MetCONNX

MEMORANDUM

To	Simon Lenton, Manger Statutory Planning, DevelopmentWA
From	MetCONNX / Urbsol
Copy to	Cheyenne Ellis – Senior Planner, DevleopmentWA
Reference	Byford Rail Extension – Development Application 2 – Eleventh Road Bridge
Date	25 May 2023
Subject	Eleventh Road Bridge, Transport Impacts

Introduction

This technical memo presents a summary of the traffic impacts associated with the development of Eleventh Road Bridge. The need to provide this technical memo is a result of a meeting held with DevelopmentWA on Monday 15 May 2023.

The purpose of this technical memo is to summarise the detail in the WSP Traffic Analysis Summary relevant to the Eleventh Road Bridge. The Traffic Analysis Summary assessed the potential traffic impacts to the road network surrounding Armadale and Byford Stations and the closure of level crossings, under the future year demands associated with project and non-project traffic growth.

This technical memo includes the following information:

1. Design Evolution
2. WSP Traffic Analysis Summary
3. Road Modifications
4. Pedestrian and Cycling Modifications
5. Impact Summary

This technical memo is to be read in conjunction with the Development Application Report and the Bushfire Vehicular Access Review prepared by Linfire Consultancy.

1. Design Evolution

Background

Eleventh Road, immediately west of the Southwestern Highway, is currently at-grade. As part of the BRE project, the road is to be grade separated, with a road bridge over the proposed rail alignment. The extents of the road that are part of the project upgrades are included in Figure 1. This includes the road 500m either side of the rail crossing.

Figure 1: Eleventh Road Design Extents

Currently this is an at grade level crossing but will change to a road bridge over rail as part of the design. The horizontal alignment of the new design will generally follow the existing alignment, with a bridge slightly to the North of the existing at-grade crossing to minimise impact on adjacent properties. The vertical alignment will change to accommodate the road bridge over the rail with minimum vertical clearance from bridge soffit to rail of 6.3m. Refer to Interim Detailed Design drawings for details (Appendix A).

Stakeholders for the works include the Public Transport Authority (PTA),Main Road Western Australia (MRWA), City of Armadale (CoA) and Shire of Serpentine Jarrahdale (SSJ). All stakeholders have provided review comments at each design milestone, with reference design submitted December 2022 and IDD February 2023.

Key comment raised form CoA was to ensure that proposed design did not preclude future upgrades for Eleventh Rd ultimate design. Advice received notes Eleventh Rd is not It earmarked for additional lanes in future, 2 x 3.5 lanes in both directions only. It is noted as per MRA “Wungong Urban Water – Movement Network Policy” that CoA plan to upgrade Eleventh Rd to a divided road cross section of 28.2m cross section in the future however timing and nominated tie in points have not been determined.

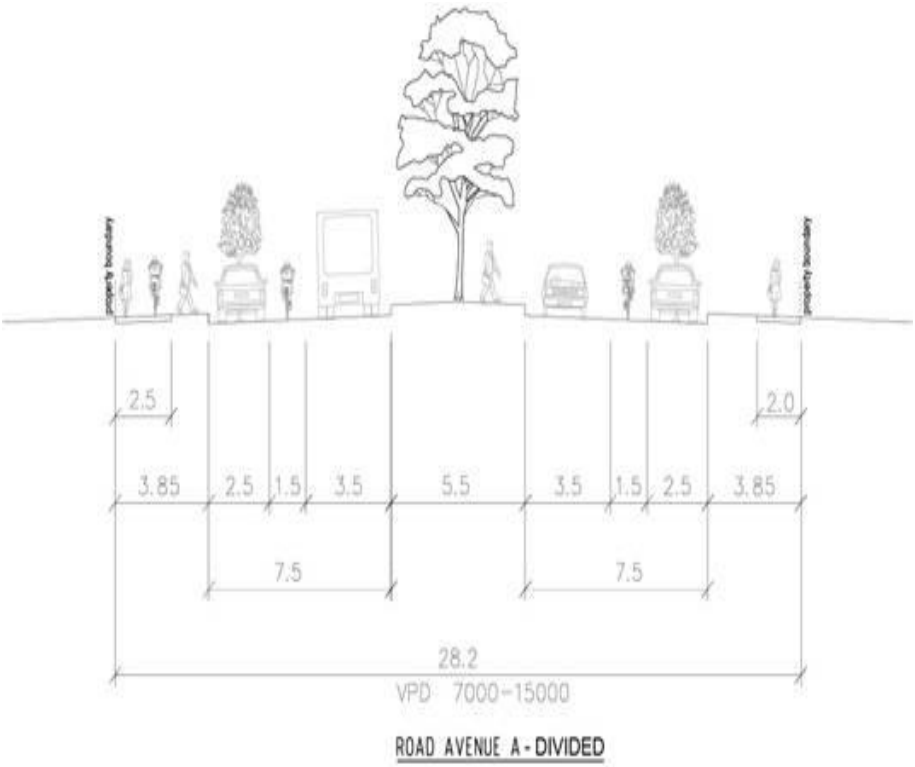


Figure 2: Eleventh Road Ultimate Lane Configuration Extract Wungong Urban Water – Movement Network Policy

2. WSP Traffic Analysis Summary

WSP was previously engaged by the PTA to assess the potential traffic impacts to the road network surrounding Armadale and Byford Stations and the closure of level crossings, under the future year demands associated with project and non-project traffic growth. The outcomes of the investigations, relevant to the Eleventh Road Bridge, were documented in the report Byford Rail Extension Future Year Traffic Impact Analysis Armadale (March 2022). Those investigations focussed on intersections in the vicinity of the stations, and as such included an assessment of the SWH/Eleventh Road intersection but did not consider the basic capacity of Eleventh Road in the immediate vicinity of the proposed rail grade separation.

As part of the development of the BRE project, and to assist WSP with their traffic investigations, MRWA updated the ROM24 model specifically for the projects, and also included making changes to the land uses around the stations and implementing the project road network configuration changes. Because of the modified land use assumptions in that model scenario, it was not possible to identify which traffic volumes are associated with the BRE project and which will occur irrespective of the project.

As a result, the analysis conducted by WSP should be viewed as an investigation of likely required intersection upgrades that may be required if land use and future road (and rail) network development for the entire Metropolitan Area occurs in line with current assumptions.

Based on the assessment undertaken by WSP, it was suggested that SWH needed to be duplicated, in order to provide a staged right turn out, to operate satisfactorily in 2026. Interestingly, replacing the projected 2026 traffic volumes with 2021 traffic counts undertaken at the intersection (in the SIDRA assessment) indicated that the intersection already operates beyond capacity, with the right turn out operating at Level of Service (Los) F in the peak traffic periods.

Traffic analysis undertaken as part of the Armadale Station Redevelopment Transport Impact Assessment (TIA) indicated that compared to existing trip generation at the station, proportioning up trip generation in accordance with patronage growth would result in an additional 3 trips in the 2026 AM peak and 6 trips in the 2026 PM peak (including both inbound and outbound trips). These additional trips are considered insignificant. Further, in the assessment undertaken to date for the Byford Station TIA, as agreed with the Shire of Serpentine-Jarrahdale, very few trips to/from the station are expected to originate from SWH to the north, or from Eleventh Road.

The WSP assessment undertaken went on to assess intersection performance out to a 2036 time horizon. For this assessment, it was determined that the provision of a roundabout or traffic control signals would be required to accommodate the forecast traffic projections at the intersection.

Referring back to the Armadale Station Redevelopment TIA, the additional traffic estimated to be generated as a result of patronage growth to 2036 was a total of 61 AM peak trips and 101 PM Peak trips (including both inbound and outbound traffic).

This estimated additional traffic was considered highly conservative, because if planned mode share targets are achieved, private vehicle traffic generated to Armadale Station would actually reduce compared to current levels. Regardless, hardly any of that conservatively estimated additional traffic, if any, would be expected through the SWH/Eleventh Road intersection. And as already mentioned and agreed with the Shire of Serpentine-Jarrahdale, very few trips to/from the new Byford Station are expected to originate from SWH to the north, or from Eleventh Road.

Based on the above information, the BRE project is expected to contribute an insignificant amount of traffic at the SWH/Eleventh Road intersection. And whilst the intersection may well require upgrades to accommodate existing traffic volumes and future traffic projections, the upgrades are not considered to be attributable to the BRE project.

3. Road Modifications

The construction of Eleventh Road Bridge does not materially modify Eleventh Road Bridge. It is simply raising an existing crossing that is typically a free flowing road to traffic (closed a few times a day for regional rail purposes). Additionally, The proposal does not generate any additional traffic because it is not introducing / adding / modifying any land uses in the immediate area.

As part of the proposed development, road modifications are proposed along a section of Eleventh Road to accommodate the development. The following modifications are proposed:

- Construction of new bridge crossing over the existing railway line, and resultant elevation of Eleventh Road to the new bridge height.
- Relocation of Bruns Drive connection to Eleventh Road further to the east and reconfiguration as a one-way access or egress to Eleventh Road (currently under review), and construction of new cul-de-sac road to south-east of bridge, on southern side of Eleventh Road.
- Construction of new drainage basin and private driveway to north-east of new bridge.
- Construction of a new drainage basin to west of new bridge, and extension of Keenan Street further to the east and north, terminating immediately south of Eleventh Road.
- Construction of an Emergency Access Way (EAW) from the existing termination of Keenan Street, further east within the road reserve to connect to the existing EAW from Rivose Crescent.
- Construction of a new Fire Service Access Way (FSAR)/Emergency Access Way (EAW) along the railway and underneath Eleventh Road, from Rivose Crescent to the existing Wilson Street cul-de-sac 250 m to the north.
- Construction of a new PSP south of, and underneath, Eleventh Road.
- Realignment of existing driveways from various lots, to accommodate new road layout.
- Realignment of services to accommodate the proposed modifications.

Please refer to Appendix B for the Bushfire Vehicular Access Strategy for further details on the road modifications and the impact on the surrounding area.

4. Pedestrian and Cycling Modifications

Existing Eleventh Rd Lane configuration has one 3.5m lane in each direction with 500mm sealed shoulders with no shared path facilities or cycle lanes on the vicinity of the works site.

Figure 3: Eleventh Road Existing Cross section facing east

The proposed works will include a new shared path on the southern side of Eleventh Rd over the grade separation 3.5m wide incl shoulders which will provide connectivity from Bruns Drive to the proposed PSP which runs from Armadale Rd to Abernathy Rd.

5. Impact Summary

Eleventh Road Capacity Assessment

Eleventh Road is an east-west road that links SWH to the suburbs of Hilbert and Haynes and provides further indirect connectivity to Armadale Road and Tonkin Highway. It is a single carriageway road with a single lane in each direction and has a sign posted speed limit of 80 km/h. It is classified as a "Distributor B" road within the MRWA Road Hierarchy and intersects the existing Armadale railway line (at-grade boom gates) at a location approximately 660m west of SWH.

Traffic surveys conducted by Surveytech in May 2021 indicate that Eleventh Road, at the SWH intersection carries approximately 1,320vpd in each direction i.e. a total of 2,640vpd.

To estimate future traffic volumes on Eleventh Road, information from Main Roads' ROM24 traffic model was sourced. That model indicates uneven growth between directions on Eleventh Road. This can be attributed to the nature of the model coding of the road network in the vicinity, which includes parallel links that provide connectivity between SWH and Wungong Road i.e. Eleventh Road and the Byron Road-Eliot Road-Stone Street route. Because of this, and due to the Byron Road rail crossing to the north being removed, traffic growth on both Byron Road and Eleventh Road were summed, and then added to existing traffic on Eleventh Road.

Total traffic growth on both Eleventh Road and Byron Road between 2021 and 2036 is expected to be 3,100vpd eastbound and 3,200vpd westbound. Summing this growth with existing volumes results in 2036 traffic projections of 4,400vpd eastbound and 4,500vpd westbound. Even with the conservative nature of these calculations which assumes all traffic growth from Byron Road will divert to Eleventh Road, the projected volume of traffic is well within the available capacity and function of the road.

Local Impacts

The grade separation of the rail line requires some restrictions to a number of existing traffic movements that are possible at the intersection of Eleventh Road and Bruns Drive (west). This includes the removal of the following movements:

- Left turn from Bruns Drive (west) to Eleventh Road
- Right turn from Bruns Drive (west) to Eleventh Road
- Right turn from Eleventh Road to Bruns Drive (west)

The removal of these movements means that they will need to be facilitated at the Eleventh Road/Bruns Road (east) intersection.

Currently the Bruns Drive approaches at Eleventh Road services approximately 83 residential lots. The WAPC Transport Impact Assessment Guidelines contains typical trip generation rates for residential developments. These indicate the following:

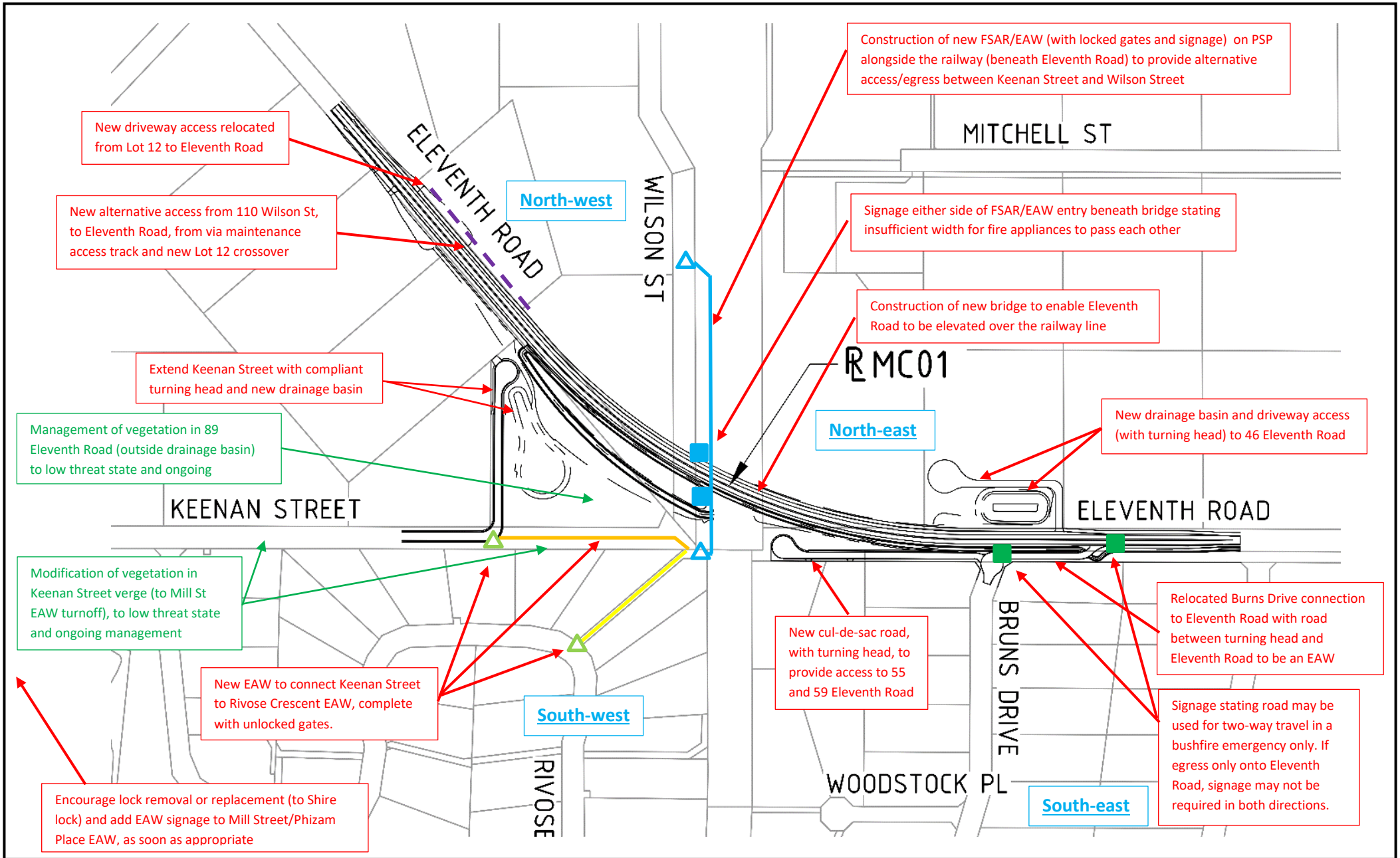
- AM peak hour trip rates:
    - 0.2 trips in per dwelling
    - 0.6 trips our per dwelling
- PM peak hour trip rates:
    - 0.5 trips in per dwelling
    - 0.3 trips our per dwelling

Whilst the semi-rural nature of the properties in the vicinity would likely result in lower trip generation rates, applying the above rates would result in approximately 17 inbound trips and 50 outbound trips in the AM peak, and around 42 inbound trips and 25 outbound trips during the PM peak.

The highest peak volumes on Eleventh Road (west of SWH) occurs during the PM peak, with a total of around 130vph in each direction (noting that these volumes would include any traffic in/out of the aforementioned 83 lots). This volume of traffic is equivalent to around 4 vehicle per minute on average. This low level of traffic means there are ample gaps in the priority traffic stream to not cause any concerns around intersection capacity, even if all movements were combined at one of the Bruns Drive intersections with Eleventh Road.

The local impacts of traffic redistribution as a result of access restrictions at the Bruns Drive (west) intersection are therefore considered to be manageable, with the Bruns Drive (east) intersection having ample capacity to accommodate the expected additional movements without any operational issues. Even considering future traffic growth on Eleventh Road, the intersection would operate satisfactorily with the low volumes in and out of the Bruns Drive intersections.

Appendix A – Attachment 5: Proposed Bushfire Management Measures Incorporated into Eleventh Road Modification Works



Attachment 5: Proposed bushfire management measures incorporated into Eleventh Road modification works

LINFIRE

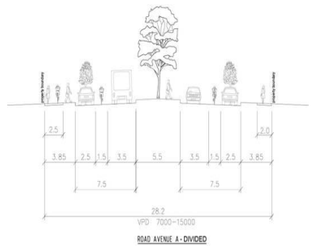
Appendix B – Stakeholder Review Comments

PUBLIC TRANSPORT AUTHORITY (PTA) PTA200142
BRE - Byford Rail Extension

Design Pkg Title:	**ELEVENTH ROAD CIVIL**
Design Report No.:	**R30-MET-RPT-CI-405-00001**
Reviewer/ Verifier:	**Select**
Comment Sheet No.:	**R30-MET-COM-CI-405-00002**
Design Stage:	**Reference Design**

Category of Non-Compliance		
N1	Critical	Critical to functionality, safety and RAM. Must be addressed and closed prior to proceeding to next stage. Designer to resubmit corrected information
N2	Immediate	Major concern for functionality, safety and RAM. Should be addressed at this stage, but can be addressed at next stage if Reviewer is provided with sufficient supporting evidence that requirements can be met.
N3	Discussion	Not a concern for functionality, safety and RAM however should be addressed in next stage for compliance with Schedule 12 scope of work and technical specification. Accepted with comments (proceed to next stage)

Compliance Status	
Cat 1	Accepted. No further information is required
Cat 2	Accepted with Clarification. subject to agreeing with the response comment, and additional information is received.
Cat 3	Not Accepted. non-compliant and introduces risk, therefore are not accepted. Supplier to reissue amended documentation with a written response to the comment

Item	Reviewer (N. Last Name)	Reference (Dwg or Doc.)	Revision	Classification (N1, N2, N3)	Reviewer Comment	Date	Comment Accepted?	Designer / Design Consult Response	Design Lead (N. Lastname)	Date	APPROVED BY DESIGN MANAGEMENT	Response Status (Cat 1, 2, 3)	Reviewer Comment on Response	Date
<---------- Reviewer to Fill ---------->							<---------- Designer to Complete ---------->					<---------- Reviewer to Complete ---------->		
REFERENCE DESIGN REVIEW														
1	CoA			N2	Detail required how proposed DUP either side of Eleventh Road will connect to bridge path		Accepted	RD design design allows for shared path to connect to Bruns Drive which then connects back to PSP along rail reserve. Verge to west of shared path has been space proffed for future 2.5m width path extension	John Perrott	01.12.22	Yes - Rob Sutton	N		
2	CoA			N1	Are traffic lanes sufficient to accommodate buses using future Route 250?		Accepted	Lane widening of 200m for design speed 90km/hr has been applied as per table 7.13 Austroads Part 3 for B doubles.	John Perrott	01.12.22	Yes - Rob Sutton	N		
3	CoA	2.3.3 on Pg 12 of report		N1	Report does not consider future proofing bridge against future road widening, only future additional rail lines.		Not Accepted	Advice received notes Eleventh Rd is not It earmarked for additional lanes in future, 2 x 3.5 lanes in both directions only. It is noted as per MRA "Wungong Urban Water – Movement Network Policy" that CoA plan to upgrade Eleventh Rd to a divided road cross section of 28.2m cross section in the future however timing and nominated tie in points have not been determined. Report to be updated noting the above. 	John Perrott	01.12.22	Yes - Rob Sutton	Select	Road design works should tie into the ultimate cross section for Eleventh Rd - as per the DevelopmentWA's requirements and the City's advice.	
4	CoA			N1	Metconnex traffic modelling of 2018 traffic count (2,218vpd?) + 5% growth rate from 2024 **(and the proposed bridge cross-section)** does not account for full residential development of Hilbert and Haynes: refer DPLH's 2018 (MRWA) modelling of 7200vpd in 2031, Transcore's 2016 modelling of 7112 vpd in or KCTT's 2022 modelling for Cell H structure plan submission of 13,400 vpd in 2031		Accepted	Key impacts will be pavement design and length of barriers required. Road geometry and cross section will not be affected. It is noted extending barriers will be problematic due to interface with exisitng and proposed driveways. Volumes updated as per recieved MRWA approved ROM data for ELeventh Rd forcasting AADT of 10,400 for 2036.ROM data to be included as appendix at next design phase.	John Perrott	01.12.22	Yes - Rob Sutton	Select		
5	CoA			N1	Eleventh Road bridge design and assumption need to be elevated and discussed;		Accepted	It is noted that western end of Eleventh Rd has a 70km/hr posted speed however eastern end (in proximity of site works) has 80km/h rpostd speed. Query raised with Main Roads and CoA if design spped for grade sepperation can be amended to 80km/hr. It is also noted that Eleventh is currently noted at a Rev Network for 27.5m B Doubles. This is requiring 200mm lane widening to be applied. Requiremnt to be reviewed by MRWA and CoA. Items to be noted in design report, no change to design required.	John Perrott	01.12.22	Yes - Rob Sutton	Select		
6	CoA			N1	The Eleventh Road bridge structure will need to connect into the City's future 28.2m wide cross-section for Eleventh Road.		Accepted	Noted, design to tie into exisitng geometry. Design alows for future shared path extension & connection on the south.	John Perrott	01.12.22	Yes - Rob Sutton	N	City's original comment is still relevant.	

PUBLIC TRANSPORT AUTHORITY (PTA) PTA200142
BRE - Byford Rail Extension

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Reviewer/ Verifier:	Select
Comment Sheet No.:	R30-MET-COM-CI-405-00002
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N3	Discussion	Not a concern for functionality, safety and RAM however should be addressed in next stage for compliance with Schedule 12 scope of work and technical specification. Accepted with comments (proceed to next stage)

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7	CoA				In relation to the Eleventh Road bridge structure it was also discussed that this would be provided to the City for review and advice before detailed design occurred, so if we could *have follow up on this* as well it would be appreciated.		Not Accepted	ST440 has been provided to CoA for review/comment. .	John Perrott	01.12.22	Yes - Rob Sutton	Select		
8	CoA			N1	No additional cul-de-sacs that service lots without emergency fire access/escape routes should be created, as the whole area is a high fire risk and all road designs will need to comply with the WAPC's SPP for Bushfire Planning.		Not Accepted	Bush firse assessment is being complete and will be included as part of next design phase submisison and DA submission. Documented cul de sacs are currently compliant.	John Perrott	01.12.22	Yes - Rob Sutton			
9	CoA			N1	The bridge structure/retaining should have a visual treatment similar to other MRD projects where visible from existing/future development. See photos attached		Accepted	Itme noted to stakeholder register. To be disucssed further with PTA/OMTID.	John Perrott	01.12.22	Yes - Rob Sutton		Bridge maintenance to site with MRD	
10	CoA	R30-MET-DWG-CI-405-04001.dwg		N2	A standard street truncation is required where the extension of Keenan Street turns a corner.		Accepted	Truncation to be updated.	John Perrott	01.12.22	Yes - Rob Sutton		Truncation not yet shown on plans	
11	CoA			N2	All existing trees including those in the Keenan Street reserve should be shown on the plans, with proposed removal/retention to be shown - the City's preference is to retain wherever possible.		Accepted	Noted, trees to be shown at next design phase subject to additional, survey being obtained. Keenan St extension follows existing road reserve therefore impact on trees is already minimised.	John Perrott	01.12.22	Yes - Rob Sutton		OK, please provide full tree information at next stage	
12	CoA			N2	The existing powerlines in the Keenan Street reserve should be picked up on a survey and the design modified accordingly.		Accepted	These poles are being removed as part of project. Service survey to be added next deisgn phase.	John Perrott	01.12.22	Yes - Rob Sutton		OK, thanks for advising. Please include the detail later.	
13	CoA			N2	Drainage basins to the north and south of Eleventh Rd will be owned and maintained by CoA. LANDSCAPING of basins is required and details should be provided to the City. If drainage is from the railway, then PTA will need to manage.		Accepted	These basins are for road runoff only. Landscaping extents to be confirmed.	John Perrott	01.12.22	Yes - Rob Sutton		1. Landscaping of areas to be managed by the City still to be agreed - COA won't manage new areas from the Project if the landscape outcome and tree retention does not occur. 2. Provide confirmation that drainage coming under ramp from area to north-east can be discharged into Keenan Street drainage without compensation, and that there is capacity in Keenan Street.	
14	CoA			N1	The road/bridge need lighting for safety reasons given existing/future traffic volumes: show lighting on plans		Accepted	Lighting design to be added at next design phase. RD design has space proofed for lighting.	John Perrott	01.12.22	Yes - Rob Sutton		OK, please show in next set	
15	CoA			N2	Consider the guidelines and recommendations for determining any heavy vehicle clearance.		Accepted	Noted MRWA guide to design of oversize and over mass vehicle corridors to be considered.	John Perrott	01.12.22	Yes - Rob Sutton			
16	COA			N2	The Keane St extension could be shorten and a longer corrover provided to reduce land clearing and surplus road construction		Accepted	Noted, length of crossover/driveway to be reviewed.	John Perrott	01.12.22	Yes - Rob Sutton			
17	COA			N1	The proposal includes substantial impacts to local residents and Metro Net/MetCONNX should undertake community consultation with local residents.		Accepted	Note to be complete by stakeholder engagement team.	John Perrott	01.12.22	Yes - Rob Sutton			
18	COA			N1	The design needs to cater for future State Government services through the corridor and ensure that they can be accommodated.		Accepted	Noted, Eleventh Rd design is being coordinated with UT040 package.	John Perrott	01.12.22	Yes - Rob Sutton			
19	CoA			N2	details of proposed assets to be transferred to the City require a separate agreement that needs to be progressed before construction commences.		Accepted	Noted, asset mgt plans and report to be issued to CoA.	John Perrott	01.12.22	Yes - Rob Sutton	Select	Landscaping of areas to be managed by the City still to be agreed - COA won't manage new areas from the Project if the landscape outcome and tree retention does not occur.	
INTRIM DETAILED DESIGN REVIEW														
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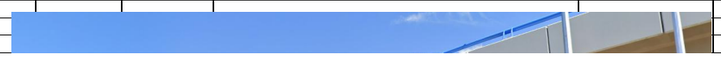

PUBLIC TRANSPORT AUTHORITY (PTA) PTA200142
BRE - Byford Rail Extension

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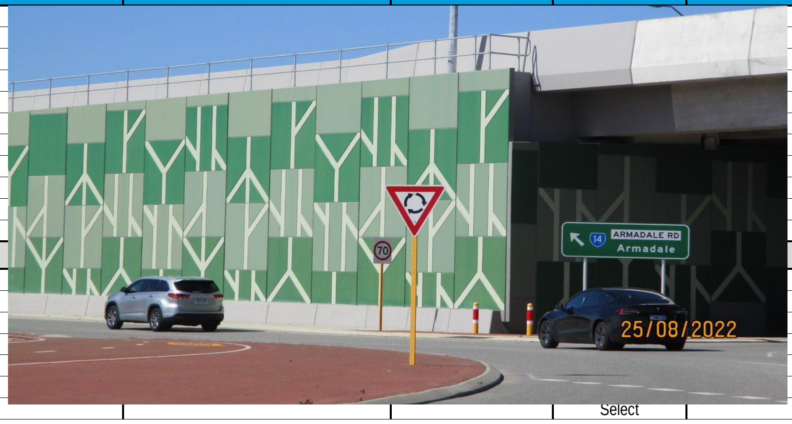

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Appendix C – Future Year Traffic Impact Analysis - Armadale

Design
for a better
future /

BRE-WSP-TE-RPT-00001_0

Public Transport Authority

Byford Rail Extension

Future Year Traffic Impact Analysis
Armadale

March 2022

Confidential

Byford Rail Extension
Future Year Traffic Impact Analysis
Armadale

Public Transport Authority

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Rev	Date	Details
0	08/03/2022	Final

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Reviewed by:	Phil Greenwood	03/03/2022	
Approved by:	Mark Fowler	08/03/2022	

WSP acknowledges that every project we work on takes place on First Peoples lands.
We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

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Appendix C **SIDRA Modelling Results (2026)**

Appendix D **SIDRA Modelling Results (2036)**

1 Introduction

1.1 Project Details

The Byford Rail Extension (BRE) project is an initiative by METRONET that facilitates the extension of the Armadale rail line by approximately 8km south, to Byford. This project will result in the upgrade of Armadale Station (elevated) and the provision of a new station at Byford (either at grade or elevated). The project also includes several level crossing removals via grade separation (Armadale Road, Forrest Road, Church Avenue, Eleventh Road and Thomas Road) and the provision of a new road connection (Clara Street) across the railway line. All these changes have the potential to have a traffic impact, both positive and negative, on the existing traffic distribution.

WSP has been engaged by the Public Transport Authority (PTA) to assess the potential traffic impact to the road network surrounding Armadale Station and the closure of level crossings, under the future year demands associated with project and non-project traffic growth. The locations identified for assessment were defined and instructed by Main Roads WA (MRWA).

SIDRA base case models have been developed to provide the basis for option testing of the project.

The SIDRA modelling for the base case is documented in *PS125110-PAM-REP-002 RevF Public Transport Authority – Armadale Rail Extension, Sidra Base Model Calibration and Validation Report, WSP, 2021.* The base models have been endorsed by MRWA for use for the future year analysis.

1.2 Overall Project Process

This piece of analysis is one step in an overall piece of work to assess the traffic impact of the BRE.

During the concept design development stage of the project various high-level analyses were undertaken for the BRE project as a whole, which included analysis of the traffic impact adjacent the stations as a result of the project, in addition to further analysis to inform the potential impacts of grade separation of existing level crossings. The work undertaken at that time focussed on design development and so tended to focus in and around the stations.

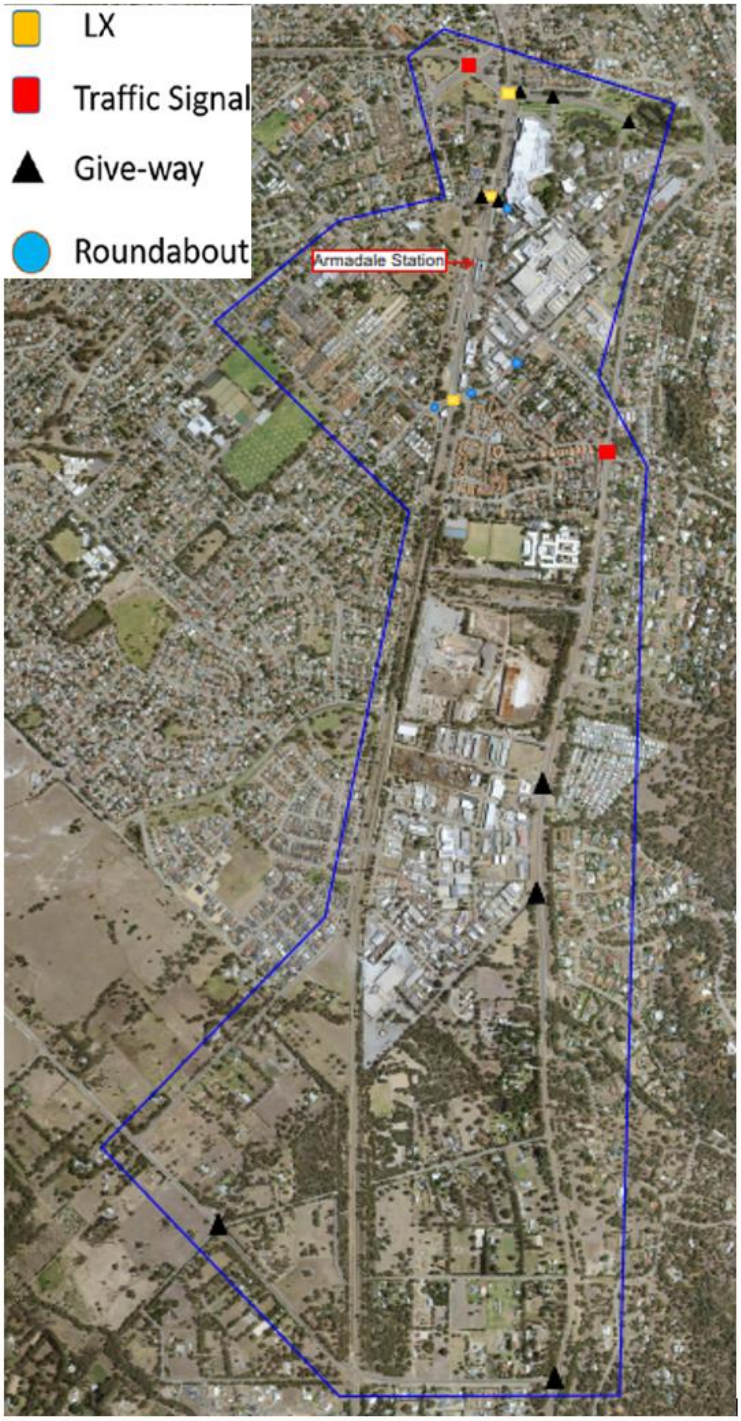
This report has been instructed by PTA to further inform the BRE project, and its subsequent stages beyond concept design. The scope of this project has been informed by Traffic Modelling Instruction Forms (TMIF) requested by PTA and provided by MRWA. TMIFs were originally provided with the tender documentation and then subsequently updated as part of this project (refer Section 2).

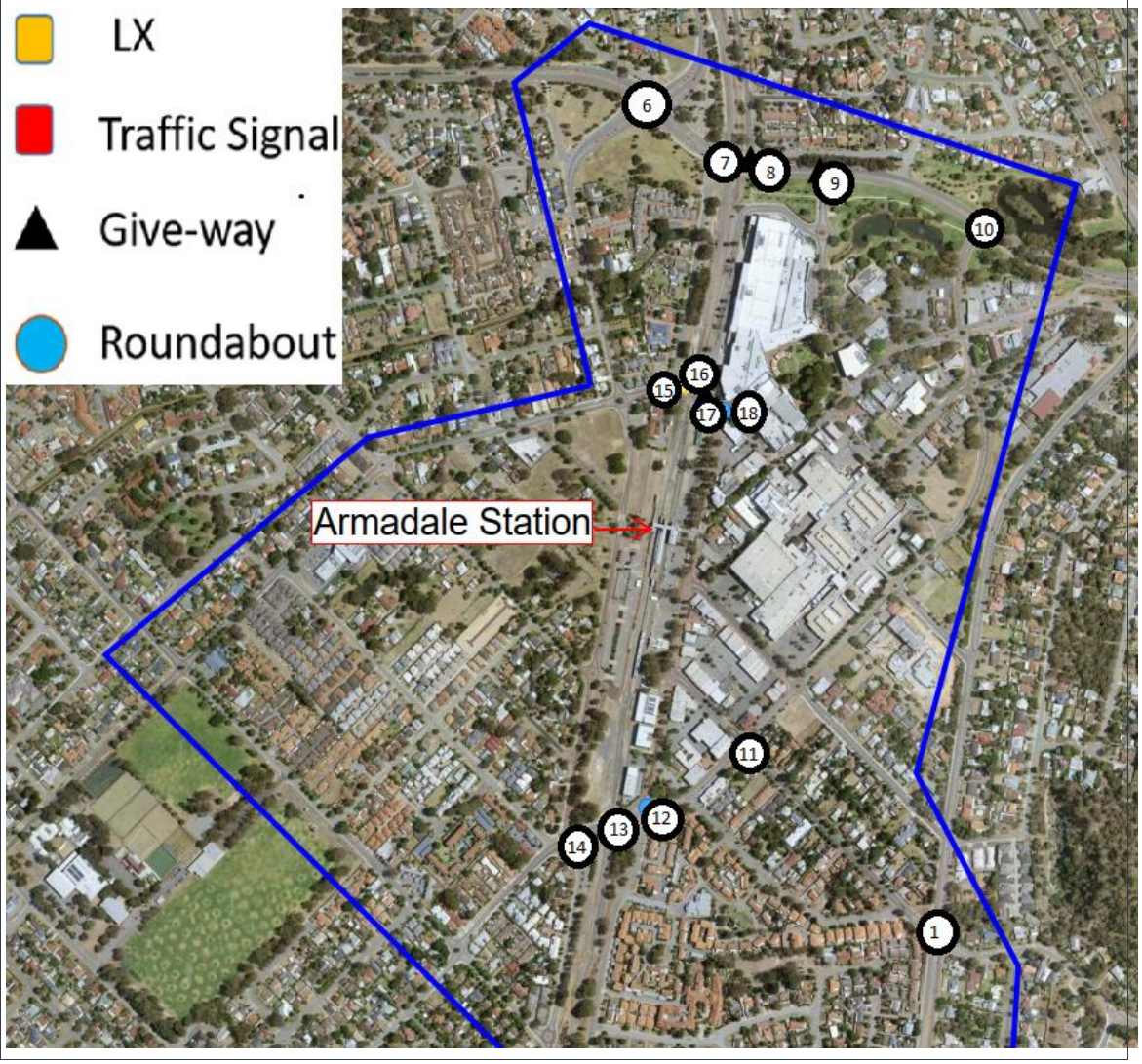
The scope of the analysis in this report (as requested in the TMIF) differs from that completed to inform the concept design in that it covers a much larger geographical area, somewhat distant from the station precincts. It has been assumed this has been requested to be analysed as the potential “area of influence” of the BRE project that is not just focussed on access to and from the stations, but considers areas where level crossings may be removed, or locations that may be physically impacted by the provision of an elevated rail line.

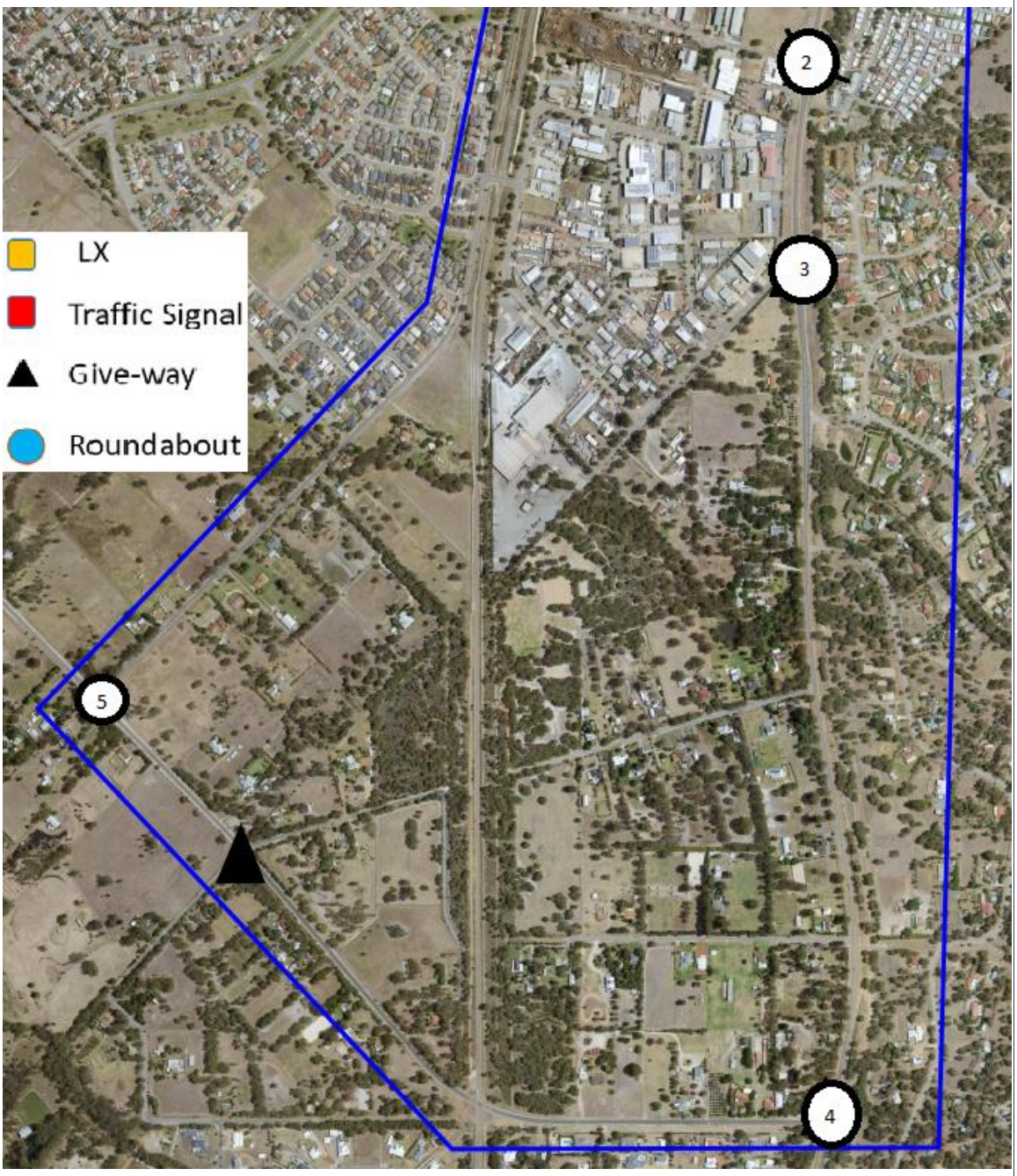
1.3 Project Location and Modelling Area

The location of the intersections modelled in SIDRA are shown in Table 1.1. Locations have been numbered with the corresponding locations detailed following the Table.

Table 1.1 Modelled Location and Area

Project Name	**Armadale rail extension**
Project area – Overall (refer to enlarged area for detail for the northern and southern zones)	

Project Name	Armadale rail extension
Project Area – Northern zone	

Project Name	Armadale rail extension
Project Area – Southern zone	
Local Government Area	City of Armadale
Suburb	Armadale
Main Corridors	Armadale Road, South Western Highway (SWH), Forrest Road and Church Avenue
Secondary Roads	Eleventh Road, Railway Parade, William Road, Orchard Avenue and Wungong Road

As specified in the TMIF for this project received from MRWA, some intersections have been modelled stand-alone, and others as part of a network. These models have been used to test Do Nothing and Proposed future scenarios.

The stand-alone intersections for which the SIDRA models have been developed are:

1. SWH (South Western Highway)/ William Street/ Bedfordale Hill Road
2. SWH/ Dickens Place
3. SWH/ Stone Street
4. SWH/ Eleventh Road
5. Eleventh Road/ Wungong Road.

Several intersections have been modelled as part of networks as listed below.

Armadale Road network consisting:

6. Armadale Road/ Abbey Road/ Railway Ave
7. Armadale Road Level Crossing
8. Armadale Road/ Streich Avenue
9. Armadale Road/ Orchard Avenue
10. Armadale Road/ Church Avenue.

Church Avenue network consisting:

11. Church Avenue/ William Street
12. Church Avenue/ Hobbs Drive/ Commerce Avenue
13. Church Avenue Level Crossing
14. Church Avenue/ Wungong Road/ Green Avenue.

Forrest Road network consisting:

15. Forrest Road/ Aragon Court
16. Forrest Road Level Crossing
17. Forrest Road/ Third Road/ Neerigen Street
18. Third Road/ Commerce Avenue/ Supermarket Access.

1.4 Modelled Scenarios

Following confirmation from the PTA that Armadale Station will be elevated and the level crossings of Armadale Road, Forrest Road and Church Avenue will be grade separated, the following options have been modelled, using the previously approved base models:

- 2026 AM peak hour – Do Nothing scenario (LX at grade and grade separated)
- 2026 PM peak hour - Do Nothing scenario (LX at grade and grade separated)
- 2026 AM peak hour – Do Something scenario (grade separated)
- 2026 PM peak hour – Do Something scenario (grade separated)
- 2036 AM peak hour – Do Nothing scenario (LX at grade and grade separated)
- 2036 PM peak hour - Do Nothing scenario (LX at grade and grade separated)

— 2036 AM peak hour – Do Something scenario (grade separated)

— 2036 PM peak hour – Do Something scenario (grade separated).

In the absence of "without BRE" ROM24 model outputs provided as part of the project, the Do Nothing modelling utilises the project scenario ROM24 outputs and analyses them on the existing intersection / road layouts. It is acknowledged this is not a perfect analysis. It is expected however that due to the limited increase in car parking at the rail stations, and a focus in the future on more sustainable modes for access to the stations the traffic impact associated purely with the project will be limited, and the future year analysis results are expected to be more heavily influenced by general traffic growth in the ROM24 outputs.

This Do Nothing scenario was not requested in the TMIF, but has been carried out using the available information to provide an indication and inform the next steps of the project and the area over which the BRE will be responsible for providing road network upgrades.

The Do Something scenario applies the future year ROM24 outputs to upgraded road and intersection layouts to identify what additional infrastructure provision may be required to accommodate the future year traffic demands, on the area specified in the TMIF.

2 Methodology

2.1 Background

To satisfy the project requirements the following tasks have been undertaken for this project to identify the expected future year performance of the subject intersections:

— The base SIDRA modelling was calibrated, validated and approved by Main Roads WA. This modelling is complete and is documented in *PS125110-PAM-REP-002 RevF Public Transport Authority – Armadale Rail Extension, Sidra Base Model Calibration and Validation Report, WSP, 2021*.

— Future year traffic forecasts were derived using the MRWA Urban Road Planning (URP) method with volume outputs from ROM24 used as a base for those calculations. The volumes have been reviewed and approved by MRWA for use in the proposed models. This is further detailed in Section 3.

— Do Nothing SIDRA models were developed using the approved future year volumes, testing the existing intersection layouts with LX at grade and grade separated configurations.

— A review of the Do Nothing results was carried out to determine if the existing layout can accommodate the future year demands. Where the demands could be accommodated, no further analysis was undertaken.

— Do Something SIDRA models (grade separated option) were developed using the approved future year volumes for intersections and networks where the future year demands could not be accommodated in the existing layout. This further analysis was conducted to determine a theoretical layout which could accommodate the future year traffic volumes. This analysis considered all at-grade intersection layout options (priority controlled, roundabout and traffic signals).

— Reporting of the above (this report) documenting the results.

The above steps were carried out in the context of the MRWA provided TMIF. The final TMIF is provided in Appendix A.

2.2 Next Steps

It should be noted that the analysis contained in this report has been conducted somewhat independent of any design work. It has been a stand-alone task, with the outputs intended to inform the next stages of project development. As such, WSP have considered all potential at grade intersection forms as potentially implementable and arrived at the proposed future year layout following an incremental improvement approach whereby we have added minimum additional capacity to the intersections until they function satisfactorily at an intersection level, for further investigation.

In the context, it is suggested the key next steps are:

1. Work with MRWA and the local government to determine which intersection upgrades are the responsibility of the project, noting that some intersections analysed are remote from the project, and that the traffic forecasts used for assessment include general region-wide traffic changes in addition to those instigated by the project.
2. Review the ability to implement / construct the potential future year layouts in an engineering constraints context..

3 Future year traffic forecasts

3.1 Forecast Development

The opening year for BRE is expected to be 2024. For the purposes of this assessment however PTA have provided WSP with instruction to adopt 2036 at the Opening Year + 10 years assessment scenario as this aligned directly with a ROM24 outputs and allowed for ease of MRWA traffic volume endorsement. In this context, 2026 has also been adopted as the opening year scenario for consistency, which allows for a little contingency also.

The future year traffic forecasts to be adopted for assessment of 2026 and 2036 were calculated using the MRWA Urban Road Planning (URP) method. This method compares base and future year strategic model data to develop demands for the individual sites based on comparison with observed traffic patterns and allows the ROM24 data to be calibrated for adoption in the modelling. As a result, ROM24 2021, 2031 and 2036 project scenario data and existing survey data were used as a basis from which to calculate and calibrate the final volumes.

As part of the development of the project, MRWA incrementally updated the ROM24 model specifically for the Byford Rail Extension project, which included making changes to the land uses around the station and implementing the project road network configuration changes. These changes were added to the existing ROM24 configuration. As such, it should be noted that it is not possible to identify which traffic volumes are associated with the BRE project and which will occur irrespective of the project, since no ROM24 were provided without the project changes.

In order to estimate opening year (assumed 2026 for this analysis), the provided 2021 and 2031 ROM24 data sets were utilised to determine linear growth and estimate 2026 ROM24 data. This was then used in the URP spreadsheets to develop peak hour turning counts for the opening year, in the same way as the other future years were determined and approved.

In instances where ROM24 data was not available for certain roads on intersection approaches (such as minor roads), a uniform growth factor of 3% per year has been adopted for those links as a base, and further calibration was undertaken as instructed by MRWA Planning and Technical Services. The final volumes have been reviewed and approved by MRWA for use in the future year models, as provided in Appendix A.

Appendix B shows the final 2026 and 2036 traffic volumes used in the proposed SIDRA models for both the Do Nothing and Do Something scenarios. It should also be noted that the traffic volumes provided include all vehicle classes with the volumes for different classes being proportioned using existing data and incorporated into the model.

In addition, further forecast traffic year volumes have been determined including 2031 and 2041 adopting the same methodology.

3.2 Network flow inconsistencies

While undertaking the base network modelling for the Armadale study area, a “network peak” was adopted for each of the network models as opposed to modelling each of the individual intersection peak periods in agreement with MRWA Network Operations and as approved in the base modelling. This is considered to more accurately reflect the operation of the network, and also seeks to reduce differences in approach and departure volumes between intersections in the network.

Despite the adoption of a network peak, some volumes differences still existed in the base modelling when comparing intersection departure and approach volumes. From the analysis, the reasons for these inconsistencies were noted as:

1. Armadale Road network
    - A residential access at Fountains Court exists between Armadale Road/ Orchard Avenue and Armadale Road/ Church Avenue.

2. Church Avenue network
    - A residential access at John Street exists between Church Avenue/ Commerce Avenue/ Hobbs Drive and Church Avenue/ William Street.
3. Forrest Road network
    - While there are inconsistencies, they are relatively negligible. As there are no intermediary intersections between sites, this is likely attributed to survey limitations.

The above issues were raised as part of the base modelling approval process, where these inconsistencies were noted and accepted by MRWA.

The future year traffic volume forecasting exercise was undertaken by adopting the URP method for the future years. The URP growth method uses existing traffic volumes at the intersections being forecast, to calibrate the ROM24 data.

For individual intersections, there is no differentiation to make between intersection and network peak, and so the existing traffic data to be adopted for use in the forecasting is clear. In the development of the demands for use in a network model, where the approved base models were completed adopting a network peak, a choice can be made for the basis of the ROM24 forecasting between adopting the network peak to align with the base model development, or to adopt the individual intersection peak. WSP initially adopted the former, to remain consistent with the base modelling and to reduce the exacerbation of any flow differences in the base through forecasting to future years.

As part of the future year forecast development, a review conducted by MRWA Planning and Technical Services on WSP's initial URP outputs identified that MRWA forecasts had adopted the individual intersection peak periods for the basis of the calculations and WSP were instructed to use this approach over the network peak approach. Whilst this creates greater inconsistency in the flows departing and approaching adjacent intersections than identified in the base modelling, PTA instructed WSP to adopt the intersection peak method for forecasting. Correspondence in this regard is provided in Appendix A.

In order to provide some context to the results in the proceeding sections of this report, Figure 3.1 to Figure 3.12 identify the level of flow inconsistencies in the 2026 and 2036 volumes being used for the analysis through adopting the individual intersection peaks. These volumes also include the adoption of the previously discussed 3% annual growth assumption in the absence of ROM24 on specific approaches or road links.

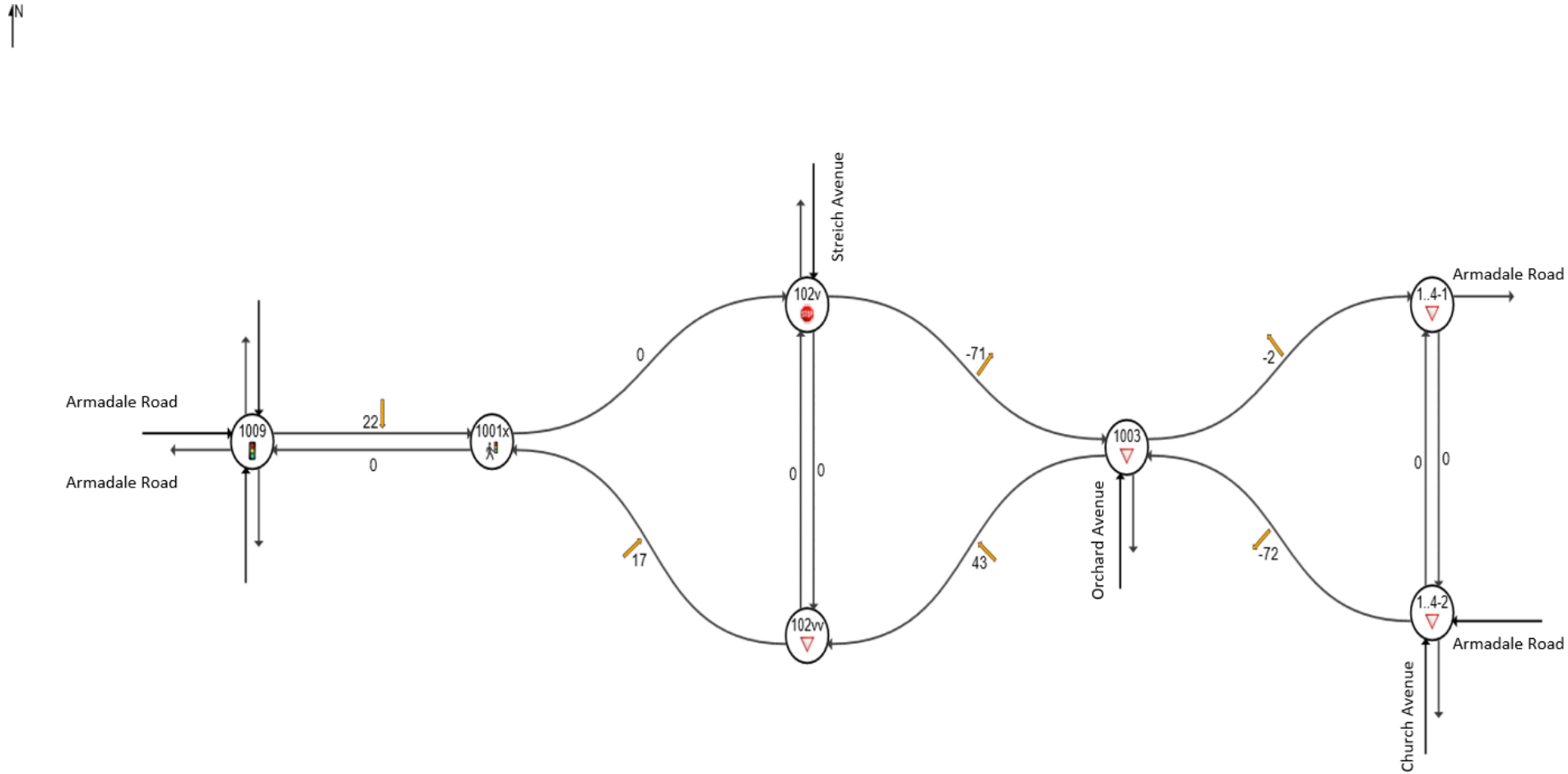


Figure 3.1 Armadale Road Network – Flow inconsistencies (vehicles) – 2026 AM Peak

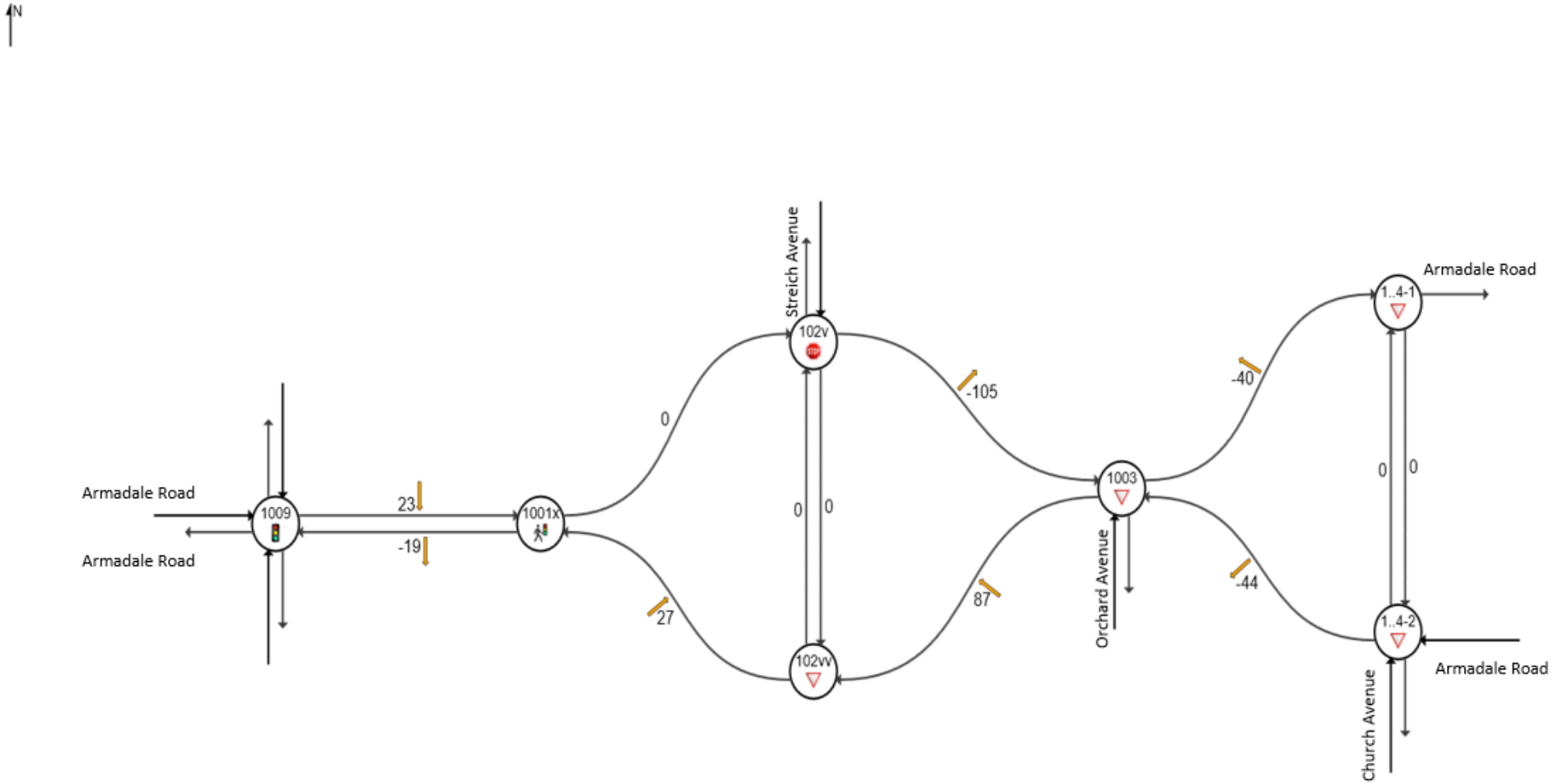


Figure 3.2 Armadale Road Network – Flow inconsistencies (vehicles) – 2026 PM Peak

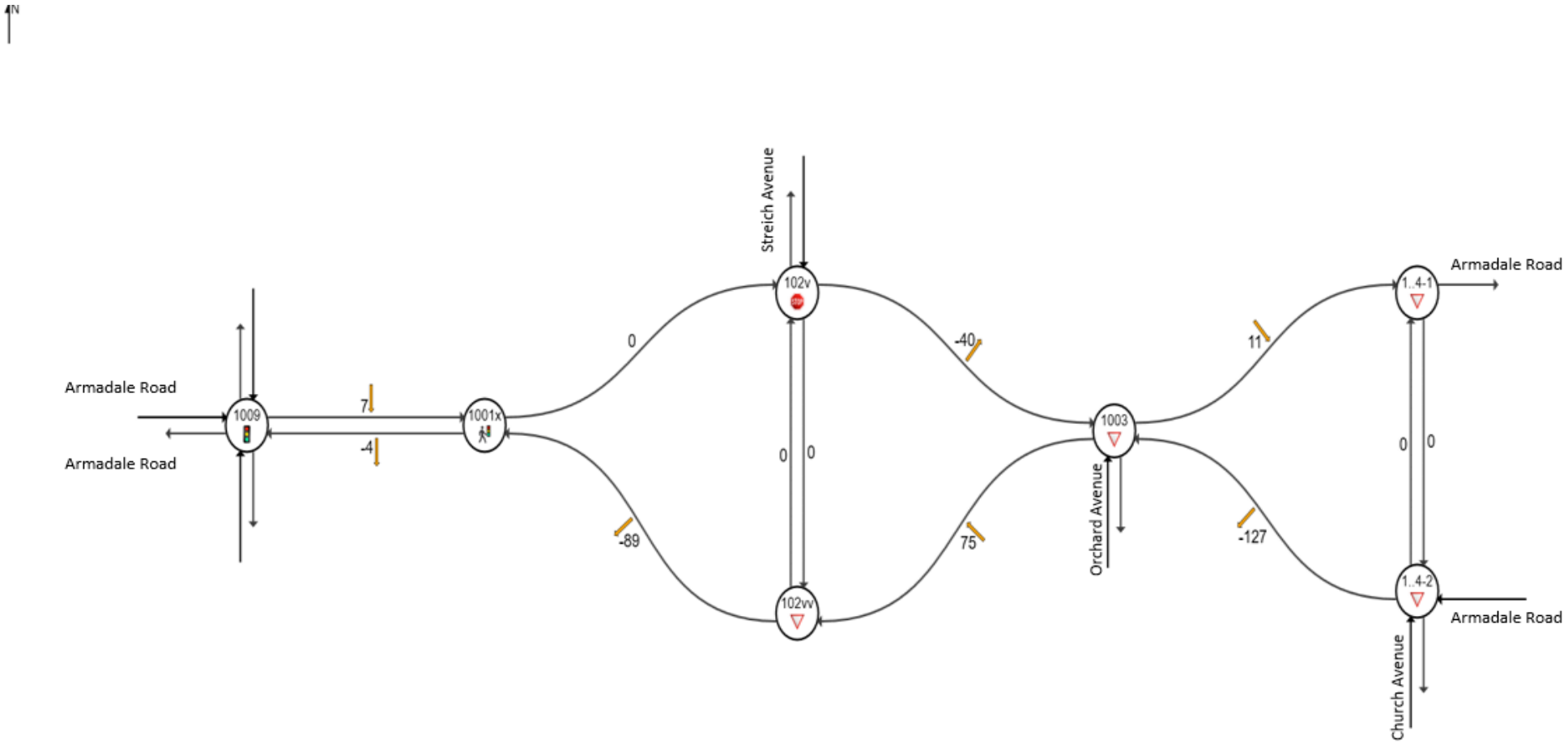


Figure 3.3 Armadale Road Network – Flow inconsistencies (vehicles) – 2036 AM Peak

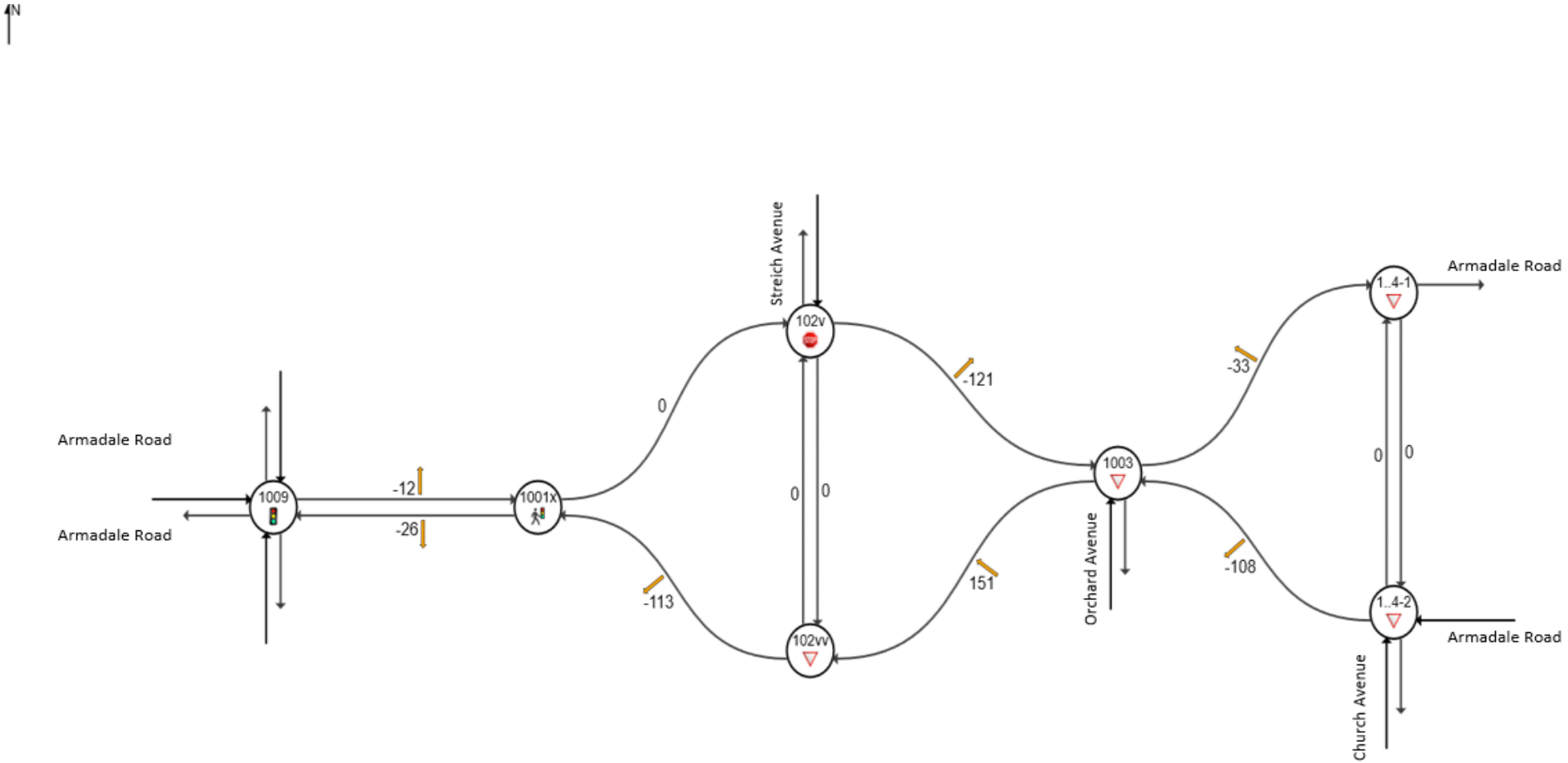


Figure 3.4 Armadale Road Network – Flow inconsistencies (vehicles) – 2036 PM Peak

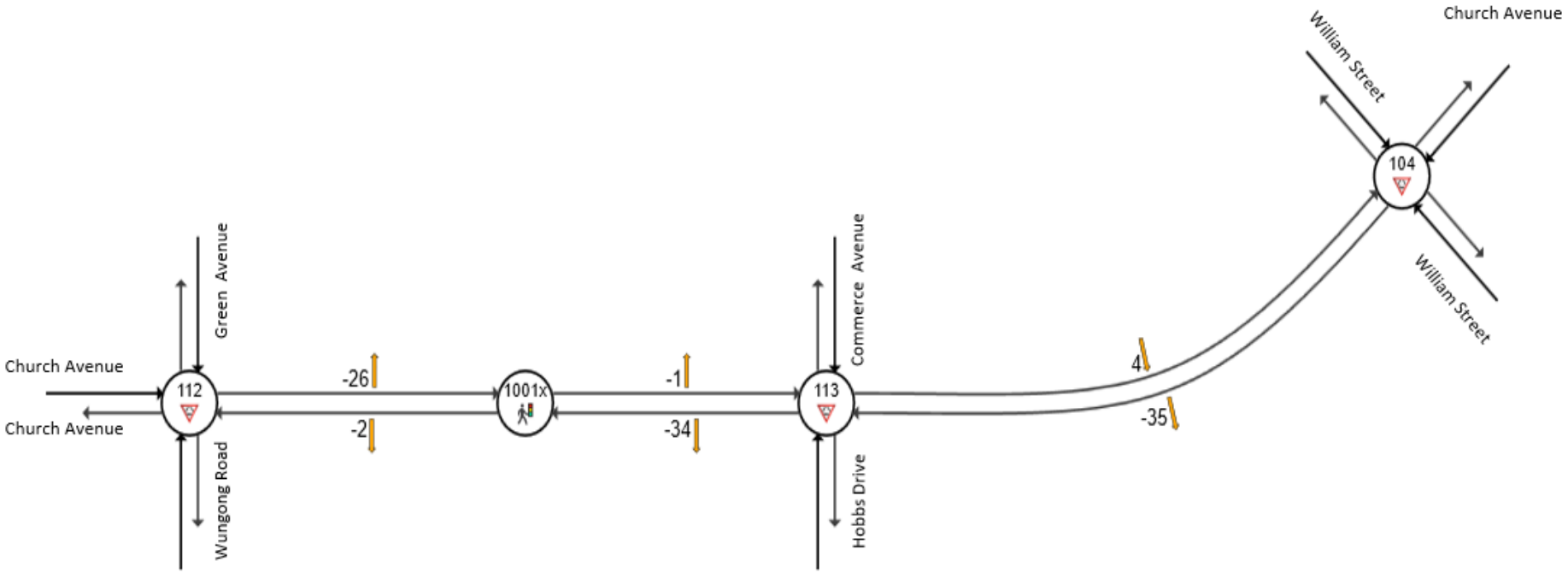


Figure 3.5 Church Avenue Road Network – Flow inconsistencies (vehicles) – 2026 AM Peak

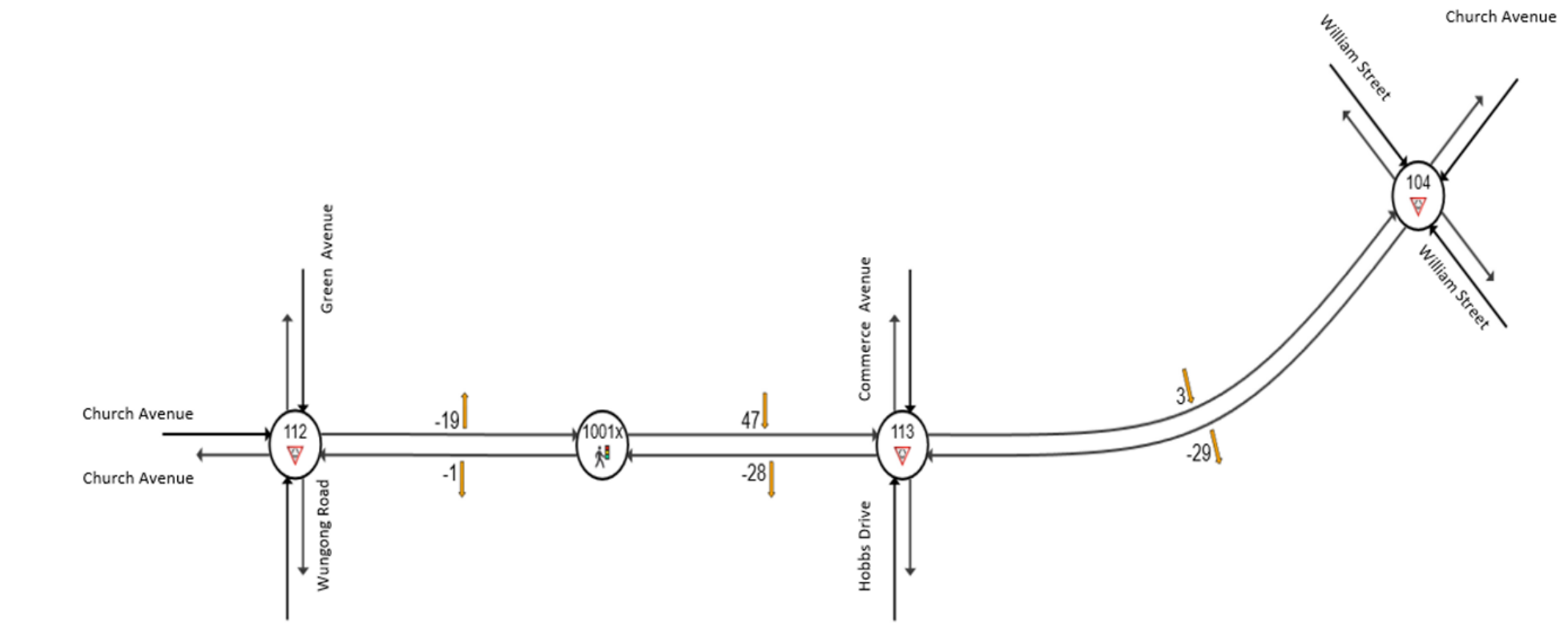


Figure 3.6 Church Avenue Road Network – Flow inconsistencies (vehicles) – 2026 PM Peak

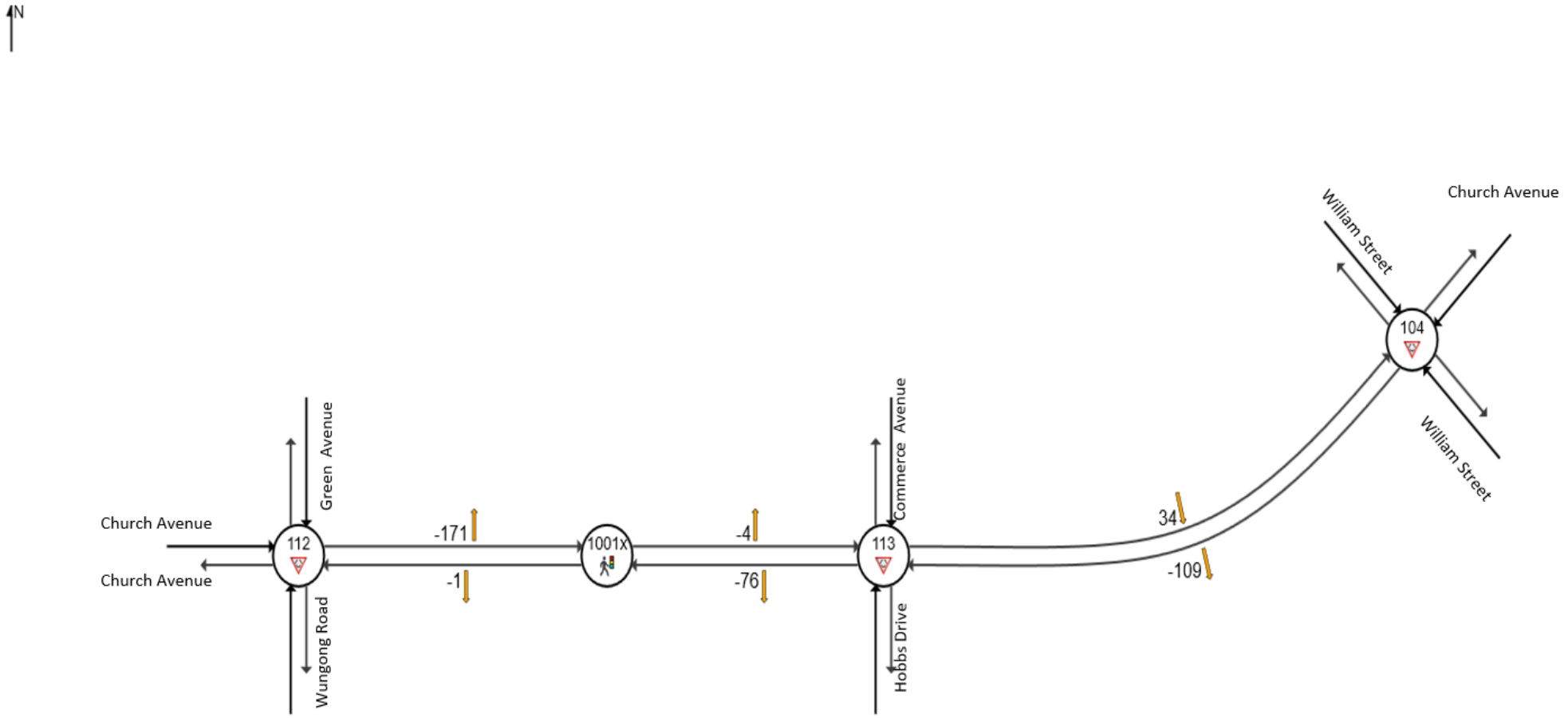


Figure 3.7 Church Avenue Road Network – Flow inconsistencies (vehicles) – 2036 AM Peak

