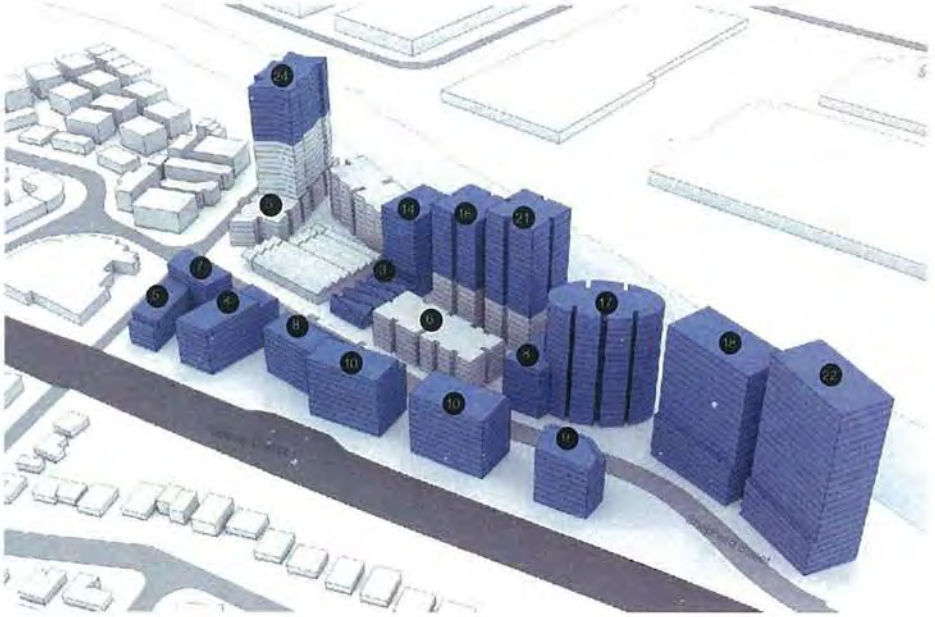


View 02

Key

Site Boundary

Proposed Allowable

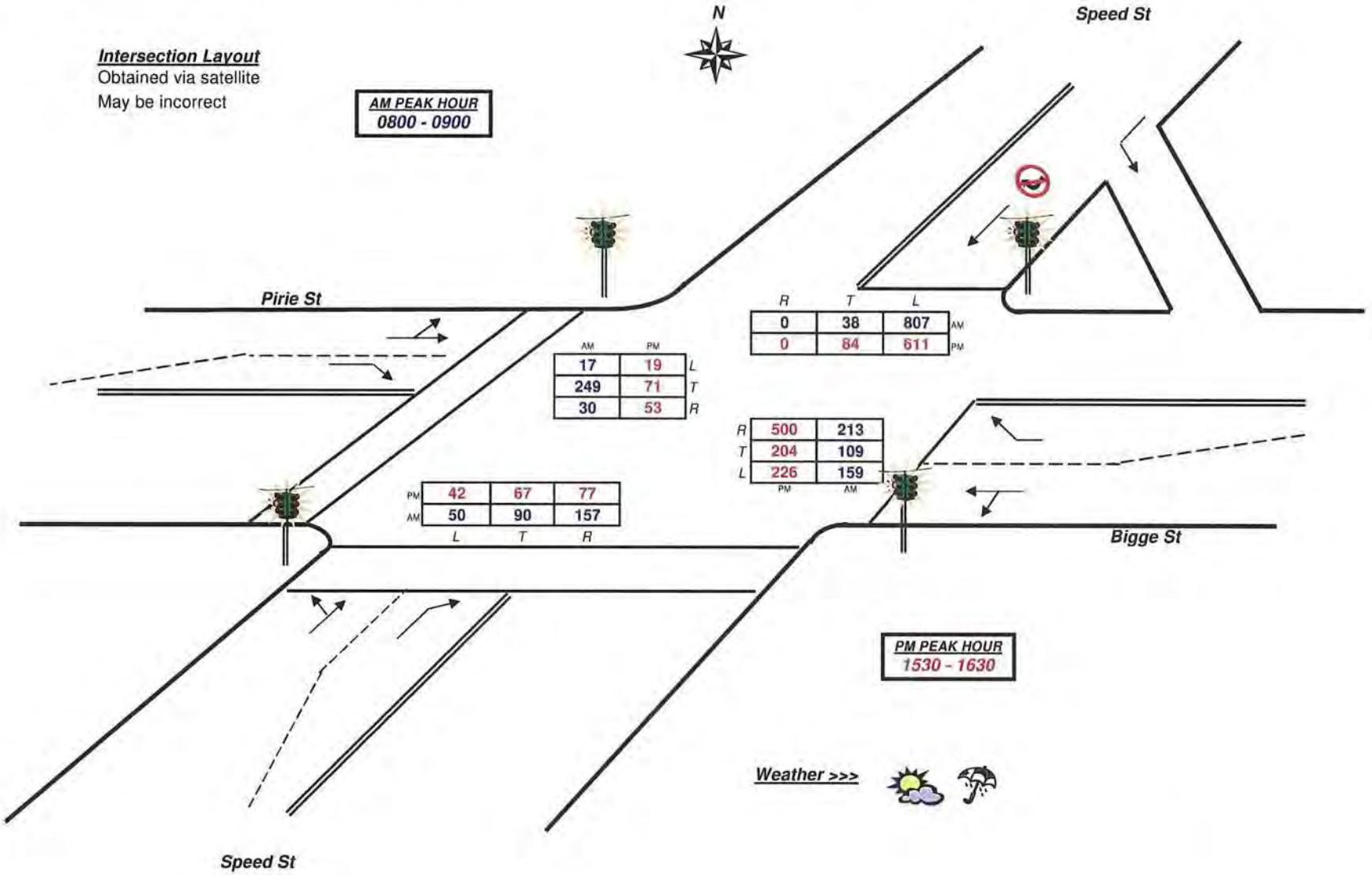
Approved

APPENDIX B

Existing Traffic Volumes

R.O.A.R. DATA
Reliable, Original & Authentic Results
Ph.88196847, Fax 88196849, Mob.0418-239019

Client : Inroads Group
Job No/Name : 6096 LIVERPOOL Speed St
Day/Date : Tuesday 31st May 2016

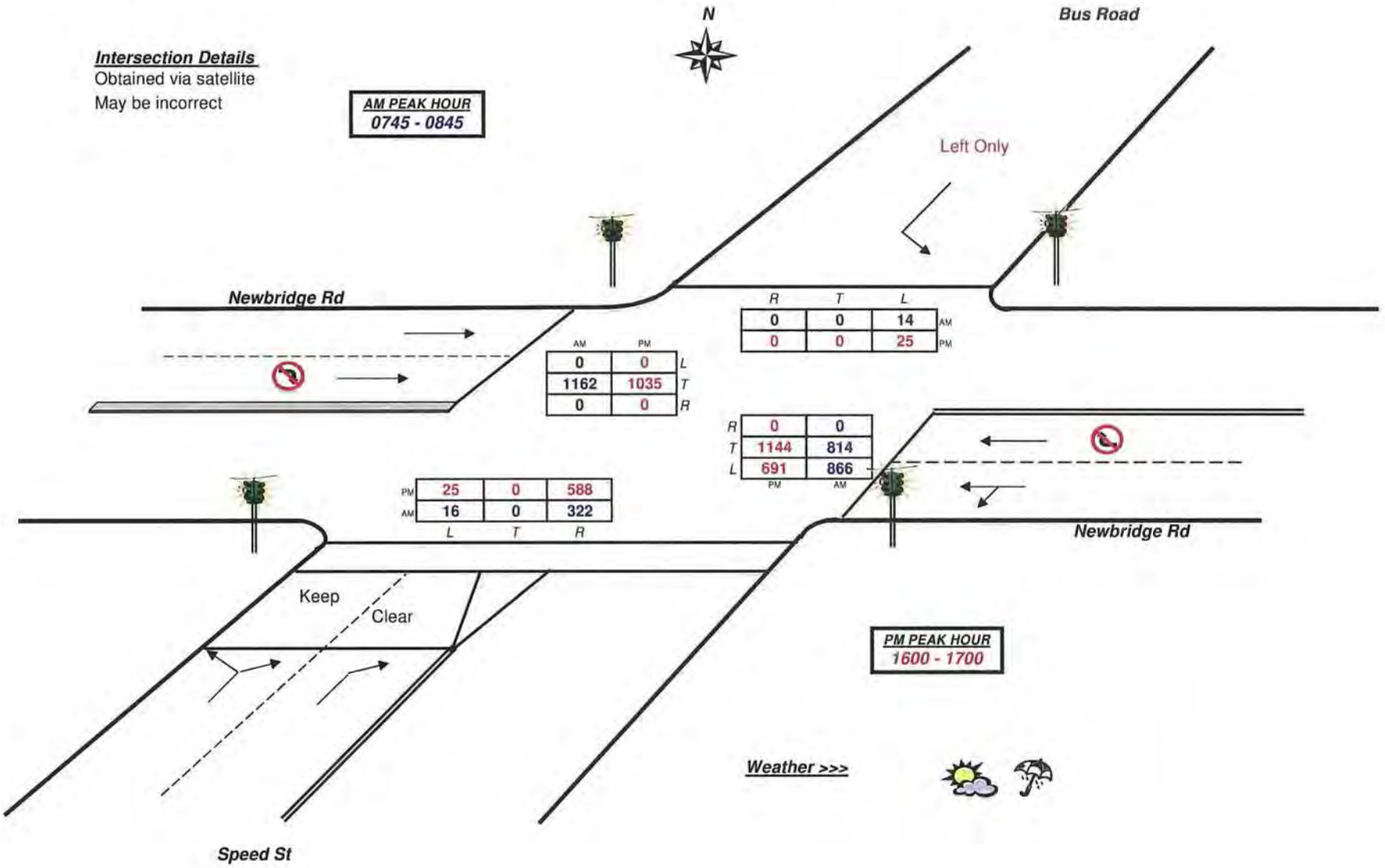


R.O.A.R. DATA
Reliable, Original & Authentic Results
Ph.88196847,Mob.0418-239019

Client : Inroads Group
Job No/Name : 6096 LIVERPOOL Speed St
Day/Date : Tuesday 31st May 2016

Intersection Details
Obtained via satellite
May be incorrect

AM PEAK HOUR
0745 - 0845



PM PEAK HOUR
1600 - 1700

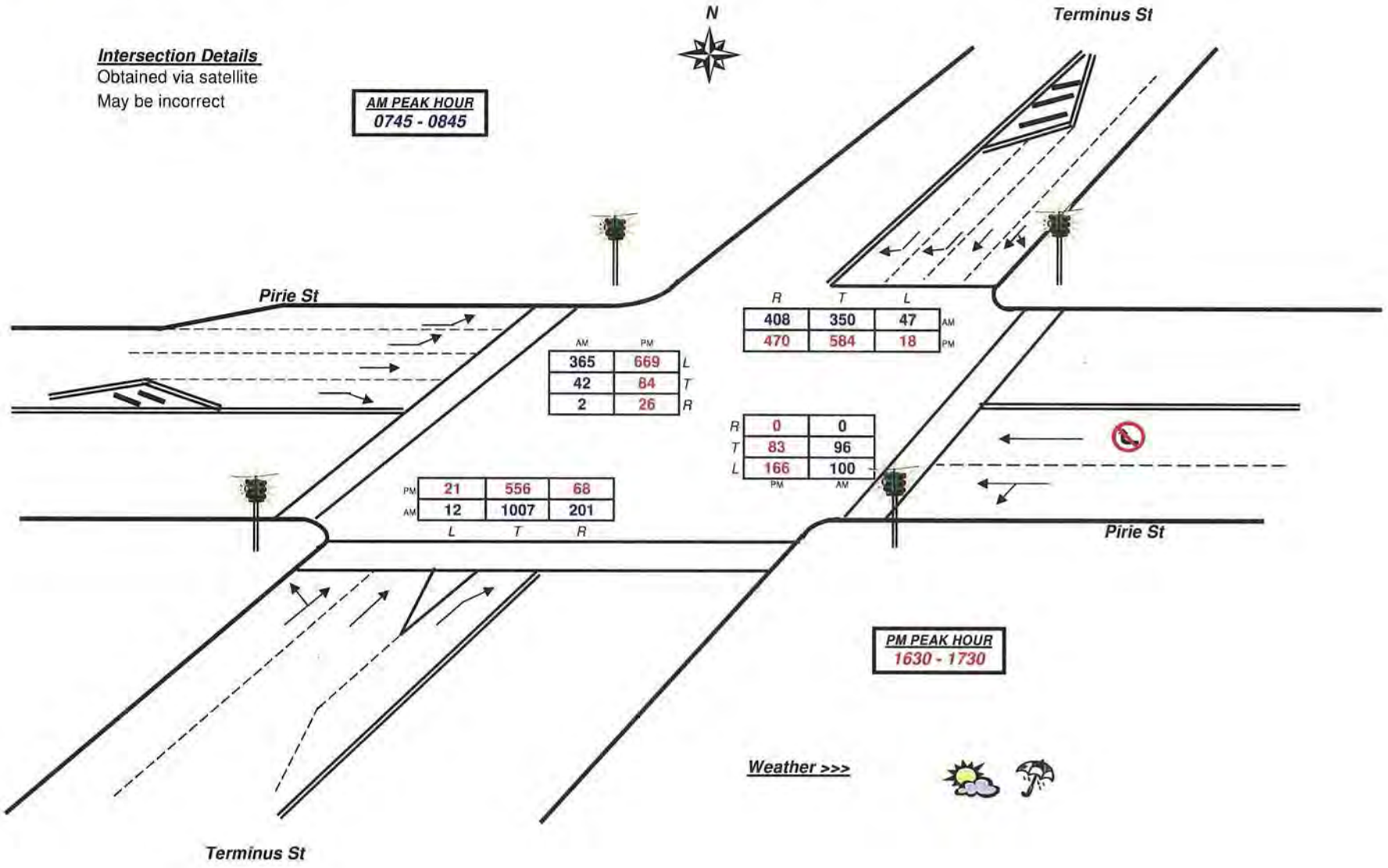
Weather >>>

R.O.A.R. DATA
Reliable, Original & Authentic Results
Ph.88196847,Mob.0418-239019

Client : Inroads Group
Job No/Name : 6096 LIVERPOOL Speed St
Day/Date : Tuesday 31st May 2016

Intersection Details
Obtained via satellite
May be incorrect

AM PEAK HOUR
0745 - 0845



PM PEAK HOUR
1630 - 1730

Weather >>>

APPENDIX C

RMS Forecast Traffic Volumes (Emme Strategic Traffic Assignment Model, 7-9 AM, 4-6 PM (2 hour peak volumes))

RMS EMME Model Assumptions and Disclaimer.txt

RMS Emme Strategic Traffic Assignment Model (2015 Future Networks Version, All Vehicles) - Periods: 7-9 AM, 4-6 PM (2 hours Peak)
Travel Forecast Assumptions (Auto Trip Tables): BTS Strategic Travel Model Ver.3.0 , BTS Sept 2014 Land Use Assumptions).

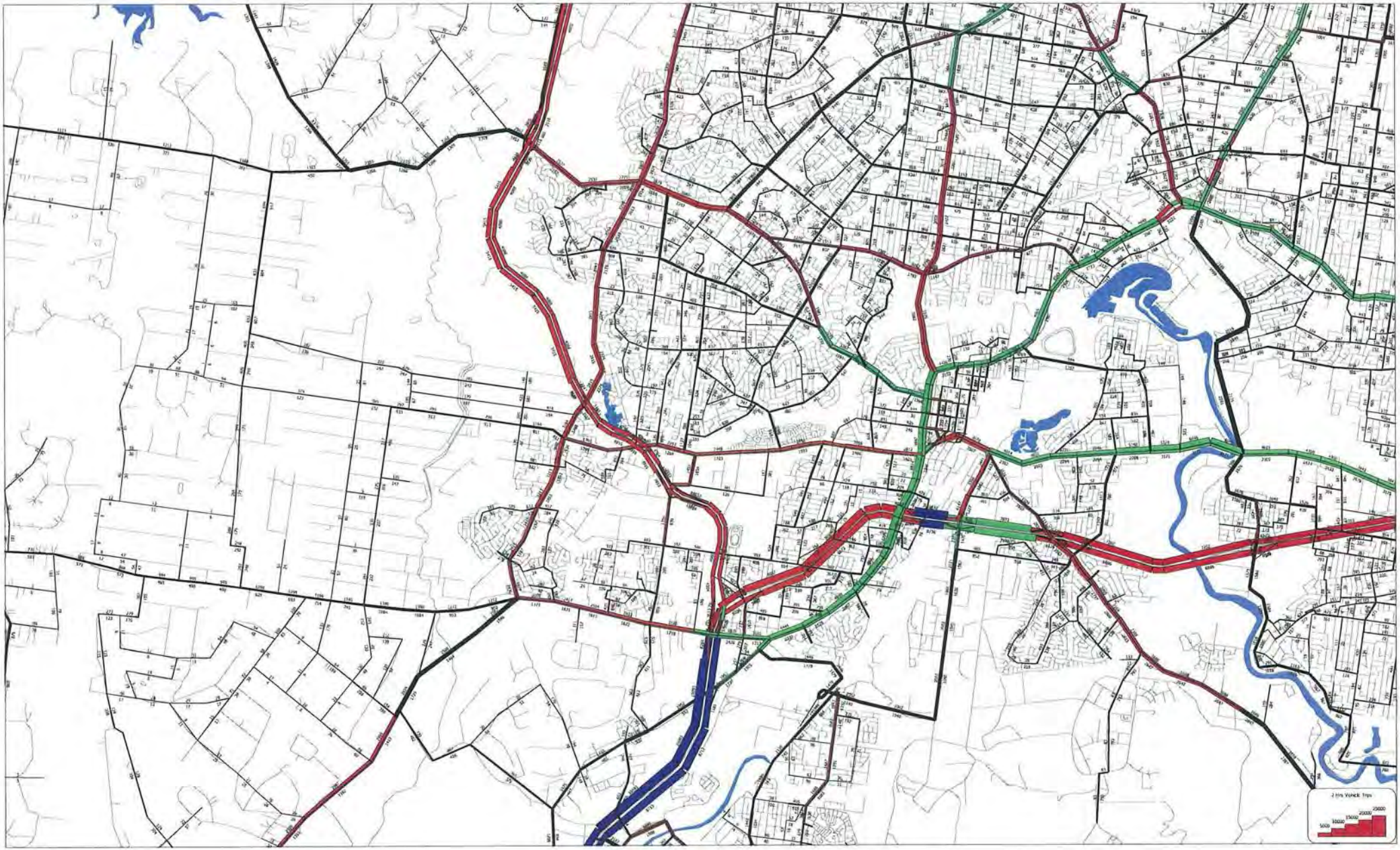
Future Road Projects assumed in the model are for modelling purposes only and may change, they are not Government Policy nor do they reflect Government plans.

Currently the Future Road Projects list and Trip Tables are in the process of being updated to reflect most likely up to date policies and Land Use Assumptions (TNSW BTS).

Disclaimer

While all care is taken in producing and publishing the traffic modelling data, no responsibility is taken or warrant made with respect to the accuracy of any information, data or representation. The authors (including copyright owners) and publishers expressly disclaim all liability in respect of anything done or omitted to be done and the consequences upon reliance of the contents of this information.

TRAFFIC VOLUMES__



2011TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 8: 2015 SYDNEY ROAD NETWORK (INTDELAY)-7-9AM(mf40)
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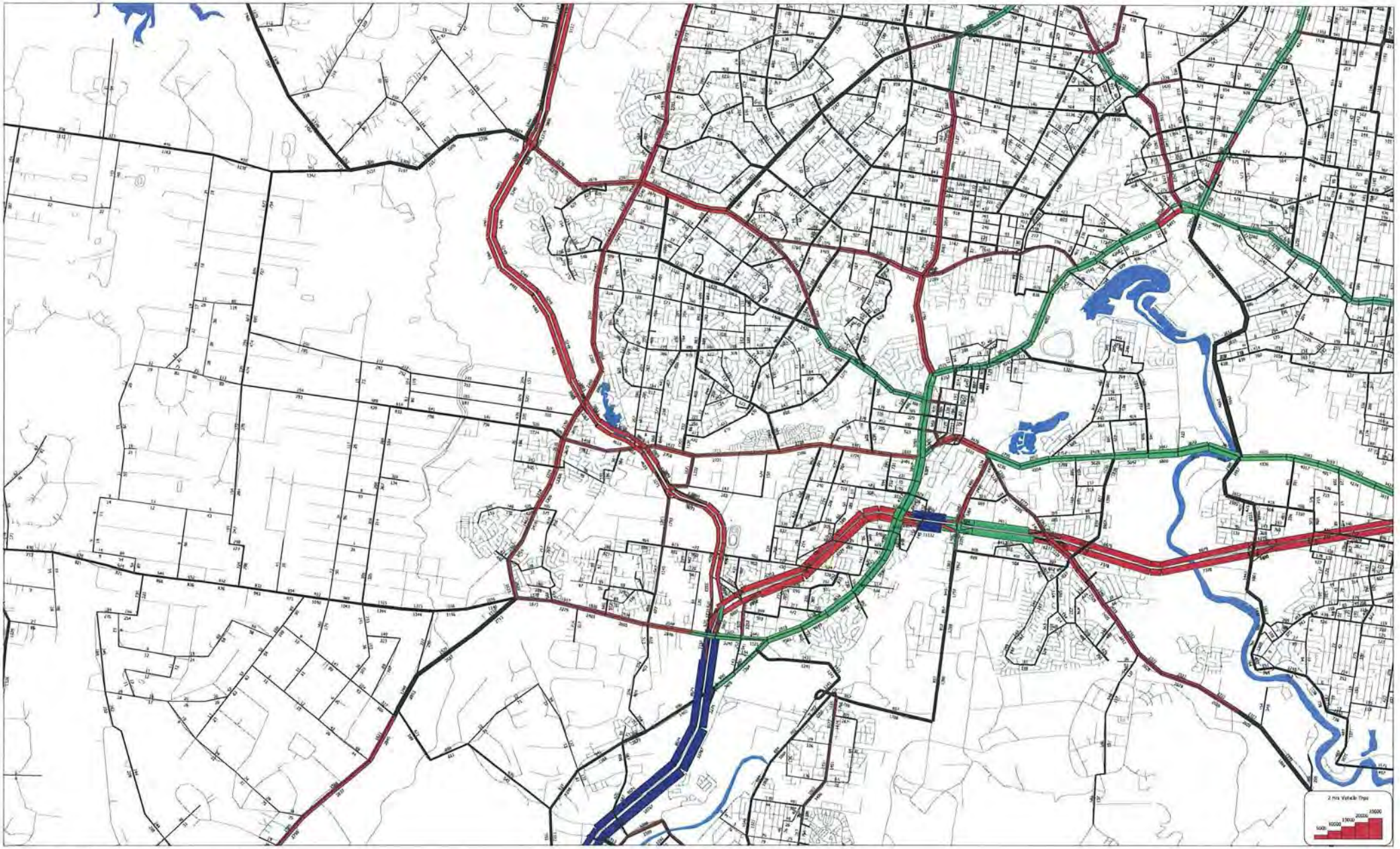
TRAFFIC VOLUMES__



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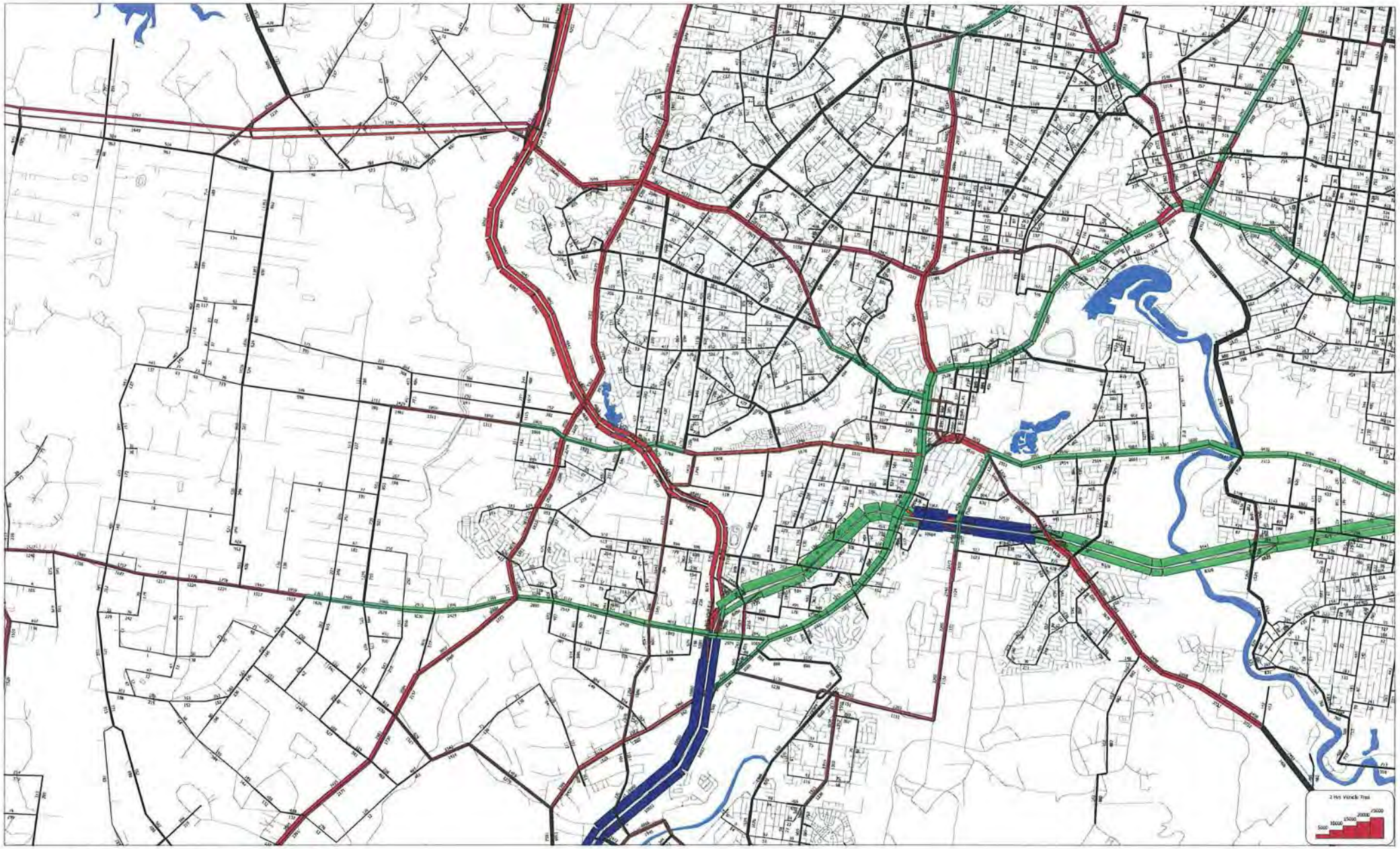

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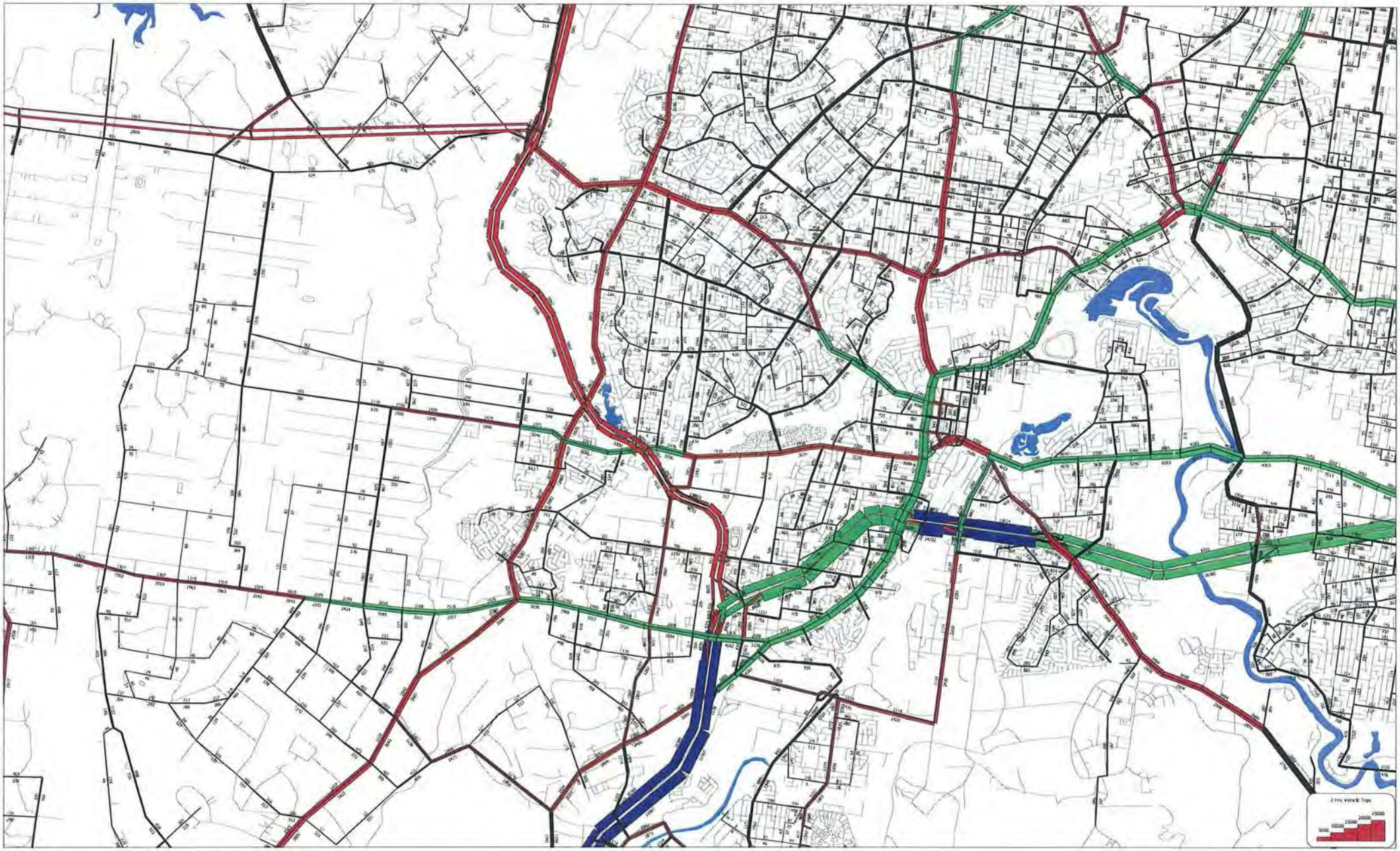
TRAFFIC VOLUMES__



