Stage 2 Report: Assess, Design & Report

Kalamunda Road Functional Review and Upgrade

CW1063000

Prepared for
City of Kalamunda

17 February 2020

Cardno

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Table of Contents

Appendices

Tables

Figures

Executive Summary

Cardno has been engaged by the City of Kalamunda (the City) to identify the future road function and capabilities for Kalamunda Road from Abernethy Road to Roe Highway, High Wycombe.

The purpose of this project is to identify the long-term function of Kalamunda Road and produce a forward plan for the upgrade of the road. The process involved a series of data collection, stakeholder consultation, constraints mapping, traffic modelling and intersection analysis, and preparation of concept designs, cost estimates and forward works plans, all of which were undertaken in two stages.

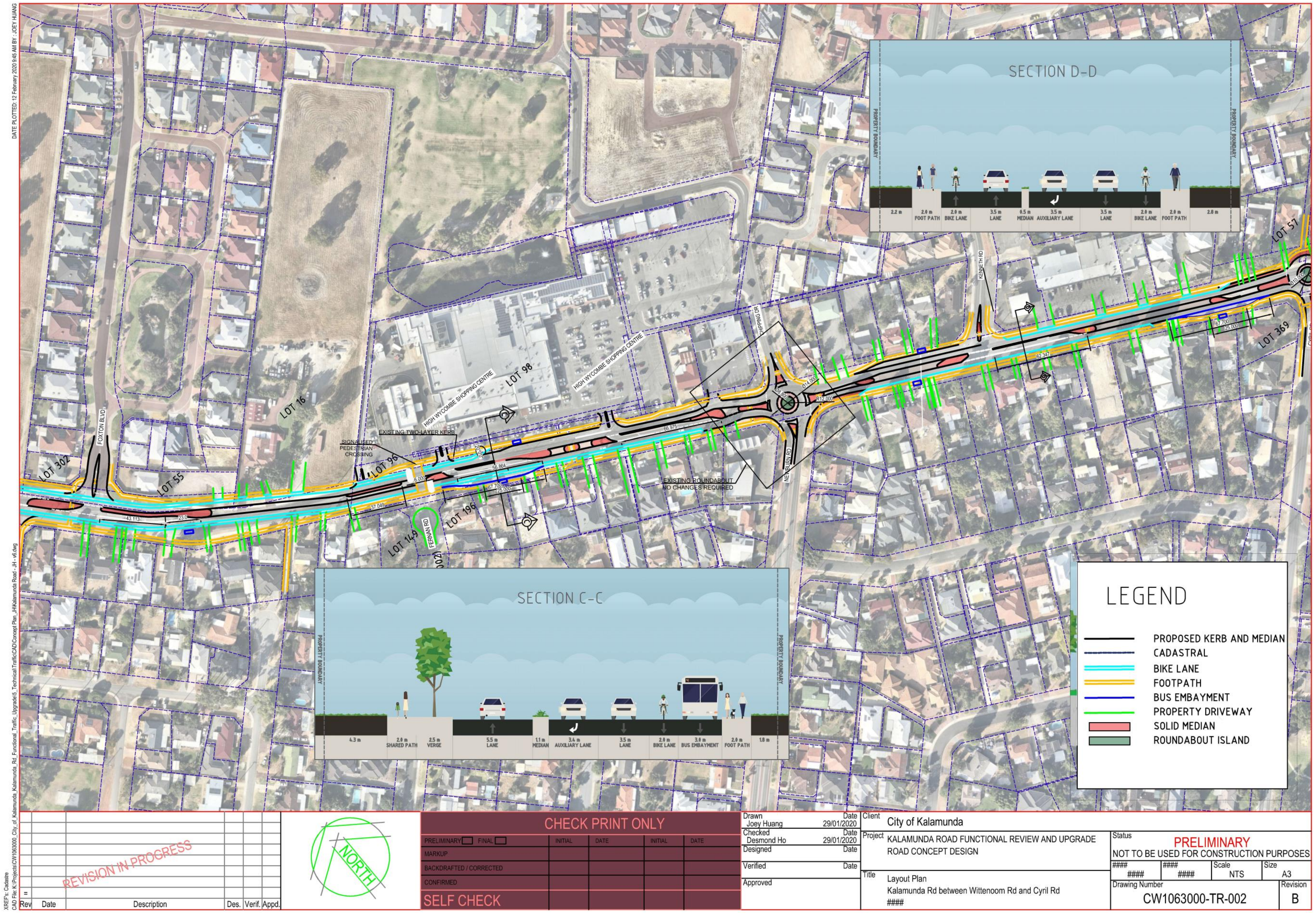
The Stage 1 report – which includes the preparation and stakeholder consultations – concluded that the low capacity design for Kalamunda Road is preferred by more residents as compared to the higher capacity design. The City of Kalamunda has endorsed the low capacity option and Stage 2 (this report) has proceeded with the assessment and design of this option for Kalamunda Road.