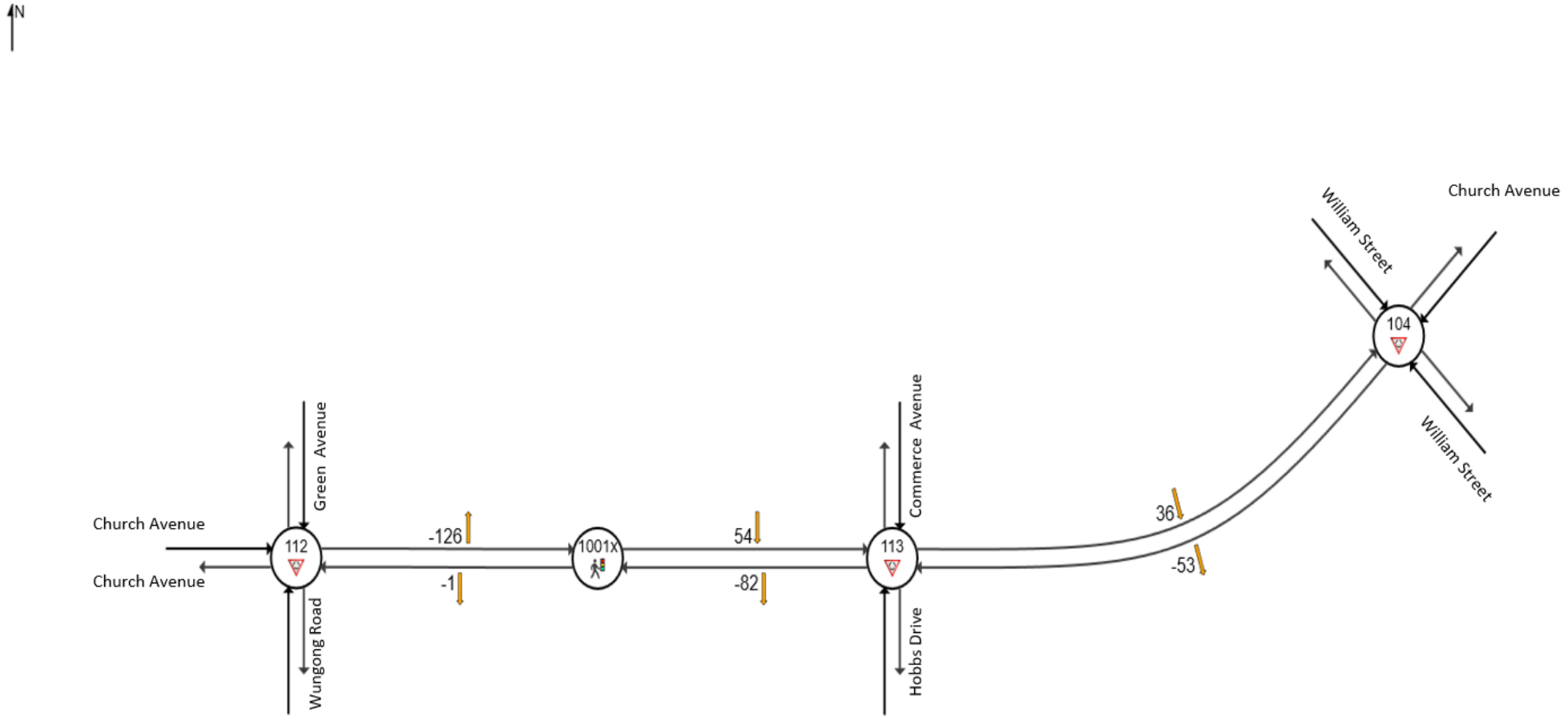


Figure 3.8 Church Avenue Road Network – Flow inconsistencies (vehicles) – 2036 PM Peak

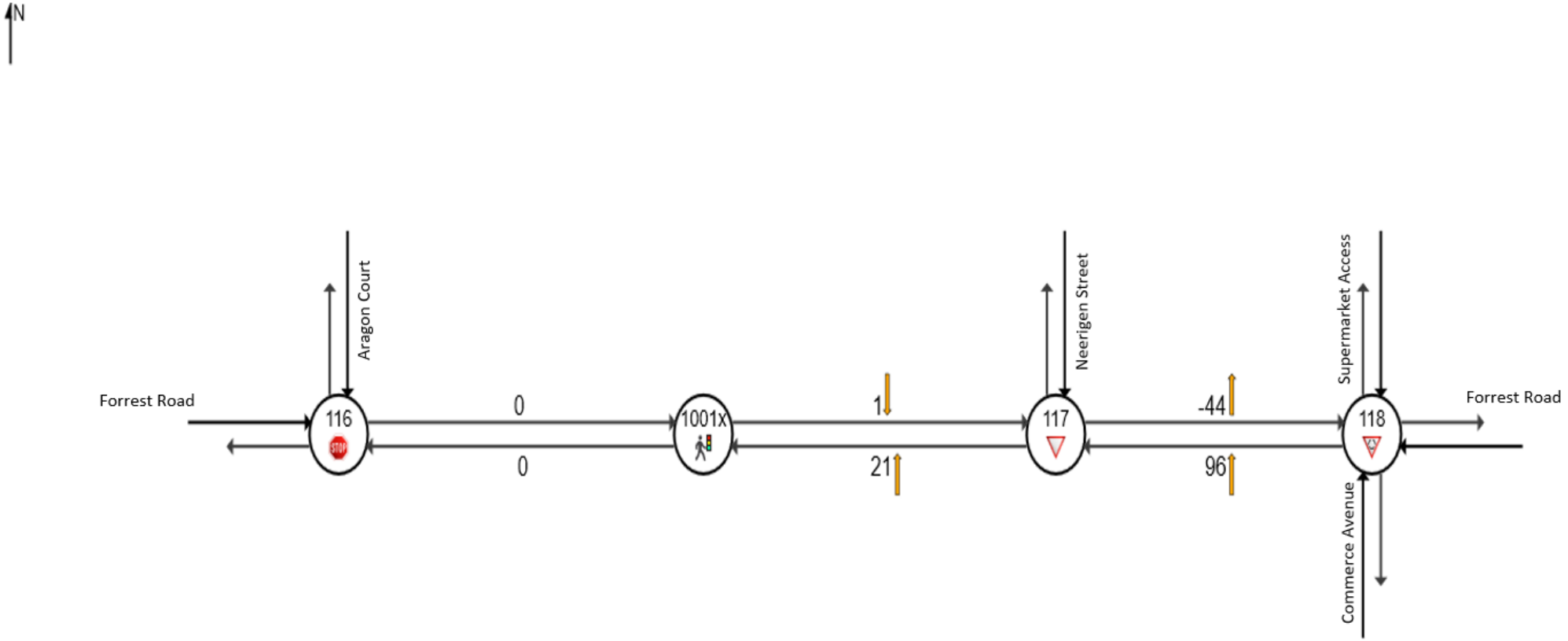


Figure 3.9 Forrest Road Network – Flow inconsistencies (vehicles) – 2026 AM Peak

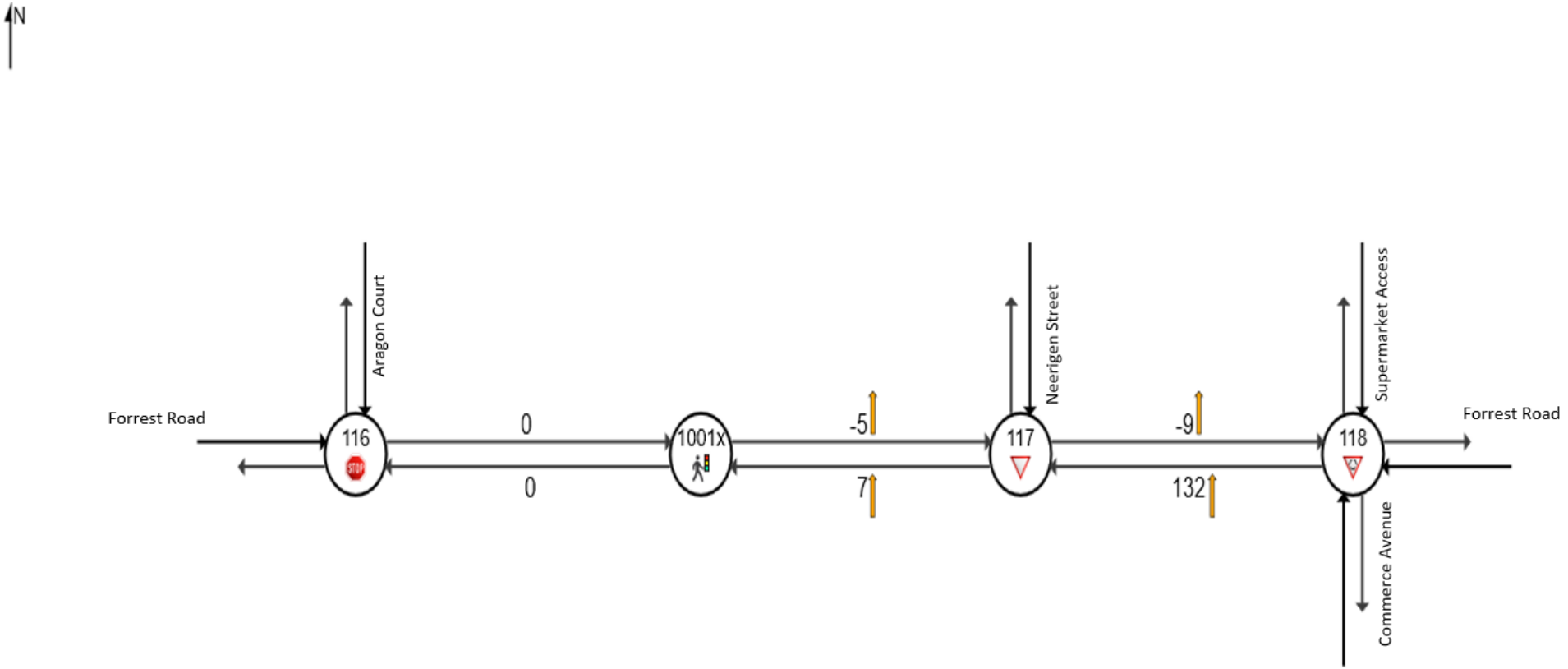


Figure 3.10 Forrest Road Network – Flow inconsistencies (vehicles) – 2026 PM Peak

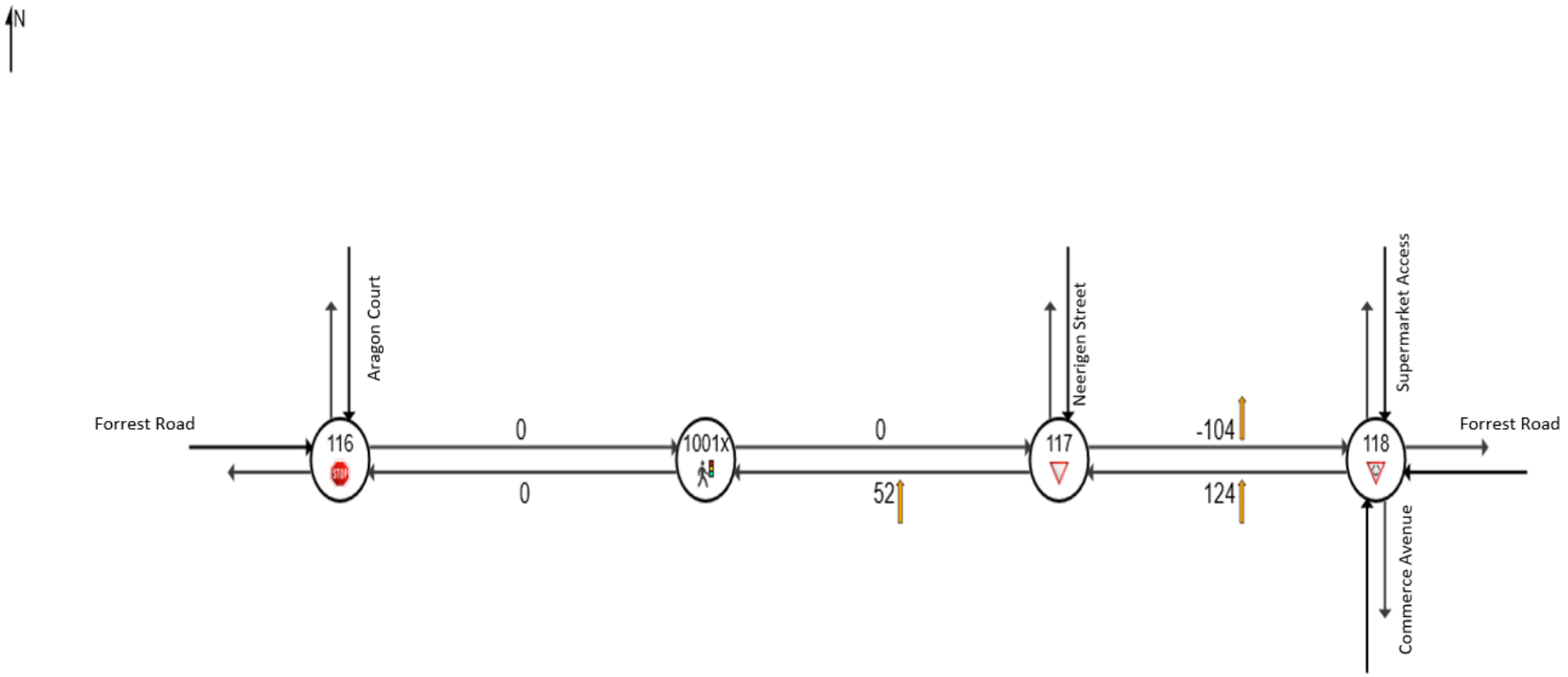


Figure 3.11 Forrest Road Network – Flow inconsistencies (vehicles) – 2036 AM Peak

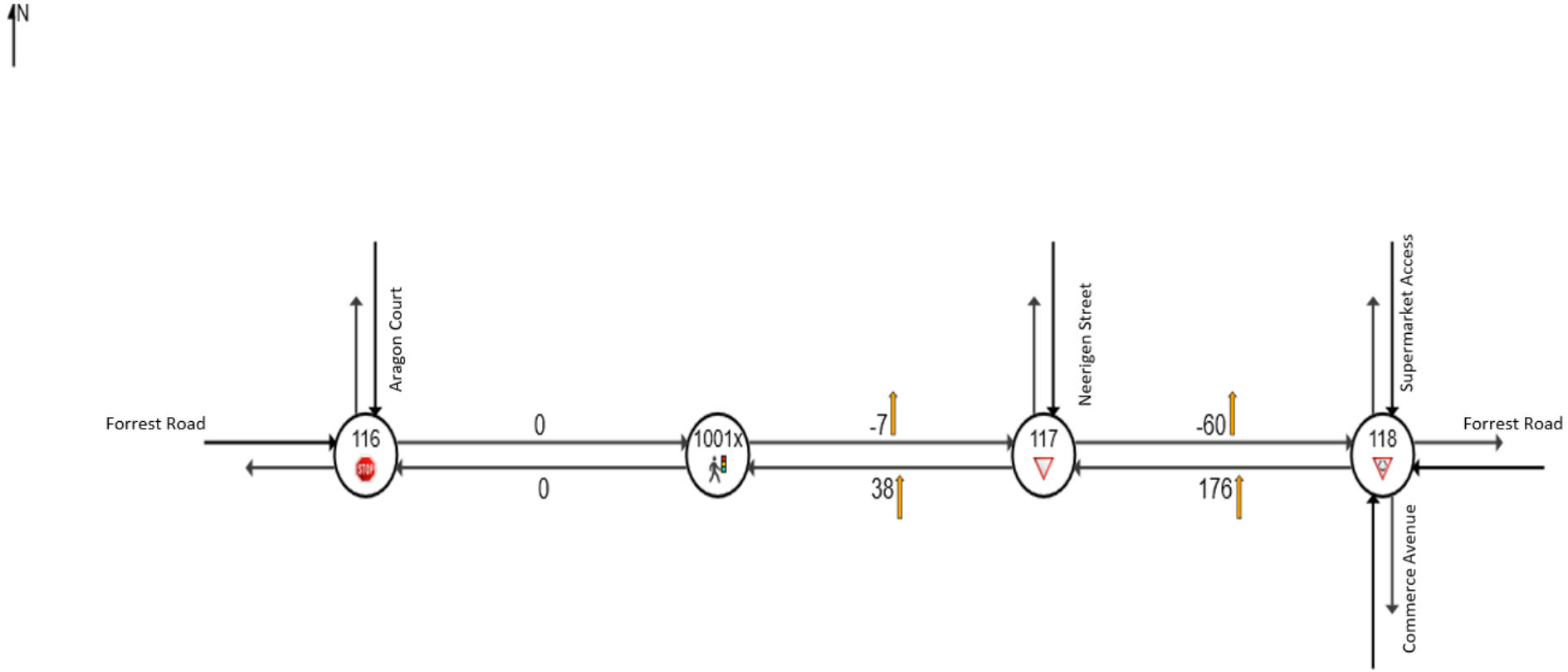


Figure 3.12 Forrest Road Network – Flow inconsistencies (vehicles) – 2036 PM Peak

4 Individual Intersection Modelling Results – Opening year (2026)

4.1 Introduction

This section details the network and intersection performance at the prescribed locations that were required to be modelled as per the TMIF requirements under the 2026 traffic forecasts for both the Do Nothing and Do Something (grade separated scenarios) in the AM and PM peak periods.

This section also provides recommendations on changes to geometry and intersection control wherever necessary/ appropriate, noting the previous comments with regards to context in which this has been executed.

Summary results are provided in this section of the report for ease of reference, with detailed outputs provided in Appendix C.

4.2 SWH/ William Street/ Bedfordale Road

4.2.1 2026 Do Nothing Scenario

Figure 6.1 represents the existing layout at the intersection of SWH/ William Street/ Bedfordale Hill Road.

Figure 4.2 and Figure 4.3 show the degree of saturation at the SWH/ William Street/ Bedfordale Hill Road intersection in the AM and PM peak periods respectively in the 2026 Do Nothing scenario. In this scenario, the intersection is forecast to operate within capacity in both the AM and PM peaks with the highest degree of saturation being 0.664 and 0.830 respectively. The highest delay is forecast to be just over a minute in the PM peak on the left turn only lane of the east approach. Queuing is forecast to be reasonable with the longest modelled queue (95% back of queue) forecast to be around 150m on the south approach in the AM peak.

Due to the modelled intersection performance and the available capacity, no additional infrastructure upgrade is forecast to be needed for the year 2026. It is noted that whilst the intersection operates within capacity, further signal optimisation with LinSig might be required to optimise the signals to the satisfaction of MRWA.

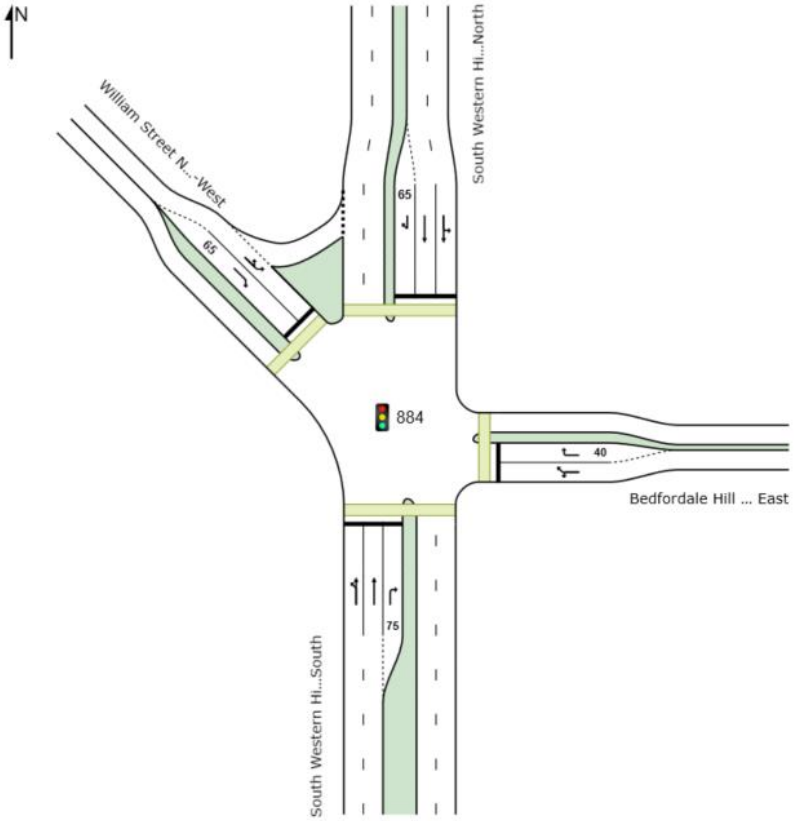


Figure 4.1 SWH/ William St/ Bedfordale Hill Rd – Existing intersection layout

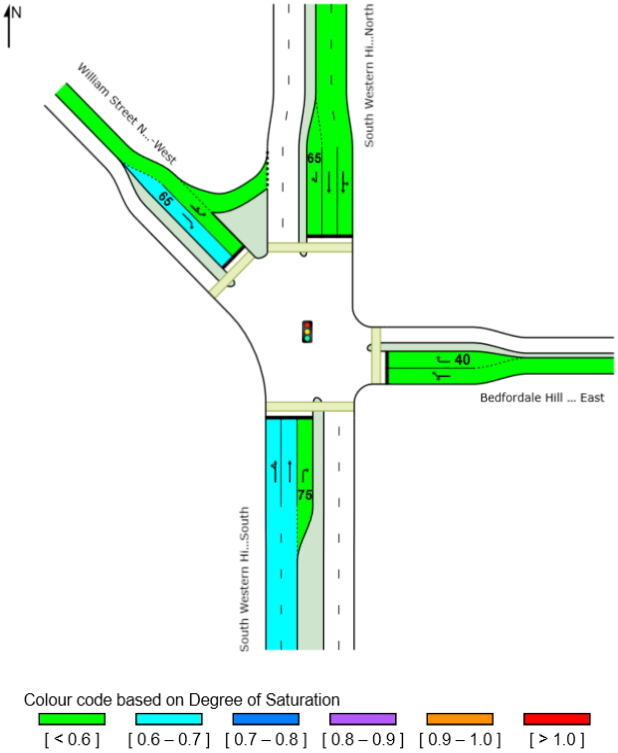


Figure 4.2 Degree of Saturation – AM Peak – Do Nothing

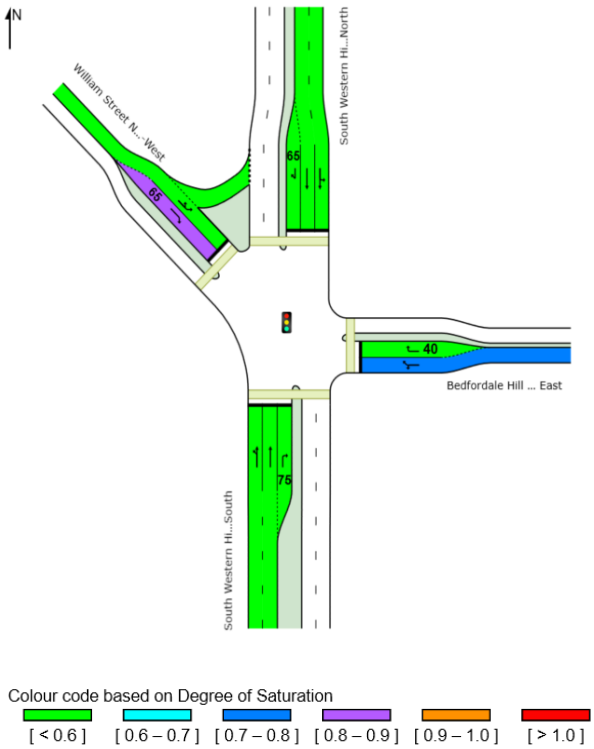


Figure 4.3 Degree of Saturation – PM Peak – Do Nothing

4.3 SWH/ Dickens Place

4.3.1 2026 Do Nothing Scenario

Figure 4.4 shows the existing layout at the intersection of SWH/ Dickens Place.

Figure 4.5 and Figure 4.6 show the degree of saturation at the SWH/ Dickens Place intersection in the AM and PM peak periods respectively in the 2026 Do Nothing scenario. In this scenario, the intersection is forecast to operate within capacity in both the AM and PM peaks with the highest degree of saturation being 0.621 and 0.653 respectively. However, it should be noted that the west approach in the AM peak is forecast to experience delay of up to 80 seconds resulting in this approach being forecast to operate at LoS F. This is due to the large volume of through traffic on SWH meaning right turning vehicles from Dickens Place cannot find a gap in traffic on SWH.

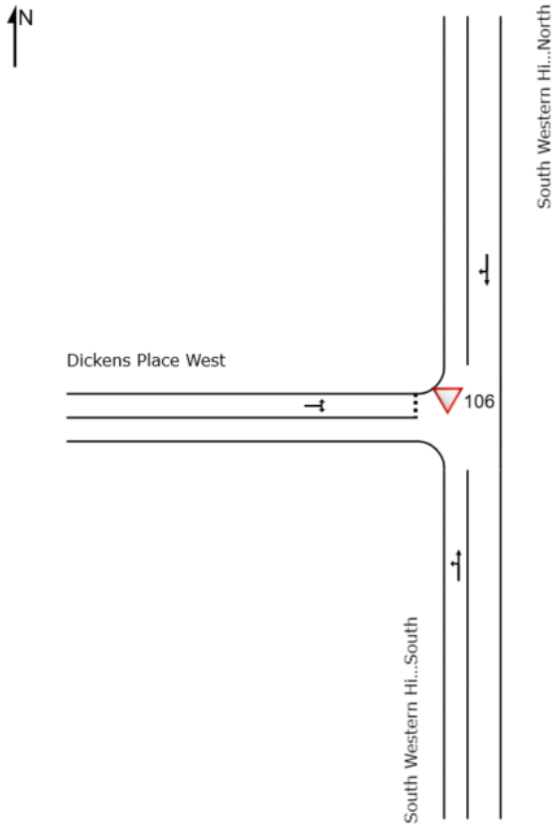


Figure 4.4 SWH/ Dickens Pl – Existing intersection layout

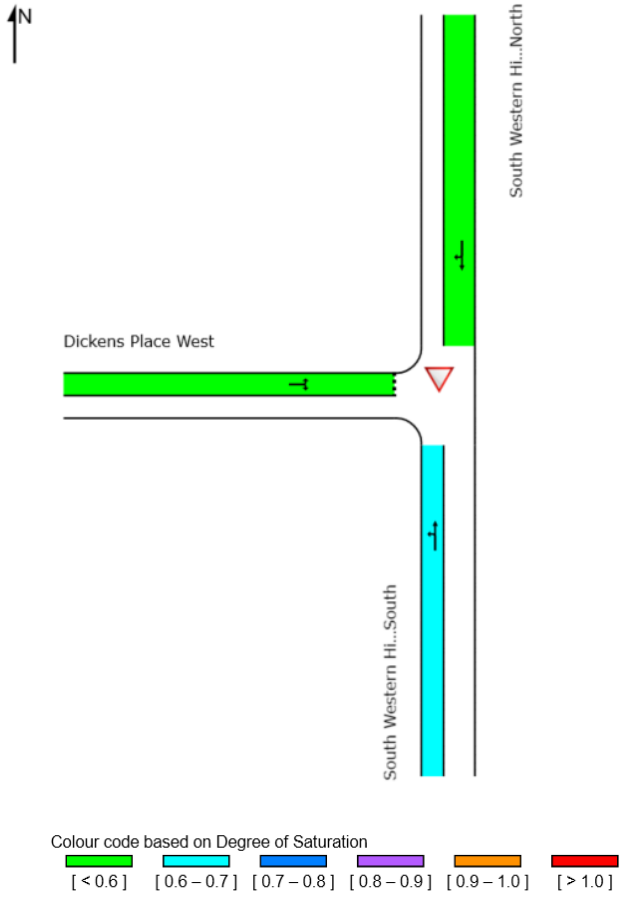


Figure 4.5 Degree of Saturation – AM Peak – Do Nothing

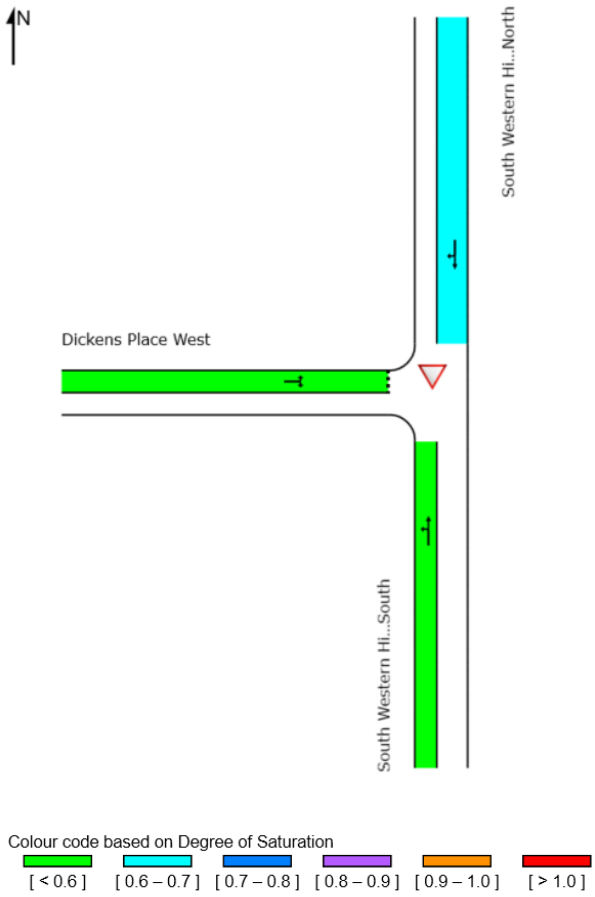


Figure 4.6 Degree of Saturation – PM Peak – Do Nothing

4.3.2 2026 Do Something Scenario

A Do Something scenario was assessed for this intersection to reduce the delay on Dickens Place which is forecast to result in the approach operating at LoS F in the 2026 AM Do Nothing scenario.

It was noted that in the 2036 ROM24 plots SWH has been upgraded to two lanes in each direction. However, due to no 2026 ROM24 plots being made available, there was uncertainty regarding this duplication of SWH by the year 2026. Therefore, two Do Something models were created where one model assumes that SWH will be duplicated in 2026 and the other model assumes that SWH will remain a single lane carriageway.

In both the dual lane carriageway and single lane carriageway scenarios, turning pockets were provided for turning movements into Dickens Place and a right turn pocket was added for the right turning movement from Dickens Place. Additionally, the intersection was modelled as a two staged layout in SIDRA to replicate median storage being in place.

Figure 4.7 and Figure 4.8 represent the two stage proposed intersection layouts for SWH/ Dickens Place for the opening year 2026 with and without the duplication of SWH respectively.

Figure 4.9 and Figure 4.10 show the degree of saturation at the proposed two staged layout with SWH duplication while Figure 4.11 and Figure 4.12 show the degree of saturation at the proposed two staged layout of the SWH/ Dickens Place intersection without the SWH duplication in the AM and PM peak periods respectively in the 2026 Do Something scenario.

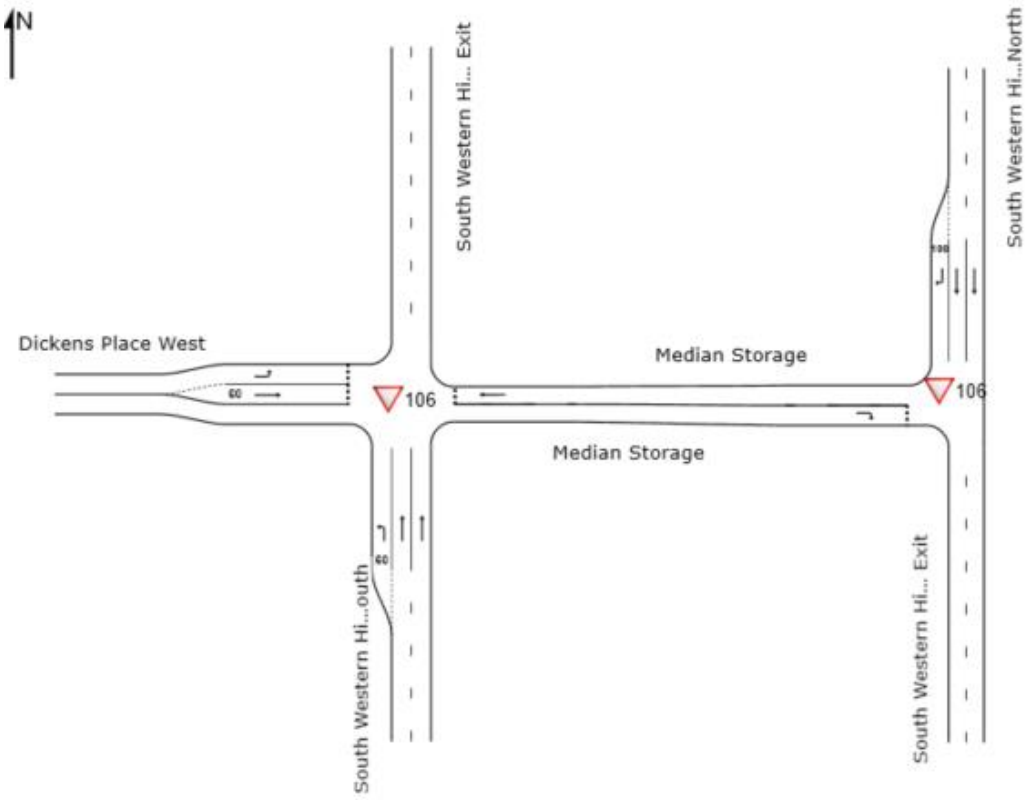


Figure 4.7 SWH/ Dickens Pl – two staged intersection layout – with SWH duplication

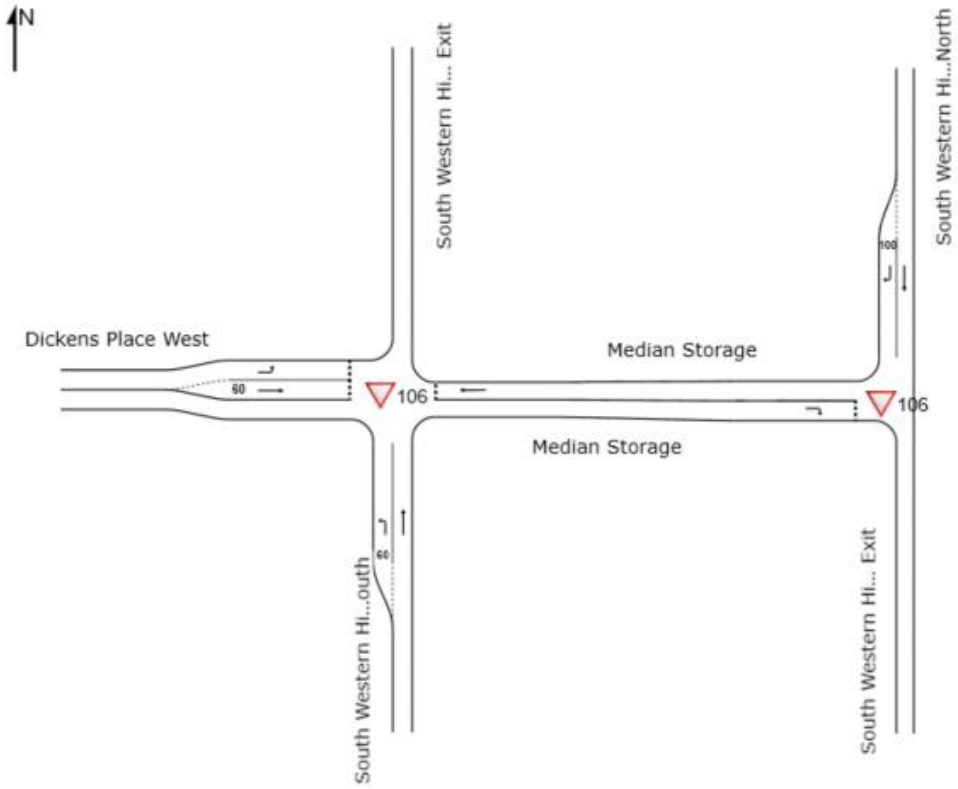


Figure 4.8 SWH/ Dickens Pl – two staged intersection layout – without SWH duplication

Figure 4.9 Degree of Saturation -SWH/ Dickens Pl – AM Peak - with SWH duplication

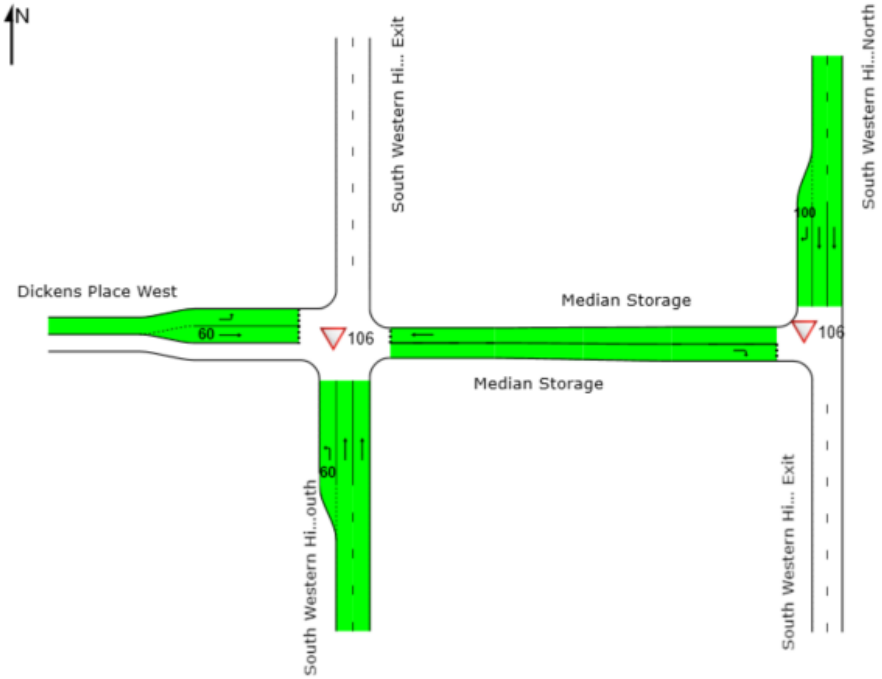


Figure 4.10 Degree of Saturation -SWH/ Dickens Pl – PM Peak - with SWH duplication

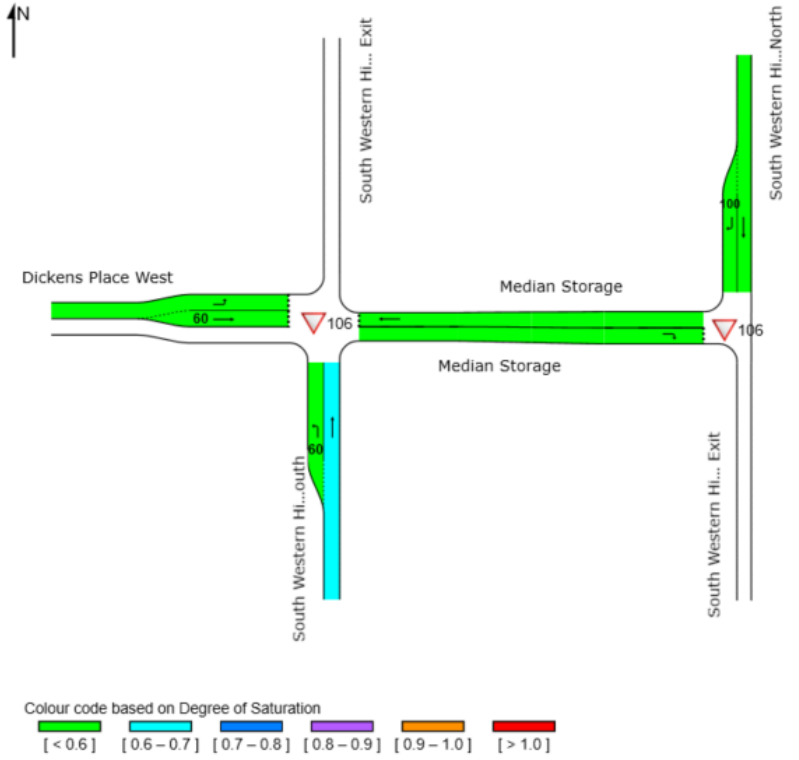


Figure 4.11 Degree of Saturation -SWH/ Dickens Pl – AM Peak - without SWH duplication

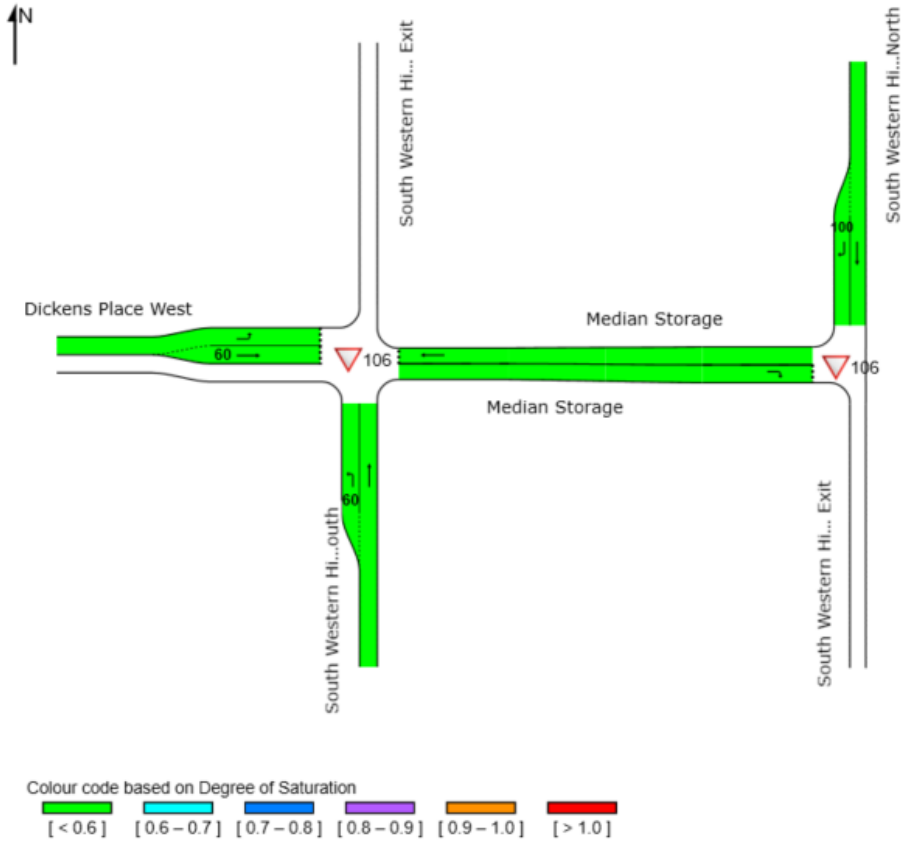


Figure 4.12 Degree of Saturation -SWH/ Dickens Pl – PM Peak - without SWH duplication

The intersection is forecast to operate within capacity in both dual and single lane configurations of SWH. Table 4.1 shows the intersection performance with and without the SWH duplication for the 2026 traffic forecasts.

Table 4.1 SWH/ Dickens Pl – proposed two stage Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Two staged with SWH duplication	A	0.306	1.4	A	0.283	1.7
Two staged without SWH duplication	A	0.612	1.5	A	0.567	1.6

As a result of the right turn from Dickens Place being two stages with the SWH duplication in place, the intersection is forecast to operate satisfactorily at LoS A in both peak hours. The intersection is forecast to operate within capacity with a maximum degree of saturation of 0.306 observed in the AM peak period and 0.283 observed in the PM peak period. The highest delay forecast for this option was for the left turn movement from Dickens Place into SWH with a delay of approximately 17 seconds and 10 seconds in the AM and PM peak periods respectively. The forecast queues are reasonable with the longest queue forecast to be around two metres on the west approach in the AM peak.

Without the SWH duplication, the intersection is forecast to operate at LoS A in both peak periods with a degree of saturation of 0.612 and 0.567 in the AM and PM peak periods respectively. Forecast delays and queues are significantly lower than in the Do Nothing scenario with the highest delay being 19 seconds on the west approach in the AM peak and highest queue being around three metres on the west approach in the AM peak.

4.4 SWH/ Stone Street

4.4.1 2026 Do Nothing Scenario

Figure 4.13 represents the existing layout at the intersection of SWH/ Stone Street.

Figure 4.14 and Figure 4.15 show the degree of saturation at the existing layout of the SWH/ Stone Street intersection in the AM and PM peak periods respectively in the 2026 Do Nothing scenario. In this scenario in both peak periods, the intersection is forecast to be over capacity in 2026 and operating at LoS F. The most significantly impacted approach is forecast to be the west approach due to the large volume of through traffic utilising SWH. This is due to the large volume of through traffic on SWH meaning right turning vehicles from Dickens Place cannot find a gap in traffic on SWH. This is forecast to lead to extensive queuing on the west approach with the longest forecast queues being up to 800m.

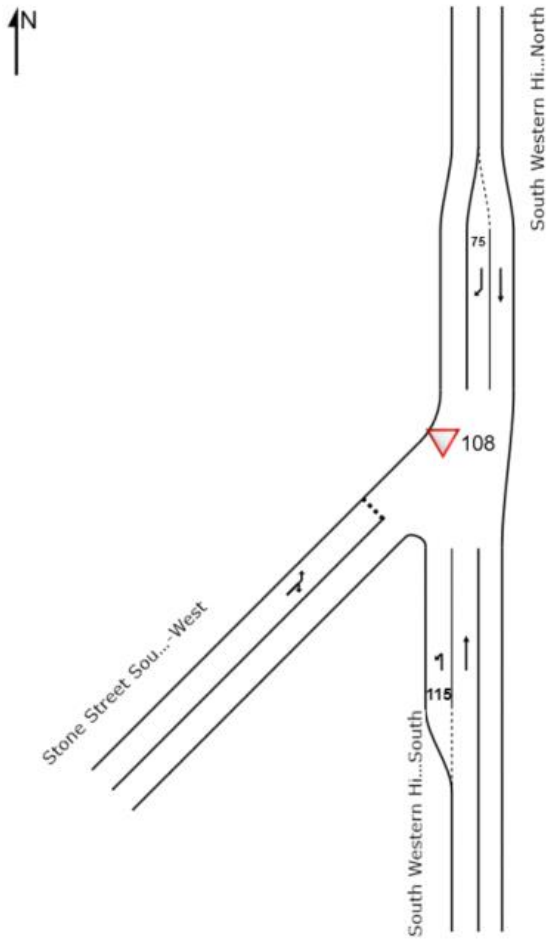


Figure 4.13 SWH/ Stone St – Existing intersection layout

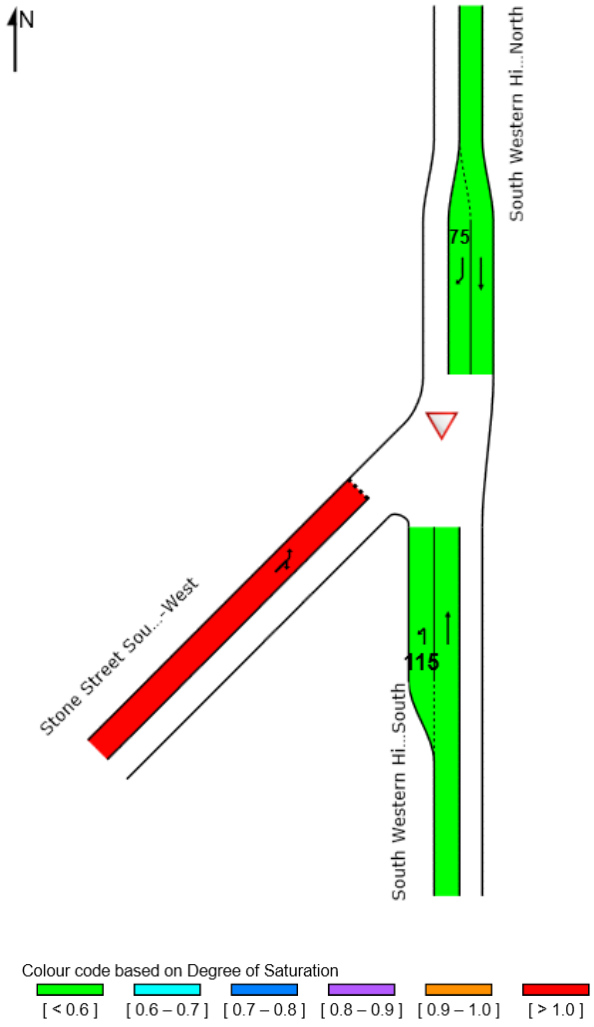


Figure 4.14 Degree of Saturation – AM Peak – Do Nothing

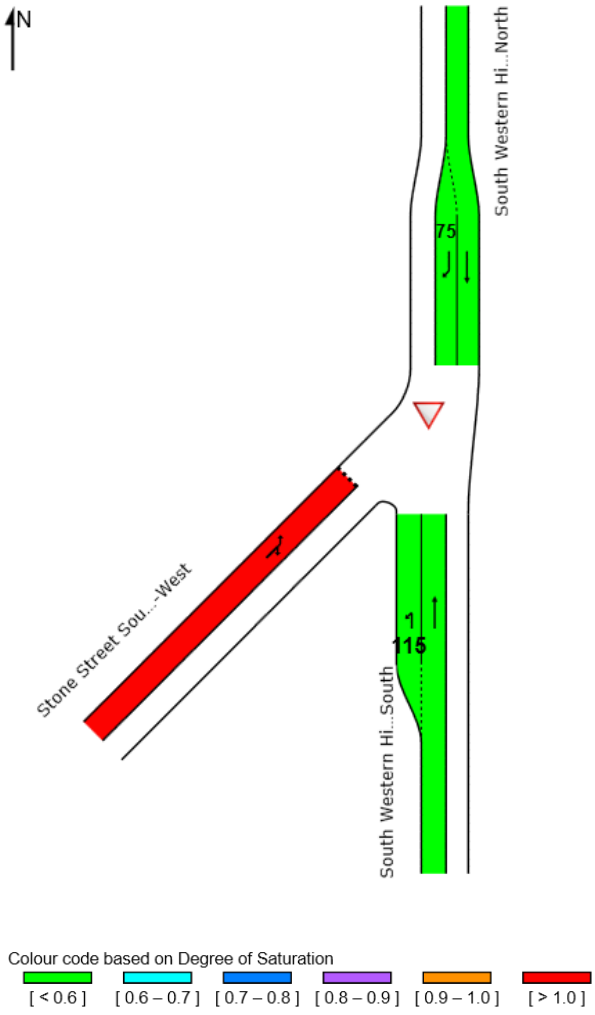


Figure 4.15 Degree of Saturation – PM Peak – Do Nothing

4.4.2 Do Something Scenario

A Do Something scenario was assessed for this intersection to reduce the delay and increase the capacity on Stone Street which is forecast to operate at LoS F and above its capacity in both peaks in the Do Nothing scenario.

Again, two Do Something models were created where one model assumes that SWH will be duplicated by 2026 and the other assumes that SWH will remain a single lane carriageway. Pockets were added on SWH for turning movements into Stone Street. Following this, the intersection continued to perform within capacity. Therefore, a further intersection improvement was tested with a turn pocket added for the left turning movement from Stone Street into SWH. The intersection was modelled as a two staged layout in SIDRA to replicate median storage in both the single lane and dual lane carriage way options.

Figure 4.16 and Figure 4.17 represent the two stage proposed intersection layouts for the intersection of SWH/ Stone Street for the opening year 2026 with and without the duplication of SWH respectively.

Figure 4.18 and Figure 4.19 show the degree of saturation at the proposed two staged layout with SWH duplication and Figure 4.20 and Figure 4.21 show the degree of saturation at the proposed two staged layout of the SWH/ Stone Street intersection without the SWH duplication in the AM and PM peak periods respectively in the 2026 Do Something scenario.

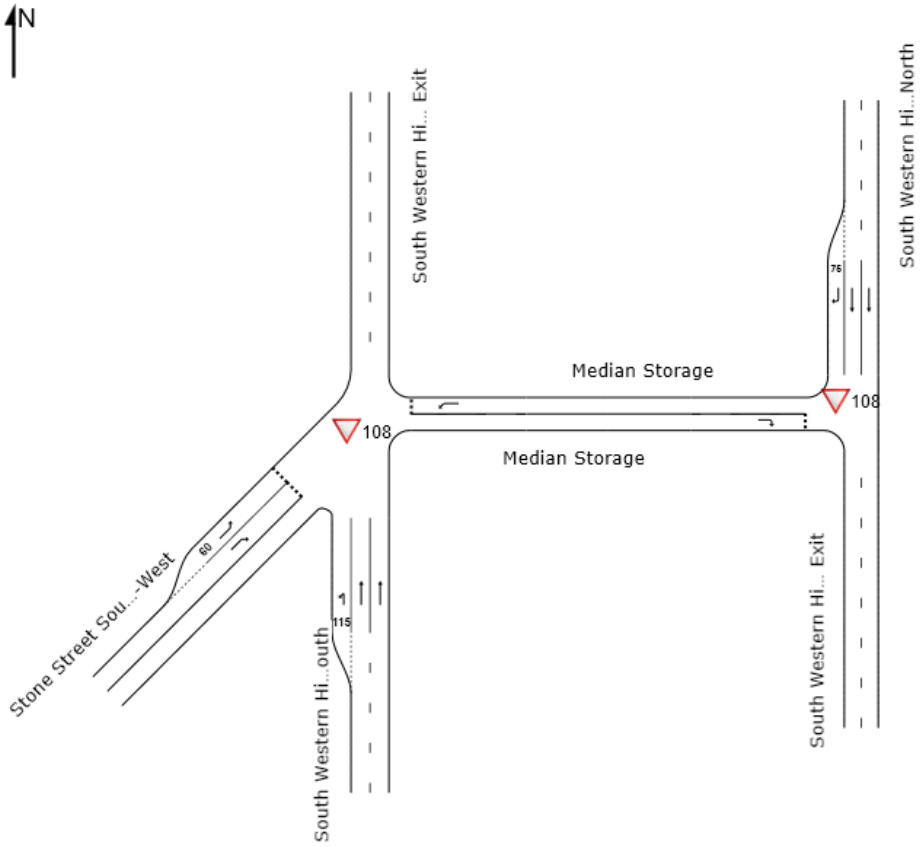


Figure 4.16 SWH/ Stone St – two staged intersection layout – with SWH duplication

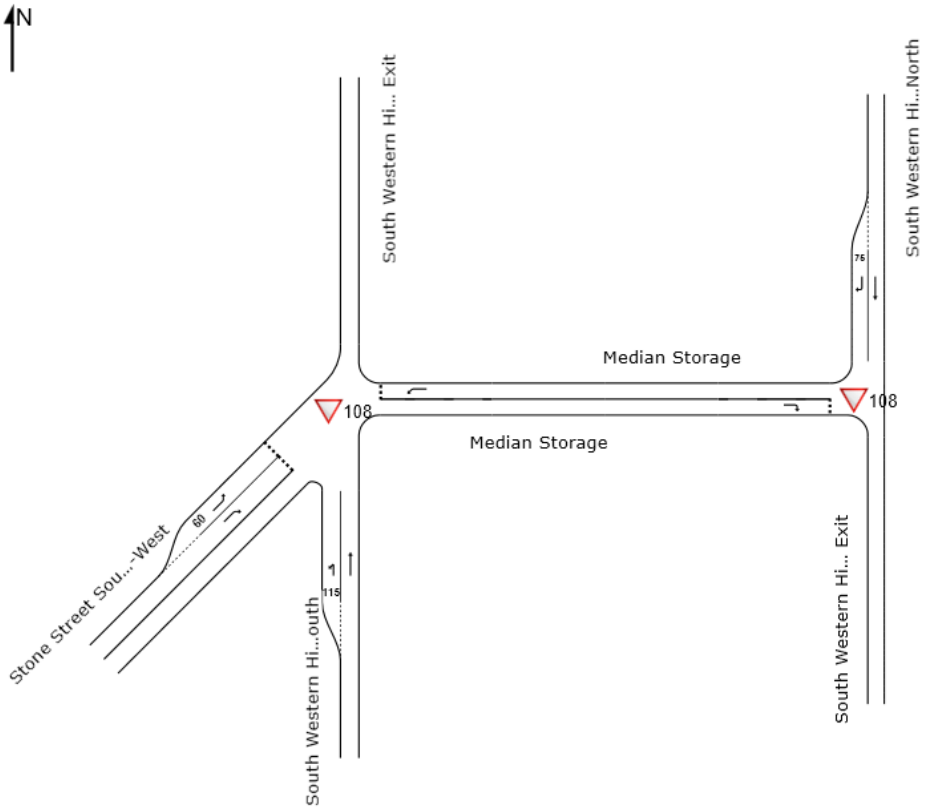


Figure 4.17 SWH/ Stone St – two staged intersection layout – without SWH duplication

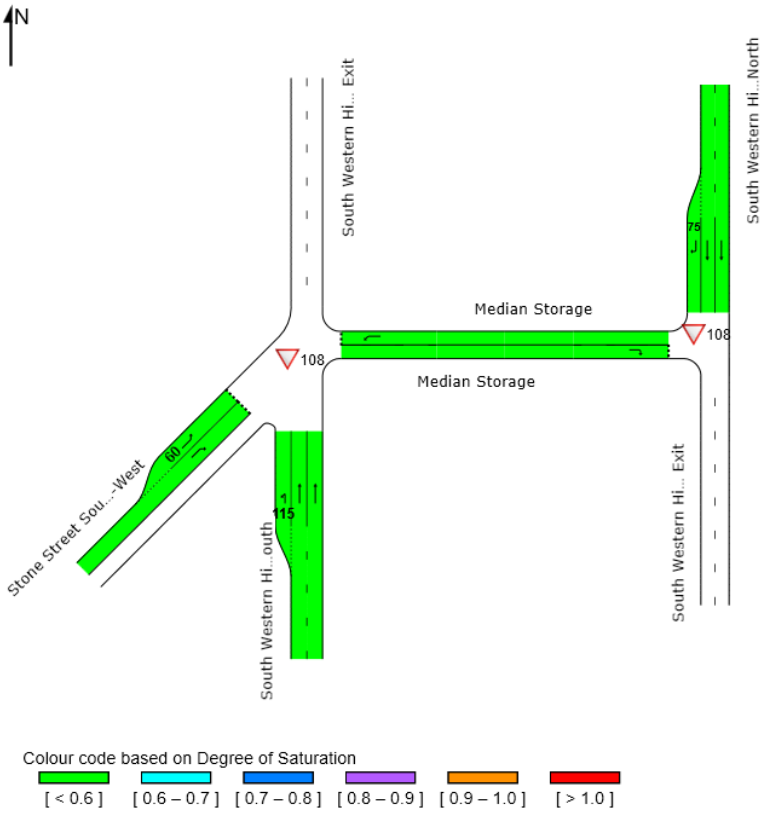


Figure 4.18 Degree of Saturation -SWH/ Stone St – AM Peak - with SWH duplication

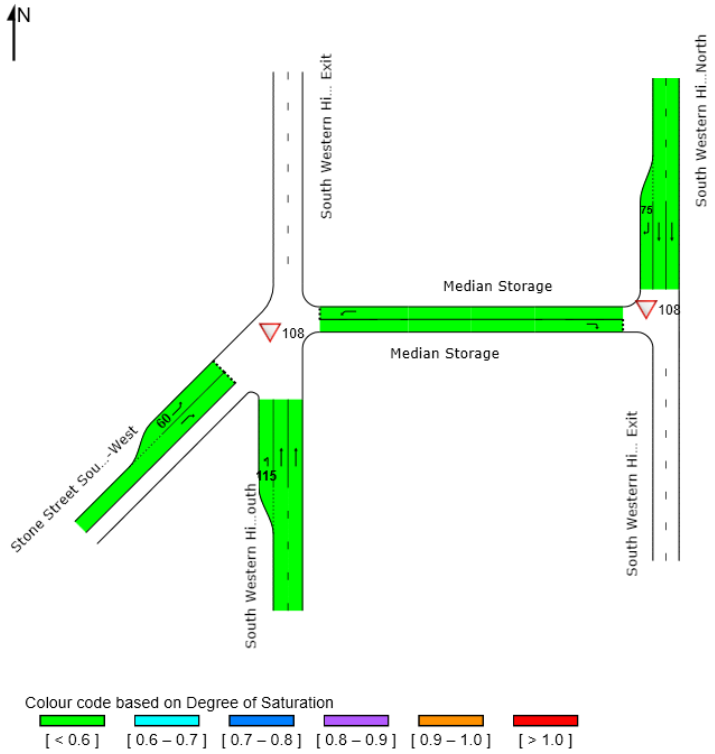


Figure 4.19 Degree of Saturation -SWH/ Stone St – PM Peak - with SWH duplication

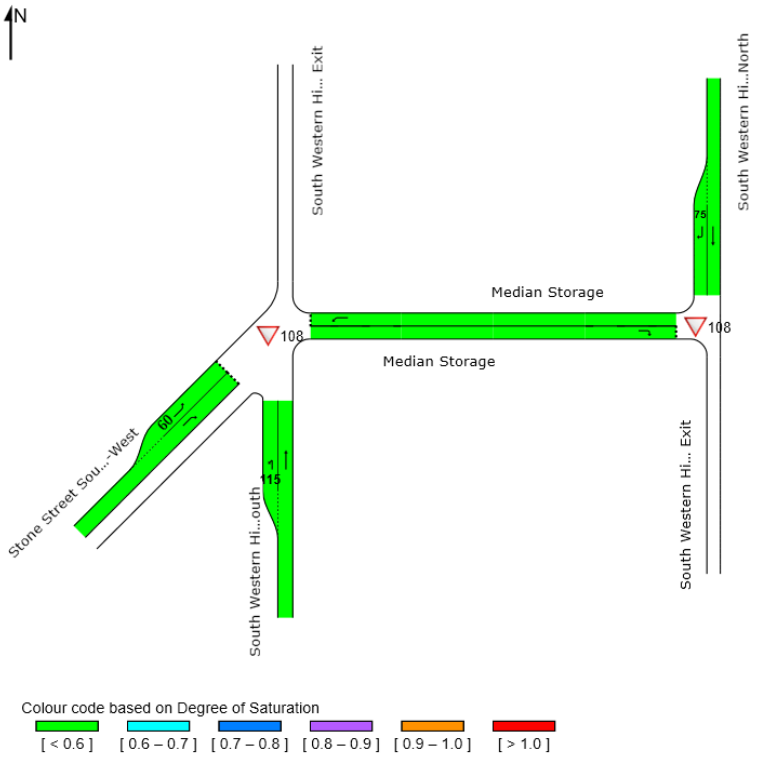


Figure 4.20 Degree of Saturation -SWH/ Stone St – AM Peak - without SWH duplication

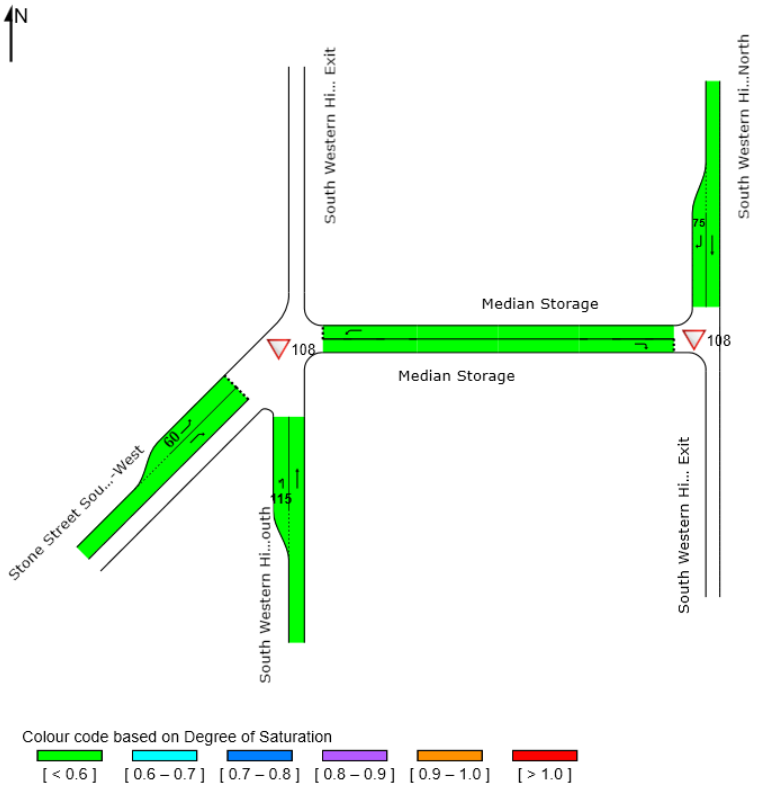


Figure 4.21 Degree of Saturation -SWH/ Stone St – PM Peak - without SWH duplication

The intersection is forecast to operate within capacity in both dual and single lane configurations of SWH. Table 4.2 shows the intersection performance with and without the SWH duplication for the 2026 traffic forecasts.

Table 4.2 SWH/ Stone St – proposed two stage Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Two staged with SWH duplication	A	0.291	1.5	A	0.290	2.1
Two staged without SWH duplication	A	0.581	1.8	A	0.581	1.8

As a result of the right turn from Dickens Place being two stages with the SWH duplication in place, the intersection is forecast to operate satisfactorily at LoS A in both peak hours. The intersection is forecast to operate within capacity with a maximum degree of saturation of 0.291 in the AM peak period and 0.290 in the PM peak period. The highest delay forecast for this option was for the left turn movement from Stone Street into SWH with a delay of approximately 23 seconds and 13 seconds in the AM and PM peak periods respectively. The forecast queues are negligible with the longest queue forecast to be around three metres on the west approach in the AM peak.

Without the SWH duplication, the intersection is forecast to operate at LoS A in both peak periods with a degree of saturation of 0.581 in both the AM and PM peak periods respectively. Forecast delays and queues are significantly lower than in the Do Nothing scenario with the highest delay being 27 seconds for the left turn from the west approach in the AM peak and highest queue being around three metres on the west approach in the AM peak.

4.5 SWH/ Eleventh Road

4.5.1 2026 Do Nothing Scenario

Figure 4.22 shows the existing layout at the intersection of SWH/ Eleventh Road.

Figure 4.23 and Figure 4.24 show the degree of saturation at the existing layout of the SWH/ Dickens Place intersection in the AM and PM peak periods respectively in the 2026 Do Nothing scenario. This layout is forecast to result in the intersection being oversaturated and operating at LoS F in both the peak periods in the year 2026. Again, the west approach is forecast to experience significant delay and queuing due to the large volume of through traffic using SWH meaning right turning vehicles from Eleventh Road cannot find a gap in traffic on SWH. The longest queue of around 730m is forecast on the west approach.

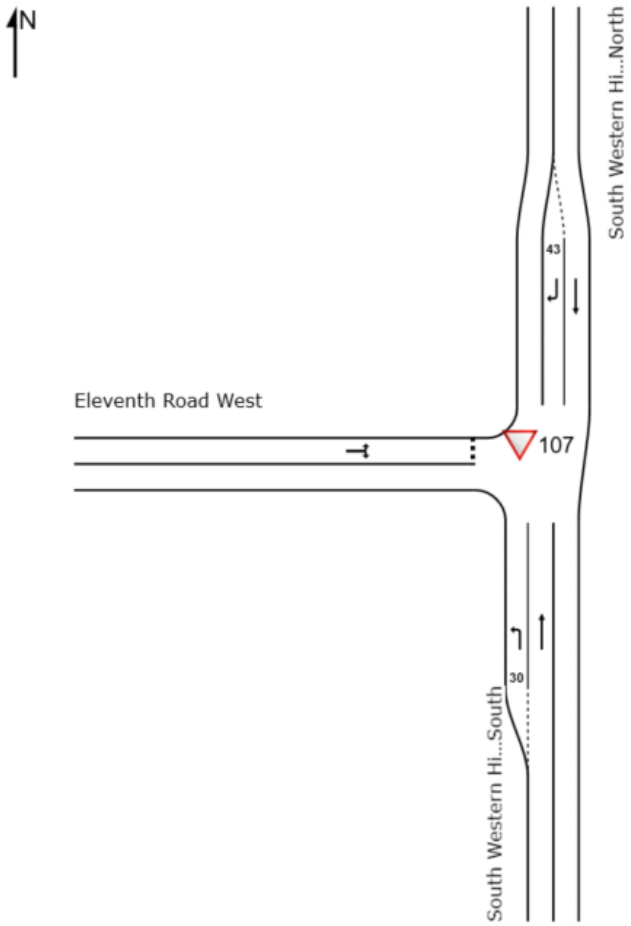


Figure 4.22 SWH/ Eleventh Road – Existing intersection layout

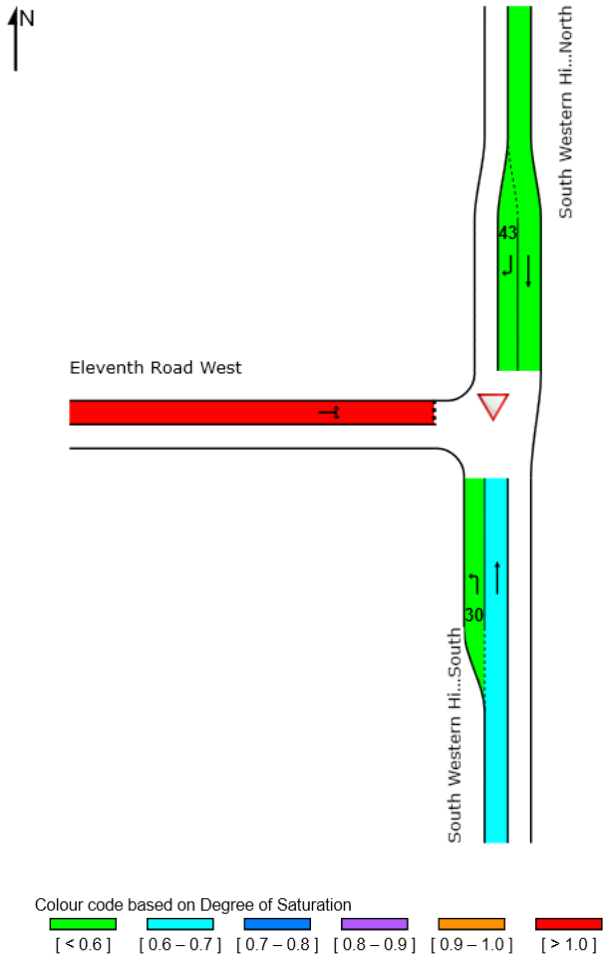


Figure 4.23 Degree of Saturation – AM Peak – Do Nothing

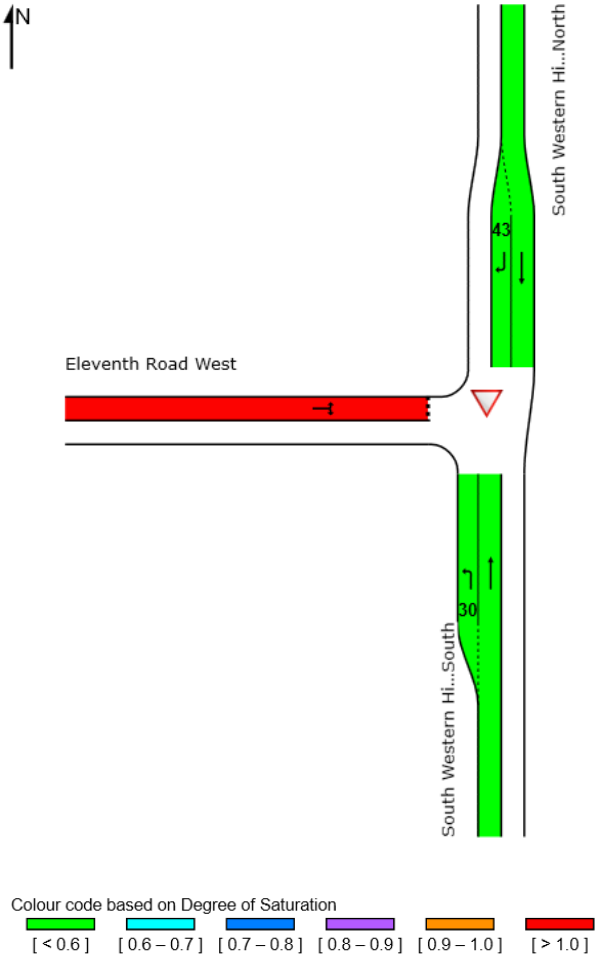


Figure 4.24 Degree of Saturation – PM Peak – Do Nothing

4.5.1.1 2026 Do Something Scenario

A Do Something scenario was assessed for this intersection to reduce the delay and increase the capacity on Stone Street which is forecast to operate at LoS F and above its capacity in both peaks in the Do Nothing scenario.

Again, two Do Something models were created where one model assumes that SWH will be duplicated in 2026 and the other model assumes that SWH will remain a single lane carriageway. A turn pocket was added in both scenarios for the left turning movement from Eleventh Road into SWH. Additionally, the intersection was modelled as a two staged layout in SIDRA to replicate a median storage in both the single lane and dual lane carriage way options.

Figure 4.25 and Figure 4.26 represent the two stage proposed intersection layouts for the intersection of SWH/ Stone Street for the opening year 2026 with and without the duplication of SWH respectively.

Figure 4.27 and Figure 4.28 show the degree of saturation at the proposed two staged layout with SWH duplication and Figure 4.29 and Figure 4.30 show the degree of saturation at the proposed two staged layout of the SWH/ Stone Street intersection without the SWH duplication in the AM and PM peak periods respectively in the 2026 Do Something scenario.