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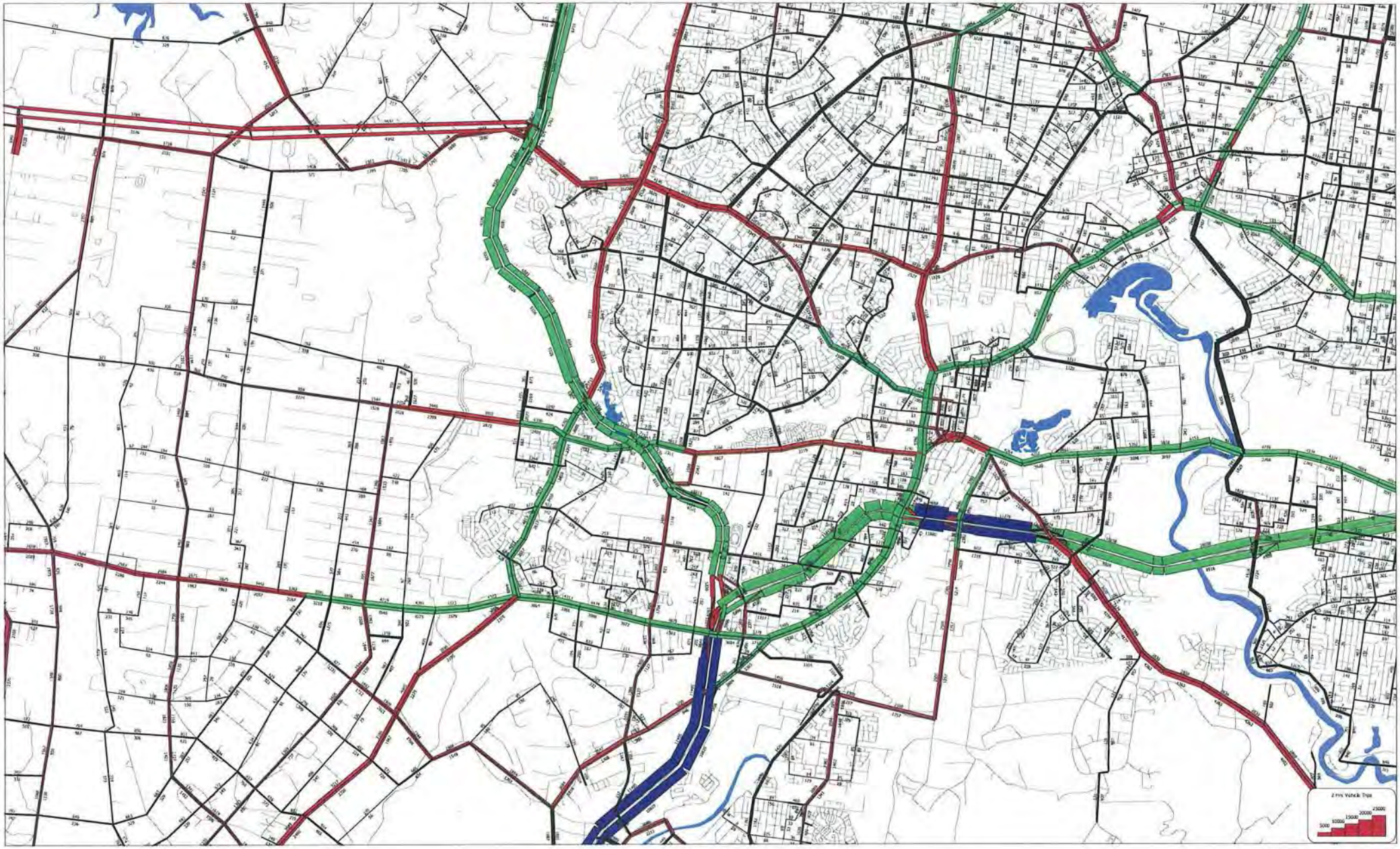
TRAFFIC VOLUMES__



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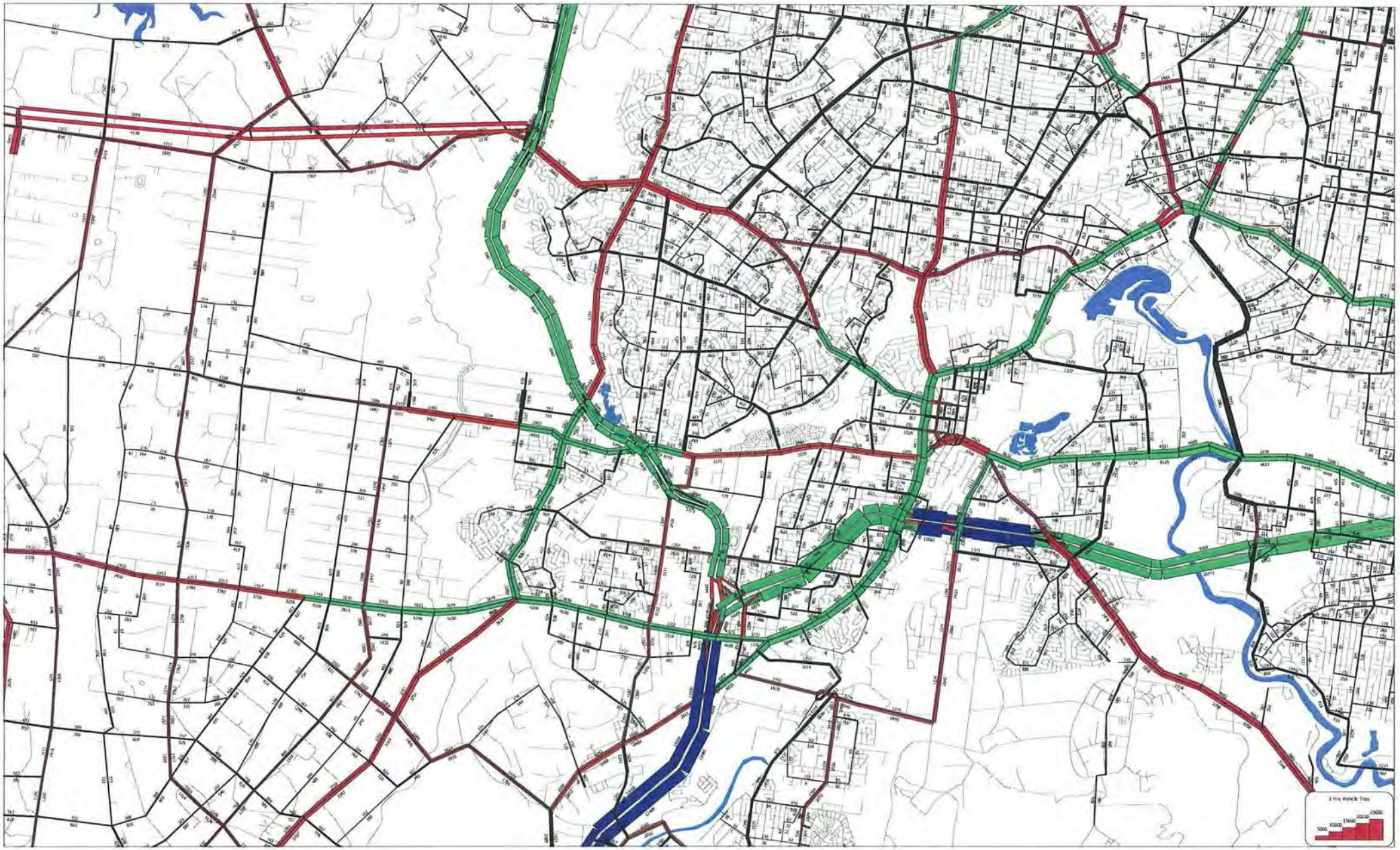
Scenario 31127: 2036 SYDNEY ROAD NETWORK (INTDELAY)-7-9AM(mf36)
2015-09-03 14:16

TRAFFIC VOLUMES__



2011TZ SYDNEY GMA STRATEGIC TRAFFIC FORECASTING MODEL
Scenario 1118: 2036 SYDNEY ROAD NETWORK ([INTDELAY]-4-6PM(mf56)
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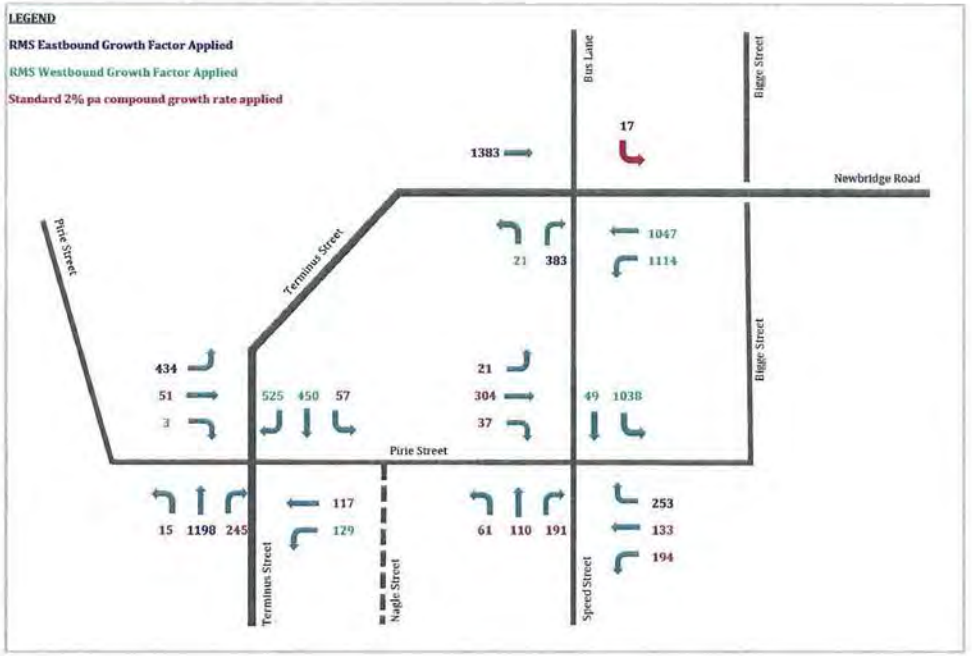
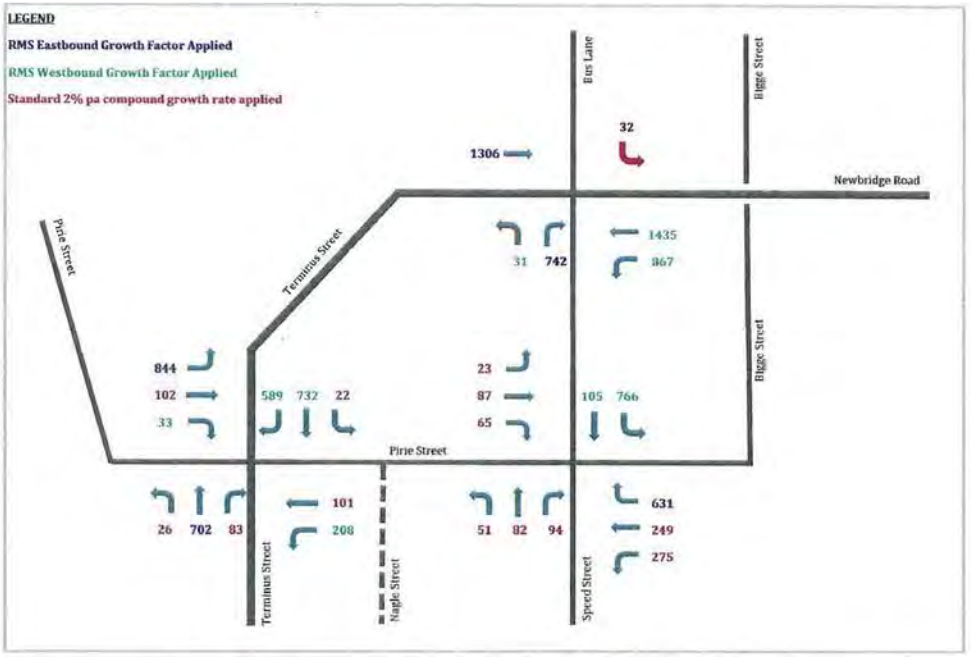
APPENDIX D

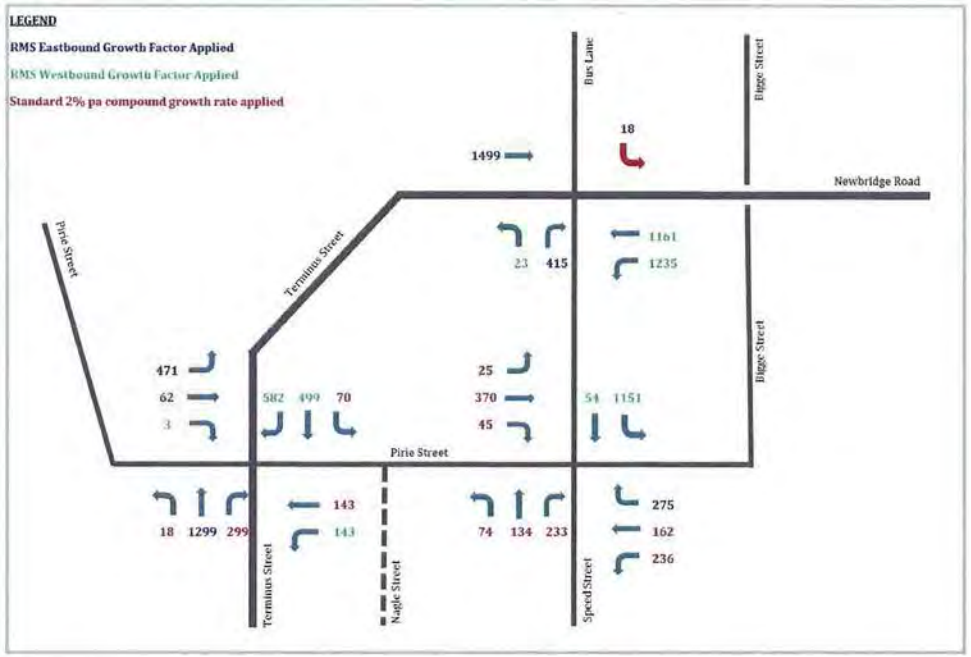
Forecast Future (2026 and 2036) Background Traffic Volumes