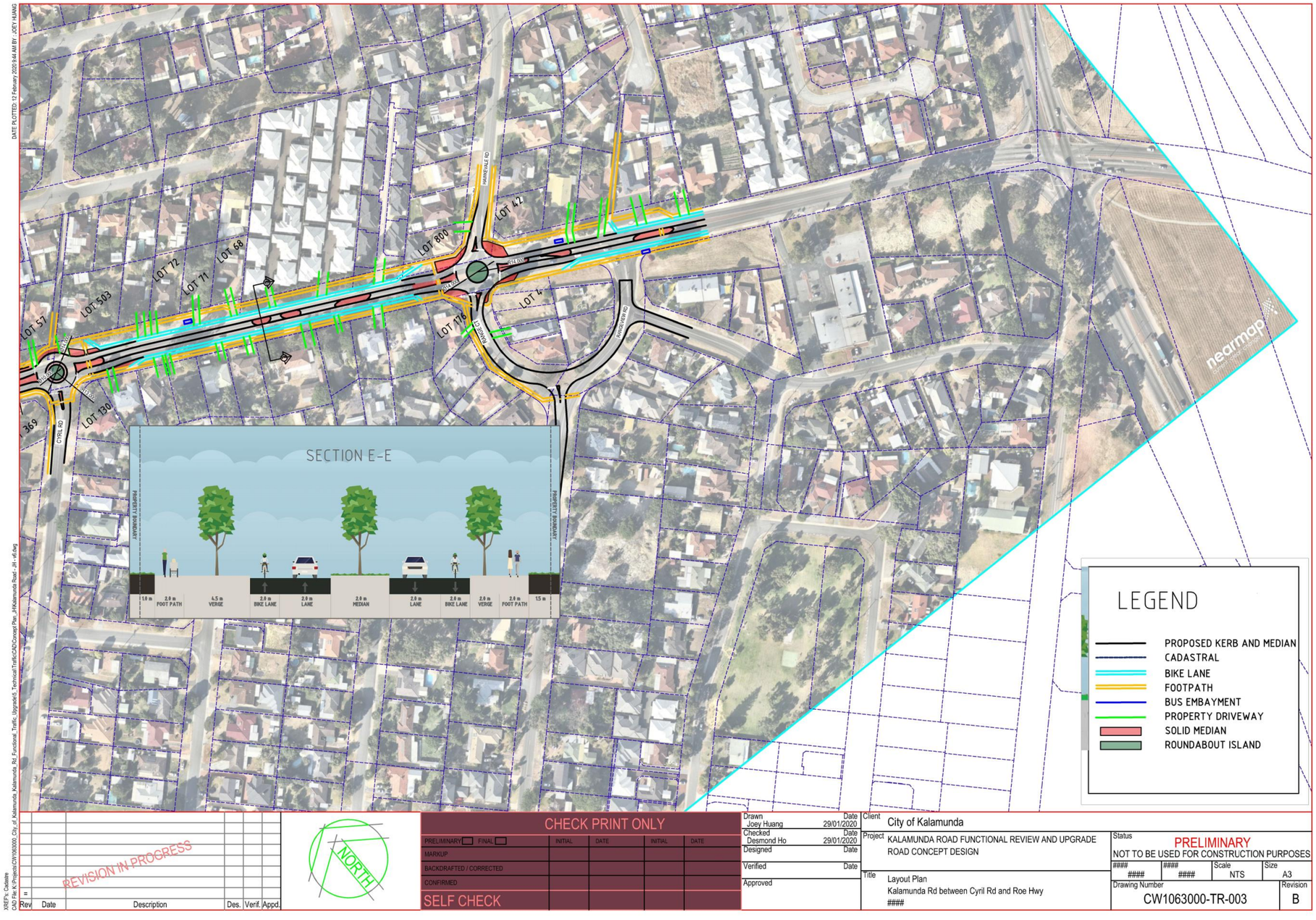
The functional environment of Kalamunda Road between Abernethy Road and Roe Highway can be divided into three distinctive sections:

- Section 1- The section between Abernethy Road and Wittenoom Road. Section 1A extends between Abernethy Rd and Stirling Crescent and Section 1B between Stirling Crescent and Wittenoom Road;
- Section 2 - The section comprising the High Wycombe Shopping Centre between Wittenoom Road and Cyril Road. Section 2A extends between Wittenoom Road and Newburn Road/Chipping Drive and Section 2B between Newburn Road/Chipping Drive and Cyril Road; and
- Section 3 - The section between Cyril Road and Roe Highway.

The final concept design for Kalamunda Road generally comprises of a 3.5-metre-wide lane, a 2-metre-wide bike lane, a 2-metre-wide pedestrian footpath on either side of the road and a 4-metre-wide median separator, which was designed to constrain traffic flows at 15,000 vehicles per day (vpd). The proposed concept design is illustrated in Drawing No. CW1063000-TR-001, CW1063000-TR-002 and CW1063000-TR-003.


SECTION A-A
PROPOSED PROPERTY BOUNDARY
PROPERTY BOUNDARY
2.0 m FOOT PATH
4.1 m VERGE
2.0 m BIKE LANE
3.5 m LANE
3.5 m AUXILIARY LANE
2.5 m MEDIAN
3.5 m LANE
2.0 m BIKE LANE
5.5 m VERGE
2.0 m FOOT PATH
1.0 m
ABERNETHY RD
LOT 200
STIRLING CRES
LOT 13
LOT 100
WITTENOOM RD
SECTION B-B
6.0 m MEDIAN
3.5 m AUXILIARY LANE
4.9 m VERGE
LEGEND
PROPOSED KERB AND MEDIAN
CADASTRAL
BIKE LANE
FOOTPATH
BUS EMBAYMENT
PROPERTY DRIVEWAY
SOLID MEDIAN
ROUNDABOUT ISLAND
REVISION IN PROGRESS
NORTH
CHECK PRINT ONLY
PRELIMINARY
FINAL
MARKUP
BACKDRAFTED / CORRECTED
CONFIRMED
SELF CHECK
Drawn Joey Huang 29/01/2020
Checked Desmond Ho 29/01/2020
Designed
Verified
Approved
Client City of Kalamunda
Project KALAMUNDA ROAD FUNCTIONAL REVIEW AND UPGRADE ROAD CONCEPT DESIGN
Title Layout Plan
Kalamunda Rd between Abernethy Rd and Wittenoom Rd
Status PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
Scale NTS
Size A3
Drawing Number CW1063000-TR-001
Revision B


SECTION D-D
SECTION C-C
LEGEND
PROPOSED KERB AND MEDIAN
CADASTRAL
BIKE LANE
FOOTPATH
BUS EMBAYMENT
PROPERTY DRIVEWAY
SOLID MEDIAN
ROUNDABOUT ISLAND
LOT 302
LOT 55
LOT 16
LOT 96
LOT 98
LOT 196
LOT 57
LOT 369
FOXTON BLVD
HIGH WYCOMBE SHOPPING CENTRE
SIGNALISED PEDESTRIAN CROSSING
EXISTING TWO-LAYER KERB
EXISTING ROUNDABOUT NO CHANGES REQUIRED
REVISION IN PROGRESS
Rev Date Description Des. Verif. Appd.
NORTH
CHECK PRINT ONLY
SELF CHECK
Drawn Joey Huang 29/01/2020
Checked Desmond Ho 29/01/2020
Designed
Verified
Approved
Client City of Kalamunda
Project KALAMUNDA ROAD FUNCTIONAL REVIEW AND UPGRADE ROAD CONCEPT DESIGN
Title Layout Plan Kalamunda Rd between Wittenoom Rd and Cyril Rd
Status PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
Scale NTS
Size A3
Drawing Number CW1063000-TR-002
Revision B