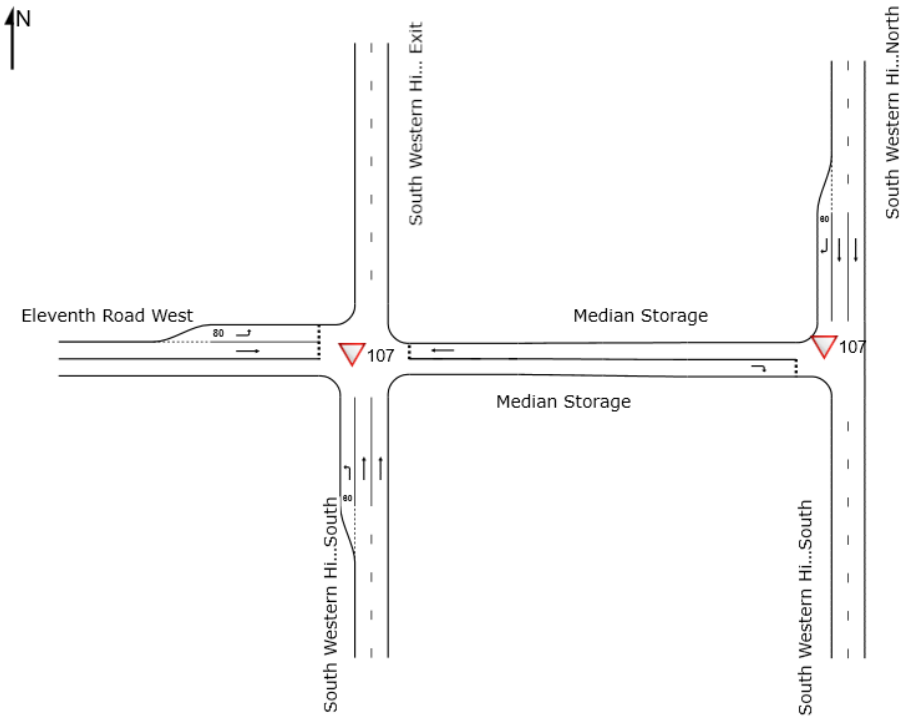


Figure 4.25 SWH/ Eleventh Road – two staged intersection layout – with SWH duplication

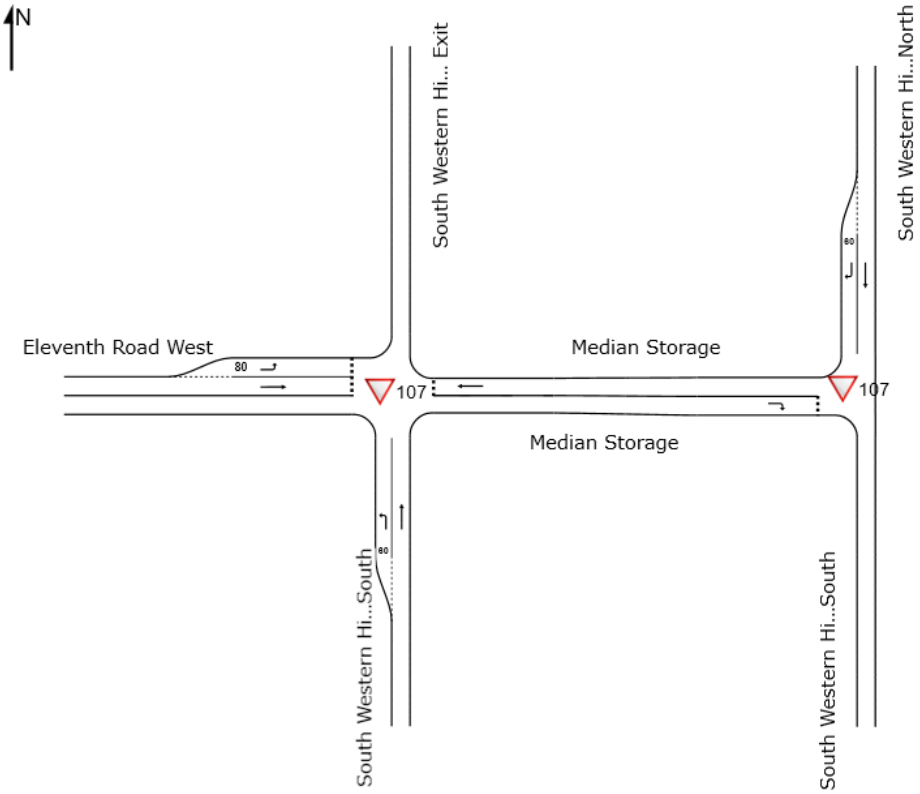


Figure 4.26 SWH/ Eleventh Road – two staged intersection layout – without SWH duplication

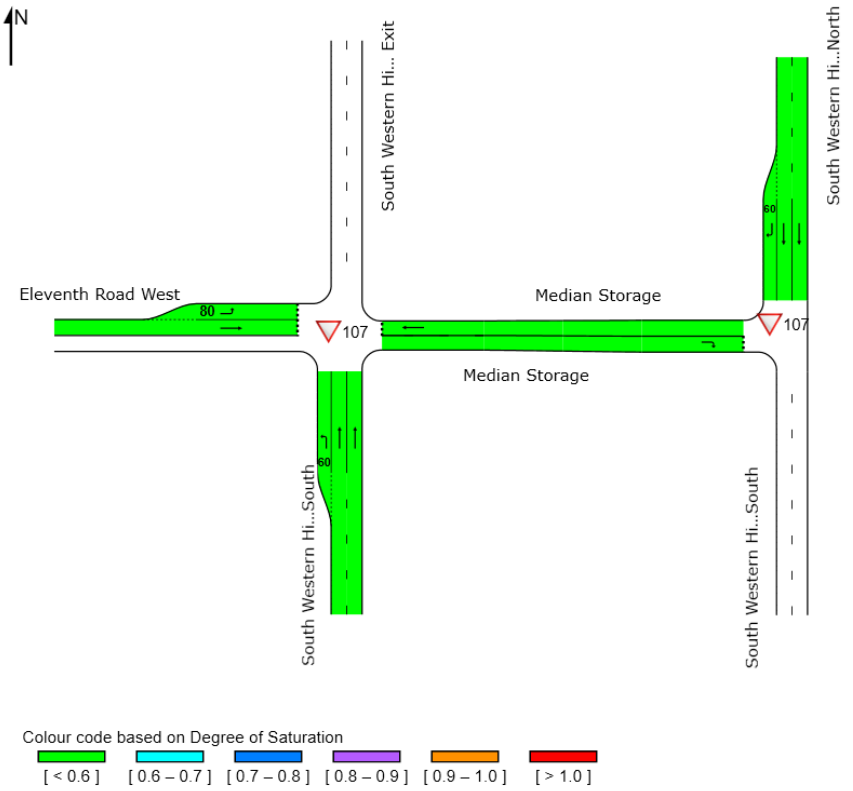


Figure 4.27 Degree of Saturation -SWH/ Eleventh Rd – AM Peak - with SWH duplication

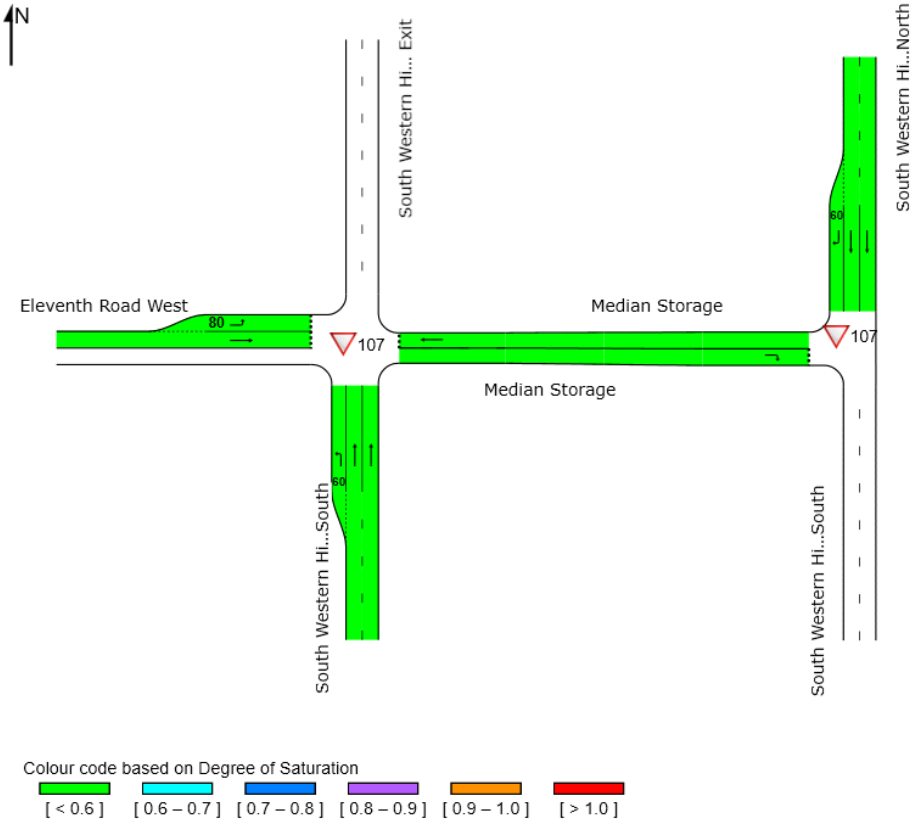


Figure 4.28 Degree of Saturation -SWH/ Eleventh Rd – PM Peak - with SWH duplication

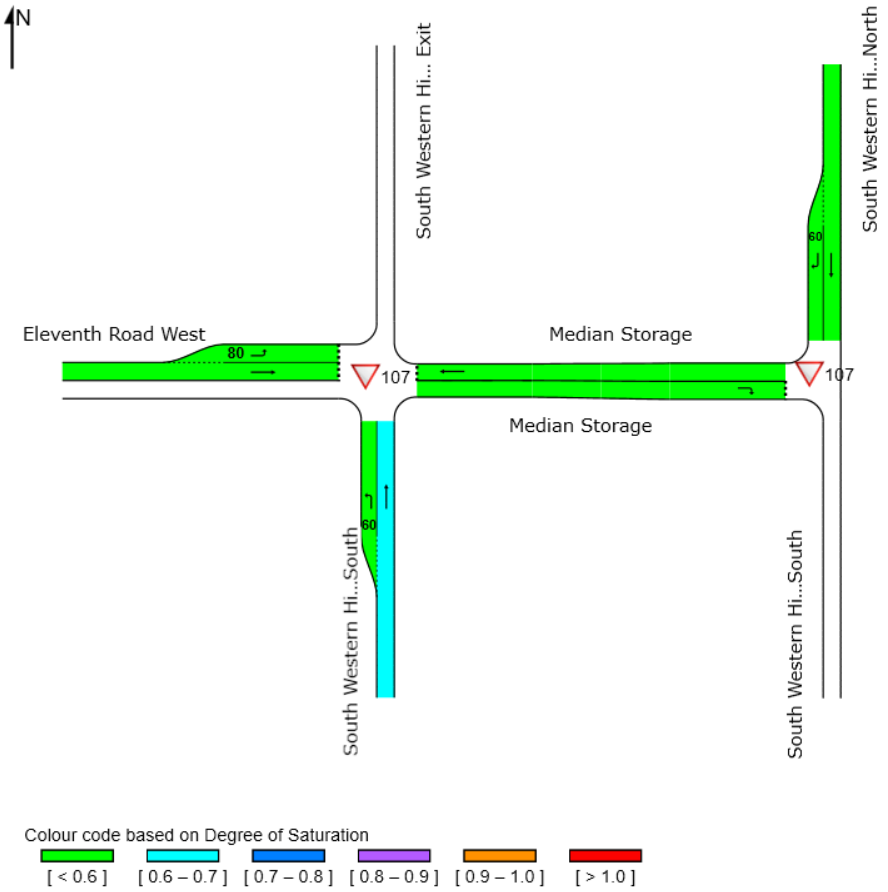


Figure 4.29 Degree of Saturation -SWH/ Eleventh Rd – AM Peak - without SWH duplication

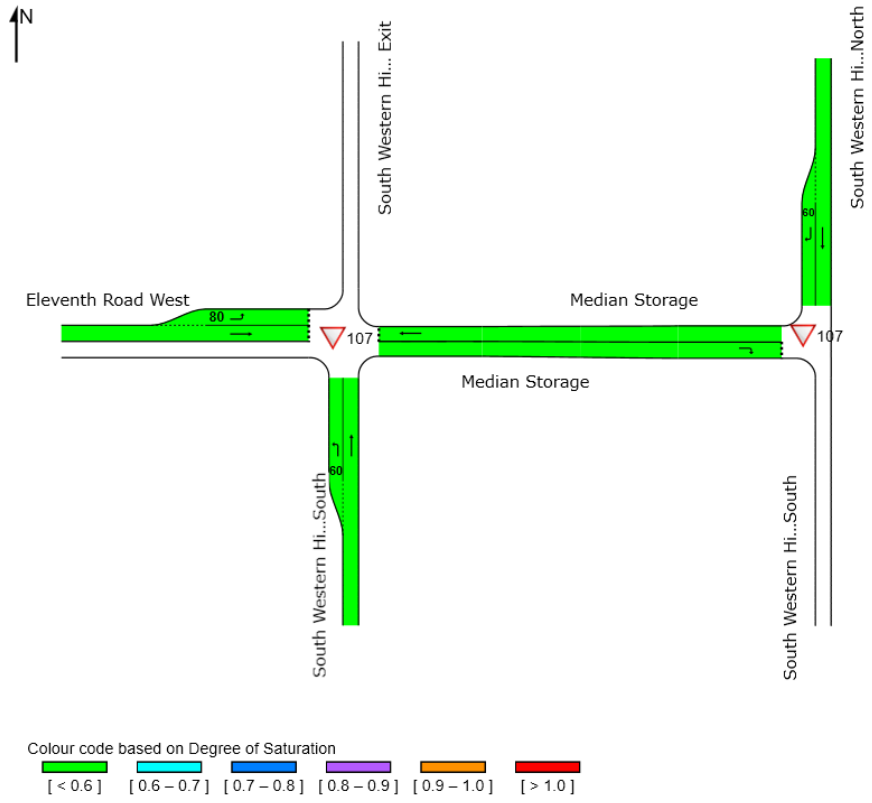


Figure 4.30 Degree of Saturation -SWH/ Eleventh Rd – PM Peak - without SWH duplication

The intersection is forecast to operate within capacity in both dual and single lane configurations of SWH. Table 4.3 shows the intersection performance with and without the SWH duplication for the 2026 traffic forecasts.

Table 4.3 SWH/ Eleventh Road – proposed two stage Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Two staged with SWH duplication	A	0.317	2.3	A	0.296	2.5
Two staged without SWH duplication	A	0.633	2.0	A	0.593	2.1

As a result of the right turn from Eleventh Road being two stages with the SWH duplication in place, the intersection is forecast to operate satisfactorily at LoS A in both peak hours. The intersection is forecast to operate within capacity with a maximum degree of saturation of 0.317 in the AM peak period and 0.296 in the PM peak period. The highest delay forecast for this option was for the left turn movement from Eleventh Road into SWH with a delay of approximately 20 seconds and 12 seconds in the AM and PM peak periods respectively. The forecast queues are negligible with the longest queue forecast to be around three metres on the west approach in the AM peak.

Without the SWH duplication, the intersection is forecast to operate at LoS A in both peak periods with a degree of saturation of 0.633 in the AM peak period and 0.593 in the PM peak period. Forecast delays and queues are significantly lower than in the Do Nothing scenario with the highest delay being 22 seconds on the west approach in the AM peak and highest queue being below two metres on the west approach in the AM peak.

4.6 Eleventh Road/ Wungong Road

4.6.1 Do Nothing Scenario

Figure 4.31 and Figure 4.32 show the degree of saturation at the Eleventh Road/ Wungong Road intersection in the AM and PM peak periods respectively in the 2026 Do Nothing scenario. The intersection is forecast to perform satisfactorily operating at LoS A in both peak periods with a degree of saturation of 0.168 and 0.249 in the AM and PM peak periods respectively. There is negligible delay across the intersection with the highest forecast delay being around eight seconds on the east approach in the PM peak. There is also negligible queuing forecast at the intersection with the longest forecast queue being around four metres on the north approach in the PM peak period.

Due to the modelled intersection performance and the available capacity, no additional infrastructure upgrade is forecast to be needed for the year 2026.

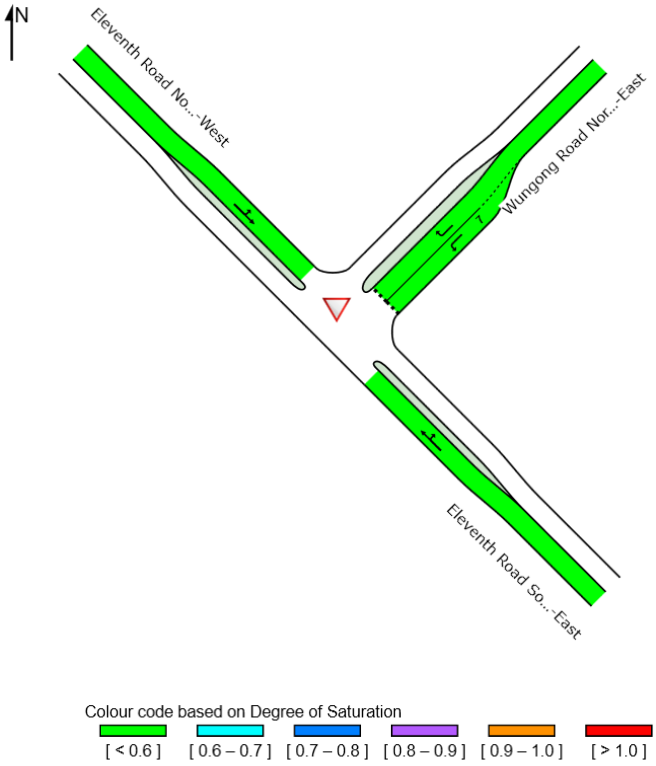


Figure 4.31 Degree of Saturation – AM Peak – Do Nothing

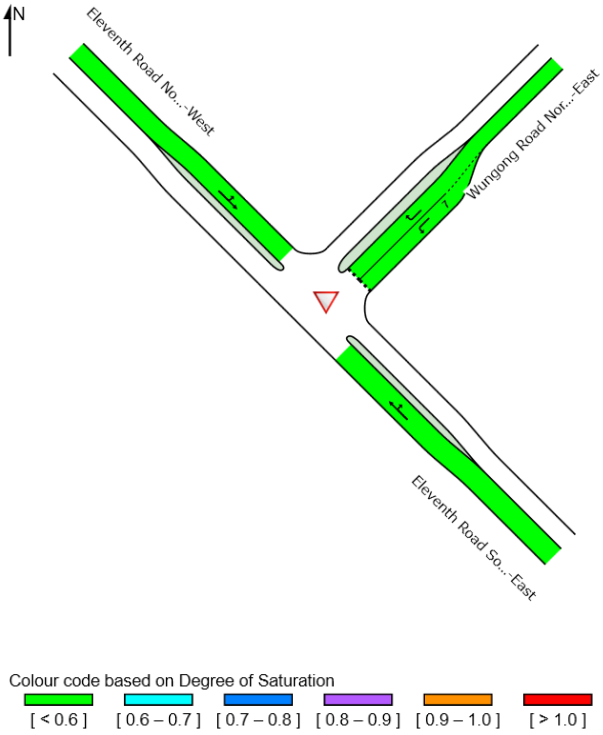


Figure 4.32 Degree of Saturation – PM Peak – Do Nothing

5 Network Modelling Results – Opening year (2026)

5.1 Introduction

The following section details the performance of the road networks in the Do Nothing (at grade) and Do Something (grade separated) scenarios that were required to be modelled as per the TMIF, under 2026 traffic forecasts.

5.2 Armadale Road Network

5.2.1 2026 Do Nothing Scenario (LX included and at grade)

The Do Nothing scenario assumes that the Armadale Road network will maintain the level crossing at grade in 2026. With the existing intersection layouts retained, the 2026 volume forecasts are applied to understand the performance of the road network.

The Armadale Road network in this scenario comprises the following intersections as shown schematically (as an output from SIDRA) in Figure 7.1:

1. Armadale Road/ Abbey Road/ Railway Avenue
2. Armadale level crossing
3. Armadale Road/ Streich Avenue
4. Armadale Road/ Orchard Avenue
5. Armadale Road/ Church Avenue.

Figure 5.2 and Figure 5.3 show the degree of saturation at the Armadale Road network with the Level crossing at grade in the AM and PM peak periods respectively in the 2026 Do Nothing (LX at grade) scenario.

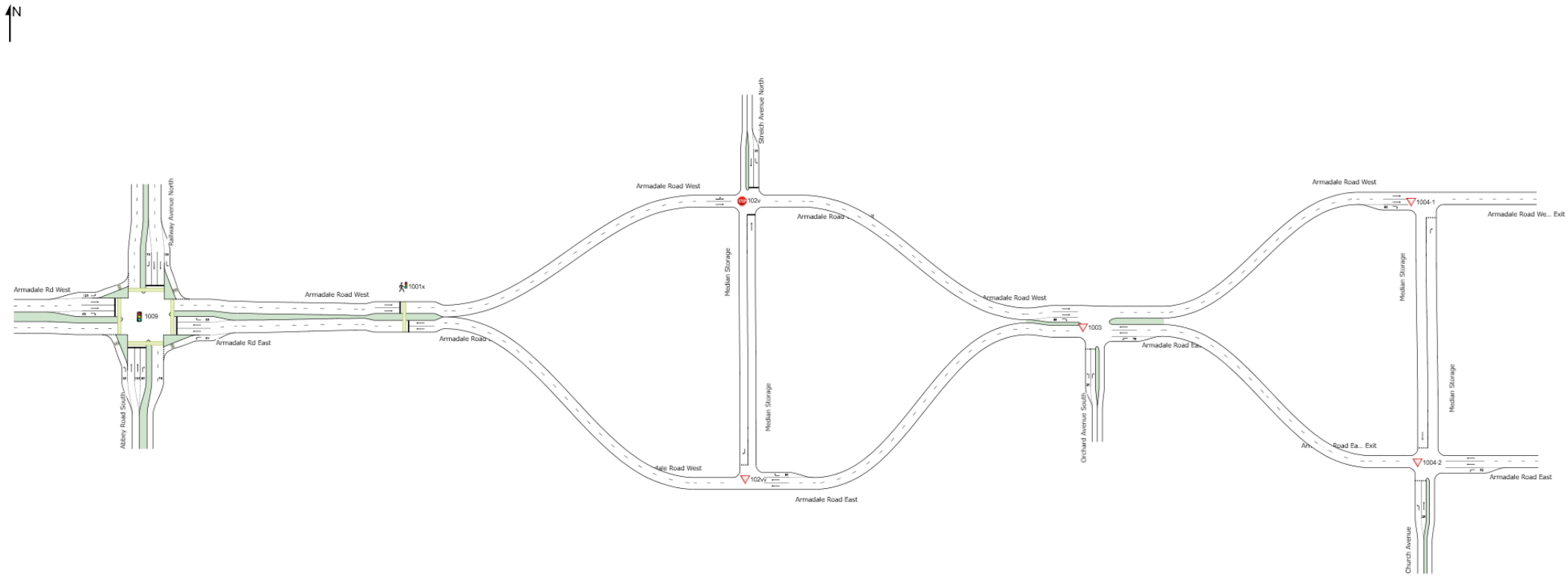


Figure 5.1 Armadale Road Network – Do Nothing Scenario (LX at grade)

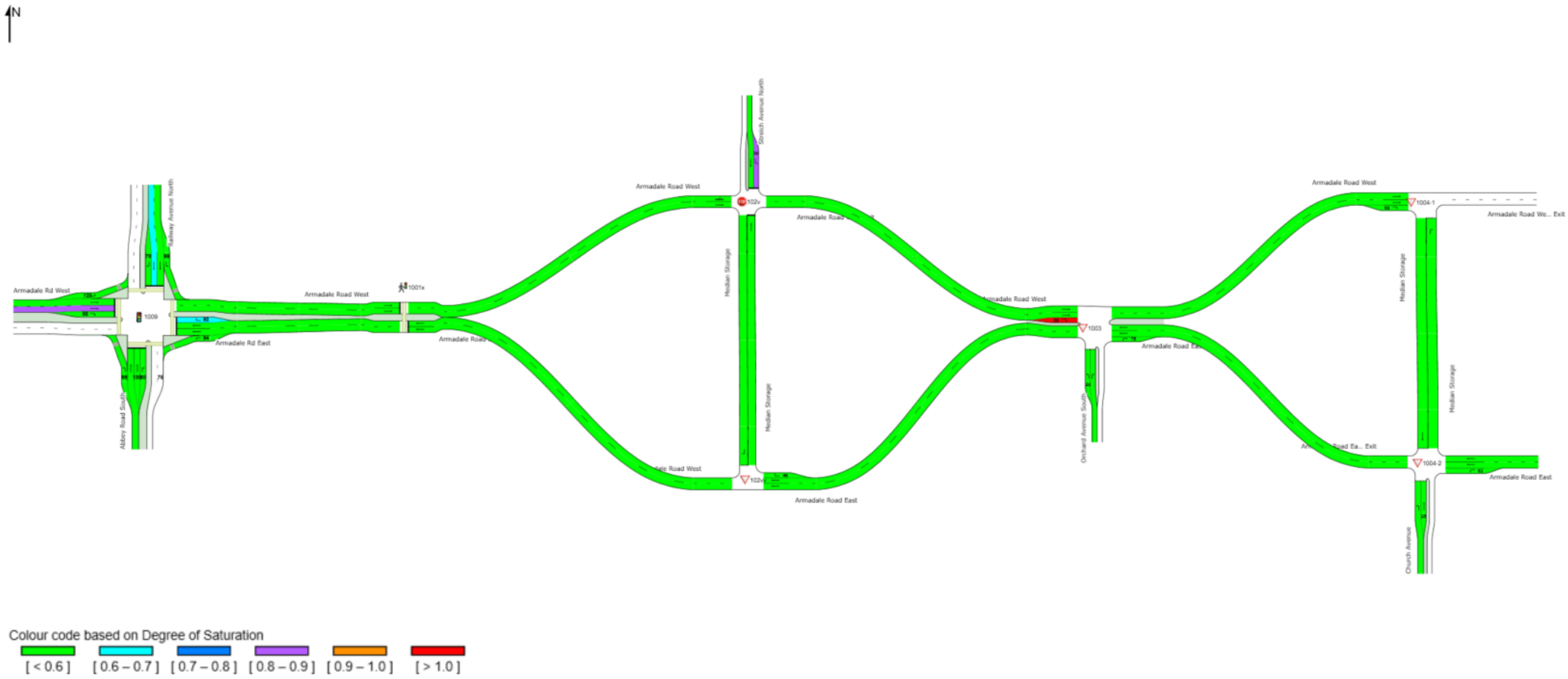


Figure 5.2 Degree of Saturation - Armadale Road Network – AM Peak - Do Nothing Scenario (LX at grade)

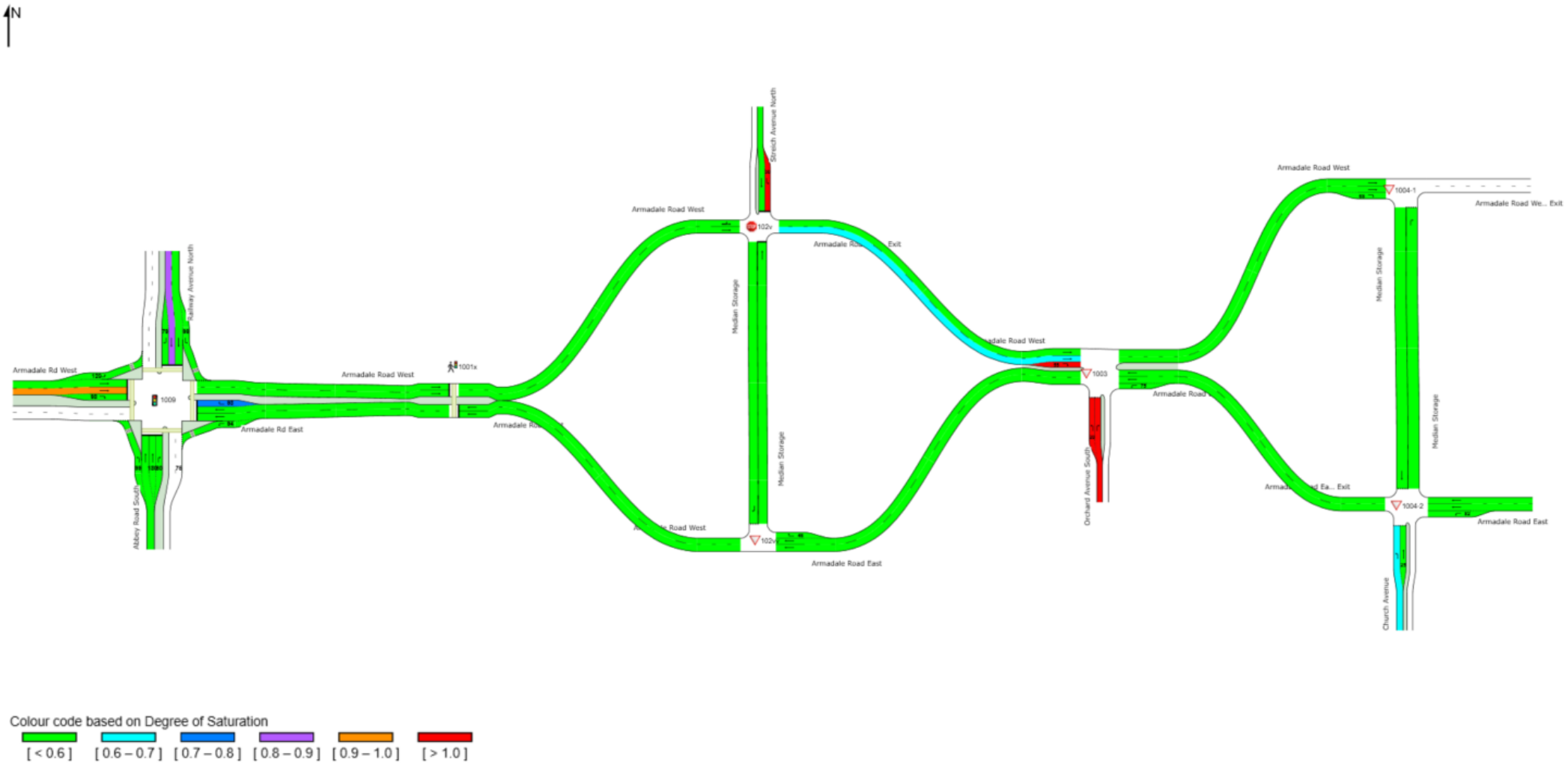


Figure 5.3 Degree of Saturation - Armadale Road Network – PM Peak - Do Nothing Scenario (LX at grade)

Table 7.1 summarises the intersection performance of all the intersections in the Armadale Road network in the Do Nothing scenario with the level crossing at grade.

Table 5.1 Armadale Road Network performance – Do Nothing Scenario (LX at grade)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	1.106	-	E	1.265	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.837	32.3	D	0.927	37.9
Armadale level crossing	A	0.528	9.4	B	0.550	10.0
Armadale Rd/ Streich Ave	F	0.882	8.5	F	1.265	43.1
Armadale Rd/ Orchard Ave	F	1.106	29.8	F	1.192	44.8
Armadale Rd/ Church Ave	A	0.272	2.4	C	0.609	5.1

In both the AM and PM peak periods, the network is forecast to operate over capacity with Armadale Road / Streich Avenue and Armadale Road / Orchard Avenue being forecast to operate at LoS F. The predominant problem is insufficient gaps in traffic for the vehicles turning into Armadale Road from minor roads such as Streich Avenue and Orchard Avenue, and also for vehicles turning right from Armadale Road into Orchard Avenue.

5.2.2 2026 Do Nothing Scenario (grade separated)

Following confirmation from PTA regarding their intent to grade separate the level crossing on Armadale Road, this scenario analyses the Armadale Road network with grade separation in the future year whilst still retaining the existing layouts for the other intersections.

The Armadale Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 7.4:

1. Armadale Road/ Abbey Road/ Railway Avenue
2. Armadale Road/ Streich Avenue
3. Armadale Road/ Orchard Avenue
4. Armadale Road/ Church Avenue.

Figure 5.5 and Figure 5.6 and show the degree of saturation at the Armadale Road network with grade separation in the AM and PM peak periods respectively in the 2026 Do Nothing (grade separated) scenario.

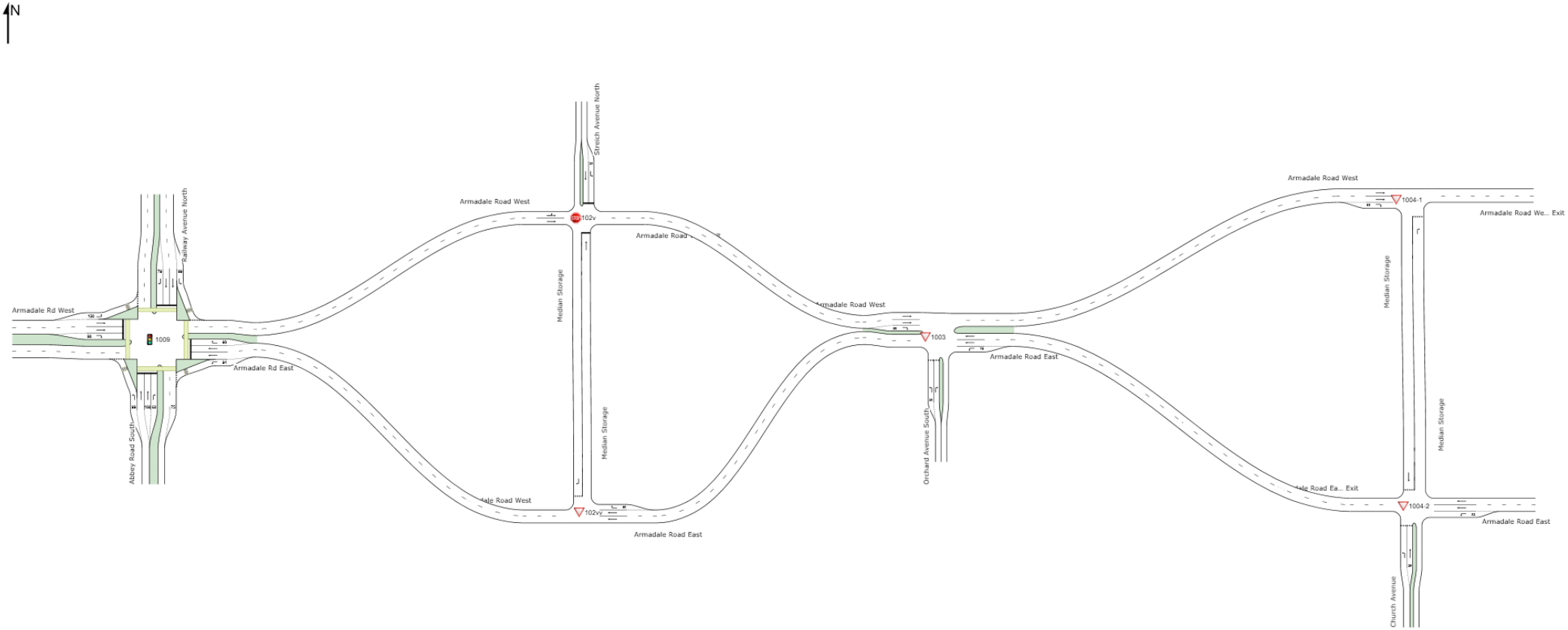


Figure 5.4 Armadale Road Network – Do Nothing Scenario (grade separated)

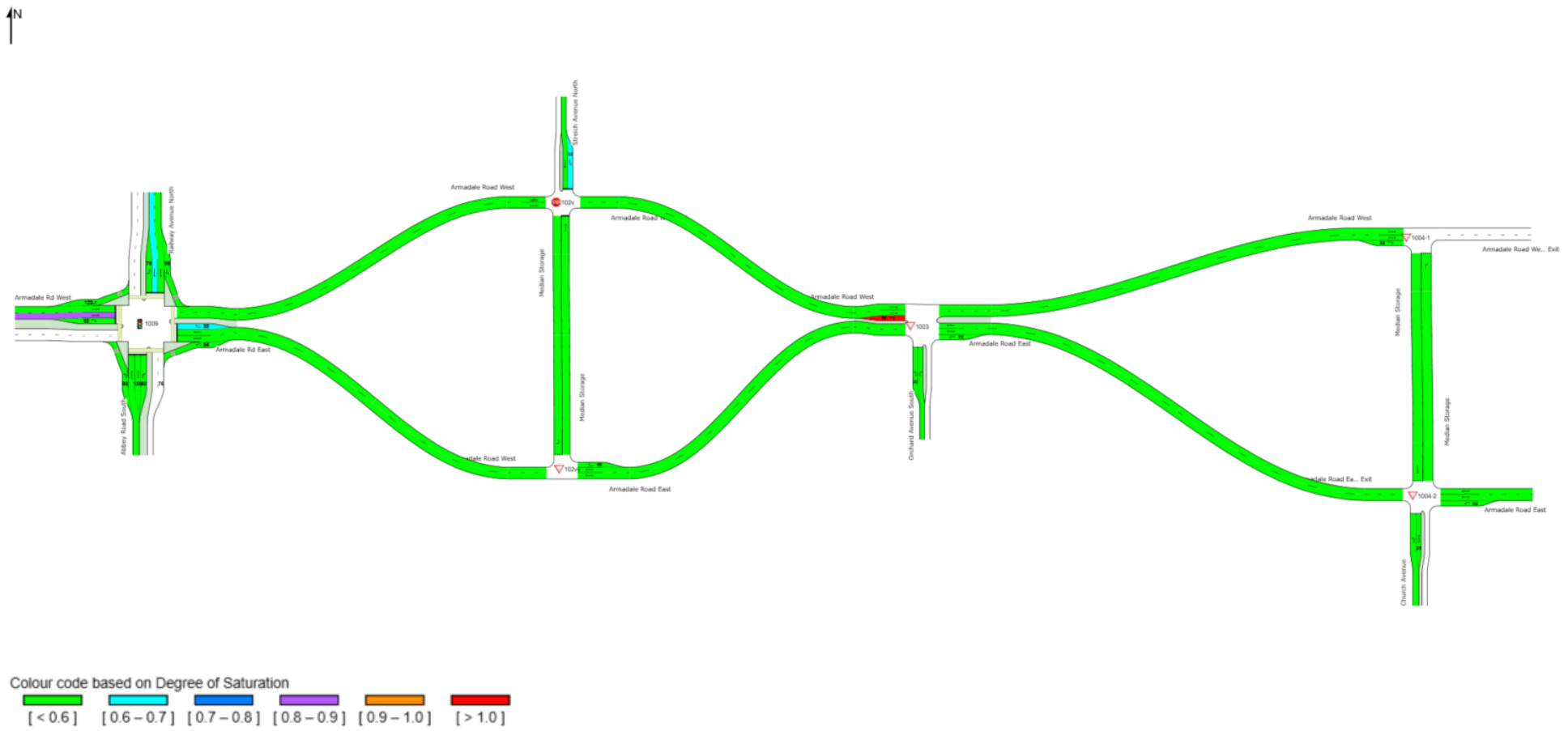


Figure 5.5 Degree of Saturation - Armadale Road Network – AM Peak - Do Nothing Scenario (grade separated)

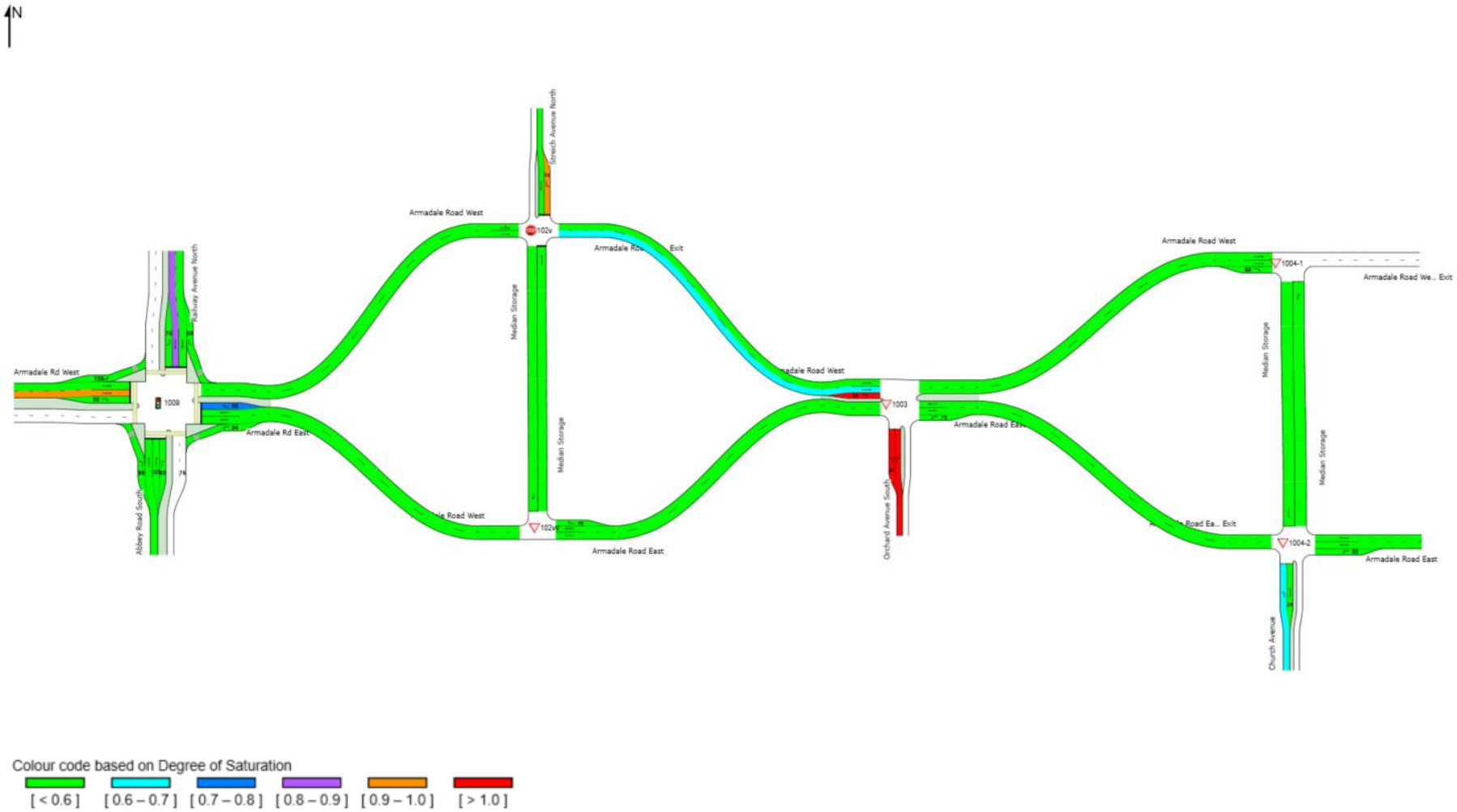


Figure 5.6 Degree of Saturation - Armadale Road Network – PM Peak - Do Nothing Scenario (grade separated)

Table 7.2 details the network and individual intersection performance of all the intersections in the Armadale Road network in the Do Nothing scenario with grade separation.

Table 5.2 Armadale Road Network performance – Do Nothing Scenario (grade separated)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	1.106	-	E	1.298	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.837	32.3	D	0.927	37.9
Armadale Rd/ Streich Ave	E	0.671	5.4	F	0.960	13.1
Armadale Rd/ Orchard Ave	F	1.106	29.8	F	1.298	50.6
Armadale Rd/ Church Ave	A	0.272	2.4	C	0.609	5.1

As in the at grade scenario, the network operates over-capacity in both the AM and PM peak periods with Armadale Road / Orchard Avenue being forecast to operate at LoS F in both peaks and Armadale Road / Streich Avenue being forecast to operate at LoS F in the PM peak. The predominant problem remains insufficient gaps in traffic for the vehicles turning into Armadale Road from minor roads such as Streich Avenue and Orchard Avenue, and also for vehicles turning right from Armadale Road into Orchard Avenue.

5.2.3 Do Something Scenario (grade separated)

To achieve satisfactory network performance, three scenarios with various layouts have been modelled and detailed as below:

1. Option 1: Fully signalised
2. Option 2: Roundabouts only
3. Option 3: Partial treatment with roundabouts and signals.

5.2.3.1 Option 1: Fully signalised

In this option, it is assumed that all intersections in the Armadale Road network which are currently priority controlled will be converted to signalised intersections in the future as shown in Figure 5.7.

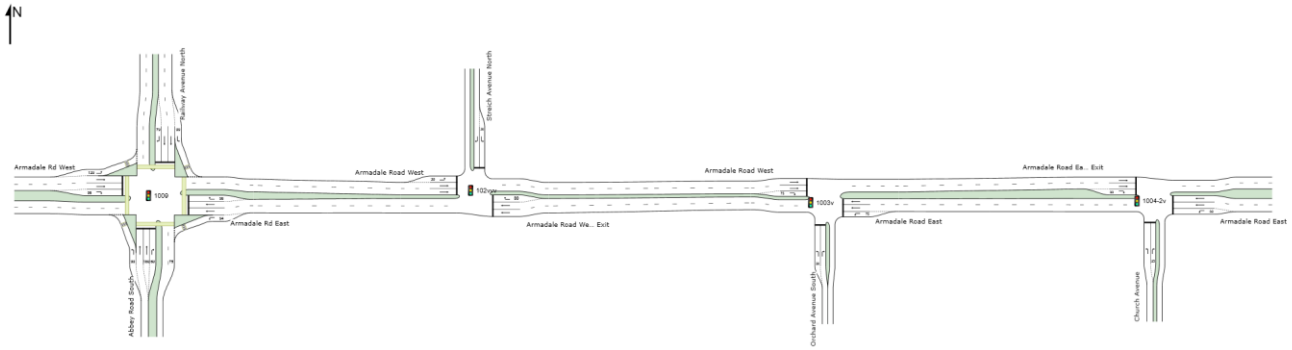


Figure 5.7 Armadale Road Network – Do Something Scenario (grade separated) – Fully signalised

At the intersection of Armadale Road/ Streich Avenue, the existing lane geometry is retained for the most part with the addition of a left turn pocket of 30m on the west approach of Armadale Road, and a reduction of the right turn pocket from 60m to 30m on the east approach of Armadale Road as shown in Figure 5.8.

At the intersection of Armadale Road/ Orchard Avenue, the existing lane geometry is retained for the most part with just the extension of the right turn pocket on the west approach of Armadale Road from 55m to 75m as shown in Figure 5.9.

The intersections of Armadale Road/ Church Avenue, as shown in Figure 5.10, and Armadale Road/ Abbey Road/ Railway Avenue will retain their existing layouts with Armadale Road/ Church Avenue becoming signalised.

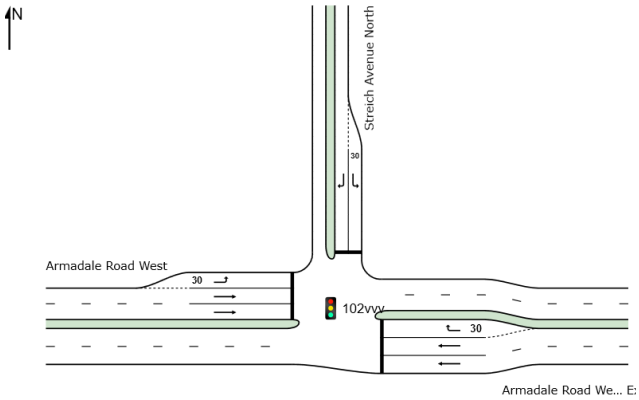


Figure 5.8 Armadale Road/ Streich Avenue – Signalised intersection option

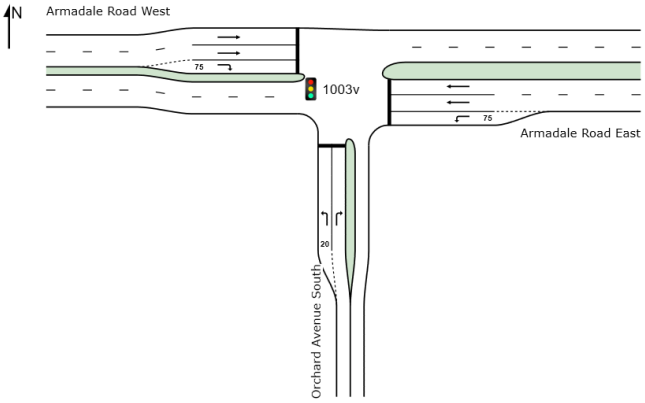


Figure 5.9 Armadale Road/ Orchard Avenue – Signalised intersection option

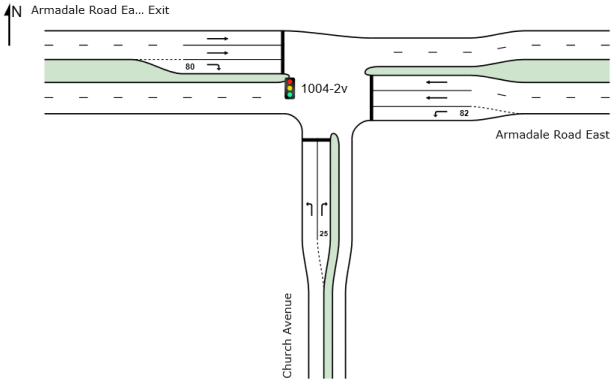


Figure 5.10 Armadale Road/ Church Avenue – Signalised intersection option

Figure 5.11 and Figure 5.12 show the degree of saturation at the Armadale Road network with grade separation and all intersections signalised in the AM and PM peak periods respectively in the 2026 Do Something (grade separated) scenario.

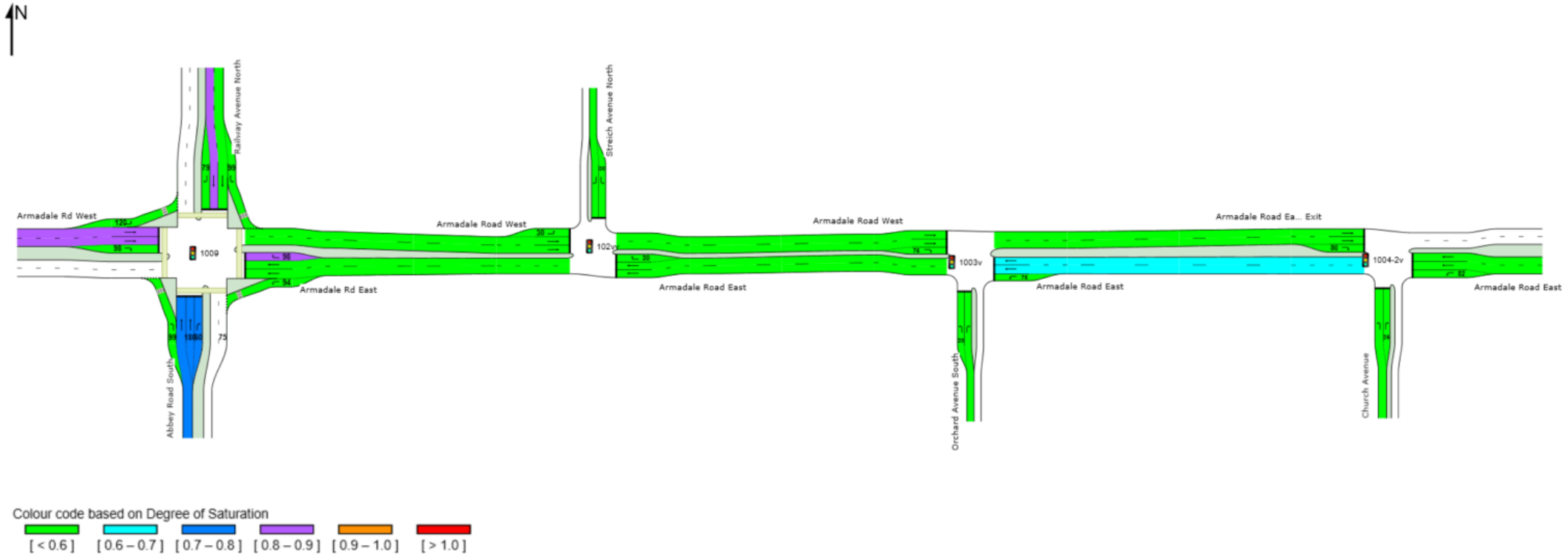


Figure 5.11 Degree of Saturation – Armadale Road Network – Do Something Scenario (grade separated) – Fully signalised – AM Peak

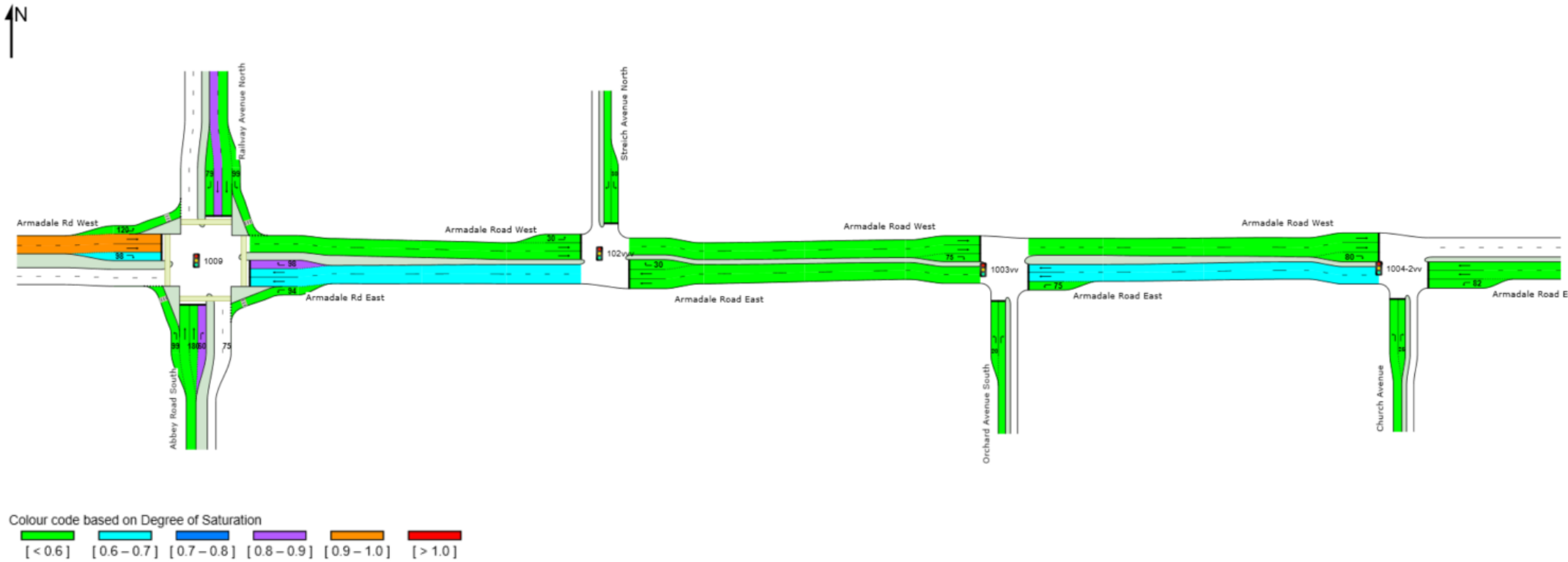


Figure 5.12 Degree of Saturation – Armadale Road Network – Do Something Scenario (grade separated) – Fully signalised – PM Peak

Table 7.3 details the performance of all the intersections in the Armadale Road Network in the Do Something scenario with all intersections signalised.

Table 5.3 Armadale Road Network performance – Do Something Scenario (grade separated) – Fully signalised

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	0.831	-	D	0.920	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.831	30.3	D	0.920	35.2
Armadale Rd/ Streich Ave	A	0.525	5.5	A	0.551	7.2
Armadale Rd/ Orchard Ave	B	0.682	14.7	B	0.656	13.0
Armadale Rd/ Church Ave	B	0.441	10.1	B	0.475	13.9

The fully signalised Armadale Road network and all of the intersections within the network are forecast to operate satisfactorily and within capacity. It is noted that whilst all of the intersections operate within capacity, further signal optimisation with LinSig would be required to optimise the signals to the satisfaction of MRWA.

5.2.3.2 Option 2: Roundabouts only

In this option, it is assumed that all intersections in the Armadale Road network which are currently priority controlled will be converted to roundabouts in the future as shown schematically (as an output from SIDRA) in Figure 5.13.

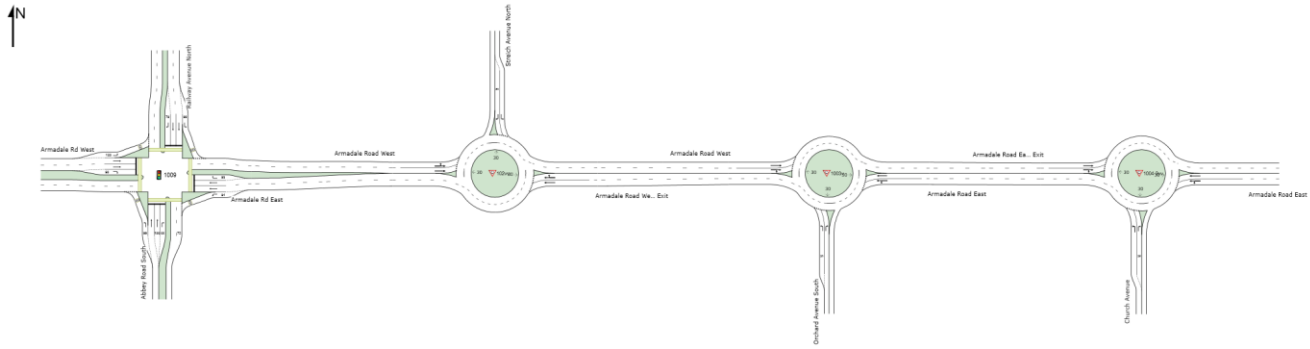


Figure 5.13 Armadale Road Network – Do Something Scenario (grade separated) – Roundabouts only

The intersection of Armadale Road/ Streich Avenue is converted to a two-lane circulating roundabout with no turning pockets on Armadale Road. The north approach of Streich Avenue will adopt a right turn pocket of 60m as shown in Figure 5.14.

The intersection of Armadale Road/ Orchard Avenue is converted to a two lane circulating roundabout with no turning pockets on Armadale Road. The south approach of Orchard Avenue retains the same lane geometry as the existing layout as shown in Figure 5.15.

The intersection of Armadale Road/ Church Avenue is converted to a two-lane circulating roundabout with no turning pockets on Armadale Road. The south approach of Church Avenue retains the same lane geometry as the existing layout as shown in Figure 5.16.

The intersection of Armadale Road/ Abbey Road/ Railway Avenue will retain its existing layout in this scenario.

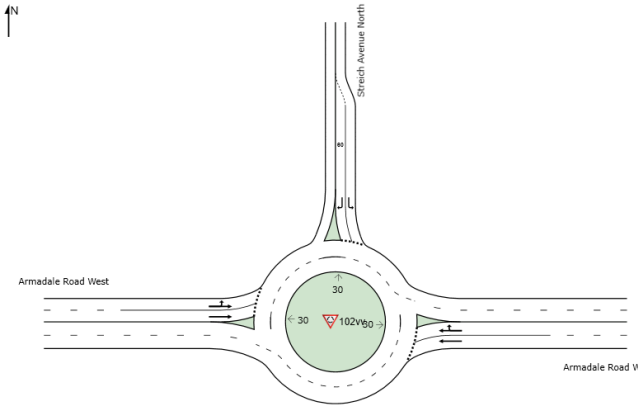


Figure 5.14 Armadale Road/ Streich Avenue – Roundabout option

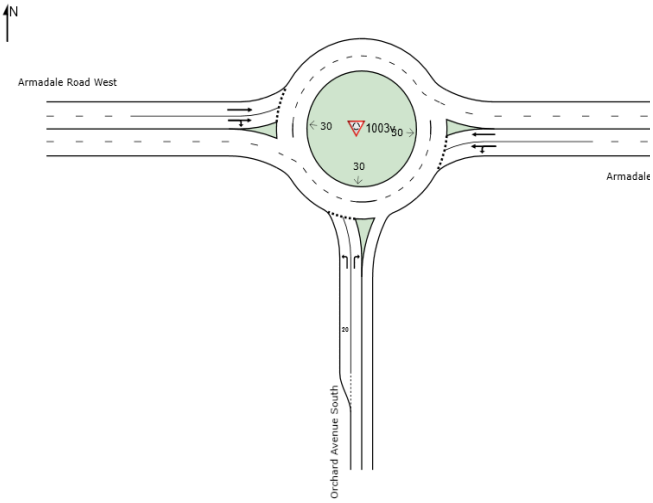


Figure 5.15 Armadale Road/ Orchard Avenue – Roundabout option

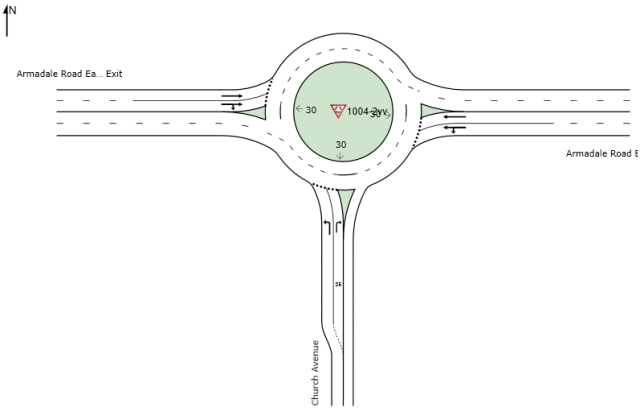


Figure 5.16 Armadale Road/ Church Avenue – Roundabout option

Figure 5.17 and Figure 5.18 show the degree of saturation at the Armadale Road network with grade separation and all intersections converted roundabouts in the AM and PM peak periods respectively in the 2036 Do Something (grade separated) scenario.

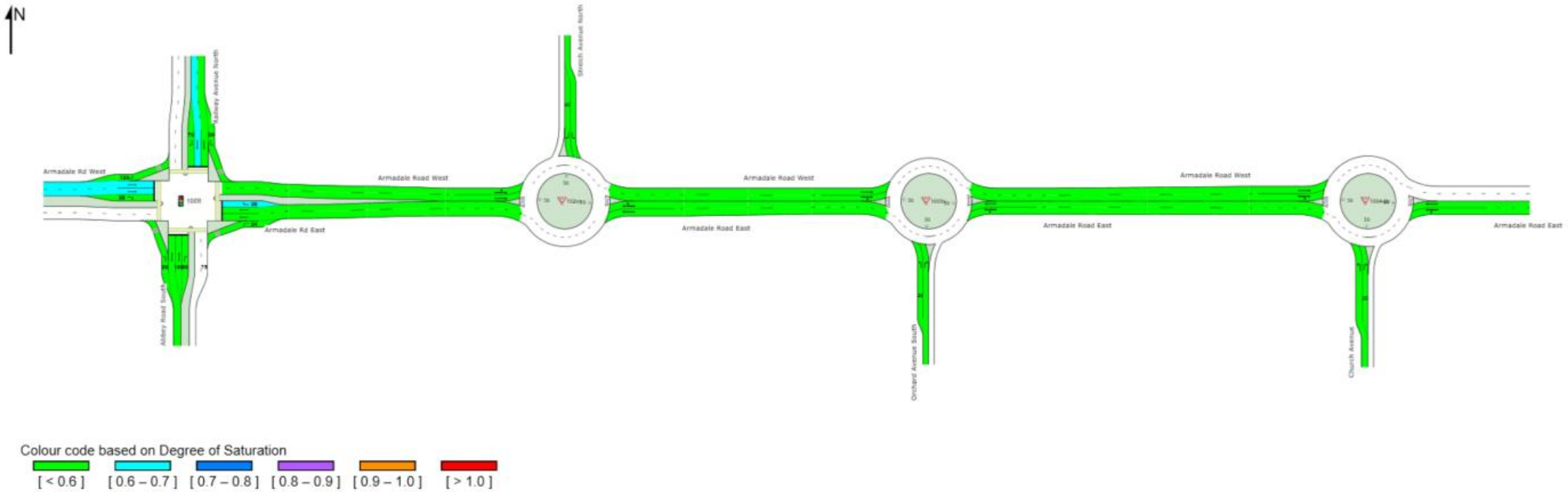


Figure 5.17 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Roundabouts only – AM Peak

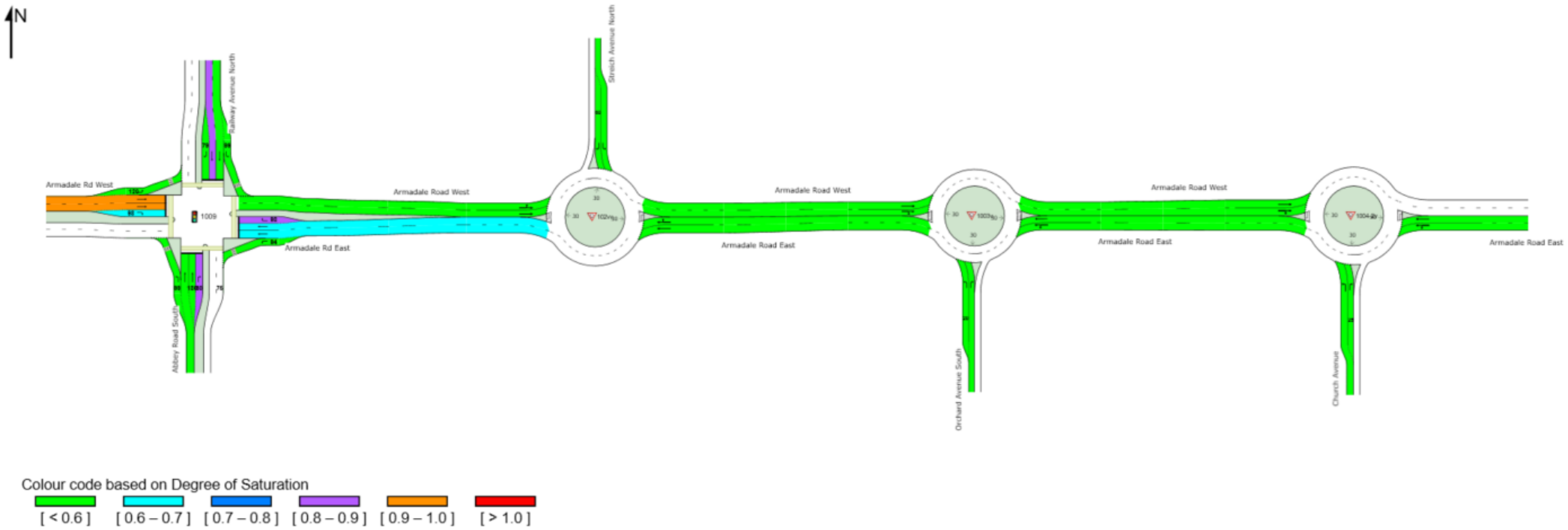


Figure 5.18 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Roundabouts only – PM Peak

Table 7.4 details the intersection performance of the Armadale Road Network in the Do Something scenario where all intersections, with exception of the intersection of Armadale Rd/ Abbey Rd/ Railway Ave, are converted to roundabouts.

Table 5.4 Armadale Road Network performance – Do Something Scenario (grade separated) – Roundabouts only

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	0.683	-	D	0.920	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.683	30.9	C	0.920	34.7
Armadale Rd/ Streich Ave	A	0.423	5.4	A	0.454	5.7
Armadale Rd/ Orchard Ave	A	0.391	6.9	A	0.431	6.6
Armadale Rd/ Church Ave	A	0.329	6.5	A	0.312	6.5

With the grade separation and the conversion to roundabouts, the network performs satisfactorily in both the peak periods with all intersections operating with reasonable delay and queuing. It is noted that whilst all the intersections operate within capacity, further signal optimisation with LinSig would be required to optimise the signals to the satisfaction of MRWA.

5.2.3.3 Option 3: Partial treatment with roundabouts and signals

In this option, it is assumed that two intersections in the Armadale Road network – Armadale Road/ Streich Avenue and Armadale Road/ Orchard Avenue – which are currently priority controlled will be converted to roundabouts and the intersection of Armadale Road/ Church Avenue will be converted to a signalised intersection in the future as shown in Figure 7.19. Different layouts and combinations of signalised intersections and roundabouts were tested and the layout adopted above was found to be the best performing network configuration.

Figure 5.20 and Figure 5.21 show the degree of saturation at the Armadale Road network with grade separation and partial treatment with roundabouts and signalisation in the AM and PM peak periods respectively in the 2026 Do Something (grade separated) scenario.

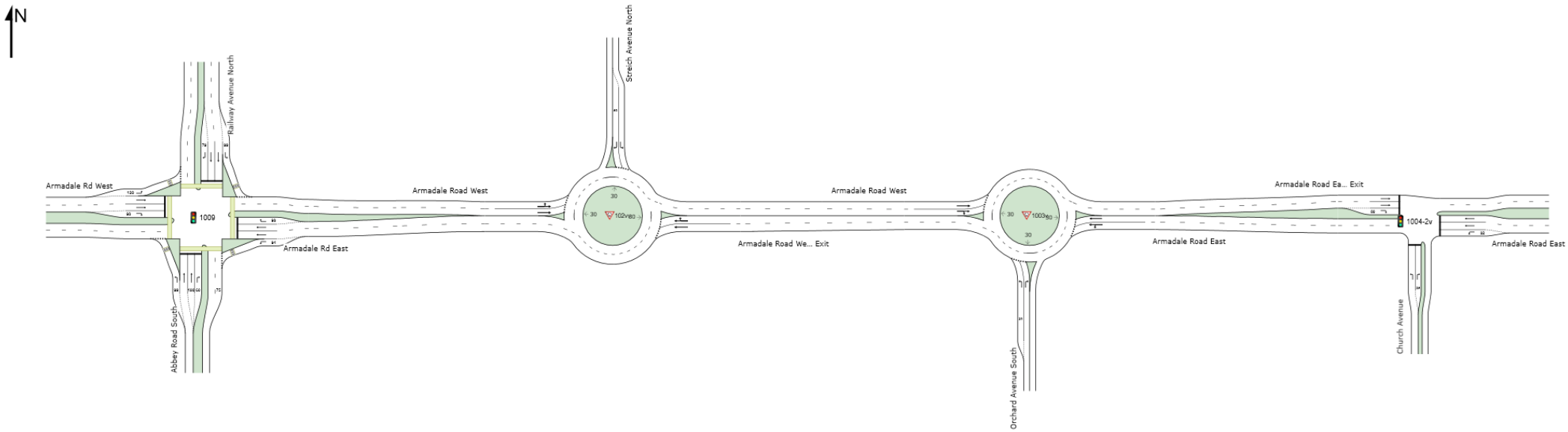


Figure 5.19 Armadale Road Network – Do Something Scenario (grade separated) – partial treatment

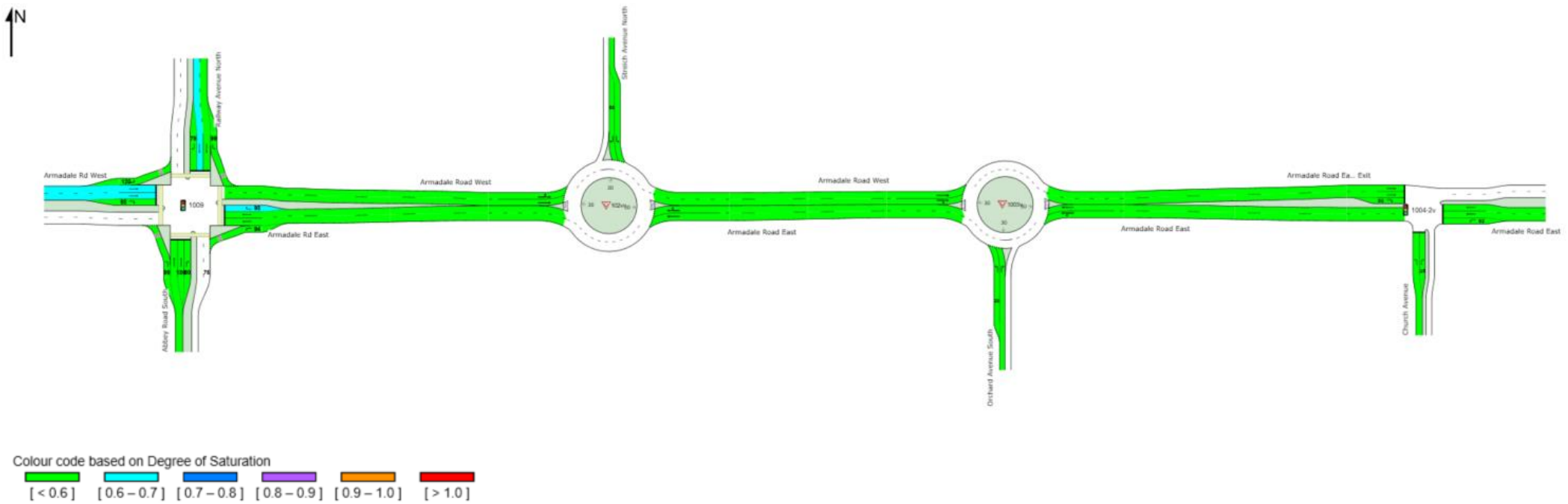


Figure 5.20 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Partial treatment – AM Peak

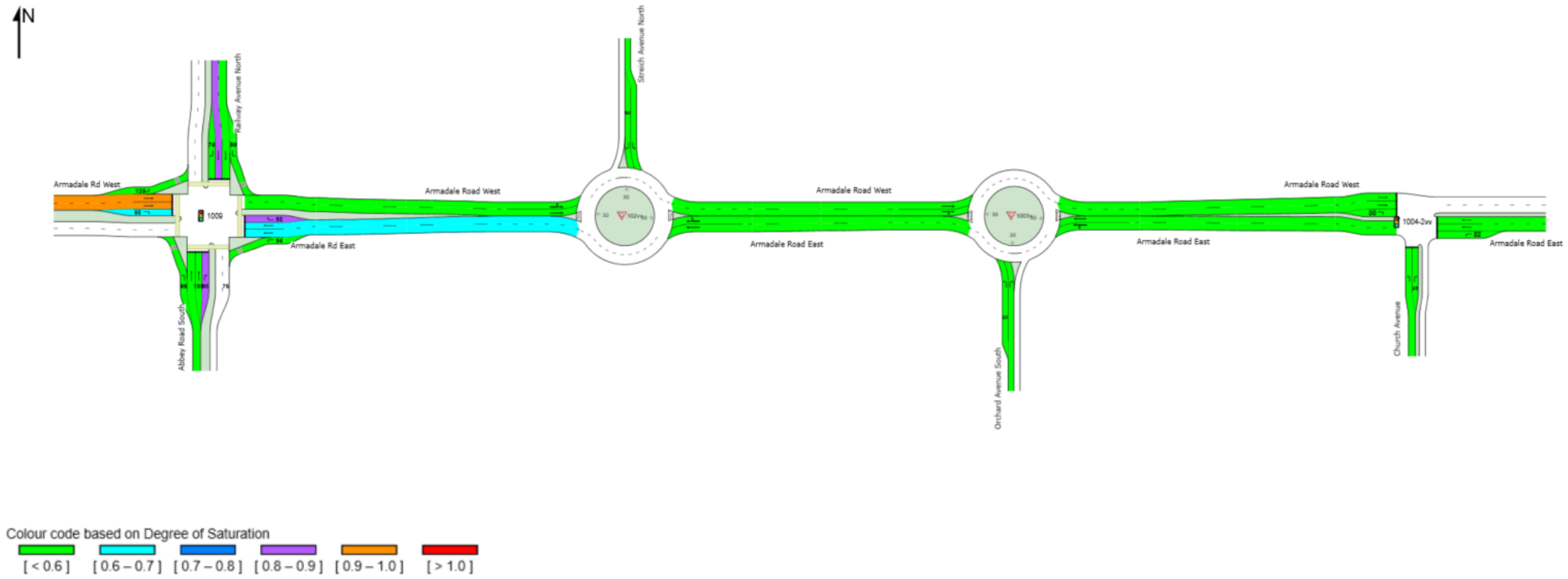


Figure 5.21 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Partial treatment – PM Peak

All intersections within this network would adopt the same layouts as detailed in the previous sections.

Table 7.5 details intersection performance of the Armadale Road Network in the Do Something scenario.

Table 5.5 Armadale Road Network performance – Do Something Scenario (grade separated) – Partial treatment

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	0.683	-	D	0.920	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.683	30.9	C	0.920	34.7
Armadale Rd/ Streich Ave	A	0.423	5.4	A	0.454	5.7
Armadale Rd/ Orchard Ave	A	0.391	6.8	A	0.431	6.6
Armadale Rd/ Church Ave	B	0.595	11.1	B	0.564	11.6

With the grade separation and the adopted intersection layouts, the network performs satisfactorily in both the peak periods with all intersections operating within capacity. It is noted that whilst all the intersections operate within capacity, further signal optimisation with LinSig would be required to address these issues and optimise the signals to the satisfaction of MRWA.

5.3 Church Avenue Road Network

5.3.1 Do Nothing Scenario (LX included and at grade)

This scenario assumes that the Church Avenue Road network will have the level crossing at grade. With the existing intersection layouts retained, the 2026 volume forecasts are applied to understand the performance of the road network.

The Church Avenue Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 5.22:

1. Church Avenue/ William Street
2. Church Avenue/ Hobbs Drive/ Commerce Avenue
3. Church Avenue/ Green Avenue/ Wungong Road
4. Church Avenue level crossing.

Figure 5.23 and Figure 5.24 show the degree of saturation at the Church Avenue Road network with the level crossing at grade in the AM and PM peak periods respectively in the 2026 Do Nothing (LX at grade) scenario.

Figure 5.22 Church Avenue Road Network – Do Nothing Scenario (LX at grade)

Figure 5.23 Degree of Saturation - Church Avenue Road Network – AM Peak - Do Nothing Scenario (LX at grade)

Figure 5.24 Degree of Saturation - Church Avenue Road Network – PM Peak - Do Nothing Scenario (LX at grade

Table 7.6 details the performance of all the intersections in the Church Avenue network.

Table 7.6 details the performance of all the intersections in the Church Avenue Road network.