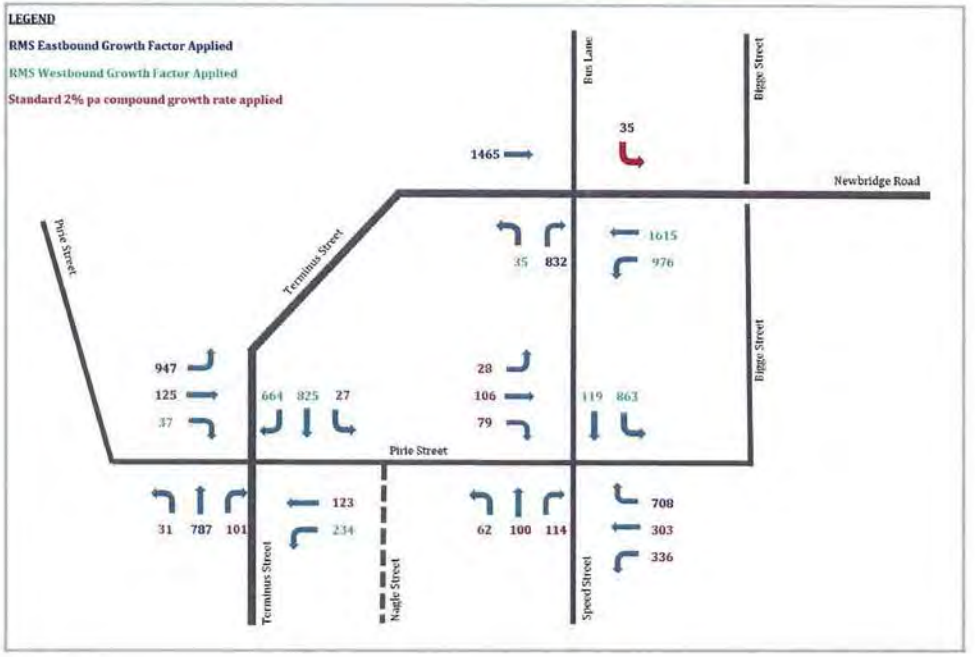
AM Peak



PM Peak



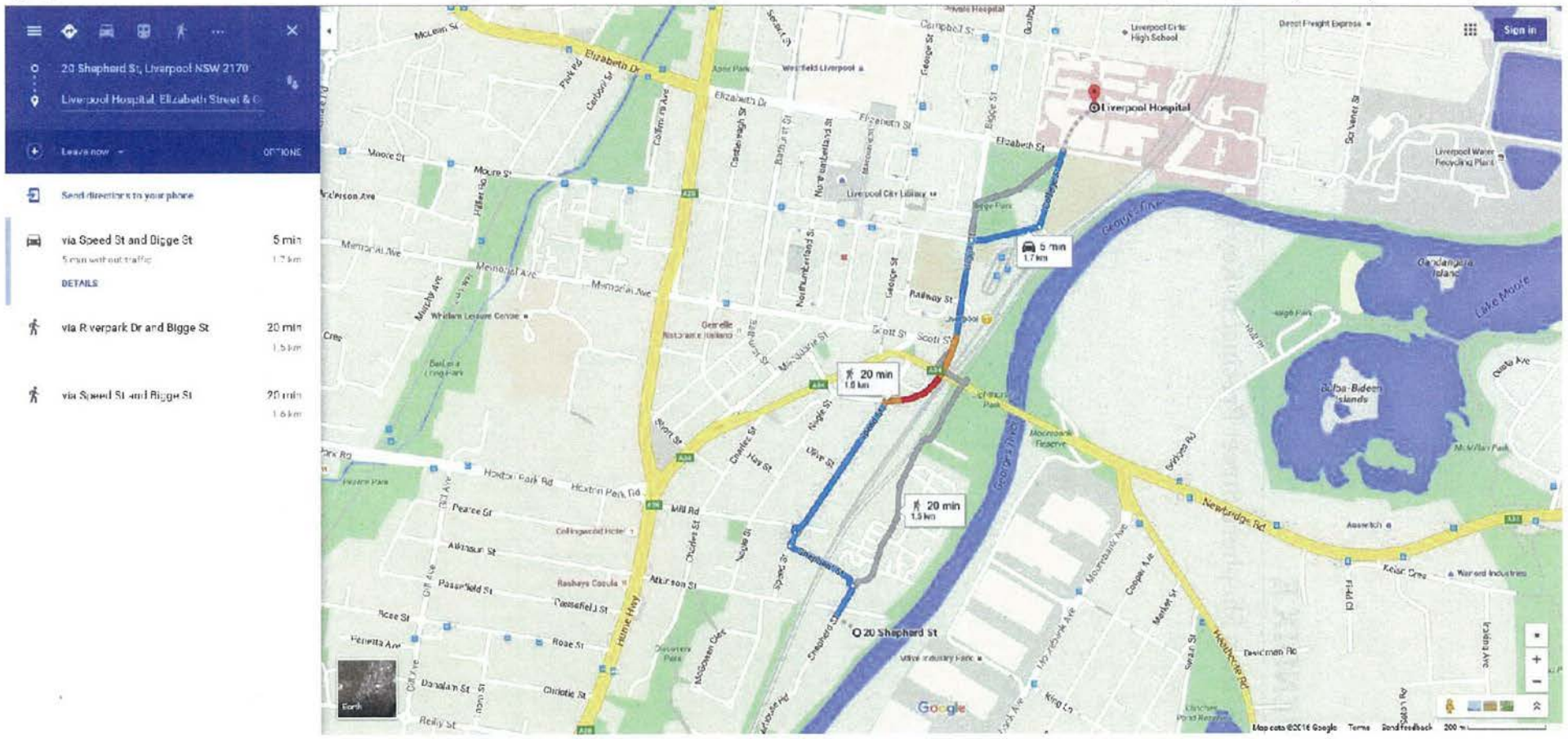
AM Peak

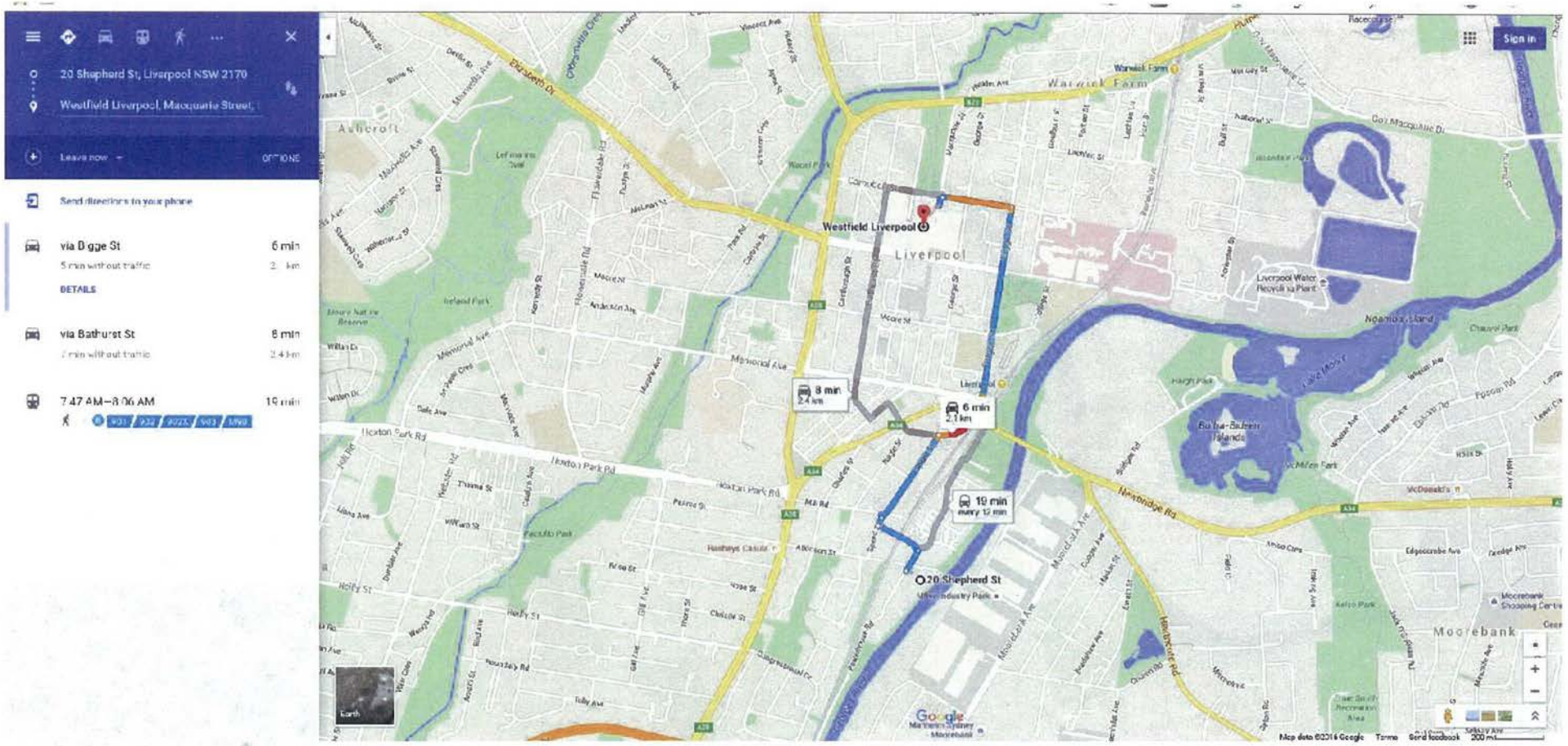


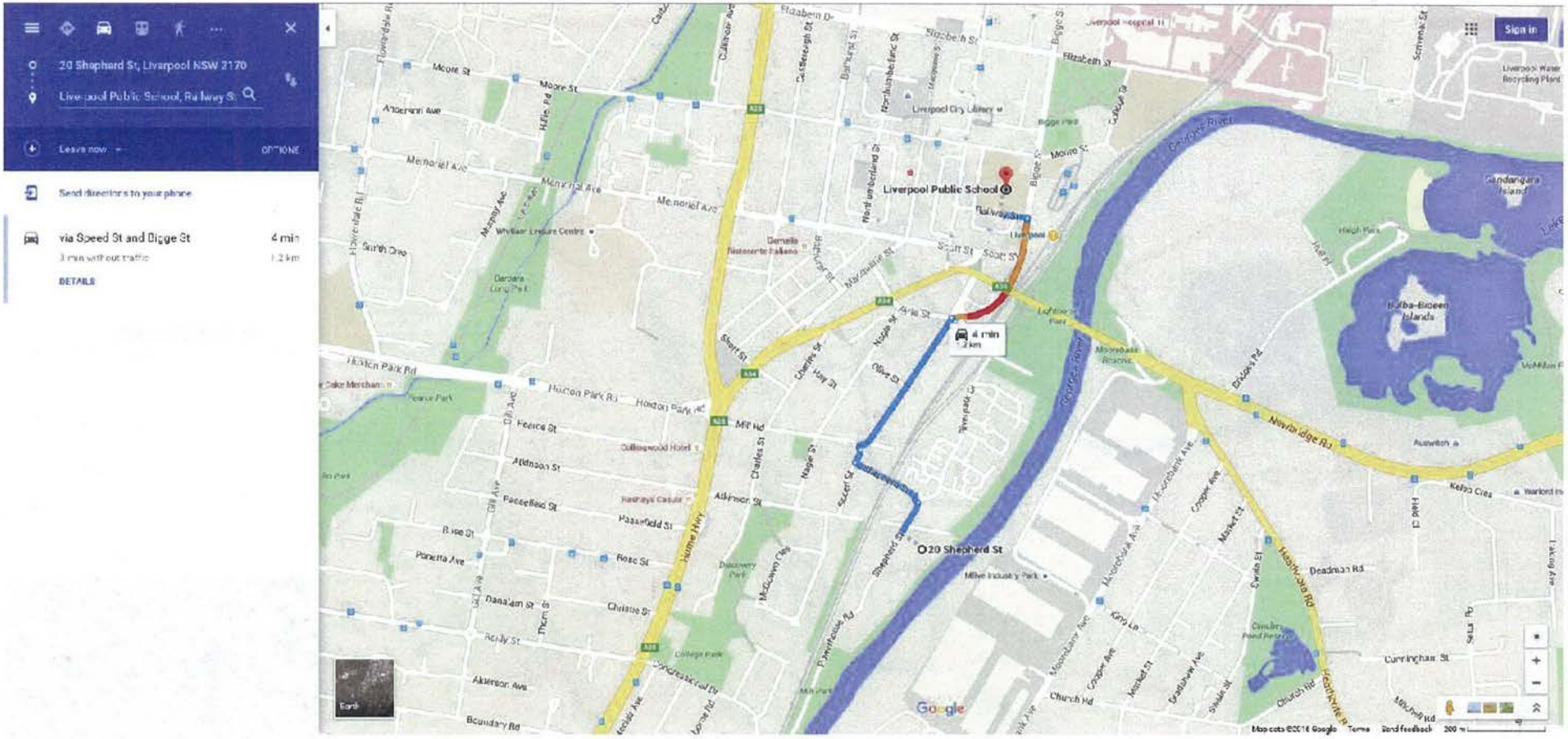
PM Peak

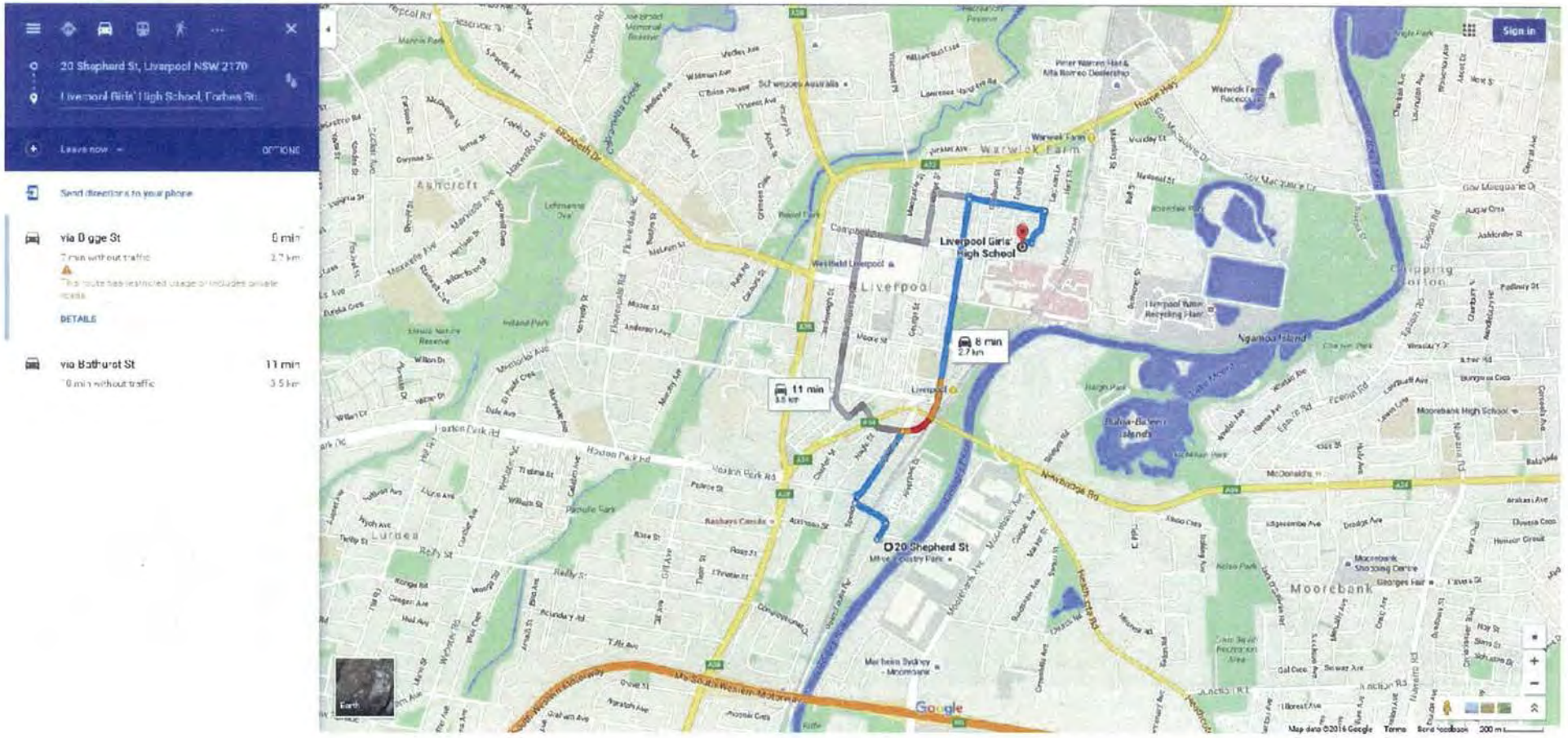
APPENDIX E

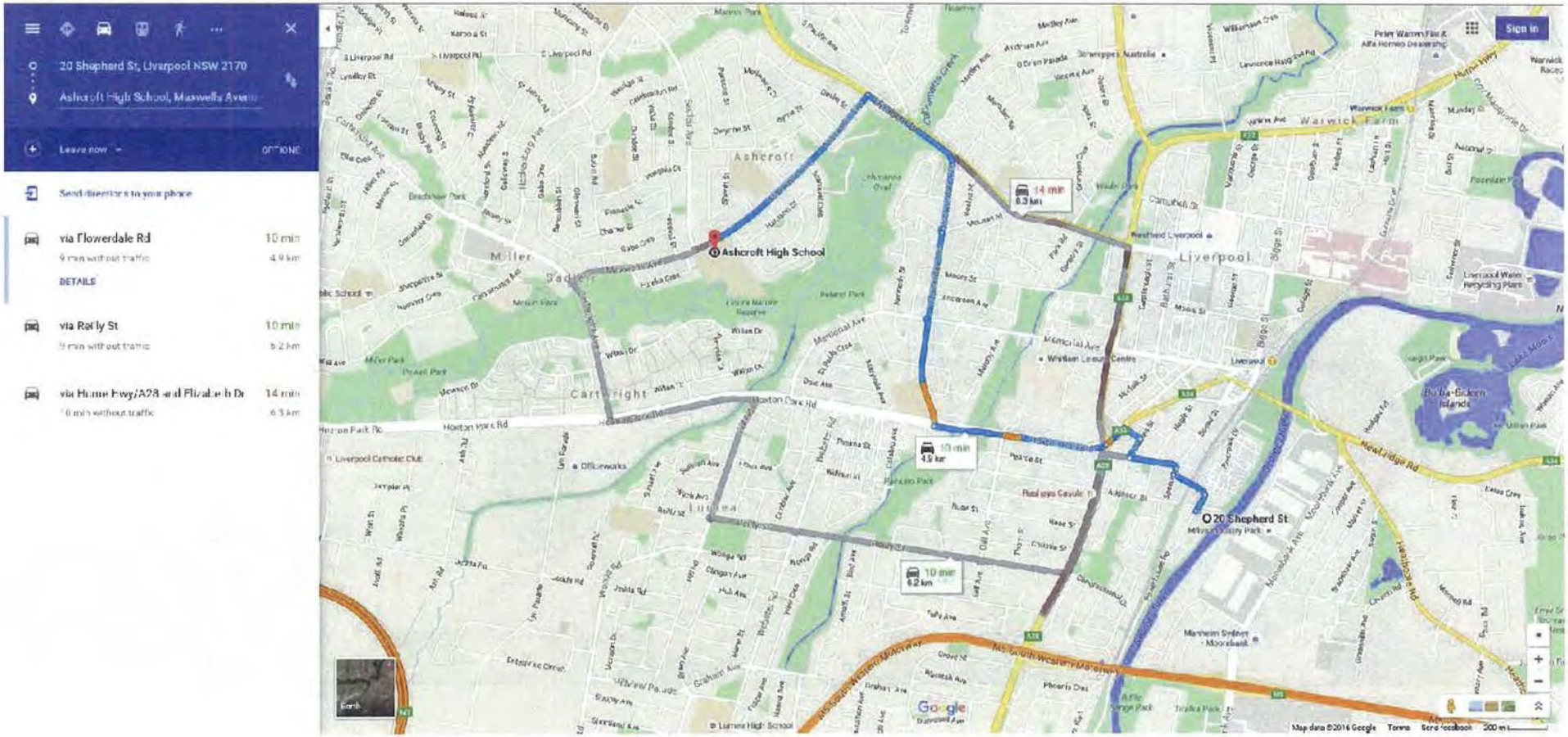
Routes from Shepherd Street Precinct to Key Destinations

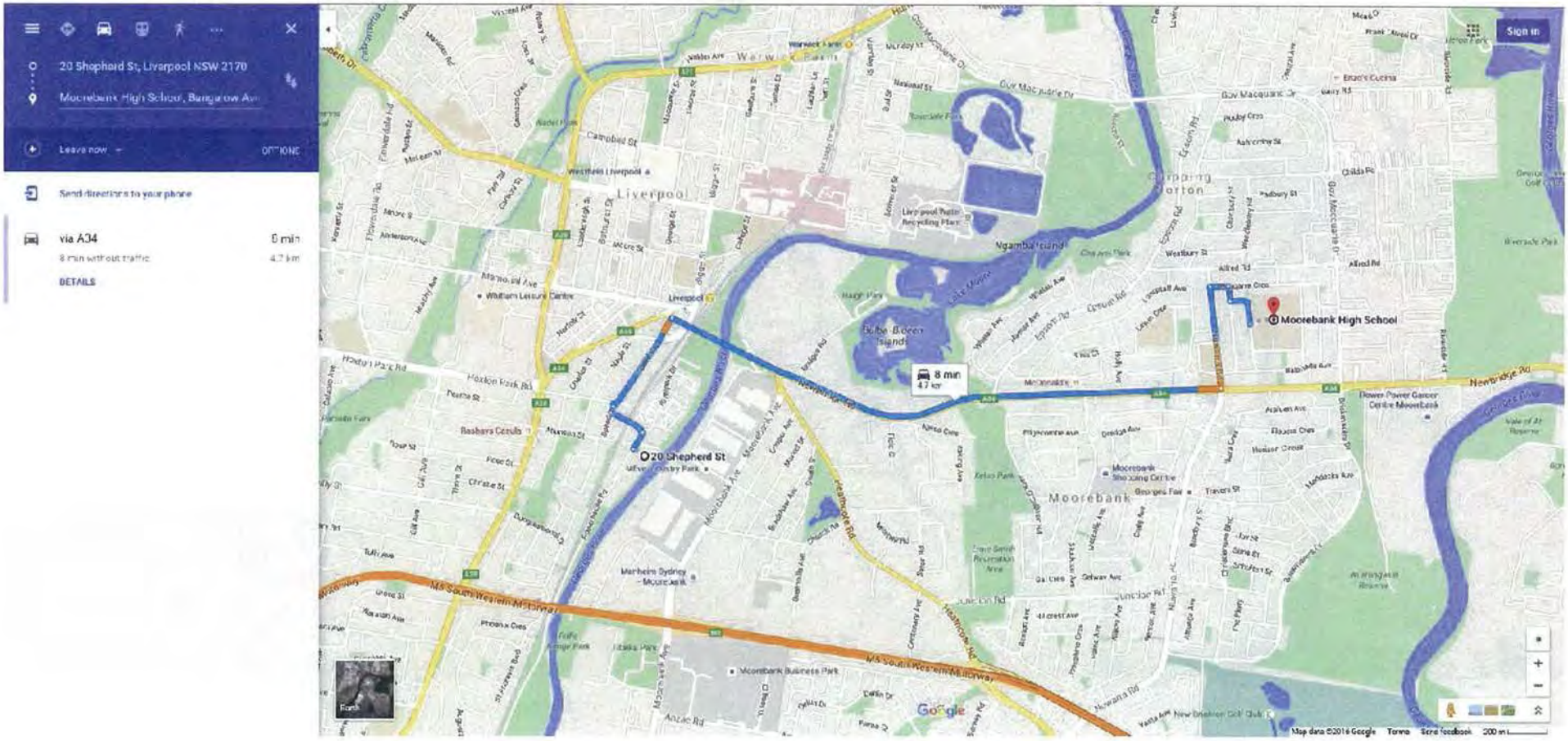

20 Shepherd St, Liverpool NSW 2170
Liverpool Hospital, Elizabeth Street & C
Leave now
OPTIONS
Send directions to your phone
via Speed St and Bigge St
5 min
5 min without traffic
1.7 km
DETAILS
via Riverpark Dr and Bigge St
20 min
1.5 km
via Speed St and Bigge St
20 min
1.6 km
Sign in
Liverpool Hospital
20 Shepherd St
5 min
1.7 km
20 min
1.6 km
20 min
1.5 km
Google
Map data ©2016 Google
Terms
Send feedback
200 m

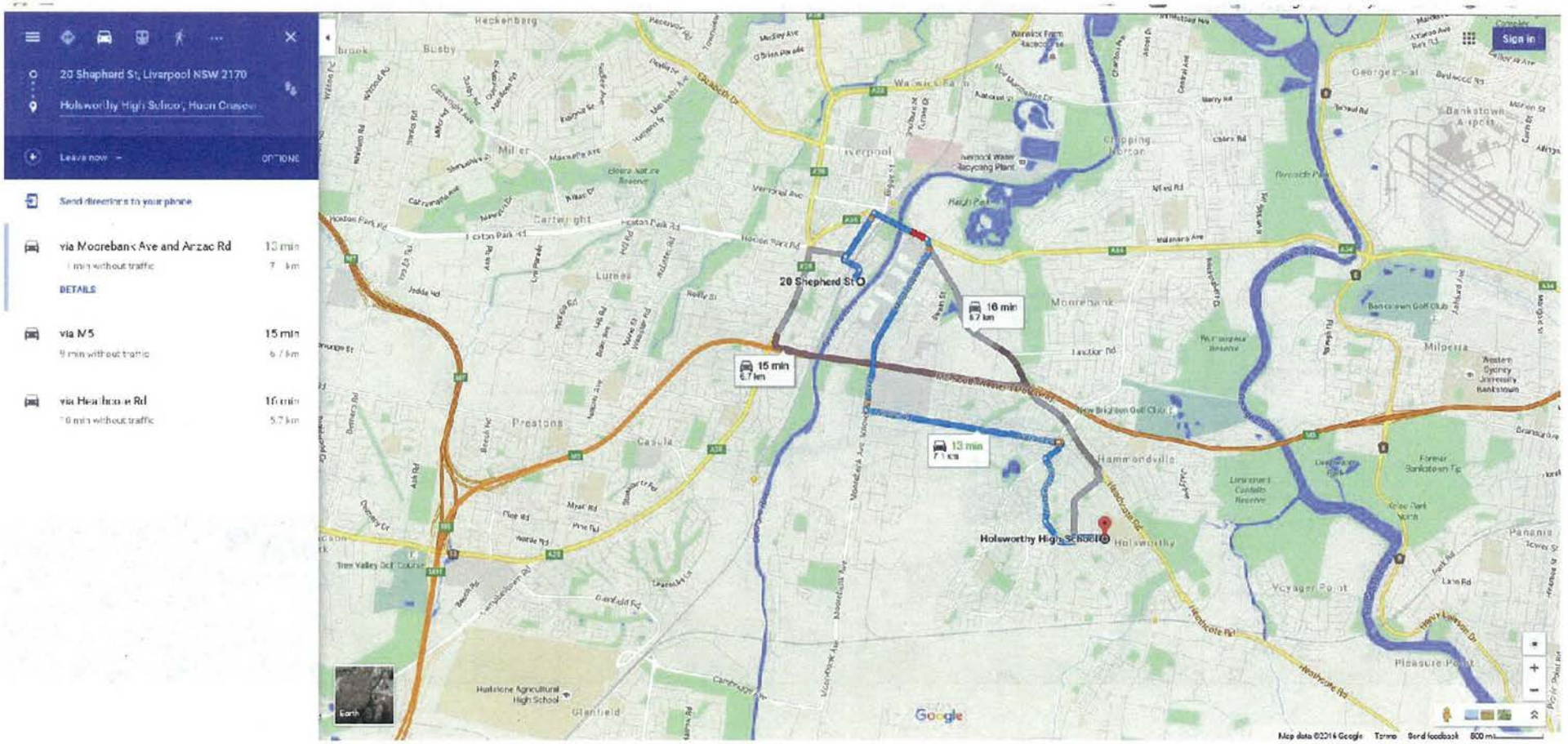

20 Shepherd St, Liverpool NSW 2170
Westfield Liverpool, Macquarie Street, L
Leave now
OPTIONS
Send directions to your phone
via Digge St
6 min
5 min without traffic
2 km
DETAILS
via Bathurst St
8 min
7 min without traffic
2.4 km
7:47 AM–8:06 AM
19 min
931
932
932X
983
M90
Sign in
Westfield Liverpool
Liverpool
8 min
2.4 km
6 min
2.1 km
19 min
every 10 min
20 Shepherd St
Warwick Farm
Ashcroft
Heathcote Rd
Moorebank
Earth
Google
Map data ©2016 Google
Terms
Send feedback
200 m


20 Shepherd St, Liverpool NSW 2170
Liverpool Public School, Railway St
Leave now
OPTIONS
Send directions to your phone
via Speed St and Digge St
4 min
3 min without traffic
1.2 km
DETAILS
Sign in
Liverpool Public School
20 Shepherd St
4 min
2 km
Moore St
Memorial Ave
Scott St
Hoxton Park Rd
Newbridge Rd
Heathcote Rd
Deadman Rd
Cumberland Hwy
Boundary Rd
Google
Map data ©2016 Google
Terms
Send feedback
200 m

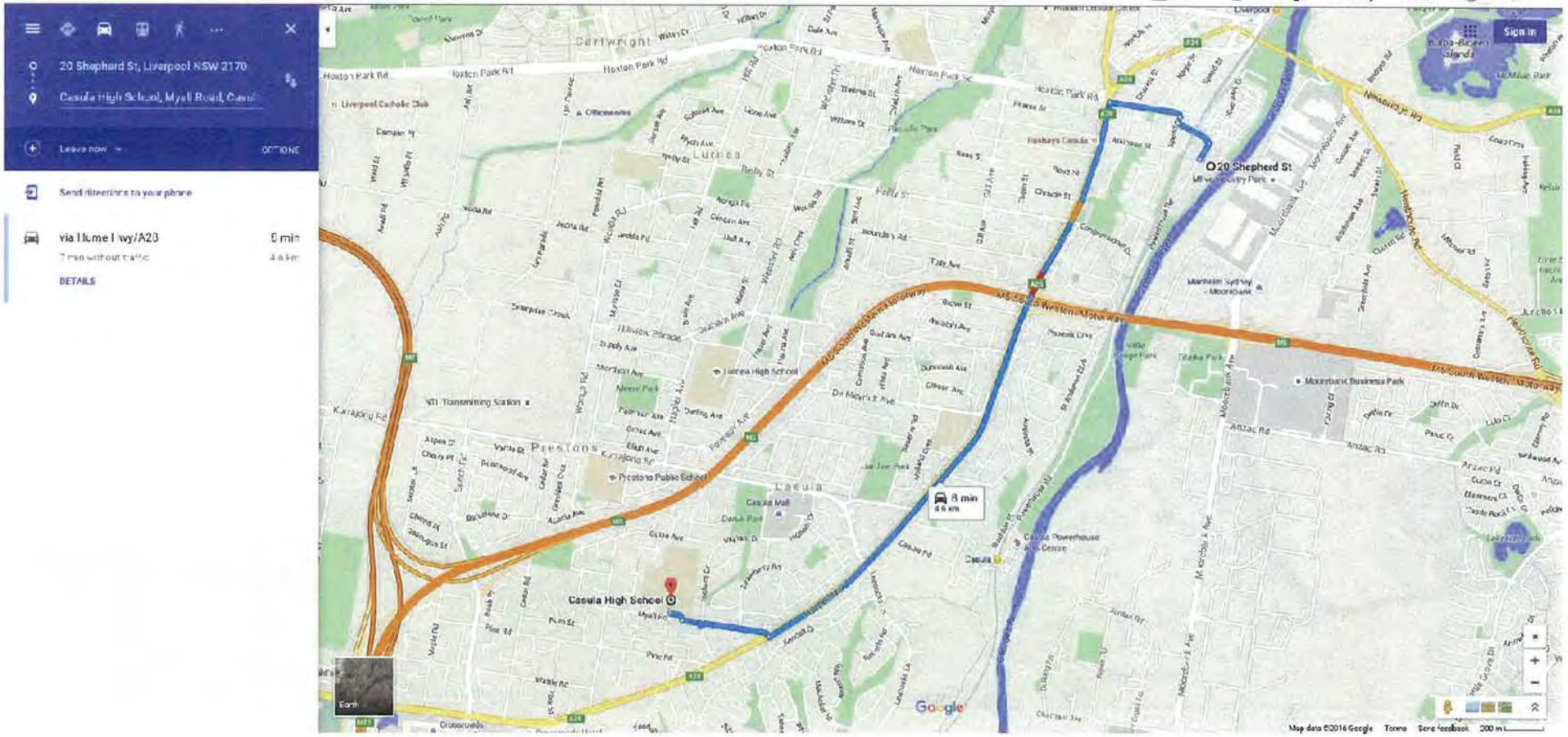

20 Shepherd St, Liverpool NSW 2170
Liverpool Girls' High School, Forbes St
Leave now
OPTIONS
Send directions to your phone
via Digge St
6 min
2.7 km
This route has restricted usage or includes private roads
DETAILS
via Bathurst St
11 min
3.5 km
Sign in
Liverpool Girls' High School
8 min
2.7 km
11 min
3.5 km
20 Shepherd St
Liverpool
Ashcroft
Lurnea
Moorebank
Warwick Farm
Casula
Chipping Norton
Nganmou Island
Google

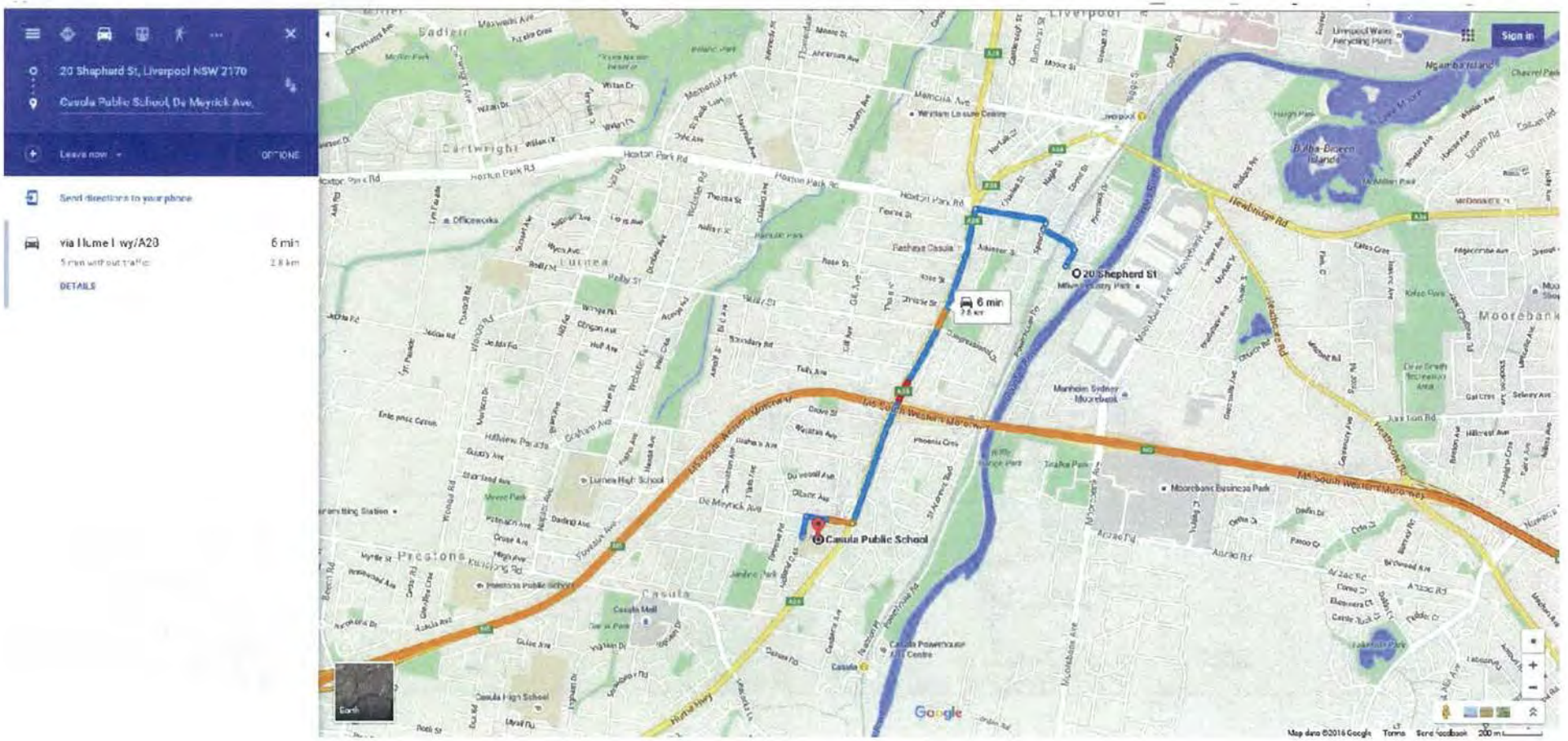

20 Shepherd St, Liverpool NSW 2170
Ashcroft High School, Maxwells Avenue
Leave now
OPTIONS
Send directions to your phone
via Flowerdale Rd
10 min
9 min without traffic
4.9 km
DETAILS
via Rafly St
10 min
9 min without traffic
5.2 km
via Hume Hwy/A28 and Elizabeth Dr
14 min
10 min without traffic
6.5 km
Sign in
Ashcroft High School
20 Shepherd St
14 min
8.3 km
10 min
4.9 km
10 min
6.2 km
Liverpool
Warwick Farm
Casula
Cartwright
Hoxton Park Rd
Memorial Ave
Newbridge Rd
Moorebank Ave
Heathcote Rd
Georges River
Google
Map data ©2016 Google
Terms
Send feedback
500 m

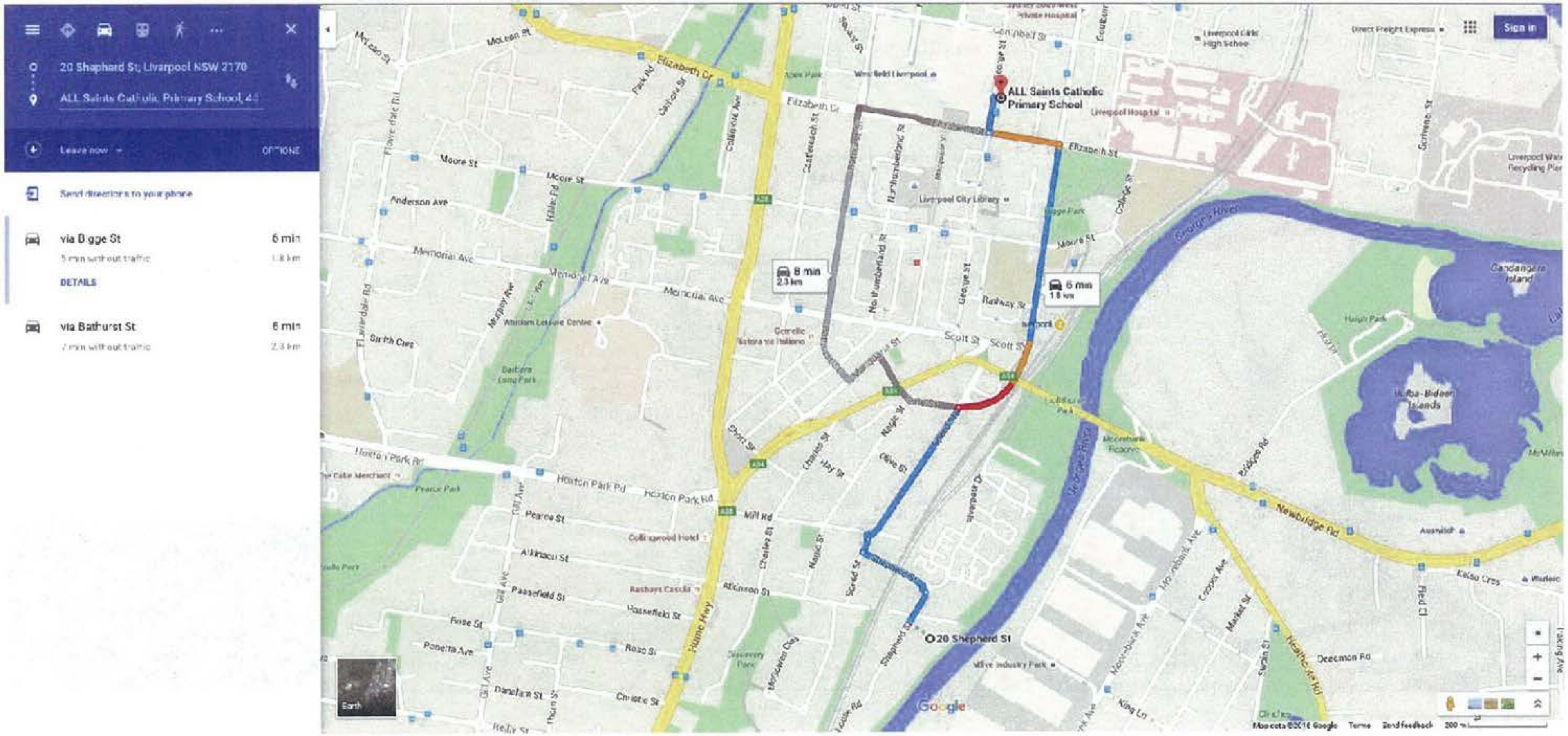

20 Shephard St, Liverpool NSW 2170
Moorebank High School, Bungalow Av
Leave now
OPTIONS
Send directions to your phone
via A34
6 min
8 min without traffic
4.7 km
DETAILS
Sign in
Liverpool
Moorebank
Moorebank High School
20 Shepherd St
8 min
4.7 km
Newbridge Rd
Hoxton Park Rd
M5 South Western Motorway
Google

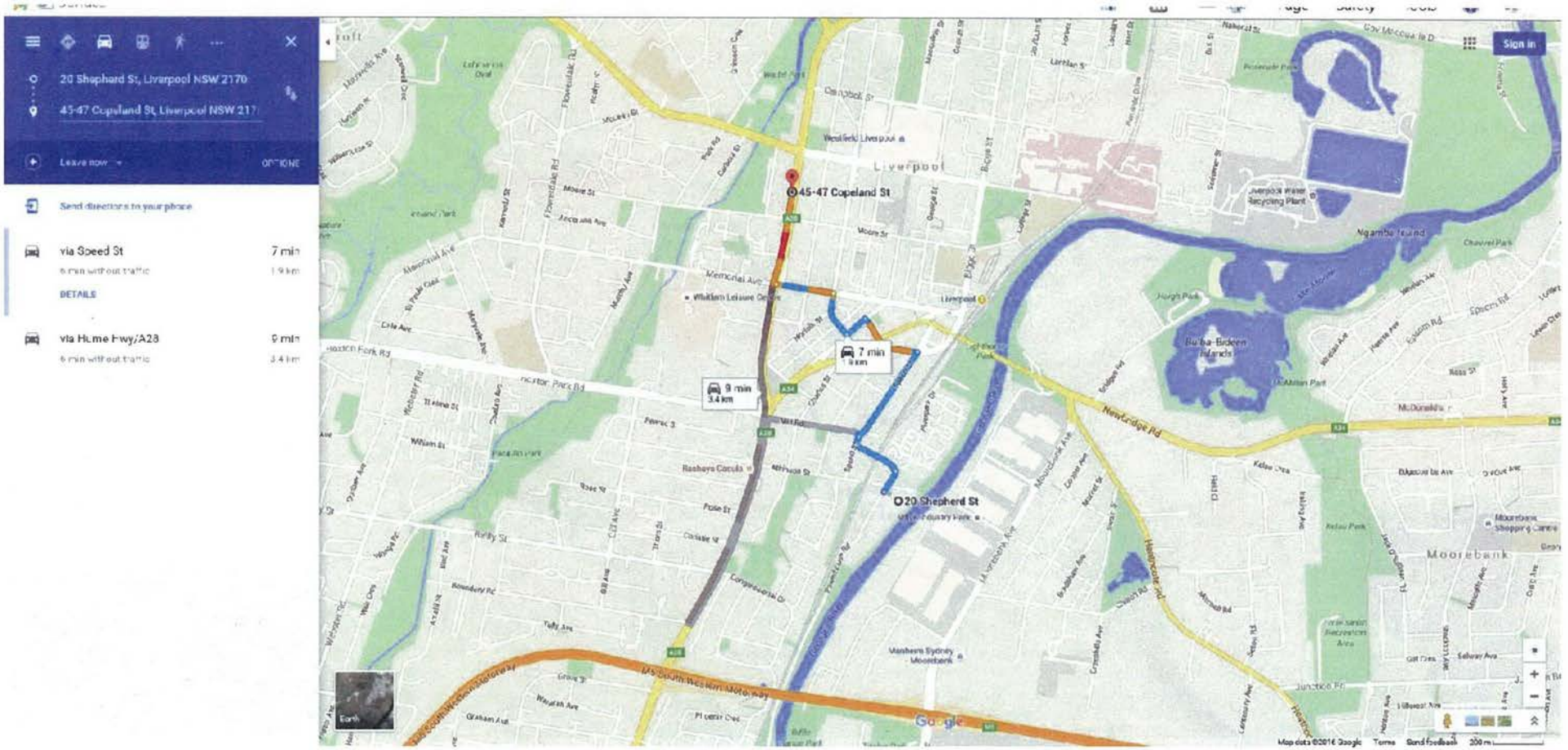

20 Shephard St, Liverpool NSW 2170
Holsworthy High School, Huon Crescent
Leave now
OPTIONS
Send directions to your phone
via Moorebank Ave and Anzac Rd
13 min
DETAILS
via M5
15 min
via Heathcote Rd
16 min
Sign in
20 Shepherd St
16 min
6.7 km
15 min
6.7 km
13 min
7.1 km
Holsworthy High School
Liverpool
Moorebank
Casula
Prestons
Hammondville
Milperra
Bankstown Airport
Chipping Norton
Georges Hall
Panania
Voyager Point
Pleasure Point
Glenfield
Hurlstone Agricultural High School
Earth
Google
Map data ©2016 Google
Terms
Send feedback
500 m