SECTION E-E
1.0 m
2.0 m FOOT PATH
4.5 m VERGE
2.0 m BIKE LANE
2.0 m LANE
2.0 m MEDIAN
2.0 m LANE
2.0 m BIKE LANE
2.6 m VERGE
2.6 m FOOT PATH
1.5 m
PROPERTY BOUNDARY
PROPERTY BOUNDARY
LEGEND
PROPOSED KERB AND MEDIAN
CADASTRAL
BIKE LANE
FOOTPATH
BUS EMBAYMENT
PROPERTY DRIVEWAY
SOLID MEDIAN
ROUNDABOUT ISLAND
nearmap
LOT 42
LOT 800
LOT 72
LOT 71
LOT 68
LOT 503
LOT 57
LOT 130
LOT 369
LOT 176
LOT 4
HAWKDALE RD
CYRIL RD
DE HAVILLAND
REVISION IN PROGRESS
NORTH
CHECK PRINT ONLY
PRELIMINARY
FINAL
MARKUP
BACKDRAFTED / CORRECTED
CONFIRMED
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DATE
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Designed
Verified
Approved
Client City of Kalamunda
Project KALAMUNDA ROAD FUNCTIONAL REVIEW AND UPGRADE ROAD CONCEPT DESIGN
Title Layout Plan
Kalamunda Rd between Cyril Rd and Roe Hwy
Status PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
Scale NTS
Size A3
Drawing Number CW1063000-TR-003
Revision B

It is proposed that the intersections at Stirling Crescent and Cyril Road with Kalamunda Road be converted into roundabouts. Furthermore, the existing Kalamunda Road/Rangeview Road intersection is proposed to be closed and a new 4-legged roundabout controlled intersection be introduced at the Kalamunda Road/Hawkevale Road/Range Court intersection. This treatment would remove the staggered intersections that currently exists between Rangeview Road and Hawkevale Road which will improve safety and traffic operations.

The Public Transport Authority (PTA) has advised that ideally bus stops would be located in bus bays only where buses may be contractually required to dwell if running early or where there is a significant attractor such as a shopping centre, or where it is known or expected that there would be heavy passenger loadings.

It is proposed that a bus embayment be provided on the westbound carriageway opposite the High Wycombe Shopping Centre. In the eastbound direction the bus stop will be located adjacent to the left turn pocket as per the existing situation. All bus embayments along this section of road, except for the one located west of Cyril Road (westbound direction), are proposed to be removed and buses are proposed to stop in the roadway. It should be noted it is recommended that the proposed bus embayment to the west of Cyril Road (westbound direction) be retained in order to reduce the potential impact of this bus stop on traffic operations at the Kalamunda Rd/Cyril Road intersection.

The bus stops are proposed to be located at existing locations along Kalamunda Road between Abernethy Road and Roe Highway except for two bus stops which are required to be relocated as a result of the proposed concept design. The existing bus stops at Cyril Road (eastbound direction) and Range Court (westbound direction) would have to be relocated due to the new roundabout treatments proposed at these intersections.

Traffic analysis has shown that all the proposed roundabout control intersections and accesses to the High Wycombe Shopping Centre is expected to operate at acceptable levels of service for 2031 and 2041 design years. The analysis also shows that the Kalamunda Road/Stirling Crescent and Kalamunda Road/Newburn Road/Chipping Drive intersections will experience the highest delays, longest queues, and highest degrees of saturation of all the intersections along this corridor.

A Forward Works Plan (FWP) for various work packages including details on the broad-brush cost estimates for the proposed concept design was developed. The forward works has been developed in terms of the three work package sections mentioned above, with the addition of Section 2C, comprising the signalised pedestrian crossing, cul-de-sac of Fernan Road & minor improvements to the existing accesses to the High Wycombe Shopping Centre.