Table 5.6 Church Avenue Road Network performance – Do Nothing Scenario (LX at grade)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	B	0.697	-	B	0.507	-
Church Avenue/ William Street	A	0.322	5.8	B	0.479	6.5
Church Avenue LX	A	0.272	3.0	A	0.239	2.9
Church Avenue/ Hobbs Drive/ Commerce Avenue	A	0.366	4.8	A	0.461	5.1
Church Avenue/ Green Avenue/ Wungong Road	A	0.697	6.5	A	0.507	5.6

With the existing network layout, the network and the relevant intersections perform satisfactorily with all intersections operating with reasonable delay and queuing.

However as confirmed by PTA, the Church Avenue Road network is to be grade separated in the future.

5.3.2 Do Nothing Scenario (grade separated)

The scenario analyses the Church Avenue network with grade separation in the future year whilst still retaining the existing layouts for the other intersections.

The Church Avenue network in this scenario comprises of the following intersections as shown in Figure 7.25:

1. Church Avenue/ William Street
2. Church Avenue/ Hobbs Drive/ Commerce Avenue
3. Church Avenue/ Green Avenue/ Wungong Road.

Figure 5.26 and Figure 5.27 show the degree of saturation at the Church Avenue Road network with grade separation in the AM and PM peak periods respectively in the 2026 Do Nothing (grade separated) scenario.

Figure 5.25 Church Avenue Road Network – Do Nothing Scenario (grade separated)

Figure 5.26 Degree of saturation - Church Avenue Road Network – AM Peak - Do Nothing Scenario (grade separated)

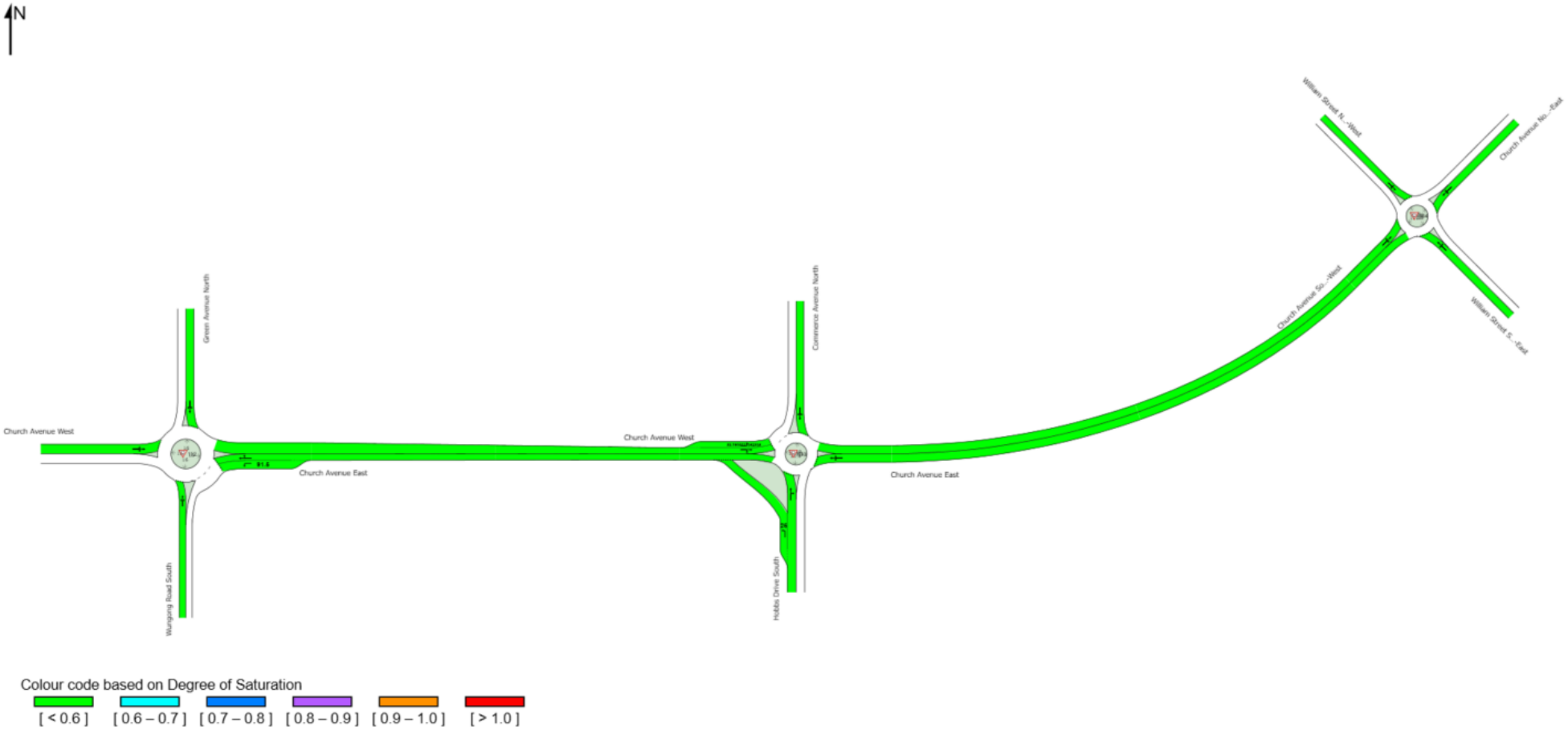


Figure 5.27 Degree of saturation - Church Avenue Road Network – PM Peak - Do Nothing Scenario (grade separated)

Table 7.7 details the performance of all the intersections in the Church Avenue network.

Table 5.7 Church Avenue Network performance – Do Nothing Scenario (grade separated)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	B	0.368	-	B	0.479	-
Church Avenue/ William Street	A	0.322	5.8	A	0.479	6.5
Church Avenue/ Hobbs Drive/ Commerce Avenue	A	0.276	5.4	A	0.246	5.6
Church Avenue/ Green Avenue/ Wungong Road	A	0.368	6.0	A	0.296	5.9

With the grade separation and with no changes to the existing layout, the network and intersections perform satisfactorily with all intersection operating with reasonable delay and queueing.

Due to the network performing satisfactorily with just the grade separation, no additional infrastructure is expected to be required for the remaining intersections in the network.

5.4 Forrest Road Network

5.4.1 Do Nothing Scenario (LX included and at grade)

This scenario assumes that the Forrest Road network would still be at grade with the level crossing in place. With the existing intersection layouts retained, the 2026 volume forecasts are applied to understand the performance of the road network.

The Forrest Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 5.28:

1. Forrest Road/ Aragon Court
2. Forrest Road Level Crossing
3. Forrest Road/ Third Road/ Neerigen Street
4. Commerce Avenue/ Third Road/ Supermarket Access.

Figure 5.29 and Figure 5.30 show the degree of saturation at the Forrest Road network with the level crossing at grade in the AM and PM peak periods respectively in the 2026 Do Nothing (LX at grade) scenario.

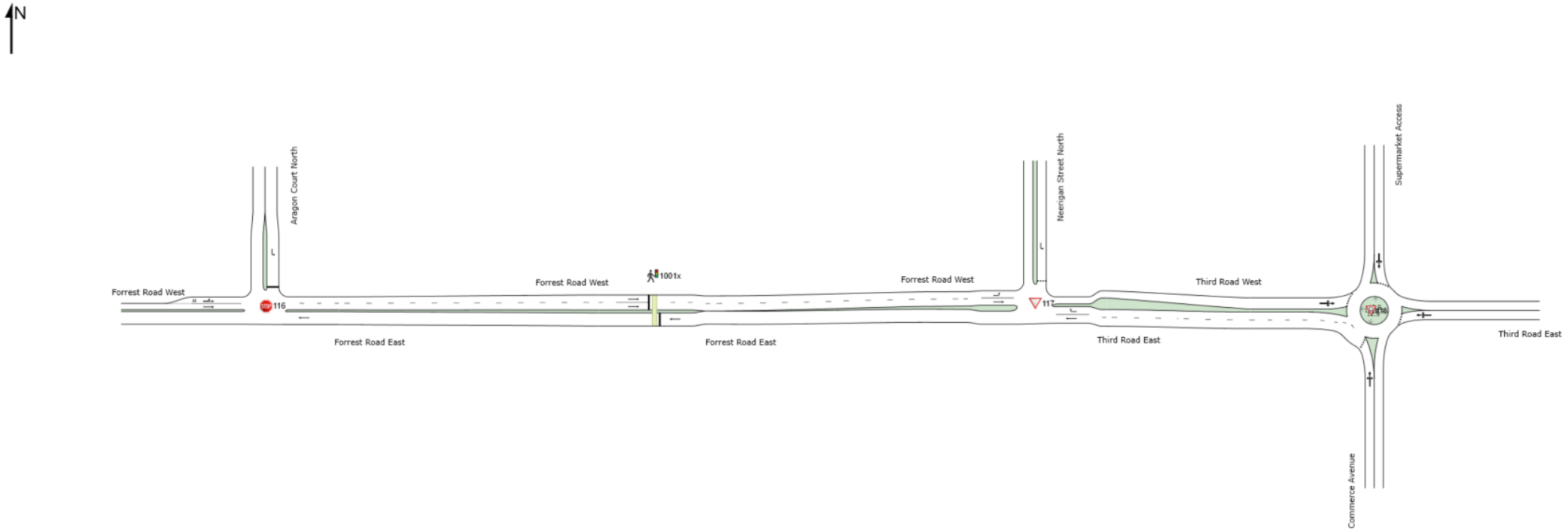


Figure 5.28 Forrest Road Network – Do Nothing Scenario (LX at grade)

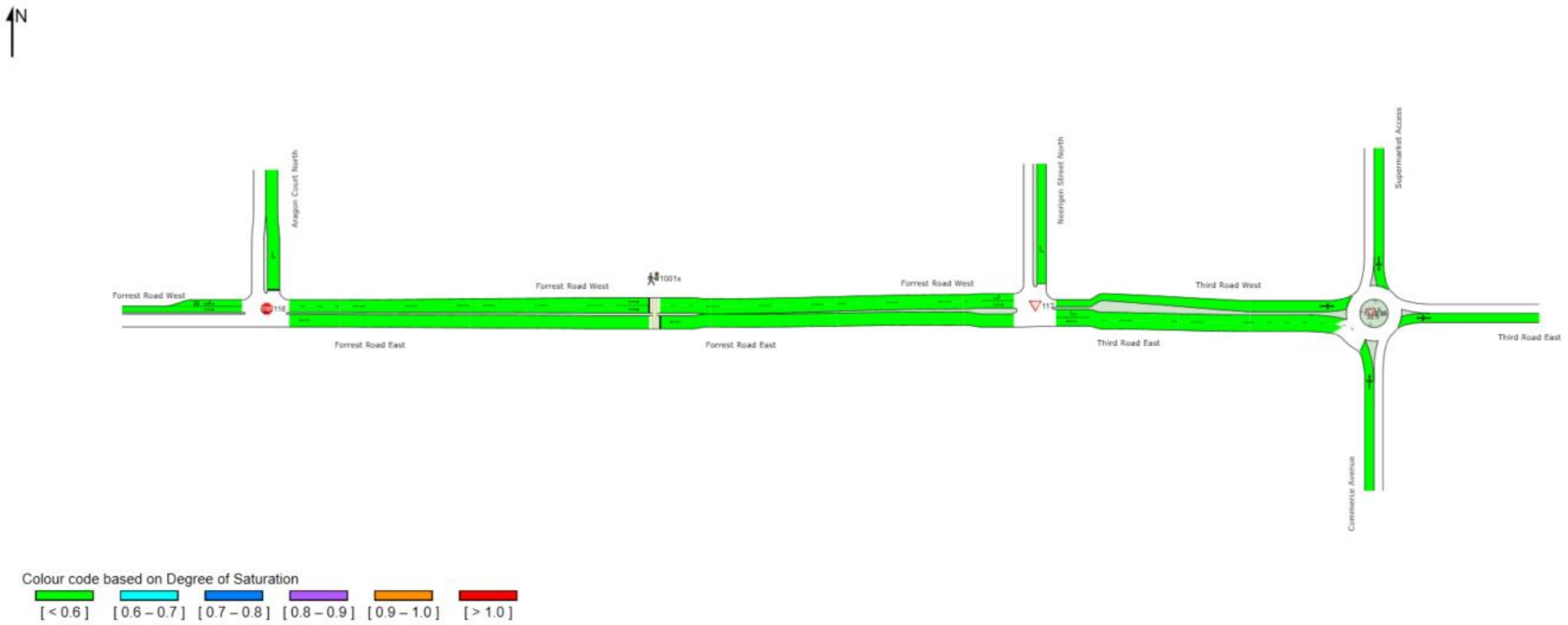


Figure 5.29 Degree of Saturation – Forrest Road Network – AM Peak – Do Nothing Scenario (LX at grade)

Figure 5.30 Degree of Saturation – Forrest Road Network – PM Peak – Do Nothing Scenario (LX at grade

Table 7.8 details the performance of all the intersections in the Forrest Road network.

Table 5.8 Forrest Road Network performance – Do Nothing Scenario (LX at grade)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	**Degree of Saturation (DoS)**	**Average Delay (s)**	**Level of Service (LoS)**	**Degree of Saturation (DoS)**	**Average Delay (s)**
Overall Network	B	0.541	-	B	0.567	-
Forrest Road/ Aragon Court	A	0.204	0.9	A	0.229	1.0
Forrest Road LX	A	0.246	7.4	A	0.277	7.6
Forrest Road/ Neerigan Street	A	0.370	2.0	A	0.374	1.9
Third Road West/ Commerce Avenue	A	0.541	5.6	A	0.567	5.5

With the existing network layout, the network and the relevant intersections perform satisfactorily with all intersections operating with reasonable delay and queueing.

However as confirmed by PTA, the Forrest Road network is to be grade separated in the future.

5.4.2 Do Nothing Scenario (grade separated)

This scenario analyses the Forrest Road network with grade separation in the future year, whilst still retaining the existing layouts for the other intersections.

The Forrest Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 7.31:

1. Forrest Road/ Aragon Court
2. Forrest Road Level Crossing
3. Forrest Road/ Third Road/ Neerigen Street
4. Commerce Avenue/ Third Road/ Supermarket Access.

Figure 5.32 and Figure 5.33 show the degree of saturation at the Forrest Road network with grade separation in the AM and PM peak periods respectively in the 2026 Do Nothing (grade separated) scenario.

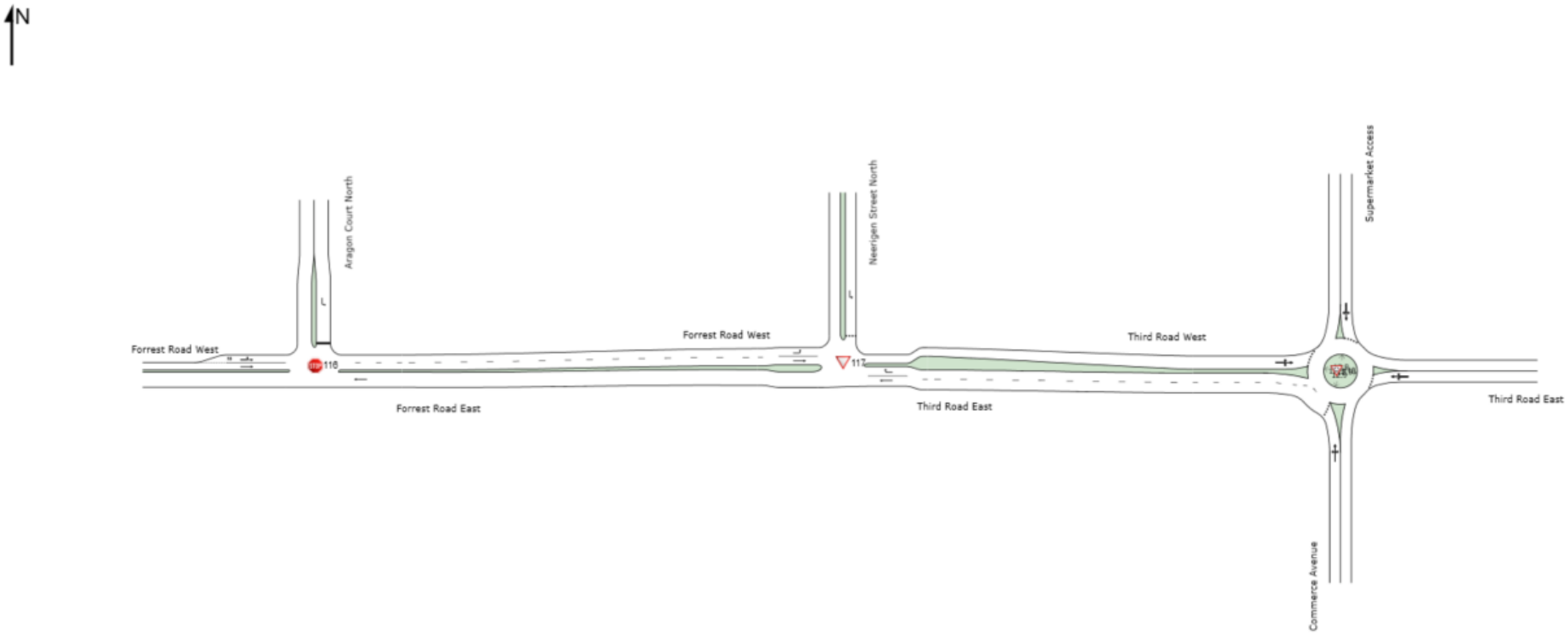


Figure 5.31 Forrest Road Network – Do Nothing Scenario (grade separated)

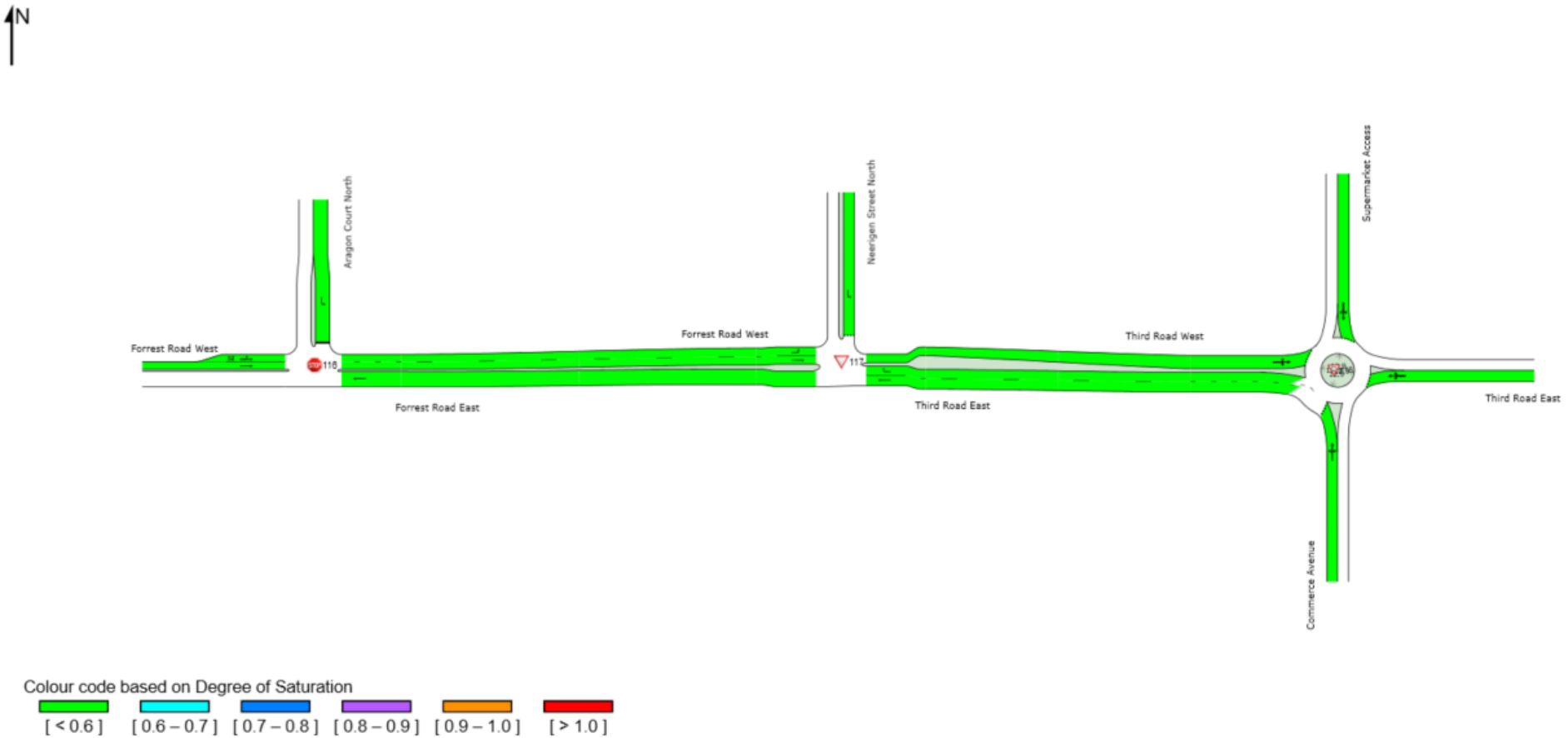


Figure 5.32 Degree of Saturation - Forrest Road Network – AM peak - Do Nothing Scenario (grade separated)

Figure 5.33 Degree of Saturation - Forrest Road Network – PM peak - Do Nothing Scenario (grade separated)

Table 7.9 details the performance of all the intersections in the Forrest Road network.

Table 5.9 Forrest Road Network performance – Do Nothing Scenario (grade separated)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	A	0.541	-	A	0.558	-
Forrest Road/ Aragon Court	A	0.204	0.9	A	0.229	1.0
Forrest Road/ Neerigan Street	A	0.375	2.1	A	0.380	2.0
Third Road West/ Commerce Avenue/ Supermarket Access	A	0.541	5.3	A	0.558	5.3

With the grade separation and with no changes to the existing layout, the intersections perform satisfactorily with all intersections operating with reasonable delay and queueing.

Due to the network performing satisfactorily with just the grade separation, no additional infrastructure is expected to be required for the remaining intersections in the network.

6 Individual Intersection Modelling Results – Opening year + 10 (2036)

6.1 Introduction

This section details the network and intersection performance at the prescribed locations as per the TMIF requirements under the 2036 traffic forecasts for both the Do Nothing and Do Something (grade separated scenarios) in the AM and PM peak periods.

This section also provides recommendations on changes to geometry and intersection control wherever necessary/ appropriate, noting the previous comments with regards to context in which this has been executed.

Summary results are provided in this section of the report for ease of reference, with detailed outputs provided in Appendix D.

6.2 SWH/ William Street/ Bedfordale Road

6.2.1 2036 Do Nothing Scenario

Figure 6.1 represents the existing layout at the intersection of SWH/ William Street/ Bedfordale Hill Road.

Figure 6.2 and Figure 6.3 show the degree of saturation at the existing layout of the SWH/ William Street/ Bedfordale Hill Road intersection in the AM and PM peak periods respectively in the 2036 Do Nothing scenario.

While the intersection is forecast to operate within capacity in the AM peak with the degree of saturation being 0.951, in the PM peak the intersection is forecast to be oversaturated. Both west and east approaches are forecast to operate above capacity in the PM peak with the highest degree of saturation being 2.054 on the right/through lane on the east approach. This is forecast to result in extensive delays at the intersection in the PM peak with the highest forecast delay being over 16 minutes. Additionally, queuing is forecast to be significant on the south and west approaches with the longest modelled queue (95% back of queue) forecast to be around 540m on the west approach in the PM peak.

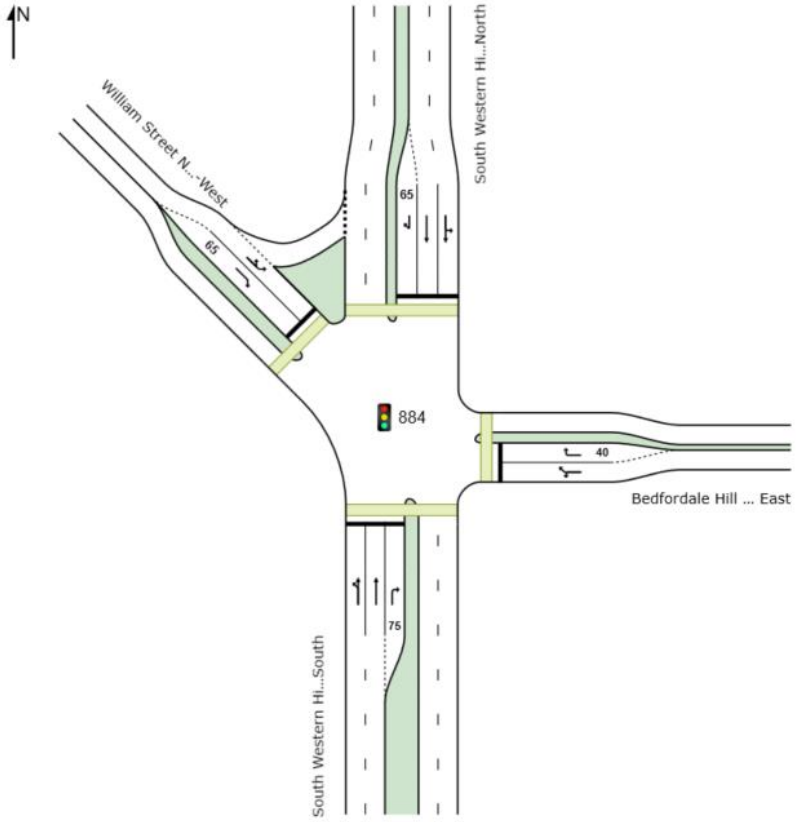


Figure 6.1 SWH/ William St/ Bedfordale Hill Rd – Existing intersection layout

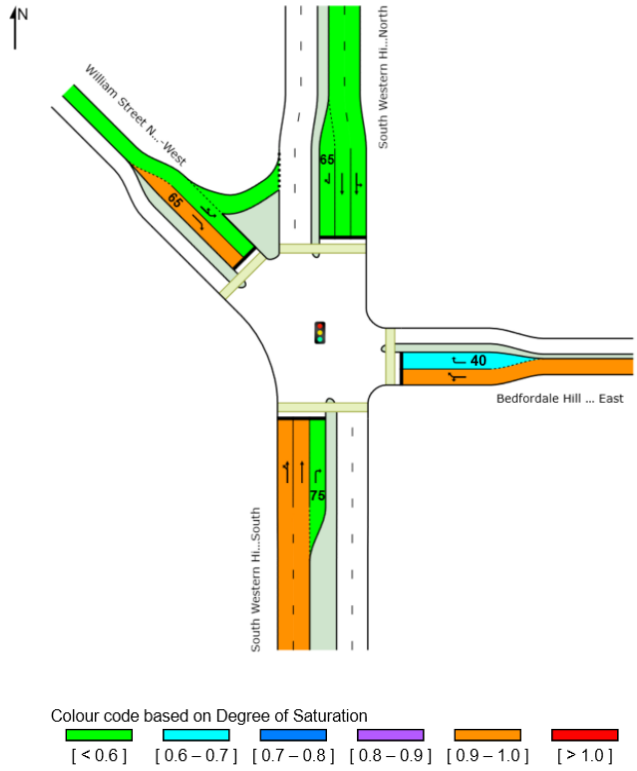


Figure 6.2 Degree of Saturation – AM Peak – Do Nothing

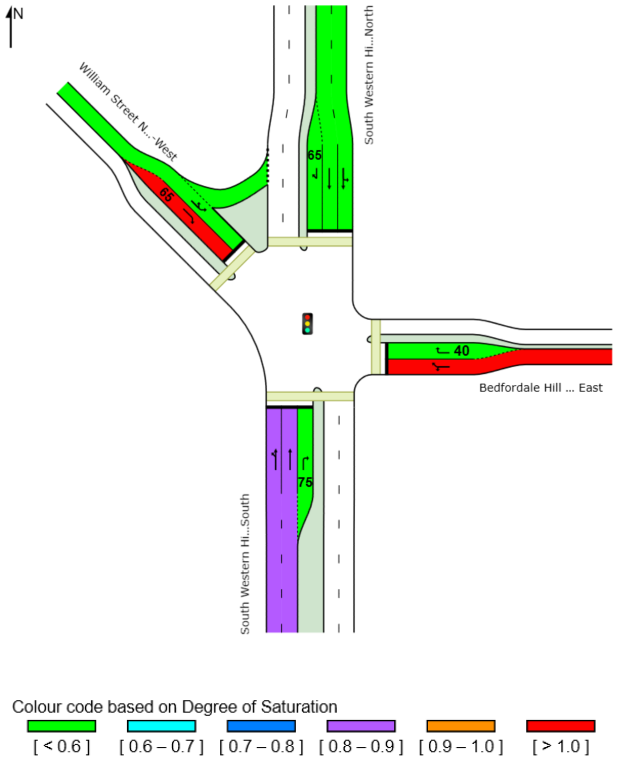


Figure 6.3 Degree of Saturation – PM Peak – Do Nothing

6.2.2 2036 Do Something Scenario

A Do Something scenario was assessed for this intersection to improve capacity and reduce the delay at the intersection.

In this scenario, the left lane on the west approach was changed to a left, through and right shared lane as shown in Figure 6.4 due to the right turn lane being oversaturated in the Do Nothing scenario. Additionally, the signal cycle time was increased to 150 seconds in the PM peak to reduce the amount of lost time within each cycle.

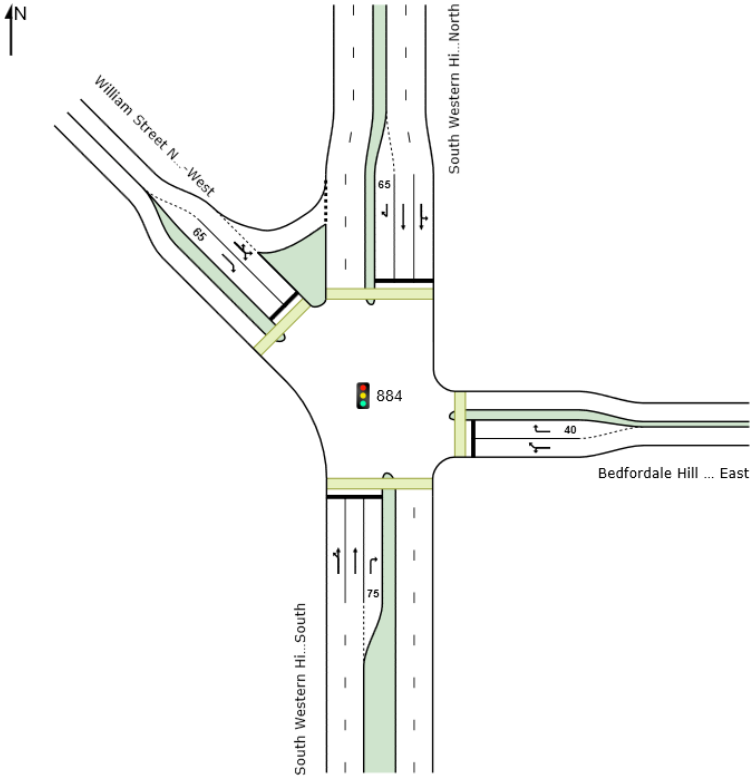


Figure 6.4 SWH/ William St/ Bedfordale Hill Rd – Modified intersection layout

Figure 6.5 and Figure 6.6 show the degree of saturation at the proposed layout of the SWH/ William Street/ Bedfordale Hill Road intersection in the AM and PM peak periods respectively in the 2036 Do Something scenario.

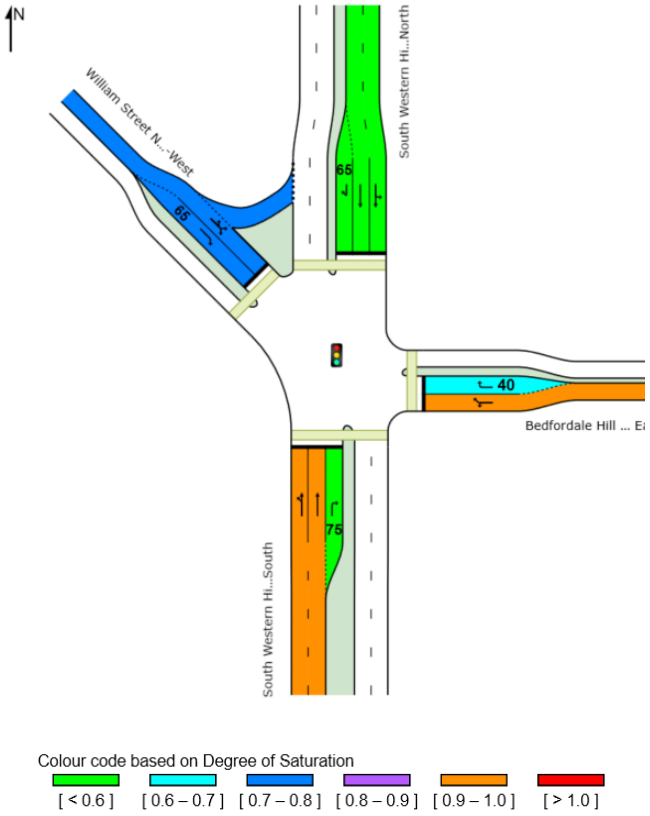


Figure 6.5 Degree of Saturation – AM Peak – Do Something

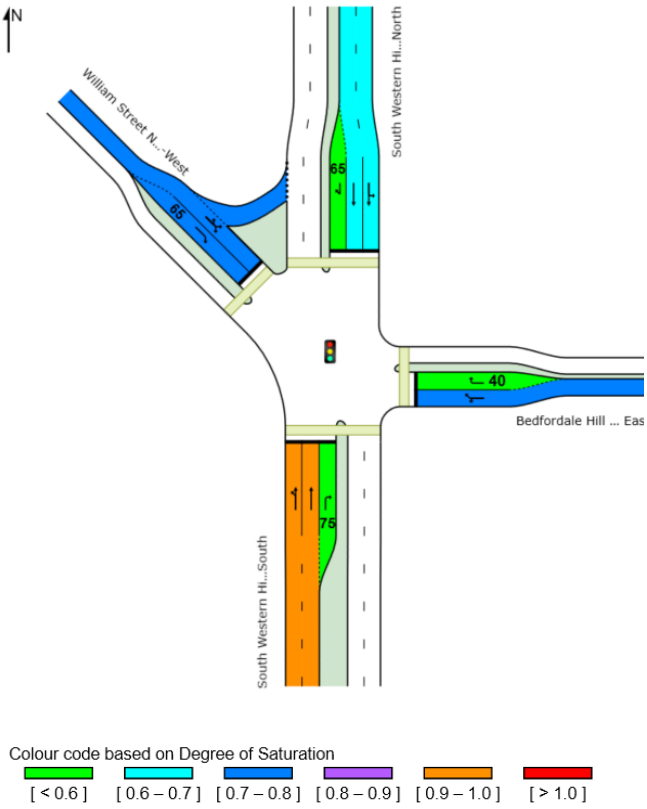


Figure 6.6 Degree of Saturation – PM Peak – Do Something

The results of these modifications to the intersection show that if implemented, the intersection is forecast to operate just under capacity in both the AM and PM peaks, with the highest degree of saturation forecast to be 0.951 and 0.939 respectively as shown in Table 6.1. The highest delay in this scenario is forecast to be to around 65 seconds in the AM peak and 78 seconds in the PM peak period. Whilst queueing of around 410m and 380m is still observed on the south approach in the AM and PM peak periods, the maximum queue length forecast on the west approach is forecast to reduce from around 540m to 170m.

Table 6.1 SWH/ William St/ Bedfordale Hill Rd – Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Do Nothing	D	0.951	49.6	F	2.054	123.7
Do Something	D	0.951	49.0	E	0.939	57.1

6.3 SWH/ Dickens Place

6.3.1 2036 Do Nothing Scenario

Figure 6.7 shows the existing layout at the intersection of SWH/ Dickens Place.

Figure 6.8 and Figure 6.9 show the degree of saturation at the existing layout of the SWH/ Dickens Place intersection in the AM and PM peak periods respectively in the 2036 Do Nothing scenario.

In the Do Nothing scenario, the intersection is forecast to be oversaturated and operate at LoS F in both the peak periods in the year 2036. This is due to the large volume of through traffic on SWH. This means that right turning vehicles from SWH cannot find a gap to enter Dickens Place resulting in delays for southbound through traffic while those exiting from Dickens Place also cannot find sufficient gaps in traffic on SWH in which to exit. This is forecast to lead to extensive queuing on the north and west approaches with the longest queues of up to 4.3km being forecast on the north approach and queues of up to 900m on the west approach.

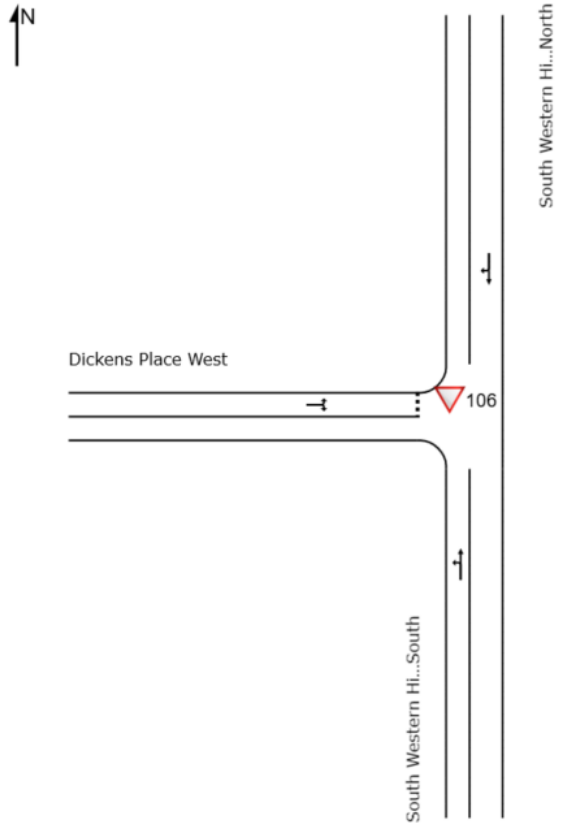


Figure 6.7 SWH/ Dickens Pl – Existing intersection layout

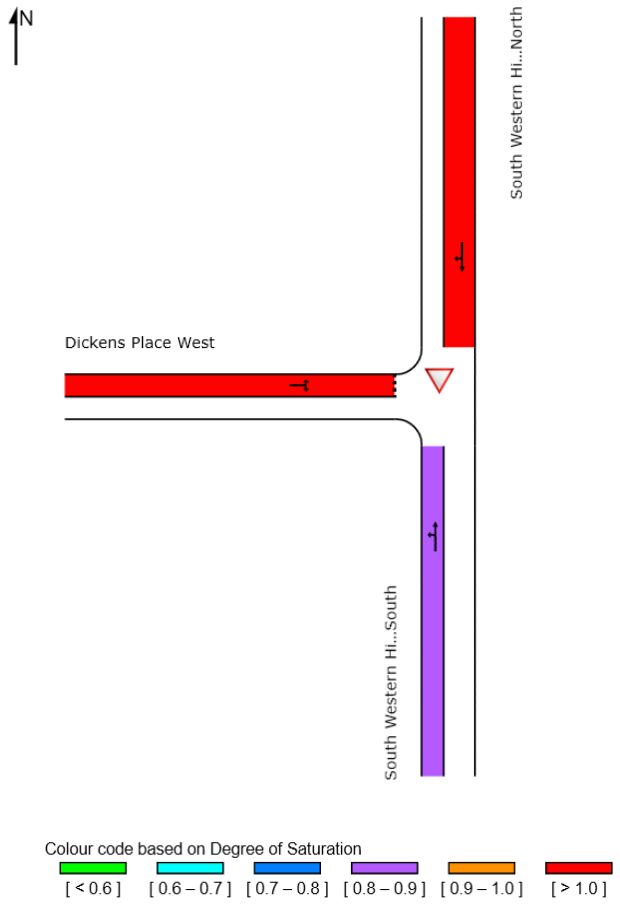


Figure 6.8 Degree of Saturation – AM Peak – Do Nothing

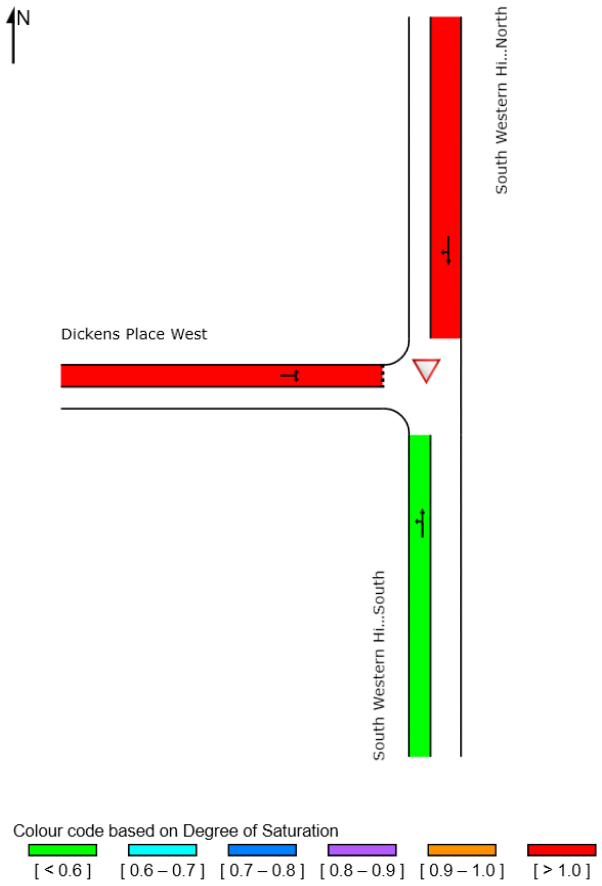


Figure 6.9 Degree of Saturation – PM Peak – Do Nothing

6.3.2 2036 Do Something Scenario

A Do Something scenario was assessed for this intersection to improve capacity and reduce delay at this intersection in 2036.

It was noted that in the 2036 ROM24 plots that SWH has been allocated two lanes in each direction. Therefore, this was implemented in the Do Something model with turning pockets also provided for turning movements into Dickens Place. To compliment the dualling, a right turn pocket was added for the right turning movement from Dickens Place.

Initially, the intersection was modelled as a two staged priority controlled intersection in SIDRA to replicate median storage as in the opening year (2026) Do Something scenario. However, as a priority controlled intersection, the intersection is forecast to continue to operate within capacity , howevera significant delay is forecast on the west approach in the two staged configuration due to insufficient gaps for vehicles from Dickens Place to turn into SWH.

Therefore, two alternative options were developed. A signalised option was tested where SWH was converted into a dual carriageway with 60m turning pockets for both approaches of SWH into Dickens Place. The existing layout of a single carriageway for Dickens Place was retained in the model as shown in Figure 6.10.

The second option involved converting the existing layout into a two-lane circulating roundabout, with SWH being a dual carriageway and Dickens Place being a single lane carriageway as shown in Figure 6.11.

Figure 6.12 and Figure 6.13 show the degree of saturation at the proposed Signalised layout and Figure 6.14 and Figure 6.15 show the degree of saturation at the proposed roundabout layout of the SWH/ Dickens Place intersection in the AM and PM peak periods respectively in the 2036 Do Something scenario.

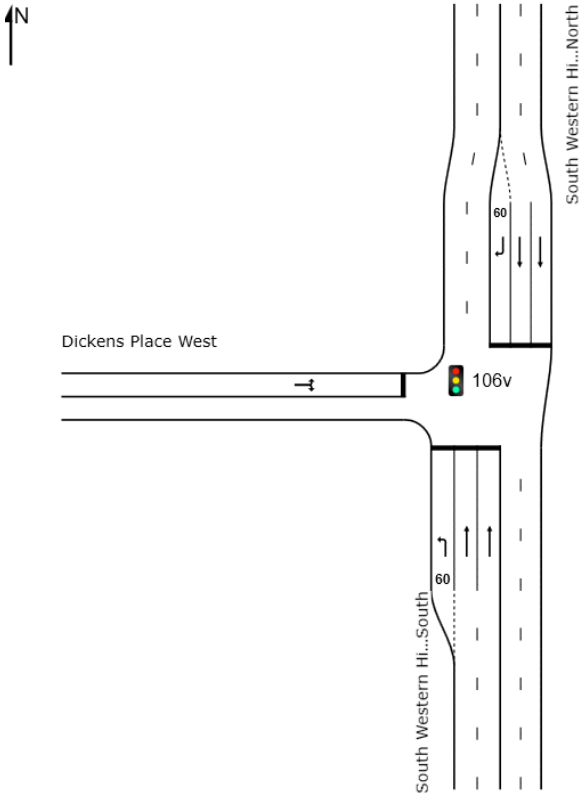


Figure 6.10 SWH/ Dickens Pl – Signalised intersection option

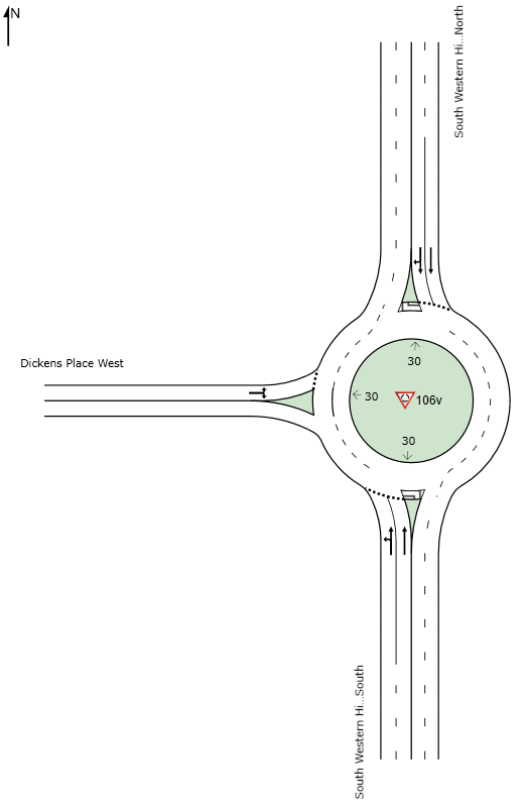
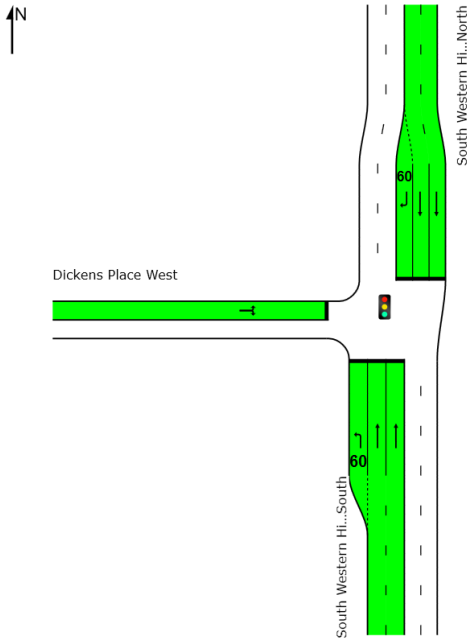


Figure 6.11 SWH/ Dickens Pl – Roundabout option



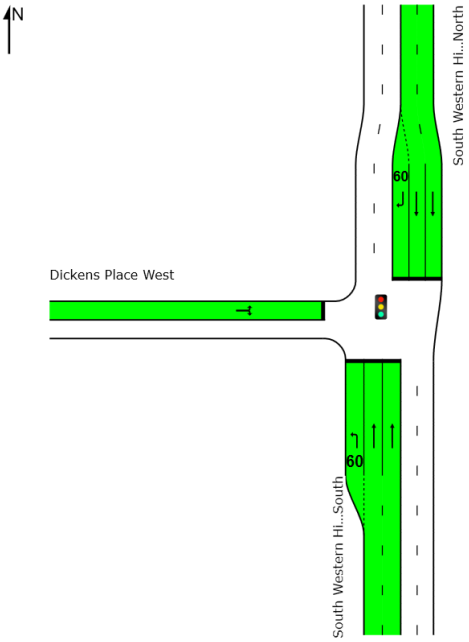
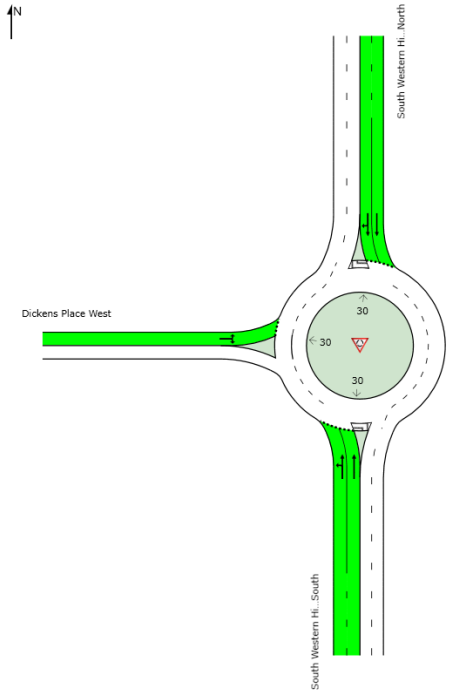


Figure 6.12 Degree of Saturation – AM Peak – Do Something - Signalised intersection

Figure 6.13 Degree of Saturation – PM Peak – Do Something - Signalised intersection



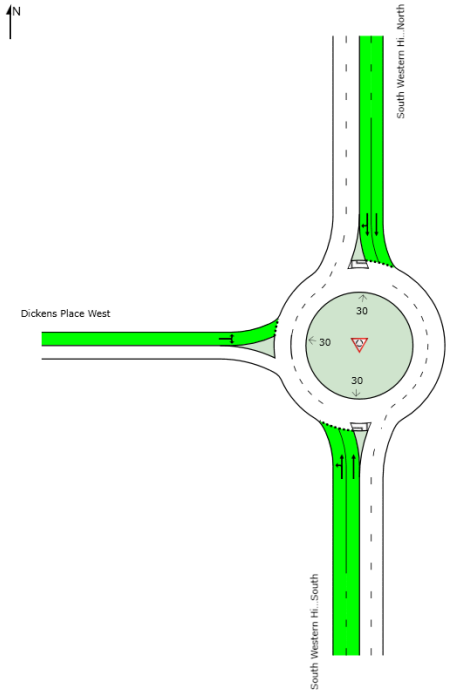


Figure 6.14 Degree of Saturation – AM Peak – Do Something - Roundabout

Figure 6.15 Degree of Saturation – PM Peak – Do Something - Roundabout

Table 6.2 SWH/ Dickens Pl – Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Priority controlled (single stage)	F	3.585	84.6	F	6.491	78.6
Priority controlled (Two stage)	F	0.705	4.7	A	0.391	3.9
Signalised	A	0.596	8.0	A	0.573	9.2
Roundabout	A	0.516	5.6	A	0.473	5.6

Table 6.2 shows the intersection performance with the three different layouts for the year 2036.

As a result of signalisation, the intersection is forecast to operate satisfactorily at LoS A in both peak hours. The intersection is forecast to operate within capacity with a degree of saturation of 0.596 in the AM peak and 0.573 in the

PM peak. The highest forecast delay for this option is on Dickens Place with a delay of approximately 55s and 30s in the AM and PM peak periods respectively. The forecast queues are reasonable with the longest queue forecast to be around 160m for the through movement on the south approach in the AM peak.

In the roundabout option, the intersection is forecast to operate at LoS A in both peak periods with a degree of saturation of 0.516 and 0.473 in the AM and PM peak periods respectively. Forecast delays and queues are significantly lower than in both the priority controlled and signalised options with the highest delay being 15 seconds on the west approach in the AM peak and highest queue being around 40m on the north approach in the PM peak.

6.4 SWH/ Stone Street

6.4.1 2036 Do Nothing Scenario

Figure 6.16 represents the existing layout at the intersection of SWH/ Stone Street.

Figure 6.17 and Figure 6.18 show the degree of saturation at the existing layout of the SWH/ Stone Street intersection in the AM and PM peak periods respectively in the 2036 Do Nothing scenario.

In the Do Nothing scenario, the intersection is forecast to operate over capacity and at LoS F in both peak periods. This is due to the large volume of through traffic on SWH. This means that right turning vehicles from SWH cannot find a gap to enter Stone Street resulting in delays for southbound through traffic while those exiting from Stone Street also cannot find sufficient gaps in traffic on SWH in which to exit. This is forecast to lead to extensive queuing on the north and west approaches with the longest queues of up to 6km forecast on the north approach and queues of up to 2.4km being forecast on the west approach.

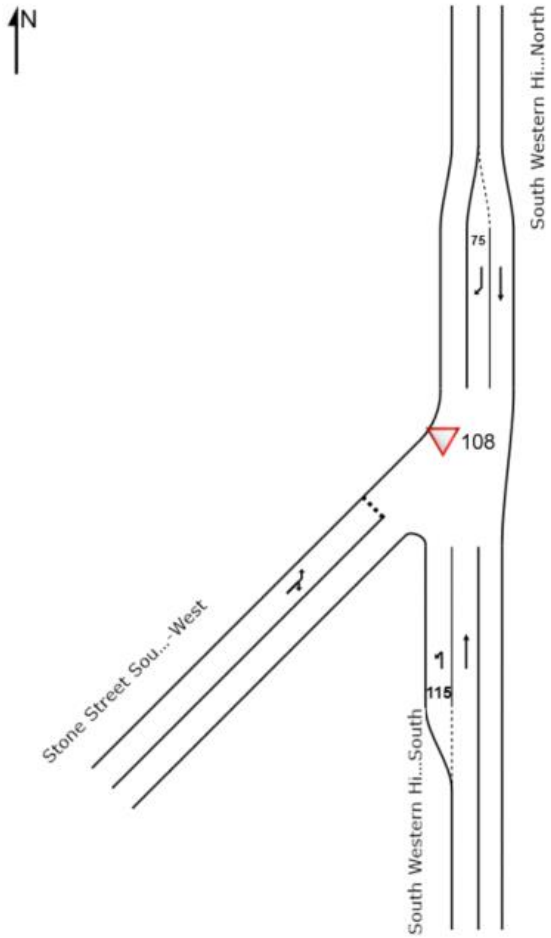


Figure 6.16 SWH/ Stone St – Existing intersection layout

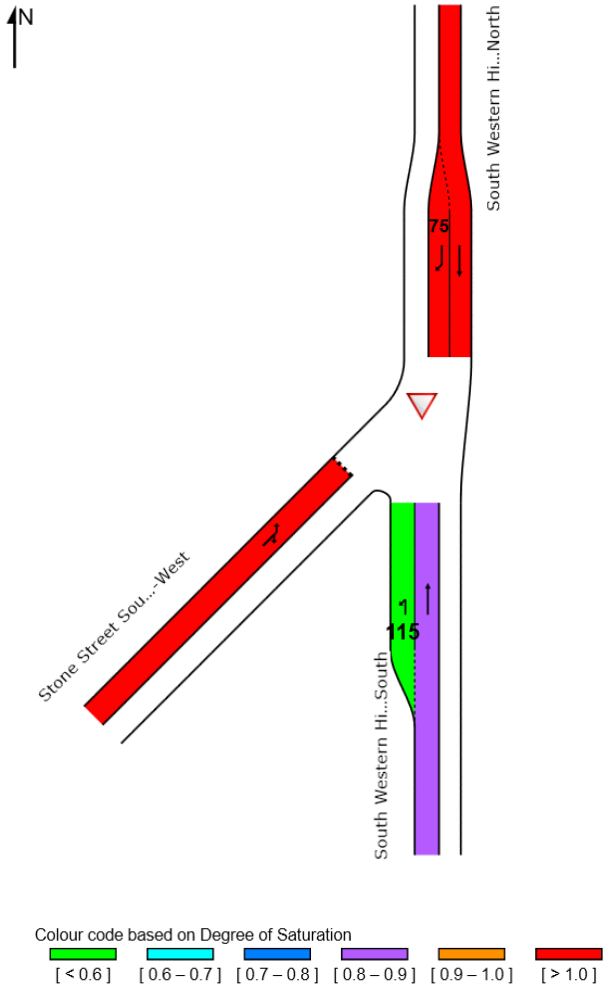


Figure 6.17 Degree of Saturation – AM Peak – Do Nothing

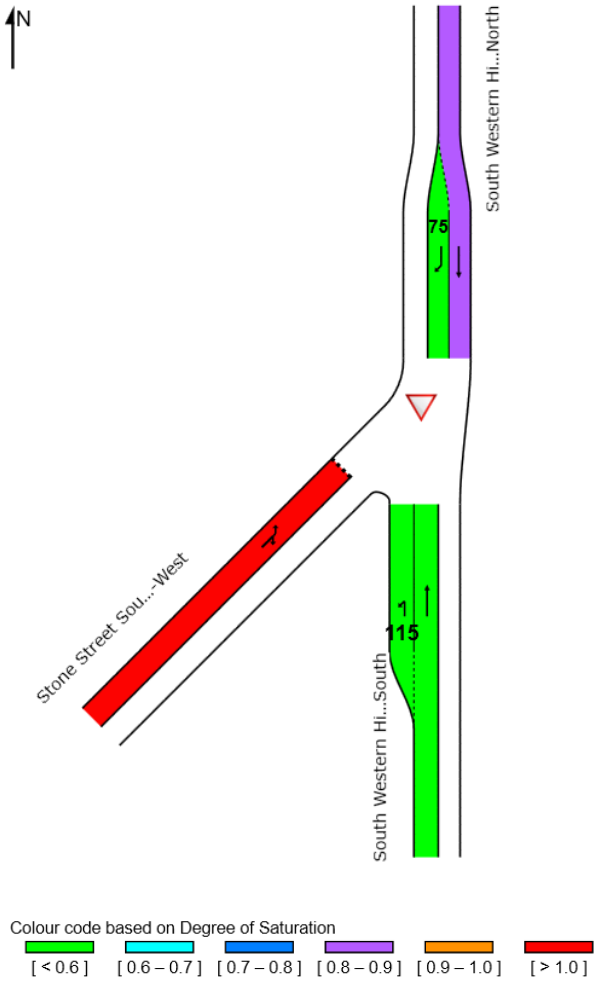


Figure 6.18 Degree of Saturation – PM Peak – Do Nothing

6.4.2 Do Something Scenario

A Do Something scenario was assessed for this intersection to improve capacity and reduce delay at this intersection in 2036.

Initially, with the proposed duplication of SWH, SWH was changed to a dual carriageway with pockets added for turning movements into Stone Street. Additionally, the intersection was modelled as a two staged layout in SIDRA to replicate a median storage as in the opening year (2026) scenario. However, in this option the intersection was forecast to operate above capacity. A further intersection improvement was then tested with a turn pocket added for the left turning movement from Stone Street into SWH. However, the priority-controlled intersection was still forecast to operate significantly over capacity and with considerable delays in this scenario due to insufficient gaps for vehicles from Stone Street to turn into SWH and for vehicles to turn right from SWH north into Stone Street.

Two alternative options were therefore developed. For the first option, the priority-controlled intersection was converted into a signalised intersection (without the additional left turning pocket on Stone Street tested as a priority control) as shown in Figure 6.19.

The second option involved converting the existing layout into a two-lane circulating roundabout, with SWH being a dual carriageway and Stone Street being a single lane carriageway with a left turn pocket of 30m as shown in Figure 6.20.

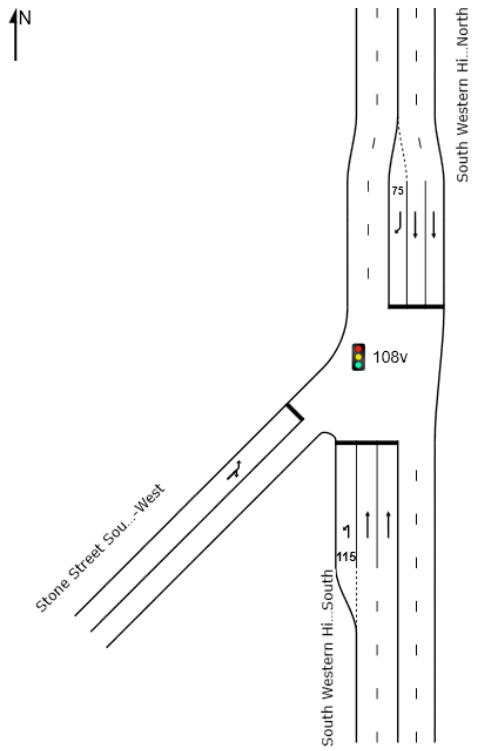


Figure 6.19 SWH/ Stone St – Signalised intersection option

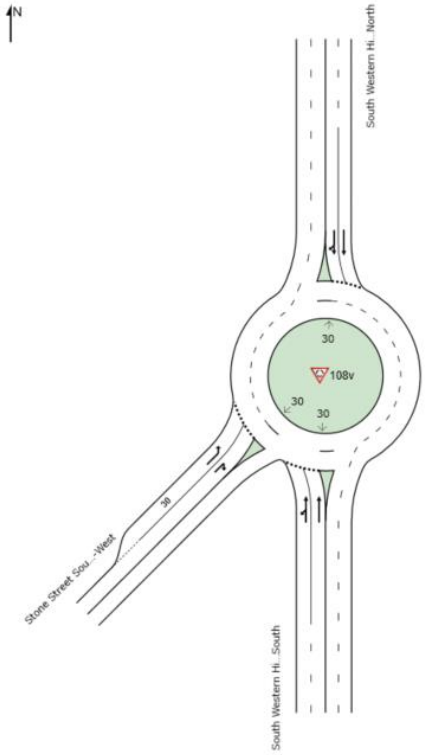
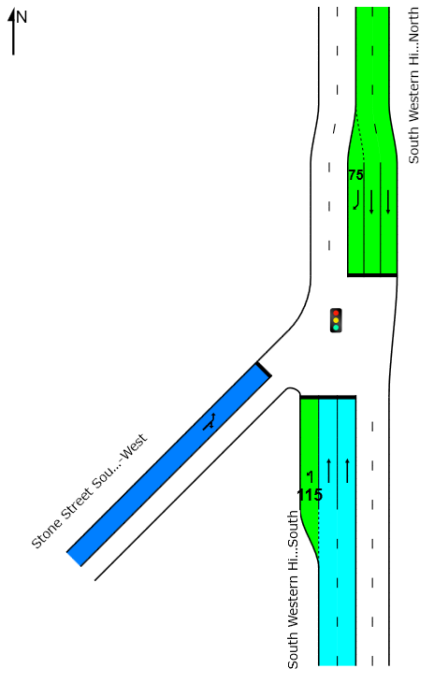
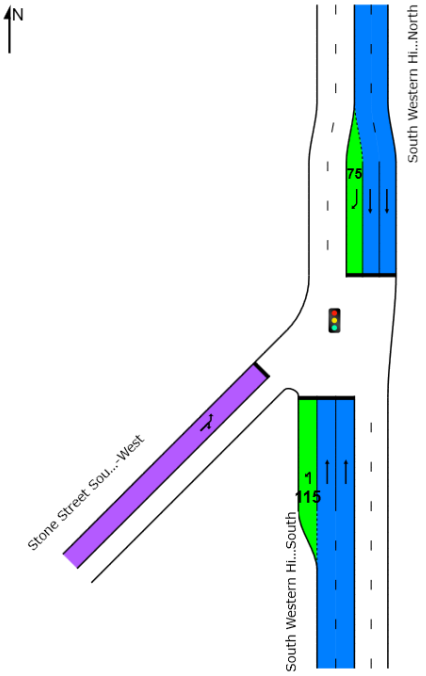


Figure 6.20 SWH/ Stone St – Roundabout option

Figure 6.21 and Figure 6.22 show the degree of saturation for the proposed signalised layout and Figure 6.23 and Figure 6.24 show the degree of saturation for the proposed roundabout layout of the SWH/ Stone Street intersection in the AM and PM peak periods respectively in the 2036 Do Something scenario.





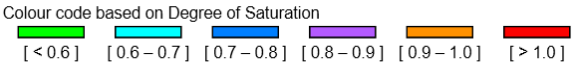


Figure 6.21 Degree of Saturation – AM Peak – Do Something - Signalised intersection

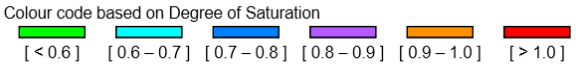


Figure 6.22 Degree of Saturation – PM Peak – Do Something - Signalised intersection

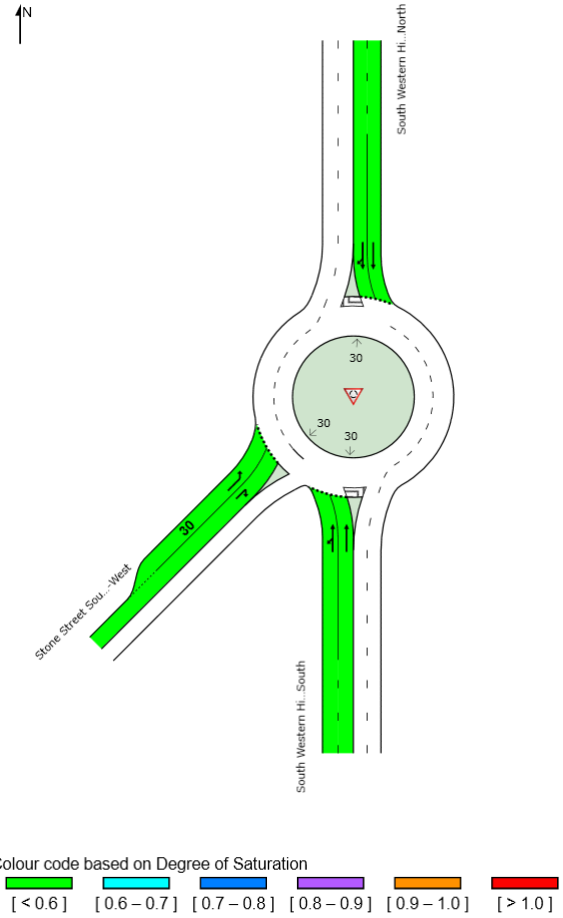


Figure 6.23 Degree of Saturation – AM Peak – Do Something - Signalised intersection

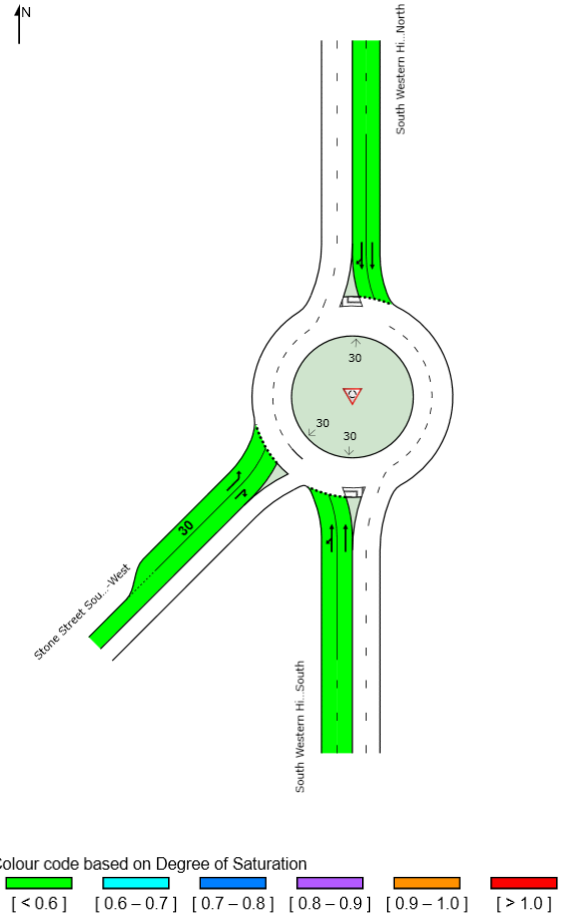


Figure 6.24 Degree of Saturation – PM Peak – Do Something - Signalised intersection

Table 6.3 SWH/ Stone St – Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Priority controlled (single stage)	F	11.053	275.1	F	40.351	3006.0
Priority controlled (two stage)	F	0.910	8.2	F	2.608	260.3
Signalised	B	0.712	11.2	B	0.813	17.9
Roundabout	A	0.485	5.5	A	0.589	6.6

Table 6.3 shows the forecast intersection performance with different layouts in the year 2036. In the signalised scenario, the intersection is forecast to operate satisfactorily at LoS B in both peaks and within capacity with a degree of saturation of 0.712 and 0.813 in the AM and PM peak periods respectively. The highest delay forecast is for the right turn from Stone Street to SWH with a delay of around 45s in the AM peak and 35s in the PM peak. Queue lengths are forecast to be reasonable with the longest queue being around 160m on the south approach in the AM peak.

In the roundabout option, the intersection operates at LoS A in both peak periods with a degree of saturation of 0.485 and 0.589 in the AM and PM peak periods respectively. The forecast delays and queues are significantly lower than in the priority controlled and signalised scenarios with the highest delay forecast to be 14 seconds on the north approach in the PM peak and longest queue around 45 metres on the north approach in the PM peak.

6.5 SWH/ Eleventh Road

6.5.1 2036 Do Nothing Scenario

Figure 6.25 shows the existing layout at the intersection of SWH/ Eleventh Road.

Figure 6.26 and Figure 6.27 show the degree of saturation at the existing layout of the SWH/ Eleventh Road intersection in the AM and PM peak periods respectively in the 2036 Do Nothing scenario.

This layout is forecast to result in the intersection being oversaturated and operating at LoS F in both the peak periods in the year 2036. Again, this is due to the large volume of through traffic using SWH with the longest queue of around 1.6km forecast on the west approach in the PM peak.

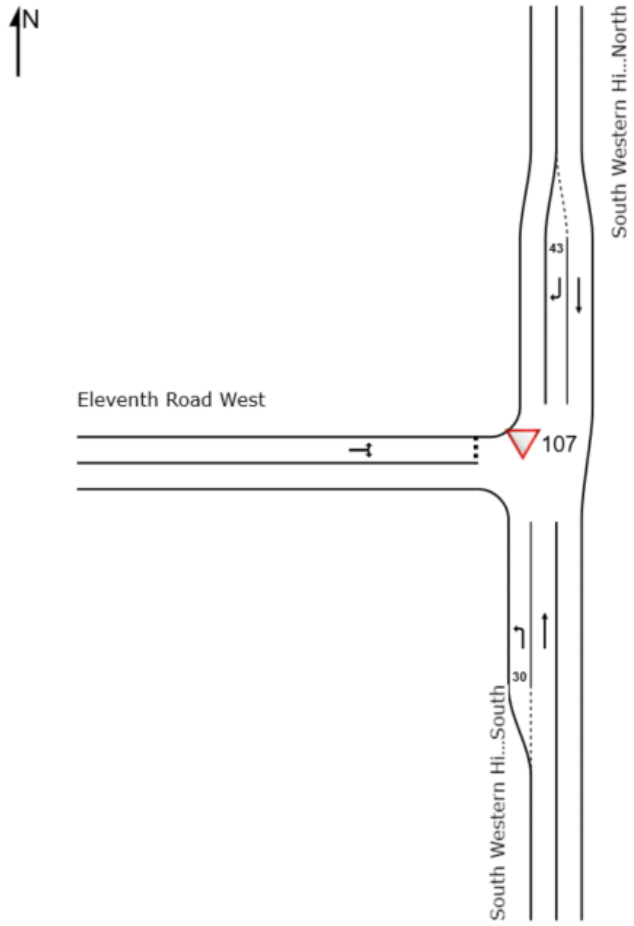


Figure 6.25 SWH/ Eleventh Road – Existing intersection layout

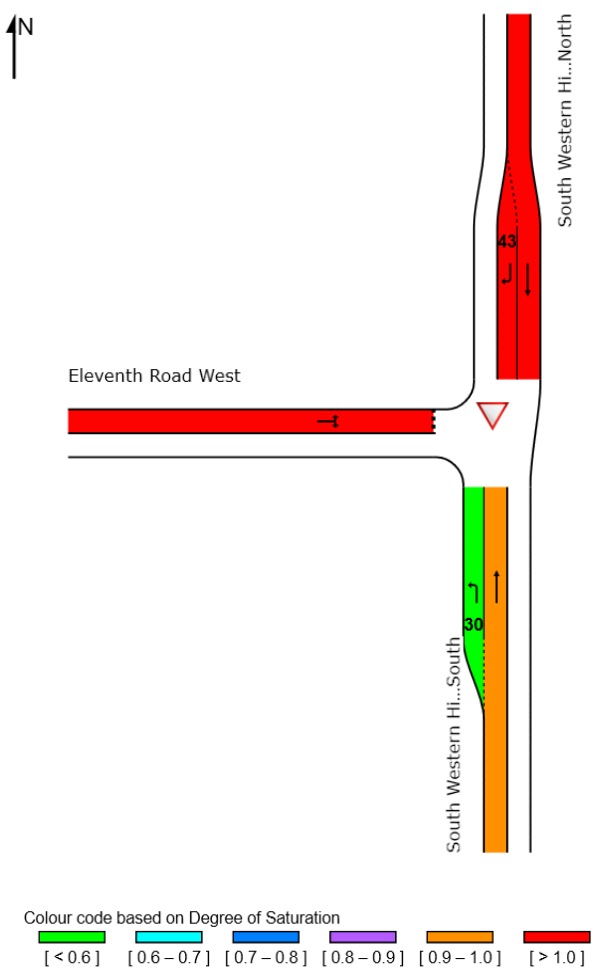


Figure 6.26 Degree of Saturation – AM Peak – Do Nothing

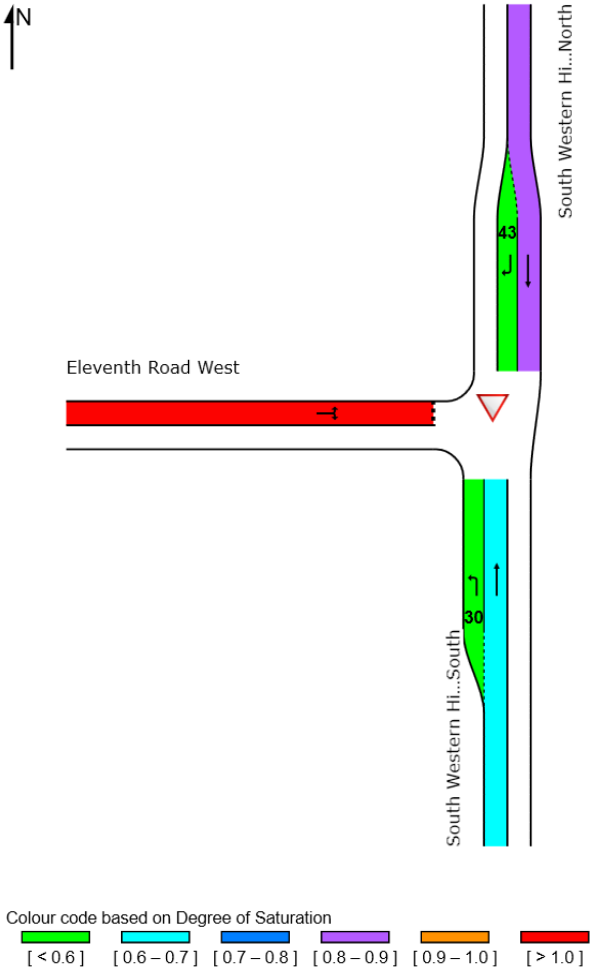


Figure 6.27 Degree of Saturation – PM Peak – Do Nothing

6.5.1.1 2036 Do Something Scenario

A Do Something scenario was assessed for this intersection to improve capacity and reduce delay at this intersection in 2036.

Initially, SWH was changed to a dual carriageway with pockets for turning movements into Eleventh Road. Additionally, the intersection was modelled as a two staged layout in SIDRA to replicate a median storage as in the opening year (2026) scenario. However, this results in the intersection operating over capacity. Therefore, a turn pocket was added for the left turning movement from Eleventh Road into SWH. However, the priority controlled intersection is still forecast to operate over capacity due to insufficient gaps for vehicles from Eleventh Road to turn into SWH and for vehicles to turn right from SWH north into Eleventh Road.

As an alternative, two options have been developed. In the first option, the priority controlled intersection was converted into a signalised intersection as shown in Figure 6.28.

The second option involved converting the existing layout into a two-lane circulating roundabout, with SWH being a dual carriageway and Eleventh Road being a single carriageway as shown in Figure 6.29.