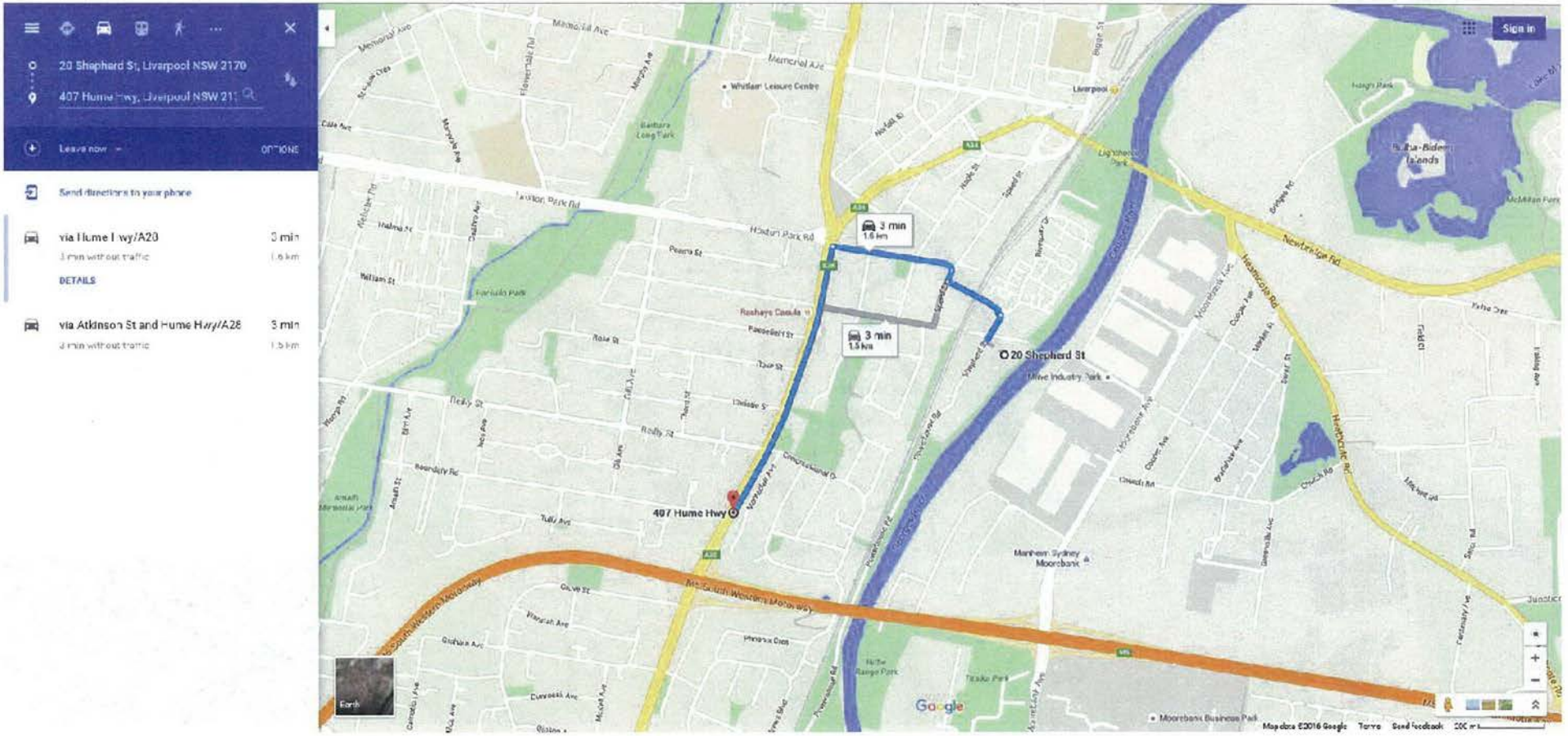

20 Shephard St, Liverpool NSW 2170
Lurnea High School, Hillview Parade, L
Leave now
OPTIONS
Send directions to your phone
via Reilly St
7 min
6 min without traffic
3.8 km
DETAILS
via Reilly St and Webster Rd
9 min
8 min without traffic
4.2 km
via Horton Park Rd and Webster Rd
9 min
8 min without traffic
4.1 km
Sign in
9 min
4.1 km
9 min
4.2 km
7 min
3.8 km
20 Shepherd St
Lurnea High School
Liverpool
Lurnea
Miller
Sadleir
Cartwright
Prestons
Casula
Horton Park Rd
Reilly St
Hillview Parade
Heathcote Rd
Moorebank Sydney
Map data ©2016 Google
Terms
Send feedback
200 m

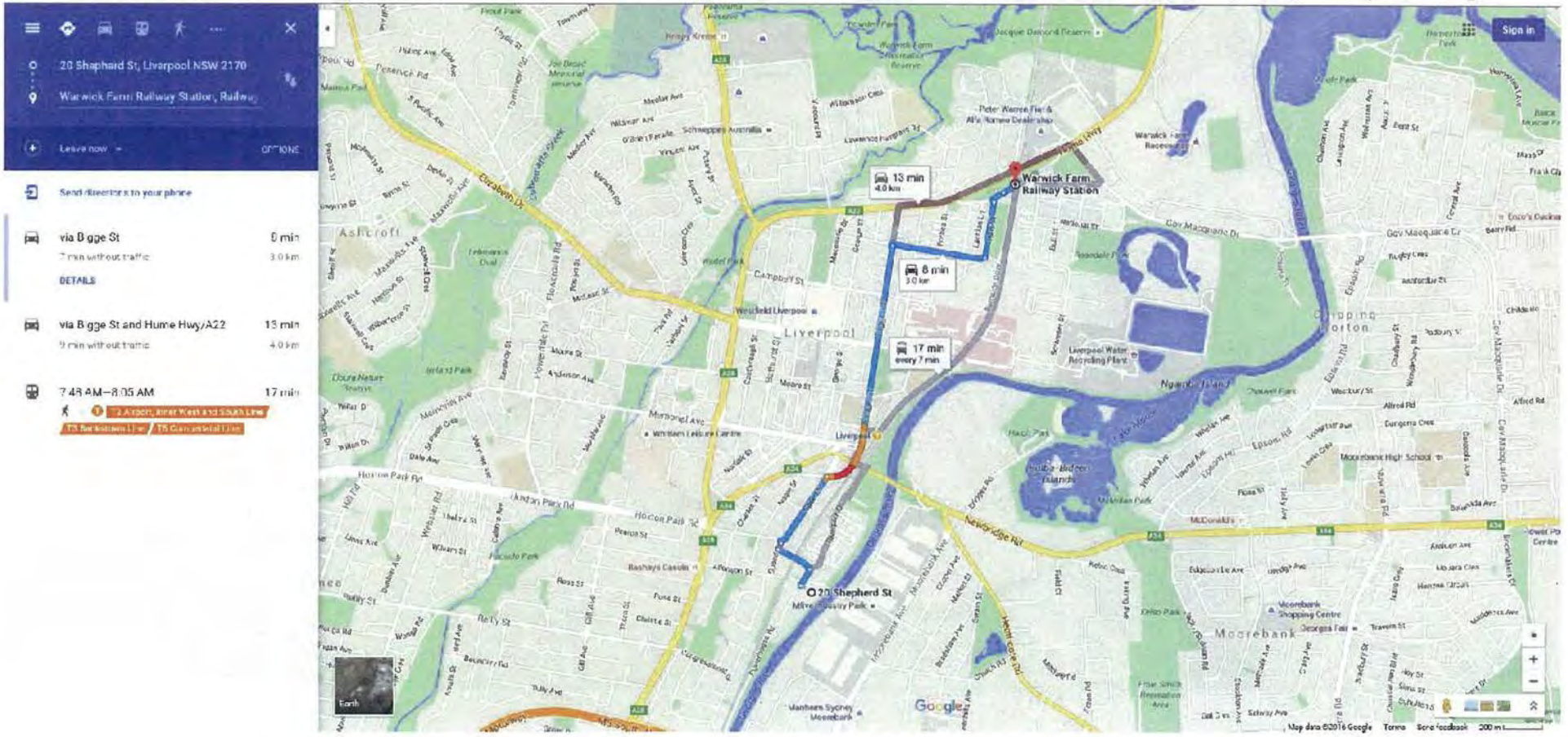

20 Shepherd St, Liverpool NSW 2170
Casula High School, Myall Road, Casul
Leave now
OPTIONS
Send directions to your phone
via Hume Hwy/A23
7 min without traffic
5 min
4.6 km
DETAILS
Sign in
20 Shepherd St
Casula High School
8 min
4.6 km
Earth
Google
Map data ©2016 Google
Terms
Send feedback
200 m

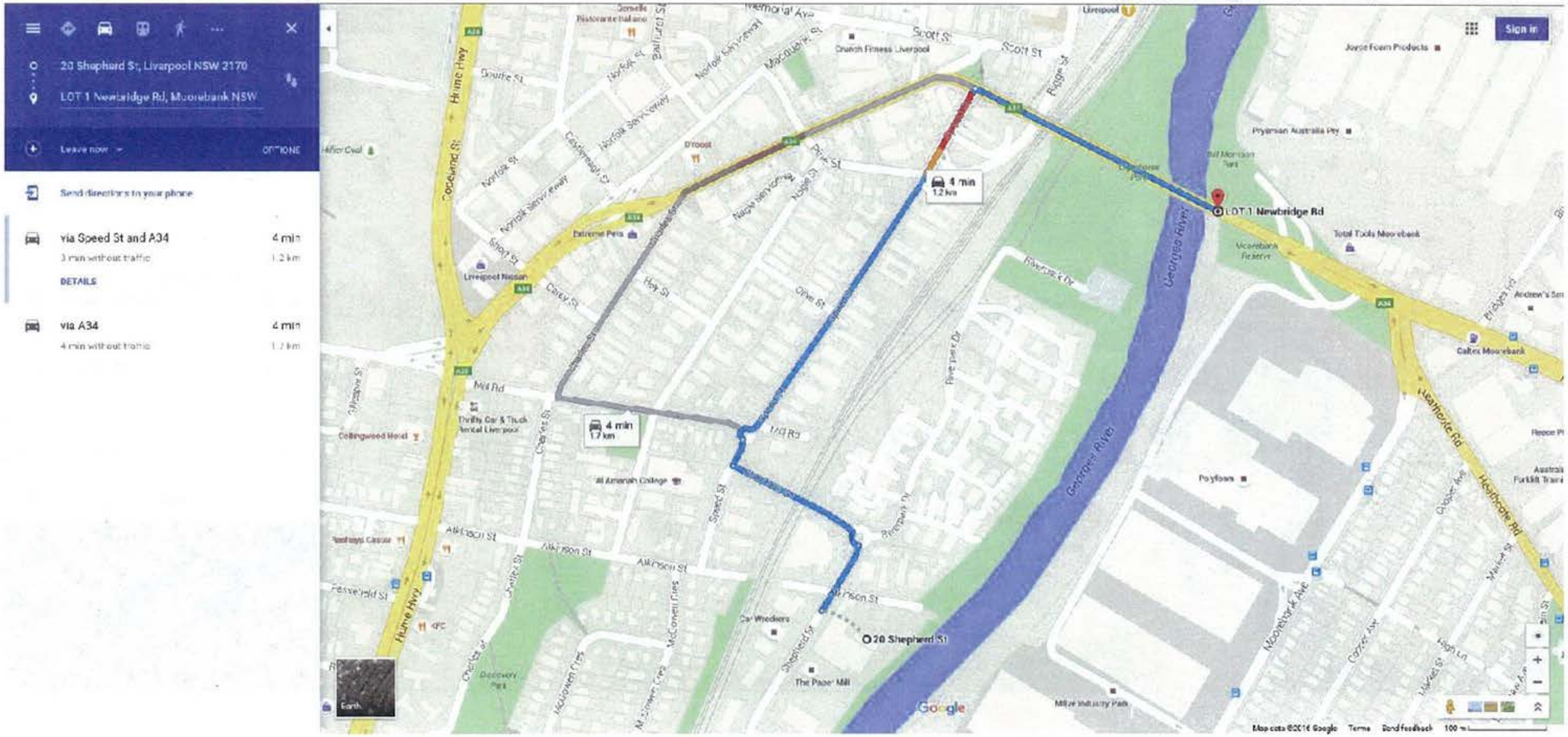

20 Shepherd St, Liverpool NSW 2170
Casula Public School, De Meyrick Ave
Leave now
OPTIONS
Send directions to your phone
via Hume Hwy/A20
6 min
5 min without traffic
2.8 km
DETAILS
Sign in
20 Shepherd St
Casula Public School
6 min
2.8 km
Hume Hwy
Horton Park Rd
Newbridge Rd
Moorebank
Casula
Liverpool
Google
Map data ©2016 Google
Terms
200 m

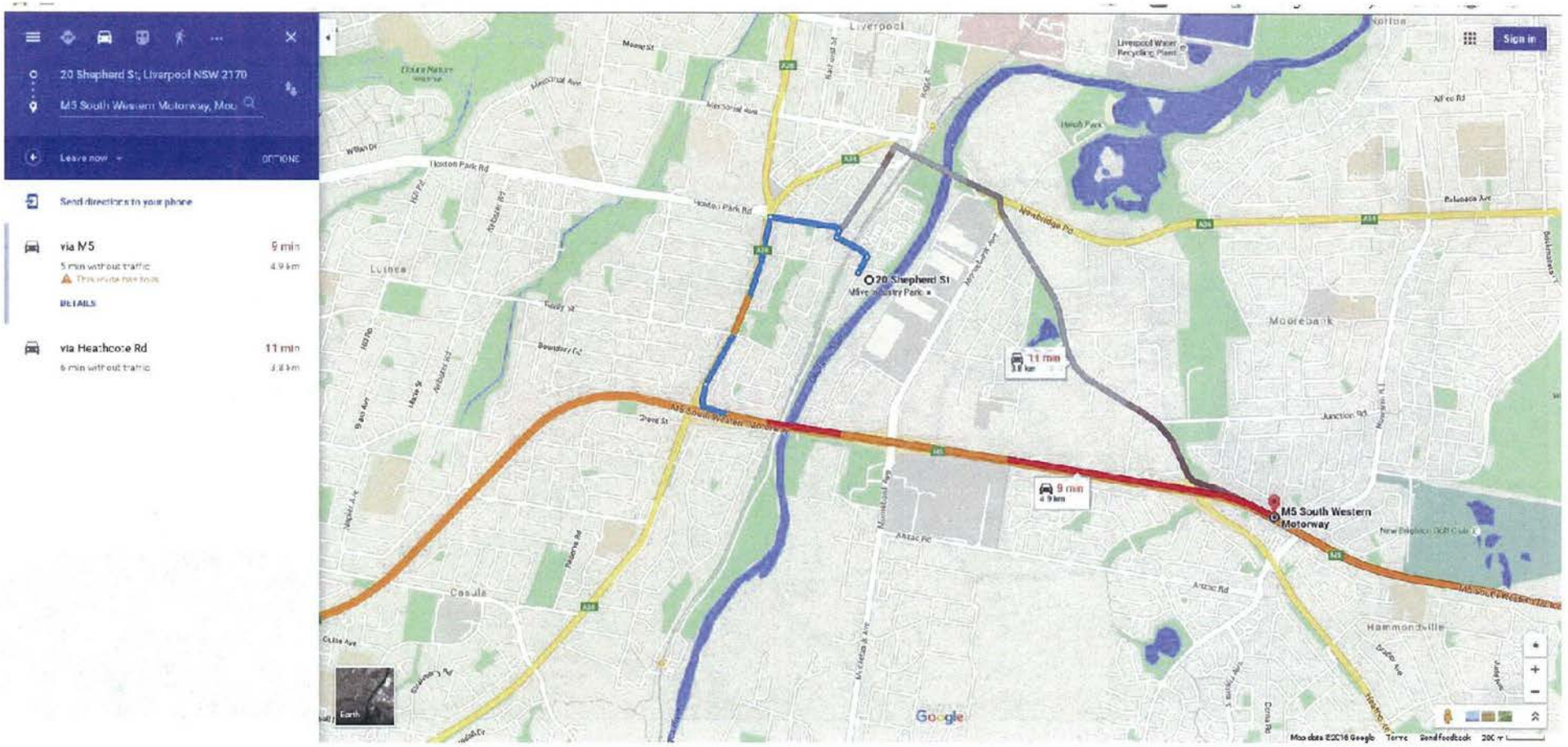

20 Shaphard St, Liverpool NSW 2170
ALL Saints Catholic Primary School, 4
Leave now
Send directions to your phone
via Bigge St
6 min
5 min without traffic
1.8 km
DETAILS
via Bathurst St
8 min
2.3 km
Sign in
ALL Saints Catholic Primary School
Liverpool Hospital
Elizabeth St
Moore St
Memorial Ave
Scott St
Hoxton Park Rd
Hume Hwy
Newbridge Rd
Georges River
Liverpool City Library
8 min
2.3 km
6 min
1.8 km
20 Shepherd St
Earth
Google

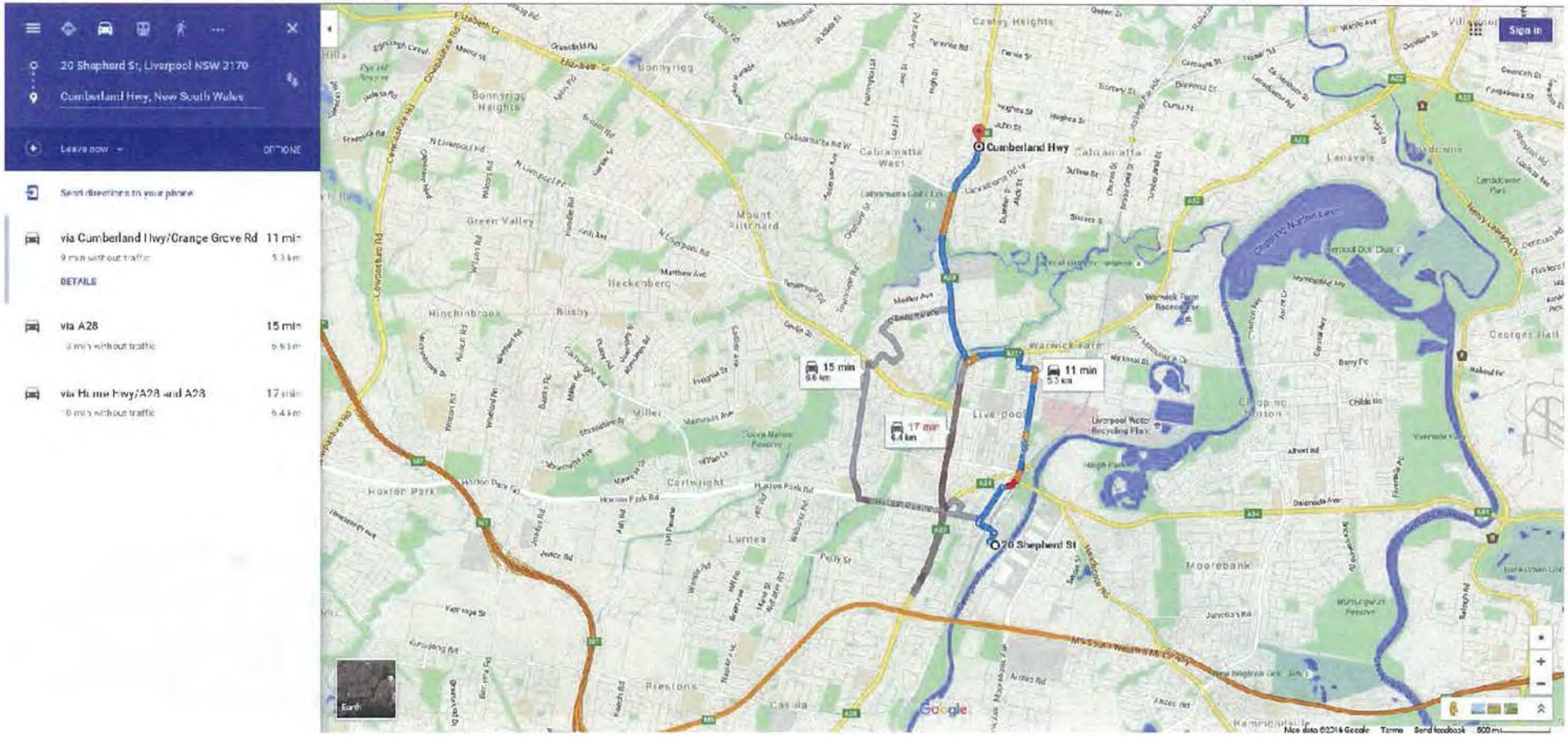

20 Shepherd St, Liverpool NSW 2170
45-47 Copeland St, Liverpool NSW 217
Leave now
OPTIONS
Send directions to your phone
via Speed St
7 min
6 min without traffic
1.9 km
DETAILS
via Hume Hwy/A28
9 min
6 min without traffic
3.4 km
Sign in
45-47 Copeland St
20 Shepherd St
7 min
1.9 km
9 min
3.4 km
Liverpool
Moorebank
Newbridge Rd
Hoxton Park Rd
Memorial Ave
Moore St
Elizabeth Dr
M5 South Western Motorway
Earth
Google

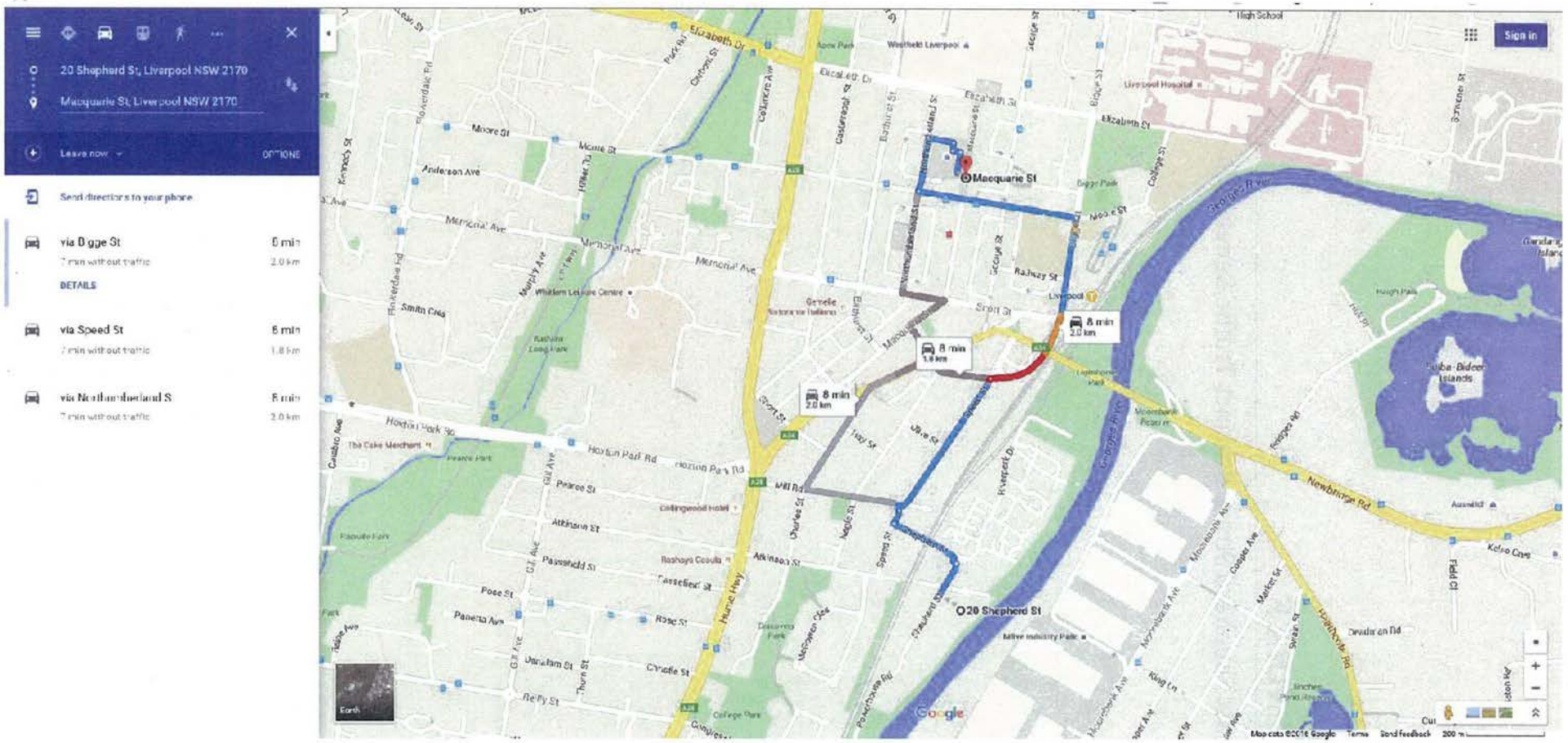

20 Shepherd St, Liverpool NSW 2170
407 Hume Hwy, Liverpool NSW 21
Leave now
OPTIONS
Send directions to your phone
via Hume Hwy/A28
3 min
3 min without traffic
1.6 km
DETAILS
via Atkinson St and Hume Hwy/A28
3 min without traffic
1.5 km
Sign in
3 min
1.6 km
3 min
1.5 km
20 Shepherd St
407 Hume Hwy
Memorial Ave
Whitlam Leisure Centre
Liverpool
Newbridge Rd
Heathcote Rd
Moorebank Ave
Moorebank Industry Park
Menhem Sydney Moorebank
Moorebank Business Park
Hume Motorway
Earth
Google
Map data ©2016 Google
Terms
Send feedback


20 Shepherd St, Liverpool NSW 2170
Warwick Farm Railway Station, Railway
Leave now
OPTIONS
Send directions to your phone
via Bigge St
7 min without traffic
6 min
3.0 km
DETAILS
via Bigge St and Hume Hwy/A22
9 min without traffic
13 min
4.0 km
7:48 AM–8:05 AM
17 min
13 min
4.0 km
8 min
3.0 km
17 min
every 7 min
Warwick Farm Railway Station
20 Shepherd St
Liverpool
Ashcroft
Moorebank
Chipping Norton
Newbridge Rd
Hoxton Park Rd
Anzac Park Rd
Campbell St
Moore St
Macquarie Mall
Sign in
Earth
Google
Map data ©2016 Google
Terms
Send feedback
200 m


20 Shepherd St, Liverpool NSW 2170
LOT 1 Newbridge Rd, Moorebank NSW
Leave now
OPTIONS
Send directions to your phone
via Speed St and A34
4 min
3 min without traffic
1.2 km
DETAILS
via A34
4 min
4 min without traffic
1.7 km
Sign in
4 min
1.2 km
4 min
1.7 km
LOT 1 Newbridge Rd
20 Shepherd St
Georges River
Hume Hwy
Scott St
Mill Rd
Atkinson St
Heathcote Rd
Moorebank Ave
Speed St
Google

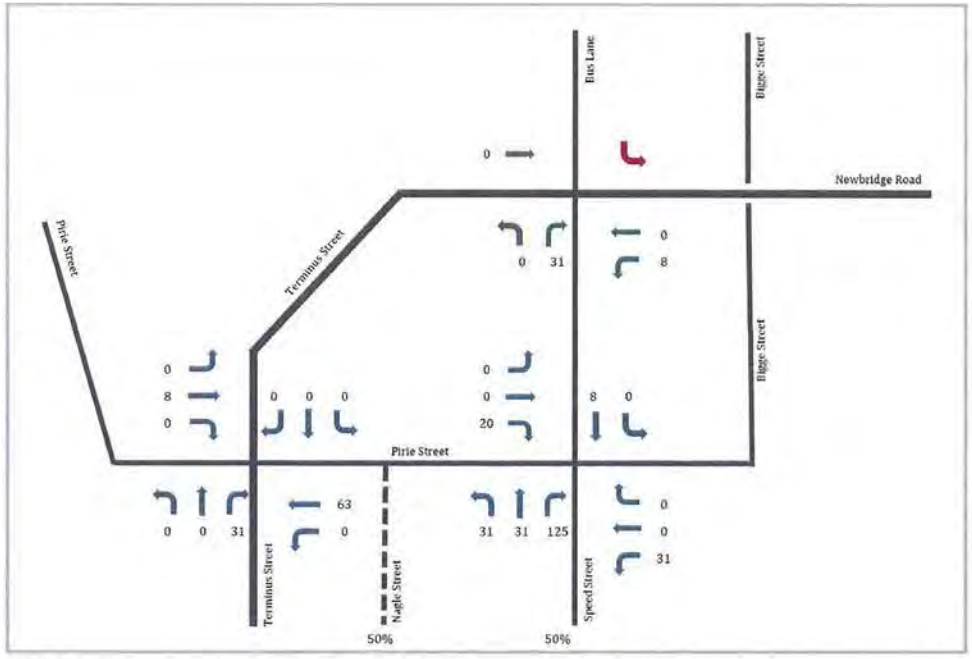

20 Shepherd St, Liverpool NSW 2170
M5 South Western Motorway, Mos
Leave now
OPTIONS
Send directions to your phone
via M5
9 min
5 min without traffic
4.9 km
This route has tolls
DETAILS
via Heathcote Rd
11 min
6 min without traffic
3.8 km
Sign in
Liverpool
Lurnea
Casula
Moorebank
Hammondville
20 Shepherd St
11 min
3.8 km
9 min
4.9 km
M5 South Western Motorway
Newbridge Rd
Heathcote Rd
Anzac Rd
Junction Rd
Google


20 Shepherd St, Liverpool NSW 2170
Cumberland Hwy, New South Wales
Leave now
OPTIONS
Send directions to your phone
via Cumberland Hwy/Orange Grove Rd 11 min
9 min without traffic 5.3 km
DETAILS
via A28 15 min
8 min without traffic 6.6 km
via Hume Hwy/A28 and A28 17 min
10 min without traffic 6.4 km
Sign in
Cumberland Hwy
20 Shepherd St
15 min
11 min
17 min
Google

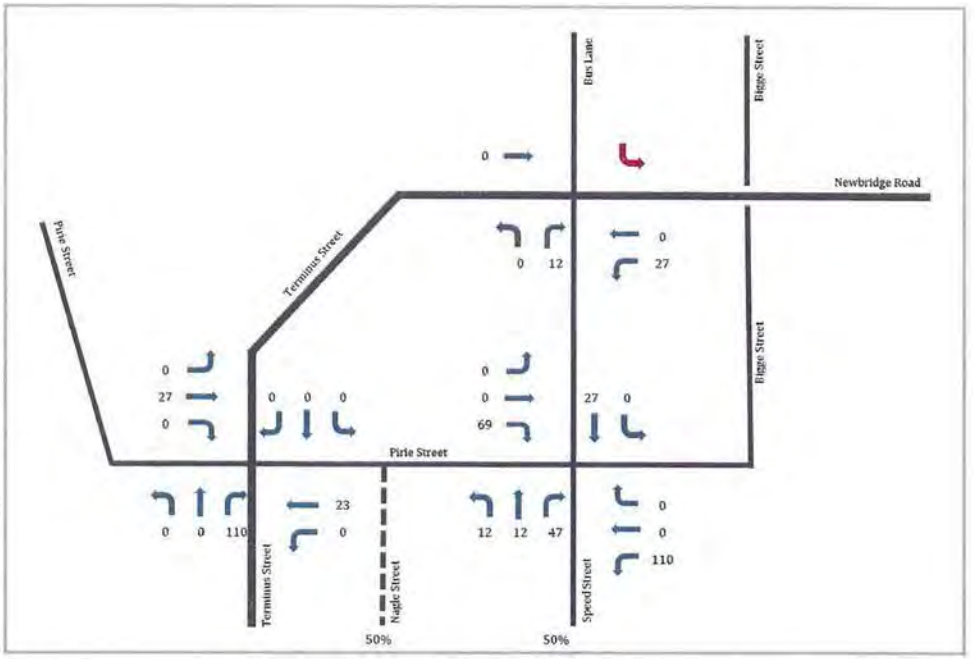

20 Shepherd St, Liverpool NSW 2170
Macquarie St, Liverpool NSW 2170
Leave now
OPTIONS
Send directions to your phone
via Digge St
7 min without traffic
6 min
2.0 km
DETAILS
via Speed St
7 min without traffic
6 min
1.8 km
via Northumberland S
7 min without traffic
6 min
2.0 km
Sign in
Macquarie St
20 Shepherd St
8 min
2.0 km
8 min
1.8 km
8 min
2.0 km
Elizabeth Dr
Moore St
Memorial Ave
Smith Cres
Hoxton Park Rd
Pearce St
Atkinson St
Rose St
Chisolm St
Railway St
Scott St
Hume Hwy
Mill Rd
Speed St
Newbridge Rd
Liverpool
Earth
Google

APPENDIX F

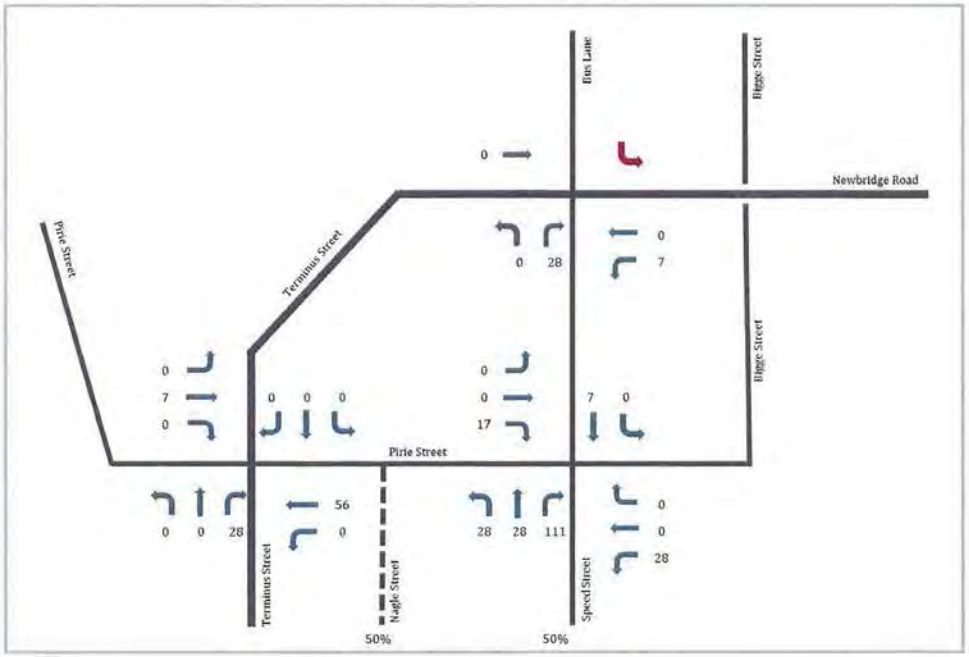
Forecast Shepherd Street Precinct Traffic Generation



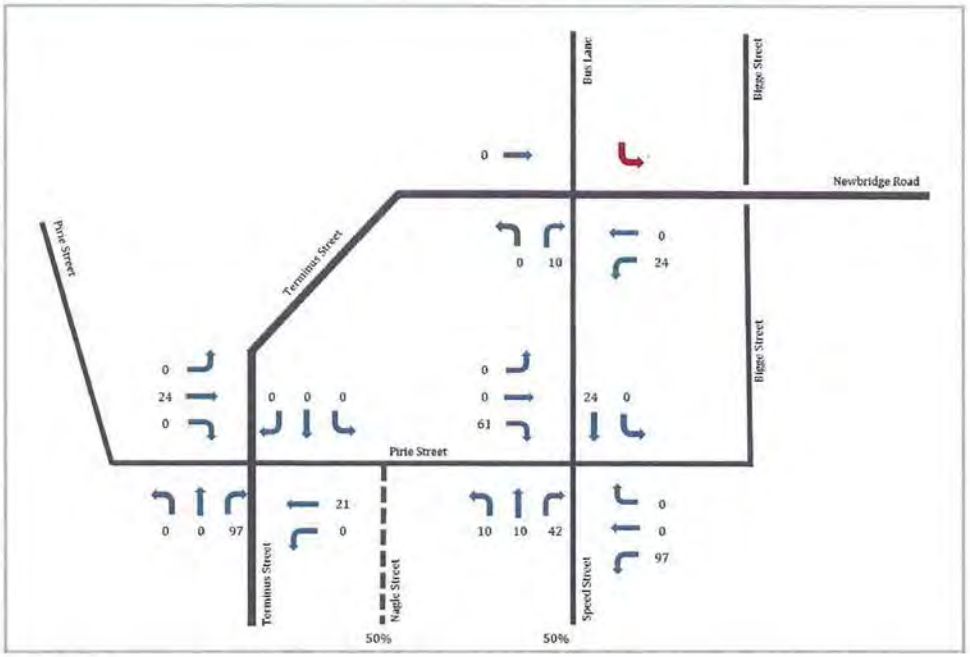
AM Peak



PM Peak



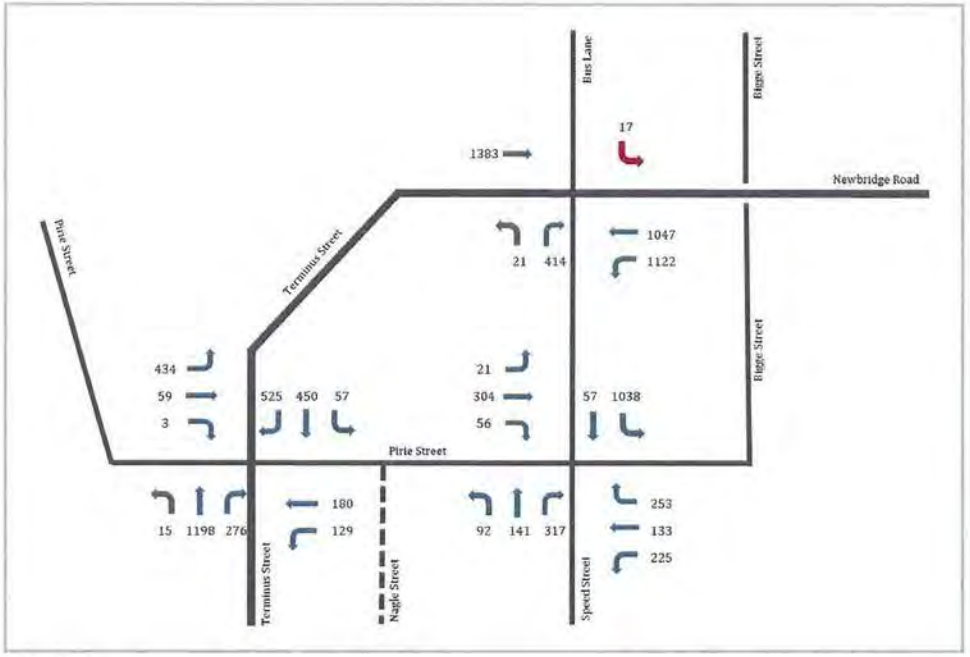
AM Peak



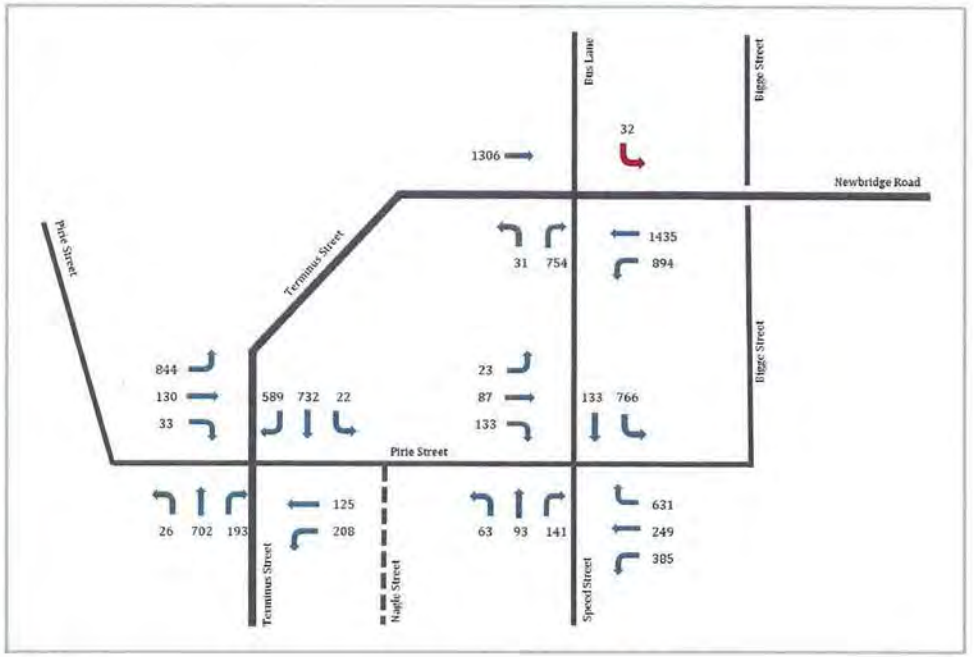
PM Peak

APPENDIX G

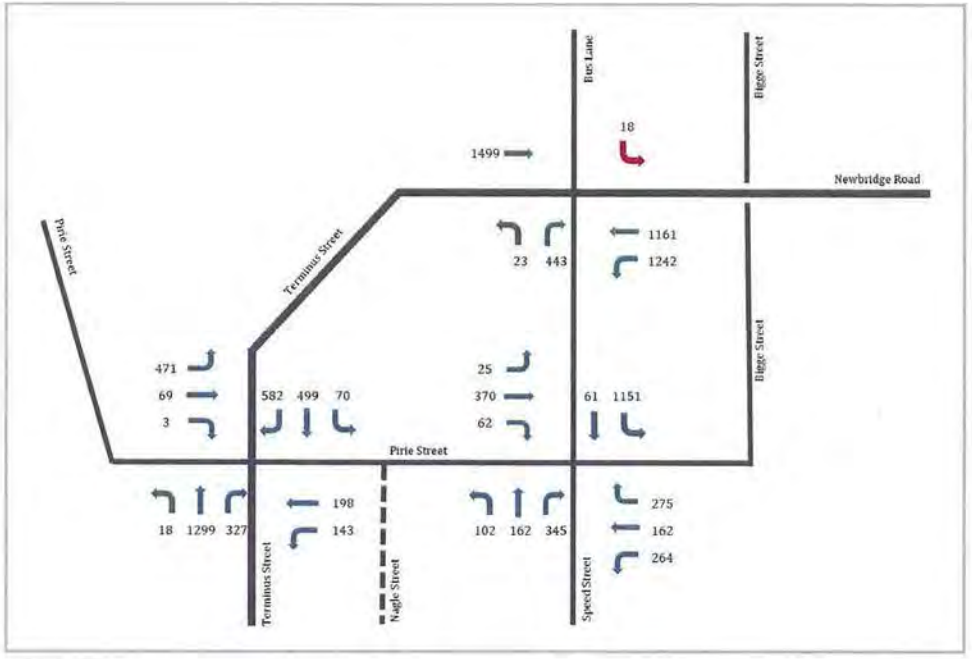
2026 and 2036 Design Traffic Volumes (Background + Development Traffic)



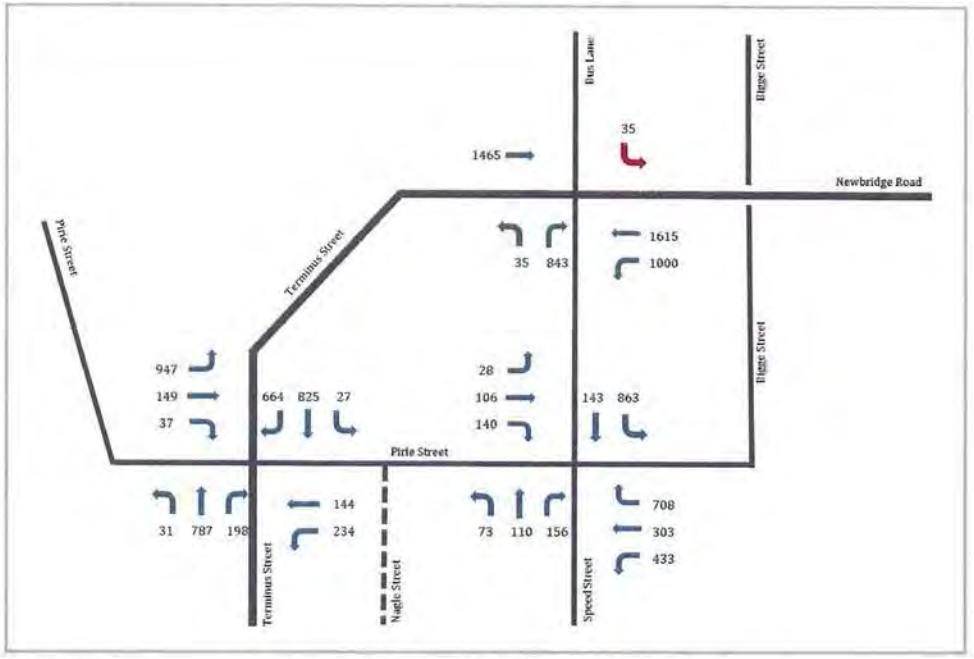
AM Peak



PM Peak



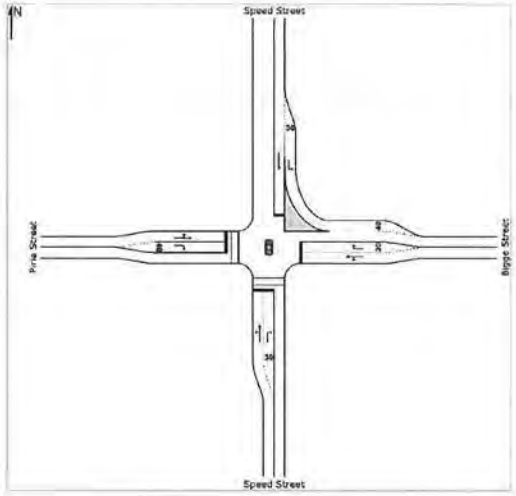
AM Peak

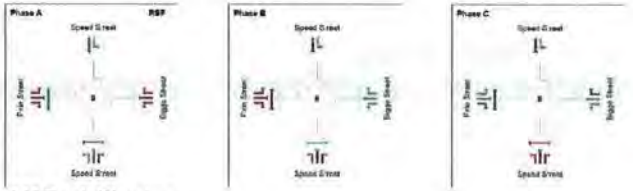


PM Peak

APPENDIX H

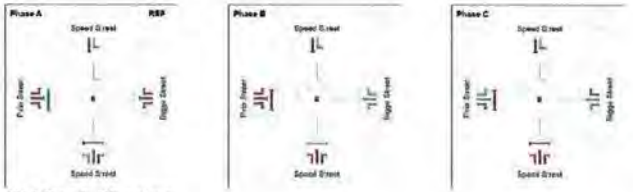
SIDRA Model Results - Speed Street / Bigge Street / Pirie Street intersection (Background Traffic only, Existing Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 40 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

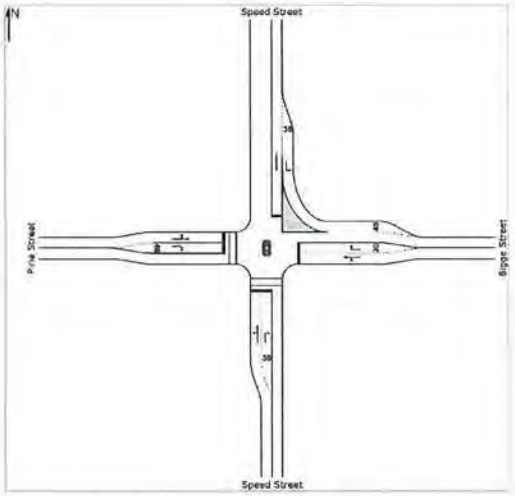
Signals - Fixed Time Isolated Cycle Time = 45 seconds (Optimum Cycle Time - Minimum Delay)

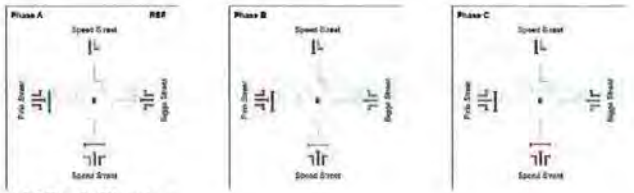
AM Peak Hour

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	50	5.0	0.512	23.1	LOS B	2.8	20.1	0.96	0.77	34.6
2	T1	90	5.0	0.512	18.5	LOS B	2.8	20.1	0.96	0.77	34.2
3	R2	157	5.0	0.583	23.6	LOS B	3.2	23.2	0.98	0.82	37.3
Approach		297	5.0	0.583	22.0	LOS B	3.2	23.2	0.97	0.80	36.2
East: Bigge Street											
4	L2	159	5.0	0.270	9.8	LOS A	2.8	20.6	0.56	0.61	44.6
5	T1	109	5.0	0.270	5.2	LOS A	2.8	20.6	0.56	0.61	42.9
6	R2	213	5.0	0.418	12.1	LOS A	2.3	17.2	0.86	0.77	38.4
Approach		481	5.0	0.418	9.8	LOS A	2.8	20.6	0.69	0.68	41.9
North: Speed Street											
7	L2	807	5.0	0.457	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	38	5.0	0.136	17.0	LOS B	0.7	5.0	0.90	0.66	36.0
Approach		845	5.0	0.457	5.0	LOS A	0.7	5.0	0.04	0.47	45.8
West: Pirie Street											
10	L2	17	5.0	0.574	19.7	LOS B	4.9	35.5	0.92	0.78	26.5
11	T1	249	5.0	0.574	15.1	LOS B	4.9	35.5	0.92	0.78	37.8
12	R2	30	5.0	0.080	17.6	LOS B	0.5	3.4	0.79	0.69	35.8
Approach		296	5.0	0.574	15.7	LOS B	4.9	35.5	0.91	0.77	37.2
All Vehicles		1919	5.0	0.583	10.5	LOS A	4.9	35.5	0.48	0.62	41.3

PM Peak Hour

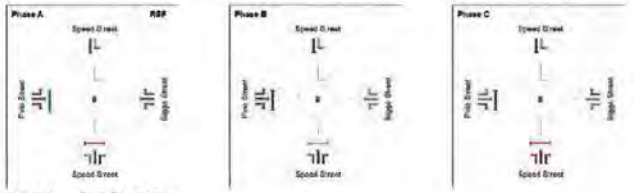
Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	42	5.0	0.449	25.7	LOS B	2.4	17.6	0.96	0.76	33.3
2	T1	67	5.0	0.449	21.1	LOS B	2.4	17.6	0.96	0.76	32.8
3	R2	77	5.0	0.376	26.5	LOS B	1.7	12.6	0.97	0.75	36.2
Approach		186	5.0	0.449	24.4	LOS B	2.4	17.6	0.96	0.75	34.6
East: Bigge Street											
4	L2	226	5.0	0.396	9.8	LOS A	5.0	36.8	0.56	0.61	44.8
5	T1	204	5.0	0.396	5.2	LOS A	5.0	36.8	0.56	0.61	43.2
6	R2	500	5.0	0.634	11.4	LOS A	6.4	47.0	0.84	0.81	38.8
Approach		930	5.0	0.634	9.6	LOS A	6.4	47.0	0.71	0.72	41.6
North: Speed Street											
7	L2	611	5.0	0.346	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	84	5.0	0.339	20.7	LOS B	1.8	13.2	0.95	0.72	33.9
Approach		695	5.0	0.346	6.4	LOS A	1.8	13.2	0.11	0.50	44.5
West: Pirie Street											
10	L2	19	5.0	0.367	25.4	LOS B	2.0	14.3	0.95	0.74	22.4
11	T1	71	5.0	0.367	20.8	LOS B	2.0	14.3	0.95	0.74	34.4
12	R2	53	5.0	0.232	25.0	LOS B	1.1	8.2	0.93	0.73	32.2
Approach		143	5.0	0.367	22.9	LOS B	2.0	14.3	0.94	0.73	32.5
All Vehicles		1954	5.0	0.634	10.9	LOS A	6.4	47.0	0.54	0.64	40.8





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 40 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

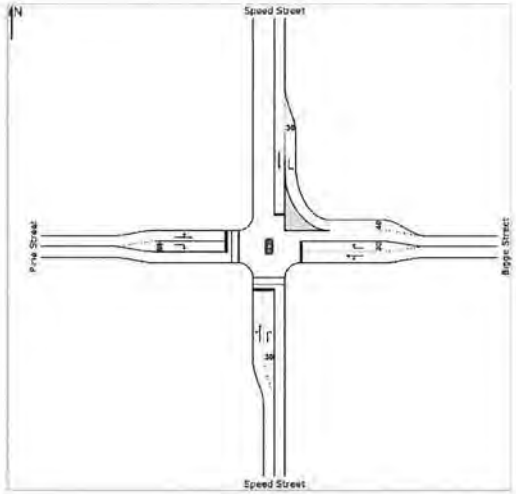
Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

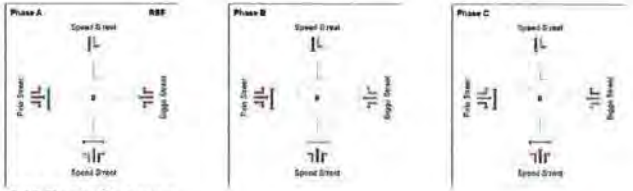
AM Peak Hour

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	61	5.0	0.625	24.0	LOS B	3.5	25.6	0.98	0.84	34.2
2	T1	110	5.0	0.625	19.4	LOS B	3.5	25.6	0.98	0.84	33.8
3	R2	191	5.0	0.730	25.5	LOS B	4.2	30.3	1.00	0.93	36.6
Approach		362	5.0	0.730	23.4	LOS B	4.2	30.3	0.99	0.89	35.6
East: Bigge Street											
4	L2	194	5.0	0.330	10.1	LOS A	3.6	26.2	0.58	0.63	44.5
5	T1	133	5.0	0.330	5.5	LOS A	3.6	26.2	0.58	0.63	42.7
6	R2	253	5.0	0.534	12.7	LOS A	2.9	21.0	0.91	0.79	37.9
Approach		580	5.0	0.534	10.2	LOS A	3.6	26.2	0.73	0.70	41.6
North: Speed Street											
7	L2	1038	5.0	0.588	4.4	LOS A	0.0	0.0	0.00	0.46	46.3
8	T1	49	5.0	0.176	17.2	LOS B	0.9	6.6	0.91	0.67	35.9
Approach		1087	5.0	0.588	5.0	LOS A	0.9	6.6	0.04	0.47	45.7
West: Pirie Street											
10	L2	21	5.0	0.702	21.5	LOS B	6.5	47.4	0.96	0.89	25.2
11	T1	304	5.0	0.702	16.9	LOS B	6.5	47.4	0.96	0.89	36.8
12	R2	37	5.0	0.103	17.8	LOS B	0.6	4.3	0.80	0.70	35.7
Approach		362	5.0	0.702	17.3	LOS B	6.5	47.4	0.95	0.87	36.3
All Vehicles		2391	5.0	0.730	10.9	LOS A	6.5	47.4	0.49	0.65	41.0

PM Peak Hour

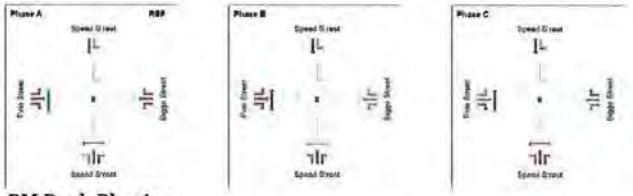
Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	51	5.0	0.730	37.0	LOS C	4.3	31.3	1.00	0.90	28.8
2	T1	82	5.0	0.730	32.4	LOS C	4.3	31.3	1.00	0.90	28.0
3	R2	94	5.0	0.752	39.6	LOS C	3.1	22.7	1.00	0.88	32.0
Approach		227	5.0	0.752	36.4	LOS C	4.3	31.3	1.00	0.89	30.2
East: Bigge Street											
4	L2	275	5.0	0.414	8.7	LOS A	6.5	47.3	0.45	0.56	45.4
5	T1	249	5.0	0.414	4.1	LOS A	6.5	47.3	0.45	0.56	44.0
6	R2	631	5.0	0.795	15.2	LOS B	11.4	83.4	0.72	0.84	36.4
Approach		1155	5.0	0.795	11.2	LOS A	11.4	83.4	0.60	0.71	40.5
North: Speed Street											
7	L2	766	5.0	0.434	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	105	5.0	0.565	30.3	LOS C	3.2	23.4	1.00	0.80	29.5
Approach		871	5.0	0.565	7.5	LOS A	3.2	23.4	0.12	0.50	43.4
West: Pirie Street											
10	L2	23	5.0	0.598	35.3	LOS C	3.4	24.8	1.00	0.82	18.0
11	T1	87	5.0	0.598	30.7	LOS C	3.4	24.8	1.00	0.82	30.1
12	R2	65	5.0	0.392	34.3	LOS C	1.9	14.2	0.97	0.75	28.6
Approach		175	5.0	0.598	32.6	LOS C	3.4	24.8	0.99	0.79	28.5
All Vehicles		2428	5.0	0.795	13.8	LOS A	11.4	83.4	0.49	0.66	38.9





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 75 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

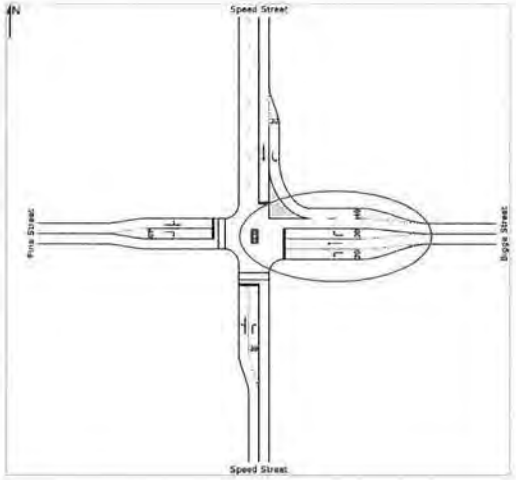
Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	74	5.0	0.518	24.1	LOS B	4.7	34.4	0.93	0.77	34.1
2	T1	134	5.0	0.518	19.5	LOS B	4.7	34.4	0.93	0.77	33.7
3	R2	233	5.0	0.704	27.5	LOS B	5.9	43.4	0.98	0.89	35.8
Approach		441	5.0	0.704	24.5	LOS B	5.9	43.4	0.96	0.84	35.1
East: Bigge Street											
4	L2	236	5.0	0.409	12.0	LOS A	5.8	42.5	0.63	0.66	43.5
5	T1	162	5.0	0.409	7.4	LOS A	5.8	42.5	0.63	0.66	41.3
6	R2	275	5.0	0.669	16.2	LOS B	4.3	31.1	0.95	0.85	35.8
Approach		673	5.0	0.669	12.6	LOS A	5.8	42.5	0.76	0.74	40.2
North: Speed Street											
7	L2	1151	5.0	0.652	4.4	LOS A	0.0	0.0	0.00	0.46	46.3
8	T1	54	5.0	0.132	17.5	LOS B	1.1	8.0	0.84	0.63	35.7
Approach		1205	5.0	0.652	5.0	LOS A	1.1	8.0	0.04	0.47	45.7
West: Pirie Street											
10	L2	25	5.0	0.711	23.4	LOS B	9.4	68.6	0.95	0.88	23.9
11	T1	370	5.0	0.711	18.8	LOS B	9.4	68.6	0.95	0.88	35.7
12	R2	45	5.0	0.124	19.0	LOS B	0.8	6.1	0.76	0.71	35.1
Approach		440	5.0	0.711	19.1	LOS B	9.4	68.6	0.93	0.86	35.3
All Vehicles		2759	5.0	0.711	12.2	LOS A	9.4	68.6	0.50	0.66	40.2