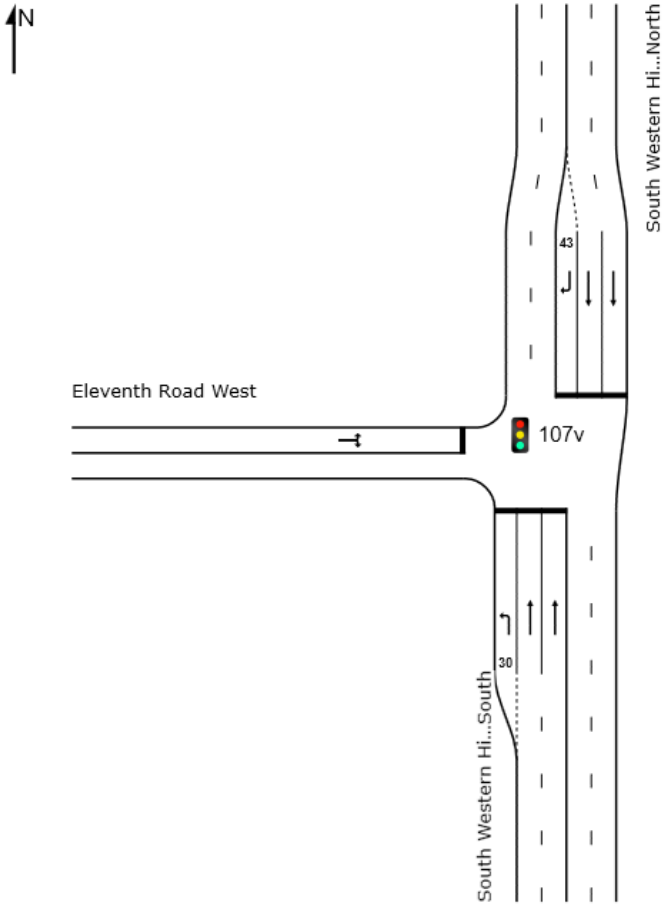


Figure 6.28 SWH/ Eleventh Road – Signalised intersection option

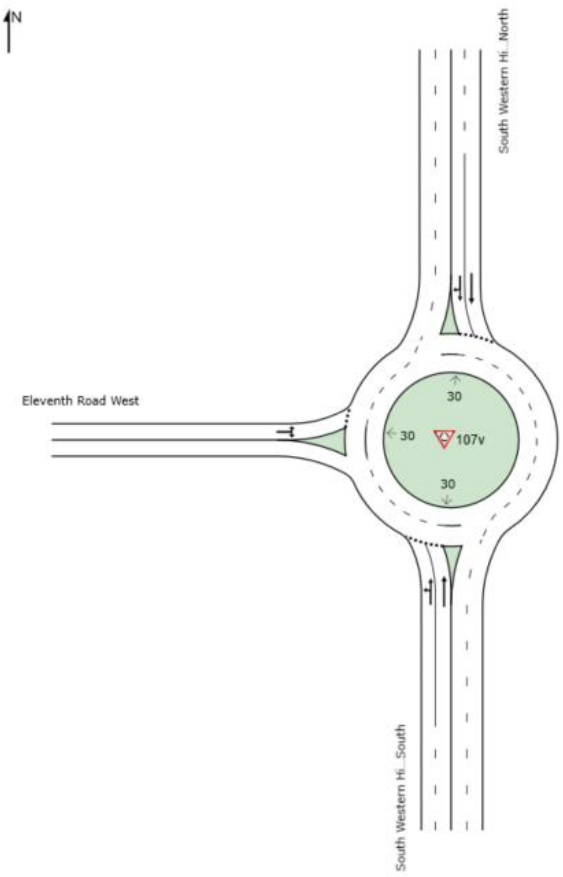


Figure 6.29 SWH/ Eleventh Road – Roundabout option

Figure 6.30 and Figure 6.31 show the degree of saturation for the proposed signalised layout and Figure 6.32 and Figure 6.33 show the degree of saturation for the proposed roundabout layout of the SWH/ Stone Street intersection in the AM and PM peak periods respectively in the 2036 Do Something scenario.

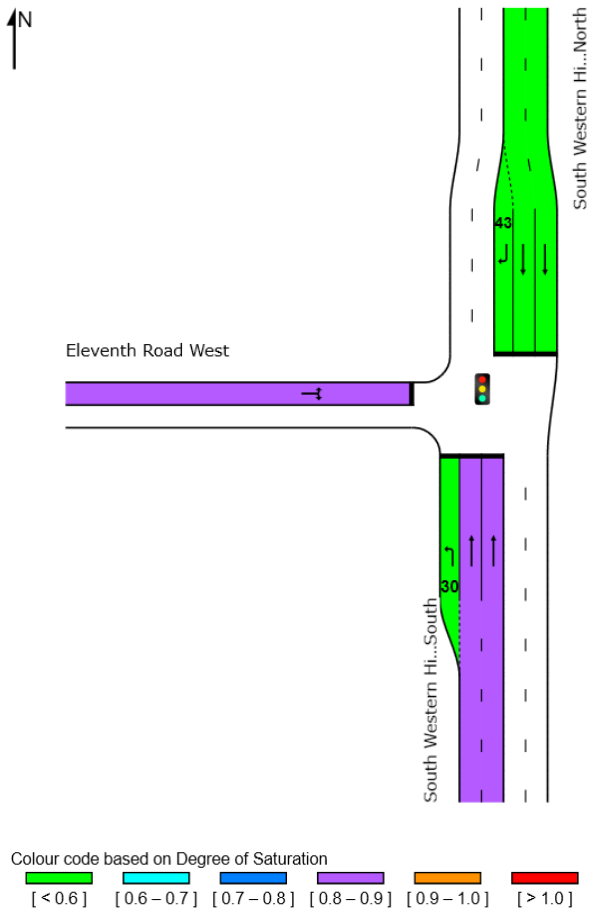


Figure 6.30 Degree of Saturation – AM Peak – Do Something - Signalised intersection

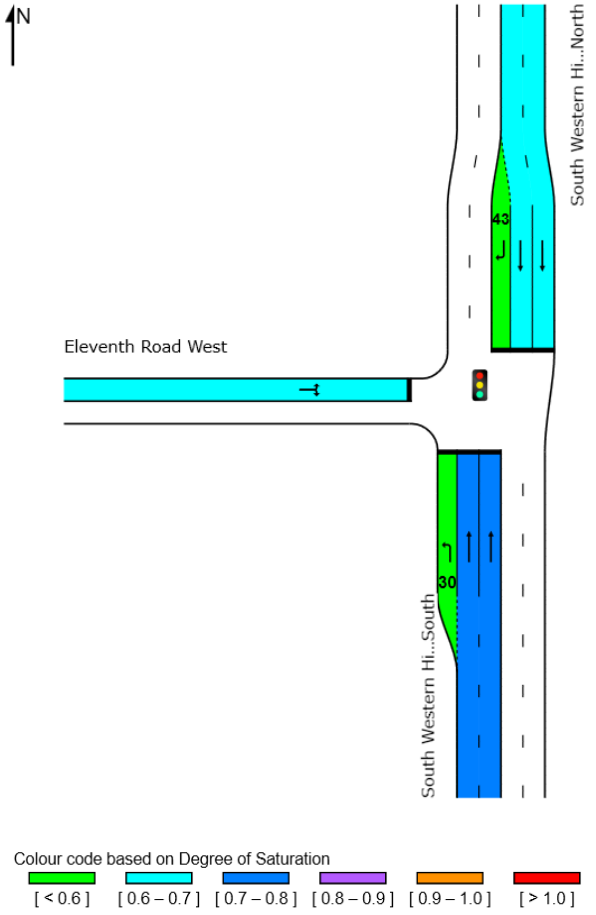


Figure 6.31 Degree of Saturation – PM Peak – Do Something - Signalised intersection

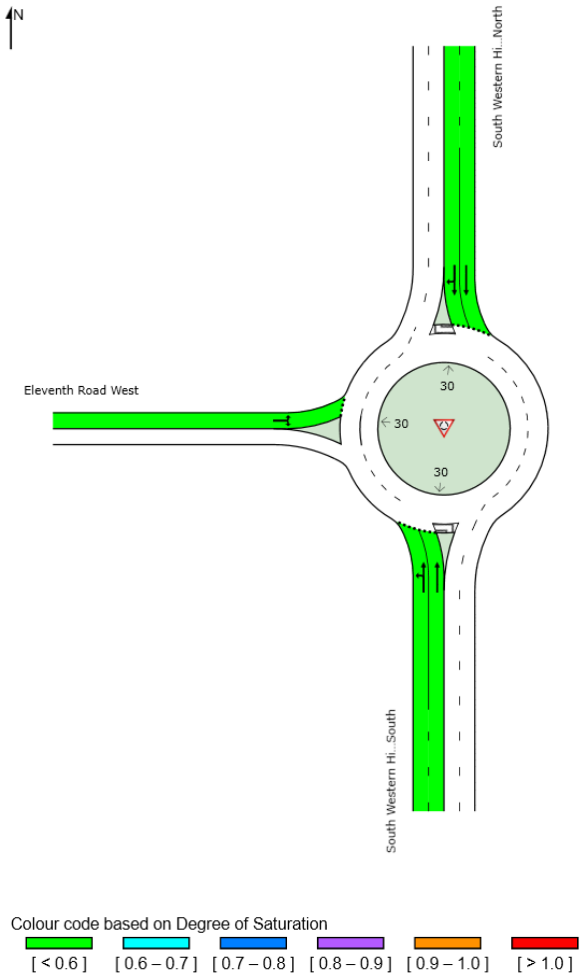


Figure 6.32 Degree of Saturation – AM Peak – Do Something - Signalised intersection

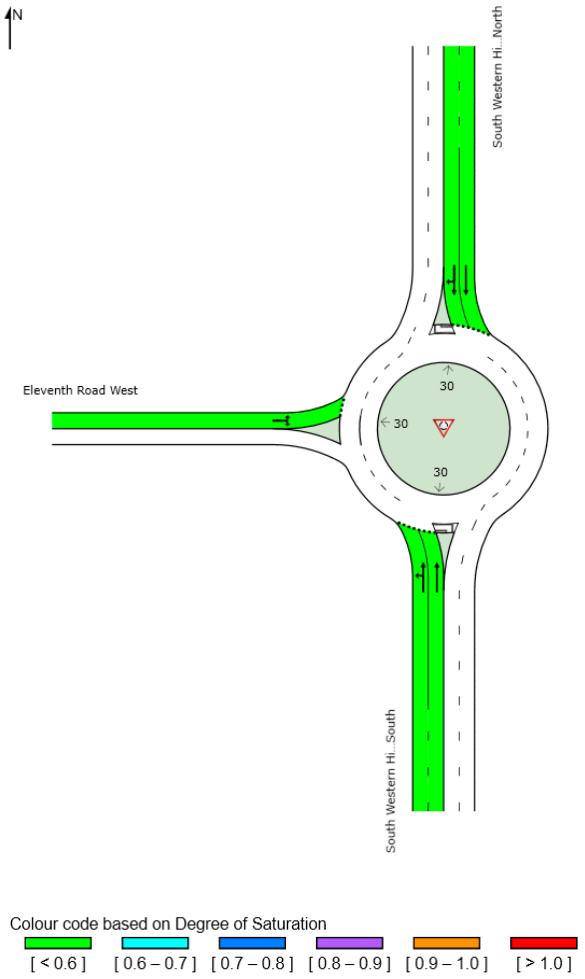


Figure 6.33 Degree of Saturation – PM Peak – Do Something - Signalised intersection

Table 6.4 SWH/ Eleventh Road – Intersection performance

Intersection layout	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Priority controlled (single stage)	F	28.246	1425.3	F	34.035	1890.9
Priority controlled (two stage)	F	1.140	20.1	F	2.211	142.4
Signalised	B	0.861	19.6	B	0.715	14.9
Roundabout	A	0.576	7.5	A	0.613	7.9

Table 6.4 shows the intersection performance of the three options with the 2036 traffic forecasts. In the signalised option, the intersection is forecast to operate satisfactorily at LoS B in both peaks and within capacity with a degree of saturation of 0.861 and 0.715 in the AM and PM peak periods respectively. The highest delay forecast was for the right turn movement from Eleventh Road into SWH with a delay of around one minute in the AM peak. The longest forecast queue lengths are around 300m on the southern approach in the AM peak.

In the roundabout option, the intersection is forecast to operate at LoS A in both peak periods with a degree of saturation of 0.576 and 0.613 in the AM and PM peak periods respectively. The forecast delays and queues are significantly lower than in the priority controlled and signalised options with the highest delay being around 20s on the west approach in the AM peak and highest queue being around 50m on the south approach in the AM peak.

6.6 Eleventh Road/ Wungong Road

6.6.1 Do Nothing Scenario

Figure 6.34 and Figure 6.35 show the degree of saturation at the Eleventh Road/ Wungong Road intersection in the AM and PM peak periods respectively in the 2036 Do Nothing scenario. The intersection is forecast to perform satisfactorily operating at LoS A in both peak periods with a degree of saturation of 0.258 and 0.392 in the AM and PM peak periods respectively. There is negligible delay across the intersection with the highest forecast delay being ten seconds on the east approach in the PM peak. There is also negligible queuing forecast at the intersection with the longest forecast queue being ten metres on the north approach in the PM peak period.

Due to the modelled intersection performance and the available capacity, no additional infrastructure upgrade is forecast to be needed for the year 2036.

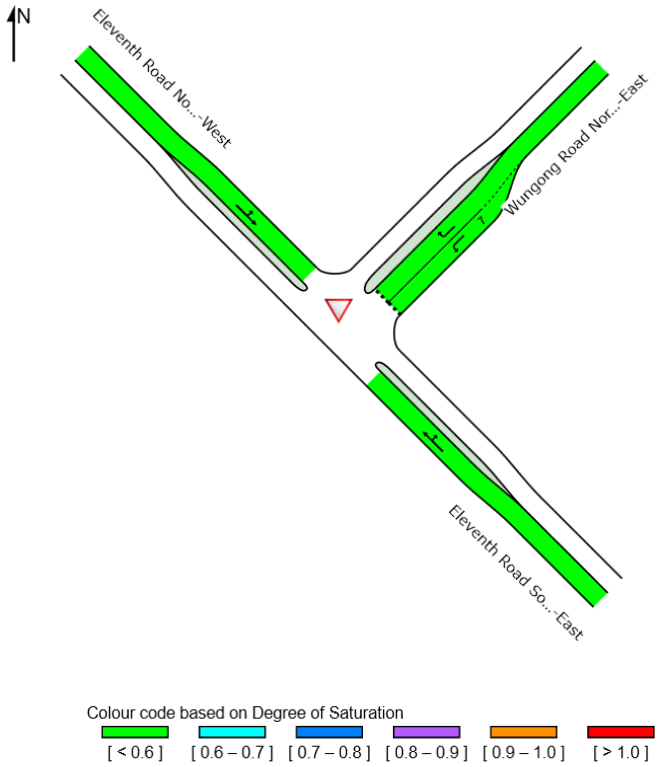


Figure 6.34 Degree of Saturation – AM Peak – Do Nothing

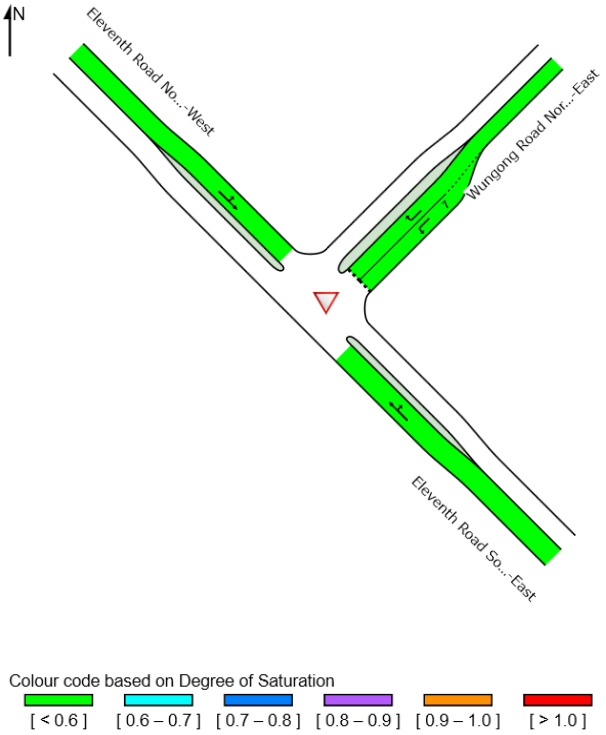


Figure 6.35 Degree of Saturation – PM Peak – Do Nothing

7 Network Modelling Results – Opening year + 10 (2036)

7.1 Introduction

The following section details the performance of the road networks in the Do Nothing (at grade) and Do Something (grade separated) scenarios that were required to be modelled as per the TMIF, under 2036 traffic forecasts.

7.2 Armadale Road Network

7.2.1 2036 Do Nothing Scenario (LX included and at grade)

The Do Nothing scenario assumes that the Armadale Road network will maintain the level crossing at grade in 2036. With the existing intersection layouts retained, the 2036 volume forecasts are applied to understand the performance of the road network.

The Armadale Road network in this scenario comprises the following intersections as shown schematically (as an output from SIDRA) in Figure 7.1:

1. Armadale Road/ Abbey Road/ Railway Avenue
2. Armadale level crossing
3. Armadale Road/ Streich Avenue
4. Armadale Road/ Orchard Avenue
5. Armadale Road/ Church Avenue.

Figure 7.2 and Figure 7.3 show the degree of saturation at the Armadale Road network with the level crossing at grade in the AM and PM peak periods respectively in the 2036 Do Nothing (LX at grade) scenario.

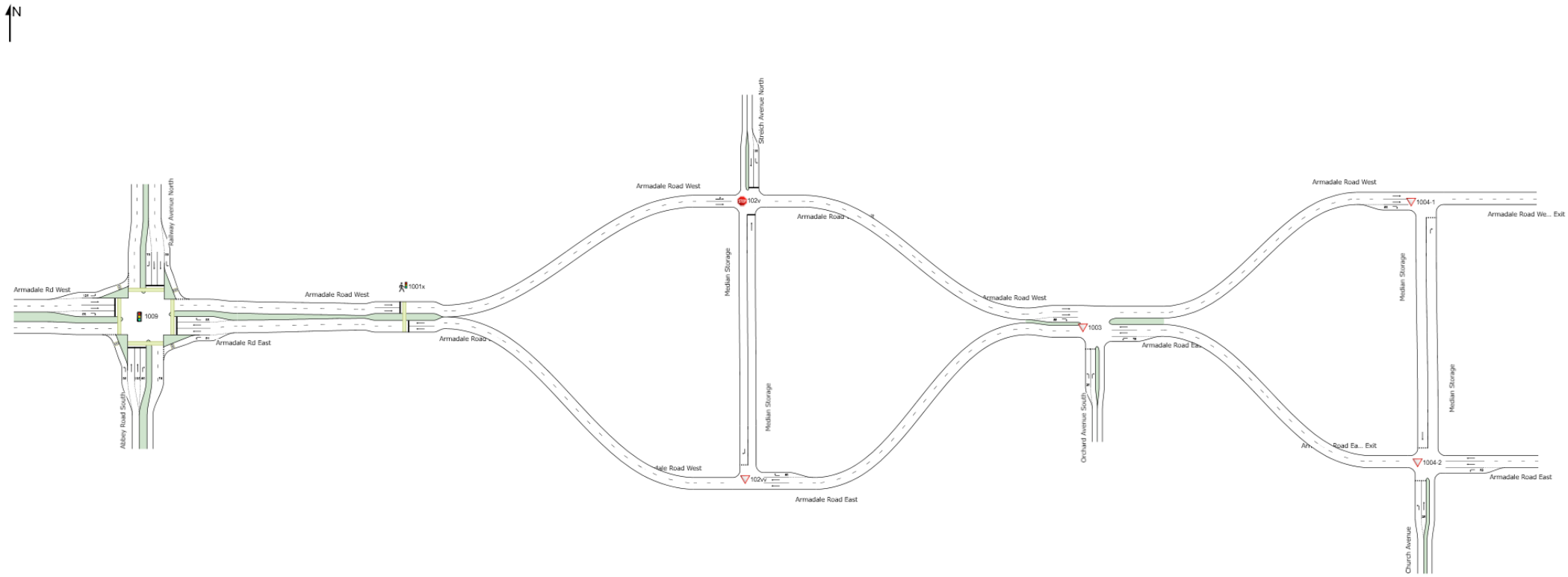


Figure 7.1 Armadale Road Network – Do Nothing Scenario (LX at grade)

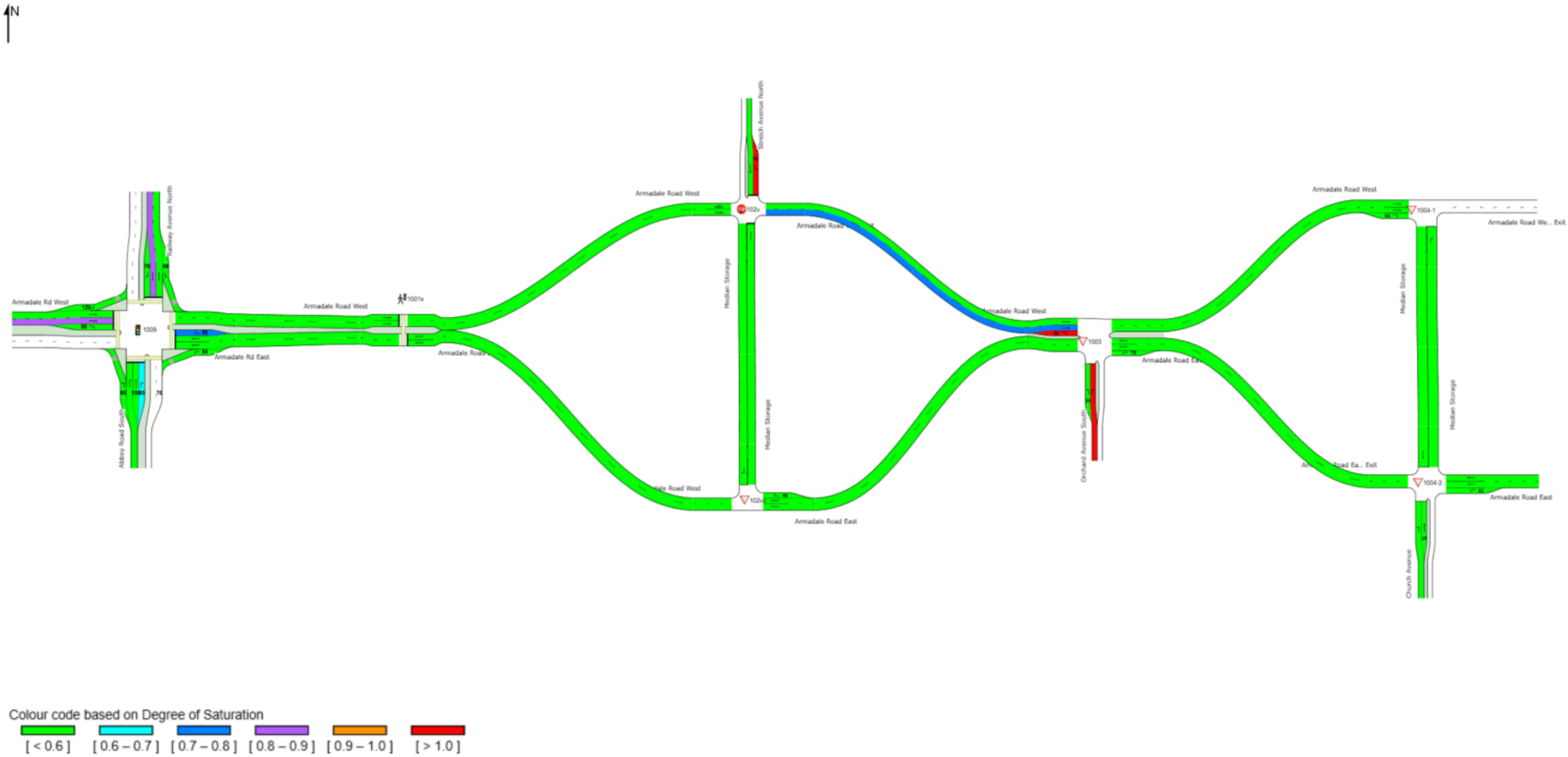


Figure 7.2 Degree of Saturation - Armadale Road Network – AM Peak - Do Nothing Scenario (LX at grade)

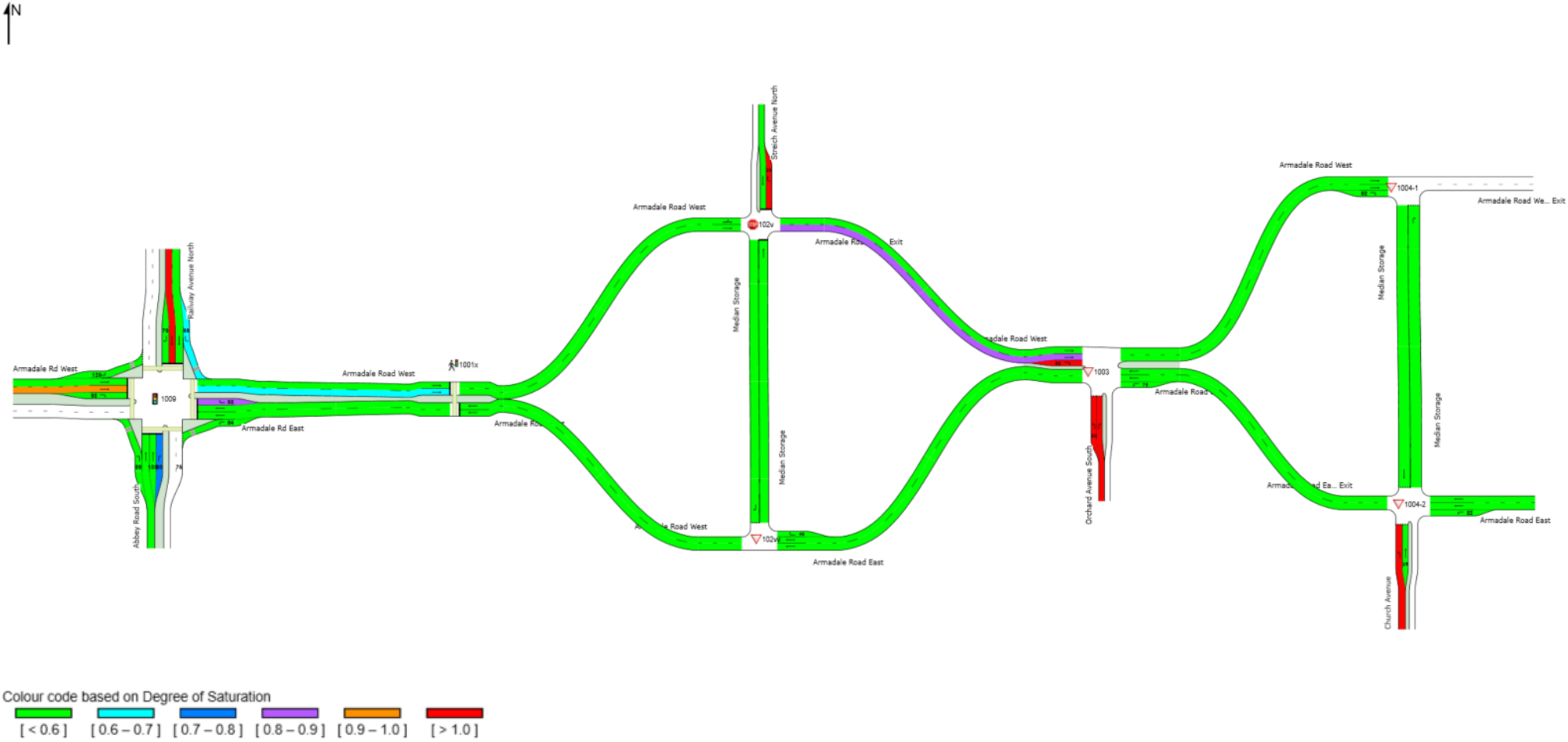


Figure 7.3 Degree of Saturation - Armadale Road Network – PM Peak - Do Nothing Scenario (LX at grade)

Table 7.1 summarises the intersection performance of all the intersections in the Armadale Road network in the Do Nothing scenario with the level crossing at grade.

Table 7.1 Armadale Road Network performance – Do Nothing Scenario (LX at grade)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	F	2.149	-	F	3.083	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.878	34.6	D	1.064	45.7
Armadale level crossing	B	0.598	10.1	B	0.622	10.6
Armadale Rd/ Streich Ave	F	2.149	167.6	F	3.083	390.4
Armadale Rd/ Orchard Ave	F	1.801	145.4	F	2.941	215.0
Armadale Rd/ Church Ave	A	0.407	3.6	F	1.226	52.1

In both the AM and PM peak periods, the network is forecast to operate at LoS F and over capacity with the predominant problem being insufficient gaps in traffic for the vehicles turning into Armadale Road from minor roads such as Streich Avenue and Orchard Avenue, and also for vehicles turning right from Armadale Road into Orchard Avenue.

7.2.2 2036 Do Nothing Scenario (grade separated)

Following confirmation from PTA regarding their intent to grade separate the level crossing on Armadale Road, this scenario analyses the Armadale Road network with grade separation in the future year whilst still retaining the existing layouts for the other intersections.

The Armadale Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 7.4:

1. Armadale Road/ Abbey Road/ Railway Avenue
2. Armadale Road/ Streich Avenue
3. Armadale Road/ Orchard Avenue
4. Armadale Road/ Church Avenue.

Figure 7.5 and Figure 7.6 show the degree of saturation at the Armadale Road network with grade separation in the AM and PM peak periods respectively in the 2036 Do Nothing (grade separated) scenario.

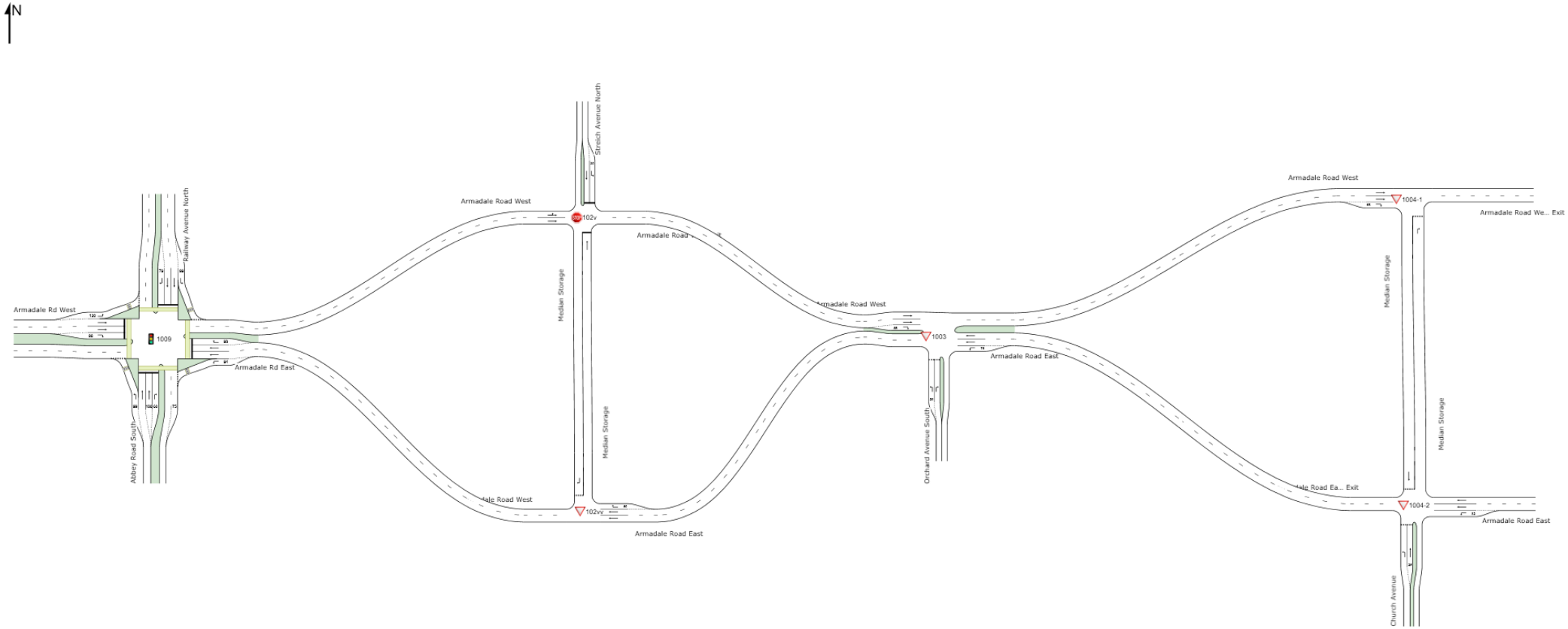


Figure 7.4 Armadale Road Network – Do Nothing Scenario (grade separated)

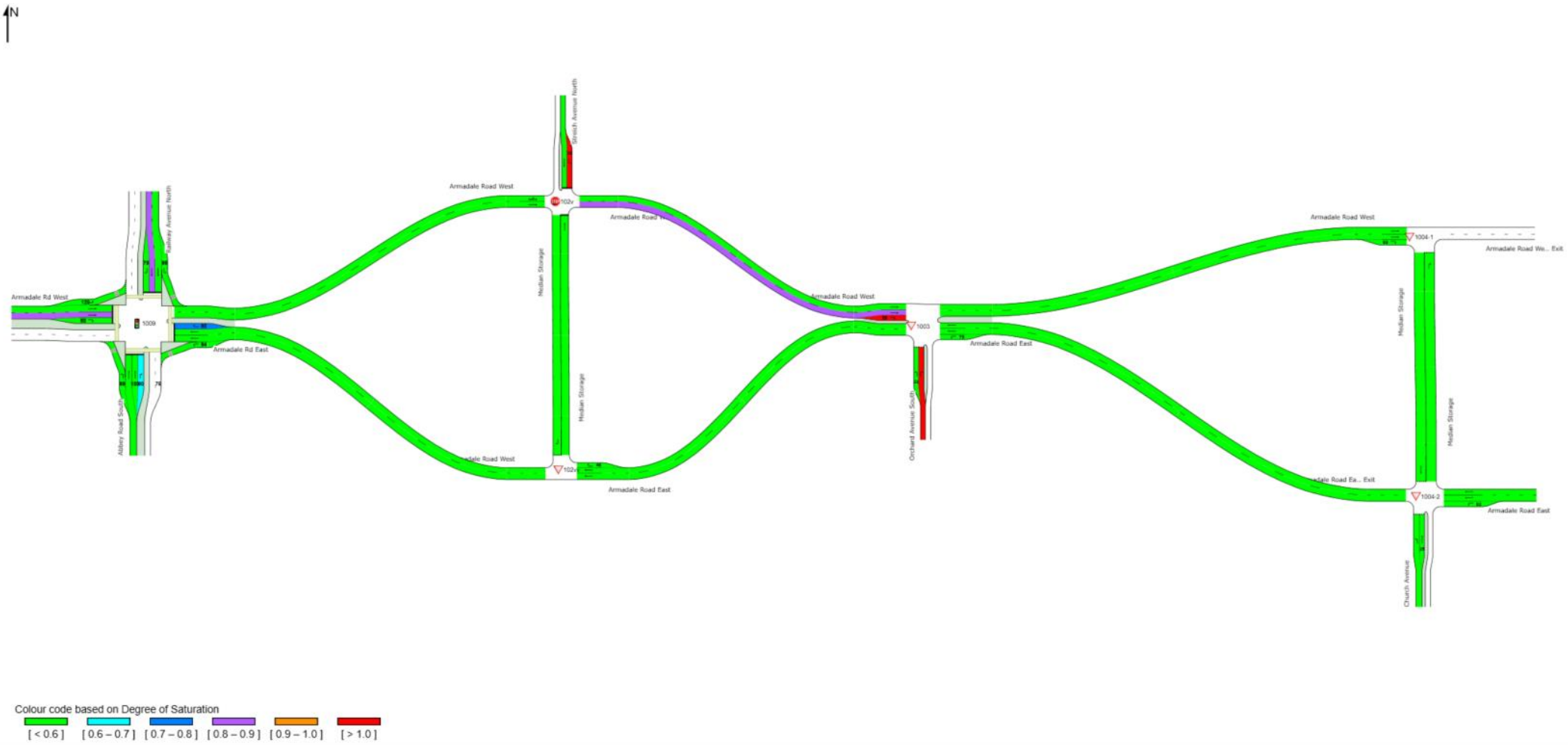


Figure 7.5 Degree of Saturation - Armadale Road Network – AM Peak - Do Nothing Scenario (grade separated)

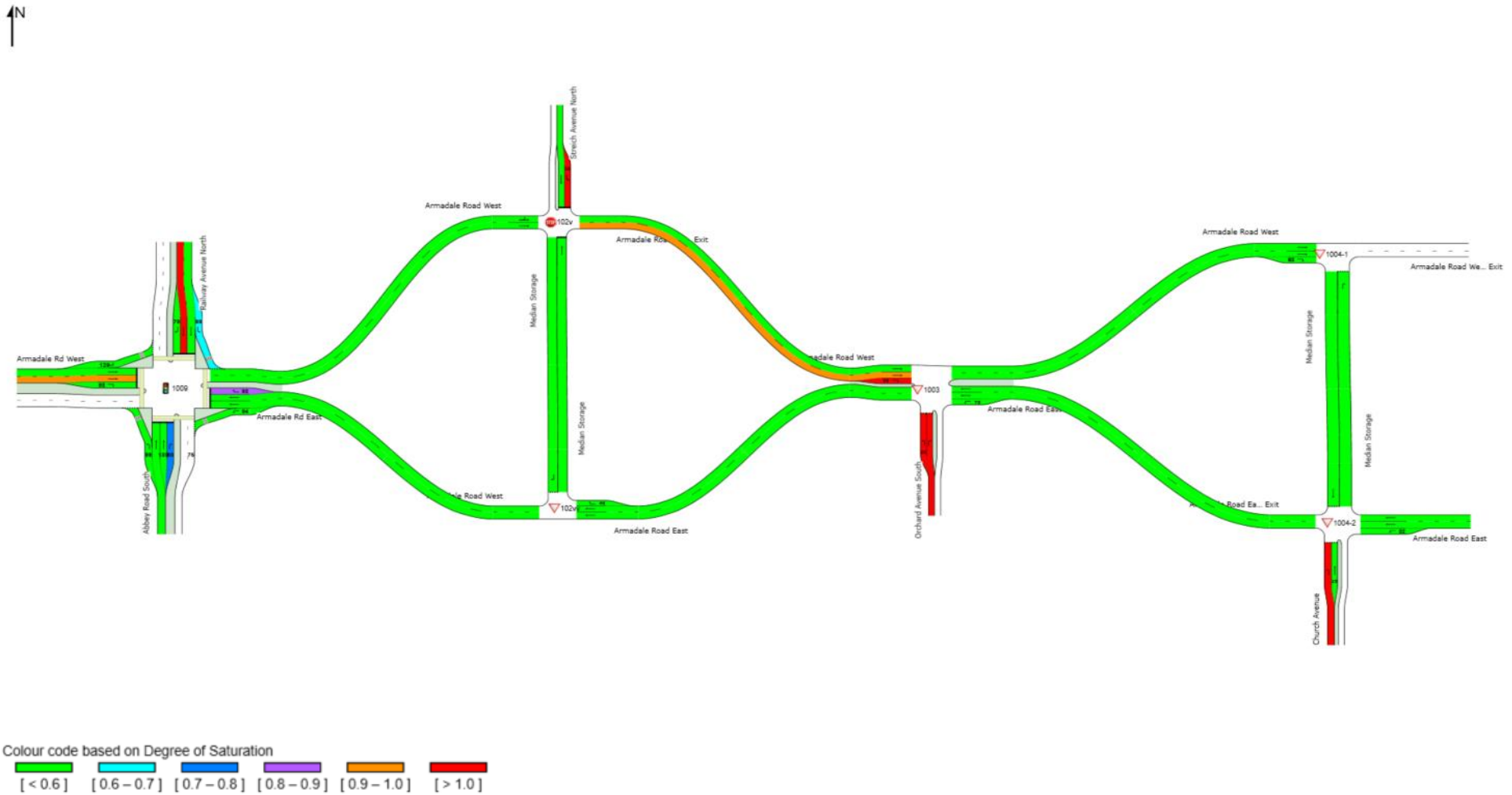


Figure 7.6 Degree of Saturation - Armadale Road Network – PM Peak - Do Nothing Scenario (grade separated)

Table 7.2 details the network and individual intersection performance of all the intersections in the Armadale Road network in the Do Nothing scenario with grade separation.

Table 7.2 Armadale Road Network performance – Do Nothing Scenario (grade separated)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	F	1.876	-	F	3.311	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.878	34.4	D	1.064	45.7
Armadale Rd/ Streich Ave	F	1.523	81.3	F	2.160	221.3
Armadale Rd/ Orchard Ave	F	1.876	162.1	F	3.311	229.8
Armadale Rd/ Church Ave	A	0.422	3.6	F	1.226	51.9

As in the at grade scenario, the network operates at LoS F and over capacity in both the AM and PM peak periods. Again, the predominant problem is insufficient gaps in traffic for the vehicles turning into Armadale Road from minor roads such as Streich Avenue and Orchard Avenue, and also for vehicles turning right from Armadale Road into Orchard Avenue.

7.2.3 Do Something Scenario (grade separated)

To achieve satisfactory network performance, three scenarios with various layouts have been modelled and detailed as below:

1. Option 1: Fully signalised
2. Option 2: Roundabouts only
3. Option 3: Partial treatment with roundabouts and signals.

7.2.3.1 Option 1: Fully signalised

In this option, it is assumed that all intersections in the Armadale Road network which are currently priority controlled will be converted to signalised intersections in the future as shown in Figure 7.7.

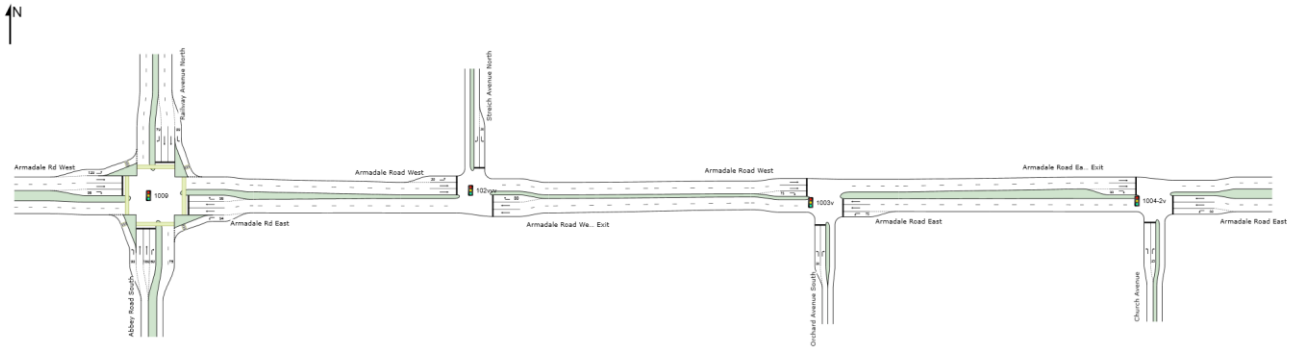


Figure 7.7 Armadale Road Network – Do Something Scenario (grade separated) – Fully signalised

At the intersection of Armadale Road/ Streich Avenue, the existing lane geometry is retained for the most part with the addition of a left turn pocket of 30m on the west approach of Armadale Road, and a reduction of the right turn pocket from 60m to 30m on the east approach of Armadale Road as shown in Figure 7.8.

At the intersection of Armadale Road/ Orchard Avenue, the existing lane geometry is retained for the most part with just the extension of the right turn pocket on the west approach of Armadale Road from 55m to 75m as shown in Figure 7.9.

The intersections of Armadale Road/ Church Avenue, as shown in Figure 7.10, and Armadale Road/ Abbey Road/ Railway Avenue will retain its existing signalised layout.

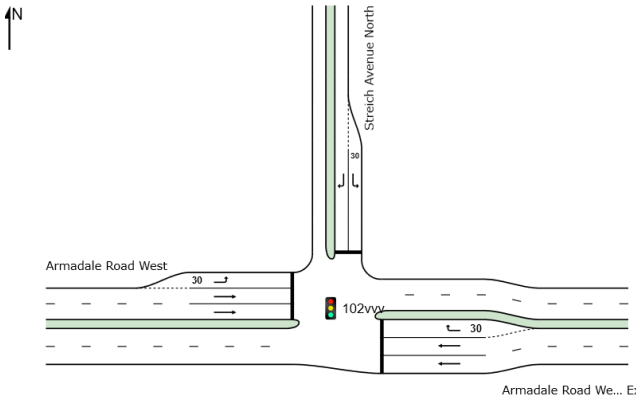


Figure 7.8 Armadale Road/ Streich Avenue – Signalised intersection option

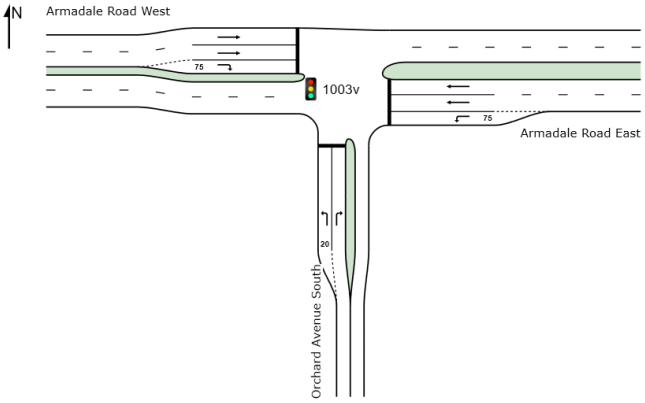


Figure 7.9 Armadale Road/ Orchard Avenue – Signalised intersection option

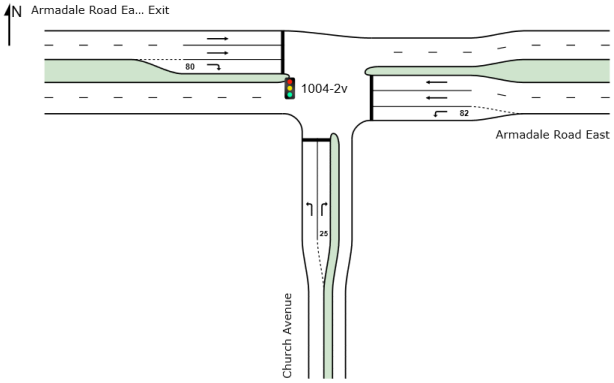


Figure 7.10 Armadale Road/ Church Avenue – Signalised intersection option

Figure 7.11 and Figure 7.12 show the degree of saturation at the Armadale Road network with grade separation and all intersections signalised in the AM and PM peak periods respectively in the 2036 Do Something (grade separated) scenario.

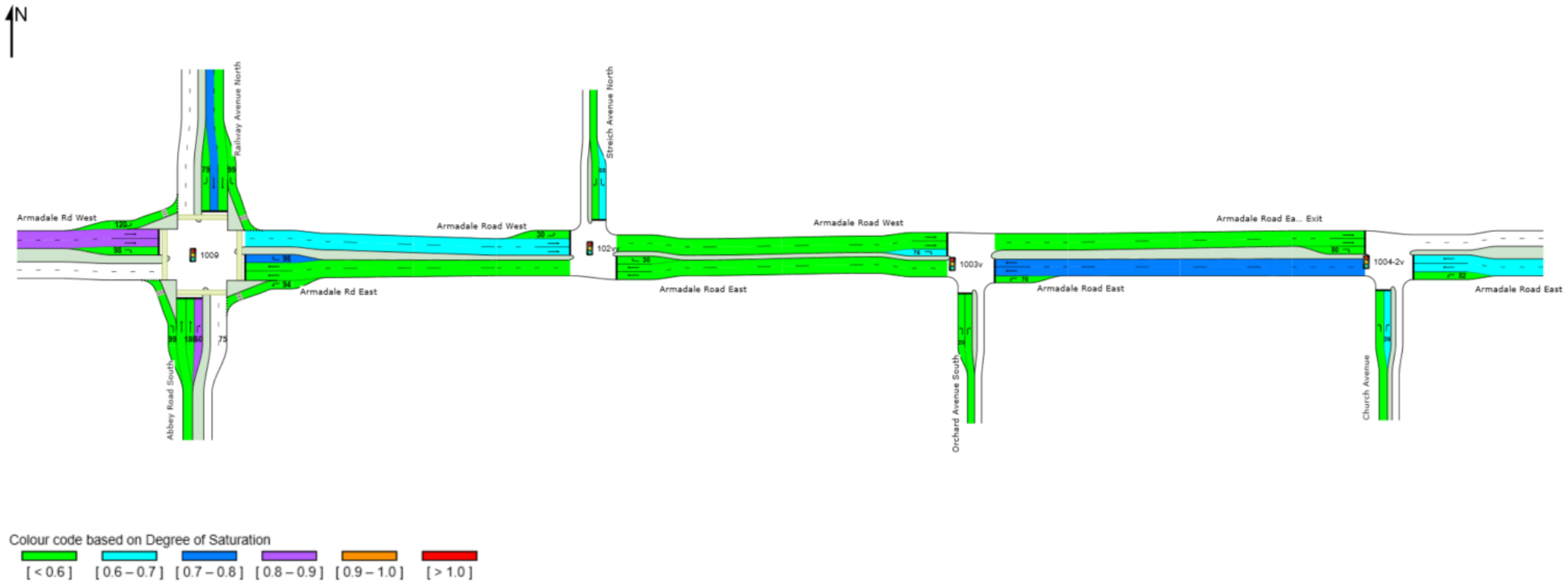


Figure 7.11 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Fully signalised – AM Peak

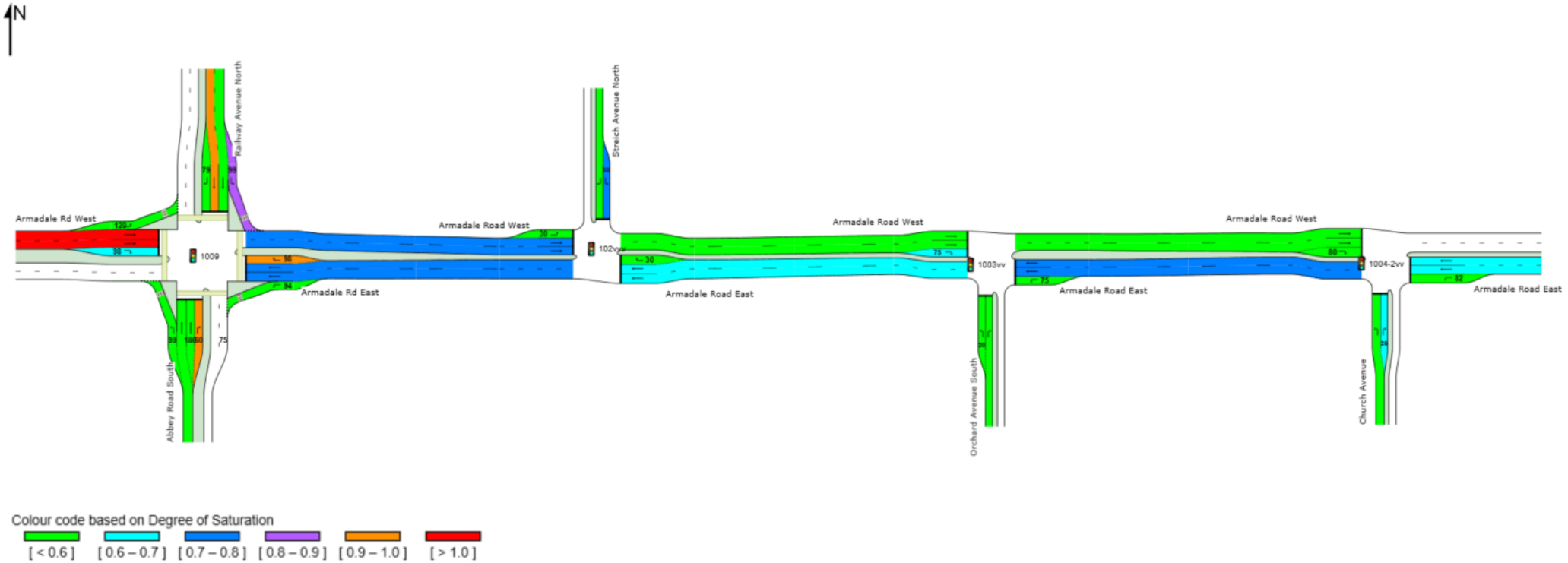


Figure 7.12 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Fully signalised – PM Peak

Table 7.3 details the performance of all the intersections in the Armadale Road Network in the Do Something scenario Option 1 with all intersections signalised.

Table 7.3 Armadale Road Network performance – Do Something Scenario (grade separated) – Fully signalised

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	0.858	-	E	1.070	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.858	34.8	E	1.070	61.6
Armadale Rd/ Streich Ave	A	0.635	9.0	B	0.759	14.9
Armadale Rd/ Orchard Ave	B	0.760	15.7	B	0.786	15.7
Armadale Rd/ Church Ave	B	0.639	14.2	B	0.698	19.2

Whilst in the AM peak the network and all intersections operate satisfactorily and within capacity, the network is oversaturated in the PM peak as a result of the through movement on the west approach of Armadale Road/ Abbey Road/ Railway Avenue being over capacity.

It is noted that whilst all but one of the intersections operate within capacity, some approaches and movements at the intersection of Armadale Road/ Abbey Road/ Railway Avenue have extensive delays due to the cycle time used for the modelling. Further signal optimisation with LinSig would be required to address these issues and optimise the signals to the satisfaction of MRWA.

7.2.3.2 Option 2: Roundabouts only

In this option, it is assumed that all intersections in the Armadale Road network which are currently priority controlled will be converted to roundabouts in the future as shown schematically (as an output from SIDRA) in Figure 7.13.

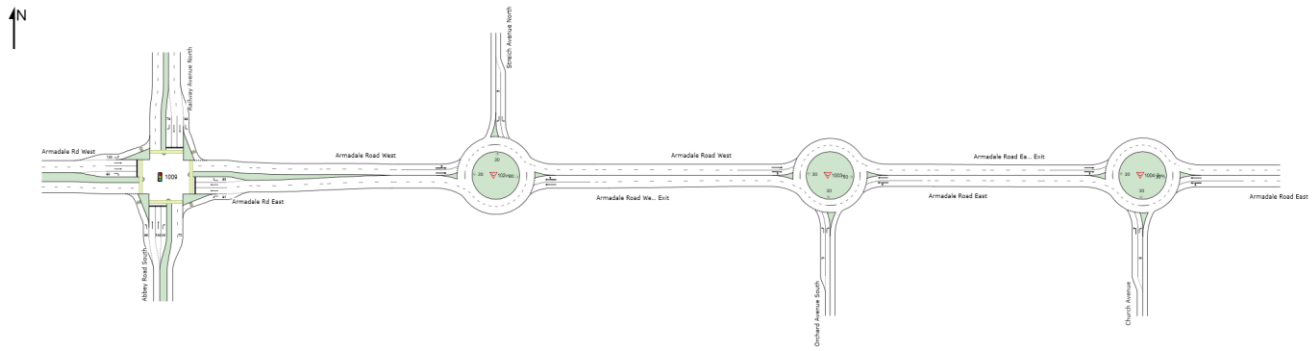


Figure 7.13 Armadale Road Network – Do Something Scenario (grade separated) – Roundabouts only

The intersection of Armadale Road/ Streich Avenue is converted to a two-lane circulating roundabout with no turning pockets on Armadale Road. The north approach of Streich Avenue will adopt a right turn pocket of 60m as shown in Figure 7.14.

The intersection of Armadale Road/ Orchard Avenue is converted to a two lane circulating roundabout with no turning pockets on Armadale Road. The south approach of Orchard Avenue retains the same lane geometry as the existing layout as shown in Figure 7.15.

The intersection of Armadale Road/ Church Avenue is converted to a two-lane circulating roundabout with no turning pockets on Armadale Road. The south approach of Church Avenue retains the same lane geometry as the existing layout as shown in Figure 7.16.

The intersection of Armadale Road/ Abbey Road/ Railway Avenue will retain its existing layout in this scenario.

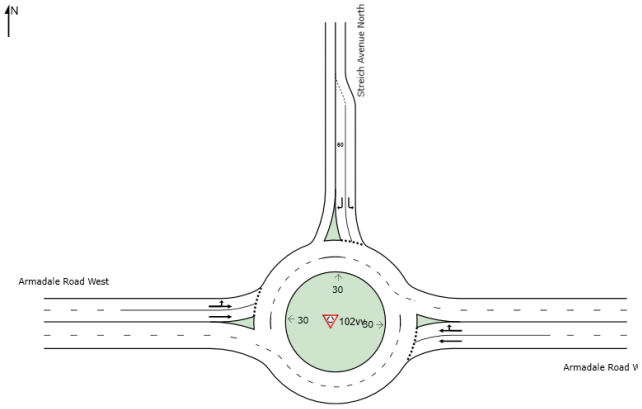


Figure 7.14 Armadale Road/ Streich Avenue – Roundabout option

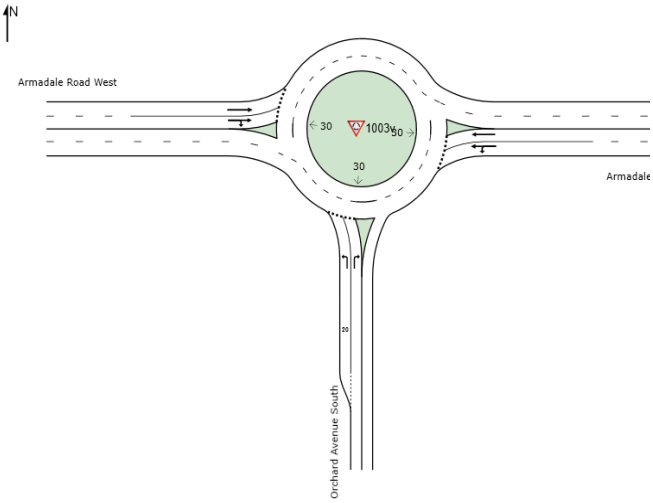


Figure 7.15 Armadale Road/ Orchard Avenue – Roundabout option

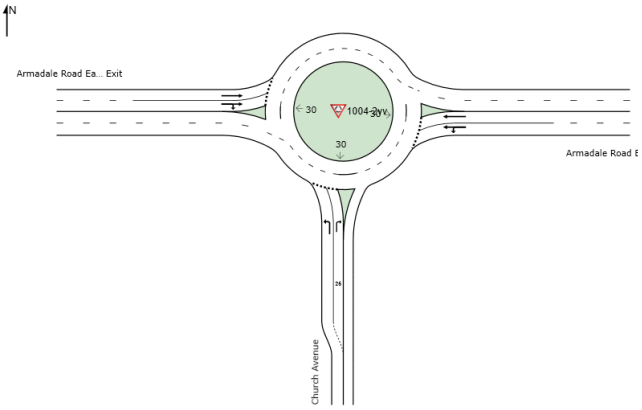


Figure 7.16 Armadale Road/ Church Avenue – Roundabout option

Figure 7.17 and Figure 7.18 show the degree of saturation at the Armadale Road network with grade separation and all intersections converted roundabouts in the AM and PM peak periods respectively in the 2036 Do Something (grade separated) scenario.

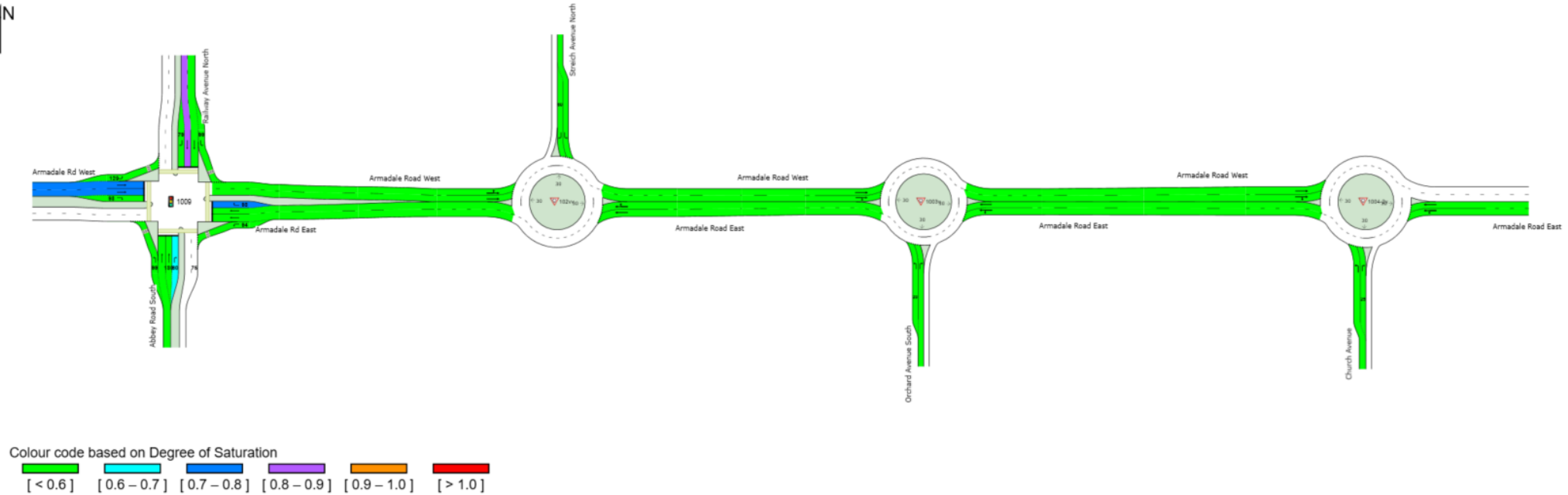


Figure 7.17 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Roundabouts only – AM Peak

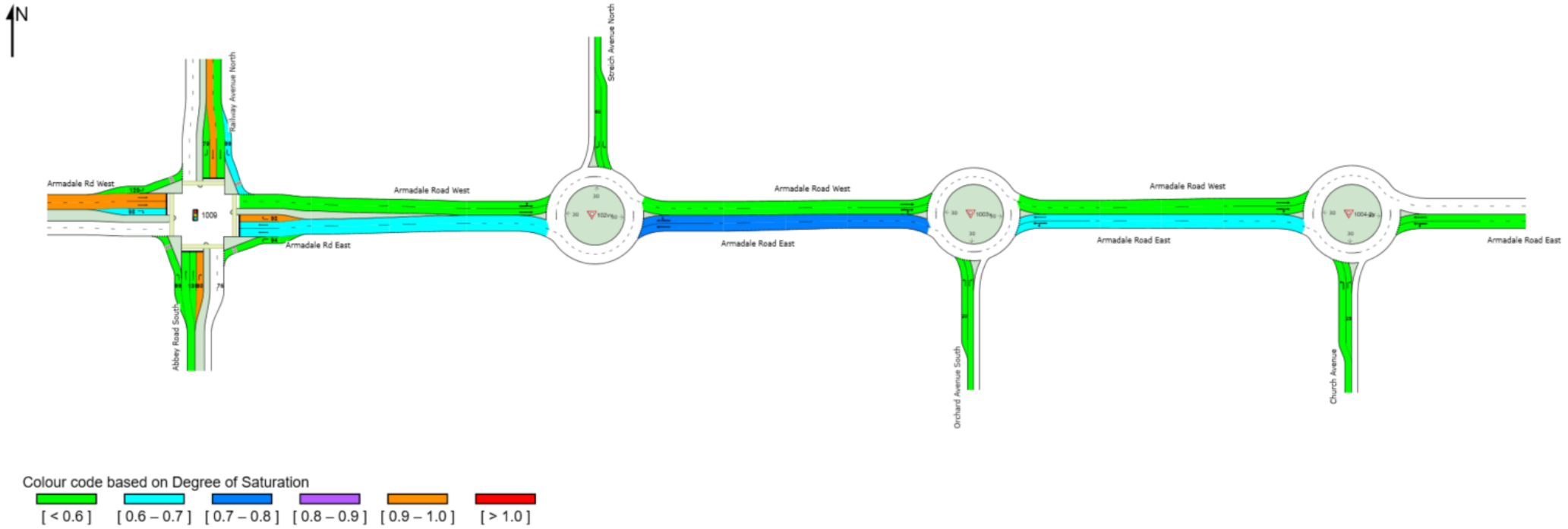


Figure 7.18 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Roundabouts only – PM Peak

Table 7.4 details the intersection performance of the Armadale Road Network in the Do Something Option 2 scenario where all intersections, with exception of the intersection of Armadale Rd/ Abbey Rd/ Railway Ave, are converted to roundabouts.

Table 7.4 Armadale Road Network performance – Do Something Scenario (grade separated) – Roundabouts only

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	0.878	-	D	0.942	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.878	32.5	D	0.942	51.1
Armadale Rd/ Streich Ave	A	0.529	5.8	A	0.782	6.4
Armadale Rd/ Orchard Ave	A	0.590	8.1	B	0.644	8.1
Armadale Rd/ Church Ave	A	0.485	6.9	A	0.450	7.0

With the grade separation and the conversion to roundabouts, the network performs satisfactorily in both the peak periods with all intersections operating with reasonable delay and queuing.

It is noted that whilst all the intersections operate within capacity, some approaches and movements at the intersection of Armadale Road/ Abbey Road/ Railway Avenue have extensive delays due to the cycle time used for the modelling. Further signal optimisation with LinSig would be required to address these issues and optimise the signals to the satisfaction of MRWA.

7.2.3.3 Option 3: Partial treatment with roundabouts and signals

In this option, it is assumed that two intersections in the Armadale Road network – Armadale Road/ Streich Avenue and Armadale Road/ Orchard Avenue – which are currently priority controlled will be converted to roundabouts and the intersection of Armadale Road/ Church Avenue will be converted to a signalised intersection in the future as shown in Figure 7.19. Different layouts and combinations of signalised intersections and roundabouts were tested and the layout adopted above was found to be the best performing network configuration.

Figure 7.20 and Figure 7.21 show the degree of saturation at the Armadale Road network with grade separation and partial treatment with roundabouts and signalisation in the AM and PM peak periods respectively in the 2036 Do Something (grade separated) scenario.

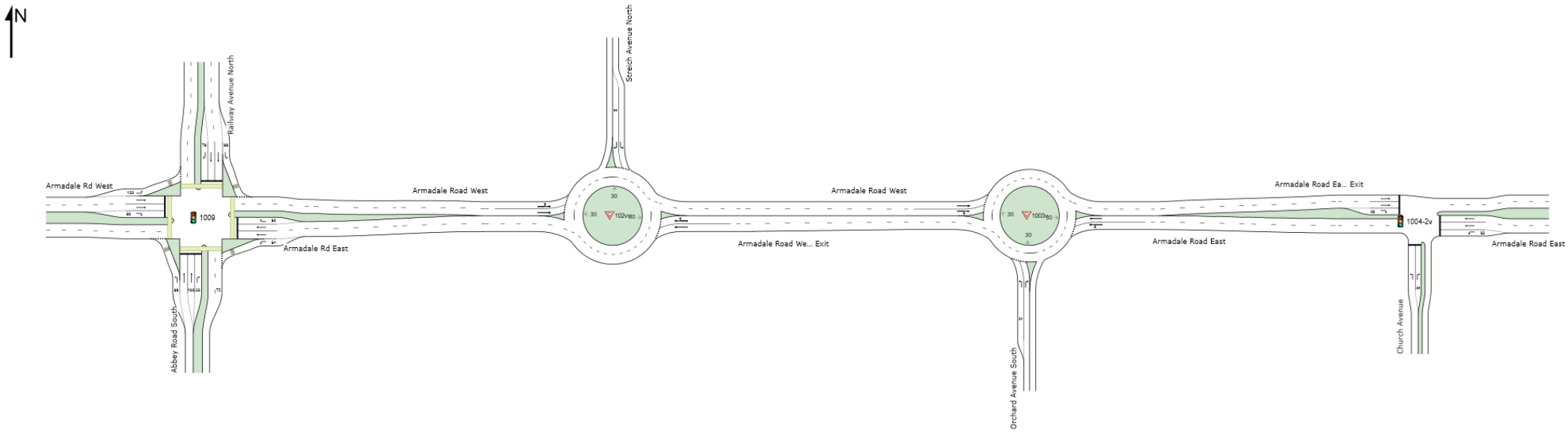


Figure 7.19 Armadale Road Network – Do Something Scenario (grade separated) – partial treatment

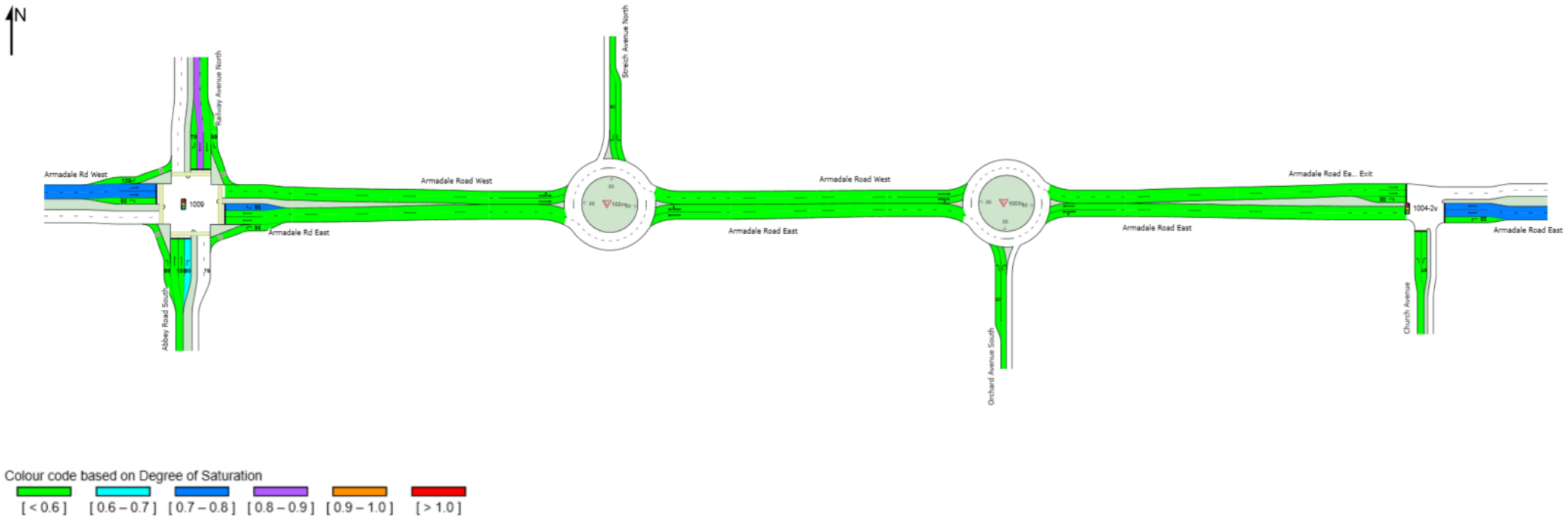


Figure 7.20 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Partial treatment – AM Peak

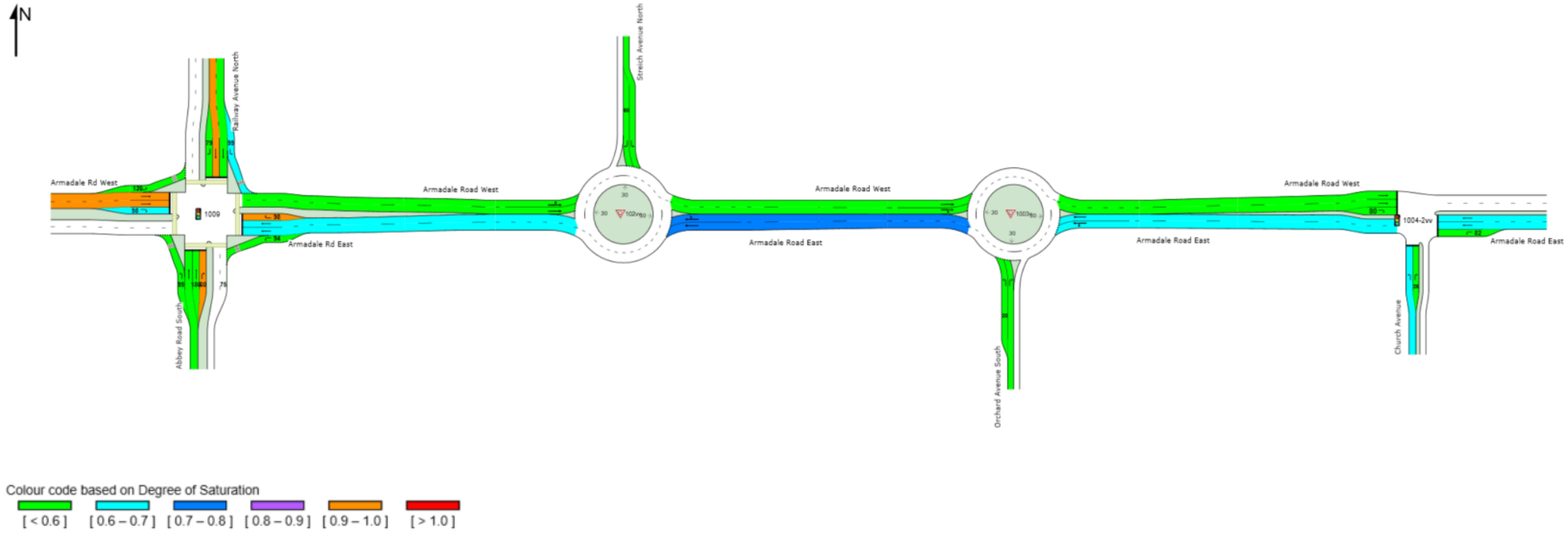


Figure 7.21 Degree of Saturation - Armadale Road Network – Do Something Scenario (grade separated) – Partial treatment – PM Peak

All intersections within this network would adopt the same layouts as detailed in the previous sections.

Table 7.5 details intersection performance of the Armadale Road Network in the Do Something scenario.

Table 7.5 Armadale Road Network performance – Do Something Scenario (grade separated) – Partial treatment

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	D	0.878	-	D	0.942	-
Armadale Rd/ Abbey Rd/ Railway Ave	C	0.878	32.5	D	0.942	51.1
Armadale Rd/ Streich Ave	A	0.529	5.8	A	0.782	6.4
Armadale Rd/ Orchard Ave	A	0.590	7.9	A	0.644	7.8
Armadale Rd/ Church Ave	B	0.760	14.4	B	0.666	13.7

With the grade separation and the adopted intersection layouts, the network performs satisfactorily in both the peak periods with all intersections operating within capacity.

It is noted that whilst all the intersections operate within capacity, some approaches and movements at the intersection of Armadale Road/ Abbey Road/ Railway Avenue have extensive delays due to the cycle time used for the modelling. Further signal optimisation with LinSig would be required to address these issues and optimise the signals to the satisfaction of MRWA

7.3 Church Avenue Road Network

7.3.1 Do Nothing Scenario (LX included and at grade)

The scenario assumes that the Church Avenue network will have the level crossing at grade. With the existing intersection layouts retained, the 2036 volume forecasts are applied to understand the performance of the road network.

The Church Avenue network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 7.22:

1. Church Avenue/ William Street
2. Church Avenue/ Hobbs Drive/ Commerce Avenue
3. Church Avenue/ Green Avenue/ Wungong Road
4. Church Avenue level crossing.

Figure 7.23 and Figure 7.24 and show the degree of saturation at the Church Avenue network with the level crossing at grade in the AM and PM peak periods respectively in the 2036 Do Nothing (LX at grade) scenario.

Figure 7.22 Church Avenue Road Network – Do Nothing Scenario (LX at grade)

Figure 7.23 Degree of Saturation - Church Avenue Road Network – AM Peak - Do Nothing Scenario (LX at grade)

Figure 7.24 Degree of Saturation - Church Avenue Road Network – PM Peak - Do Nothing Scenario (LX at grade

Table 7.6 details the performance of all the intersections in the Church Avenue network.

Table 7.6 Church Avenue Network performance – Do Nothing Scenario (LX at grade)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	**Degree of Saturation (DoS)**	**Average Delay (s)**	**Level of Service (LoS)**	**Degree of Saturation (DoS)**	**Average Delay (s)**
Overall Network	D	1.128	-	C	0.815	-
Church Avenue/ William Street	A	0.620	7.2	B	0.812	13.8
Church Avenue LX	A	0.330	3.2	A	0.295	3.0
Church Avenue/ Hobbs Drive/ Commerce Avenue	A	0.491	5.2	A	0.637	6.3
Church Avenue/ Green Avenue/ Wungong Road	E	1.128	50.3	A	0.815	9.1

Whilst in the PM peak, the network and the relevant intersections operate satisfactorily within capacity, the network is oversaturated in the AM peak as a result of the west approach at the intersection of Church Avenue/ Green Avenue/ Wungong Road being over capacity.

7.3.2 Do Nothing Scenario (grade separated)

This scenario analyses the Church Avenue network with grade separation in the future year whilst still retaining the existing layouts for the other intersections.