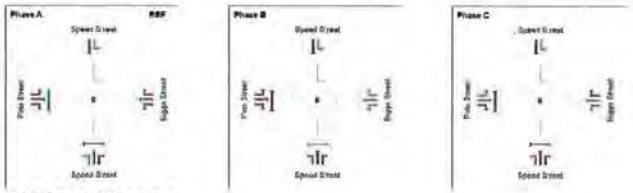
PM Peak Hour

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	62	5.0	0.834	47.2	LOS D	6.7	49.3	1.00	1.01	25.6
2	T1	100	5.0	0.834	42.6	LOS D	6.7	49.3	1.00	1.01	24.8
3	R2	114	5.0	1.032	127.4	LOS F	8.8	64.1	1.00	1.60	18.1
Approach		276	5.0	1.032	78.7	LOS F	8.8	64.1	1.00	1.25	20.8
East: Bigge Street											
4	L2	336	5.0	0.825	17.9	LOS B	14.2	103.8	0.45	0.65	40.8
5	T1	303	5.0	0.825	13.3	LOS A	14.2	103.8	0.45	0.65	37.7
6	R2	708	5.0	0.964	63.0	LOS E	35.1	255.9	0.66	1.11	20.2
Approach		1347	5.0	0.964	40.6	LOS C	35.1	255.9	0.56	0.89	27.8
North: Speed Street											
7	L2	863	5.0	0.489	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	119	5.0	0.600	37.1	LOS C	4.5	32.7	1.00	0.81	27.0
Approach		982	5.0	0.600	8.4	LOS A	4.5	32.7	0.12	0.51	42.7
West: Pirie Street											
10	L2	28	5.0	0.911	54.7	LOS D	6.1	44.4	1.00	1.15	13.1
11	T1	106	5.0	0.911	50.1	LOS D	6.1	44.4	1.00	1.15	24.2
12	R2	79	5.0	0.618	44.6	LOS D	3.1	22.7	1.00	0.82	25.5
Approach		213	5.0	0.911	48.7	LOS D	6.1	44.4	1.00	1.03	23.6
All Vehicles		2818	5.0	1.032	33.7	LOS C	35.1	255.9	0.48	0.80	29.6

APPENDIX I

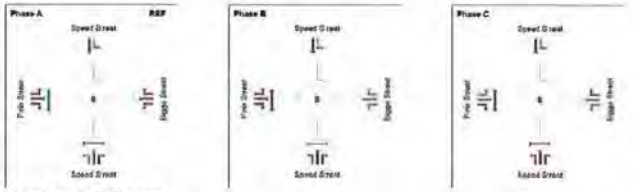
SIDRA Model Results - Speed Street / Bigge Street / Pirie Street intersection (Background Traffic only, Upgraded Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

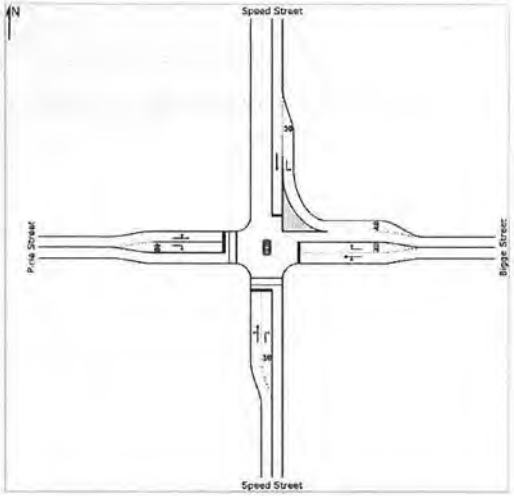
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	74	5.0	0.518	24.1	LOS B	4.7	34.4	0.93	0.77	34.2
2	T1	134	5.0	0.518	19.5	LOS B	4.7	34.4	0.93	0.77	33.7
3	R2	233	5.0	0.704	27.5	LOS B	5.9	43.4	0.98	0.90	36.0
Approach		441	5.0	0.704	24.5	LOS B	5.9	43.4	0.96	0.84	35.2
East: Bigge Street											
4	L2	236	5.0	0.248	11.3	LOS A	3.1	22.6	0.56	0.70	42.9
5	T1	162	5.0	0.161	6.3	LOS A	2.0	14.6	0.53	0.44	44.2
6	R2	275	5.0	0.669	16.2	LOS B	4.3	31.1	0.95	0.85	35.8
Approach		673	5.0	0.669	12.1	LOS A	4.3	31.1	0.72	0.70	40.5
North: Speed Street											
7	L2	1151	5.0	0.652	4.4	LOS A	0.0	0.0	0.00	0.46	46.3
8	T1	54	5.0	0.132	17.5	LOS B	1.1	8.0	0.84	0.63	35.7
Approach		1205	5.0	0.652	5.0	LOS A	1.1	8.0	0.04	0.47	45.7
West: Pirie Street											
10	L2	25	5.0	0.711	23.4	LOS B	9.4	68.6	0.95	0.88	23.9
11	T1	370	5.0	0.711	18.8	LOS B	9.4	68.6	0.95	0.88	35.7
12	R2	45	5.0	0.122	18.9	LOS B	0.8	6.1	0.76	0.71	35.1
Approach		440	5.0	0.711	19.1	LOS B	9.4	68.6	0.93	0.86	35.3
All Vehicles		2759	5.0	0.711	12.1	LOS A	9.4	68.6	0.49	0.65	40.3

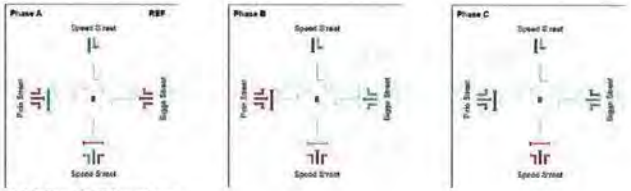
PM Peak Hour

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	62	5.0	0.692	39.2	LOS C	5.8	42.3	1.00	0.87	28.1
2	T1	100	5.0	0.692	34.6	LOS C	5.8	42.3	1.00	0.87	27.3
3	R2	114	5.0	0.799	45.0	LOS D	4.4	32.1	1.00	0.94	30.7
Approach		276	5.0	0.799	39.9	LOS C	5.8	42.3	1.00	0.90	29.2
East: Bigge Street											
4	L2	336	5.0	0.272	8.8	LOS A	4.2	30.8	0.40	0.66	44.2
5	T1	303	5.0	0.233	4.0	LOS A	3.7	26.8	0.38	0.33	46.1
6	R2	708	5.0	0.808	16.4	LOS B	15.6	113.7	0.73	0.84	35.6
Approach		1347	5.0	0.808	11.7	LOS A	15.6	113.7	0.57	0.68	40.3
North: Speed Street											
7	L2	863	5.0	0.489	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	119	5.0	0.498	32.4	LOS C	4.0	29.3	0.97	0.77	28.7
Approach		982	5.0	0.498	7.8	LOS A	4.0	29.3	0.12	0.50	43.2
West: Pirie Street											
10	L2	28	5.0	0.850	46.6	LOS D	5.3	39.0	1.00	1.03	14.8
11	T1	106	5.0	0.850	42.0	LOS C	5.3	39.0	1.00	1.03	26.4
12	R2	79	5.0	0.566	41.1	LOS C	2.9	20.9	1.00	0.79	26.4
Approach		213	5.0	0.850	42.3	LOS C	5.3	39.0	1.00	0.94	25.3
All Vehicles		2818	5.0	0.850	15.4	LOS B	15.6	113.7	0.49	0.66	38.0

APPENDIX J

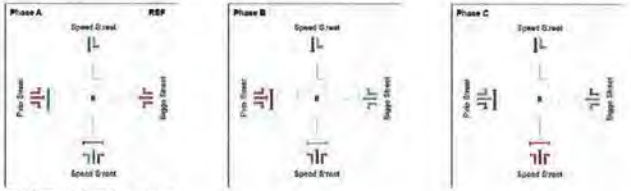
SIDRA Model Results - Speed Street / Bigge Street / Pirie Street intersection (With Development Traffic)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

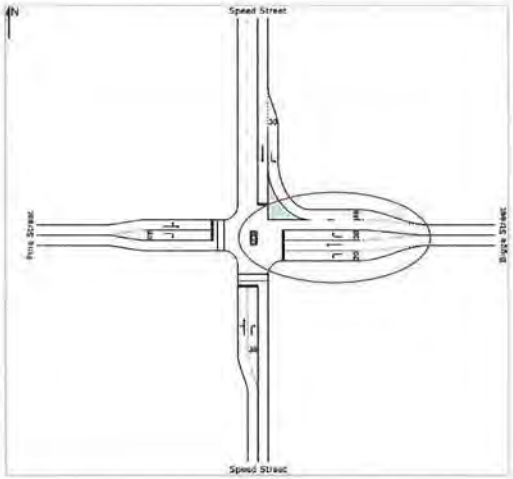
Signals - Fixed Time Isolated Cycle Time = 50 seconds (Optimum Cycle Time - Minimum Delay)

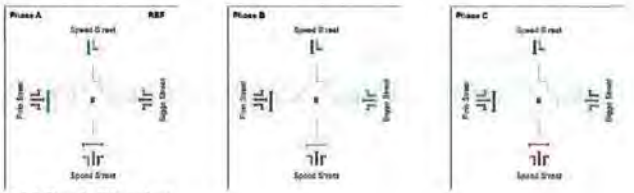
AM Peak Hour

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	92	5.0	0.457	21.3	LOS B	4.9	35.7	0.87	0.75	35.5
2	T1	141	5.0	0.457	16.7	LOS B	4.9	35.7	0.87	0.75	35.1
3	R2	317	5.0	0.777	27.6	LOS B	8.4	61.5	0.98	0.95	35.8
Approach		550	5.0	0.777	23.7	LOS B	8.4	61.5	0.94	0.87	35.6
East: Bigge Street											
4	L2	225	5.0	0.415	13.9	LOS A	5.8	42.2	0.69	0.70	42.5
5	T1	133	5.0	0.415	9.3	LOS A	5.8	42.2	0.69	0.70	39.9
6	R2	253	5.0	0.657	17.4	LOS B	4.3	31.4	0.97	0.84	35.1
Approach		611	5.0	0.657	14.3	LOS A	5.8	42.2	0.81	0.76	39.3
North: Speed Street											
7	L2	1038	5.0	0.588	4.4	LOS A	0.0	0.0	0.00	0.46	46.3
8	T1	57	5.0	0.109	14.8	LOS B	1.1	7.7	0.77	0.59	37.3
Approach		1095	5.0	0.588	5.0	LOS A	1.1	7.7	0.04	0.47	45.8
West: Pirie Street											
10	L2	21	5.0	0.731	26.2	LOS B	8.2	59.7	0.98	0.92	22.3
11	T1	304	5.0	0.731	21.6	LOS B	8.2	59.7	0.98	0.92	34.3
12	R2	56	5.0	0.175	21.8	LOS B	1.1	8.4	0.83	0.73	33.7
Approach		381	5.0	0.731	21.9	LOS B	8.2	59.7	0.95	0.89	33.8
All Vehicles		2637	5.0	0.777	13.5	LOS A	8.4	61.5	0.54	0.68	39.5

PM Peak Hour

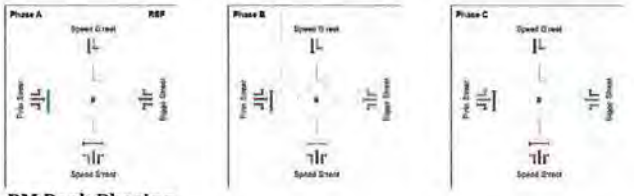
Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	63	5.0	0.714	30.9	LOS C	4.2	30.5	1.00	0.90	31.0
2	T1	93	5.0	0.714	26.3	LOS B	4.2	30.5	1.00	0.90	30.4
3	R2	141	5.0	0.963	47.7	LOS D	4.9	36.0	1.00	1.37	29.9
Approach		297	5.0	0.963	37.5	LOS C	4.9	36.0	1.00	1.12	30.2
East: Bigge Street											
4	L2	385	5.0	0.879	26.5	LOS B	16.1	117.5	0.60	0.93	37.1
5	T1	249	5.0	0.879	21.9	LOS B	16.1	117.5	0.60	0.93	33.0
6	R2	631	5.0	0.952	46.3	LOS D	22.5	163.9	0.85	1.25	23.9
Approach		1265	5.0	0.952	35.5	LOS C	22.5	163.9	0.72	1.09	29.8
North: Speed Street											
7	L2	766	5.0	0.434	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	133	5.0	0.596	24.8	LOS B	3.4	24.8	0.99	0.82	31.8
Approach		899	5.0	0.596	7.4	LOS A	3.4	24.8	0.15	0.52	43.5
West: Pirie Street											
10	L2	23	5.0	0.499	28.7	LOS C	2.7	20.0	0.98	0.76	20.7
11	T1	87	5.0	0.499	24.1	LOS B	2.7	20.0	0.98	0.76	32.8
12	R2	133	5.0	0.692	30.9	LOS C	3.6	26.0	1.00	0.89	29.8
Approach		243	5.0	0.692	28.3	LOS B	3.6	26.0	0.99	0.83	30.4
All Vehicles		2704	5.0	0.963	25.7	LOS B	22.5	163.9	0.59	0.88	33.0





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 50 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

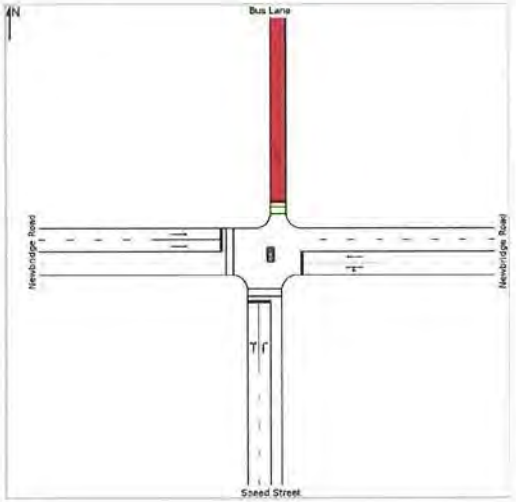
Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	102	5.0	0.518	21.6	LOS B	5.7	41.3	0.89	0.77	35.3
2	T1	162	5.0	0.518	17.0	LOS B	5.7	41.3	0.89	0.77	35.0
3	R2	345	5.0	0.921	42.5	LOS D	12.3	89.7	1.00	1.27	31.4
Approach		609	5.0	0.921	32.3	LOS C	12.3	89.7	0.95	1.05	32.5
East: Bigge Street											
4	L2	264	5.0	0.312	13.3	LOS A	4.0	29.3	0.65	0.73	41.9
5	T1	162	5.0	0.182	8.1	LOS A	2.3	16.6	0.60	0.49	42.8
6	R2	275	5.0	0.748	19.1	LOS B	5.0	36.4	1.00	0.90	34.1
Approach		701	5.0	0.748	14.4	LOS A	5.0	36.4	0.78	0.74	39.3
North: Speed Street											
7	L2	1151	5.0	0.652	4.4	LOS A	0.0	0.0	0.00	0.46	46.3
8	T1	61	5.0	0.117	14.8	LOS B	1.1	8.3	0.78	0.59	37.4
Approach		1212	5.0	0.652	5.0	LOS A	1.1	8.3	0.04	0.47	45.8
West: Pirie Street											
10	L2	25	5.0	0.888	35.4	LOS C	12.4	90.7	1.00	1.20	18.2
11	T1	370	5.0	0.888	30.8	LOS C	12.4	90.7	1.00	1.20	30.3
12	R2	62	5.0	0.200	21.9	LOS B	1.3	9.4	0.83	0.73	33.6
Approach		457	5.0	0.888	29.8	LOS C	12.4	90.7	0.98	1.13	30.3
All Vehicles		2979	5.0	0.921	16.6	LOS B	12.4	90.7	0.54	0.75	37.7

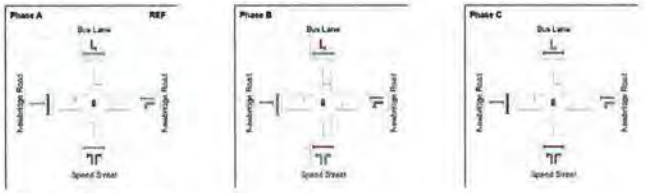
PM Peak Hour

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	73	5.0	0.603	31.3	LOS C	5.3	38.8	0.97	0.82	30.9
2	T1	110	5.0	0.603	26.7	LOS B	5.3	38.8	0.97	0.82	30.3
3	R2	156	5.0	0.843	40.4	LOS C	5.4	39.1	1.00	1.03	32.0
Approach		339	5.0	0.843	34.0	LOS C	5.4	39.1	0.99	0.92	31.3
East: Bigge Street											
4	L2	433	5.0	0.455	10.4	LOS A	6.2	45.1	0.52	0.71	43.4
5	T1	303	5.0	0.257	5.2	LOS A	3.9	28.3	0.47	0.40	45.1
6	R2	708	5.0	0.947	46.0	LOS D	28.2	206.0	0.88	1.17	24.0
Approach		1444	5.0	0.947	26.7	LOS B	28.2	206.0	0.69	0.87	33.0
North: Speed Street											
7	L2	863	5.0	0.489	4.4	LOS A	0.0	0.0	0.00	0.46	46.4
8	T1	143	5.0	0.461	25.6	LOS B	4.0	29.1	0.95	0.76	31.5
Approach		1006	5.0	0.489	7.4	LOS A	4.0	29.1	0.13	0.51	43.5
West: Pirie Street											
10	L2	28	5.0	0.729	37.0	LOS C	4.3	31.5	1.00	0.90	17.5
11	T1	106	5.0	0.729	32.3	LOS C	4.3	31.5	1.00	0.90	29.5
12	R2	140	5.0	0.884	44.0	LOS D	5.1	37.3	1.00	1.12	25.6
Approach		274	5.0	0.884	38.8	LOS C	5.1	37.3	1.00	1.01	26.6
All Vehicles		3063	5.0	0.947	22.3	LOS B	28.2	206.0	0.57	0.77	34.5

APPENDIX K

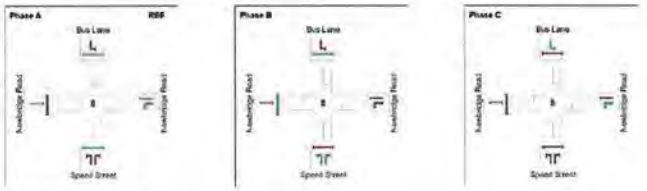
SIDRA Model Results - Newbridge Road / Speed Street intersection
(Background Traffic only, Existing Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 70 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 110 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

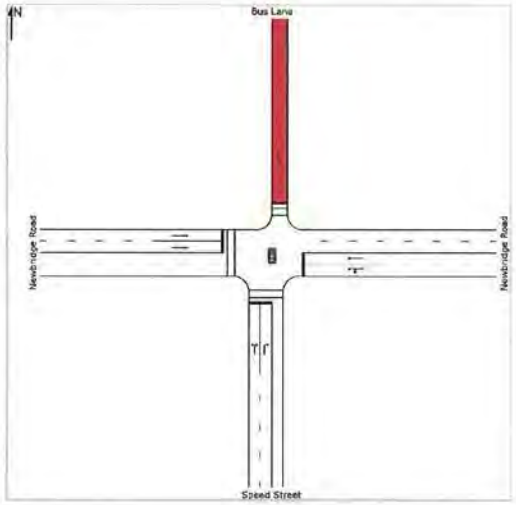
Movement Performance - Vehicles

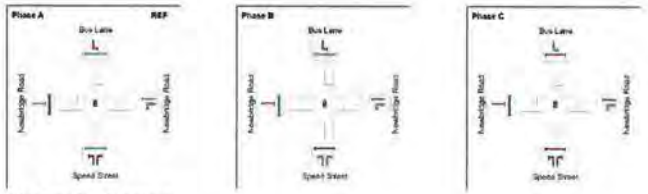
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	16	5.0	0.825	44.0	LOS D	6.6	47.9	1.00	0.99	17.4
3	R2	322	5.0	0.825	44.0	LOS D	6.6	47.9	1.00	0.99	26.0
Approach		338	5.0	0.825	44.0	LOS D	6.6	47.9	1.00	0.99	25.6
East: Newbridge Road											
4	L2	866	5.0	0.728	20.8	LOS B	28.1	205.0	0.95	0.90	37.2
5	T1	814	5.0	0.728	13.3	LOS A	28.1	205.0	0.83	0.75	45.8
Approach		1680	5.0	0.728	17.1	LOS B	28.1	205.0	0.89	0.83	41.3
North: Bus Lane											
7	L2	14	100.0	0.142	40.1	LOS C	0.5	6.3	0.95	0.69	27.6
Approach		14	100.0	0.142	40.1	LOS C	0.5	6.3	0.95	0.69	27.6
West: Newbridge Road											
11	T1	1162	5.0	0.567	11.4	LOS A	13.1	95.9	0.71	0.63	47.6
Approach		1162	5.0	0.567	11.4	LOS A	13.1	95.9	0.71	0.63	47.6
All Vehicles		3194	5.4	0.825	18.0	LOS B	28.1	205.0	0.84	0.77	41.1

PM Peak Hour

Movement Performance - Vehicles

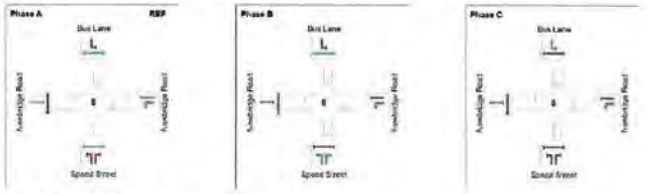
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	25	5.0	0.855	59.3	LOS E	18.1	131.9	1.00	0.96	14.2
3	R2	588	5.0	0.855	59.3	LOS E	18.1	131.9	1.00	0.96	21.9
Approach		613	5.0	0.855	59.3	LOS E	18.1	131.9	1.00	0.96	21.7
East: Newbridge Road											
4	L2	691	5.0	0.852	28.8	LOS C	40.3	294.5	0.84	0.88	33.1
5	T1	1144	5.0	0.852	23.8	LOS B	44.2	322.8	0.89	0.87	38.5
Approach		1835	5.0	0.852	25.7	LOS B	44.2	322.8	0.87	0.87	36.5
North: Bus Lane											
7	L2	25	100.0	0.398	65.1	LOS E	1.4	18.7	1.00	0.72	21.1
Approach		25	100.0	0.398	65.1	LOS E	1.4	18.7	1.00	0.72	21.1
West: Newbridge Road											
11	T1	1035	5.0	0.471	14.1	LOS A	15.8	115.1	0.62	0.55	45.5
Approach		1035	5.0	0.471	14.1	LOS A	15.8	115.1	0.62	0.55	45.5
All Vehicles		3508	5.7	0.855	28.4	LOS B	44.2	322.8	0.82	0.79	34.9





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

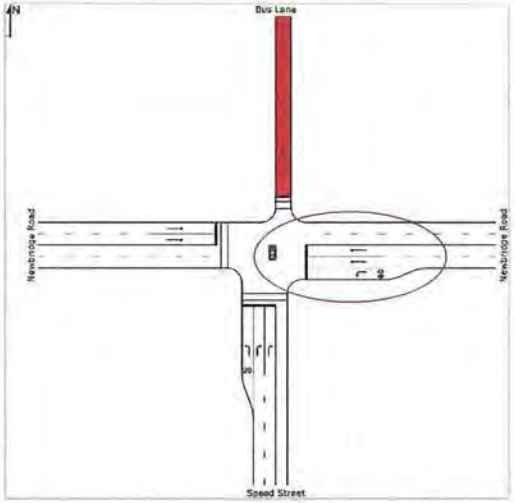
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	21	5.0	0.867	60.7	LOS E	11.2	81.9	1.00	1.00	13.9
3	R2	383	5.0	0.867	60.7	LOS E	11.2	81.9	1.00	1.00	21.6
Approach		404	5.0	0.867	60.7	LOS E	11.2	81.9	1.00	1.00	21.3
East: Newbridge Road											
4	L2	1114	5.0	0.818	8.9	LOS A	22.0	160.7	0.61	0.78	46.4
5	T1	1047	5.0	0.818	15.0	LOS B	36.7	267.6	0.81	0.78	44.5
Approach		2161	5.0	0.818	11.8	LOS A	36.7	267.6	0.71	0.78	45.3
North: Bus Lane											
7	L2	17	100.0	0.246	58.3	LOS E	0.9	11.4	0.98	0.71	22.5
Approach		17	100.0	0.246	58.3	LOS E	0.9	11.4	0.98	0.71	22.5
West: Newbridge Road											
11	T1	1383	5.0	0.581	11.5	LOS A	19.4	142.0	0.63	0.57	47.6
Approach		1383	5.0	0.581	11.5	LOS A	19.4	142.0	0.63	0.57	47.6
All Vehicles		3965	5.4	0.867	16.9	LOS B	36.7	267.6	0.71	0.73	41.8

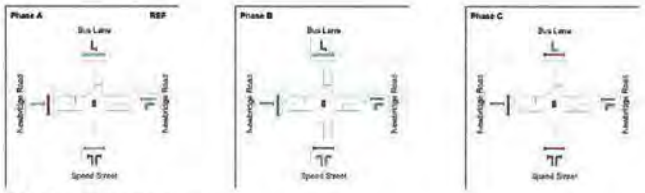
PM Peak Hour

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	31	5.0	0.980	118.5	LOS F	40.1	293.0	1.00	1.14	8.2
3	R2	742	5.0	0.980	118.5	LOS F	40.1	293.0	1.00	1.13	13.7
Approach		773	5.0	0.980	118.5	LOS F	40.1	293.0	1.00	1.13	13.5
East: Newbridge Road											
4	L2	867	5.0	0.972	67.9	LOS E	106.0	773.8	1.00	1.07	20.8
5	T1	1435	5.0	0.972	66.6	LOS E	108.7	793.7	1.00	1.13	23.7
Approach		2302	5.0	0.972	67.1	LOS E	108.7	793.7	1.00	1.11	22.6
North: Bus Lane											
7	L2	32	100.0	0.695	91.9	LOS F	2.6	34.0	1.00	0.85	16.8
Approach		32	100.0	0.695	91.9	LOS F	2.6	34.0	1.00	0.85	16.8
West: Newbridge Road											
11	T1	1306	5.0	0.558	17.4	LOS B	27.1	198.0	0.63	0.57	43.0
Approach		1306	5.0	0.558	17.4	LOS B	27.1	198.0	0.63	0.57	43.0
All Vehicles		4413	5.7	0.980	61.6	LOS E	108.7	793.7	0.89	0.95	23.7

APPENDIX L

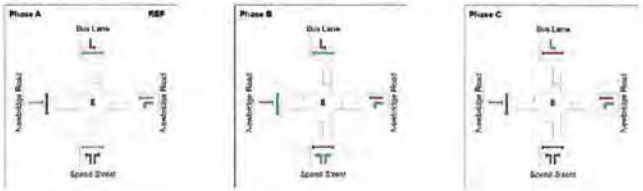
SIDRA Model Results - Newbridge Road / Speed Street intersection
(Background Traffic only, Upgraded Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 90 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

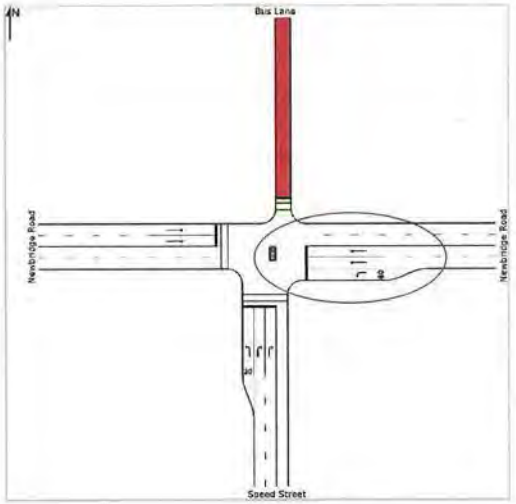
Movement Performance - Vehicles

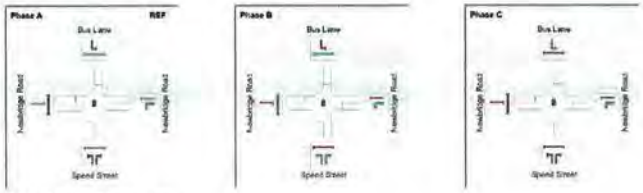
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	21	5.0	0.070	28.1	LOS B	0.5	3.9	0.87	0.69	22.9
3	R2	383	5.0	0.643	31.9	LOS C	5.7	41.5	0.98	0.85	30.6
Approach		404	5.0	0.643	31.7	LOS C	5.7	41.5	0.98	0.84	30.3
East: Newbridge Road											
4	L2	1114	5.0	0.777	8.3	LOS A	9.9	72.0	0.57	0.78	46.8
5	T1	1047	5.0	0.640	14.6	LOS B	12.2	89.3	0.84	0.74	45.1
Approach		2161	5.0	0.777	11.3	LOS A	12.2	89.3	0.70	0.76	45.9
North: Bus Lane											
7	L2	17	100.0	0.148	34.3	LOS C	0.5	6.5	0.94	0.70	29.8
Approach		17	100.0	0.148	34.3	LOS C	0.5	6.5	0.94	0.70	29.8
West: Newbridge Road											
11	T1	1383	5.0	0.845	23.4	LOS B	22.1	161.5	0.96	1.01	39.2
Approach		1383	5.0	0.845	23.4	LOS B	22.1	161.5	0.96	1.01	39.2
All Vehicles		3965	5.4	0.845	17.7	LOS B	22.1	161.5	0.82	0.85	41.3

PM Peak Hour

Movement Performance - Vehicles

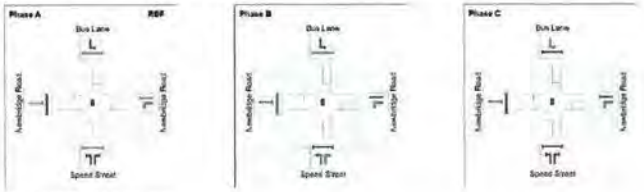
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	31	5.0	0.074	33.7	LOS C	1.1	7.8	0.81	0.70	20.6
3	R2	742	5.0	0.912	58.2	LOS E	21.1	153.7	1.00	1.09	22.3
Approach		773	5.0	0.912	57.3	LOS E	21.1	153.7	0.99	1.07	22.3
East: Newbridge Road											
4	L2	867	5.0	0.558	6.4	LOS A	5.0	36.4	0.28	0.66	48.4
5	T1	1435	5.0	0.916	41.5	LOS C	46.7	341.1	0.91	1.07	31.0
Approach		2302	5.0	0.916	28.3	LOS B	46.7	341.1	0.67	0.92	35.2
North: Bus Lane											
7	L2	32	100.0	0.417	53.4	LOS D	1.5	19.6	1.00	0.73	23.7
Approach		32	100.0	0.417	53.4	LOS D	1.5	19.6	1.00	0.73	23.7
West: Newbridge Road											
11	T1	1306	5.0	0.692	18.5	LOS B	21.9	159.6	0.82	0.74	42.3
Approach		1306	5.0	0.692	18.5	LOS B	21.9	159.6	0.82	0.74	42.3
All Vehicles		4413	5.7	0.916	30.6	LOS C	46.7	341.1	0.77	0.89	33.9





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

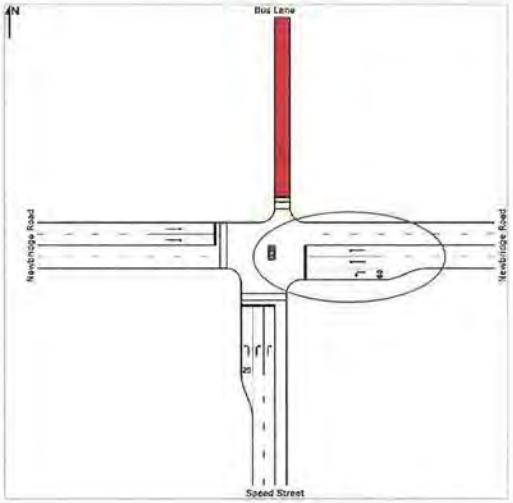
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	23	5.0	0.044	31.9	LOS C	0.8	5.8	0.75	0.68	21.3
3	R2	415	5.0	0.408	35.5	LOS C	8.4	61.3	0.85	0.79	29.1
Approach		438	5.0	0.408	35.3	LOS C	8.4	61.3	0.85	0.78	28.8
East: Newbridge Road											
4	L2	1235	5.0	0.783	6.9	LOS A	11.7	85.5	0.42	0.71	47.8
5	T1	1161	5.0	0.654	21.7	LOS B	21.6	157.5	0.82	0.74	40.2
Approach		2396	5.0	0.783	14.1	LOS A	21.6	157.5	0.62	0.72	43.4
North: Bus Lane											
7	L2	18	100.0	0.260	58.4	LOS E	0.9	12.1	0.99	0.71	22.5
Approach		18	100.0	0.260	58.4	LOS E	0.9	12.1	0.99	0.71	22.5
West: Newbridge Road											
11	T1	1499	5.0	0.844	30.2	LOS C	35.4	258.6	0.95	0.93	35.6
Approach		1499	5.0	0.844	30.2	LOS C	35.4	258.6	0.95	0.93	35.6
All Vehicles		4351	5.4	0.844	22.0	LOS B	35.4	258.6	0.75	0.80	38.5

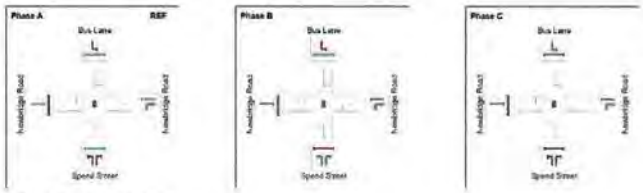
PM Peak Hour

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	35	5.0	0.079	50.7	LOS D	1.9	14.2	0.80	0.71	15.9
3	R2	832	5.0	0.974	112.2	LOS F	43.9	320.2	1.00	1.13	14.4
Approach		867	5.0	0.974	109.7	LOS F	43.9	320.2	0.99	1.12	14.4
East: Newbridge Road											
4	L2	976	5.0	0.592	6.2	LOS A	6.3	45.8	0.19	0.63	48.8
5	T1	1615	5.0	0.997	103.4	LOS F	123.9	904.7	0.88	1.21	18.0
Approach		2591	5.0	0.997	66.8	LOS E	123.9	904.7	0.62	0.99	22.7
North: Bus Lane											
7	L2	35	100.0	0.760	93.4	LOS F	2.9	37.7	1.00	0.90	16.6
Approach		35	100.0	0.760	93.4	LOS F	2.9	37.7	1.00	0.90	16.6
West: Newbridge Road											
11	T1	1465	5.0	0.654	21.3	LOS B	34.9	254.4	0.72	0.66	40.5
Approach		1465	5.0	0.654	21.3	LOS B	34.9	254.4	0.72	0.66	40.5
All Vehicles		4958	5.7	0.997	61.0	LOS E	123.9	904.7	0.72	0.92	23.9

APPENDIX M

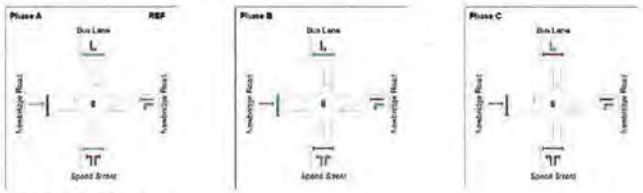
SIDRA Model Results - Newbridge Road / Speed Street intersection
(With Development Traffic, Upgraded Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 60 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

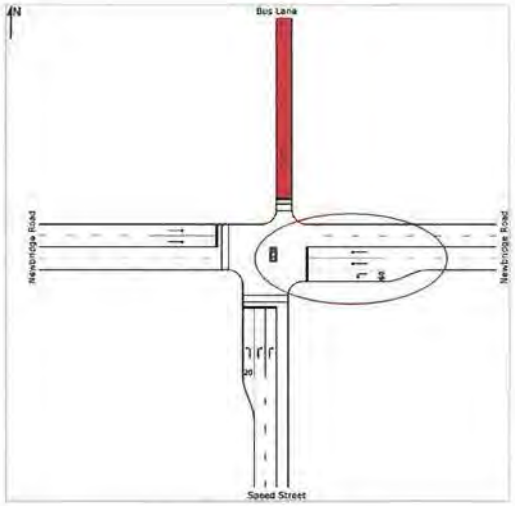
Movement Performance - Vehicles

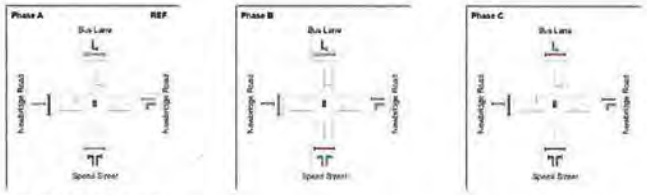
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	21	5.0	0.070	28.1	LOS B	0.5	3.9	0.87	0.69	22.9
3	R2	414	5.0	0.698	32.8	LOS C	6.3	46.3	0.99	0.88	30.2
Approach		435	5.0	0.698	32.6	LOS C	6.3	46.3	0.99	0.87	29.9
East: Newbridge Road											
4	L2	1122	5.0	0.782	8.6	LOS A	10.3	75.3	0.58	0.78	46.5
5	T1	1047	5.0	0.640	14.6	LOS B	12.2	89.3	0.84	0.74	45.1
Approach		2169	5.0	0.782	11.5	LOS A	12.2	89.3	0.70	0.76	45.8
North: Bus Lane											
7	L2	17	100.0	0.148	34.3	LOS C	0.5	6.5	0.94	0.70	29.8
Approach		17	100.0	0.148	34.3	LOS C	0.5	6.5	0.94	0.70	29.8
West: Newbridge Road											
11	T1	1383	5.0	0.845	23.4	LOS B	22.1	161.5	0.96	1.01	39.2
Approach		1383	5.0	0.845	23.4	LOS B	22.1	161.5	0.96	1.01	39.2
All Vehicles		4004	5.4	0.845	18.0	LOS B	22.1	161.5	0.82	0.86	41.1

PM Peak Hour

Movement Performance - Vehicles

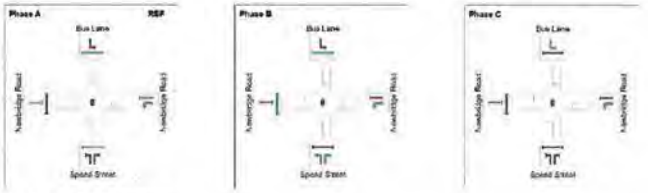
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	31	5.0	0.072	36.3	LOS C	1.2	8.5	0.80	0.70	19.7
3	R2	754	5.0	0.902	59.9	LOS E	22.8	166.6	1.00	1.05	22.0
Approach		785	5.0	0.902	59.0	LOS E	22.8	166.6	0.99	1.03	21.9
East: Newbridge Road											
4	L2	894	5.0	0.567	6.4	LOS A	5.3	38.5	0.26	0.66	48.5
5	T1	1435	5.0	0.897	36.6	LOS C	47.2	344.6	0.88	0.97	32.8
Approach		2329	5.0	0.897	25.0	LOS B	47.2	344.6	0.64	0.85	36.9
North: Bus Lane											
7	L2	32	100.0	0.463	59.6	LOS E	1.7	21.9	1.00	0.74	22.2
Approach		32	100.0	0.463	59.6	LOS E	1.7	21.9	1.00	0.74	22.2
West: Newbridge Road											
11	T1	1306	5.0	0.665	18.8	LOS B	23.2	169.5	0.79	0.71	42.1
Approach		1306	5.0	0.665	18.8	LOS B	23.2	169.5	0.79	0.71	42.1
All Vehicles		4452	5.7	0.902	29.4	LOS C	47.2	344.6	0.75	0.84	34.5





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	23	5.0	0.044	31.9	LOS C	0.8	5.8	0.75	0.68	21.3
3	R2	443	5.0	0.436	35.8	LOS C	9.1	66.1	0.86	0.79	29.0
Approach		466	5.0	0.436	35.6	LOS C	9.1	66.1	0.85	0.79	28.7
East: Newbridge Road											
4	L2	1242	5.0	0.787	6.9	LOS A	11.9	87.1	0.42	0.71	47.8
5	T1	1161	5.0	0.654	21.7	LOS B	21.6	157.5	0.82	0.74	40.2
Approach		2403	5.0	0.787	14.0	LOS A	21.6	157.5	0.62	0.72	43.4
North: Bus Lane											
7	L2	18	100.0	0.260	58.4	LOS E	0.9	12.1	0.99	0.71	22.5
Approach		18	100.0	0.260	58.4	LOS E	0.9	12.1	0.99	0.71	22.5
West: Newbridge Road											
11	T1	1499	5.0	0.844	30.2	LOS C	35.4	258.6	0.95	0.93	35.6
Approach		1499	5.0	0.844	30.2	LOS C	35.4	258.6	0.95	0.93	35.6
All Vehicles		4386	5.4	0.844	22.1	LOS B	35.4	258.6	0.76	0.80	38.4

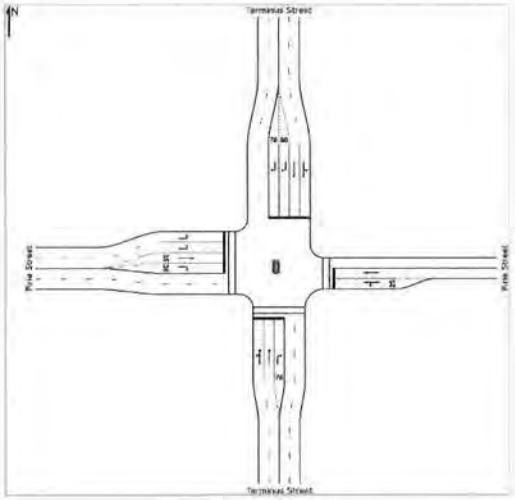
PM Peak Hour

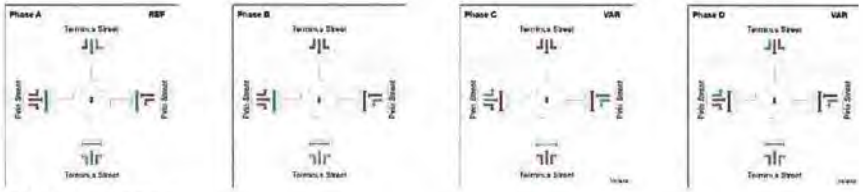
Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Speed Street											
1	L2	35	5.0	0.079	50.7	LOS D	1.9	14.2	0.80	0.71	15.9
3	R2	843	5.0	0.986	122.8	LOS F	46.7	340.8	1.00	1.17	13.5
Approach		878	5.0	0.986	119.9	LOS F	46.7	340.8	0.99	1.15	13.5
East: Newbridge Road											
4	L2	1000	5.0	0.606	6.2	LOS A	6.6	48.3	0.20	0.64	48.8
5	T1	1615	5.0	1.002	125.9	LOS F	127.7	932.0	1.00	1.35	15.6
Approach		2615	5.0	1.002	80.1	LOS F	127.7	932.0	0.69	1.08	20.2
North: Bus Lane											
7	L2	35	100.0	0.760	93.4	LOS F	2.9	37.7	1.00	0.90	16.6
Approach		35	100.0	0.760	93.4	LOS F	2.9	37.7	1.00	0.90	16.6
West: Newbridge Road											
11	T1	1465	5.0	0.654	21.3	LOS B	34.9	254.4	0.72	0.66	40.5
Approach		1465	5.0	0.654	21.3	LOS B	34.9	254.4	0.72	0.66	40.5
All Vehicles		4993	5.7	1.002	70.0	LOS E	127.7	932.0	0.76	0.97	22.0

APPENDIX N

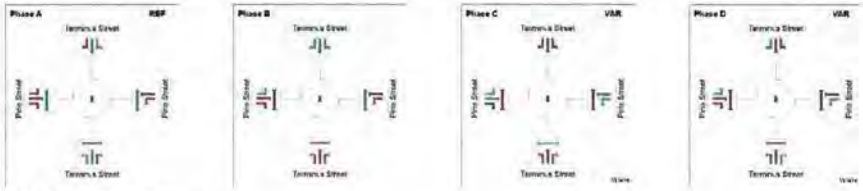
SIDRA Model Results - Terminus Street / Pirie Street intersection
(Background Traffic only, Existing Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

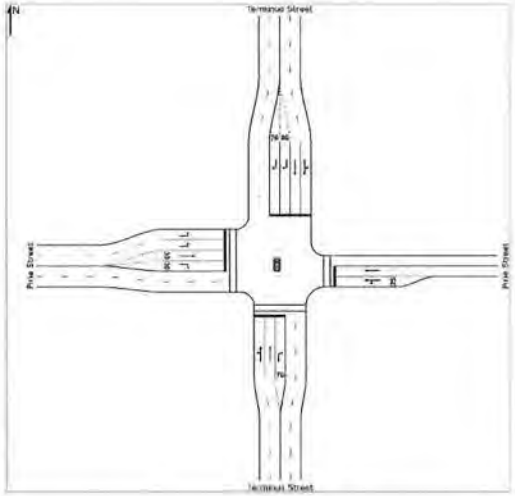
Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

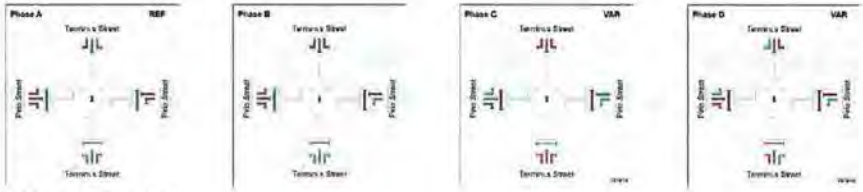
AM Peak Hour

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	12	5.0	0.608	26.0	LOS B	19.6	143.2	0.79	0.71	29.6
2	T1	1007	5.0	0.608	19.9	LOS B	19.6	143.2	0.77	0.68	41.5
3	R2	201	5.0	0.295	18.0	LOS B	4.2	30.8	0.74	0.76	39.9
Approach		1220	5.0	0.608	19.6	LOS B	19.6	143.2	0.76	0.69	41.1
East: Pirie Street											
4	L2	100	5.0	0.273	36.8	LOS C	5.0	36.5	0.83	0.75	31.0
5	T1	96	5.0	0.273	39.8	LOS C	5.0	36.5	0.91	0.73	15.6
Approach		196	5.0	0.273	38.3	LOS C	5.0	36.5	0.87	0.74	24.7
North: Terminus Street											
7	L2	47	5.0	0.423	39.8	LOS C	8.2	59.6	0.89	0.75	23.0
8	T1	350	5.0	0.423	34.2	LOS C	8.3	60.3	0.89	0.74	33.7
9	R2	408	5.0	0.542	44.4	LOS D	9.1	66.2	0.94	0.81	17.1
Approach		805	5.0	0.542	39.7	LOS C	9.1	66.2	0.92	0.78	25.4
West: Pirie Street											
10	L2	365	5.0	0.254	26.2	LOS B	5.9	43.2	0.71	0.75	23.5
11	T1	42	5.0	0.171	42.8	LOS D	1.9	13.7	0.93	0.69	15.3
12	R2	2	5.0	0.012	49.2	LOS D	0.1	0.7	0.92	0.61	24.6
Approach		409	5.0	0.254	28.0	LOS B	5.9	43.2	0.73	0.75	22.5
All Vehicles		2630	5.0	0.608	28.5	LOS B	19.6	143.2	0.81	0.73	32.3

PM Peak Hour

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	21	5.0	0.450	33.3	LOS C	11.0	80.1	0.83	0.71	26.8
2	T1	556	5.0	0.450	27.7	LOS B	11.0	80.4	0.83	0.71	36.9
3	R2	68	5.0	0.379	53.1	LOS D	3.3	23.8	0.98	0.76	25.2
Approach		645	5.0	0.450	30.6	LOS C	11.0	80.4	0.84	0.72	35.0
East: Pirie Street											
4	L2	166	5.0	0.336	35.7	LOS C	6.4	46.7	0.83	0.78	30.9
5	T1	83	5.0	0.336	43.9	LOS D	6.4	46.7	0.95	0.74	14.9
Approach		249	5.0	0.336	38.4	LOS C	6.4	46.7	0.87	0.77	26.5
North: Terminus Street											
7	L2	18	5.0	0.271	16.2	LOS B	7.0	51.4	0.52	0.47	38.6
8	T1	584	5.0	0.271	10.6	LOS A	7.1	51.6	0.52	0.46	48.3
9	R2	470	5.0	0.452	23.2	LOS B	6.2	45.5	0.86	0.79	25.3
Approach		1072	5.0	0.452	16.2	LOS B	7.1	51.6	0.67	0.60	39.3
West: Pirie Street											
10	L2	669	5.0	0.361	18.6	LOS B	9.7	70.5	0.61	0.75	28.0
11	T1	84	5.0	0.342	44.1	LOS D	3.9	28.1	0.95	0.74	14.9
12	R2	26	5.0	0.245	56.4	LOS D	1.3	9.5	0.99	0.71	22.7
Approach		779	5.0	0.361	22.6	LOS B	9.7	70.5	0.66	0.75	25.7
All Vehicles		2745	5.0	0.452	23.4	LOS B	11.0	80.4	0.73	0.69	33.5





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

PM Peak Phasing

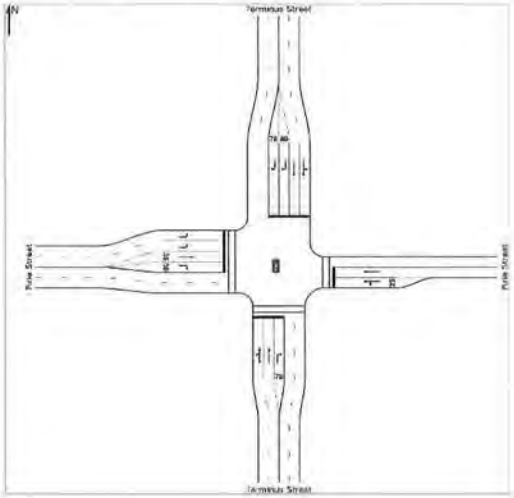
Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

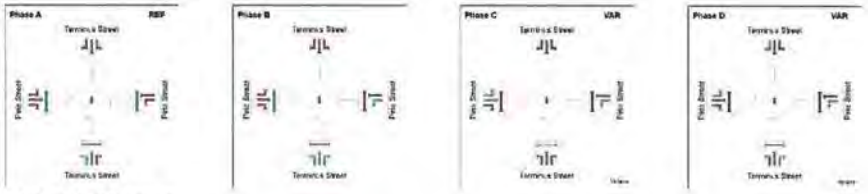
AM Peak Hour

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	15	5.0	0.730	27.3	LOS B	26.0	189.9	0.86	0.78	29.1
2	T1	1198	5.0	0.730	20.7	LOS B	26.0	189.9	0.82	0.73	40.9
3	R2	245	5.0	0.380	19.4	LOS B	5.6	40.9	0.78	0.78	39.0
Approach		1458	5.0	0.730	20.5	LOS B	26.0	189.9	0.81	0.74	40.5
East: Pirie Street											
4	L2	129	5.0	0.314	37.7	LOS C	6.7	49.2	0.85	0.77	30.7
5	T1	117	5.0	0.314	39.8	LOS C	6.7	49.2	0.92	0.74	15.6
Approach		246	5.0	0.314	38.7	LOS C	6.7	49.2	0.88	0.76	24.7
North: Terminus Street											
7	L2	57	5.0	0.500	39.1	LOS C	10.5	76.5	0.90	0.77	23.3
8	T1	450	5.0	0.500	33.5	LOS C	10.6	77.4	0.90	0.76	34.0
9	R2	525	5.0	0.732	48.7	LOS D	12.7	92.7	0.99	0.87	16.1
Approach		1032	5.0	0.732	41.5	LOS C	12.7	92.7	0.95	0.82	24.8
West: Pirie Street											
10	L2	434	5.0	0.310	27.5	LOS B	7.3	53.5	0.74	0.77	22.8
11	T1	51	5.0	0.208	43.0	LOS D	2.3	16.7	0.93	0.70	15.2
12	R2	3	5.0	0.020	50.6	LOS D	0.1	1.0	0.93	0.63	24.2
Approach		488	5.0	0.310	29.2	LOS C	7.3	53.5	0.76	0.76	21.9
All Vehicles		3224	5.0	0.732	30.0	LOS C	26.0	189.9	0.85	0.77	31.5

PM Peak Hour

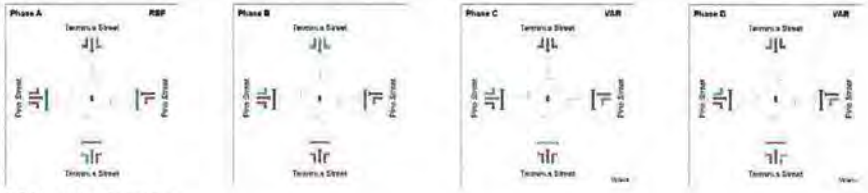
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	26	5.0	0.568	34.8	LOS C	14.6	106.3	0.87	0.76	26.3
2	T1	702	5.0	0.568	29.2	LOS C	14.6	106.6	0.87	0.76	36.2
3	R2	83	5.0	0.463	53.7	LOS D	4.0	29.3	0.99	0.77	25.0
Approach		811	5.0	0.568	31.8	LOS C	14.6	106.6	0.88	0.76	34.4
East: Pirie Street											
4	L2	208	5.0	0.466	36.5	LOS C	8.2	60.0	0.85	0.79	30.6
5	T1	101	5.0	0.411	44.6	LOS D	4.7	34.2	0.96	0.76	14.8
Approach		309	5.0	0.466	39.2	LOS C	8.2	60.0	0.89	0.78	26.3
North: Terminus Street											
7	L2	22	5.0	0.339	16.7	LOS B	9.3	67.7	0.55	0.50	38.1
8	T1	732	5.0	0.339	11.1	LOS A	9.3	68.0	0.55	0.49	47.9
9	R2	589	5.0	0.566	24.0	LOS B	8.1	59.5	0.90	0.81	24.9
Approach		1343	5.0	0.566	16.9	LOS B	9.3	68.0	0.70	0.63	38.8
West: Pirie Street											
10	L2	844	5.0	0.475	19.5	LOS B	13.8	100.5	0.65	0.77	27.3
11	T1	102	5.0	0.415	44.6	LOS D	4.7	34.6	0.96	0.76	14.8
12	R2	33	5.0	0.390	59.6	LOS E	1.7	12.5	1.00	0.71	21.9
Approach		979	5.0	0.475	23.5	LOS B	13.8	100.5	0.69	0.77	25.2
All Vehicles		3442	5.0	0.568	24.3	LOS B	14.6	106.6	0.76	0.71	33.0





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

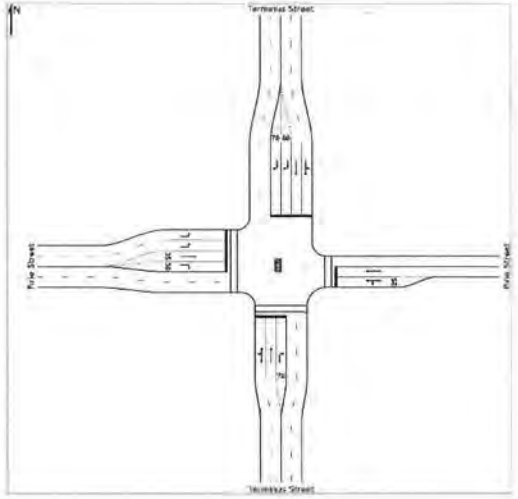
Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	18	5.0	0.801	30.2	LOS C	31.3	228.7	0.91	0.85	28.0
2	T1	1299	5.0	0.801	24.2	LOS B	31.3	228.7	0.86	0.81	38.8
3	R2	299	5.0	0.451	19.4	LOS B	6.9	50.3	0.80	0.79	39.0
Approach		1616	5.0	0.801	23.4	LOS B	31.3	228.7	0.85	0.80	38.7
East: Pirie Street											
4	L2	143	5.0	0.418	38.1	LOS C	7.4	54.1	0.87	0.78	30.5
5	T1	143	5.0	0.418	41.2	LOS C	7.4	54.1	0.94	0.76	15.3
Approach		286	5.0	0.418	39.7	LOS C	7.4	54.1	0.90	0.77	24.1
North: Terminus Street											
7	L2	70	5.0	0.583	40.8	LOS C	12.2	88.9	0.93	0.80	22.7
8	T1	499	5.0	0.583	35.2	LOS C	12.3	90.1	0.93	0.79	33.3
9	R2	582	5.0	0.811	52.6	LOS D	15.0	109.5	1.00	0.93	15.2
Approach		1151	5.0	0.811	44.3	LOS D	15.0	109.5	0.96	0.86	23.9
West: Pirie Street											
10	L2	471	5.0	0.337	27.7	LOS B	8.1	58.8	0.75	0.77	22.7
11	T1	62	5.0	0.253	43.4	LOS D	2.8	20.5	0.94	0.71	15.1
12	R2	3	5.0	0.022	51.8	LOS D	0.1	1.0	0.94	0.63	23.9
Approach		536	5.0	0.337	29.7	LOS C	8.1	58.8	0.77	0.77	21.7
All Vehicles		3589	5.0	0.811	32.3	LOS C	31.3	228.7	0.88	0.81	30.3

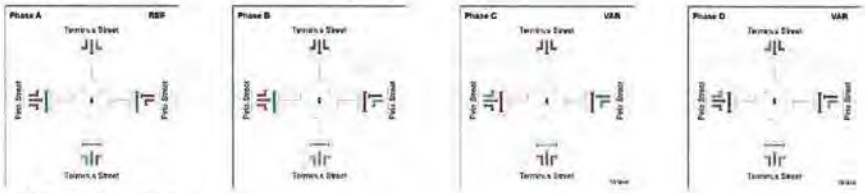
PM Peak Hour

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	31	5.0	0.639	35.7	LOS C	16.9	123.3	0.90	0.79	26.0
2	T1	787	5.0	0.639	30.1	LOS C	16.9	123.4	0.90	0.79	35.7
3	R2	101	5.0	0.563	54.3	LOS D	5.0	36.2	1.00	0.79	24.9
Approach		919	5.0	0.639	32.9	LOS C	16.9	123.4	0.91	0.79	33.9
East: Pirie Street											
4	L2	234	5.0	0.552	37.1	LOS C	9.4	68.7	0.87	0.80	30.4
5	T1	123	5.0	0.501	45.2	LOS D	5.8	42.3	0.98	0.78	14.6
Approach		357	5.0	0.552	39.9	LOS C	9.4	68.7	0.90	0.79	25.9
North: Terminus Street											
7	L2	27	5.0	0.383	17.1	LOS B	10.8	79.2	0.57	0.52	37.6
8	T1	825	5.0	0.383	11.5	LOS A	10.9	79.4	0.57	0.51	47.5
9	R2	664	5.0	0.638	24.5	LOS B	9.4	68.8	0.92	0.82	24.6
Approach		1516	5.0	0.638	17.3	LOS B	10.9	79.4	0.72	0.65	38.5
West: Pirie Street											
10	L2	947	5.0	0.537	20.2	LOS B	16.3	119.1	0.67	0.78	26.9
11	T1	125	5.0	0.509	45.3	LOS D	5.9	43.0	0.98	0.78	14.6
12	R2	37	5.0	0.516	61.6	LOS E	2.0	14.3	1.00	0.72	21.5
Approach		1109	5.0	0.537	24.4	LOS B	16.3	119.1	0.72	0.78	24.7
All Vehicles		3901	5.0	0.639	25.1	LOS B	16.9	123.4	0.78	0.73	32.5

APPENDIX O

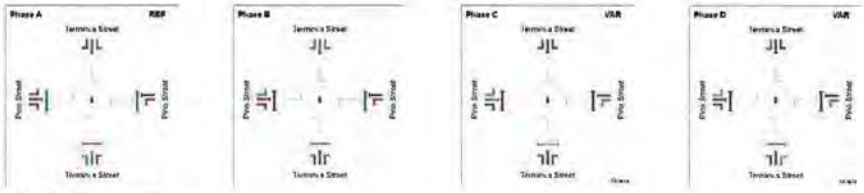
SIDRA Model Results - Terminus Street / Pirie Street intersection
(With Development Traffic, Existing Intersection Configuration)