The Church Avenue network in this scenario comprises of the following intersections as shown in Figure 7.25:

1. Church Avenue/ William Street
2. Church Avenue/ Hobbs Drive/ Commerce Avenue
3. Church Avenue/ Green Avenue/ Wungong Road.

Figure 7.26 and Figure 7.27 show the degree of saturation at the Church Avenue network with grade separation in the AM and PM peak periods respectively in the 2036 Do Nothing (grade separated) scenario.

Figure 7.25 Church Avenue Network – Do Nothing Scenario (grade separated)

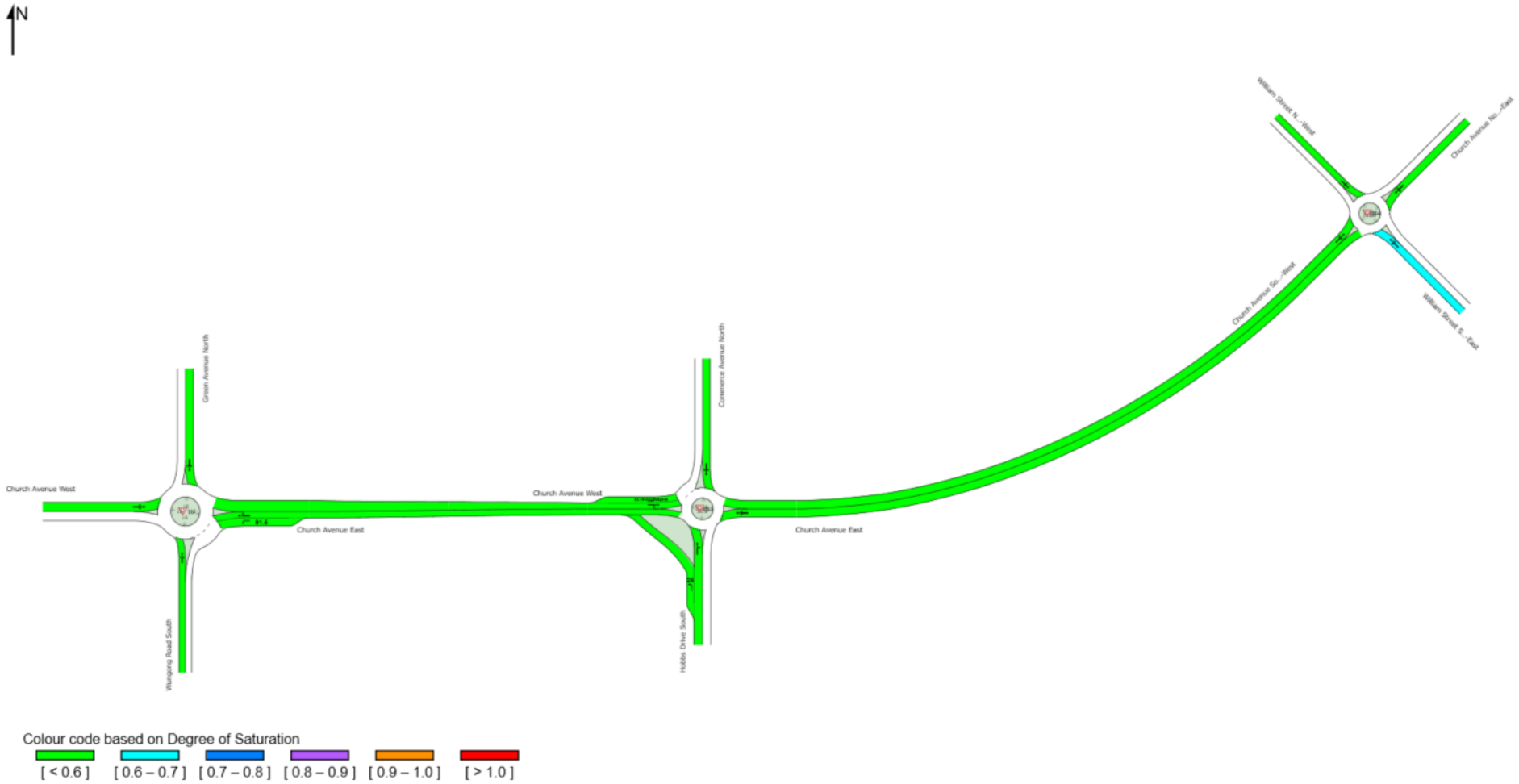


Figure 7.26 Degree of saturation - Church Avenue Network – AM Peak - Do Nothing Scenario (grade separated)

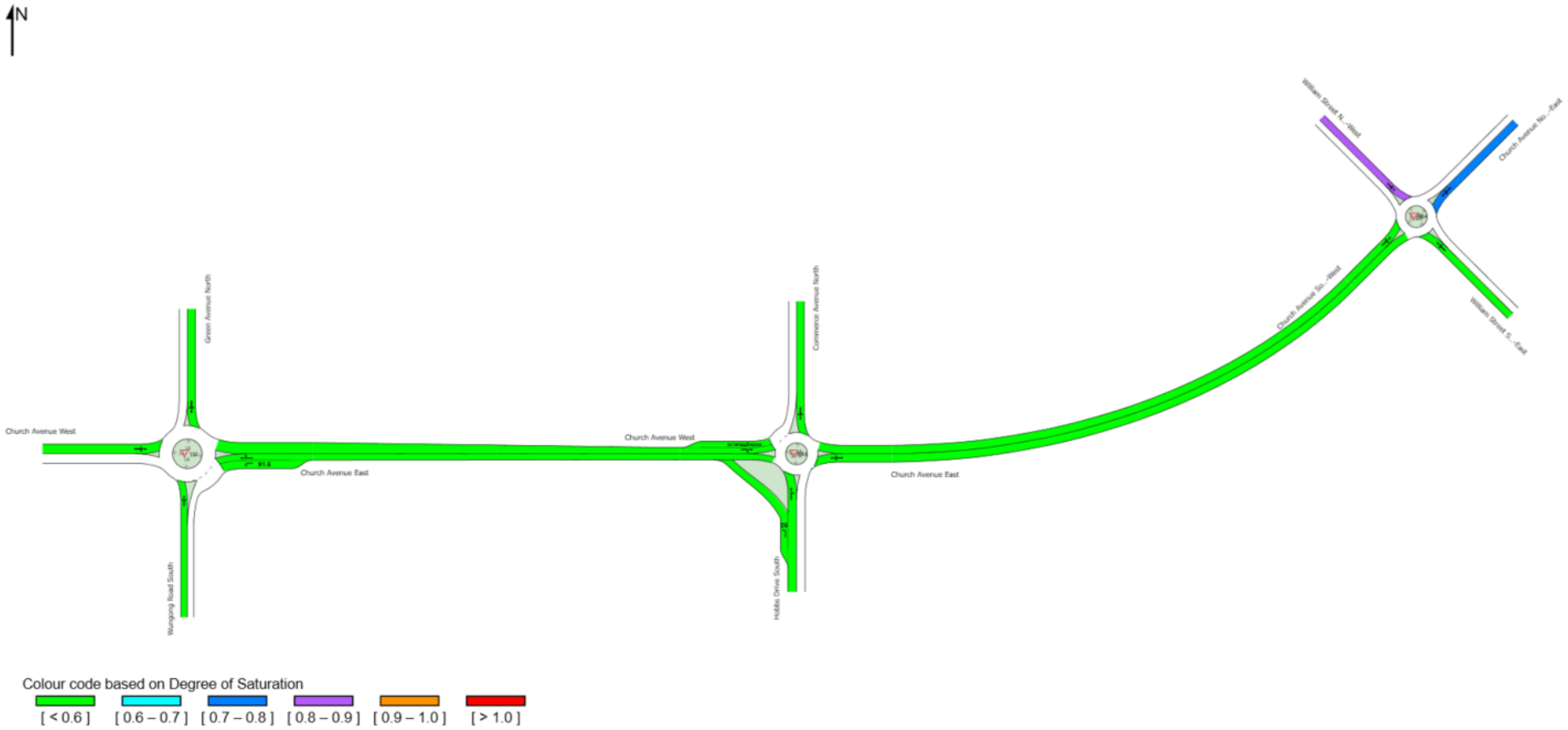


Figure 7.27 Degree of saturation - Church Avenue Network – PM Peak - Do Nothing Scenario (grade separated)

Table 7.7 details the performance of all the intersections in the Church Avenue network.

Table 7.7 Church Avenue Network performance – Do Nothing Scenario (grade separated)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	B	0.620	-	C	0.812	-
Church Avenue/ William Street	A	0.620	7.2	B	0.812	13.8
Church Avenue/ Hobbs Drive/ Commerce Avenue	A	0.341	5.8	A	0.340	6.1
Church Avenue/ Green Avenue/ Wungong Road	A	0.594	7.6	A	0.462	7.0

With the grade separation and with no changes to the existing layout, the intersections and network perform satisfactorily with all intersection operating with reasonable delay and queueing.

Due to the network performing satisfactorily with just the grade separation, no additional infrastructure is forecast to be added to the remaining intersections in the network.

7.4 Forrest Road Network

7.4.1 Do Nothing Scenario (LX included and at grade)

This scenario assumes that the Forrest Road network would still be at grade with the level crossing in place. With the existing intersection layouts retained, the 2036 volume forecasts are applied to understand the performance of the road network.

The Forrest Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 7.28:

1. Forrest Road/ Aragon Court
2. Forrest Road Level Crossing
3. Forrest Road/ Third Road/ Neerigen Street
4. Commerce Avenue/ Third Road/ Supermarket Access.

Figure 7.29 and Figure 7.30 show the degree of saturation at the Forrest Road network with the Level crossing at grade in the AM and PM peak periods respectively in the 2036 Do Nothing (LX at grade) scenario.

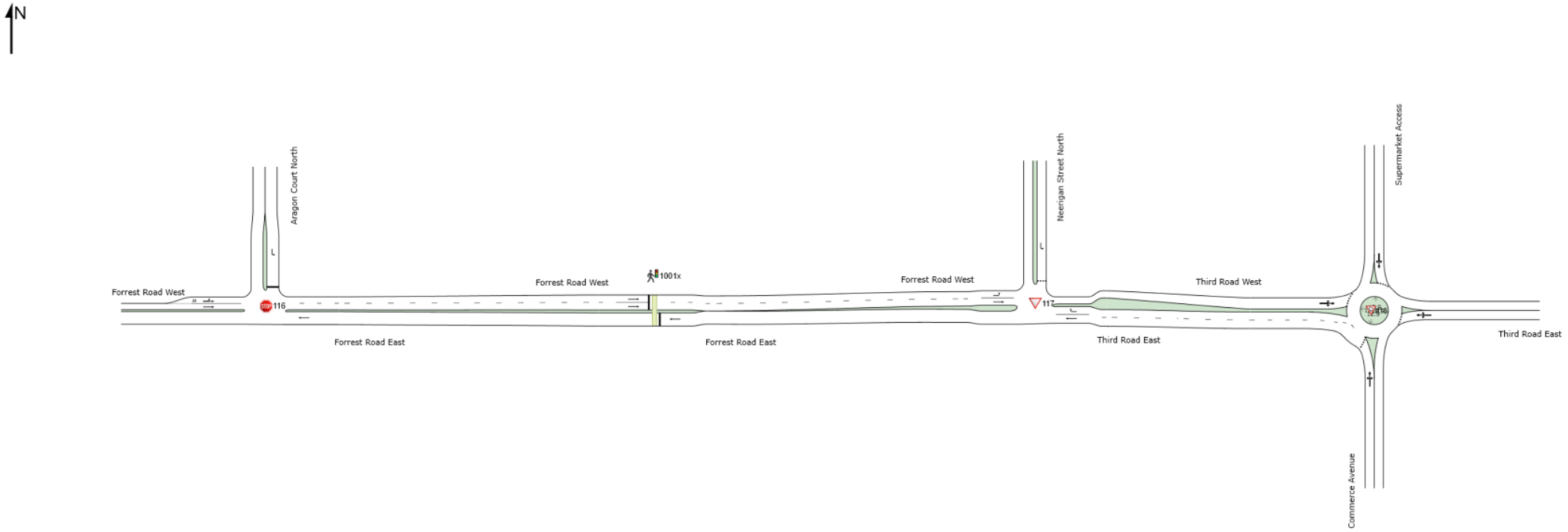


Figure 7.28 Forrest Road Network – Do Nothing Scenario (LX at grade)

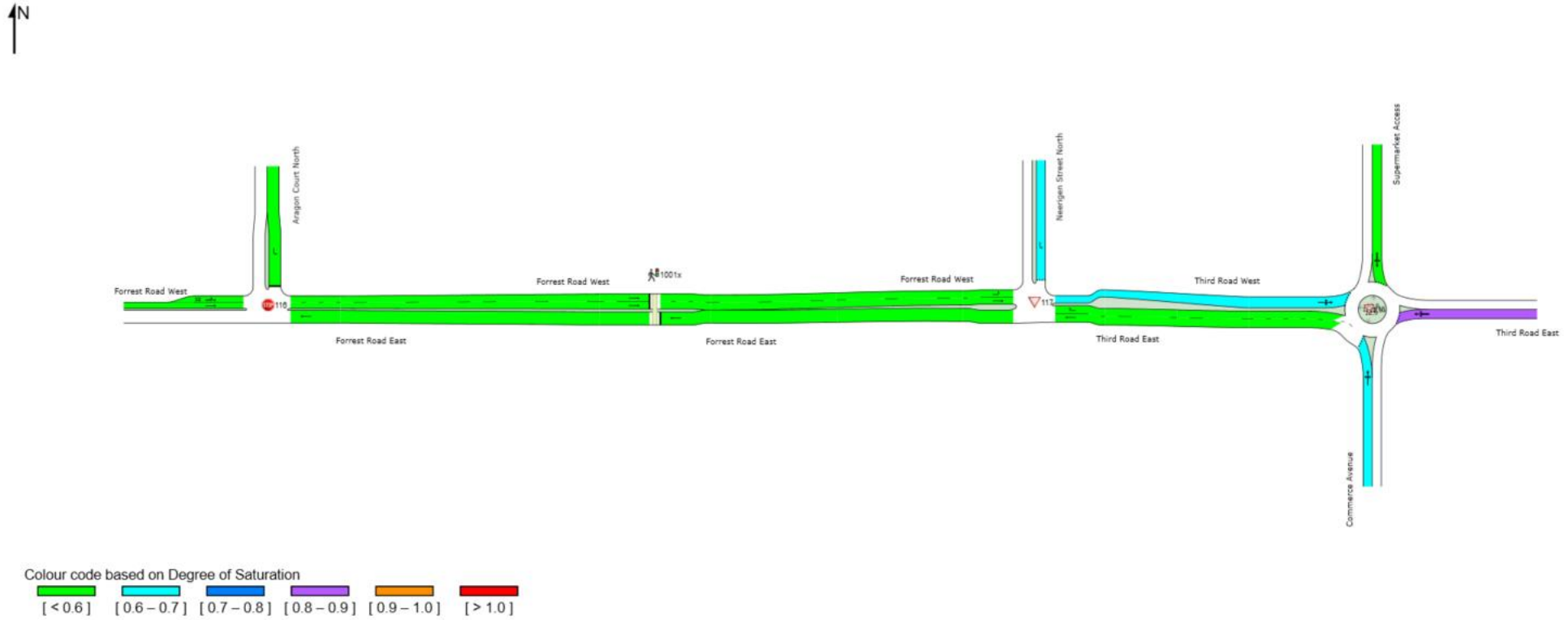


Figure 7.29 Degree of Saturation - Forrest Road Network – AM Peak - Do Nothing Scenario (LX at grade)

Figure 7.30 Degree of Saturation - Forrest Road Network – PM Peak - Do Nothing Scenario (LX at grade

Table 7.8 details the performance of all the intersections in the Forrest Road network.

Table 7.8 Forrest Road Network performance – Do Nothing Scenario (LX at grade)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)	Level of Service (LoS)	Degree of Saturation (DoS)	Average Delay (s)
Overall Network	B	0.807	-	B	0.744	-
Forrest Road/ Aragon Court	A	0.268	0.9	A	0.301	1.0
Forrest Road LX	A	0.324	7.9	A	0.364	8.2
Forrest Road/ Neerigan Street	A	0.614	2.8	A	0.656	2.8
Third Road West/ Commerce Avenue	A	0.807	9.3	A	0.744	8.6

With the existing network layout, the network and the relevant intersections perform satisfactorily with all intersections operating with reasonable delay and queueing.

However as confirmed by PTA, the Forrest Road network is to be grade separated in the future.

7.4.2 Do Nothing Scenario (grade separated)

This scenario analyses the Forrest Road network with grade separation in the future year, whilst still retaining the existing layouts for the other intersections.

The Forrest Road network in this scenario comprises of the following intersections as shown schematically (as an output from SIDRA) in Figure 7.31:

1. Forrest Road/ Aragon Court
2. Forrest Road Level Crossing
3. Forrest Road/ Third Road/ Neerigen Street
4. Commerce Avenue/ Third Road/ Supermarket Access.

Figure 7.32 and Figure 7.33show the degree of saturation at the Forrest Road network with grade separation in the AM and PM peak periods respectively in the 2036 Do Nothing (grade separated) scenario.

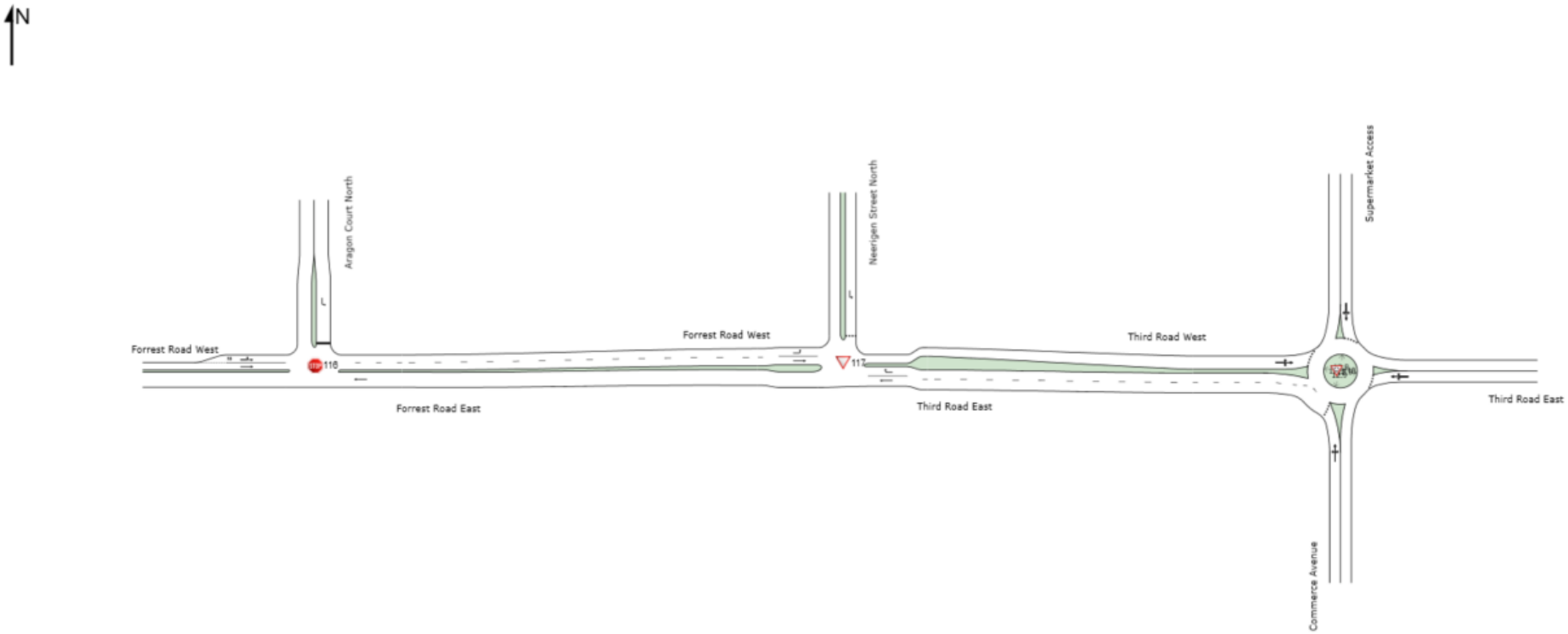


Figure 7.31 Forrest Road Network – Do Nothing Scenario (grade separated)

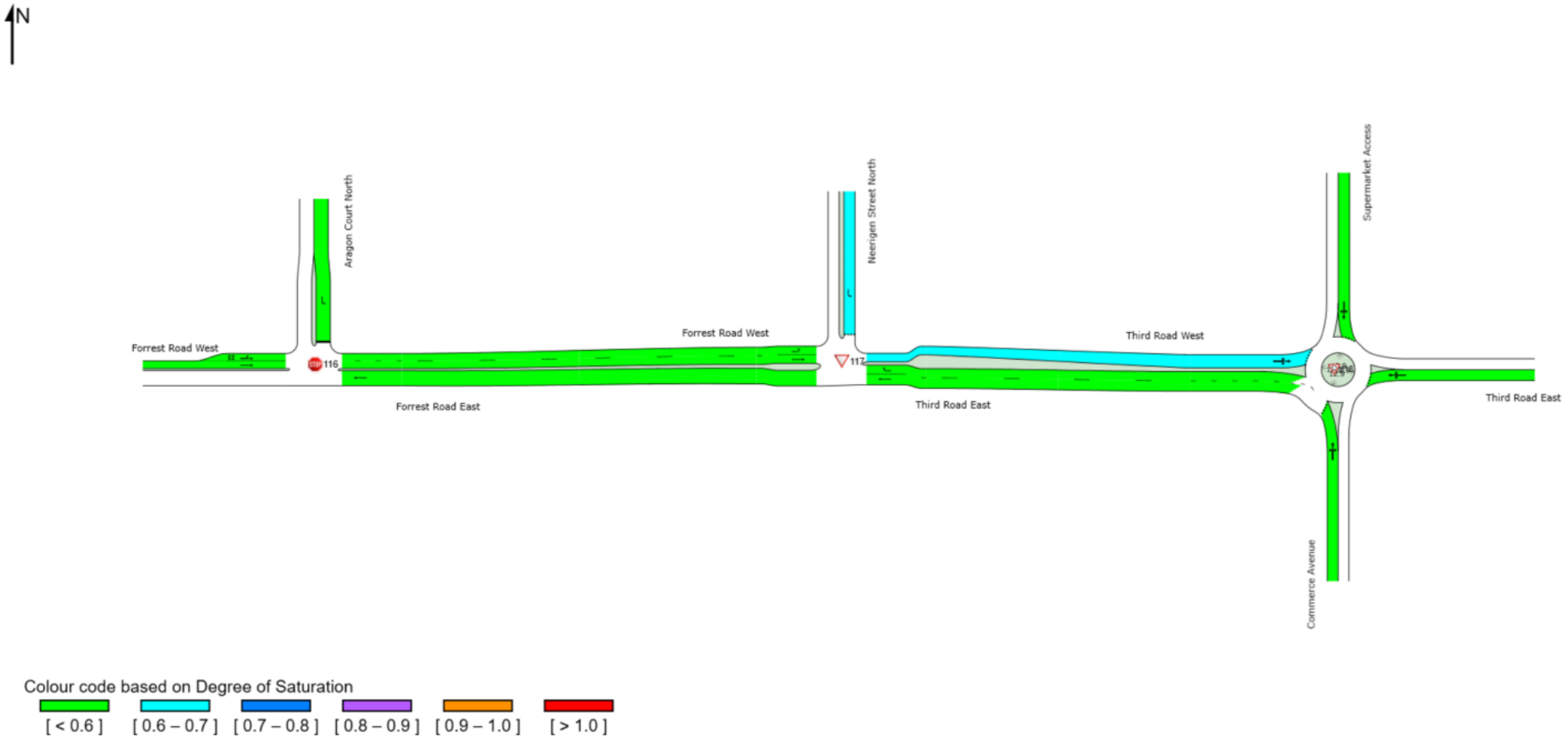


Figure 7.32 Degree of Saturation - Forrest Road Network – AM peak - Do Nothing Scenario (grade separated)

Figure 7.33 Degree of Saturation - Forrest Road Network – PM peak - Do Nothing Scenario (grade separated)

Table 7.9 details the performance of all the intersections in the Forrest Road network.

Table 7.9 Forrest Road Network performance – Do Nothing Scenario (grade separated)

Intersection	AM Peak			PM Peak		
	Level of Service (LoS)	**Degree of Saturation (DoS)**	**Average Delay (s)**	**Level of Service (LoS)**	**Degree of Saturation (DoS)**	**Average Delay (s)**
Overall Network	B	0.659	-	B	0.677	-
Forrest Road/ Aragon Court	A	0.268	0.9	A	0.301	1.0
Forrest Road/ Neerigan Street	A	0.628	2.9	A	0.673	2.9
Third Road West/ Commerce Avenue/ Supermarket Access	A	0.659	6.9	A	0.677	6.6

With the grade separation and with no changes to the existing layout, the intersections perform satisfactorily with all intersections operating with reasonable delay and queueing.

Due to the network performing satisfactorily with just the grade separation, no additional infrastructure is forecast to be added to the remaining intersections in the network.

8 Summary

WSP has been engaged by the Public Transport Authority (PTA) to assess the potential traffic impact to the road network surrounding Armadale Station and the closure of level crossings, under the future year demands associated with project and non-project traffic growth. The locations identified for assessment were defined and instructed by Main Roads WA (MRWA).

SIDRA base case models have been developed to provide the basis for option testing of the project.

The SIDRA modelling for the base case is documented in *PS125110-PAM-REP-002 RevF Public Transport Authority – Armadale Rail Extension, Sidra Base Model Calibration and Validation Report, WSP, 2021.* The base models have been endorsed by MRWA for use for the future year analysis.

The future year 2036 traffic volumes forecast using the Urban Road Planning (URP) method and agreed as suitable by MRWA before adoption for 'Do Nothing' and 'Do Something' modelling, to test the function of the road network under the forecast demands. For the future year 2026 traffic estimates, 2021 and 2031 ROM24 data were utilised to determine linear growth and estimate 2026 ROM24 data. This was then used in the URP spreadsheets to develop peak hour turning counts for the opening year

In locations where the existing layouts were unable to accommodate demands, a series of alternate at-grade intersection layout options were tested for capacity, which were somewhat independent of any design work. It was a stand-alone assessment, with the outputs intended to inform the next stages of project development.

In the context, it is suggested the key next steps are:

— Work with MRWA and the local government to determine which intersection upgrades are the responsibility of the project, noting that some intersections analysed are remote from the project, and that the traffic forecasts used for assessment include general region-wide traffic changes in addition to those instigated by the project.

— Review the ability to implement / construct the potential future year layouts in an engineering constraints context.

Irrespective, the following conclusions were drawn from the modelling undertaken:

— For intersections modelled as individual sites, all intersection which are priority controlled in the existing year, except for the intersection of Eleventh Road/ Wungong Road, need to be upgraded to a two staged priority controlled intersection in the opening year (2026). In the opening year + 10 (2036) scenarios, all intersection which are priority controlled in the existing year, except for the intersection of Eleventh Road/ Wungong Road either need to be signalised or converted to roundabouts to ensure that they operate satisfactorily.

— The intersection of SWH/ William St/ Bedfordale Hill Rd operates within capacity with changes to the lane discipline (shared through and right turn movement) on lane 1 of the west approach of William Street and with modifications to the phasing of the intersection. While the intersection still operates within capacity, the intersection needs to be further analysed and optimised with LinSig to MRWA satisfaction.

— For the Armadale Road network, it was noted that the current layout in the future year with grade separation operates over capacity. As a result, different layouts have been proposed as alternatives. Again, whilst the layouts operate within capacity, all intersections (both roundabouts and signals) need to be optimised further to MRWA satisfaction.

— For the road networks of Church Avenue and Forrest Road, grade separation ensures that the network operates within capacity with the existing layout. However, further upgrades might be needed to satisfy Main Roads WA requirements.

Figure 8.1 and Figure 8.2 summarises the proposed intersection configurations for all individual and network intersections in the Armadale study area.

Intersection	2026		2036	
	Do Nothing	Proposed	Do Nothing	Proposed
South Western Highway / William Street / Bedfordale Road	✓	-	✗	*
South Western Highway / Dickens Place	✗	*	✗	
South Western Highway / Stone Street	✗	*	✗	
South Western Highway / Eleventh Road	✗	*	✗	
Eleventh Road / Wungong Road	✓	-	✓	-

* Same intersection control as existing, modified layout

Figure 8.1 Armadale – Individual Intersection summary

	Intersection		2026		2036
			Do Nothing	Proposed	Proposed
Armadale Network	Armadale Road / Abbey Road / Railway Avenue		✓	-	* * *
	Armadale Road / Streich Avenue		✗		
	Armadale Road / Orchard Road		✗		
	Armadale Road / Church Avenue		✓		
Church Avenue Network	Church Avenue / Wungong Road / Green Avenue		✓	-	-
	Church Avenue / Commerce Avenue / Hobbs Drive		✓	-	-
	Church Avenue / William Street		✓	-	-
Forrest Road Network	Forrest Road / Aragon Court		✓	-	-
	Forrest Road / Neerigan Street / Third Road		✓	-	-
	Third Road / Commerce Avenue / supermarket access		✓	-	-

* Same intersection control, modified layout

* * Further optimization in LinSig required to operate below capacity

Figure 8.2 Armadale – Network summary

Appendix A

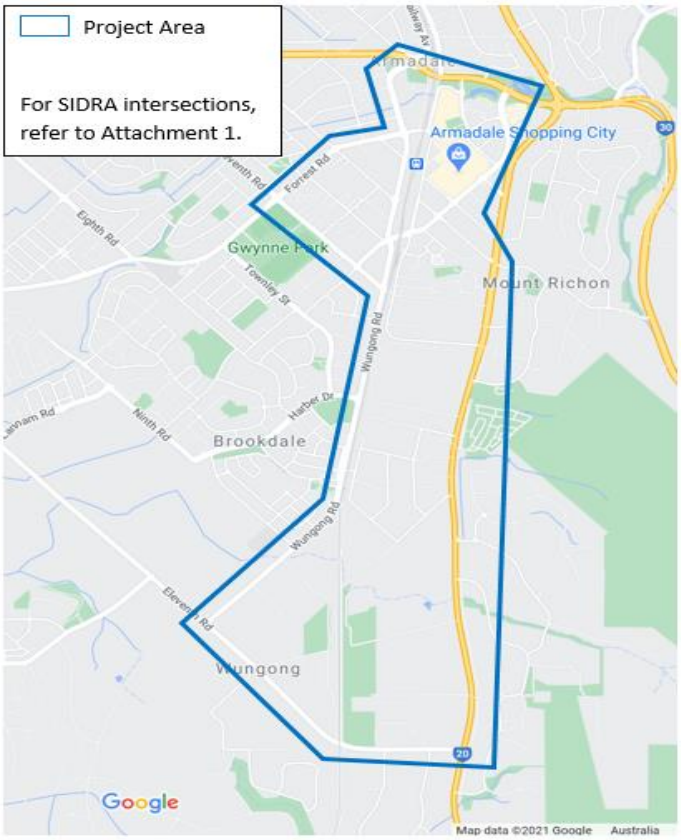
MRWA Correspondence & Approvals

Traffic Modelling Instruction Form

General

Title of The Project	METRONET - Byford Rail Extension (Armadale Station)
Stage	Traffic Impact Assessment
Applicant	METRONET
Modeller (if known)	
Requested by	Other
Please specify:	Eddie Mesina (METRONET)
Main Roads Reference Number (Requester)	
Main Roads Reference Number (Approver)	
Modelling Objectives - purpose of the modelling; - who if it for; - and, …	☑ Feasibility Assessment ☑ Intersection Layout Justification Analysis The purpose of the modelling is to investigate the traffic impacts of the Metronet upgrade works and suitable intersection treatments associated with Armadale Station on the wider road network performance. Following a recent Australian Government funding announcement, Armadale Station is now confirmed to be elevated, and the existing level crossings (LX) at Armadale Road, Forrest Road and Church Avenue will also be grade separated. In addition, METRONET will close the existing Byron Road LX and grade separate the existing Eleventh Road LX. It is assumed there is no traffic diversion as a result of the other proposed Byford Rail Extension level crossing removal schemes south of Eleventh Road.
Study Area (i.e. Corridor or Intersection/s (TCS Number))	See image below (refer map in Attachment 1 for locations of individual intersections)

Study Area Image



Modelling Requirements

Software 1	SIDRA
Pedestrian Movement	☐ Tick this box if pedestrain modelling is required
Additional Notes	Refer to map in Attachment 1 for intersection locations (corresponding to the numbers below) and their existing control type. Sites to be modelled in SIDRA as a **network**: 1) Armadale Rd / Abbey Rd / Railway Ave 2a) Armadale Rd LX (existing layout only) 2) Armadale Rd / Streich Ave 3) Armadale Rd / Orchard Ave 4) Armadale Rd / Church Ave Sites to be modelled in SIDRA as a **network**: 5) Forrest Rd / Aragon Ct 5a) Forrest Rd LX (existing layout only) 6) Forrest Rd / Third Rd / Neerigen St 7) Third Rd / Commerce Ave Sites to be modelled in SIDRA as a **network**: 8) Church Ave / Green Ave / Wungong Rd 8a) Church Ave LX (existing layout only) 9) Church Ave / Commerce Ave / Hobbs Dr 10) Church Ave / William St Sites to be modelled in SIDRA as **individual sites**: 11) SWH (South Western Hwy) / William St / Bedfordale Hill Rd 12) SWH / Dickens Pl 13) SWH / Stone St 14) SWH / Eleventh Rd 15) Eleventh Rd / Wungong Rd Additional OD video survey locations **(no modelling required - for traffic redistribution purposes only)**: 16) Byron Rd LX / Wungong Road

Modelling Time Period

Please define all the time period options for the modelling

Time Period Option 1

Weekday		From	To	Weekend		From	To
AM	✔	TBC	TBC	**Saturday Peak Hour/s**	✘		
PM	✔	TBC	TBC	**Sunday Peak Hour/s**	✘		
Other	✘			**Other**	✘		

Warm-up (minutes)

Cool-down (minutes)

Please specify the purpose of peak time:

Peak periods to be determined from the traffic survey data. Consultant to commission traffic surveys as per the Operational Modelling Guidelines.

Modelling Scenarios

Existing Base ☑ Date of the Base Model: New Survey TBC

i.e. date of surveys used for model or date used to determine future traffic

Scenario 1: Opening Year, Existing Layout

Year: 2023 Time Period Option*: 1

Description:

Scenario 2: Opening Year, Proposed Layouts

Year: 2023 Time Period Option*: 1

Description: Proposed layout options to be modelled:
Armadale Rd LX grade separated (rail over road), Forrest Rd LX grade separated (rail over road), Church Ave LX grade separated (rail over road), Byron Rd LX closed

Scenario 3: Opening Year + 10 Years, Proposed Layouts

Year: 2033 Time Period Option*: 1

Description: As per Scenario 2 (Opening Year, Proposed Layouts)

*** 1 Time Period Option/s were defined in the previous page (Modelling Time Period)**

Input Data

Please list all the available data for the modelling.

Input 1: Traffic Volume (New Survey) — Please specify: For all intersections, 24-hour video surveys are to be commissioned during one weekday (excluding public holidays and school holidays). If 24-hour video surveys of all intersections is not feasible, liaise with MRWA to confirm surveying requirements.

Source of Data: Traffic counts survey

Input 2: SCATS History File — Please specify: For existing signalised intersections, historical phasing data (history file data & LX files) is to be requested for the same date as video surveys.

Source of Data: Main Roads Western Australia

Input 3: Other — Please specify: ROM24 All-Day link volume plots to be provided for 2016, 2021, 2031, 2036 & 2041 by Road Planning &

	Source of Data: Main Roads Western Australia		Development (RPD) branch. The URP method is recommended for calibration of the ROM24 data. RPD branch to be consulted to review and approve the calibration process.
Input 4	Public Transport	Please specify	Data on train arrivals at each level crossing/boom gate closure times to be obtained. (For base model only)
	Source of Data: Public Transport Authority Train arrivals and boom gate closure times.		
Input 5	CAD	Please specify	CAD drawing should be used to code the network configuration.
	Source of Data: Proposed CAD design		
Input 6	Other	Please specify	Other signal-related information (i.e. traffic signal arrangement & phase sequence) to be sourced from TrafficMap website (https://trafficmap.mainroads.wa.gov.au/map).
	Source of Data: Main Roads Western Australia		
Input 7	Other	Please specify	Queue lengths at intersections along Armadale Road and SWH (consultant to state assumptions and measurement methodology), to be used for model calibration and validation.
	Source of Data: Main Roads Western Australia		
Input 8	Saturation Flows for Critial	Please specify	Saturation flows should be measured on-site or via video from the same day of the traffic survey (where possible). These surveys should be undertaken in accordance with Appendix B of the Operational Modelling Guidelines.
	Source of Data: Saturation Flow Survey		

Outputs

Output 1	Average Queue Length	Please specify	Average and maximum queue lengths at key intersections to be reported for all scenarios.
	Requested Format: Spreadsheet		
Output 2	Tables and Graphs	Please specify	Intersection performance outputs need to be generated for each future year scenario, including Average delay, Maximum queue length, Degree of saturation and Level of service for all intersections analysed in SIDRA.
	Requested Format: Spreadsheet		
Output 3	Report	Please specify	The modelling report should include modelling methodology, base year model calibration and validation results, parameters derived from Operational Modelling Guidelines, future traffic forecast assumptions, proposed network changes, network performance outputs and relevant recommendations (such as traffic management plans) if necessary.
	Requested Format: Other Please specify: Report		
Output 4	Model Checklist	Please specify	Model Audit Checklist for Base and Proposed models to be populated.
	Requested Format: Spreadsheet		

Approvals

Requested By
e.g. Project Manager

Title

Signature

Date

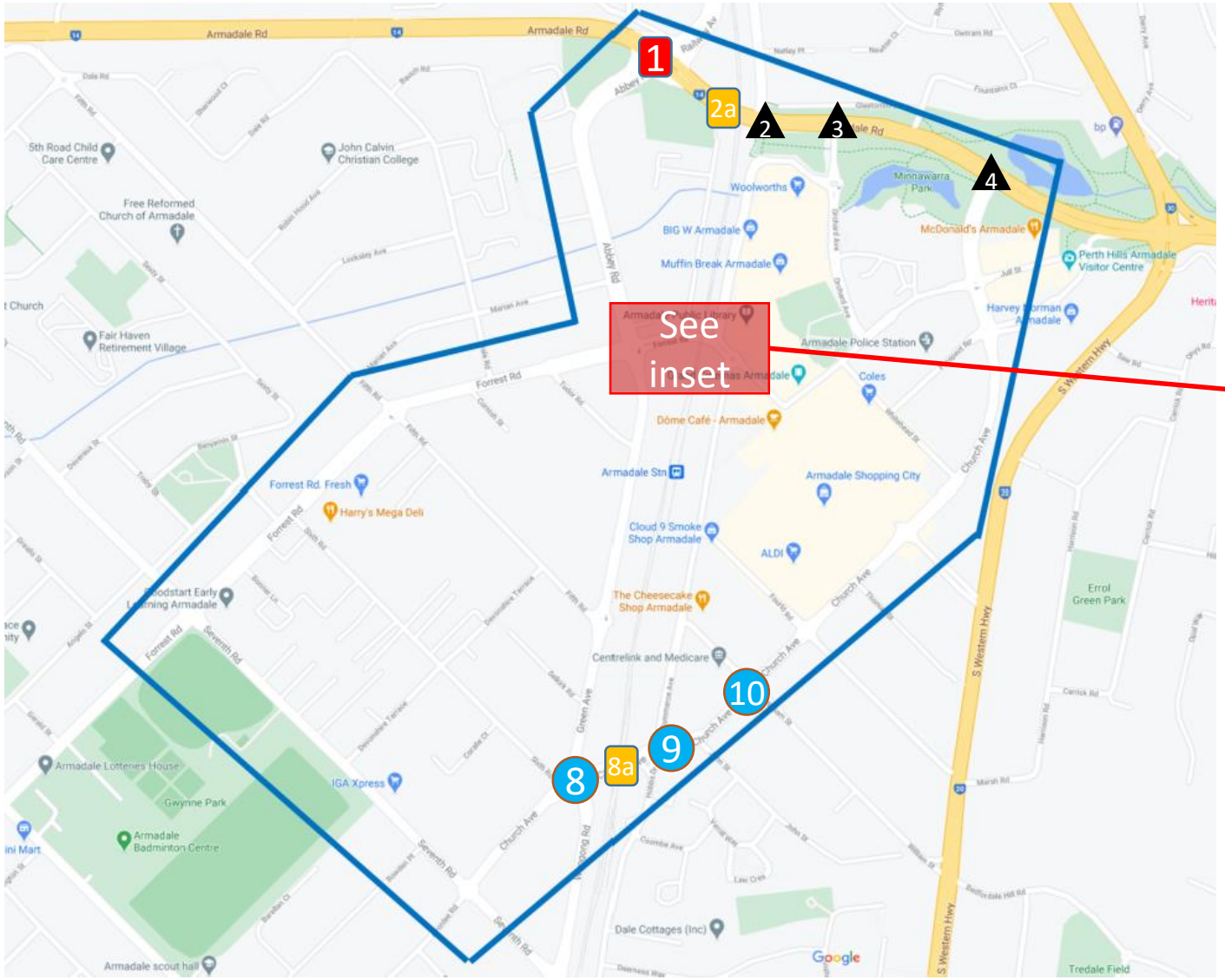
Approved By
e.g. OMV Team, Network Performance Manager or Traffic Management Services Manager

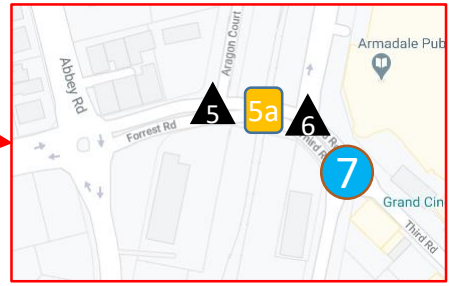
Title

Signature

Date

Armadale Station Modelling (north of Church Avenue)

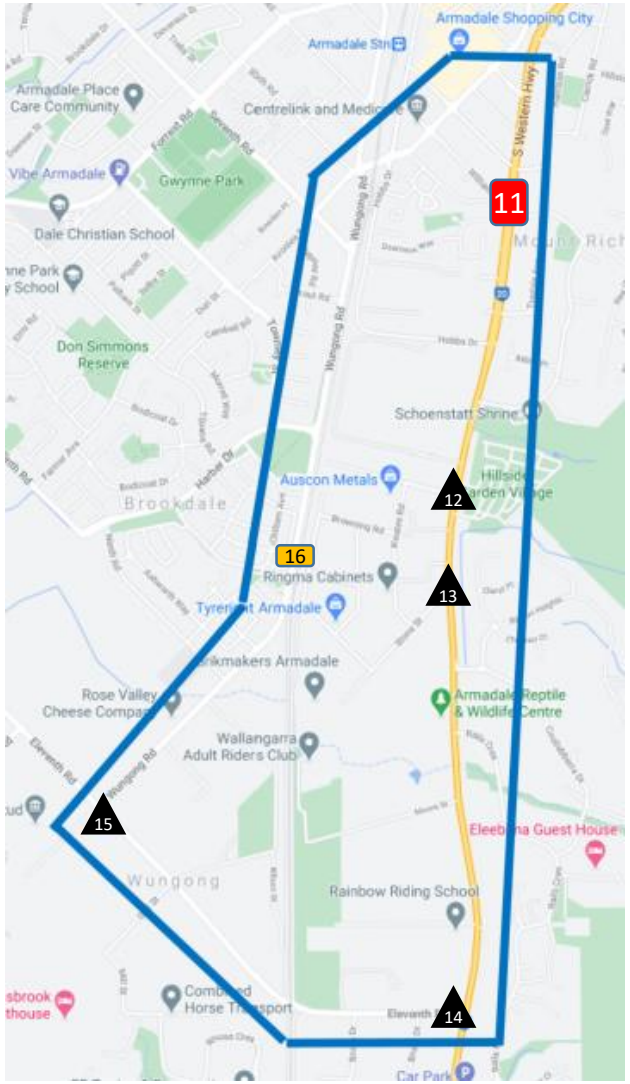




Existing Control Type

- Traffic Signals
- Give-way
- Roundabout
- LX

Armadale Station Modelling (south of Church Avenue)



Existing Control Type

- LX Closure (survey only)
- Give-way
- Roundabout
- Traffic Signals

From: FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>
Sent: Friday, 28 January 2022 4:38 PM
To: Jan, Mohammad <Mohammad.Jan@pta.wa.gov.au>; Fowler, Mark <Mark.Fowler@wsp.com>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>; Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>; Parolo,Alf <Alf.Parolo@pta.wa.gov.au>; PAROLO Alf (RRM) <alf.parolo@mainroads.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Mohammad

I have looked at the volumes and am unable to find significant issues.

I suggest proceeding with the revised volumes in the attached.

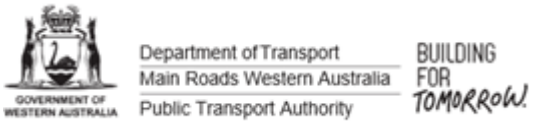
Regards

Paul Fourie
Network Planning and Development Manager
PTS / Road Planning and Development
p: +61 8 9323 4417
w: www.mainroads.wa.gov.au


From: Jan, Mohammad <Mohammad.Jan@pta.wa.gov.au>
Sent: Friday, 28 January 2022 11:40 AM
To: FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>; Fowler, Mark <mark.fowler@wsp.com>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>; Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>; Parolo,Alf <Alf.Parolo@pta.wa.gov.au>; PAROLO Alf (RRM) <alf.parolo@mainroads.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Paul,
Thanks for pushing the approval ,really appreciate your support for the BRE project.
I will be thankful if you can finalise the remaining last intersection (Church/William)so that we can proceed with modelling and final report.
It is becoming now critical for the BRE project team as we have entered in negotiation LOI phase.
Looking forward to hear from you soon.

Regards,
Mohammad Asif Jan
BSc (Civil Eng), MIEAust, CPEng, NER
Project Manager
Byford Rail Extension
Office of Major Transport Infrastructure Delivery(OMTID)
Tel: (08) 9326 5811 | Mob: 0402 33 44 34
34 - 50 Stirling Street Perth WA 6000



From: FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>
Sent: Friday, 21 January 2022 4:44 PM
To: Fowler, Mark <mark.fowler@wsp.com>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>; Jan, Mohammad <Mohammad.Jan@pta.wa.gov.au>; Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Mark

I have compared the volumes in the revised spreadsheets with the previous versions (DVD email 22 Dec 21) and am happy that the updates have been done.

However, I still need to discuss Church/William – will do that on Monday.

Regards

Paul Fourie
Network Planning and Development Manager
PTS / Road Planning and Development
p: +61 8 9323 4417
w: www.mainroads.wa.gov.au

We're working for Western Australia.

From: Fowler, Mark <Mark.Fowler@wsp.com>
Sent: Tuesday, 11 January 2022 11:46 AM
To: FOURIE Paul (On Leave) <paul.fourie@mainroads.wa.gov.au>
Cc: BROADHURST Lindsay (On Leave) <lindsay.broadhurst@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Paul

Happy new year!

As per David's request below, I am sending you the handful of outstanding sites for review. For ease of reference / tracking, I have added another column to the table from the email and copied it below.

Please give me a shout if you have any questions.

Cheers
Mark

No.	Location	Site peak update required?	David instruction from phone call	Status / Action from 29/12	Current status / action
1	Armadale / Abbey	No change – same peak	Approach volumes on abbey to be updated from new data provided by David yesterday	To be updated using new ROM data. Will be issued by COB 11th Jan.	Analysis supplemented with newly provided ROM data, attached for review and approval by Paul.
2	Armadale / Orchard	Updated AM Peak	No more action	Peak data updated, attached for review and approval by David.	Signed off by David on 4/1/22.
3	Forrest / Neerigan	No change – same peak	Approach on Neerigan considered high, southbound correct, use 3% linear for Neerigan as growth method (16 years * 3% = times by 1.48)	3% growth method applied in previous issue of data. To be further updated using new ROM data. Will be issued COB 11th Jan.	Updated using instructed 3% growth method to supplement missing ROM data, attached for review and approval by Paul.
4	Church / William	Updated AM and PM Peak	Make sure roundabout is coded correctly with u-turns. Nothing more.	Previously coded, attached for review and approval by David.	Have double checked all inputs and method. We can't work out what David considers "low" or what needs corrected. Have attached for Paul to review and advise please.
5	Church / Hobbs / Commerce	Updated PM Peak	PM video coded incorrectly, excessive demands on Hobbs and Commerce –	Peak data updated and 3% growth method applied in previous issue of	Updated using instructed 3% growth method to supplement missing ROM

			use 3% growth on these links as do not exist in ROM.	data. To be further updated using new ROM data. Will be issued COB 11th Jan	data, attached for review and approval by Paul.
6	Abernethy / George	Updated PM Peak	Apply 3% to the driveway to the pub. Note: in future where George meets Abernethy it will be LILO.	Peak data updated, to be further updated using 3% growth method. Will be issued COB 11th Jan.	Updated using instructed 3% growth method to supplement missing ROM data, attached for review and approval by Paul.
7	SWH / Beenyup / Abernethy	No change – same peak	Check PM volumes.	Updated previously and checked, attached for review and approval by David.	Signed off by David on 4/1/22.
8	Gordin / Sansimeon	No change – same peak	Use 3% method here as we don't have Gordin.	To be updated using 3% growth method. Will be issued by COB 11th Jan.	Updated using instructed 3% growth method to supplement missing ROM data, attached for review and approval by Paul.

Mark Fowler
Regional Executive; Planning and Mobility, WA

T: +61 8 94894366

Mark.Fowler@wsp.com

WSP Australia Pty Limited
Level 5, 503 Murray St
Perth, WA, 6000
Australia

wsp.com/au

WSP acknowledges that every project we work on takes place on First Peoples lands. We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

From: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>
Sent: Tuesday, 4 January 2022 9:32 AM
To: Fowler, Mark <Mark.Fowler@wsp.com>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (On Leave) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>
Subject: RE: Byford Rail Extension forecast traffic volumes

Good morning Mark, Mohammad and Eddie,

Thank you Mark for your email and the three amended intersection assessment. I have reviewed the three excel files and confirm the following:

- Church Ave – William St – 2031 demands on the southbound approach on Church Avenue, your demands are low.
- Armadale Road – Orchard Avenue – OK
- SWH – Abernethy Rd – Beenyup Rd – OK.

Mark, you have indicated to me in your email below that the remaining will be available for review on Tuesday next week. As I am on extended leave (6 months), can you please have the remaining assessment sent to Paul Fourie. Paul email address is paul.fourie@mainroads.wa.gov.au

Regards

David Van Den Dries

From: Fowler, Mark <Mark.Fowler@wsp.com>
Sent: Wednesday, 29 December 2021 9:37 AM
To: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi all

David and I caught up on the morning of the 23rd to run through each of the 8 outstanding sites, in the context of the three potential instructed directions. The status of each is confirmed below.

No.	Location	Site peak update required?	David instruction from phone call	Current status / Action
1	Armadale / Abbey	No change – same peak	Approach volumes on abbey to be updated from new data provided by David yesterday	To be updated using new ROM data. Will be issued by COB 11th Jan.
2	Armadale / Orchard	Updated AM Peak	No more action	Peak data updated, attached for review and approval by David.
3	Forrest / Neerigan	No change – same peak	Approach on Neerigan considered high, southbound correct, use 3% linear for Neerigan as growth method (16 years * 3% = times by 1.48)	3% growth method applied in previous issue of data. To be further updated using new ROM data. Will be issued COB 11th Jan.
4	Church / William	Updated AM and PM Peak	Make sure roundabout is coded correctly with u-turns. Nothing more.	Previously coded, attached for review and approval by David.

5	Church / Hobbs / Commerce	Updated PM Peak	PM video coded incorrectly, excessive demands on Hobbs and Commerce – use 3% growth on these links as do not exist in ROM.	Peak data updated and 3% growth method applied in previous issue of data. To be further updated using new ROM data. Will be issued COB 11th Jan
6	Abernethy / George	Updated PM Peak	Apply 3% to the driveway to the pub. Note: in future where George meets Abernethy it will be LILO.	Peak data updated, to be further updated using 3% growth method. Will be issued COB 11th Jan.
7	SWH / Beenyup / Abernethy	No change – same peak	Check PM volumes.	Updated previously and checked, attached for review and approval by David.
8	Gordin / Sansimeon	No change – same peak	Use 3% method here as we don't have Gordin.	To be updated using 3% growth method. Will be issued by COB 11th Jan.

As I identified in an earlier email, some intersections that require attention for the other resolutions will take longer to modify. @VAN DEN DRIES David (URPM) given the above documents exactly what you want us to change, and we have gotten the other 21 to your expectations, would you be comfortable in approving these without seeing the outputs? Otherwise, for this handful of intersections, would you be able to give someone in your team the target forecast data to sign it off in your absence – we will be able to issue by COB 11th Jan at the latest?

Thanks all
Mark

Mark Fowler
Regional Executive; Planning and Mobility, WA

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From: Fowler, Mark
Sent: Thursday, 23 December 2021 8:09 AM
To: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>; Selby, Tim <Tim.Selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi all

Sorry, just to clarify a couple of things

@Mohammad Jan @Eddie Mesina the question in red text below was for you both, and needs an urgent answer within the next hour before I speak to David.

There are 18 intersections approved, so on the 10th January we can start the future year modelling on these 18.

Thanks

Mark Fowler
Regional Executive; Planning and Mobility, WA

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From: Fowler, Mark
Sent: Wednesday, 22 December 2021 7:11 PM
To: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>; Selby, Tim <Tim.Selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>
Subject: RE: Byford Rail Extension forecast traffic volumes
Importance: High

Thanks David and thanks for taking my call.

Of the 8 (of 26) intersections you have concerns with, the resolutions can be summarised as follows:

- You have instructed WSP to utilise the individual intersection peaks as opposed to adopting the network peak. This item is what you have identified as a coding error, but it is not an error, rather use of a different data set. It should be noted that we adopted the network peak approach (as opposed to your intersection peak approach) to ensure consistency with the mandated Network Operations SIDRA modelling methodology. Adoption of the intersection peak as the basis for future year traffic forecasting could result in flow imbalances between intersections, which isn't ideal in a network model (although not a massive issue). We can adopt either but @Eddie Mesina @Mohammad Jan PTA need to be aware of this potential imbalance with the intersection peak method and be accepting of it **– I urgently need your direction on this to adapt the data if required.**
- Confirmation that of the two growth options we have presented to date for where ROM data is missing, we should adopt the **3% linear traffic growth** method.
- Data gaps from the currently provided ROM data is to be plugged using the additional data sent through today, as opposed to making an assumption using the previously provided data.

David and I have agreed to catch up for half an hour in the morning to basically populate the below table (I will try to make sure our modeller is available to join also)

No.	Location	Current concern	Method to address
1	Armadale / Abbey		
2	Armadale / Orchard		
3	Forrest / Neerigan		
4	Church / William		
5	Church / Hobbs / Commerce		
6	Abernethy / George		
7	SWH / Beenyup / Abernethy		
8	Gordin / Sansimeon		

I am concerned that WSP office closes at lunchtime tomorrow until 10th January. Of the three resolutions, the decision between network and intersection peak is a quick one to update if required and those intersection where this is all that needs changed can be done and hopefully re-issued tomorrow.

Those intersections that require attention for the other resolutions will take longer to modify. @VAN DEN DRIES David (URPM) given you will give us direction tomorrow on what exactly needs done, for these intersections that are a more time consuming update, would you be comfortable in approving these without seeing the outputs given we have already correctly forecast 18 of the intersections and those remaining you will have given us clear direction on? Otherwise, for this handful of intersections, would you be able to give someone in your team the target forecast data to sign it off in your absence – we will be able to issue by COB 11th Jan at the latest?

Thanks all

Mark Fowler
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WSP acknowledges that every project we work on takes place on First Peoples lands. We recognise Aboriginal and Torres Strait Islander Peoples as the first scientists and engineers and pay our respects to Elders past and present.

From: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>
Sent: Wednesday, 22 December 2021 3:22 PM
To: Fowler, Mark <Mark.Fowler@wsp.com>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Mark,

I have reviewed your assessment in determining the likely future demand for BRE project. The attached files are those files which have issues associated with them. They require correcting. All other files are OK.

The issue identified in each attached intersection assessment varies where some are just coding errors from existing AM and PM video surveys. Where there are no road links as shown in the ROM24 link volume plots, please adopt 3% linear growth for those links using the existing video surveys as the basis.

I have included for you an enlargement of the link volume plots for the Armadale Road/Abbey Road/Railway Avenue intersection assessment. The plots which have been provided previously did not illustrate the demand on Railway Avenue where it approaches Armadale Road.

Once I have receive the corrected files (hopefully just after the new year) I will make time to review the assessment.

Please be mindful that I will be on leave for some 6 months commencing from the 7th January 2022. I am also away between Xmas and the New Year.

Best wishes

David Van Den Dries

From: Fowler, Mark <Mark.Fowler@wsp.com>
Sent: Tuesday, 21 December 2021 12:04 PM
To: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes
Importance: High

Hi David

I can confirm this has all been reviewed, noting also this is the first time you have seen the Abernethy / Sansimeon site as the compression software seemed to have omitted it previously.

With the comments we have provided for the other intersections where you have previously disputed the coding of traffic data, you will see that in our response, we have used a network peak instead of the intersection peak given we are modelling the intersections as networks – using the intersection peaks will cause disparity in approach and departure volumes. The coding of the data using the network peaks is correct. I believe this could be the issue you are identifying with this intersection also – can you please confirm?

With the 3% traffic growth, this has been adopted and the outputs provided (for comparison to the original adopted method), but also in our previous issue of data you will see we have raised some site-specific questions about the adoption of the 3% growth, and also set out how we developed these forecasts without adopting the 3% growth – is your email below an answer to these questions and an instruction to adopt 3% growth as the default approach, even where we have raised concerns about doing so?

Can I ask that you please populate any specific comments / concerns in the spreadsheet we provided so we can be targeted in addressing them – it would make this process much easier and assist with the auditing process.

Thanks
Mark

Mark Fowler
Regional Executive; Planning and Mobility, WA

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From: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>
Sent: Tuesday, 21 December 2021 10:58 AM
To: Fowler, Mark <Mark.Fowler@wsp.com>; Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Mohammad and Eddie,

I have just started to check WSP re-assessment based on my email response dated 9 December 2021. The first file which I had reviewed was the Abernethy Road/Sansimeon Boulevard intersection. The 2036 demand as derived by WSP does not correlate to the demand which I had computed. The issue here is the inputs are coded incorrectly. Has this been checked by WSP prior to sending these files to Main Roads for review? Also, where there is no road link as presented in ROM24, hence I would adopt a growth of 3% linear in this instance from base 2021 traffic survey.

I will not be reviewing the remaining files until I have been informed that these outstanding files/issues been checked by WSP and confirm that they have addressed the concerns raised in the 9 December 2021 email.

Please note that URGENT action is required as of 7th January 2022 I will be away from the office for some 7months.

Best wishes

David Van Den Dries

From: Fowler, Mark <Mark.Fowler@wsp.com>
Sent: Friday, 17 December 2021 2:12 PM
To: Mohammad Jan <Mohammad.Jan@pta.wa.gov.au>; VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>
Cc: Eddie Mesina <Eddie.Mesina@pta.wa.gov.au>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi David / Mohammad

Please see attached updated files, and a spreadsheet containing the comments, our response and the proposed next steps.

Thanks

Mark Fowler
Regional Executive; Planning and Mobility, WA

T: +61 8 94894366

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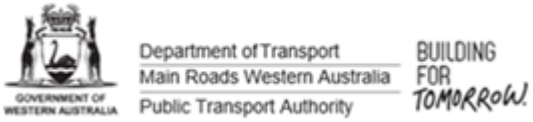
From: Jan, Mohammad <Mohammad.Jan@pta.wa.gov.au>
Sent: Friday, 10 December 2021 8:32 AM
To: Fowler, Mark <Mark.Fowler@wsp.com>
Cc: Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>
Subject: FW: Byford Rail Extension forecast traffic volumes
Importance: High

Hi Mark,
Following are the comments from MRWA for your action and information.

Regards,
Mohammad Asif Jan
BSc (Civil Eng), MIEAust, CPEng, NER
Project Manager
Byford Rail Extension
Office of Major Transport Infrastructure Delivery(OMTID)
Tel: (08) 9326 5811 | Mob: 0402 33 44 34
34 - 50 Stirling Street Perth WA 6000



From: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>
Sent: Thursday, 9 December 2021 4:53 PM
To: Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>; Jan, Mohammad <Mohammad.Jan@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>
Subject: Byford Rail Extension forecast traffic volumes
Importance: High

Hi Eddie and Mohammad,

Please note that I have computed 2026 and 2036 demands. If you require other design years like 2041 for example, please let me know.

I have now assessed my generated outputs with those from WSP and the following are my comments:

There are three intersection assessments missing from the set provided by WSP.

- Armadale Road/Abbey Road/Railway Ave intersection
- South West Highway/Pitman Way
- Abernethy Road/Sansimeon Boulevard

The following intersection outputs where they differ from what I have computed are as follows:

- Armadale Road/Orchard Road – AM 2021 traffic survey demand incorrectly coded.
- Forrest Road/Neerigen Street – some ROM24 values cannot be provided. In this case there should be some allowances for growth. I would adopt a growth of 3% linear in this instance from base 2021 traffic survey.
- Forrest Road/Commerce Avenue/Shopping center – WSP has not included the “U” turn demand in their assessment as indicated in the 2021 traffic surveys.
- Church Avenue/William Street – inputs error from 24 hr traffic survey and ROM24.
- Church Avenue/Hobbs/Commerce Avenue – how did WSP compute the forecast flows for both Hobbs and Commerce Avenue???? There are no ROM24 links. In this case there should be some allowances for growth. I would adopt a growth of 3% linear in this instance from base 2021 traffic survey. Base inputs parameters from traffic survey coded incorrectly. WSP has not included the “U” turn demand in their assessment as indicated in the 2021 traffic surveys.

- SWH/Eleventh Avenue - Base inputs parameters from traffic survey coded incorrectly.
- SWH/Thomas Road - Base inputs parameters from traffic survey coded incorrectly.
- SWH/Larsen Road - Base inputs parameters from traffic survey coded incorrectly.

All other intersection have computed correctly.

If you require clarification with the above advise, please do not hesitate to contact me on 93234917. Please note that I do not work on Fridays.

Best wishes

David Van Den Dries
Urban Road Planning Manager
Planning and Technical Services Directorate
p: +61 Telephone (08) 93234917 | **m:** +61 438969981
w: www.mainroads.wa.gov.au

-LAEmHhHzdJzBlTWfa4Hgs7pbKl

Fowler, Mark

From: Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>
Sent: Thursday, 23 December 2021 8:27 AM
To: Fowler, Mark; VAN DEN DRIES David (URPM); Jan, Mohammad
Cc: BROADHURST Lindsay (DRPD); FOURIE Paul (NPDM); Selby, Tim; Ling, Bruce
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi Mark,

Thanks for letting us know about the potential imbalance at the intersection.
This is noted from our side. Please proceed to satisfy David's requirements.

Regards,
Eddie

Eddie Mesina
Principal Civil Engineer | PTA Project Delivery
Public Transport Authority of Western Australia
Public Transport Centre, West Parade, Perth, 6000
PO Box 8125, Perth Business Centre, WA, 6849
Tel: (08) 9326 5493 Fax: (08) 9326 2000
Email: eddie.mesina@pta.wa.gov.au | Web: www.pta.wa.gov.au

From: Fowler, Mark <Mark.Fowler@wsp.com>
Sent: Thursday, 23 December 2021 8:09 AM
To: VAN DEN DRIES David (URPM) <david.vandendries@mainroads.wa.gov.au>; Jan, Mohammad <Mohammad.Jan@pta.wa.gov.au>; Mesina, Eddie <Eddie.Mesina@pta.wa.gov.au>
Cc: BROADHURST Lindsay (DRPD) <lindsay.broadhurst@mainroads.wa.gov.au>; FOURIE Paul (NPDM) <paul.fourie@mainroads.wa.gov.au>; Selby, Tim <tim.selby@wsp.com>; Ling, Bruce <Bruce.Ling@wsp.com>
Subject: RE: Byford Rail Extension forecast traffic volumes

Hi all

Sorry, just to clarify a couple of things

@Mohammad Jan @Eddie Mesina the question in red text below was for you both, and needs an urgent answer within the next hour before I speak to David.

There are 18 intersections approved, so on the 10th January we can start the future year modelling on these 18.

Thanks

Appendix B

URP Traffic Volume Forecasts

B1 2026 volume forecasts

Intersection	Approach	Turn	2026 volumes (veh)	
			AM Peak	PM Peak
Armadale Road/ Abbey Road/ Railway Road	North	L	379	406
		T	251	319
		R	36	55
	South	L	57	118
		T	299	302
		R	106	143
	East	L	66	80
		T	561	765
		R	235	335
	West	L	40	53
		T	726	654
		R	109	103
Armadale Road/ Streich Avenue	North	L	161	232
		R	38	41
	East	T	808	1131
		R	71	128
	West	L	193	181
		T	1039	1044
Armadale Road/ Orchard Avenue	South	L	138	311
		R	25	43
	East	L	125	82
		T	700	865
	West	T	738	839
		R	395	337
Armadale Road/ Church Avenue	South	L	107	255
		R	68	113
	East	L	30	31
		T	786	734

Intersection	Approach	Turn	2026 volumes (veh)	
			AM Peak	PM Peak
	West	T	567	673
		R	194	171
Armadale Level Crossing	East	T	862	1198
	West	T	1232	1225
Church Avenue/ Green Avenue/ Wungong Road	North	L	95	69
		T	65	113
		R	7	19
	South	L	1	5
		T	107	104
		R	138	106
	East	L	63	130
		T	147	219
		R	113	98
	West	L	26	11
		T	274	204
		R	6	17
Church Avenue Level Crossing	East	T	325	448
	West	T	482	361
Church Avenue/ Hobbs Drive/ Commerce Avenue	North	L	8	14
		T	16	20
		R	56	135
	South	L	151	132
		T	55	35
		R	25	32
	East	L	26	29
		T	150	208
		R	4	1
	West	L	117	103
		T	206	210
		R	158	93

Intersection	Approach	Turn	2026 volumes (veh)	
			AM Peak	PM Peak
Church Avenue/ William Street	North	L	66	193
		T	88	181
		R	18	6
	South	L	24	9
		T	112	139
		R	107	111
	East	L	111	55
		T	121	64
		R	84	72
	West	L	11	21
		T	73	204
		R	14	30
Forrest Road/ Aragon Court	North	L	4	11
		R	0	0
	East	T	402	454
		R	0	0
	West	L	6	11
		T	353	387
Forrest Road Level Crossing	East	T	402	454
	West	T	357	398
Forrest Road/ Neerigen Court	North	L	301	284
		R	0	0
	East	T	382	447
		R	97	106
	West	L	60	81
		T	298	312
SWH/ Eleventh Road	North	T	569	1049
		R	23	45
	South	L	112	115
		T	1058	705

Intersection	Approach	Turn	2026 volumes (veh)	
			AM Peak	PM Peak
	West	L	30	37
		R	102	123
SWH/ William Street/ Bedfordale Road	North	L	32	33
		T	418	633
		R	33	35
	South	L	177	128
		T	810	677
		R	23	15
	East	L	11	17
		T	53	34
		R	44	18
	West	L	63	54
		T	43	90
		R	131	290
SWH/ Dickens Place	North	T	546	988
		R	45	57
	South	L	15	23
		T	1043	688
	West	L	55	88
		R	9	25
SWH/ Stone Street	North	T	567	1025
		R	21	15
	South	L	39	35
		T	1007	675
	West	L	33	33
		R	33	119

B2 2036 volume forecasts

Intersection	Approach	Turn	2036 volumes (veh)	
			AM Peak	PM Peak
Armadale Road/ Abbey Road/ Railway Road	North	L	501	536
		T	332	422
		R	47	73
	South	L	76	156
		T	395	400
		R	141	189
	East	L	75	91
		T	642	876
		R	269	384
	West	L	41	54
		T	745	672
		R	112	105
Armadale Road/ Streich Avenue	North	L	285	410
		R	67	72
	East	T	1,008	1,411
		R	89	159
	West	L	219	205
		T	1,175	1,181
Armadale Road/ Orchard Avenue	South	L	156	352
		R	28	48
	East	L	156	102
		T	870	1,075
	West	T	926	1,053
		R	496	423
Armadale Road/ Church Avenue	South	L	143	342
		R	91	152
	East	L	38	40

Intersection	Approach	Turn	2036 volumes (veh)	
			AM Peak	PM Peak
		T	1,004	938
	West	T	718	853
		R	246	217
Armadale Level Crossing	East	T	990	1,376
	West	T	1,394	1,386
Church Avenue/ Green Avenue/ Wungong Road	North	L	158	115
		T	109	189
		R	12	31
	South	L	1	6
		T	135	131
		R	174	133
	East	L	75	154
		T	175	260
		R	134	117
	West	L	39	17
		T	410	306
		R	8	25
Church Avenue Level Crossing	East	T	385	532
	West	T	580	434
Church Avenue/ Hobbs Drive/ Commerce Avenue	North	L	10	17
		T	20	25
		R	71	170
	South	L	190	167
		T	70	44
		R	32	41
	East	L	34	38
		T	196	273
		R	5	1
	West	L	140	123
		T	247	251

Intersection	Approach	Turn	2036 volumes (veh)	
			AM Peak	PM Peak
		R	189	111
Church Avenue/ William Street	North	L	73	212
		T	97	199
		R	20	6
	South	L	31	12
		T	149	184
		R	141	147
	East	L	217	107
		T	237	125
		R	163	140
	West	L	20	39
		T	135	379
		R	25	56
Forrest Road/ Aragon Court	North	L	6	14
		R	0	0
	East	T	529	597
		R	0	0
	West	L	8	13
		T	446	489
Forrest Road Level Crossing	East	T	529	597
	West	T	452	503
Forrest Road/ Neerigen Court	North	L	380	358
		R	0	0
	East	T	480	561
		R	122	133
	West	L	76	102
		T	376	394
SWH/ Eleventh Road	North	T	817	1,508
		R	33	65
	South	L	170	174

Intersection	Approach	Turn	2036 volumes (veh)	
			AM Peak	PM Peak
		T	1,602	1,068
	West	L	47	58
		R	161	194
SWH/ William Street/ Bedfordale Road	North	L	39	41
		T	524	793
		R	41	44
	South	L	254	184
		T	1,159	969
		R	33	21
	East	L	30	45
		T	143	93
		R	118	48
	West	L	94	81
		T	65	136
		R	197	436
SWH/ Dickens Place	North	T	747	1,353
		R	62	78
	South	L	21	33
		T	1470	970
	West	L	83	134
		R	14	37
SWH/ Stone Street	North	T	779	1,408
		R	29	21
	South	L	55	48
		T	1,413	948
	West	L	63	63
		R	63	230

Appendix C

SIDRA Modelling Results (2026)

C1 Individual sites – Do Nothing

C1.1 SWH/ William St/ Bedfordale Hill Rd

C1.1.1 AM Peak

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
3	L1	177	3.8	186	3.8	*0.664	31.3	LOS C	17.4	143.7	0.85	0.88	0.85	36.7
4	T1	810	9.8	853	9.8	*0.664	25.0	LOS C	17.9	153.1	0.83	0.85	0.83	42.2
5	R2	23	10.0	24	10.0	0.062	20.4	LOS C	0.7	5.3	0.62	0.66	0.62	38.5
Approach		1010	8.8	1063	8.8	0.664	26.0	LOS C	17.9	153.1	0.83	0.85	0.83	41.1
East: Bedfordale Hill Road East														
6	L2	11	0.0	12	0.0	0.338	50.0	LOS D	3.1	22.7	0.97	0.75	0.97	28.5
6a	R1	53	0.0	56	0.0	*0.338	48.3	LOS D	3.1	22.7	0.97	0.75	0.97	25.9
7	R2	44	6.4	46	6.4	0.252	49.9	LOS D	2.1	16.5	0.96	0.74	0.96	27.5
Approach		108	2.6	114	2.6	0.338	49.1	LOS D	3.1	22.7	0.96	0.74	0.96	26.8
North: South Western Highway North														
8	L2	32	13.8	34	13.8	0.289	23.2	LOS C	6.4	54.7	0.65	0.58	0.65	38.9
9	T1	418	10.7	440	10.7	0.289	15.9	LOS B	6.8	58.2	0.63	0.55	0.63	47.3
10	R3	33	0.0	35	0.0	*0.175	25.2	LOS C	1.0	7.0	0.81	0.72	0.81	38.5
Approach		483	10.2	508	10.2	0.289	17.1	LOS B	6.8	58.2	0.65	0.57	0.65	46.1
NorthWest: William Street North-West														
11	L3	63	1.8	66	1.8	0.348	23.6	LOS C	2.7	20.2	0.88	0.76	0.88	39.5
1	L1	43	2.6	45	2.6	0.348	21.5	LOS C	2.7	20.2	0.88	0.76	0.88	34.4
2	R1	131	5.2	138	5.2	*0.626	49.4	LOS D	6.5	50.7	1.00	0.82	1.04	29.5
Approach		237	3.8	249	3.8	0.626	37.5	LOS D	6.5	50.7	0.95	0.80	0.97	32.5
All Vehicles		1838	8.1	1935	8.1	0.664	26.5	LOS C	17.9	153.1	0.80	0.76	0.81	40.1

C1.1.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
3	L1	128	0.9	135	0.9	*0.573	33.1	LOS C	13.8	110.7	0.83	0.86	0.83	36.2
4	T1	677	8.5	713	8.5	*0.573	26.9	LOS C	14.2	117.7	0.81	0.83	0.81	41.3
5	R2	15	7.7	16	7.7	0.059	23.7	LOS C	0.5	3.7	0.71	0.66	0.71	37.2
Approach		820	7.3	863	7.3	0.573	27.8	LOS C	14.2	117.7	0.82	0.83	0.82	40.4
East: Bedfordale Hill Road East														
6	L2	17	11.1	18	11.1	0.770	63.7	LOS E	2.9	23.3	1.00	0.87	1.36	25.0
6a	R1	34	5.4	36	5.4	*0.770	61.7	LOS E	2.9	23.3	1.00	0.87	1.36	22.7
7	R2	18	10.5	19	10.5	0.157	54.3	LOS D	0.9	7.4	0.97	0.70	0.97	26.0
Approach		69	8.1	73	8.1	0.770	60.2	LOS E	2.9	23.3	0.99	0.83	1.26	24.2
North: South Western Highway North														
8	L2	33	0.0	35	0.0	0.454	27.4	LOS C	11.2	92.4	0.75	0.67	0.75	38.7
9	T1	633	8.1	666	8.1	0.454	20.4	LOS C	12.1	100.9	0.74	0.65	0.74	44.8
10	R3	35	9.4	37	9.4	*0.173	27.1	LOS C	1.1	9.1	0.79	0.71	0.79	37.5
Approach		701	7.8	738	7.8	0.454	21.1	LOS C	12.1	100.9	0.74	0.65	0.74	44.1
NorthWest: William Street North-West														
11	L3	54	4.3	57	4.3	0.388	28.9	LOS C	4.1	31.2	0.89	0.80	0.89	36.9
1	L1	90	2.5	95	2.5	0.388	26.7	LOS C	4.1	31.2	0.89	0.80	0.89	32.3
2	R1	290	3.1	305	3.1	*0.830	51.0	LOS D	15.8	120.2	1.00	0.96	1.21	29.1
Approach		434	3.1	457	3.1	0.830	43.2	LOS D	15.8	120.2	0.96	0.91	1.10	30.5
All Vehicles		2024	6.6	2131	6.6	0.830	29.9	LOS C	15.8	120.2	0.83	0.79	0.87	38.4

C1.2 SWH/ Dickens Place

C1.2.1 AM Peak

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	15	7.7	16	7.7	0.621	6.8	LOS A	0.0	0.0	0.00	0.01	0.00	63.2
2	T1	1043	7.0	1098	7.0	0.621	0.3	LOS A	0.0	0.0	0.00	0.01	0.00	69.1
Approach		1058	7.0	1114	7.0	0.621	0.4	NA	0.0	0.0	0.00	0.01	0.00	69.0
North: South Western Highway North														
8	T1	546	7.8	575	7.8	0.557	10.9	LOS B	11.2	92.9	1.00	0.07	1.30	56.2
9	R2	45	22.5	47	22.5	0.557	36.2	LOS E	11.2	92.9	1.00	0.07	1.30	47.0
Approach		591	8.9	622	8.9	0.557	12.9	NA	11.2	92.9	1.00	0.07	1.30	55.4
West: Dickens Place West														
10	L2	55	13.8	58	13.8	0.395	25.4	LOS D	1.4	12.1	0.92	1.03	1.14	35.0
12	R2	9	40.0	9	40.0	0.395	79.6	LOS F	1.4	12.1	0.92	1.03	1.14	31.4
Approach		64	17.5	67	17.5	0.395	33.0	LOS D	1.4	12.1	0.92	1.03	1.14	34.4
All Vehicles		1713	8.1	1803	8.1	0.621	5.9	NA	11.2	92.9	0.38	0.07	0.49	61.5