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

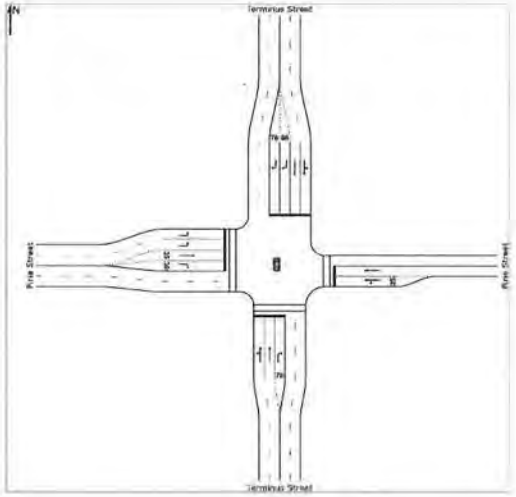
Movement Performance - Vehicles

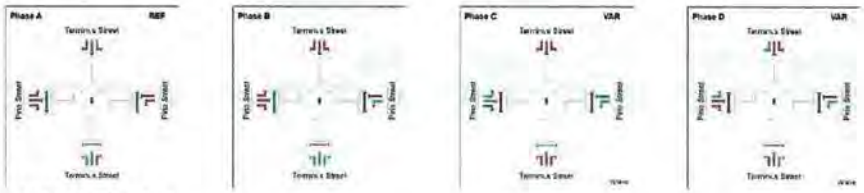
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	15	5.0	0.738	27.4	LOS B	26.4	193.0	0.86	0.78	29.1
2	T1	1198	5.0	0.738	20.9	LOS B	26.4	193.0	0.82	0.74	40.8
3	R2	276	5.0	0.416	19.2	LOS B	6.3	45.7	0.79	0.78	39.2
Approach		1489	5.0	0.738	20.6	LOS B	26.4	193.0	0.81	0.75	40.4
East: Pirie Street											
4	L2	129	5.0	0.520	41.7	LOS C	7.7	56.3	0.91	0.78	29.3
5	T1	180	5.0	0.520	42.7	LOS D	7.7	56.3	0.96	0.78	14.9
Approach		309	5.0	0.520	42.3	LOS C	7.7	56.3	0.94	0.78	22.1
North: Terminus Street											
7	L2	57	5.0	0.519	40.1	LOS C	10.6	77.7	0.91	0.78	23.0
8	T1	450	5.0	0.519	34.5	LOS C	10.8	78.6	0.91	0.77	33.6
9	R2	525	5.0	0.732	48.7	LOS D	12.7	92.7	0.99	0.87	16.1
Approach		1032	5.0	0.732	42.0	LOS C	12.7	92.7	0.95	0.82	24.7
West: Pirie Street											
10	L2	434	5.0	0.310	27.5	LOS B	7.3	53.5	0.74	0.77	22.8
11	T1	59	5.0	0.240	43.3	LOS D	2.7	19.4	0.94	0.71	15.1
12	R2	3	5.0	0.025	53.1	LOS D	0.1	1.0	0.95	0.63	23.5
Approach		496	5.0	0.310	29.5	LOS C	7.3	53.5	0.76	0.76	21.8
All Vehicles		3326	5.0	0.738	30.6	LOS C	26.4	193.0	0.86	0.78	31.1

PM Peak Hour

Movement Performance - Vehicles

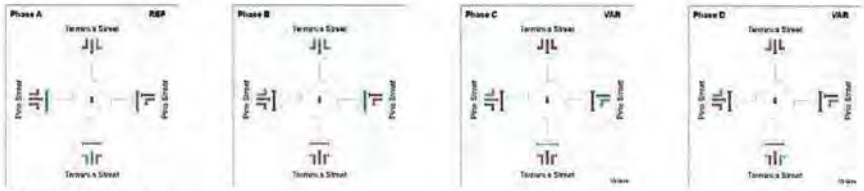
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	26	5.0	0.644	38.6	LOS C	15.5	113.2	0.93	0.80	25.2
2	T1	702	5.0	0.644	33.0	LOS C	15.6	113.7	0.93	0.80	34.4
3	R2	193	5.0	0.633	48.6	LOS D	9.1	66.2	0.98	0.82	26.4
Approach		921	5.0	0.644	36.4	LOS C	15.6	113.7	0.94	0.80	32.3
East: Pirie Street											
4	L2	208	5.0	0.423	38.9	LOS C	9.5	69.1	0.89	0.80	29.9
5	T1	125	5.0	0.423	42.7	LOS D	9.5	69.1	0.95	0.77	15.0
Approach		333	5.0	0.423	40.3	LOS C	9.5	69.1	0.91	0.79	25.4
North: Terminus Street											
7	L2	22	5.0	0.384	20.9	LOS B	10.9	79.6	0.64	0.57	34.2
8	T1	732	5.0	0.384	15.3	LOS B	10.9	79.9	0.64	0.57	44.5
9	R2	589	5.0	0.498	21.6	LOS B	7.5	54.8	0.85	0.80	26.3
Approach		1343	5.0	0.498	18.2	LOS B	10.9	79.9	0.73	0.67	37.8
West: Pirie Street											
10	L2	844	5.0	0.453	17.1	LOS B	12.9	94.5	0.59	0.75	29.1
11	T1	130	5.0	0.529	45.4	LOS D	6.2	44.9	0.98	0.78	14.6
12	R2	33	5.0	0.364	58.5	LOS E	1.7	12.4	1.00	0.72	22.2
Approach		1007	5.0	0.529	22.1	LOS B	12.9	94.5	0.66	0.75	26.0
All Vehicles		3604	5.0	0.644	26.0	LOS B	15.6	113.7	0.78	0.74	32.1





AM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)



PM Peak Phasing

Signals - Fixed Time Isolated Cycle Time = 100 seconds (Optimum Cycle Time - Minimum Delay)

AM Peak Hour

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	18	5.0	0.807	30.7	LOS C	32.0	233.7	0.91	0.86	27.8
2	T1	1299	5.0	0.807	24.8	LOS B	32.0	233.7	0.86	0.82	38.5
3	R2	327	5.0	0.480	19.1	LOS B	7.5	54.5	0.81	0.80	39.2
Approach		1644	5.0	0.807	23.7	LOS B	32.0	233.7	0.85	0.81	38.5
East: Pirie Street											
4	L2	143	5.0	0.629	38.5	LOS C	7.6	55.5	0.87	0.78	30.4
5	T1	198	5.0	0.629	43.5	LOS D	7.6	55.5	0.97	0.81	14.8
Approach		341	5.0	0.629	41.4	LOS C	7.6	55.5	0.93	0.80	22.5
North: Terminus Street											
7	L2	70	5.0	0.606	41.8	LOS C	12.4	90.3	0.94	0.80	22.3
8	T1	499	5.0	0.606	36.2	LOS C	12.5	91.4	0.94	0.80	32.9
9	R2	582	5.0	0.811	52.6	LOS D	15.0	109.5	1.00	0.93	15.2
Approach		1151	5.0	0.811	44.8	LOS D	15.0	109.5	0.97	0.86	23.7
West: Pirie Street											
10	L2	471	5.0	0.337	27.7	LOS B	8.1	58.8	0.75	0.77	22.7
11	T1	69	5.0	0.281	43.6	LOS D	3.1	22.9	0.94	0.72	15.0
12	R2	3	5.0	0.030	55.6	LOS D	0.1	1.1	0.97	0.62	22.9
Approach		543	5.0	0.337	29.9	LOS C	8.1	58.8	0.77	0.77	21.6
All Vehicles		3679	5.0	0.811	32.9	LOS C	32.0	233.7	0.88	0.82	30.0

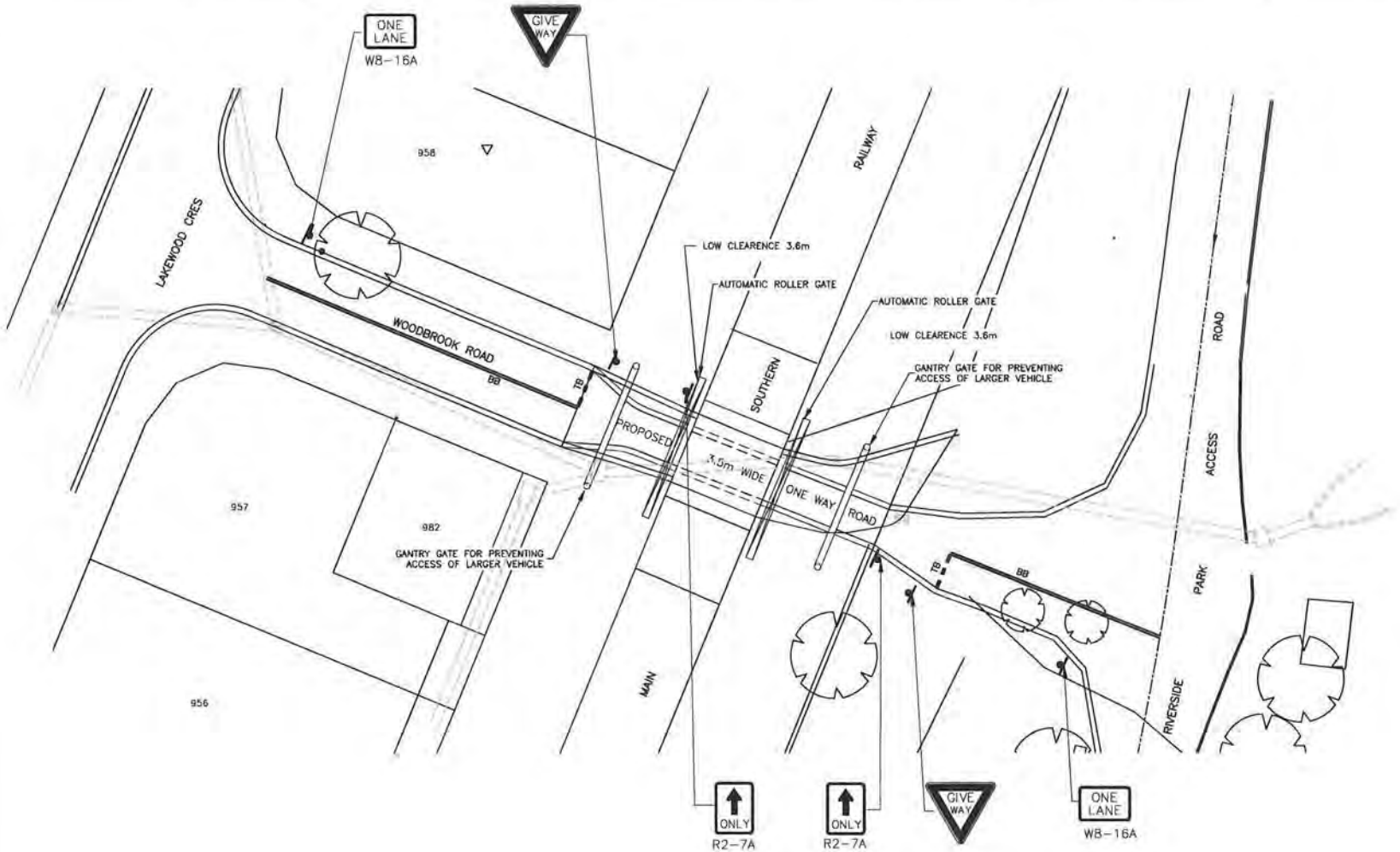
PM Peak Hour

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Terminus Street											
1	L2	31	5.0	0.711	39.0	LOS C	18.2	132.7	0.95	0.83	25.0
2	T1	787	5.0	0.711	33.3	LOS C	18.2	132.7	0.94	0.83	34.2
3	R2	198	5.0	0.690	50.7	LOS D	9.6	70.2	1.00	0.85	25.8
Approach		1016	5.0	0.711	36.9	LOS C	18.2	132.7	0.95	0.83	32.1
East: Pirie Street											
4	L2	234	5.0	0.708	34.0	LOS C	9.0	65.8	0.79	0.81	31.6
5	T1	144	5.0	0.587	45.8	LOS D	6.9	50.2	0.99	0.79	14.5
Approach		378	5.0	0.708	38.5	LOS C	9.0	65.8	0.87	0.80	26.0
North: Terminus Street											
7	L2	27	5.0	0.426	20.8	LOS B	12.5	91.0	0.65	0.59	34.3
8	T1	825	5.0	0.426	15.2	LOS B	12.5	91.3	0.65	0.58	44.6
9	R2	664	5.0	0.579	22.6	LOS B	8.9	64.9	0.89	0.81	25.7
Approach		1516	5.0	0.579	18.6	LOS B	12.5	91.3	0.75	0.68	37.6
West: Pirie Street											
10	L2	947	5.0	0.518	18.2	LOS B	15.6	113.9	0.63	0.77	28.3
11	T1	149	5.0	0.607	46.1	LOS D	7.2	52.3	0.99	0.80	14.4
12	R2	37	5.0	0.296	53.7	LOS D	1.8	13.2	0.97	0.74	23.4
Approach		1133	5.0	0.607	23.0	LOS B	15.6	113.9	0.69	0.77	25.4
All Vehicles		4043	5.0	0.711	26.3	LOS B	18.2	132.7	0.80	0.76	31.8

APPENDIX P

Liverpool City Council Concept Plan – Woodbrook Road Underpass



ISSUE	DATE	REASON FOR ISSUE	DRAWN	SIGNED	APPROV	OWNER

DATE OF COMPLETION	DESIGNER
DATE OF RELEASE	COORDINATOR – M&D
DATE OF ACCEPTANCE	PROJECT ENGINEER
DATE OF RELEASE	MANAGER – CC&A

LIVERPOOL CITY COUNCIL INVESTIGATIONS & DESIGN

1 HOXTON PARK ROAD, LIVERPOOL, NSW 2170
Ph (02) 9821 9288 Fax (02) 9821 9192

CONCEPT PLAN

SURVEYED DATE	DATUM A.H.D./M.G.A.
DESIGNED KBF DATE	CHECKED B.P DATE
DRAWN KBF DATE	CAD FILE

DRAWING TITLE

WOODBROOK ROAD, CASULA
SINGLE LANE ROAD DESIGN
SITE PLAN

SHEET No 01 OF 01 SHEETS	JOB No
SCALES SCALE: 1: 200	ISSUE No
	CONTRACT No

Plotted: 21/04/2014 1:28:09 PM File: C:\LPCSCA\JOBS\2013\2013-036 Woodbrook Road Casula\Advanced Concept Drawings\WOODBROOK KB.dwg

SMYTH CONSULTING

mecone

CORONATION PROPERTY CO.

Strategic Integrated Transport Assessment for the Shepherd Street Precinct

Final (8th June V03)

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1 INTRODUCTION

1.1 Purpose of the Integrated Transport Assessment

The purpose of the *Strategic Integrated Transport Assessment for Shepherd Street Precinct* ("The Integrated Transport Assessment") is to:

- Provide a strategic-level assessment of the transport challenges and opportunities affecting the Shepherd Street Precinct. This assessment integrates all modes of access and takes a balanced view of the future role of all modes to provide access to the Precinct.
- Support the Planning Approvals process for the Shepherd Street Precinct by drawing on and complementing the outputs of the *Planning Proposal, Shepherd Street, Liverpool - Traffic Report* (InRoads Group, 10 March 2016).

The *Integrated Transport Assessment* has been developed for the Coronation Property Co (CPC) to provide a resource to serve the following purposes:

- Inform internal discussions and considerations in relation to the Shepherd Street Precinct;
- Inform engagement with Liverpool City Council in relation to the Shepherd Street Precinct;
- Inform a strategic position in dealings with other stakeholders (and potentially in relation to other development in the broader Liverpool City Centre).

1.2 Aims of the Integrated Transport Assessment

The aims of the *Integrated Transport Assessment* are:

- Reach a strategic level understanding of the transport and land use context in which the Shepherd Street Precinct ("the Precinct") is being developed and the likely future travel needs of the Shepherd Street Precinct;
- Through and integrated, multi-modal process, assess the potential and degree to which travel choices and behaviour in the precinct could be influenced through the provision of different initiatives;
- Identify a set of initiatives (infrastructure, management, policy etc) that can deliver appropriate levels of access for the Shepherd Street precinct while minimising impacts on the surrounding transport network.

It is noted that the *Strategic Integrated Transport Assessment* does not incorporate estimates of traffic generation. Should these be required, they would be developed by the traffic consultants using the estimates of future mode shares for the development incorporated within this document.

1.3 Structure of this document

This document is structured as follows:

- Section 2 Outlines the transport and land use context in which the Shepherd Street Precinct is located. This includes a review and assessment of travel data relevant to the Precinct

- Section 3 Identifies the future access needs and opportunities associated with the Shepherd Street Precinct (all modes)
- Section 4 identifies a set of initiatives to achieve integrated transport / land use outcomes for the Shepherd Street Precinct. It is structured in two parts:
  - Initiatives for the overall evolving Liverpool City Centre;
  - Initiatives for the Shepherd Street Precinct development.

Text that relates to the overall approach to the strategic integrated transport assessment process has been provided in blue 'break-out boxes'.

2 THE TRANSPORT AND LAND USE CONTEXT

2.1 Strategic Framework affecting the Liverpool City Centre and the Shepherd Street Precinct

The following strategy documents constitute the key elements of the strategic framework affecting the *Strategic Integrated Transport Assessment for the Shepherd Street Precinct.*

A Plan for Growing Sydney

A Plan for Growing Sydney[1] nominates Liverpool as a 'Regional City Centre' and a 'Strategic Centre'. 'Strategic Centres' are locations:

- That currently or are planned to have least 10,000 jobs. These are priority locations for employment, retail, housing, services and mixed-uses.
- Which provide services benefitting local areas and (in the case of Liverpool) the South West Growth Centre.
- For significant metropolitan health and education precincts.

A Plan for Growing Sydney) identifies the following key priorities for Liverpool Strategic Centre that could influence the integrated transport planning for Shepherd Street precinct:

- Retention of a commercial core in Liverpool, as required, for long-term employment growth.
- Provision of capacity for additional mixed-use development in Liverpool including offices, retail, services and housing.
- Improve walking and cycling connections to Liverpool train station from east of the train line.
- Work with council to improve walking and cycling connections between Liverpool and the Georges River.

NSW Long Term Transport Masterplan

The NSW Long Term Transport Master Plan[2] classifies Liverpool as a 'Regional City Centre' and provides strategic level guidance affecting the Liverpool area.

Liverpool City Centre Plan - Vision

The *Liverpool City Centre Plan - Vision*[3] was prepared by the Regional Cities Taskforce, a group that included planners and urban designers from the Department of Planning and the local council for each of the six regional cities.

The plan is almost 10 years old. It incorporates a strategic overview of the LCC and provides the current spatial definition of the Liverpool City Centre, shown in Figure 1, below.

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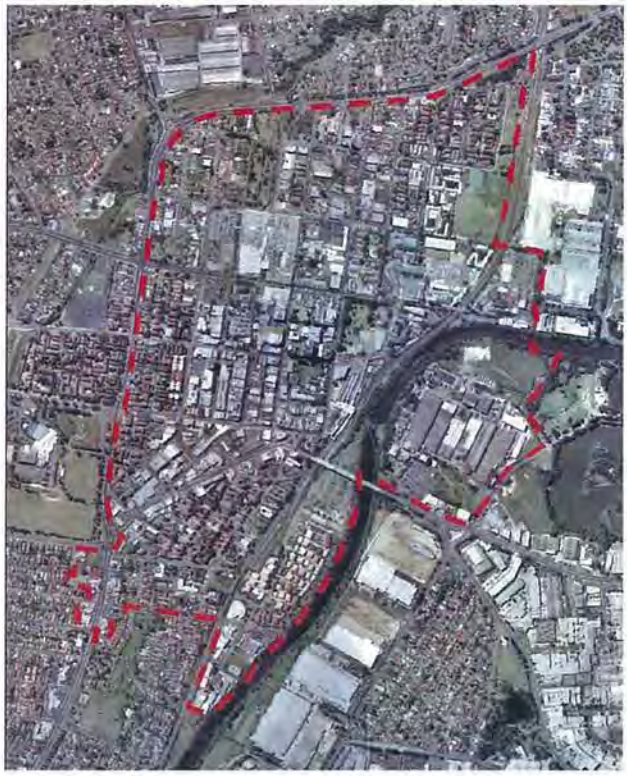
[1] NSW Government, Department of Planning and Environment, 2014
[2] NSW Government, Transport for NSW, December 2012
[3] NSW Government, Department of Planning, 2006

Figure 1 Liverpool City Centre - definition

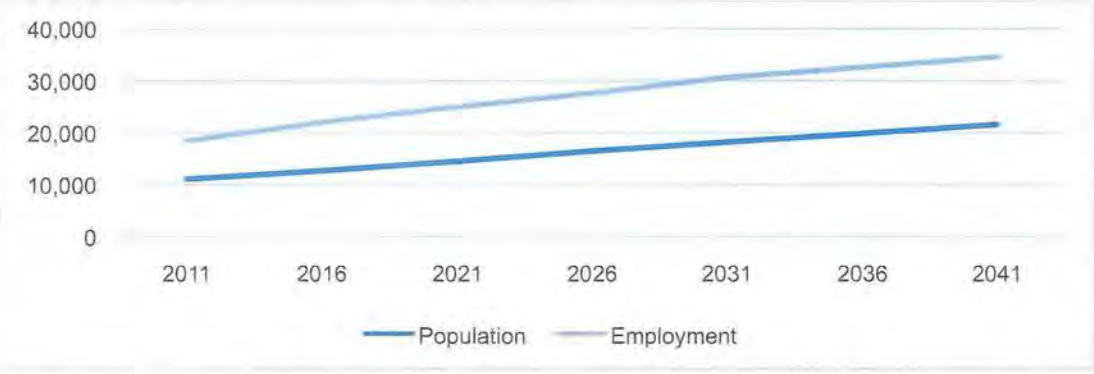


Source: *Liverpool City Centre Plan – Vision* (NSW Government, Department of Planning, 2006)

Strategic Land Use Projections

The number of people living and working in the Liverpool city centre is projected to almost double between 2011 and 2041. State Government projections are shown in Figure 2.

Figure 2 – Growth projections for Liverpool City Centre



Source: TfNSW BTS population and employment projections for travel zones that most closely match the Liverpool City Centre as defined in Figure 1. Travel Zones: 3811, 3837, 3839, 3841, 3843, 3845, 3847.

2.2 The Evolution of the Liverpool City Centre

As the Liverpool City Centre (LCC) evolves, so will the transport system and the travel patterns and behaviour of people travelling to/from and within the LCC.

Changes in urban structure and transport system

For a city centre where the number of people living and working is projected to increase significantly in the next 25 years, a suite of initiatives to improve access will be required if the projected development is to occur. This will result in changes to the urban structure and transport system within the city centre.

The integrated transport planning process for individual precincts needs to consider which city centre–wide initiatives are likely to be implemented and how these will affect the planning and development of particular precincts, in this case the Shepherd Street precinct.

Changes in travel behaviour

Key evolutions in travel characteristics associated with urbanisation and intensification of mixed land uses around rail hubs include:

- Increased mode share to public transport, walking and cycling;
- Reduced proportion of trips made in private vehicles;

For the purpose of strategic transport planning, it is useful to look city centres with demographic and land use characteristics similar to those expected in Liverpool City Centre in 10 to 20 years.

Key characteristics of such a centre include:

- Presence of a major rail hub and bus interchange
- Travel times (rail and/or road) to the Sydney CBD of approximately one hour;
- Travel times (rail and/or road) to a secondary CBD or centre (such as Chatswood, Parramatta, Blacktown) of approximately 30 minutes;
- Travel time to an international airport of approximately 30 minutes;
- Constrained parking supply and increasing traffic congestion;
- Local services in terms of retail, commercial, community services etc.;
- Similar built form (intensity and dwelling type)

Integrated transport planning in a fast-developing city centre

The integrated transport planning process for the Shepherd Street Precinct needs to take account of likely changes to the surrounding access network that will occur as part of the overall development of the Liverpool City Centre.

For strategic, integrated, multi-modal transport planning within evolving city centres, an assessment of precedents generally offers a more accurate picture of future travel behaviour than trend-based estimates.

2.3 Review and assessment of travel data relevant to Shepherd Street Precinct

2.3.1 Journey to Work Data (2011)

We identified travel zones in the Blacktown, Bankstown and Parramatta city centres that reflect the demographic and land use characteristics expected in the Shepherd Street Precinct within a future, more evolved Liverpool City Centre.

Journey to work data is derived from the Census. The most recent journey to work data available is from 2011. It is recognised that journey to work trips only account for around 15% of all AM peak hour trips, but journey to work data do serve as a valuable proxy for travel behaviour in the morning peak period.

Journey to work data for applicable travel zones within these centres are summarised in Table 1, with the full data and travel zone mapping provided in Appendix A.

Table 1 Journey to Work Mode Share Data[1]. Comparison of city centres locations in similar contexts

Mode	'Outer Western Sydney' City Centres						'Western Sydney' City Centre	
	Liverpool 2011[2]		Blacktown 2011[3]		Bankstown 2011[4]		Parramatta 2011[5]	
	Residents from	Workers to	Residents from	Workers to	Residents from	Workers to	Residents from	Workers to
No. Persons	**1,188**	**3,844**	**2,418**	**449**	**2,389**	**2,659**	**7,178**	**3,484**
Vehicle driver	56%	76%	55%	80%	60%	74%	42%	70%
Vehicle pasngr.	6%	9%	6%	2%	6%	7%	4%	7%
Train	20%	6%	29%	5%	24%	8%	35%	13%
Bus	3%	3%	3%	3%	3%	3%	6%	4%
Walked only	10%	4%	4%	2%	4%	5%	12%	4%
Other mode/not stated	5%	3%	1%	3%	1%	3%	2%	4%

Notes:
1 Source: 2011 Journey to Work Data Tables 12 and 13 based on the 2011 BTS Travel Zone (TZ) and 2011 Australian Standard Geographical Classification (ASGC)
2 Sample Travel Zones for Liverpool: 3844
3 Sample Travel Zones for Blacktown: 4106, 4122
4 Sample Travel Zones for Bankstown: 2304, 2307, 2311
5 Sample Travel Zones for Parramatta: 1056, 1063, 1064, 1026, 1024, 10489.

Key findings from Table 1 are described below.

- In city centres in outer western Sydney (Liverpool, Blacktown and Bankstown), in travel zones with similar land use and transport characteristics to Shepherd Street:
  - The mode shares for journey to work trips are relatively similar. This is true for residents commuting *from* the area and workers commuting *to* the areas;
  - Residents commuting *from* these city centres are much more likely to catch public transport or walk to work than workers commuting *to* these city centres: 33% compared to 13% of journeys – some 150% higher.
  - Workers commuting *to* these city centre locations are much more likely to use private vehicles to travel to work than residents commuting *from* city centre locations: 83% compared to 63% of journeys – some 30% higher
- For the Parramatta City Centre, which is located closer to the geographical centre of the Sydney Metropolitan area, in travel zones with similar land use and transport characteristics to Shepherd Street:
  - A higher proportion of journey to work trips are made by public transport and walking than the outer western Sydney city centres. Mode shares for public transport and walking are some 60% higher (for both residents commuting *from* and workers commuting *to* the city centres).
  - A lower proportion of journey to work trips are made in private vehicles than the outer western Sydney city centres. Residents commuting *from* Parramatta are some 27% less likely to drive and workers commuting *to* Parramatta are some 7% less likely to drive.

2.3.2 Estimates of future mode share in Shepherd Street Precinct

For the purpose of this strategic level assessment, it is assumed that as the Liverpool City Centre evolves, so will its travel characteristics.

Land use estimates provided earlier in Figure 2 indicate that over the next 25 years:

- The population of the Liverpool City Centre is projected to increase by 70% from around 12,700 to 21,600
- The employment of Liverpool City Centre is projected to increase by 57% from around 22,100 to 34,600

Based on this significant evolution of the Liverpool City Centre within the 25 year planning horizon, it is assumed the Journey to Work mode shares in Liverpool 2041 will more closely reflect the current mode shares in the western Sydney city centre of Parramatta than the current mode shares in outer western Sydney city centres such as Liverpool, Blacktown and Bankstown.

Table 2 summarises the existing, estimated future and percentage change in mode share for Journey to Work trips in parts of the Liverpool City Centre with similar land use and transport characteristics to Shepherd Street. The projected change in mode shares are considered reasonable in light of the location of Shepherd Street within the city centre and likely impacts of State Government land use and transport planning policies.

Table 2 Journey to Work Mode Share Data - Estimate of future mode share for the Shepherd Street Precinct

Mode	2011[1]		2041[2] (Proxy)		% Change (2011-2041)	
	Residents from	Workers To	Residents from	Workers To	Residents from	Workers To
Vehicle driver	56%	76%	42%	70%	-25%	-8%
Vehicle passenger	6%	9%	4%	7%	-33%	-22%
Train	20%	6%	35%	13%	+75%	+117%
Bus	3%	3%	6%	4%	+100%	+33%
Walked only	10%	4%	12%	4%	+20%	0%
Other mode	5%	3%	2%	4%	-60%	33%

Notes:

1 Source: 2011 Journey to Work Data Tables 12 and 13 based on the 2011 BTS Travel Zone (TZ) and 2011 Australian Standard Geographical Classification (ASGC). Travel zone 2844.

2 Indicative, order of magnitude estimate based on applying the current JTW mode shares in similar parts of the Parramatta city centre (2011, sample Travel Zones: 1056, 1063, 1064, 1026, 1024, 10489) as a proxy for the future JTW mode shares in Shepherd Street precinct (2041).

Key Travel Characteristics of the evolving Liverpool City Centre

Currently, in city centres in outer Western Sydney:

- Residential land uses generate journey to work trips by private vehicle at a rate some 30% lower than employment land uses; and
- Residential land uses will generate journey to work trips by public transport and walking at a rate some three times higher (i.e. 150%) than employment land uses.

In the future, as outer western Sydney city centres like Liverpool evolve, they are likely to exhibit travel characteristics more similar to western Sydney city centres like Parramatta today. This is likely to result in mode shares to public transport and walking that are some 60% higher than today (residents and workers), with reductions in the rate of residents driving to work of some 26%.