C1.2.2 PM Peak

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	23	5.0	24	5.0	0.420	6.6	LOS A	0.0	0.0	0.00	0.02	0.00	64.3
2	T1	688	7.3	724	7.3	0.420	0.1	LOS A	0.0	0.0	0.00	0.02	0.00	69.4
Approach		711	7.2	748	7.2	0.420	0.3	NA	0.0	0.0	0.00	0.02	0.00	69.2
North: South Western Highway North														
8	T1	988	4.6	1040	4.6	0.653	2.4	LOS A	3.5	27.6	0.28	0.04	0.45	65.7
9	R2	57	17.7	60	17.7	0.653	21.2	LOS C	3.5	27.6	0.28	0.04	0.45	53.7
Approach		1045	5.3	1100	5.3	0.653	3.4	NA	3.5	27.6	0.28	0.04	0.45	65.0
West: Dickens Place West														
10	L2	88	9.7	93	9.7	0.421	14.0	LOS B	1.7	13.4	0.83	1.02	1.11	40.2
12	R2	25	0.0	26	0.0	0.421	47.0	LOS E	1.7	13.4	0.83	1.02	1.11	42.0
Approach		113	7.6	119	7.6	0.421	21.3	LOS C	1.7	13.4	0.83	1.02	1.11	40.6
All Vehicles		1869	6.2	1967	6.2	0.653	3.3	NA	3.5	27.6	0.20	0.09	0.32	64.1

C1.3 SWH/ Stone Street

C1.3.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	39	11.8	41	11.8	0.028	7.6	LOS A	0.0	0.0	0.00	0.63	0.00	56.0
2	T1	1007	5.9	1060	5.9	0.581	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	69.3
Approach		1046	6.1	1101	6.1	0.581	0.5	NA	0.0	0.0	0.00	0.02	0.00	68.7
North: South Western Highway North														
8	T1	567	8.4	597	8.4	0.342	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
9a	R1	21	27.9	22	27.9	0.185	34.1	LOS D	0.5	5.6	0.90	0.96	0.94	37.6
Approach		588	9.1	619	9.1	0.342	1.3	NA	0.5	5.6	0.03	0.03	0.03	67.7
SouthWest: Stone Street South-West														
30a	L1	33	31.6	35	31.6	1.622	657.9	LOS F	21.6	226.4	1.00	2.51	5.85	4.6
32b	R3	33	15.8	35	15.8	1.622	720.0	LOS F	21.6	226.4	1.00	2.51	5.85	4.6
Approach		66	23.7	69	23.7	1.622	689.0	LOS F	21.6	226.4	1.00	2.51	5.85	4.6
All Vehicles		1700	7.8	1789	7.8	1.622	27.5	NA	21.6	226.4	0.05	0.12	0.24	44.3

C1.3.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	35	16.6	37	16.6	0.027	7.7	LOS A	0.0	0.0	0.00	0.63	0.00	54.8
2	T1	675	6.5	711	6.5	0.392	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
Approach		710	7.0	747	7.0	0.392	0.5	NA	0.0	0.0	0.00	0.03	0.00	68.7
North: South Western Highway North														
8	T1	1025	4.0	1079	4.0	0.584	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	69.3
9a	R1	15	38.5	16	38.5	0.069	18.8	LOS C	0.2	2.7	0.75	0.89	0.75	44.7
Approach		1040	4.5	1095	4.5	0.584	0.5	NA	0.2	2.7	0.01	0.01	0.01	68.8
SouthWest: Stone Street South-West														
30a	L1	33	26.3	35	26.3	4.630	3307.6	LOS F	90.4	796.9	1.00	3.27	8.89	1.1
32b	R3	119	7.2	125	7.2	4.630	3333.4	LOS F	90.4	796.9	1.00	3.27	8.89	1.1
Approach		152	11.3	160	11.3	4.630	3327.8	LOS F	90.4	796.9	1.00	3.27	8.89	1.1
All Vehicles		1902	6.0	2002	6.0	4.630	266.4	NA	90.4	796.9	0.09	0.28	0.72	11.1

C1.4 SWH/ Eleventh Road

C1.4.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	112	10.0	118	10.0	0.073	7.1	LOS A	0.0	0.0	0.00	0.63	0.00	62.0
2	T1	1058	6.6	1114	6.6	0.633	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	79.1
Approach		1170	6.9	1232	6.9	0.633	0.9	NA	0.0	0.0	0.00	0.06	0.00	77.1
North: South Western Highway North														
8	T1	569	9.9	599	9.9	0.347	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.7
9	R2	23	5.3	24	5.3	0.144	25.9	LOS D	0.4	2.9	0.87	0.96	0.87	47.6
Approach		592	9.7	623	9.7	0.347	1.1	NA	0.4	2.9	0.03	0.04	0.03	77.7
West: Eleventh Road West														
10	L2	30	17.4	32	17.4	3.879	2640.6	LOS F	74.6	557.8	1.00	2.39	8.68	1.3
12	R2	102	7.7	107	7.7	3.879	2665.0	LOS F	74.6	557.8	1.00	2.39	8.68	1.3
Approach		132	9.9	139	9.9	3.879	2659.4	LOS F	74.6	557.8	1.00	2.39	8.68	1.3
All Vehicles		1894	8.0	1994	8.0	3.879	186.3	NA	74.6	557.8	0.08	0.22	0.62	15.3

C1.4.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	115	2.2	121	2.2	0.068	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	64.6
2	T1	705	7.6	742	7.6	0.421	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.6
Approach		820	6.8	863	6.8	0.421	1.1	NA	0.0	0.0	0.00	0.09	0.00	77.1
North: South Western Highway North														
8	T1	1049	4.0	1104	4.0	0.599	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	79.2
9	R2	45	8.1	47	8.1	0.125	14.5	LOS B	0.4	2.8	0.70	0.89	0.70	55.3
Approach		1094	4.2	1152	4.2	0.599	0.8	NA	0.4	2.8	0.03	0.04	0.03	77.9
West: Eleventh Road West														
10	L2	37	3.6	39	3.6	5.903	4460.6	LOS F	102.3	730.9	1.00	2.31	8.05	0.8
12	R2	123	2.1	129	2.1	5.903	4485.1	LOS F	102.3	730.9	1.00	2.31	8.05	0.8
Approach		160	2.4	168	2.4	5.903	4479.4	LOS F	102.3	730.9	1.00	2.31	8.05	0.8
All Vehicles		2074	5.1	2183	5.1	5.903	346.4	NA	102.3	730.9	0.09	0.23	0.64	9.1

C1.5 Eleventh Road/ Wungong Road

C1.5.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
SouthEast: Eleventh Road South-East														
5	T1	156	9.7	164	9.7	0.134	0.4	LOS A	0.3	2.8	0.18	0.16	0.18	75.4
6	R2	47	0.0	49	0.0	0.134	8.0	LOS A	0.3	2.8	0.18	0.16	0.18	63.3
Approach		203	7.5	214	7.5	0.134	2.2	NA	0.3	2.8	0.18	0.16	0.18	71.9
NorthEast: Wungong Road North-East														
7	L2	46	7.7	48	7.7	0.028	6.1	LOS A	0.1	1.0	0.29	0.54	0.29	54.9
9	R2	91	14.3	96	14.3	0.105	6.9	LOS A	0.3	2.1	0.31	0.67	0.31	51.3
Approach		137	12.1	144	12.1	0.105	6.6	LOS A	0.3	2.1	0.30	0.63	0.30	52.5
NorthWest: Eleventh Road North-West														
10	L2	191	10.5	201	10.5	0.168	7.2	LOS A	0.0	0.0	0.00	0.44	0.00	61.5
11	T1	89	8.1	94	8.1	0.168	0.0	LOS A	0.0	0.0	0.00	0.44	0.00	71.7
Approach		280	9.7	295	9.7	0.168	4.9	NA	0.0	0.0	0.00	0.44	0.00	64.4
All Vehicles		620	9.5	653	9.5	0.168	4.4	NA	0.3	2.8	0.13	0.39	0.13	63.4

C1.5.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
SouthEast: Eleventh Road South-East														
5	T1	169	4.0	178	4.0	0.151	0.6	LOS A	0.5	3.6	0.21	0.17	0.21	75.2
6	R2	57	8.8	60	8.8	0.151	8.4	LOS A	0.5	3.6	0.21	0.17	0.21	59.5
Approach		226	5.2	238	5.2	0.151	2.5	NA	0.5	3.6	0.21	0.17	0.21	70.1
NorthEast: Wungong Road North-East														
7	L2	55	0.0	58	0.0	0.033	6.1	LOS A	0.2	1.1	0.31	0.55	0.31	57.6
9	R2	215	7.2	226	7.2	0.249	7.1	LOS A	0.7	5.3	0.36	0.72	0.36	53.1
Approach		270	5.7	284	5.7	0.249	6.9	LOS A	0.7	5.3	0.35	0.69	0.35	54.0
NorthWest: Eleventh Road North-West														
10	L2	148	11.6	156	11.6	0.175	7.2	LOS A	0.0	0.0	0.00	0.33	0.00	62.4
11	T1	142	7.1	149	7.1	0.175	0.0	LOS A	0.0	0.0	0.00	0.33	0.00	73.7
Approach		290	9.4	305	9.4	0.175	3.7	NA	0.0	0.0	0.00	0.33	0.00	67.5
All Vehicles		786	6.9	827	6.9	0.249	4.5	NA	0.7	5.3	0.18	0.41	0.18	62.8

C2 Individual sites – Do Something

C2.1 SWH/ Dickens Place

C2.1.1 AM Peak – Priority Controlled – two staged – with SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.97					
Travel Time Index	9.67					
Congestion Coefficient	1.03					
Travel Speed (Average)	67.2	km/h			67.2	km/h
Travel Distance (Total)	1827.1	veh-km/h			2192.6	pers-km/h
Travel Time (Total)	27.2	veh-h/h			32.6	pers-h/h
Desired Speed (Program)	69.3	km/h				
Demand Flows (Total for all Sites)	1860	veh/h			2232	pers/h
Arrival Flows (Total for all Sites)	1860	veh/h			2232	pers/h
Demand Flows (Entry Total)	1803	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	8.6	%				
Percent Heavy Vehicles (Arrival)	8.6	%				
Degree of Saturation	0.306					
Control Delay (Total)	0.58	veh-h/h			0.69	pers-h/h
Control Delay (Average)	1.1	sec			1.1	sec
Control Delay (Worst Lane)	17.0	sec				
Control Delay (Worst Movement)	17.0	sec			17.0	sec
Geometric Delay (Average)	0.4	sec				
Stop-Line Delay (Average)	0.7	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.14					
Total Effective Stops	147	veh/h			176	pers/h
Effective Stop Rate	0.08		0.08	per km	0.08	
Proportion Queued	0.05				0.05	
Performance Index	29.0				29.0	
Cost (Total)	1322.91	$/h	0.72	$/km	1322.91	$/h
Fuel Consumption (Total)	187.8	L/h	102.8	mL/km		
Fuel Economy	10.3	L/100km				
Carbon Dioxide (Total)	454.7	kg/h	248.9	g/km		
Hydrocarbons (Total)	0.031	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.551	kg/h	0.302	g/km		
NOx (Total)	1.763	kg/h	0.965	g/km		

C2.1.2 PM Peak – Priority Controlled – two staged – with SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.97					
Travel Time Index	9.69					
Congestion Coefficient	1.03					
Travel Speed (Average)	67.0	km/h			67.0	km/h
Travel Distance (Total)	1991.9	veh-km/h			2390.3	pers-km/h
Travel Time (Total)	29.7	veh-h/h			35.7	pers-h/h
Desired Speed (Program)	68.9	km/h				
Demand Flows (Total for all Sites)	2054	veh/h			2464	pers/h
Arrival Flows (Total for all Sites)	2054	veh/h			2464	pers/h
Demand Flows (Entry Total)	1967	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	6.4	%				
Percent Heavy Vehicles (Arrival)	6.4	%				
Degree of Saturation	0.283					
Control Delay (Total)	0.62	veh-h/h			0.75	pers-h/h
Control Delay (Average)	1.1	sec			1.1	sec
Control Delay (Worst Lane)	10.3	sec				
Control Delay (Worst Movement)	10.3	sec			10.3	sec
Geometric Delay (Average)	0.6	sec				
Stop-Line Delay (Average)	0.5	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.11					
Total Effective Stops	210	veh/h			252	pers/h
Effective Stop Rate	0.10		0.11	per km	0.10	
Proportion Queued	0.06				0.06	
Performance Index	32.2				32.2	
Cost (Total)	1400.32	$/h	0.70	$/km	1400.32	$/h
Fuel Consumption (Total)	184.7	L/h	92.7	mL/km		
Fuel Economy	9.3	L/100km				
Carbon Dioxide (Total)	444.8	kg/h	223.3	g/km		
Hydrocarbons (Total)	0.032	kg/h	0.016	g/km		
Carbon Monoxide (Total)	0.580	kg/h	0.291	g/km		
NOx (Total)	1.470	kg/h	0.738	g/km		

C2.1.3 AM Peak – Priority Controlled – two staged – without SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.97					
Travel Time Index	9.62					
Congestion Coefficient	1.03					
Travel Speed (Average)	66.9	km/h			66.9	km/h
Travel Distance (Total)	1826.9	veh-km/h			2192.3	pers-km/h
Travel Time (Total)	27.3	veh-h/h			32.8	pers-h/h
Desired Speed (Program)	69.3	km/h				
Demand Flows (Total for all Sites)	1860	veh/h			2232	pers/h
Arrival Flows (Total for all Sites)	1860	veh/h			2232	pers/h
Demand Flows (Entry Total)	1803	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	8.6	%				
Percent Heavy Vehicles (Arrival)	8.6	%				
Degree of Saturation	0.612					
Control Delay (Total)	0.62	veh-h/h			0.75	pers-h/h
Control Delay (Average)	1.2	sec			1.2	sec
Control Delay (Worst Lane)	19.2	sec				
Control Delay (Worst Movement)	19.2	sec			19.2	sec
Geometric Delay (Average)	0.4	sec				
Stop-Line Delay (Average)	0.8	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.08					
Total Effective Stops	145	veh/h			174	pers/h
Effective Stop Rate	0.08		0.08	per km	0.08	
Proportion Queued	0.05				0.05	
Performance Index	28.8				28.8	
Cost (Total)	1326.70	$/h	0.73	$/km	1326.70	$/h
Fuel Consumption (Total)	187.7	L/h	102.8	mL/km		
Fuel Economy	10.3	L/100km				
Carbon Dioxide (Total)	454.7	kg/h	248.9	g/km		
Hydrocarbons (Total)	0.031	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.545	kg/h	0.298	g/km		
NOx (Total)	1.766	kg/h	0.967	g/km		

C2.1.4 PM Peak – Priority Controlled – two staged – without SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.97					
Travel Time Index	9.67					
Congestion Coefficient	1.03					
Travel Speed (Average)	66.9	km/h			66.9	km/h
Travel Distance (Total)	1991.6	veh-km/h			2389.9	pers-km/h
Travel Time (Total)	29.8	veh-h/h			35.7	pers-h/h
Desired Speed (Program)	68.9	km/h				
Demand Flows (Total for all Sites)	2054	veh/h			2464	pers/h
Arrival Flows (Total for all Sites)	2054	veh/h			2464	pers/h
Demand Flows (Entry Total)	1967	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	6.4	%				
Percent Heavy Vehicles (Arrival)	6.4	%				
Degree of Saturation	0.567					
Control Delay (Total)	0.61	veh-h/h			0.73	pers-h/h
Control Delay (Average)	1.1	sec			1.1	sec
Control Delay (Worst Lane)	9.6	sec				
Control Delay (Worst Movement)	9.6	sec			9.6	sec
Geometric Delay (Average)	0.6	sec				
Stop-Line Delay (Average)	0.5	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.06					
Total Effective Stops	202	veh/h			242	pers/h
Effective Stop Rate	0.10		0.10	per km	0.10	
Proportion Queued	0.06				0.06	
Performance Index	31.8				31.8	
Cost (Total)	1401.87	$/h	0.70	$/km	1401.87	$/h
Fuel Consumption (Total)	184.7	L/h	92.7	mL/km		
Fuel Economy	9.3	L/100km				
Carbon Dioxide (Total)	444.6	kg/h	223.2	g/km		
Hydrocarbons (Total)	0.032	kg/h	0.016	g/km		
Carbon Monoxide (Total)	0.574	kg/h	0.288	g/km		
NOx (Total)	1.473	kg/h	0.739	g/km		

C2.2 SWH/ Stone Street

C2.2.1 AM Peak – Priority Controlled – two staged – with SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.97					
Travel Time Index	9.68					
Congestion Coefficient	1.03					
Travel Speed (Average)	67.1	km/h			67.1	km/h
Travel Distance (Total)	1811.1	veh-km/h			2173.4	pers-km/h
Travel Time (Total)	27.0	veh-h/h			32.4	pers-h/h
Desired Speed (Program)	69.0	km/h				
Demand Flows (Total for all Sites)	1846	veh/h			2216	pers/h
Arrival Flows (Total for all Sites)	1846	veh/h			2216	pers/h
Demand Flows (Entry Total)	1789	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	8.2	%				
Percent Heavy Vehicles (Arrival)	8.2	%				
Degree of Saturation	0.291					
Control Delay (Total)	0.59	veh-h/h			0.70	pers-h/h
Control Delay (Average)	1.1	sec			1.1	sec
Control Delay (Worst Lane)	23.4	sec				
Control Delay (Worst Movement)	23.4	sec			23.4	sec
Geometric Delay (Average)	0.5	sec				
Stop-Line Delay (Average)	0.7	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.09					
Total Effective Stops	142	veh/h			171	pers/h
Effective Stop Rate	0.08		0.08	per km	0.08	
Proportion Queued	0.05				0.05	
Performance Index	29.3				29.3	
Cost (Total)	1365.03	$/h	0.75	$/km	1365.03	$/h
Fuel Consumption (Total)	209.2	L/h	115.5	mL/km		
Fuel Economy	11.5	L/100km				
Carbon Dioxide (Total)	503.4	kg/h	277.9	g/km		
Hydrocarbons (Total)	0.033	kg/h	0.018	g/km		
Carbon Monoxide (Total)	0.571	kg/h	0.315	g/km		
NOx (Total)	2.230	kg/h	1.231	g/km		

C2.2.2 PM Peak – Priority Controlled – two staged – with SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.96					
Travel Time Index	9.61					
Congestion Coefficient	1.04					
Travel Speed (Average)	66.3	km/h			66.3	km/h
Travel Distance (Total)	2027.0	veh-km/h			2432.4	pers-km/h
Travel Time (Total)	30.6	veh-h/h			36.7	pers-h/h
Desired Speed (Program)	68.7	km/h				
Demand Flows (Total for all Sites)	2143	veh/h			2572	pers/h
Arrival Flows (Total for all Sites)	2143	veh/h			2572	pers/h
Demand Flows (Entry Total)	2002	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	6.3	%				
Percent Heavy Vehicles (Arrival)	6.3	%				
Degree of Saturation	0.290					
Control Delay (Total)	0.75	veh-h/h			0.90	pers-h/h
Control Delay (Average)	1.3	sec			1.3	sec
Control Delay (Worst Lane)	12.8	sec				
Control Delay (Worst Movement)	12.8	sec			12.8	sec
Geometric Delay (Average)	0.6	sec				
Stop-Line Delay (Average)	0.6	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.19					
Total Effective Stops	273	veh/h			328	pers/h
Effective Stop Rate	0.13		0.13	per km	0.13	
Proportion Queued	0.09				0.09	
Performance Index	33.3				33.3	
Cost (Total)	1490.59	$/h	0.74	$/km	1490.59	$/h
Fuel Consumption (Total)	212.3	L/h	104.7	mL/km		
Fuel Economy	10.5	L/100km				
Carbon Dioxide (Total)	508.5	kg/h	250.8	g/km		
Hydrocarbons (Total)	0.035	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.617	kg/h	0.304	g/km		
NOx (Total)	1.994	kg/h	0.984	g/km		

C2.2.3 AM Peak – Priority Controlled – two staged – without SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.97					
Travel Time Index	9.62					
Congestion Coefficient	1.04					
Travel Speed (Average)	66.7	km/h			66.7	km/h
Travel Distance (Total)	1811.0	veh-km/h			2173.2	pers-km/h
Travel Time (Total)	27.1	veh-h/h			32.6	pers-h/h
Desired Speed (Program)	69.0	km/h				
Demand Flows (Total for all Sites)	1846	veh/h			2216	pers/h
Arrival Flows (Total for all Sites)	1846	veh/h			2216	pers/h
Demand Flows (Entry Total)	1789	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	8.2	%				
Percent Heavy Vehicles (Arrival)	8.2	%				
Degree of Saturation	0.581					
Control Delay (Total)	0.66	veh-h/h			0.79	pers-h/h
Control Delay (Average)	1.3	sec			1.3	sec
Control Delay (Worst Lane)	27.0	sec				
Control Delay (Worst Movement)	27.0	sec			27.0	sec
Geometric Delay (Average)	0.5	sec				
Stop-Line Delay (Average)	0.8	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.12					
Total Effective Stops	140	veh/h			168	pers/h
Effective Stop Rate	0.08		0.08	per km	0.08	
Proportion Queued	0.04				0.04	
Performance Index	29.3				29.3	
Cost (Total)	1369.66	$/h	0.76	$/km	1369.66	$/h
Fuel Consumption (Total)	209.1	L/h	115.5	mL/km		
Fuel Economy	11.5	L/100km				
Carbon Dioxide (Total)	503.3	kg/h	277.9	g/km		
Hydrocarbons (Total)	0.033	kg/h	0.018	g/km		
Carbon Monoxide (Total)	0.567	kg/h	0.313	g/km		
NOx (Total)	2.231	kg/h	1.232	g/km		

C2.2.4 PM Peak – Priority Controlled – two staged – without SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.96					
Travel Time Index	9.60					
Congestion Coefficient	1.04					
Travel Speed (Average)	66.2	km/h			66.2	km/h
Travel Distance (Total)	2026.6	veh-km/h			2432.0	pers-km/h
Travel Time (Total)	30.6	veh-h/h			36.7	pers-h/h
Desired Speed (Program)	68.7	km/h				
Demand Flows (Total for all Sites)	2143	veh/h			2572	pers/h
Arrival Flows (Total for all Sites)	2143	veh/h			2572	pers/h
Demand Flows (Entry Total)	2002	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	6.3	%				
Percent Heavy Vehicles (Arrival)	6.3	%				
Degree of Saturation	0.581					
Control Delay (Total)	0.68	veh-h/h			0.81	pers-h/h
Control Delay (Average)	1.1	sec			1.1	sec
Control Delay (Worst Lane)	12.4	sec				
Control Delay (Worst Movement)	12.4	sec			12.4	sec
Geometric Delay (Average)	0.7	sec				
Stop-Line Delay (Average)	0.5	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.09					
Total Effective Stops	252	veh/h			303	pers/h
Effective Stop Rate	0.12		0.12	per km	0.12	
Proportion Queued	0.07				0.07	
Performance Index	32.5				32.5	
Cost (Total)	1490.29	$/h	0.74	$/km	1490.29	$/h
Fuel Consumption (Total)	211.9	L/h	104.6	mL/km		
Fuel Economy	10.5	L/100km				
Carbon Dioxide (Total)	507.7	kg/h	250.5	g/km		
Hydrocarbons (Total)	0.035	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.611	kg/h	0.301	g/km		
NOx (Total)	1.993	kg/h	0.983	g/km		

C2.3 SWH/ Eleventh Road

C2.3.1 AM Peak – Priority Controlled – two staged – with SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.94					
Travel Time Index	9.35					
Congestion Coefficient	1.06					
Travel Speed (Average)	74.5	km/h			74.5	km/h
Travel Distance (Total)	2022.1	veh-km/h			2426.5	pers-km/h
Travel Time (Total)	27.1	veh-h/h			32.6	pers-h/h
Desired Speed (Program)	79.1	km/h				
Demand Flows (Total for all Sites)	2125	veh/h			2550	pers/h
Arrival Flows (Total for all Sites)	2125	veh/h			2550	pers/h
Demand Flows (Entry Total)	1994	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	8.0	%				
Percent Heavy Vehicles (Arrival)	8.0	%				
Degree of Saturation	0.317					
Control Delay (Total)	1.07	veh-h/h			1.29	pers-h/h
Control Delay (Average)	1.8	sec			1.8	sec
Control Delay (Worst Lane)	20.7	sec				
Control Delay (Worst Movement)	20.7	sec			20.7	sec
Geometric Delay (Average)	0.9	sec				
Stop-Line Delay (Average)	0.9	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.15					
Total Effective Stops	311	veh/h			374	pers/h
Effective Stop Rate	0.15		0.15	per km	0.15	
Proportion Queued	0.09				0.09	
Performance Index	30.5				30.5	
Cost (Total)	1577.31	$/h	0.78	$/km	1577.31	$/h
Fuel Consumption (Total)	301.5	L/h	149.1	mL/km		
Fuel Economy	14.9	L/100km				
Carbon Dioxide (Total)	731.4	kg/h	361.7	g/km		
Hydrocarbons (Total)	0.050	kg/h	0.025	g/km		
Carbon Monoxide (Total)	0.901	kg/h	0.446	g/km		
NOx (Total)	3.647	kg/h	1.803	g/km		

C2.3.2 PM Peak – Priority Controlled – two staged – with SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.95					
Travel Time Index	9.44					
Congestion Coefficient	1.05					
Travel Speed (Average)	74.9	km/h			74.9	km/h
Travel Distance (Total)	2213.2	veh-km/h			2655.8	pers-km/h
Travel Time (Total)	29.5	veh-h/h			35.5	pers-h/h
Desired Speed (Program)	78.9	km/h				
Demand Flows (Total for all Sites)	2360	veh/h			2832	pers/h
Arrival Flows (Total for all Sites)	2360	veh/h			2832	pers/h
Demand Flows (Entry Total)	2183	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	5.0	%				
Percent Heavy Vehicles (Arrival)	5.0	%				
Degree of Saturation	0.296					
Control Delay (Total)	1.11	veh-h/h			1.33	pers-h/h
Control Delay (Average)	1.7	sec			1.7	sec
Control Delay (Worst Lane)	12.3	sec				
Control Delay (Worst Movement)	12.3	sec			12.3	sec
Geometric Delay (Average)	1.0	sec				
Stop-Line Delay (Average)	0.7	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.28					
Total Effective Stops	390	veh/h			469	pers/h
Effective Stop Rate	0.17		0.18	per km	0.17	
Proportion Queued	0.10				0.10	
Performance Index	32.9				32.9	
Cost (Total)	1485.00	$/h	0.67	$/km	1485.00	$/h
Fuel Consumption (Total)	225.1	L/h	101.7	mL/km		
Fuel Economy	10.2	L/100km				
Carbon Dioxide (Total)	543.8	kg/h	245.7	g/km		
Hydrocarbons (Total)	0.041	kg/h	0.019	g/km		
Carbon Monoxide (Total)	0.839	kg/h	0.379	g/km		
NOx (Total)	2.209	kg/h	0.998	g/km		

C2.3.3 AM Peak – Priority Controlled – two staged – without SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.94					
Travel Time Index	9.39					
Congestion Coefficient	1.06					
Travel Speed (Average)	74.8	km/h			74.8	km/h
Travel Distance (Total)	2021.6	veh-km/h			2426.0	pers-km/h
Travel Time (Total)	27.0	veh-h/h			32.4	pers-h/h
Desired Speed (Program)	79.1	km/h				
Demand Flows (Total for all Sites)	2125	veh/h			2550	pers/h
Arrival Flows (Total for all Sites)	2125	veh/h			2550	pers/h
Demand Flows (Entry Total)	1994	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	8.0	%				
Percent Heavy Vehicles (Arrival)	8.0	%				
Degree of Saturation	0.633					
Control Delay (Total)	0.91	veh-h/h			1.09	pers-h/h
Control Delay (Average)	1.5	sec			1.5	sec
Control Delay (Worst Lane)	22.2	sec				
Control Delay (Worst Movement)	22.2	sec			22.2	sec
Geometric Delay (Average)	0.9	sec				
Stop-Line Delay (Average)	0.6	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.08					
Total Effective Stops	297	veh/h			356	pers/h
Effective Stop Rate	0.14		0.15	per km	0.14	
Proportion Queued	0.07				0.07	
Performance Index	29.3				29.3	
Cost (Total)	1572.91	$/h	0.78	$/km	1572.91	$/h
Fuel Consumption (Total)	301.0	L/h	148.9	mL/km		
Fuel Economy	14.9	L/100km				
Carbon Dioxide (Total)	730.3	kg/h	361.3	g/km		
Hydrocarbons (Total)	0.050	kg/h	0.025	g/km		
Carbon Monoxide (Total)	0.893	kg/h	0.441	g/km		
NOx (Total)	3.648	kg/h	1.804	g/km		

C2.3.4 PM Peak – Priority Controlled – two staged – without SWH duplication

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.95					
Travel Time Index	9.47					
Congestion Coefficient	1.05					
Travel Speed (Average)	75.2	km/h			75.2	km/h
Travel Distance (Total)	2212.6	veh-km/h			2655.1	pers-km/h
Travel Time (Total)	29.4	veh-h/h			35.3	pers-h/h
Desired Speed (Program)	78.9	km/h				
Demand Flows (Total for all Sites)	2360	veh/h			2832	pers/h
Arrival Flows (Total for all Sites)	2360	veh/h			2832	pers/h
Demand Flows (Entry Total)	2183	veh/h				
Midblock Inflows (Total)	0	veh/h				
Midblock Outflows (Total)	0	veh/h				
Percent Heavy Vehicles (Demand)	5.0	%				
Percent Heavy Vehicles (Arrival)	5.0	%				
Degree of Saturation	0.593					
Control Delay (Total)	0.94	veh-h/h			1.13	pers-h/h
Control Delay (Average)	1.4	sec			1.4	sec
Control Delay (Worst Lane)	11.7	sec				
Control Delay (Worst Movement)	11.7	sec			11.7	sec
Geometric Delay (Average)	1.0	sec				
Stop-Line Delay (Average)	0.5	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.15					
Total Effective Stops	365	veh/h			438	pers/h
Effective Stop Rate	0.15		0.16	per km	0.15	
Proportion Queued	0.08				0.08	
Performance Index	31.9				31.9	
Cost (Total)	1480.70	$/h	0.67	$/km	1480.70	$/h
Fuel Consumption (Total)	224.7	L/h	101.6	mL/km		
Fuel Economy	10.2	L/100km				
Carbon Dioxide (Total)	542.8	kg/h	245.3	g/km		
Hydrocarbons (Total)	0.041	kg/h	0.019	g/km		
Carbon Monoxide (Total)	0.831	kg/h	0.375	g/km		
NOx (Total)	2.209	kg/h	0.998	g/km		

C3 Armadale Road Network

C3.1 Do Nothing (LX at grade)

C3.1.1 AM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.52							
Travel Time Index	4.71							
Congestion Coefficient	1.91							
Travel Speed (Average)	32.8	km/h			1.3	km/h	31.8	km/h
Travel Distance (Total)	3896.0	veh-km/h			5.9	ped-km/h	4681.1	pers-km/h
Travel Time (Total)	118.9	veh-h/h			4.5	ped-h/h	147.2	pers-h/h
Desired Speed (Program)	62.5	km/h						
Demand Flows (Total for all Sites)	12119	veh/h			69	ped/h	14612	pers/h
Arrival Flows (Total for all Sites)	12119	veh/h			69	ped/h	14612	pers/h
Demand Flows (Entry Total)	3533	veh/h						
Midblock Inflows (Total)	109	veh/h						
Midblock Outflows (Total)	-171	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	1.106							
Control Delay (Total)	56.45	veh-h/h			3.10	ped-h/h	70.84	pers-h/h
Control Delay (Average)	16.8	sec			160.6	sec	17.5	sec
Control Delay (Worst Lane)	135.5	sec						
Control Delay (Worst Movement)	135.5	sec			197.4	sec	197.4	sec
Geometric Delay (Average)	1.4	sec						
Stop-Line Delay (Average)	15.4	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	5506	veh/h			68	ped/h	6676	pers/h
Effective Stop Rate	0.45		1.41	per km	0.99		0.46	
Proportion Queued	0.37				0.99		0.38	
Performance Index	446.9				4.8		451.8	
Cost (Total)	5516.27	$/h	1.42	$/km	123.27	$/h	5639.54	$/h
Fuel Consumption (Total)	701.2	L/h	180.0	mL/km				
Fuel Economy	18.0	L/100km						
Carbon Dioxide (Total)	1668.4	kg/h	428.2	g/km				
Hydrocarbons (Total)	0.134	kg/h	0.034	g/km				
Carbon Monoxide (Total)	1.627	kg/h	0.418	g/km				
NOx (Total)	6.294	kg/h	1.616	g/km				

C3.1.2 PM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS E							
Speed Efficiency	0.42							
Travel Time Index	3.57							
Congestion Coefficient	2.37							
Travel Speed (Average)	26.2	km/h			1.3	km/h	25.6	km/h
Travel Distance (Total)	4487.6	veh-km/h			5.9	ped-km/h	5391.0	pers-km/h
Travel Time (Total)	171.5	veh-h/h			4.5	ped-h/h	210.3	pers-h/h
Desired Speed (Program)	62.1	km/h						
Demand Flows (Total for all Sites)	14126	veh/h			69	ped/h	17021	pers/h
Arrival Flows (Total for all Sites)	13948	veh/h			69	ped/h	16806	pers/h
Demand Flows (Entry Total)	4119	veh/h						
Midblock Inflows (Total)	148	veh/h						
Midblock Outflows (Total)	-219	veh/h						
Percent Heavy Vehicles (Demand)	5.5	%						
Percent Heavy Vehicles (Arrival)	5.6	%						
Degree of Saturation	1.265							
Control Delay (Total)	98.59	veh-h/h			3.12	ped-h/h	121.43	pers-h/h
Control Delay (Average)	25.4	sec			161.7	sec	26.0	sec
Control Delay (Worst Lane)	378.5	sec						
Control Delay (Worst Movement)	378.5	sec			197.4	sec	378.5	sec
Geometric Delay (Average)	1.4	sec						
Stop-Line Delay (Average)	24.0	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	7825	veh/h			69	ped/h	9459	pers/h
Effective Stop Rate	0.56		1.74	per km	0.99		0.56	
Proportion Queued	0.40				0.99		0.41	
Performance Index	637.0				4.9		641.9	
Cost (Total)	7597.69	$/h	1.69	$/km	123.85	$/h	7721.53	$/h
Fuel Consumption (Total)	851.8	L/h	189.8	mL/km				
Fuel Economy	19.0	L/100km						
Carbon Dioxide (Total)	2022.6	kg/h	450.7	g/km				
Hydrocarbons (Total)	0.167	kg/h	0.037	g/km				
Carbon Monoxide (Total)	1.938	kg/h	0.432	g/km				
NOx (Total)	7.013	kg/h	1.563	g/km				

C3.2 Do Nothing (Grade separated)

C3.2.1 AM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.56							
Travel Time Index	5.10							
Congestion Coefficient	1.79							
Travel Speed (Average)	35.0	km/h			3.5	km/h	34.7	km/h
Travel Distance (Total)	3927.0	veh-km/h			3.8	ped-km/h	4716.2	pers-km/h
Travel Time (Total)	112.3	veh-h/h			1.1	ped-h/h	135.8	pers-h/h
Desired Speed (Program)	62.5	km/h						
Demand Flows (Total for all Sites)	9915	veh/h			17	ped/h	11915	pers/h
Arrival Flows (Total for all Sites)	9915	veh/h			17	ped/h	11915	pers/h
Demand Flows (Entry Total)	3533	veh/h						
Midblock Inflows (Total)	103	veh/h						
Midblock Outflows (Total)	-165	veh/h						
Percent Heavy Vehicles (Demand)	6.4	%						
Percent Heavy Vehicles (Arrival)	6.4	%						
Degree of Saturation	1.106							
Control Delay (Total)	49.39	veh-h/h			0.21	ped-h/h	59.48	pers-h/h
Control Delay (Average)	17.9	sec			45.4	sec	18.0	sec
Control Delay (Worst Lane)	135.5	sec						
Control Delay (Worst Movement)	135.5	sec			45.6	sec	135.5	sec
Geometric Delay (Average)	1.7	sec						
Stop-Line Delay (Average)	16.2	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.52							
Total Effective Stops	4875	veh/h			16	ped/h	5866	pers/h
Effective Stop Rate	0.49		1.24	per km	0.96		0.49	
Proportion Queued	0.39				0.96		0.39	
Performance Index	326.8				1.2		328.0	
Cost (Total)	5155.58	$/h	1.31	$/km	30.15	$/h	5185.73	$/h
Fuel Consumption (Total)	638.4	L/h	162.6	mL/km				
Fuel Economy	16.3	L/100km						
Carbon Dioxide (Total)	1519.5	kg/h	386.9	g/km				
Hydrocarbons (Total)	0.122	kg/h	0.031	g/km				
Carbon Monoxide (Total)	1.500	kg/h	0.382	g/km				
NOx (Total)	5.582	kg/h	1.421	g/km				

C3.2.2 PM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS E							
Speed Efficiency	0.47							
Travel Time Index	4.10							
Congestion Coefficient	2.13							
Travel Speed (Average)	29.2	km/h			3.4	km/h	29.0	km/h
Travel Distance (Total)	4545.9	veh-km/h			3.8	ped-km/h	5458.8	pers-km/h
Travel Time (Total)	155.8	veh-h/h			1.1	ped-h/h	188.0	pers-h/h
Desired Speed (Program)	62.2	km/h						
Demand Flows (Total for all Sites)	11576	veh/h			17	ped/h	13908	pers/h
Arrival Flows (Total for all Sites)	11505	veh/h			17	ped/h	13823	pers/h
Demand Flows (Entry Total)	4119	veh/h						
Midblock Inflows (Total)	125	veh/h						
Midblock Outflows (Total)	-195	veh/h						
Percent Heavy Vehicles (Demand)	5.4	%						
Percent Heavy Vehicles (Arrival)	5.4	%						
Degree of Saturation	1.298							
Control Delay (Total)	82.17	veh-h/h			0.23	ped-h/h	98.84	pers-h/h
Control Delay (Average)	25.7	sec			49.9	sec	25.7	sec
Control Delay (Worst Lane)	463.0	sec						
Control Delay (Worst Movement)	463.0	sec			50.1	sec	463.0	sec
Geometric Delay (Average)	1.8	sec						
Stop-Line Delay (Average)	23.9	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.49							
Total Effective Stops	6874	veh/h			16	ped/h	8265	pers/h
Effective Stop Rate	0.60		1.51	per km	0.96		0.60	
Proportion Queued	0.42				0.96		0.43	
Performance Index	482.7				1.2		483.9	
Cost (Total)	6893.81	$/h	1.52	$/km	30.73	$/h	6924.53	$/h
Fuel Consumption (Total)	770.8	L/h	169.6	mL/km				
Fuel Economy	17.0	L/100km						
Carbon Dioxide (Total)	1831.1	kg/h	402.8	g/km				
Hydrocarbons (Total)	0.151	kg/h	0.033	g/km				
Carbon Monoxide (Total)	1.784	kg/h	0.393	g/km				
NOx (Total)	6.225	kg/h	1.369	g/km				

C3.3 Do Something (Grade separated)

C3.3.1 AM Peak – Network Performance – Fully Signalised

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.59							
Travel Time Index	5.41							
Congestion Coefficient	1.70							
Travel Speed (Average)	36.7	km/h			3.7	km/h	36.5	km/h
Travel Distance (Total)	3916.3	veh-km/h			3.8	ped-km/h	4703.4	pers-km/h
Travel Time (Total)	106.6	veh-h/h			1.0	ped-h/h	129.0	pers-h/h
Desired Speed (Program)	62.6	km/h						
Demand Flows (Total for all Sites)	9524	veh/h			17	ped/h	11446	pers/h
Arrival Flows (Total for all Sites)	9524	veh/h			17	ped/h	11446	pers/h
Demand Flows (Entry Total)	3533	veh/h						
Midblock Inflows (Total)	103	veh/h						
Midblock Outflows (Total)	-165	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	0.831							
Control Delay (Total)	43.46	veh-h/h			0.14	ped-h/h	52.30	pers-h/h
Control Delay (Average)	16.4	sec			31.0	sec	16.4	sec
Control Delay (Worst Lane)	44.3	sec						
Control Delay (Worst Movement)	44.3	sec			31.1	sec	44.3	sec
Geometric Delay (Average)	1.7	sec						
Stop-Line Delay (Average)	14.8	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.33							
Total Effective Stops	5738	veh/h			16	ped/h	6901	pers/h
Effective Stop Rate	0.60		1.47	per km	0.94		0.60	
Proportion Queued	0.63				0.94		0.63	
Performance Index	366.5				1.1		367.6	
Cost (Total)	5307.76	$/h	1.36	$/km	28.28	$/h	5336.03	$/h
Fuel Consumption (Total)	789.6	L/h	201.6	mL/km				
Fuel Economy	20.2	L/100km						
Carbon Dioxide (Total)	1878.8	kg/h	479.7	g/km				
Hydrocarbons (Total)	0.145	kg/h	0.037	g/km				
Carbon Monoxide (Total)	1.745	kg/h	0.445	g/km				
NOx (Total)	8.093	kg/h	2.066	g/km				

C3.3.2 PM Peak – Network Performance – Fully Signalised

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.56							
Travel Time Index	5.09							
Congestion Coefficient	1.79							
Travel Speed (Average)	34.7	km/h			3.6	km/h	34.5	km/h
Travel Distance (Total)	4563.0	veh-km/h			3.8	ped-km/h	5479.4	pers-km/h
Travel Time (Total)	131.5	veh-h/h			1.0	ped-h/h	158.9	pers-h/h
Desired Speed (Program)	62.2	km/h						
Demand Flows (Total for all Sites)	11099	veh/h			17	ped/h	13336	pers/h
Arrival Flows (Total for all Sites)	11099	veh/h			17	ped/h	13336	pers/h
Demand Flows (Entry Total)	4119	veh/h						
Midblock Inflows (Total)	125	veh/h						
Midblock Outflows (Total)	-195	veh/h						
Percent Heavy Vehicles (Demand)	5.6	%						
Percent Heavy Vehicles (Arrival)	5.6	%						
Degree of Saturation	0.920							
Control Delay (Total)	57.56	veh-h/h			0.17	ped-h/h	69.24	pers-h/h
Control Delay (Average)	18.7	sec			35.9	sec	18.7	sec
Control Delay (Worst Lane)	52.8	sec						
Control Delay (Worst Movement)	52.8	sec			36.1	sec	52.8	sec
Geometric Delay (Average)	1.7	sec						
Stop-Line Delay (Average)	17.0	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.43							
Total Effective Stops	6906	veh/h			16	ped/h	8303	pers/h
Effective Stop Rate	0.62		1.51	per km	0.95		0.62	
Proportion Queued	0.64				0.95		0.64	
Performance Index	508.7				1.1		509.8	
Cost (Total)	6421.82	$/h	1.41	$/km	28.92	$/h	6450.75	$/h
Fuel Consumption (Total)	918.1	L/h	201.2	mL/km				
Fuel Economy	20.1	L/100km						
Carbon Dioxide (Total)	2181.1	kg/h	478.0	g/km				
Hydrocarbons (Total)	0.170	kg/h	0.037	g/km				
Carbon Monoxide (Total)	2.018	kg/h	0.442	g/km				
NOx (Total)	9.014	kg/h	1.975	g/km				

C3.3.3 AM Peak – Network Performance – Roundabouts Only

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.63							
Travel Time Index	5.84							
Congestion Coefficient	1.60							
Travel Speed (Average)	39.3	km/h			3.5	km/h	39.0	km/h
Travel Distance (Total)	4137.6	veh-km/h			3.8	ped-km/h	4969.0	pers-km/h
Travel Time (Total)	105.2	veh-h/h			1.1	ped-h/h	127.3	pers-h/h
Desired Speed (Program)	62.9	km/h						
Demand Flows (Total for all Sites)	9524	veh/h			17	ped/h	11446	pers/h
Arrival Flows (Total for all Sites)	9524	veh/h			17	ped/h	11446	pers/h
Demand Flows (Entry Total)	3533	veh/h						
Midblock Inflows (Total)	103	veh/h						
Midblock Outflows (Total)	-165	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	0.683							
Control Delay (Total)	37.15	veh-h/h			0.21	ped-h/h	44.79	pers-h/h
Control Delay (Average)	14.0	sec			45.4	sec	14.1	sec
Control Delay (Worst Lane)	59.5	sec						
Control Delay (Worst Movement)	59.5	sec			45.6	sec	59.5	sec
Geometric Delay (Average)	4.3	sec						
Stop-Line Delay (Average)	9.8	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.34							
Total Effective Stops	5577	veh/h			16	ped/h	6709	pers/h
Effective Stop Rate	0.59		1.35	per km	0.96		0.59	
Proportion Queued	0.50				0.96		0.50	
Performance Index	296.9				1.2		298.0	
Cost (Total)	5342.14	$/h	1.29	$/km	30.15	$/h	5372.28	$/h
Fuel Consumption (Total)	825.8	L/h	199.6	mL/km				
Fuel Economy	20.0	L/100km						
Carbon Dioxide (Total)	1964.2	kg/h	474.7	g/km				
Hydrocarbons (Total)	0.156	kg/h	0.038	g/km				
Carbon Monoxide (Total)	1.834	kg/h	0.443	g/km				
NOx (Total)	7.729	kg/h	1.868	g/km				

C3.3.4 PM Peak – Network Performance – Roundabouts Only

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.61							
Travel Time Index	5.65							
Congestion Coefficient	1.64							
Travel Speed (Average)	38.0	km/h			3.6	km/h	37.8	km/h
Travel Distance (Total)	4811.8	veh-km/h			3.8	ped-km/h	5778.0	pers-km/h
Travel Time (Total)	126.7	veh-h/h			1.0	ped-h/h	153.0	pers-h/h
Desired Speed (Program)	62.4	km/h						
Demand Flows (Total for all Sites)	11099	veh/h			17	ped/h	13336	pers/h
Arrival Flows (Total for all Sites)	11099	veh/h			17	ped/h	13336	pers/h
Demand Flows (Entry Total)	4119	veh/h						
Midblock Inflows (Total)	125	veh/h						
Midblock Outflows (Total)	-195	veh/h						
Percent Heavy Vehicles (Demand)	5.6	%						
Percent Heavy Vehicles (Arrival)	5.6	%						
Degree of Saturation	0.920							
Control Delay (Total)	46.93	veh-h/h			0.17	ped-h/h	56.49	pers-h/h
Control Delay (Average)	15.2	sec			35.9	sec	15.2	sec
Control Delay (Worst Lane)	51.3	sec						
Control Delay (Worst Movement)	51.3	sec			36.1	sec	51.3	sec
Geometric Delay (Average)	4.2	sec						
Stop-Line Delay (Average)	11.1	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.41							
Total Effective Stops	7161	veh/h			16	ped/h	8609	pers/h
Effective Stop Rate	0.65		1.49	per km	0.95		0.65	
Proportion Queued	0.56				0.95		0.56	
Performance Index	381.0				1.1		382.1	
Cost (Total)	6394.07	$/h	1.33	$/km	28.92	$/h	6423.00	$/h
Fuel Consumption (Total)	977.4	L/h	203.1	mL/km				
Fuel Economy	20.3	L/100km						
Carbon Dioxide (Total)	2321.3	kg/h	482.4	g/km				
Hydrocarbons (Total)	0.184	kg/h	0.038	g/km				
Carbon Monoxide (Total)	2.147	kg/h	0.446	g/km				
NOx (Total)	8.959	kg/h	1.862	g/km				

C3.3.5 AM Peak – Network Performance – Partial treatment

Network Performance - Hourly Values									
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.61							
Travel Time Index	5.70							
Congestion Coefficient	1.63							
Travel Speed (Average)	38.5	km/h			3.5	km/h	38.2	km/h
Travel Distance (Total)	4072.0	veh-km/h			3.8	ped-km/h	4890.2	pers-km/h
Travel Time (Total)	105.7	veh-h/h			1.1	ped-h/h	128.0	pers-h/h
Desired Speed (Program)	62.8	km/h						
Demand Flows (Total for all Sites)	9524	veh/h			17	ped/h	11446	pers/h
Arrival Flows (Total for all Sites)	9524	veh/h			17	ped/h	11446	pers/h
Demand Flows (Entry Total)	3533	veh/h						
Midblock Inflows (Total)	103	veh/h						
Midblock Outflows (Total)	-165	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	0.683							
Control Delay (Total)	39.50	veh-h/h			0.21	ped-h/h	47.61	pers-h/h
Control Delay (Average)	14.9	sec			45.4	sec	15.0	sec
Control Delay (Worst Lane)	59.5	sec						
Control Delay (Worst Movement)	59.5	sec			45.6	sec	59.5	sec
Geometric Delay (Average)	3.5	sec						
Stop-Line Delay (Average)	11.5	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.34							
Total Effective Stops	5713	veh/h			16	ped/h	6872	pers/h
Effective Stop Rate	0.60		1.40	per km	0.96		0.60	
Proportion Queued	0.54				0.96		0.54	
Performance Index	323.7				1.2		324.9	
Cost (Total)	5366.29	$/h	1.32	$/km	30.15	$/h	5396.44	$/h
Fuel Consumption (Total)	828.7	L/h	203.5	mL/km				
Fuel Economy	20.4	L/100km						
Carbon Dioxide (Total)	1971.4	kg/h	484.1	g/km				
Hydrocarbons (Total)	0.156	kg/h	0.038	g/km				
Carbon Monoxide (Total)	1.836	kg/h	0.451	g/km				
NOx (Total)	7.969	kg/h	1.957	g/km				

C3.3.6 PM Peak – Network Performance – Partial treatment

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.60							
Travel Time Index	5.51							
Congestion Coefficient	1.68							
Travel Speed (Average)	37.2	km/h			3.6	km/h	36.9	km/h
Travel Distance (Total)	4742.4	veh-km/h			3.8	ped-km/h	5694.7	pers-km/h
Travel Time (Total)	127.6	veh-h/h			1.0	ped-h/h	154.2	pers-h/h
Desired Speed (Program)	62.4	km/h						
Demand Flows (Total for all Sites)	11099	veh/h			17	ped/h	13336	pers/h
Arrival Flows (Total for all Sites)	11099	veh/h			17	ped/h	13336	pers/h
Demand Flows (Entry Total)	4119	veh/h						
Midblock Inflows (Total)	125	veh/h						
Midblock Outflows (Total)	-195	veh/h						
Percent Heavy Vehicles (Demand)	5.6	%						
Percent Heavy Vehicles (Arrival)	5.6	%						
Degree of Saturation	0.920							
Control Delay (Total)	49.83	veh-h/h			0.17	ped-h/h	59.97	pers-h/h
Control Delay (Average)	16.2	sec			35.9	sec	16.2	sec
Control Delay (Worst Lane)	51.3	sec						
Control Delay (Worst Movement)	51.3	sec			36.1	sec	51.3	sec
Geometric Delay (Average)	3.5	sec						
Stop-Line Delay (Average)	12.7	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.41							
Total Effective Stops	7248	veh/h			16	ped/h	8714	pers/h
Effective Stop Rate	0.65		1.53	per km	0.95		0.65	
Proportion Queued	0.59				0.95		0.59	
Performance Index	413.2				1.1		414.4	
Cost (Total)	6425.75	$/h	1.35	$/km	28.92	$/h	6454.67	$/h
Fuel Consumption (Total)	977.8	L/h	206.2	mL/km				
Fuel Economy	20.6	L/100km						
Carbon Dioxide (Total)	2322.2	kg/h	489.7	g/km				
Hydrocarbons (Total)	0.183	kg/h	0.039	g/km				
Carbon Monoxide (Total)	2.144	kg/h	0.452	g/km				
NOx (Total)	9.163	kg/h	1.932	g/km				

C4 Church Avenue Road Network

C4.1 Do Nothing (LX at grade)

C4.1.1 AM Peak – Network performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS B							
Speed Efficiency	0.82							
Travel Time Index	7.95							
Congestion Coefficient	1.23							
Travel Speed (Average)	39.4	km/h			0.1	km/h	28.7	km/h
Travel Distance (Total)	1216.1	veh-km/h			1.8	ped-km/h	1461.1	pers-km/h
Travel Time (Total)	30.9	veh-h/h			13.9	ped-h/h	50.9	pers-h/h
Desired Speed (Program)	48.2	km/h						
Demand Flows (Total for all Sites)	3842	veh/h			53	ped/h	4663	pers/h
Arrival Flows (Total for all Sites)	3842	veh/h			53	ped/h	4663	pers/h
Demand Flows (Entry Total)	1701	veh/h						
Midblock Inflows (Total)	6	veh/h						
Midblock Outflows (Total)	-100	veh/h						
Percent Heavy Vehicles (Demand)	3.9	%						
Percent Heavy Vehicles (Arrival)	3.9	%						
Degree of Saturation	0.697							
Control Delay (Total)	5.47	veh-h/h			13.44	ped-h/h	19.99	pers-h/h
Control Delay (Average)	5.1	sec			919.0	sec	15.4	sec
Control Delay (Worst Lane)	8.0	sec						
Control Delay (Worst Movement)	11.9	sec			919.0	sec	919.0	sec
Geometric Delay (Average)	3.0	sec						
Stop-Line Delay (Average)	2.1	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	1822	veh/h			53	ped/h	2240	pers/h
Effective Stop Rate	0.47		1.50	per km	1.00		0.48	
Proportion Queued	0.36				1.00		0.36	
Performance Index	133.7				14.1		147.8	
Cost (Total)	1379.97	$/h	1.13	$/km	382.43	$/h	1762.41	$/h
Fuel Consumption (Total)	158.4	L/h	130.3	mL/km				
Fuel Economy	13.0	L/100km						
Carbon Dioxide (Total)	375.7	kg/h	308.9	g/km				
Hydrocarbons (Total)	0.029	kg/h	0.024	g/km				
Carbon Monoxide (Total)	0.289	kg/h	0.238	g/km				
NOx (Total)	0.965	kg/h	0.794	g/km				

C4.1.2 PM Peak – Network performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS B							
Speed Efficiency	0.81							
Travel Time Index	7.93							
Congestion Coefficient	1.23							
Travel Speed (Average)	39.1	km/h			0.1	km/h	29.3	km/h
Travel Distance (Total)	1340.6	veh-km/h			1.8	ped-km/h	1610.6	pers-km/h
Travel Time (Total)	34.3	veh-h/h			13.9	ped-h/h	55.0	pers-h/h
Desired Speed (Program)	48.0	km/h						
Demand Flows (Total for all Sites)	4212	veh/h			53	ped/h	5107	pers/h
Arrival Flows (Total for all Sites)	4212	veh/h			53	ped/h	5107	pers/h
Demand Flows (Entry Total)	1939	veh/h						
Midblock Inflows (Total)	56	veh/h						
Midblock Outflows (Total)	-83	veh/h						
Percent Heavy Vehicles (Demand)	3.8	%						
Percent Heavy Vehicles (Arrival)	3.8	%						
Degree of Saturation	0.507							
Control Delay (Total)	6.06	veh-h/h			13.44	ped-h/h	20.71	pers-h/h
Control Delay (Average)	5.2	sec			919.0	sec	14.6	sec
Control Delay (Worst Lane)	8.5	sec						
Control Delay (Worst Movement)	10.4	sec			919.0	sec	919.0	sec
Geometric Delay (Average)	3.0	sec						
Stop-Line Delay (Average)	2.2	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	2110	veh/h			53	ped/h	2585	pers/h
Effective Stop Rate	0.50		1.57	per km	1.00		0.51	
Proportion Queued	0.41				1.00		0.42	
Performance Index	126.0				14.1		140.1	
Cost (Total)	1543.80	$/h	1.15	$/km	382.43	$/h	1926.24	$/h
Fuel Consumption (Total)	181.1	L/h	135.1	mL/km				
Fuel Economy	13.5	L/100km						
Carbon Dioxide (Total)	430.0	kg/h	320.8	g/km				
Hydrocarbons (Total)	0.033	kg/h	0.024	g/km				
Carbon Monoxide (Total)	0.331	kg/h	0.247	g/km				
NOx (Total)	1.166	kg/h	0.870	g/km				

C4.2 Do Nothing (grade separated)

C4.2.1 AM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS B					
Speed Efficiency	0.83					
Travel Time Index	8.14					
Congestion Coefficient	1.20					
Travel Speed (Average)	40.2	km/h			40.2	km/h
Travel Distance (Total)	1228.4	veh-km/h			1474.1	pers-km/h
Travel Time (Total)	30.6	veh-h/h			36.7	pers-h/h
Desired Speed (Program)	48.3	km/h				
Demand Flows (Total for all Sites)	2993	veh/h			3591	pers/h
Arrival Flows (Total for all Sites)	2993	veh/h			3591	pers/h
Demand Flows (Entry Total)	1701	veh/h				
Midblock Inflows (Total)	6	veh/h				
Midblock Outflows (Total)	-100	veh/h				
Percent Heavy Vehicles (Demand)	3.9	%				
Percent Heavy Vehicles (Arrival)	3.9	%				
Degree of Saturation	0.368					
Control Delay (Total)	4.78	veh-h/h			5.73	pers-h/h
Control Delay (Average)	5.7	sec			5.7	sec
Control Delay (Worst Lane)	7.9	sec				
Control Delay (Worst Movement)	9.8	sec			9.8	sec
Geometric Delay (Average)	4.2	sec				
Stop-Line Delay (Average)	1.5	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.06					
Total Effective Stops	1714	veh/h			2057	pers/h
Effective Stop Rate	0.57		1.40	per km	0.57	
Proportion Queued	0.44				0.44	
Performance Index	72.2				72.2	
Cost (Total)	1368.63	$/h	1.11	$/km	1368.63	$/h
Fuel Consumption (Total)	158.1	L/h	128.7	mL/km		
Fuel Economy	12.9	L/100km				
Carbon Dioxide (Total)	374.8	kg/h	305.1	g/km		
Hydrocarbons (Total)	0.029	kg/h	0.023	g/km		
Carbon Monoxide (Total)	0.289	kg/h	0.235	g/km		
NOx (Total)	0.985	kg/h	0.802	g/km		

C4.2.2 PM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS B					
Speed Efficiency	0.82					
Travel Time Index	8.05					
Congestion Coefficient	1.21					
Travel Speed (Average)	39.6	km/h			39.6	km/h
Travel Distance (Total)	1356.8	veh-km/h			1628.1	pers-km/h
Travel Time (Total)	34.3	veh-h/h			41.1	pers-h/h
Desired Speed (Program)	48.0	km/h				
Demand Flows (Total for all Sites)	3360	veh/h			4032	pers/h
Arrival Flows (Total for all Sites)	3360	veh/h			4032	pers/h
Demand Flows (Entry Total)	1939	veh/h				
Midblock Inflows (Total)	37	veh/h				
Midblock Outflows (Total)	-64	veh/h				
Percent Heavy Vehicles (Demand)	3.9	%				
Percent Heavy Vehicles (Arrival)	3.9	%				
Degree of Saturation	0.479					
Control Delay (Total)	5.61	veh-h/h			6.73	pers-h/h
Control Delay (Average)	6.0	sec			6.0	sec
Control Delay (Worst Lane)	8.5	sec				
Control Delay (Worst Movement)	10.4	sec			10.4	sec
Geometric Delay (Average)	4.0	sec				
Stop-Line Delay (Average)	2.0	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.11					
Total Effective Stops	2036	veh/h			2443	pers/h
Effective Stop Rate	0.61		1.50	per km	0.61	
Proportion Queued	0.50				0.50	
Performance Index	86.0				86.0	
Cost (Total)	1543.76	$/h	1.14	$/km	1543.76	$/h
Fuel Consumption (Total)	181.6	L/h	133.9	mL/km		
Fuel Economy	13.4	L/100km				
Carbon Dioxide (Total)	431.3	kg/h	317.9	g/km		
Hydrocarbons (Total)	0.033	kg/h	0.024	g/km		
Carbon Monoxide (Total)	0.333	kg/h	0.245	g/km		
NOx (Total)	1.185	kg/h	0.873	g/km		

C5 Forrest Road Network

C5.1 Do Nothing (LX at grade)

C5.1.1 AM Peak – Network performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS B							
Speed Efficiency	0.86							
Travel Time Index	8.39							
Congestion Coefficient	1.17							
Travel Speed (Average)	35.1	km/h			0.6	km/h	32.1	km/h
Travel Distance (Total)	1010.2	veh-km/h			1.9	ped-km/h	1214.2	pers-km/h
Travel Time (Total)	28.8	veh-h/h			3.3	ped-h/h	37.8	pers-h/h
Desired Speed (Program)	41.1	km/h						
Demand Flows (Total for all Sites)	4059	veh/h			53	ped/h	4923	pers/h
Arrival Flows (Total for all Sites)	4059	veh/h			53	ped/h	4923	pers/h
Demand Flows (Entry Total)	1369	veh/h						
Midblock Inflows (Total)	118	veh/h						
Midblock Outflows (Total)	-44	veh/h						
Percent Heavy Vehicles (Demand)	1.5	%						
Percent Heavy Vehicles (Arrival)	1.5	%						
Degree of Saturation	0.541							
Control Delay (Total)	4.46	veh-h/h			2.89	ped-h/h	8.23	pers-h/h
Control Delay (Average)	4.0	sec			197.4	sec	6.0	sec
Control Delay (Worst Lane)	8.9	sec						
Control Delay (Worst Movement)	10.9	sec			197.4	sec	197.4	sec
Geometric Delay (Average)	1.5	sec						
Stop-Line Delay (Average)	2.4	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	1412	veh/h			52	ped/h	1747	pers/h
Effective Stop Rate	0.35		1.40	per km	0.99		0.35	
Proportion Queued	0.25				0.99		0.26	
Performance Index	91.9				3.6		95.5	
Cost (Total)	1179.74	$/h	1.17	$/km	91.84	$/h	1271.59	$/h
Fuel Consumption (Total)	101.0	L/h	100.0	mL/km				
Fuel Economy	10.0	L/100km						
Carbon Dioxide (Total)	238.3	kg/h	235.9	g/km				
Hydrocarbons (Total)	0.018	kg/h	0.018	g/km				
Carbon Monoxide (Total)	0.139	kg/h	0.137	g/km				
NOx (Total)	0.238	kg/h	0.235	g/km				

C5.1.2 PM Peak – Network performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS B							
Speed Efficiency	0.85							
Travel Time Index	8.33							
Congestion Coefficient	1.18							
Travel Speed (Average)	35.0	km/h			0.6	km/h	32.1	km/h
Travel Distance (Total)	1044.6	veh-km/h			1.9	ped-km/h	1255.4	pers-km/h
Travel Time (Total)	29.8	veh-h/h			3.3	ped-h/h	39.1	pers-h/h
Desired Speed (Program)	41.2	km/h						
Demand Flows (Total for all Sites)	4378	veh/h			53	ped/h	5306	pers/h
Arrival Flows (Total for all Sites)	4378	veh/h			53	ped/h	5306	pers/h
Demand Flows (Entry Total)	1389	veh/h						
Midblock Inflows (Total)	139	veh/h						
Midblock Outflows (Total)	-15	veh/h						
Percent Heavy Vehicles (Demand)	1.9	%						
Percent Heavy Vehicles (Arrival)	1.9	%						
Degree of Saturation	0.567							
Control Delay (Total)	4.75	veh-h/h			2.89	ped-h/h	8.59	pers-h/h
Control Delay (Average)	3.9	sec			197.4	sec	5.8	sec
Control Delay (Worst Lane)	9.5	sec						
Control Delay (Worst Movement)	11.3	sec			197.4	sec	197.4	sec
Geometric Delay (Average)	1.5	sec						
Stop-Line Delay (Average)	2.4	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	1465	veh/h			52	ped/h	1810	pers/h
Effective Stop Rate	0.33		1.40	per km	0.99		0.34	
Proportion Queued	0.24				0.99		0.25	
Performance Index	105.5				3.6		109.1	
Cost (Total)	1230.93	$/h	1.18	$/km	91.84	$/h	1322.77	$/h
Fuel Consumption (Total)	107.9	L/h	103.3	mL/km				
Fuel Economy	10.3	L/100km						
Carbon Dioxide (Total)	255.0	kg/h	244.1	g/km				
Hydrocarbons (Total)	0.019	kg/h	0.018	g/km				
Carbon Monoxide (Total)	0.151	kg/h	0.145	g/km				
NOx (Total)	0.336	kg/h	0.321	g/km				

C5.2 Do Nothing (grade separated)

C5.2.1 AM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.91					
Travel Time Index	9.00					
Congestion Coefficient	1.10					
Travel Speed (Average)	37.6	km/h			37.6	km/h
Travel Distance (Total)	1021.3	veh-km/h			1225.5	pers-km/h
Travel Time (Total)	27.2	veh-h/h			32.6	pers-h/h
Desired Speed (Program)	41.3	km/h				
Demand Flows (Total for all Sites)	3260	veh/h			3912	pers/h
Arrival Flows (Total for all Sites)	3260	veh/h			3912	pers/h
Demand Flows (Entry Total)	1369	veh/h				
Midblock Inflows (Total)	118	veh/h				
Midblock Outflows (Total)	-44	veh/h				
Percent Heavy Vehicles (Demand)	1.4	%				
Percent Heavy Vehicles (Arrival)	1.4	%				
Degree of Saturation	0.541					
Control Delay (Total)	2.75	veh-h/h			3.30	pers-h/h
Control Delay (Average)	3.0	sec			3.0	sec
Control Delay (Worst Lane)	8.9	sec				
Control Delay (Worst Movement)	10.8	sec			10.8	sec
Geometric Delay (Average)	1.9	sec				
Stop-Line Delay (Average)	1.1	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.47					
Total Effective Stops	1229	veh/h			1475	pers/h
Effective Stop Rate	0.38		1.20	per km	0.38	
Proportion Queued	0.26				0.26	
Performance Index	50.6				50.6	
Cost (Total)	1117.79	$/h	1.09	$/km	1117.79	$/h
Fuel Consumption (Total)	96.5	L/h	94.5	mL/km		
Fuel Economy	9.4	L/100km				
Carbon Dioxide (Total)	227.6	kg/h	222.8	g/km		
Hydrocarbons (Total)	0.017	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.134	kg/h	0.132	g/km		
NOx (Total)	0.219	kg/h	0.214	g/km		

C5.2.2 PM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS A					
Speed Efficiency	0.91					
Travel Time Index	8.98					
Congestion Coefficient	1.10					
Travel Speed (Average)	37.6	km/h			37.6	km/h
Travel Distance (Total)	1056.8	veh-km/h			1268.1	pers-km/h
Travel Time (Total)	28.1	veh-h/h			33.7	pers-h/h
Desired Speed (Program)	41.4	km/h				
Demand Flows (Total for all Sites)	3481	veh/h			4177	pers/h
Arrival Flows (Total for all Sites)	3481	veh/h			4177	pers/h
Demand Flows (Entry Total)	1389	veh/h				
Midblock Inflows (Total)	139	veh/h				
Midblock Outflows (Total)	-15	veh/h				
Percent Heavy Vehicles (Demand)	1.9	%				
Percent Heavy Vehicles (Arrival)	1.9	%				
Degree of Saturation	0.558					
Control Delay (Total)	2.85	veh-h/h			3.42	pers-h/h
Control Delay (Average)	2.9	sec			2.9	sec
Control Delay (Worst Lane)	9.5	sec				
Control Delay (Worst Movement)	11.3	sec			11.3	sec
Geometric Delay (Average)	1.9	sec				
Stop-Line Delay (Average)	1.0	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.52					
Total Effective Stops	1263	veh/h			1515	pers/h
Effective Stop Rate	0.36		1.19	per km	0.36	
Proportion Queued	0.24				0.24	
Performance Index	53.5				53.5	
Cost (Total)	1164.73	$/h	1.10	$/km	1164.73	$/h
Fuel Consumption (Total)	104.2	L/h	98.6	mL/km		
Fuel Economy	9.9	L/100km				
Carbon Dioxide (Total)	246.4	kg/h	233.2	g/km		
Hydrocarbons (Total)	0.018	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.149	kg/h	0.141	g/km		
NOx (Total)	0.319	kg/h	0.302	g/km		

Appendix D

SIDRA Modelling Results (2036)

D1 Individual sites – Do Nothing

D1.1 SWH/ William St/ Bedfordale Hill Rd

D1.1.1 AM Peak

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
3	L1	254	3.8	267	3.8	*0.951	65.4	LOS E	44.9	371.0	1.00	1.26	1.39	26.5
4	T1	1159	9.8	1220	9.8	0.951	59.2	LOS E	47.9	410.1	1.00	1.29	1.38	30.2
5	R2	33	10.0	35	10.0	*0.104	20.9	LOS C	0.9	7.7	0.65	0.67	0.65	38.2
Approach		1446	8.8	1522	8.8	0.951	59.4	LOS E	47.9	410.1	0.99	1.27	1.37	29.7
East: Bedfordale Hill Road East														
6	L2	30	0.0	32	0.0	0.914	65.4	LOS E	10.3	76.0	1.00	1.10	1.54	24.8
6a	R1	143	0.0	151	0.0	*0.914	63.7	LOS E	10.3	76.0	1.00	1.10	1.54	22.4
7	R2	118	6.4	124	6.4	0.677	53.5	LOS D	6.1	47.8	1.00	0.84	1.10	26.6
Approach		291	2.6	306	2.6	0.914	59.8	LOS E	10.3	76.0	1.00	1.00	1.36	24.3
North: South Western Highway North														
8	L2	39	13.8	41	13.8	0.361	23.8	LOS C	8.3	70.8	0.68	0.61	0.68	38.6
9	T1	524	10.7	552	10.7	0.361	16.6	LOS B	8.9	76.2	0.66	0.58	0.66	46.9
10	R3	41	0.0	43	0.0	*0.324	32.4	LOS C	1.2	8.8	0.98	0.73	0.98	35.5
Approach		604	10.2	636	10.2	0.361	18.1	LOS B	8.9	76.2	0.68	0.59	0.68	45.5
NorthWest: William Street North-West														
11	L3	94	1.8	99	1.8	0.535	36.4	LOS D	6.4	48.3	0.95	0.84	0.95	34.2
1	L1	65	2.6	68	2.6	0.535	34.3	LOS C	6.4	48.3	0.95	0.84	0.95	29.3
2	R1	197	5.2	207	5.2	*0.941	69.7	LOS E	12.5	97.0	1.00	1.16	1.62	24.9
Approach		356	3.8	375	3.8	0.941	54.5	LOS D	12.5	97.0	0.98	1.02	1.32	27.6
All Vehicles		2697	7.8	2839	7.8	0.951	49.6	LOS D	47.9	410.1	0.92	1.05	1.21	31.4

D1.1.2 PM Peak

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
3	L1	184	0.9	194	0.9	*0.820	41.6	LOS D	26.1	208.3	0.96	1.03	1.05	33.0
4	T1	969	8.5	1020	8.5	*0.820	35.3	LOS D	27.2	225.6	0.95	1.02	1.03	37.7
5	R2	21	7.7	22	7.7	0.105	25.1	LOS C	0.7	5.2	0.77	0.68	0.77	36.5
Approach		1174	7.3	1236	7.3	0.820	36.1	LOS D	27.2	225.6	0.95	1.02	1.03	36.9
East: Bedfordale Hill Road East														
6	L2	45	11.1	47	11.1	2.054	987.5	LOS F	38.5	304.3	1.00	2.59	5.86	2.7
6a	R1	93	5.4	98	5.4	*2.054	985.4	LOS F	38.5	304.3	1.00	2.59	5.86	2.4
7	R2	48	10.5	51	10.5	0.418	55.9	LOS E	2.5	20.4	0.99	0.75	0.99	25.7
Approach		186	8.1	196	8.1	2.054	746.0	LOS F	38.5	304.3	1.00	2.11	4.61	3.3
North: South Western Highway North														
8	L2	41	0.0	43	0.0	0.591	28.9	LOS C	15.5	128.2	0.80	0.72	0.80	37.9
9	T1	793	8.1	835	8.1	0.591	21.8	LOS C	15.5	128.2	0.79	0.70	0.79	44.0
10	R3	44	9.4	46	9.4	*0.329	31.4	LOS C	1.4	11.6	0.93	0.74	0.93	35.8
Approach		878	7.8	924	7.8	0.591	22.6	LOS C	15.5	129.5	0.79	0.70	0.79	43.3
NorthWest: William Street North-West														
11	L3	81	4.3	85	4.3	0.585	40.0	LOS D	7.9	59.7	0.94	0.91	0.94	32.8
1	L1	136	2.5	143	2.5	0.585	37.8	LOS D	7.9	59.7	0.94	0.91	0.94	28.3
2	R1	436	3.1	459	3.1	*1.318	339.8	LOS F	71.6	543.5	1.00	2.23	3.47	7.9
Approach		653	3.1	687	3.1	1.318	239.7	LOS F	71.6	543.5	0.98	1.79	2.63	10.2
All Vehicles		2891	6.6	3043	6.6	2.054	123.7	LOS F	71.6	543.5	0.91	1.17	1.55	18.4

D1.2 SWH/ Dickens Place

D1.2.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	21	7.7	22	7.7	0.875	7.6	LOS A	0.0	0.0	0.00	0.01	0.00	63.1
2	T1	1470	7.0	1547	7.0	0.875	1.3	LOS A	0.0	0.0	0.00	0.01	0.00	66.6
Approach		1491	7.0	1569	7.0	0.875	1.4	NA	0.0	0.0	0.00	0.01	0.00	66.6
North: South Western Highway North														
8	T1	747	7.8	786	7.8	4.348	3081.7	LOS F	526.4	4367.4	1.00	0.12	5.31	1.1
9	R2	62	22.5	65	22.5	4.348	3095.0	LOS F	526.4	4367.4	1.00	0.12	5.31	1.1
Approach		809	8.9	852	8.9	4.348	3082.7	NA	526.4	4367.4	1.00	0.12	5.31	1.1
West: Dickens Place West														
10	L2	83	13.8	87	13.8	4.599	3334.0	LOS F	61.0	530.0	1.00	2.53	6.46	1.0
12	R2	14	40.0	15	40.0	4.599	3411.3	LOS F	61.0	530.0	1.00	2.53	6.46	1.0
Approach		97	17.6	102	17.6	4.599	3345.2	LOS F	61.0	530.0	1.00	2.53	6.46	1.0
All Vehicles		2397	8.1	2523	8.1	4.599	1176.7	NA	526.4	4367.4	0.38	0.15	2.05	2.8

D1.2.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	33	5.0	35	5.0	0.593	6.7	LOS A	0.0	0.0	0.00	0.02	0.00	64.0
2	T1	970	7.3	1021	7.3	0.593	0.3	LOS A	0.0	0.0	0.00	0.02	0.00	69.0
Approach		1003	7.2	1056	7.2	0.593	0.5	NA	0.0	0.0	0.00	0.02	0.00	68.8
North: South Western Highway North														
8	T1	1353	4.6	1424	4.6	1.083	94.6	LOS F	100.7	797.3	1.00	0.10	5.88	24.1
9	R2	78	17.7	82	17.7	1.083	150.2	LOS F	100.7	797.3	1.00	0.10	5.88	22.2
Approach		1431	5.3	1506	5.3	1.083	97.6	NA	100.7	797.3	1.00	0.10	5.88	24.0
West: Dickens Place West														
10	L2	134	9.7	141	9.7	6.874	5354.2	LOS F	111.3	903.5	1.00	3.42	8.60	0.7
12	R2	37	0.0	39	0.0	6.874	5421.9	LOS F	111.3	903.5	1.00	3.42	8.60	0.7
Approach		171	7.6	180	7.6	6.874	5368.8	LOS F	111.3	903.5	1.00	3.42	8.60	0.7
All Vehicles		2605	6.2	2742	6.2	6.874	406.3	NA	111.3	903.5	0.61	0.29	3.80	7.8

D1.3 SWH/ Stone Street

D1.3.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	55	11.8	58	11.8	0.039	7.6	LOS A	0.0	0.0	0.00	0.63	0.00	56.0
2	T1	1413	5.9	1487	5.9	0.816	0.8	LOS A	0.0	0.0	0.00	0.00	0.00	67.9
Approach		1468	6.1	1545	6.1	0.816	1.1	NA	0.0	0.0	0.00	0.02	0.00	67.4
North: South Western Highway North														
8	T1	779	8.4	820	8.4	1.579	1087.4	LOS F	732.6	6042.5	1.00	0.00	4.92	3.1
9a	R1	29	27.9	31	27.9	1.988	1129.4	LOS F	14.2	154.7	1.00	1.57	3.61	2.8
Approach		808	9.1	851	9.1	1.988	1088.9	NA	732.6	6042.5	1.00	0.06	4.87	3.1
SouthWest: Stone Street South-West														
30a	L1	63	31.6	66	31.6	16.569	14125.0	LOS F	114.4	1199.3	1.00	1.71	3.54	0.3
32b	R3	63	15.8	66	15.8	16.569	14137.3	LOS F	114.4	1199.3	1.00	1.71	3.54	0.3
Approach		126	23.7	133	23.7	16.569	14131.2	LOS F	114.4	1199.3	1.00	1.71	3.54	0.3
All Vehicles		2402	8.0	2528	8.0	16.569	1108.2	NA	732.6	6042.5	0.39	0.12	1.83	3.1

D1.3.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	48	16.6	51	16.6	0.038	7.7	LOS A	0.0	0.0	0.00	0.63	0.00	54.8
2	T1	948	6.5	998	6.5	0.551	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	69.4
Approach		996	7.0	1048	7.0	0.551	0.6	NA	0.0	0.0	0.00	0.03	0.00	68.5
North: South Western Highway North														
8	T1	1408	4.0	1482	4.0	0.803	0.7	LOS A	0.0	0.0	0.00	0.00	0.00	68.1
9a	R1	21	38.5	22	38.5	0.237	44.5	LOS E	0.7	9.1	0.92	0.98	0.99	34.0
Approach		1429	4.5	1504	4.5	0.803	1.4	NA	0.7	9.1	0.01	0.01	0.01	67.1
SouthWest: Stone Street South-West														
30a	L1	63	26.3	66	26.3	40.809	35895.8	LOS F	272.7	2402.4	1.00	1.69	3.63	0.1
32b	R3	230	7.2	242	7.2	40.809	35907.7	LOS F	272.7	2402.4	1.00	1.69	3.63	0.1
Approach		293	11.3	308	11.3	40.809	35905.1	LOS F	272.7	2402.4	1.00	1.69	3.63	0.1
All Vehicles		2718	6.1	2861	6.1	40.809	3871.5	NA	272.7	2402.4	0.11	0.20	0.40	0.9

D1.4 SWH/ Eleventh Road

D1.4.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	170	10.0	179	10.0	0.111	7.1	LOS A	0.0	0.0	0.00	0.63	0.00	62.0
2	T1	1602	6.6	1686	6.6	0.959	3.1	LOS A	0.0	0.0	0.00	0.00	0.00	70.5
Approach		1772	6.9	1865	6.9	0.959	3.5	NA	0.0	0.0	0.00	0.06	0.00	69.6
North: South Western Highway North														
8	T1	817	9.9	860	9.9	2.393	3008.3	LOS F	1403.3	10580.6	1.00	0.00	6.43	1.1
9	R2	33	5.3	35	5.3	3.214	2224.8	LOS F	22.1	161.6	1.00	1.42	3.58	1.5
Approach		850	9.7	895	9.7	3.214	2977.9	NA	1403.3	10580.6	1.00	0.06	6.32	1.1
West: Eleventh Road West														
10	L2	47	17.4	49	17.4	34.009	29802.0	LOS F	202.6	1514.1	1.00	1.36	3.26	0.1
12	R2	161	7.7	169	7.7	34.009	29803.7	LOS F	202.6	1514.1	1.00	1.36	3.26	0.1
Approach		208	9.9	219	9.9	34.009	29803.3	LOS F	202.6	1514.1	1.00	1.36	3.26	0.1
All Vehicles		2830	8.0	2979	8.0	34.009	3087.1	NA	1403.3	10580.6	0.37	0.15	2.14	1.1

D1.4.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	174	2.2	183	2.2	0.103	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	64.6
2	T1	1068	7.6	1124	7.6	0.638	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	79.1
Approach		1242	6.8	1307	6.8	0.638	1.2	NA	0.0	0.0	0.00	0.09	0.00	76.7
North: South Western Highway North														
8	T1	1508	4.0	1587	4.0	0.859	0.9	LOS A	0.0	0.0	0.00	0.00	0.00	77.1
9	R2	65	8.1	68	8.1	0.507	40.6	LOS E	1.6	12.1	0.94	1.03	1.24	39.6
Approach		1573	4.2	1656	4.2	0.859	2.5	NA	1.6	12.1	0.04	0.04	0.05	74.2
West: Eleventh Road West														
10	L2	58	3.6	61	3.6	34.355	30089.4	LOS F	229.1	1637.1	1.00	1.46	3.80	0.1
12	R2	194	2.1	204	2.1	34.355	30101.5	LOS F	229.1	1637.1	1.00	1.46	3.80	0.1
Approach		252	2.4	265	2.4	34.355	30098.7	LOS F	229.1	1637.1	1.00	1.46	3.80	0.1
All Vehicles		3067	5.1	3228	5.1	34.355	2474.8	NA	229.1	1637.1	0.10	0.18	0.34	1.4

D1.5 Eleventh Road/ Wungong Road

D1.5.1 AM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
SouthEast: Eleventh Road South-East														
5	T1	282	9.7	297	9.7	0.257	0.9	LOS A	0.9	6.9	0.26	0.17	0.27	74.6
6	R2	85	0.0	89	0.0	0.257	9.2	LOS A	0.9	6.9	0.26	0.17	0.27	62.8
Approach		367	7.5	386	7.5	0.257	2.8	NA	0.9	6.9	0.26	0.17	0.27	71.2
NorthEast: Wungong Road North-East														
7	L2	56	7.7	59	7.7	0.037	6.5	LOS A	0.2	1.4	0.37	0.57	0.37	54.6
9	R2	110	14.3	116	14.3	0.162	8.2	LOS A	0.4	3.4	0.45	0.78	0.45	50.2
Approach		166	12.1	175	12.1	0.162	7.6	LOS A	0.4	3.4	0.42	0.71	0.42	51.7
NorthWest: Eleventh Road North-West														
10	L2	292	10.5	307	10.5	0.258	7.2	LOS A	0.0	0.0	0.00	0.44	0.00	61.5
11	T1	136	8.1	143	8.1	0.258	0.0	LOS A	0.0	0.0	0.00	0.44	0.00	71.7
Approach		428	9.7	451	9.7	0.258	4.9	NA	0.0	0.0	0.00	0.44	0.00	64.4
All Vehicles		961	9.3	1012	9.3	0.258	4.6	NA	0.9	6.9	0.17	0.38	0.17	64.0

D1.5.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
SouthEast: Eleventh Road South-East														
5	T1	306	4.0	322	4.0	0.296	1.4	LOS A	1.3	10.0	0.32	0.19	0.35	73.9
6	R2	103	8.8	108	8.8	0.296	10.0	LOS A	1.3	10.0	0.32	0.19	0.35	58.7
Approach		409	5.2	431	5.2	0.296	3.5	NA	1.3	10.0	0.32	0.19	0.35	69.0
NorthEast: Wungong Road North-East														
7	L2	66	0.0	69	0.0	0.044	6.5	LOS A	0.2	1.5	0.40	0.59	0.40	57.3
9	R2	258	7.2	272	7.2	0.392	9.4	LOS A	1.3	10.7	0.56	0.88	0.75	51.2
Approach		324	5.7	341	5.7	0.392	8.8	LOS A	1.3	10.7	0.53	0.82	0.67	52.4
NorthWest: Eleventh Road North-West														
10	L2	226	11.6	238	11.6	0.268	7.3	LOS A	0.0	0.0	0.00	0.33	0.00	62.4
11	T1	218	7.1	229	7.1	0.268	0.0	LOS A	0.0	0.0	0.00	0.33	0.00	73.7
Approach		444	9.4	467	9.4	0.268	3.7	NA	0.0	0.0	0.00	0.33	0.00	67.4
All Vehicles		1177	6.9	1239	6.9	0.392	5.1	NA	1.3	10.7	0.26	0.42	0.31	63.0

D2 Individual sites – Do Something

D2.1 SWH/ William St/ Bedfordale Hill Rd

D2.1.1 AM Peak

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
3	L1	254	3.8	267	3.8	*0.951	65.4	LOS E	44.9	371.0	1.00	1.26	1.39	26.5
4	T1	1159	9.8	1220	9.8	0.951	59.2	LOS E	47.9	410.1	1.00	1.29	1.38	30.2
5	R2	33	10.0	35	10.0	*0.104	20.9	LOS C	0.9	7.7	0.65	0.67	0.65	38.2
Approach		1446	8.8	1522	8.8	0.951	59.4	LOS E	47.9	410.1	0.99	1.27	1.37	29.7
East: Bedfordale Hill Road East														
6	L2	30	0.0	32	0.0	0.914	65.4	LOS E	10.3	76.0	1.00	1.10	1.54	24.8
6a	R1	143	0.0	151	0.0	*0.914	63.7	LOS E	10.3	76.0	1.00	1.10	1.54	22.4
7	R2	118	6.4	124	6.4	0.677	53.5	LOS D	6.1	47.8	1.00	0.84	1.10	26.6
Approach		291	2.6	306	2.6	0.914	59.8	LOS E	10.3	76.0	1.00	1.00	1.36	24.3
North: South Western Highway North														
8	L2	39	13.8	41	13.8	0.361	23.8	LOS C	8.3	70.8	0.68	0.61	0.68	38.6
9	T1	524	10.7	552	10.7	0.361	16.6	LOS B	8.9	76.2	0.66	0.58	0.66	46.9
10	R3	41	0.0	43	0.0	*0.324	32.4	LOS C	1.2	8.8	0.98	0.73	0.98	35.5
Approach		604	10.2	636	10.2	0.361	18.1	LOS B	8.9	76.2	0.68	0.59	0.68	45.5
NorthWest: William Street North-West														
11	L3	94	1.8	99	1.8	0.765	49.9	LOS D	8.5	64.5	1.00	1.04	1.16	30.1
1	L1	65	2.6	68	2.6	*0.765	47.7	LOS D	8.5	64.5	1.00	1.04	1.16	25.4
2	R1	197	5.2	207	5.2	0.765	51.7	LOS D	8.5	64.5	1.00	0.94	1.18	28.9
Approach		356	3.8	375	3.8	0.765	50.5	LOS D	8.5	65.4	1.00	0.98	1.17	28.6
All Vehicles		2697	7.8	2839	7.8	0.951	49.0	LOS D	47.9	410.1	0.92	1.05	1.19	31.5

D2.1.2 PM Peak

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
3	L1	184	0.9	194	0.9	*0.939	78.1	LOS E	43.4	347.2	1.00	1.21	1.29	24.1
4	T1	969	8.5	1020	8.5	*0.939	72.0	LOS E	45.8	379.4	1.00	1.23	1.28	27.3
5	R2	21	7.7	22	7.7	0.139	36.6	LOS D	1.0	7.5	0.84	0.69	0.84	31.9
Approach		1174	7.3	1236	7.3	0.939	72.3	LOS E	45.8	379.4	1.00	1.22	1.28	26.9
East: Bedfordale Hill Road East														
6	L2	45	11.1	47	11.1	*0.743	68.4	LOS E	9.3	73.6	1.00	0.88	1.13	24.1
6a	R1	93	5.4	98	5.4	0.743	66.4	LOS E	9.3	73.6	1.00	0.88	1.13	21.8
7	R2	48	10.5	51	10.5	0.221	59.0	LOS E	2.9	23.3	0.93	0.74	0.93	25.0
Approach		186	8.1	196	8.1	0.743	65.0	LOS E	9.3	73.6	0.98	0.85	1.08	23.2
North: South Western Highway North														
8	L2	41	0.0	43	0.0	0.680	40.9	LOS D	21.8	180.0	0.88	0.78	0.88	32.8
9	T1	793	8.1	835	8.1	0.680	33.9	LOS C	21.9	183.4	0.87	0.77	0.87	38.4
10	R3	44	9.4	46	9.4	*0.478	44.9	LOS D	2.1	16.6	1.00	0.74	1.00	31.2
Approach		878	7.8	924	7.8	0.680	34.8	LOS C	21.9	183.4	0.87	0.77	0.87	37.8
NorthWest: William Street North-West														
11	L3	81	4.3	85	4.3	0.799	62.3	LOS E	22.2	168.4	0.99	1.00	1.08	26.8
1	L1	136	2.5	143	2.5	*0.799	60.1	LOS E	22.2	168.4	0.99	1.00	1.08	22.6
2	R1	436	3.1	459	3.1	0.799	55.7	LOS E	22.2	168.4	0.97	0.93	1.07	28.0
Approach		653	3.1	687	3.1	0.799	57.4	LOS E	22.2	168.4	0.98	0.95	1.07	26.7
All Vehicles		2891	6.6	3043	6.6	0.939	57.1	LOS E	45.8	379.4	0.95	1.00	1.10	29.3

D2.2 SWH/ Dickens Place

D2.2.1 AM Peak – Priority Controlled layout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	21	7.7	22	7.7	0.013	6.5	LOS A	0.0	0.0	0.00	0.61	0.00	57.5
2	T1	1470	7.0	1547	7.0	0.431	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.6
Approach		1491	7.0	1569	7.0	0.431	0.2	NA	0.0	0.0	0.00	0.01	0.00	69.4
North: South Western Highway North														
8	T1	747	7.8	786	7.8	0.431	7.7	LOS A	4.1	33.4	0.04	0.00	0.04	61.0
9	R2	62	22.5	65	22.5	3.585	2447.2	LOS F	38.2	353.5	1.00	1.86	5.15	1.4
Approach		809	8.9	852	8.9	3.585	194.7	NA	38.2	353.5	0.11	0.14	0.43	14.2
West: Dickens Place West														
10	L2	83	13.8	87	13.8	1.108	243.5	LOS F	11.0	92.7	1.00	1.90	4.09	11.4
12	R2	14	40.0	15	40.0	2.456	1760.5	LOS F	10.6	110.7	1.00	1.36	2.35	1.7
Approach		97	17.6	102	17.6	2.456	462.4	LOS F	11.0	110.7	1.00	1.82	3.83	6.3
All Vehicles		2397	8.1	2523	8.1	3.585	84.6	NA	38.2	353.5	0.08	0.13	0.30	25.5

D2.2.2 PM Peak – Priority Controlled layout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	33	5.0	35	5.0	0.020	6.5	LOS A	0.0	0.0	0.00	0.61	0.00	59.2
2	T1	970	7.3	1021	7.3	0.286	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.8
Approach		1003	7.2	1056	7.2	0.286	0.3	NA	0.0	0.0	0.00	0.02	0.00	69.4
North: South Western Highway North														
8	T1	1353	4.6	1424	4.6	0.388	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
9	R2	78	17.7	82	17.7	0.915	112.6	LOS F	5.0	46.1	0.99	1.36	2.59	20.7
Approach		1431	5.3	1506	5.3	0.915	6.2	NA	5.0	46.1	0.05	0.07	0.14	61.8
West: Dickens Place West														
10	L2	134	9.7	141	9.7	0.547	27.1	LOS D	2.7	22.1	0.90	1.11	1.38	37.8
12	R2	37	0.0	39	0.0	6.491	5185.0	LOS F	34.3	252.2	1.00	1.42	2.82	0.6
Approach		171	7.6	180	7.6	6.491	1143.1	LOS F	34.3	252.2	0.92	1.18	1.69	2.8
All Vehicles		2605	6.2	2742	6.2	6.491	78.6	NA	34.3	252.2	0.09	0.13	0.19	26.5

D2.2.3 AM Peak – Signalised

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	21	7.7	22	7.7	0.015	8.0	LOS A	0.2	1.5	0.17	0.63	0.17	51.2
2	T1	1470	7.0	1547	7.0	*0.596	7.6	LOS A	19.8	161.9	0.52	0.48	0.52	61.1
Approach		1491	7.0	1569	7.0	0.596	7.6	LOS A	19.8	161.9	0.52	0.48	0.52	60.9
North: South Western Highway North														
8	T1	747	7.8	786	7.8	0.268	2.0	LOS A	4.3	35.7	0.23	0.20	0.23	67.4
9	R2	62	22.5	65	22.5	*0.339	14.8	LOS B	1.4	13.2	0.57	0.73	0.57	46.5
Approach		809	8.9	852	8.9	0.339	3.0	LOS A	4.3	35.7	0.25	0.24	0.25	65.2
West: Dickens Place West														
10	L2	83	13.8	87	13.8	0.525	55.1	LOS E	5.4	46.6	0.98	0.79	0.98	28.8
12	R2	14	40.0	15	40.0	*0.525	55.2	LOS E	5.4	46.6	0.98	0.79	0.98	26.6
Approach		97	17.6	102	17.6	0.525	55.1	LOS E	5.4	46.6	0.98	0.79	0.98	28.5
All Vehicles		2397	8.1	2523	8.1	0.596	8.0	LOS A	19.8	161.9	0.45	0.41	0.45	59.5

D2.2.4 PM Peak – Signalised

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	33	5.0	35	5.0	0.029	9.4	LOS A	0.3	2.5	0.32	0.66	0.32	50.3
2	T1	970	7.3	1021	7.3	*0.573	11.5	LOS B	10.6	87.7	0.75	0.66	0.75	57.3
Approach		1003	7.2	1056	7.2	0.573	11.4	LOS B	10.6	87.7	0.74	0.66	0.74	57.1
North: South Western Highway North														
8	T1	1353	4.6	1424	4.6	0.555	4.8	LOS A	10.2	80.4	0.53	0.48	0.53	64.1
9	R2	78	17.7	82	17.7	*0.242	13.8	LOS B	0.9	8.3	0.69	0.74	0.69	47.1
Approach		1431	5.3	1506	5.3	0.555	5.3	LOS A	10.2	80.4	0.54	0.49	0.54	62.9
West: Dickens Place West														
10	L2	134	9.7	141	9.7	0.553	29.2	LOS C	5.0	40.7	0.95	0.80	0.95	37.0
12	R2	37	0.0	39	0.0	*0.553	29.1	LOS C	5.0	40.7	0.95	0.80	0.95	38.7
Approach		171	7.6	180	7.6	0.553	29.2	LOS C	5.0	40.7	0.95	0.80	0.95	37.3
All Vehicles		2605	6.2	2742	6.2	0.573	9.2	LOS A	10.6	87.7	0.64	0.58	0.64	58.0

D2.2.5 AM Peak – Roundabouts

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	21	7.7	22	7.7	0.516	5.2	LOS A	4.4	36.4	0.31	0.43	0.31	53.6
2	T1	1470	7.0	1547	7.0	0.516	5.4	LOS A	4.5	36.5	0.33	0.43	0.33	60.8
Approach		1491	7.0	1569	7.0	0.516	5.4	LOS A	4.5	36.5	0.33	0.43	0.33	60.7
North: South Western Highway North														
8	T1	747	7.8	786	7.8	0.267	5.0	LOS A	2.2	18.4	0.14	0.41	0.14	61.5
9	R2	62	22.5	65	22.5	0.267	11.2	LOS B	2.2	18.2	0.15	0.44	0.15	56.2
Approach		809	8.9	852	8.9	0.267	5.5	LOS A	2.2	18.4	0.14	0.42	0.14	61.0
West: Dickens Place West														
10	L2	83	13.8	87	13.8	0.209	8.4	LOS A	0.9	7.9	0.75	0.84	0.75	47.2
12	R2	14	40.0	15	40.0	0.209	15.1	LOS B	0.9	7.9	0.75	0.84	0.75	42.5
Approach		97	17.6	102	17.6	0.209	9.4	LOS A	0.9	7.9	0.75	0.84	0.75	46.4
All Vehicles		2397	8.1	2523	8.1	0.516	5.6	LOS A	4.5	36.5	0.28	0.44	0.28	60.1

D2.2.6 PM Peak – Roundabouts

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	33	5.0	35	5.0	0.358	5.1	LOS A	2.6	21.5	0.30	0.44	0.30	53.7
2	T1	970	7.3	1021	7.3	0.358	5.4	LOS A	2.6	21.5	0.32	0.44	0.32	60.8
Approach		1003	7.2	1056	7.2	0.358	5.4	LOS A	2.6	21.5	0.32	0.44	0.32	60.5
North: South Western Highway North														
8	T1	1353	4.6	1424	4.6	0.473	5.2	LOS A	4.9	38.8	0.27	0.41	0.27	61.7
9	R2	78	17.7	82	17.7	0.473	11.4	LOS B	4.9	38.9	0.29	0.43	0.29	55.7
Approach		1431	5.3	1506	5.3	0.473	5.5	LOS A	4.9	38.9	0.27	0.41	0.27	61.3
West: Dickens Place West														
10	L2	134	9.7	141	9.7	0.270	6.4	LOS A	1.2	9.6	0.67	0.81	0.67	49.1
12	R2	37	0.0	39	0.0	0.270	11.1	LOS B	1.2	9.6	0.67	0.81	0.67	52.8
Approach		171	7.6	180	7.6	0.270	7.4	LOS A	1.2	9.6	0.67	0.81	0.67	49.9
All Vehicles		2605	6.2	2742	6.2	0.473	5.6	LOS A	4.9	38.9	0.31	0.45	0.31	60.1

D2.3 SWH/ Stone Street

D2.3.1 AM Peak – Priority Controlled layout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	55	11.8	58	11.8	0.039	7.6	LOS A	0.0	0.0	0.00	0.63	0.00	56.0
2	T1	1413	5.9	1487	5.9	0.408	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
Approach		1468	6.1	1545	6.1	0.408	0.4	NA	0.0	0.0	0.00	0.02	0.00	69.0
North: South Western Highway North														
8	T1	779	8.4	820	8.4	0.447	6.2	LOS A	6.4	52.6	0.04	0.00	0.05	62.5
9a	R1	29	27.9	31	27.9	2.178	1297.8	LOS F	15.7	171.0	1.00	1.55	3.51	2.5
Approach		808	9.1	851	9.1	2.178	52.6	NA	15.7	171.0	0.08	0.06	0.17	33.3
SouthWest: Stone Street South-West														
30a	L1	63	31.6	66	31.6	1.490	583.4	LOS F	18.7	224.3	1.00	2.37	5.15	5.3
32b	R3	63	15.8	66	15.8	11.053	9221.0	LOS F	61.2	548.0	1.00	1.49	2.93	0.4
Approach		126	23.7	133	23.7	11.053	4902.2	LOS F	61.2	548.0	1.00	1.93	4.04	0.7
All Vehicles		2402	8.0	2528	8.0	11.053	275.1	NA	61.2	548.0	0.08	0.13	0.27	10.7

D2.3.2 PM Peak – Priority Controlled layout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	48	16.6	51	16.6	0.038	7.7	LOS A	0.0	0.0	0.00	0.63	0.00	54.8
2	T1	948	6.5	998	6.5	0.276	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.8
Approach		996	7.0	1048	7.0	0.276	0.4	NA	0.0	0.0	0.00	0.03	0.00	68.9
North: South Western Highway North														
8	T1	1408	4.0	1482	4.0	0.401	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
9a	R1	21	38.5	22	38.5	0.503	109.0	LOS F	1.5	20.2	0.96	1.04	1.20	21.5
Approach		1429	4.5	1504	4.5	0.503	1.7	NA	1.5	20.2	0.01	0.02	0.02	67.4
SouthWest: Stone Street South-West														
30a	L1	63	26.3	66	26.3	0.410	34.0	LOS D	1.6	19.7	0.90	1.04	1.16	33.5
32b	R3	230	7.2	242	7.2	40.351	35501.4	LOS F	231.4	1828.2	1.00	1.50	3.09	0.1
Approach		293	11.3	308	11.3	40.351	27875.3	LOS F	231.4	1828.2	0.98	1.40	2.68	0.1
All Vehicles		2718	6.1	2861	6.1	40.351	3006.0	NA	231.4	1828.2	0.11	0.17	0.30	1.2

D2.3.3 AM Peak – Signalised

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	55	11.8	58	11.8	0.050	9.8	LOS A	0.5	4.3	0.25	0.67	0.25	50.4
2	T1	1413	5.9	1487	5.9	*0.694	12.4	LOS B	20.2	163.0	0.75	0.68	0.75	56.6
Approach		1468	6.1	1545	6.1	0.694	12.3	LOS B	20.2	163.0	0.73	0.68	0.73	56.3
North: South Western Highway North														
8	T1	779	8.4	820	8.4	0.317	3.8	LOS A	5.4	44.7	0.37	0.32	0.37	65.2
9a	R1	29	27.9	31	27.9	*0.152	15.6	LOS B	0.5	5.6	0.68	0.69	0.68	46.9
Approach		808	9.1	851	9.1	0.317	4.3	LOS A	5.4	44.7	0.38	0.34	0.38	64.3
SouthWest: Stone Street South-West														
30a	L1	63	31.6	66	31.6	0.712	43.2	LOS D	5.5	57.8	1.00	0.90	1.18	30.1
32b	R3	63	15.8	66	15.8	*0.712	45.0	LOS D	5.5	57.8	1.00	0.90	1.18	31.8
Approach		126	23.7	133	23.7	0.712	44.1	LOS D	5.5	57.8	1.00	0.90	1.18	30.9
All Vehicles		2402	8.0	2528	8.0	0.712	11.2	LOS B	20.2	163.0	0.63	0.58	0.64	56.2

D2.3.4 PM Peak – Signalised

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	48	16.6	51	16.6	0.054	10.7	LOS B	0.5	4.2	0.33	0.68	0.33	49.7
2	T1	948	6.5	998	6.5	*0.787	22.8	LOS C	14.9	121.0	0.96	0.93	1.11	48.6
Approach		996	7.0	1048	7.0	0.787	22.2	LOS C	14.9	121.0	0.93	0.91	1.07	48.7
North: South Western Highway North														
8	T1	1408	4.0	1482	4.0	0.725	11.5	LOS B	16.7	129.9	0.81	0.74	0.82	57.3
9a	R1	21	38.5	22	38.5	*0.103	17.6	LOS B	0.3	4.5	0.83	0.69	0.83	45.7
Approach		1429	4.5	1504	4.5	0.725	11.5	LOS B	16.7	129.9	0.81	0.74	0.82	57.1
SouthWest: Stone Street South-West														
30a	L1	63	26.3	66	26.3	0.813	32.5	LOS C	10.2	89.5	0.99	0.99	1.29	33.5
32b	R3	230	7.2	242	7.2	*0.813	34.3	LOS C	10.2	89.5	0.99	0.99	1.29	36.0
Approach		293	11.3	308	11.3	0.813	33.9	LOS C	10.2	89.5	0.99	0.99	1.29	35.4
All Vehicles		2718	6.1	2861	6.1	0.813	17.9	LOS B	16.7	129.9	0.87	0.83	0.97	50.6

D2.3.5 AM Peak – Roundabouts

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	55	11.8	58	11.8	0.485	4.9	LOS A	4.2	34.3	0.21	0.41	0.21	53.2
2	T1	1413	5.9	1487	5.9	0.485	5.1	LOS A	4.2	34.3	0.22	0.41	0.22	61.8
Approach		1468	6.1	1545	6.1	0.485	5.1	LOS A	4.2	34.3	0.22	0.41	0.22	61.5
North: South Western Highway North														
8	T1	779	8.4	820	8.4	0.289	5.3	LOS A	2.3	19.0	0.30	0.43	0.30	60.6
9a	R1	29	27.9	31	27.9	0.289	10.4	LOS B	2.2	18.9	0.32	0.44	0.32	54.6
Approach		808	9.1	851	9.1	0.289	5.5	LOS A	2.3	19.0	0.30	0.43	0.30	60.4
SouthWest: Stone Street South-West														
30a	L1	63	31.6	66	31.6	0.111	6.5	LOS A	0.4	5.3	0.67	0.74	0.67	46.6
32b	R3	63	15.8	66	15.8	0.120	13.6	LOS B	0.5	4.2	0.67	0.87	0.67	46.0
Approach		126	23.7	133	23.7	0.120	10.1	LOS B	0.5	5.3	0.67	0.81	0.67	46.3
All Vehicles		2402	8.0	2528	8.0	0.485	5.5	LOS A	4.2	34.3	0.27	0.44	0.27	60.0

D2.3.6 PM Peak – Roundabouts

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1b	L3	48	16.6	51	16.6	0.331	4.9	LOS A	2.7	22.3	0.18	0.41	0.18	53.3
2	T1	948	6.5	998	6.5	0.331	5.1	LOS A	2.7	22.3	0.19	0.40	0.19	61.9
Approach		996	7.0	1048	7.0	0.331	5.0	LOS A	2.7	22.3	0.19	0.40	0.19	61.4
North: South Western Highway North														
8	T1	1408	4.0	1482	4.0	0.589	6.8	LOS A	5.9	45.7	0.70	0.59	0.70	59.4
9a	R1	21	38.5	22	38.5	0.589	13.9	LOS B	5.6	44.4	0.72	0.63	0.72	52.4
Approach		1429	4.5	1504	4.5	0.589	6.9	LOS A	5.9	45.7	0.70	0.59	0.70	59.3
SouthWest: Stone Street South-West														
30a	L1	63	26.3	66	26.3	0.151	7.7	LOS A	0.5	6.3	0.62	0.71	0.62	46.9
32b	R3	230	7.2	242	7.2	0.246	10.9	LOS B	1.0	8.2	0.59	0.81	0.59	48.9
Approach		293	11.3	308	11.3	0.246	10.2	LOS B	1.0	8.2	0.59	0.79	0.59	48.5
All Vehicles		2718	6.1	2861	6.1	0.589	6.6	LOS A	5.9	45.7	0.50	0.55	0.50	58.6

D2.4 SWH/ Eleventh Road

D2.4.1 AM Peak – Priority Controlled layout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	170	10.0	179	10.0	0.111	7.1	LOS A	0.0	0.0	0.00	0.63	0.00	62.0
2	T1	1602	6.6	1686	6.6	0.480	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.5
Approach		1772	6.9	1865	6.9	0.480	0.8	NA	0.0	0.0	0.00	0.06	0.00	77.4
North: South Western Highway North														
8	T1	817	9.9	860	9.9	0.474	5.3	LOS A	5.7	43.0	0.04	0.00	0.04	71.6
9	R2	33	5.3	35	5.3	2.451	1521.2	LOS F	18.8	137.3	1.00	1.46	3.78	2.1
Approach		850	9.7	895	9.7	2.451	64.2	NA	18.8	137.3	0.08	0.06	0.19	31.7
West: Eleventh Road West														
10	L2	47	17.4	49	17.4	1.031	275.1	LOS F	6.1	49.1	1.00	1.31	2.61	11.0
12	R2	161	7.7	169	7.7	28.246	24624.9	LOS F	160.7	1174.2	1.00	1.33	3.08	0.1
Approach		208	9.9	219	9.9	28.246	19122.8	LOS F	160.7	1174.2	1.00	1.32	2.97	0.2
All Vehicles		2830	8.0	2979	8.0	28.246	1425.3	NA	160.7	1174.2	0.10	0.15	0.27	2.4

D2.4.2 PM Peak – Priority Controlled layout

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	174	2.2	183	2.2	0.103	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	64.6
2	T1	1068	7.6	1124	7.6	0.319	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.8
Approach		1242	6.8	1307	6.8	0.319	1.0	NA	0.0	0.0	0.00	0.09	0.00	77.2
North: South Western Highway North														
8	T1	1508	4.0	1587	4.0	0.430	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	79.6
9	R2	65	8.1	68	8.1	0.998	175.3	LOS F	6.1	45.9	1.00	1.36	2.97	16.2
Approach		1573	4.2	1656	4.2	0.998	7.3	NA	6.1	45.9	0.04	0.06	0.12	68.5
West: Eleventh Road West														
10	L2	58	3.6	61	3.6	0.278	26.4	LOS D	1.0	7.4	0.87	0.98	0.99	47.6
12	R2	194	2.1	204	2.1	34.035	29819.7	LOS F	191.8	1366.5	1.00	1.33	3.17	0.1
Approach		252	2.4	265	2.4	34.035	22962.5	LOS F	191.8	1366.5	0.97	1.25	2.67	0.2
All Vehicles		3067	5.1	3228	5.1	34.035	1890.9	NA	191.8	1366.5	0.10	0.17	0.28	1.9

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D2.4.3 AM Peak – Signalised

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	170	10.0	179	10.0	0.136	9.0	LOS A	1.7	12.9	0.22	0.68	0.22	60.1
2	T1	1602	6.6	1686	6.6	*0.856	22.5	LOS C	40.7	299.2	0.82	0.82	0.91	53.5
Approach		1772	6.9	1865	6.9	0.856	21.2	LOS C	40.7	299.2	0.77	0.81	0.84	54.1
North: South Western Highway North														
8	T1	817	9.9	860	9.9	0.338	5.1	LOS A	7.4	55.8	0.39	0.34	0.39	71.9
9	R2	33	5.3	35	5.3	*0.180	26.2	LOS C	1.0	7.1	0.83	0.74	0.83	47.6
Approach		850	9.7	895	9.7	0.338	5.9	LOS A	7.4	55.8	0.40	0.36	0.40	70.5
West: Eleventh Road West														
10	L2	47	17.4	49	17.4	0.861	61.5	LOS E	12.1	90.7	1.00	0.94	1.34	31.1
12	R2	161	7.7	169	7.7	*0.861	61.5	LOS E	12.1	90.7	1.00	0.94	1.34	32.5
Approach		208	9.9	219	9.9	0.861	61.5	LOS E	12.1	90.7	1.00	0.94	1.34	32.2
All Vehicles		2830	8.0	2979	8.0	0.861	19.6	LOS B	40.7	299.2	0.67	0.68	0.75	55.2

D2.4.4 PM Peak – Signalised

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	174	2.2	183	2.2	0.133	9.4	LOS A	1.8	12.6	0.27	0.69	0.27	62.0
2	T1	1068	7.6	1124	7.6	*0.715	17.0	LOS B	18.9	141.3	0.81	0.73	0.82	58.2
Approach		1242	6.8	1307	6.8	0.715	16.0	LOS B	18.9	141.3	0.74	0.72	0.74	58.7
North: South Western Highway North														
8	T1	1508	4.0	1587	4.0	0.693	9.8	LOS A	20.7	149.2	0.68	0.62	0.68	65.8
9	R2	65	8.1	68	8.1	*0.260	19.6	LOS B	1.1	8.4	0.79	0.75	0.79	51.5
Approach		1573	4.2	1656	4.2	0.693	10.2	LOS B	20.7	149.2	0.69	0.63	0.69	65.0
West: Eleventh Road West														
10	L2	58	3.6	61	3.6	0.677	39.2	LOS D	10.0	71.2	0.97	0.85	1.02	40.8
12	R2	194	2.1	204	2.1	*0.677	39.3	LOS D	10.0	71.2	0.97	0.85	1.02	41.2
Approach		252	2.4	265	2.4	0.677	39.3	LOS D	10.0	71.2	0.97	0.85	1.02	41.1
All Vehicles		3067	5.1	3228	5.1	0.715	14.9	LOS B	20.7	149.2	0.73	0.69	0.74	59.6

D2.4.5 AM Peak – Roundabouts

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	170	10.0	179	10.0	0.576	5.9	LOS A	6.5	47.9	0.26	0.44	0.26	63.7
2	T1	1602	6.6	1686	6.6	0.576	6.3	LOS A	6.5	48.0	0.28	0.44	0.28	66.4
Approach		1772	6.9	1865	6.9	0.576	6.3	LOS A	6.5	48.0	0.28	0.44	0.28	66.1
North: South Western Highway North														
8	T1	817	9.9	860	9.9	0.334	7.2	LOS A	2.7	20.4	0.48	0.54	0.48	64.1
9	R2	33	5.3	35	5.3	0.334	13.0	LOS B	2.6	19.5	0.50	0.56	0.50	64.6
Approach		850	9.7	895	9.7	0.334	7.4	LOS A	2.7	20.4	0.49	0.54	0.49	64.1
West: Eleventh Road West														
10	L2	47	17.4	49	17.4	0.423	14.3	LOS B	2.2	16.5	0.80	0.98	0.99	51.7
12	R2	161	7.7	169	7.7	0.423	20.0	LOS C	2.2	16.5	0.80	0.98	0.99	55.4
Approach		208	9.9	219	9.9	0.423	18.7	LOS B	2.2	16.5	0.80	0.98	0.99	54.5
All Vehicles		2830	8.0	2979	8.0	0.576	7.5	LOS A	6.5	48.0	0.38	0.51	0.39	64.5

D2.4.6 PM Peak – Roundabouts

Vehicle Movement Performance														
Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: South Western Highway South														
1	L2	174	2.2	183	2.2	0.428	5.9	LOS A	4.0	29.5	0.33	0.47	0.33	65.6
2	T1	1068	7.6	1124	7.6	0.428	6.5	LOS A	4.0	29.5	0.34	0.47	0.34	65.6
Approach		1242	6.8	1307	6.8	0.428	6.4	LOS A	4.0	29.5	0.34	0.47	0.34	65.6
North: South Western Highway North														
8	T1	1508	4.0	1587	4.0	0.613	7.6	LOS A	6.6	47.6	0.68	0.60	0.68	64.3
9	R2	65	8.1	68	8.1	0.613	14.0	LOS B	6.3	45.7	0.70	0.63	0.70	62.4
Approach		1573	4.2	1656	4.2	0.613	7.9	LOS A	6.6	47.6	0.68	0.60	0.68	64.2
West: Eleventh Road West														
10	L2	58	3.6	61	3.6	0.401	10.6	LOS B	2.1	14.9	0.74	0.95	0.85	57.7
12	R2	194	2.1	204	2.1	0.401	17.0	LOS B	2.1	14.9	0.74	0.95	0.85	59.6
Approach		252	2.4	265	2.4	0.401	15.5	LOS B	2.1	14.9	0.74	0.95	0.85	59.2
All Vehicles		3067	5.1	3228	5.1	0.613	7.9	LOS A	6.6	47.6	0.55	0.57	0.56	64.3

D3 Armadale Road Network

D3.1 Do Nothing (LX at grade)

D3.1.1 AM Peak – Network Performance

Network Performance - Hourly Values									
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS F							
Speed Efficiency	0.24							
Travel Time Index	1.55							
Congestion Coefficient	4.18							
Travel Speed (Average)	14.8	km/h			1.3	km/h	14.7	km/h
Travel Distance (Total)	4704.0	veh-km/h			5.9	ped-km/h	5650.8	pers-km/h
Travel Time (Total)	317.3	veh-h/h			4.5	ped-h/h	385.2	pers-h/h
Desired Speed (Program)	62.0	km/h						
Demand Flows (Total for all Sites)	14703	veh/h			69	ped/h	17713	pers/h
Arrival Flows (Total for all Sites)	14414	veh/h			69	ped/h	17366	pers/h
Demand Flows (Entry Total)	4423	veh/h						
Midblock Inflows (Total)	132	veh/h						
Midblock Outflows (Total)	-301	veh/h						
Percent Heavy Vehicles (Demand)	6.4	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	2.149							
Control Delay (Total)	238.85	veh-h/h			3.10	ped-h/h	289.72	pers-h/h
Control Delay (Average)	59.7	sec			160.6	sec	60.1	sec
Control Delay (Worst Lane)	1070.5	sec						
Control Delay (Worst Movement)	1070.5	sec			197.4	sec	1070.5	sec
Geometric Delay (Average)	1.4	sec						
Stop-Line Delay (Average)	58.2	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	9603	veh/h			68	ped/h	11592	pers/h
Effective Stop Rate	0.67		2.04	per km	0.99		0.67	
Proportion Queued	0.40				0.99		0.41	
Performance Index	809.1				4.8		814.0	
Cost (Total)	12924.10	$/h	2.75	$/km	123.27	$/h	13047.37	$/h
Fuel Consumption (Total)	1073.3	L/h	228.2	mL/km				
Fuel Economy	22.8	L/100km						
Carbon Dioxide (Total)	2548.5	kg/h	541.8	g/km				
Hydrocarbons (Total)	0.236	kg/h	0.050	g/km				
Carbon Monoxide (Total)	2.355	kg/h	0.501	g/km				
NOx (Total)	7.965	kg/h	1.693	g/km				

D3.1.2 PM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS F							
Speed Efficiency	0.15							
Travel Time Index	0.54							
Congestion Coefficient	6.73							
Travel Speed (Average)	9.1	km/h			1.3	km/h	9.1	km/h
Travel Distance (Total)	5277.0	veh-km/h			5.9	ped-km/h	6338.3	pers-km/h
Travel Time (Total)	578.1	veh-h/h			4.5	ped-h/h	698.2	pers-h/h
Desired Speed (Program)	61.5	km/h						
Demand Flows (Total for all Sites)	17214	veh/h			69	ped/h	20726	pers/h
Arrival Flows (Total for all Sites)	16025	veh/h			69	ped/h	19299	pers/h
Demand Flows (Entry Total)	5222	veh/h						
Midblock Inflows (Total)	166	veh/h						
Midblock Outflows (Total)	-428	veh/h						
Percent Heavy Vehicles (Demand)	5.4	%						
Percent Heavy Vehicles (Arrival)	5.8	%						
Degree of Saturation	3.083							
Control Delay (Total)	485.78	veh-h/h			3.12	ped-h/h	586.06	pers-h/h
Control Delay (Average)	109.1	sec			161.7	sec	109.3	sec
Control Delay (Worst Lane)	1914.9	sec						
Control Delay (Worst Movement)	1914.9	sec			197.4	sec	1914.9	sec
Geometric Delay (Average)	1.5	sec						
Stop-Line Delay (Average)	107.6	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.19							
Total Effective Stops	14784	veh/h			69	ped/h	17809	pers/h
Effective Stop Rate	0.92		2.80	per km	0.99		0.92	
Proportion Queued	0.43				0.99		0.46	
Performance Index	1339.1				4.9		1344.0	
Cost (Total)	22469.18	$/h	4.26	$/km	123.85	$/h	22593.03	$/h
Fuel Consumption (Total)	1477.2	L/h	279.9	mL/km				
Fuel Economy	28.0	L/100km						
Carbon Dioxide (Total)	3497.5	kg/h	662.8	g/km				
Hydrocarbons (Total)	0.336	kg/h	0.064	g/km				
Carbon Monoxide (Total)	2.964	kg/h	0.562	g/km				
NOx (Total)	8.677	kg/h	1.644	g/km				

D3.2 Do Nothing (Grade separated)

D3.2.1 AM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS F							
Speed Efficiency	0.28							
Travel Time Index	1.95							
Congestion Coefficient	3.64							
Travel Speed (Average)	17.1	km/h			3.5	km/h	17.0	km/h
Travel Distance (Total)	4765.4	veh-km/h			3.8	ped-km/h	5722.3	pers-km/h
Travel Time (Total)	279.1	veh-h/h			1.1	ped-h/h	336.0	pers-h/h
Desired Speed (Program)	62.1	km/h						
Demand Flows (Total for all Sites)	12194	veh/h			17	ped/h	14649	pers/h
Arrival Flows (Total for all Sites)	12001	veh/h			17	ped/h	14418	pers/h
Demand Flows (Entry Total)	4423	veh/h						
Midblock Inflows (Total)	128	veh/h						
Midblock Outflows (Total)	-296	veh/h						
Percent Heavy Vehicles (Demand)	6.3	%						
Percent Heavy Vehicles (Arrival)	6.4	%						
Degree of Saturation	1.876							
Control Delay (Total)	200.19	veh-h/h			0.21	ped-h/h	240.44	pers-h/h
Control Delay (Average)	60.0	sec			45.4	sec	60.0	sec
Control Delay (Worst Lane)	810.5	sec						
Control Delay (Worst Movement)	810.5	sec			45.6	sec	810.5	sec
Geometric Delay (Average)	1.8	sec						
Stop-Line Delay (Average)	58.2	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	8964	veh/h			16	ped/h	10772	pers/h
Effective Stop Rate	0.75		1.88	per km	0.96		0.75	
Proportion Queued	0.42				0.96		0.42	
Performance Index	671.3				1.2		672.5	
Cost (Total)	11413.27	$/h	2.40	$/km	30.15	$/h	11443.41	$/h
Fuel Consumption (Total)	964.8	L/h	202.5	mL/km				
Fuel Economy	20.2	L/100km						
Carbon Dioxide (Total)	2291.7	kg/h	480.9	g/km				
Hydrocarbons (Total)	0.209	kg/h	0.044	g/km				
Carbon Monoxide (Total)	2.142	kg/h	0.450	g/km				
NOx (Total)	7.078	kg/h	1.485	g/km				

D3.2.2 PM Peak – Network Performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS F							
Speed Efficiency	0.18							
Travel Time Index	0.87							
Congestion Coefficient	5.61							
Travel Speed (Average)	11.0	km/h			3.4	km/h	11.0	km/h
Travel Distance (Total)	5342.8	veh-km/h			3.8	ped-km/h	6415.2	pers-km/h
Travel Time (Total)	486.7	veh-h/h			1.1	ped-h/h	585.1	pers-h/h
Desired Speed (Program)	61.5	km/h						
Demand Flows (Total for all Sites)	14306	veh/h			17	ped/h	17184	pers/h
Arrival Flows (Total for all Sites)	13396	veh/h			17	ped/h	16093	pers/h
Demand Flows (Entry Total)	5222	veh/h						
Midblock Inflows (Total)	162	veh/h						
Midblock Outflows (Total)	-425	veh/h						
Percent Heavy Vehicles (Demand)	5.3	%						
Percent Heavy Vehicles (Arrival)	5.7	%						
Degree of Saturation	3.311							
Control Delay (Total)	394.03	veh-h/h			0.23	ped-h/h	473.07	pers-h/h
Control Delay (Average)	105.9	sec			49.9	sec	105.8	sec
Control Delay (Worst Lane)	2253.3	sec						
Control Delay (Worst Movement)	2253.3	sec			50.1	sec	2253.3	sec
Geometric Delay (Average)	1.9	sec						
Stop-Line Delay (Average)	104.0	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.27							
Total Effective Stops	14275	veh/h			16	ped/h	17146	pers/h
Effective Stop Rate	1.07		2.67	per km	0.96		1.07	
Proportion Queued	0.45				0.96		0.47	
Performance Index	1141.9				1.2		1143.1	
Cost (Total)	19041.40	$/h	3.56	$/km	30.73	$/h	19072.12	$/h
Fuel Consumption (Total)	1299.0	L/h	243.1	mL/km				
Fuel Economy	24.3	L/100km						
Carbon Dioxide (Total)	3077.2	kg/h	576.0	g/km				
Hydrocarbons (Total)	0.294	kg/h	0.055	g/km				
Carbon Monoxide (Total)	2.681	kg/h	0.502	g/km				
NOx (Total)	7.726	kg/h	1.446	g/km				

D3.3 Do Something (Grade separated)

D3.3.1 AM Peak – Network Performance – Fully Signalised

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.55							
Travel Time Index	4.98							
Congestion Coefficient	1.82							
Travel Speed (Average)	34.1	km/h			3.5	km/h	33.9	km/h
Travel Distance (Total)	4806.1	veh-km/h			3.8	ped-km/h	5771.1	pers-km/h
Travel Time (Total)	141.1	veh-h/h			1.1	ped-h/h	170.4	pers-h/h
Desired Speed (Program)	62.2	km/h						
Demand Flows (Total for all Sites)	11675	veh/h			17	ped/h	14027	pers/h
Arrival Flows (Total for all Sites)	11675	veh/h			17	ped/h	14027	pers/h
Demand Flows (Entry Total)	4423	veh/h						
Midblock Inflows (Total)	128	veh/h						
Midblock Outflows (Total)	-296	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	0.858							
Control Delay (Total)	63.09	veh-h/h			0.19	ped-h/h	75.91	pers-h/h
Control Delay (Average)	19.5	sec			40.9	sec	19.5	sec
Control Delay (Worst Lane)	53.7	sec						
Control Delay (Worst Movement)	53.7	sec			41.1	sec	53.7	sec
Geometric Delay (Average)	1.7	sec						
Stop-Line Delay (Average)	17.7	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.44							
Total Effective Stops	7114	veh/h			16	ped/h	8553	pers/h
Effective Stop Rate	0.61		1.48	per km	0.95		0.61	
Proportion Queued	0.62				0.95		0.62	
Performance Index	536.0				1.2		537.2	
Cost (Total)	6849.39	$/h	1.43	$/km	29.57	$/h	6878.95	$/h
Fuel Consumption (Total)	967.6	L/h	201.3	mL/km				
Fuel Economy	20.1	L/100km						
Carbon Dioxide (Total)	2301.9	kg/h	479.0	g/km				
Hydrocarbons (Total)	0.182	kg/h	0.038	g/km				
Carbon Monoxide (Total)	2.141	kg/h	0.446	g/km				
NOx (Total)	9.649	kg/h	2.008	g/km				

D3.3.2 PM Peak – Network Performance – Fully Signalised

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS E							
Speed Efficiency	0.44							
Travel Time Index	3.79							
Congestion Coefficient	2.27							
Travel Speed (Average)	27.2	km/h			3.5	km/h	27.1	km/h
Travel Distance (Total)	5634.8	veh-km/h			3.8	ped-km/h	6765.5	pers-km/h
Travel Time (Total)	206.9	veh-h/h			1.1	ped-h/h	249.4	pers-h/h
Desired Speed (Program)	61.7	km/h						
Demand Flows (Total for all Sites)	13675	veh/h			17	ped/h	16427	pers/h
Arrival Flows (Total for all Sites)	13671	veh/h			17	ped/h	16422	pers/h
Demand Flows (Entry Total)	5222	veh/h						
Midblock Inflows (Total)	162	veh/h						
Midblock Outflows (Total)	-425	veh/h						
Percent Heavy Vehicles (Demand)	5.5	%						
Percent Heavy Vehicles (Arrival)	5.5	%						
Degree of Saturation	1.070							
Control Delay (Total)	114.47	veh-h/h			0.21	ped-h/h	137.58	pers-h/h
Control Delay (Average)	30.1	sec			45.9	sec	30.2	sec
Control Delay (Worst Lane)	137.0	sec						
Control Delay (Worst Movement)	134.9	sec			46.1	sec	134.9	sec
Geometric Delay (Average)	1.8	sec						
Stop-Line Delay (Average)	28.4	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.79							
Total Effective Stops	9865	veh/h			16	ped/h	11854	pers/h
Effective Stop Rate	0.72		1.75	per km	0.96		0.72	
Proportion Queued	0.70				0.96		0.70	
Performance Index	878.1				1.2		879.2	
Cost (Total)	9639.13	$/h	1.71	$/km	30.21	$/h	9669.34	$/h
Fuel Consumption (Total)	1237.8	L/h	219.7	mL/km				
Fuel Economy	22.0	L/100km						
Carbon Dioxide (Total)	2939.2	kg/h	521.6	g/km				
Hydrocarbons (Total)	0.240	kg/h	0.043	g/km				
Carbon Monoxide (Total)	2.689	kg/h	0.477	g/km				
NOx (Total)	11.849	kg/h	2.103	g/km				

D3.3.3 AM Peak – Network Performance – Roundabouts Only

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.62							
Travel Time Index	5.76							
Congestion Coefficient	1.62							
Travel Speed (Average)	38.6	km/h			3.5	km/h	38.4	km/h
Travel Distance (Total)	5081.1	veh-km/h			3.8	ped-km/h	6101.2	pers-kr
Travel Time (Total)	131.5	veh-h/h			1.1	ped-h/h	158.9	pers-h/
Desired Speed (Program)	62.5	km/h						
Demand Flows (Total for all Sites)	11675	veh/h			17	ped/h	14027	pers/h
Arrival Flows (Total for all Sites)	11675	veh/h			17	ped/h	14027	pers/h
Demand Flows (Entry Total)	4423	veh/h						
Midblock Inflows (Total)	128	veh/h						
Midblock Outflows (Total)	-296	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	0.878							
Control Delay (Total)	47.61	veh-h/h			0.21	ped-h/h	57.34	pers-h/
Control Delay (Average)	14.7	sec			45.4	sec	14.7	sec
Control Delay (Worst Lane)	60.4	sec						
Control Delay (Worst Movement)	60.4	sec			45.6	sec	60.4	sec
Geometric Delay (Average)	4.3	sec						
Stop-Line Delay (Average)	10.3	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.40							
Total Effective Stops	7406	veh/h			16	ped/h	8904	pers/h
Effective Stop Rate	0.63		1.46	per km	0.96		0.63	
Proportion Queued	0.55				0.96		0.55	
Performance Index	379.2				1.2		380.4	
Cost (Total)	6666.01	$/h	1.31	$/km	30.15	$/h	6696.15	$/h
Fuel Consumption (Total)	1027.1	L/h	202.1	mL/km				
Fuel Economy	20.2	L/100km						
Carbon Dioxide (Total)	2442.7	kg/h	480.7	g/km				
Hydrocarbons (Total)	0.195	kg/h	0.038	g/km				
Carbon Monoxide (Total)	2.270	kg/h	0.447	g/km				
NOx (Total)	9.595	kg/h	1.888	g/km				

D3.3.4 PM Peak – Network Performance – Roundabouts Only

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.54							
Travel Time Index	4.91							
Congestion Coefficient	1.85							
Travel Speed (Average)	33.6	km/h			3.3	km/h	33.4	km/h
Travel Distance (Total)	5945.3	veh-km/h			3.8	ped-km/h	7138.1	pers-km/h
Travel Time (Total)	176.9	veh-h/h			1.2	ped-h/h	213.5	pers-h/h
Desired Speed (Program)	62.0	km/h						
Demand Flows (Total for all Sites)	13675	veh/h			17	ped/h	16427	pers/h
Arrival Flows (Total for all Sites)	13675	veh/h			17	ped/h	16427	pers/h
Demand Flows (Entry Total)	5222	veh/h						
Midblock Inflows (Total)	162	veh/h						
Midblock Outflows (Total)	-425	veh/h						
Percent Heavy Vehicles (Demand)	5.5	%						
Percent Heavy Vehicles (Arrival)	5.5	%						
Degree of Saturation	0.942							
Control Delay (Total)	77.97	veh-h/h			0.28	ped-h/h	93.85	pers-h/h
Control Delay (Average)	20.5	sec			60.9	sec	20.6	sec
Control Delay (Worst Lane)	81.8	sec						
Control Delay (Worst Movement)	81.8	sec			61.1	sec	81.8	sec
Geometric Delay (Average)	4.2	sec						
Stop-Line Delay (Average)	16.3	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.71							
Total Effective Stops	9560	veh/h			16	ped/h	11488	pers/h
Effective Stop Rate	0.70		1.61	per km	0.97		0.70	
Proportion Queued	0.62				0.97		0.63	
Performance Index	608.7				1.3		609.9	
Cost (Total)	8642.59	$/h	1.45	$/km	32.14	$/h	8674.73	$/h
Fuel Consumption (Total)	1236.9	L/h	208.0	mL/km				
Fuel Economy	20.8	L/100km						
Carbon Dioxide (Total)	2936.7	kg/h	494.0	g/km				
Hydrocarbons (Total)	0.239	kg/h	0.040	g/km				
Carbon Monoxide (Total)	2.714	kg/h	0.457	g/km				
NOx (Total)	11.047	kg/h	1.858	g/km				

D3.3.5 AM Peak – Network Performance – Partial treatment

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.60							
Travel Time Index	5.52							
Congestion Coefficient	1.68							
Travel Speed (Average)	37.2	km/h			3.5	km/h	37.0	km/h
Travel Distance (Total)	4997.3	veh-km/h			3.8	ped-km/h	6000.6	pers-km/h
Travel Time (Total)	134.2	veh-h/h			1.1	ped-h/h	162.2	pers-h/h
Desired Speed (Program)	62.4	km/h						
Demand Flows (Total for all Sites)	11675	veh/h			17	ped/h	14027	pers/h
Arrival Flows (Total for all Sites)	11675	veh/h			17	ped/h	14027	pers/h
Demand Flows (Entry Total)	4423	veh/h						
Midblock Inflows (Total)	128	veh/h						
Midblock Outflows (Total)	-296	veh/h						
Percent Heavy Vehicles (Demand)	6.5	%						
Percent Heavy Vehicles (Arrival)	6.5	%						
Degree of Saturation	0.878							
Control Delay (Total)	52.42	veh-h/h			0.21	ped-h/h	63.11	pers-h/h
Control Delay (Average)	16.2	sec			45.4	sec	16.2	sec
Control Delay (Worst Lane)	60.4	sec						
Control Delay (Worst Movement)	60.4	sec			45.6	sec	60.4	sec
Geometric Delay (Average)	3.5	sec						
Stop-Line Delay (Average)	12.7	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.40							
Total Effective Stops	7555	veh/h			16	ped/h	9082	pers/h
Effective Stop Rate	0.65		1.51	per km	0.96		0.65	
Proportion Queued	0.59				0.96		0.59	
Performance Index	427.0				1.2		428.2	
Cost (Total)	6778.87	$/h	1.36	$/km	30.15	$/h	6809.01	$/h
Fuel Consumption (Total)	1037.1	L/h	207.5	mL/km				
Fuel Economy	20.8	L/100km						
Carbon Dioxide (Total)	2466.6	kg/h	493.6	g/km				
Hydrocarbons (Total)	0.196	kg/h	0.039	g/km				
Carbon Monoxide (Total)	2.283	kg/h	0.457	g/km				
NOx (Total)	9.978	kg/h	1.997	g/km				

D3.3.6 PM Peak – Network Performance – Partial treatment

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.53							
Travel Time Index	4.75							
Congestion Coefficient	1.90							
Travel Speed (Average)	32.7	km/h			3.3	km/h	32.5	km/h
Travel Distance (Total)	5856.4	veh-km/h			3.8	ped-km/h	7031.5	pers-km/h
Travel Time (Total)	179.3	veh-h/h			1.2	ped-h/h	216.3	pers-h/h
Desired Speed (Program)	62.0	km/h						
Demand Flows (Total for all Sites)	13675	veh/h			17	ped/h	16427	pers/h
Arrival Flows (Total for all Sites)	13675	veh/h			17	ped/h	16427	pers/h
Demand Flows (Entry Total)	5222	veh/h						
Midblock Inflows (Total)	162	veh/h						
Midblock Outflows (Total)	-425	veh/h						
Percent Heavy Vehicles (Demand)	5.5	%						
Percent Heavy Vehicles (Arrival)	5.5	%						
Degree of Saturation	0.942							
Control Delay (Total)	82.67	veh-h/h			0.28	ped-h/h	99.49	pers-h/h
Control Delay (Average)	21.8	sec			60.9	sec	21.8	sec
Control Delay (Worst Lane)	81.8	sec						
Control Delay (Worst Movement)	81.8	sec			61.1	sec	81.8	sec
Geometric Delay (Average)	3.5	sec						
Stop-Line Delay (Average)	18.3	sec						
Ave. Queue Storage Ratio (Worst Lane)	0.71							
Total Effective Stops	9541	veh/h			16	ped/h	11466	pers/h
Effective Stop Rate	0.70		1.63	per km	0.97		0.70	
Proportion Queued	0.64				0.97		0.65	
Performance Index	660.8				1.3		662.0	
Cost (Total)	8724.04	$/h	1.49	$/km	32.14	$/h	8756.18	$/h
Fuel Consumption (Total)	1237.8	L/h	211.4	mL/km				
Fuel Economy	21.1	L/100km						
Carbon Dioxide (Total)	2939.0	kg/h	501.9	g/km				
Hydrocarbons (Total)	0.238	kg/h	0.041	g/km				
Carbon Monoxide (Total)	2.709	kg/h	0.463	g/km				
NOx (Total)	11.298	kg/h	1.929	g/km				

D4 Church Avenue Road Network

D4.1 Do Nothing (LX at grade)

D4.1.1 AM Peak – Network performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS D							
Speed Efficiency	0.57							
Travel Time Index	5.20							
Congestion Coefficient	1.76							
Travel Speed (Average)	27.4	km/h			0.1	km/h	23.1	km/h
Travel Distance (Total)	1702.4	veh-km/h			1.8	ped-km/h	2044.8	pers-km/h
Travel Time (Total)	62.1	veh-h/h			13.9	ped-h/h	88.4	pers-h/h
Desired Speed (Program)	48.3	km/h						
Demand Flows (Total for all Sites)	5165	veh/h			53	ped/h	6251	pers/h
Arrival Flows (Total for all Sites)	5165	veh/h			53	ped/h	6251	pers/h
Demand Flows (Entry Total)	2554	veh/h						
Midblock Inflows (Total)	37	veh/h						
Midblock Outflows (Total)	-364	veh/h						
Percent Heavy Vehicles (Demand)	3.8	%						
Percent Heavy Vehicles (Arrival)	3.8	%						
Degree of Saturation	1.128							
Control Delay (Total)	26.51	veh-h/h			13.44	ped-h/h	45.25	pers-h/h
Control Delay (Average)	18.5	sec			919.0	sec	26.1	sec
Control Delay (Worst Lane)	138.4	sec						
Control Delay (Worst Movement)	142.2	sec			919.0	sec	919.0	sec
Geometric Delay (Average)	3.1	sec						
Stop-Line Delay (Average)	15.4	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	4578	veh/h			53	ped/h	5546	pers/h
Effective Stop Rate	0.89		2.69	per km	1.00		0.89	
Proportion Queued	0.51				1.00		0.51	
Performance Index	288.9				14.1		303.0	
Cost (Total)	2640.24	$/h	1.55	$/km	382.43	$/h	3022.67	$/h
Fuel Consumption (Total)	259.3	L/h	152.3	mL/km				
Fuel Economy	15.2	L/100km						
Carbon Dioxide (Total)	614.3	kg/h	360.9	g/km				
Hydrocarbons (Total)	0.052	kg/h	0.031	g/km				
Carbon Monoxide (Total)	0.481	kg/h	0.282	g/km				
NOx (Total)	1.516	kg/h	0.890	g/km				

D4.1.2 PM Peak – Network performance

Network Performance - Hourly Values								
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS C							
Speed Efficiency	0.74							
Travel Time Index	7.08							
Congestion Coefficient	1.36							
Travel Speed (Average)	35.4	km/h			0.1	km/h	29.0	km/h
Travel Distance (Total)	1858.3	veh-km/h			1.8	ped-km/h	2231.7	pers-km/h
Travel Time (Total)	52.5	veh-h/h			13.9	ped-h/h	76.9	pers-h/h
Desired Speed (Program)	48.0	km/h						
Demand Flows (Total for all Sites)	5597	veh/h			53	ped/h	6769	pers/h
Arrival Flows (Total for all Sites)	5597	veh/h			53	ped/h	6769	pers/h
Demand Flows (Entry Total)	2821	veh/h						
Midblock Inflows (Total)	94	veh/h						
Midblock Outflows (Total)	-267	veh/h						
Percent Heavy Vehicles (Demand)	3.8	%						
Percent Heavy Vehicles (Arrival)	3.8	%						
Degree of Saturation	0.815							
Control Delay (Total)	13.58	veh-h/h			13.44	ped-h/h	29.74	pers-h/h
Control Delay (Average)	8.7	sec			919.0	sec	15.8	sec
Control Delay (Worst Lane)	21.2	sec						
Control Delay (Worst Movement)	24.4	sec			919.0	sec	919.0	sec
Geometric Delay (Average)	3.0	sec						
Stop-Line Delay (Average)	5.7	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	3945	veh/h			53	ped/h	4786	pers/h
Effective Stop Rate	0.70		2.12	per km	1.00		0.71	
Proportion Queued	0.56				1.00		0.57	
Performance Index	220.3				14.1		234.5	
Cost (Total)	2330.43	$/h	1.25	$/km	382.43	$/h	2712.86	$/h
Fuel Consumption (Total)	263.0	L/h	141.5	mL/km				
Fuel Economy	14.2	L/100km						
Carbon Dioxide (Total)	624.2	kg/h	335.9	g/km				
Hydrocarbons (Total)	0.049	kg/h	0.026	g/km				
Carbon Monoxide (Total)	0.485	kg/h	0.261	g/km				
NOx (Total)	1.682	kg/h	0.905	g/km				

D4.2 Do Nothing (grade separated)

D4.2.1 AM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS B					
Speed Efficiency	0.81					
Travel Time Index	7.89					
Congestion Coefficient	1.23					
Travel Speed (Average)	39.1	km/h			39.1	km/h
Travel Distance (Total)	1717.1	veh-km/h			2060.5	pers-km/h
Travel Time (Total)	43.9	veh-h/h			52.7	pers-h/h
Desired Speed (Program)	48.3	km/h				
Demand Flows (Total for all Sites)	4149	veh/h			4979	pers/h
Arrival Flows (Total for all Sites)	4149	veh/h			4979	pers/h
Demand Flows (Entry Total)	2554	veh/h				
Midblock Inflows (Total)	36	veh/h				
Midblock Outflows (Total)	-363	veh/h				
Percent Heavy Vehicles (Demand)	3.8	%				
Percent Heavy Vehicles (Arrival)	3.8	%				
Degree of Saturation	0.620					
Control Delay (Total)	7.99	veh-h/h			9.58	pers-h/h
Control Delay (Average)	6.9	sec			6.9	sec
Control Delay (Worst Lane)	9.6	sec				
Control Delay (Worst Movement)	12.5	sec			12.5	sec
Geometric Delay (Average)	4.1	sec				
Stop-Line Delay (Average)	2.8	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.07					
Total Effective Stops	2801	veh/h			3361	pers/h
Effective Stop Rate	0.68		1.63	per km	0.68	
Proportion Queued	0.59				0.59	
Performance Index	121.2				121.2	
Cost (Total)	1957.31	$/h	1.14	$/km	1957.31	$/h
Fuel Consumption (Total)	224.0	L/h	130.5	mL/km		
Fuel Economy	13.0	L/100km				
Carbon Dioxide (Total)	531.0	kg/h	309.3	g/km		
Hydrocarbons (Total)	0.041	kg/h	0.024	g/km		
Carbon Monoxide (Total)	0.413	kg/h	0.240	g/km		
NOx (Total)	1.369	kg/h	0.797	g/km		

D4.2.2 PM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS C					
Speed Efficiency	0.76					
Travel Time Index	7.36					
Congestion Coefficient	1.31					
Travel Speed (Average)	36.6	km/h			36.6	km/h
Travel Distance (Total)	1877.4	veh-km/h			2252.9	pers-km/h
Travel Time (Total)	51.3	veh-h/h			61.5	pers-h/h
Desired Speed (Program)	48.0	km/h				
Demand Flows (Total for all Sites)	4580	veh/h			5496	pers/h
Arrival Flows (Total for all Sites)	4580	veh/h			5496	pers/h
Demand Flows (Entry Total)	2821	veh/h				
Midblock Inflows (Total)	41	veh/h				
Midblock Outflows (Total)	-213	veh/h				
Percent Heavy Vehicles (Demand)	4.0	%				
Percent Heavy Vehicles (Arrival)	4.0	%				
Degree of Saturation	0.812					
Control Delay (Total)	11.75	veh-h/h			14.09	pers-h/h
Control Delay (Average)	9.2	sec			9.2	sec
Control Delay (Worst Lane)	21.2	sec				
Control Delay (Worst Movement)	24.4	sec			24.4	sec
Geometric Delay (Average)	4.0	sec				
Stop-Line Delay (Average)	5.3	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.26					
Total Effective Stops	3665	veh/h			4398	pers/h
Effective Stop Rate	0.80		1.95	per km	0.80	
Proportion Queued	0.67				0.67	
Performance Index	163.6				163.6	
Cost (Total)	2285.63	$/h	1.22	$/km	2285.63	$/h
Fuel Consumption (Total)	261.3	L/h	139.2	mL/km		
Fuel Economy	13.9	L/100km				
Carbon Dioxide (Total)	620.1	kg/h	330.3	g/km		
Hydrocarbons (Total)	0.048	kg/h	0.026	g/km		
Carbon Monoxide (Total)	0.483	kg/h	0.257	g/km		
NOx (Total)	1.690	kg/h	0.900	g/km		

D5 Forrest Road Network

D5.1 Do Nothing (LX at grade)

D5.1.1 AM Peak – Network performance

Network Performance - Hourly Values									
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS B							
Speed Efficiency	0.81							
Travel Time Index	7.85							
Congestion Coefficient	1.24							
Travel Speed (Average)	33.2	km/h			0.6	km/h	30.9	km/h
Travel Distance (Total)	1252.9	veh-km/h			1.9	ped-km/h	1505.4	pers-km/h
Travel Time (Total)	37.8	veh-h/h			3.3	ped-h/h	48.7	pers-h/h
Desired Speed (Program)	41.1	km/h						
Demand Flows (Total for all Sites)	5123	veh/h			53	ped/h	6200	pers/h
Arrival Flows (Total for all Sites)	5123	veh/h			53	ped/h	6200	pers/h
Demand Flows (Entry Total)	1733	veh/h						
Midblock Inflows (Total)	176	veh/h						
Midblock Outflows (Total)	-104	veh/h						
Percent Heavy Vehicles (Demand)	1.5	%						
Percent Heavy Vehicles (Arrival)	1.5	%						
Degree of Saturation	0.807							
Control Delay (Total)	7.68	veh-h/h			2.89	ped-h/h	12.10	pers-h/h
Control Delay (Average)	5.4	sec			197.4	sec	7.0	sec
Control Delay (Worst Lane)	18.9	sec						
Control Delay (Worst Movement)	21.7	sec			197.4	sec	197.4	sec
Geometric Delay (Average)	1.5	sec						
Stop-Line Delay (Average)	3.9	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	2187	veh/h			52	ped/h	2676	pers/h
Effective Stop Rate	0.43		1.75	per km	0.99		0.43	
Proportion Queued	0.31				0.99		0.31	
Performance Index	133.6				3.6		137.2	
Cost (Total)	1545.11	$/h	1.23	$/km	91.84	$/h	1636.96	$/h
Fuel Consumption (Total)	130.7	L/h	104.3	mL/km				
Fuel Economy	10.4	L/100km						
Carbon Dioxide (Total)	308.3	kg/h	246.1	g/km				
Hydrocarbons (Total)	0.024	kg/h	0.019	g/km				
Carbon Monoxide (Total)	0.184	kg/h	0.147	g/km				
NOx (Total)	0.311	kg/h	0.248	g/km				

D5.1.2 PM Peak – Network performance

Network Performance - Hourly Values									
Performance Measure	**Vehicles**		**Per Unit Distance**		**Pedestrians**		**Persons**	
Network Level of Service (LOS)	LOS B							
Speed Efficiency	0.81							
Travel Time Index	7.83							
Congestion Coefficient	1.24							
Travel Speed (Average)	33.2	km/h			0.6	km/h	31.0	km/h
Travel Distance (Total)	1287.4	veh-km/h			1.9	ped-km/h	1546.8	pers-km/h
Travel Time (Total)	38.8	veh-h/h			3.3	ped-h/h	49.9	pers-h/h
Desired Speed (Program)	41.2	km/h						
Demand Flows (Total for all Sites)	5514	veh/h			53	ped/h	6669	pers/h
Arrival Flows (Total for all Sites)	5514	veh/h			53	ped/h	6669	pers/h
Demand Flows (Entry Total)	1743	veh/h						
Midblock Inflows (Total)	214	veh/h						
Midblock Outflows (Total)	-68	veh/h						
Percent Heavy Vehicles (Demand)	1.9	%						
Percent Heavy Vehicles (Arrival)	1.9	%						
Degree of Saturation	0.744							
Control Delay (Total)	7.95	veh-h/h			2.89	ped-h/h	12.42	pers-h/h
Control Delay (Average)	5.2	sec			197.4	sec	6.7	sec
Control Delay (Worst Lane)	17.7	sec						
Control Delay (Worst Movement)	20.5	sec			197.4	sec	197.4	sec
Geometric Delay (Average)	1.5	sec						
Stop-Line Delay (Average)	3.7	sec						
Ave. Queue Storage Ratio (Worst Lane)	1.00							
Total Effective Stops	2210	veh/h			52	ped/h	2704	pers/h
Effective Stop Rate	0.40		1.72	per km	0.99		0.41	
Proportion Queued	0.29				0.99		0.29	
Performance Index	153.6				3.6		157.3	
Cost (Total)	1594.91	$/h	1.24	$/km	91.84	$/h	1686.75	$/h
Fuel Consumption (Total)	138.1	L/h	107.2	mL/km				
Fuel Economy	10.7	L/100km						
Carbon Dioxide (Total)	326.3	kg/h	253.5	g/km				
Hydrocarbons (Total)	0.025	kg/h	0.019	g/km				
Carbon Monoxide (Total)	0.197	kg/h	0.153	g/km				
NOx (Total)	0.425	kg/h	0.330	g/km				

D5.2 Do Nothing (grade separated)

D5.2.1 AM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS B					
Speed Efficiency	0.88					
Travel Time Index	8.70					
Congestion Coefficient	1.13					
Travel Speed (Average)	36.5	km/h			36.5	km/h
Travel Distance (Total)	1267.2	veh-km/h			1520.7	pers-km/h
Travel Time (Total)	34.7	veh-h/h			41.7	pers-h/h
Desired Speed (Program)	41.3	km/h				
Demand Flows (Total for all Sites)	4091	veh/h			4909	pers/h
Arrival Flows (Total for all Sites)	4091	veh/h			4909	pers/h
Demand Flows (Entry Total)	1733	veh/h				
Midblock Inflows (Total)	176	veh/h				
Midblock Outflows (Total)	-104	veh/h				
Percent Heavy Vehicles (Demand)	1.4	%				
Percent Heavy Vehicles (Arrival)	1.4	%				
Degree of Saturation	0.659					
Control Delay (Total)	4.44	veh-h/h			5.33	pers-h/h
Control Delay (Average)	3.9	sec			3.9	sec
Control Delay (Worst Lane)	10.8	sec				
Control Delay (Worst Movement)	13.5	sec			13.5	sec
Geometric Delay (Average)	1.9	sec				
Stop-Line Delay (Average)	2.0	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.69					
Total Effective Stops	1838	veh/h			2206	pers/h
Effective Stop Rate	0.45		1.45	per km	0.45	
Proportion Queued	0.32				0.32	
Performance Index	73.1				73.1	
Cost (Total)	1426.19	$/h	1.13	$/km	1426.19	$/h
Fuel Consumption (Total)	122.8	L/h	96.9	mL/km		
Fuel Economy	9.7	L/100km				
Carbon Dioxide (Total)	289.7	kg/h	228.6	g/km		
Hydrocarbons (Total)	0.022	kg/h	0.017	g/km		
Carbon Monoxide (Total)	0.174	kg/h	0.137	g/km		
NOx (Total)	0.281	kg/h	0.222	g/km		

D5.2.2 PM Peak – Network performance

Network Performance - Hourly Values						
Performance Measure	**Vehicles**		**Per Unit Distance**		**Persons**	
Network Level of Service (LOS)	LOS B					
Speed Efficiency	0.88					
Travel Time Index	8.71					
Congestion Coefficient	1.13					
Travel Speed (Average)	36.7	km/h			36.7	km/h
Travel Distance (Total)	1303.2	veh-km/h			1563.9	pers-km/h
Travel Time (Total)	35.5	veh-h/h			42.6	pers-h/h
Desired Speed (Program)	41.5	km/h				
Demand Flows (Total for all Sites)	4356	veh/h			5227	pers/h
Arrival Flows (Total for all Sites)	4356	veh/h			5227	pers/h
Demand Flows (Entry Total)	1743	veh/h				
Midblock Inflows (Total)	214	veh/h				
Midblock Outflows (Total)	-68	veh/h				
Percent Heavy Vehicles (Demand)	1.8	%				
Percent Heavy Vehicles (Arrival)	1.8	%				
Degree of Saturation	0.677					
Control Delay (Total)	4.50	veh-h/h			5.40	pers-h/h
Control Delay (Average)	3.7	sec			3.7	sec
Control Delay (Worst Lane)	11.3	sec				
Control Delay (Worst Movement)	13.6	sec			13.6	sec
Geometric Delay (Average)	1.9	sec				
Stop-Line Delay (Average)	1.8	sec				
Ave. Queue Storage Ratio (Worst Lane)	0.78					
Total Effective Stops	1842	veh/h			2210	pers/h
Effective Stop Rate	0.42		1.41	per km	0.42	
Proportion Queued	0.30				0.30	
Performance Index	75.5				75.5	
Cost (Total)	1472.53	$/h	1.13	$/km	1472.53	$/h
Fuel Consumption (Total)	131.4	L/h	100.8	mL/km		
Fuel Economy	10.1	L/100km				
Carbon Dioxide (Total)	310.5	kg/h	238.3	g/km		
Hydrocarbons (Total)	0.023	kg/h	0.018	g/km		
Carbon Monoxide (Total)	0.191	kg/h	0.146	g/km		
NOx (Total)	0.398	kg/h	0.305	g/km		