A review of the existing vehicle usage data has identified that Section 3 (between Cyril Road and Roe Highway) has already reached the restricted demand of 15,000 vpd to accomplish the proposed function of this section of Kalamunda Road. Furthermore, it has been identified by Main Roads WA that the Roe Highway and Kalamunda Road interchange is to be a grade separated interchange and is expected to be upgraded by early 2021. Hence, Section 3 (between Cyril Road and Roe Highway) of the proposed concept design will need to be upgraded by the end of 2022.

Section 1 Kalamunda Road upgrade works will be driven primarily by the development of Lot 200. At present there is no current structure /development plans in place for the development of this lot. Vehicle demand for Section 1A (between Abernethy Road and Stirling Crescent) is expected to increase to about 15,900vpd by 2031 and Section 2A (between Wittenoom Road and Newburn Road/Chipping Drive) to 14,600 vpd by 2041. Therefore, it is envisaged that the upgrade of these sections will be undertaken in stages.

Demand forecast for Section 2A (Wittenoom Road to Newburn Road/Chipping Drive) has revealed that the traffic for this section is expected to increase to between 9,600vpd and 14,600 vpd beyond 2041. Similarly, demand forecasts for Section 2B (Newburn Road/Chipping Drive to Cyril Road) have revealed that the traffic for this section is expected to increase to over 20,600 vpd beyond 2031. It is recommended that the City of Kalamunda consider upgrading Section 2B (Newburn Road/Chipping Drive to Cyril Road) at approximately the same time as Section 3 (between Cyril Road and Roe Highway) for ease of constructability, traffic management and reducing inconvenience to the local communities.

Based on present and future demand forecasts there is no requirement to upgrade Section 2A (Wittenoom Road to Newburn Road/Chipping Drive) by 2041. However, pedestrian facilities to the existing shopping centre is limited and there is a desire from the local community for the provision of a new pedestrian crossing to improve connectivity and safety. Cardno recommends closing off Fernan Road and installing a new signalised pedestrian crossing across Kalamunda Road. Fernan Road will need to be converted into a cul de sac to enable the construction of this signalised pedestrian crossing. It is envisaged that these works and minor improvements at the shopping centre access can be undertaken independently within the next few

years even though the upgrade of Section 2A (Wittenoom Road to Newburn Road/Chipping Drive) is only required beyond 2041.

The total preliminary order of magnitude of cost estimated for the road upgrades proposed in the concept design for Kalamunda Road is approximately **$17,256,450.40 including GST.**

Land expropriation may be required in the vicinity of Kalamunda Road/Stirling Crescent and Kalamunda Road/Wittenoom Road intersections. The City of Kalamunda is to ensure that the necessary land and truncations required for the development of the proposed concept plan are ceded, where possible, through the planning and development application process.

A key risk is the possibility of installing underground Western Power services between Abernethy Road and Wittenoom Road intersection with Kalamunda Road. It is recommended that the City of Kalamunda request for Western Power to undertake a feasibility study in this regard during the future planning and detail design stages.

1 Introduction

1.1 Background

Cardno has been engaged by the City of Kalamunda (the City) to identify the future road function and capabilities for Kalamunda Road from Abernethy Road to Roe Highway, High Wycombe.

The purpose of this project is to identify the long-term function of Kalamunda Road and produce a forward plan for the upgrade of the road. The objectives of the plan and the delivery of associated actions over the life of the plan are described as follows:

- Determine the most feasible and preferred function for Kalamunda Road, considering community consultation and traffic demands;
- Ensure Kalamunda Road provides an effective transport connection for the local community;
- Significantly improve road safety for road users including pedestrians and cyclists;
- Significantly increase active transport and public transport through the provision of supporting infrastructure;
- Provide clarity for the City of Kalamunda and land owners in their future land ownership and development plans, associated with the function and design of Kalamunda Road;
- Achieve support from the Council and state agencies including the Department of Transport, Main Roads WA and the Department of Planning, Lands and Heritage; and
- Alignment with City and State policies and strategies including the City's draft Traffic and Transport Policy.

This project has been undertaken in two stages. Stage 1 culminated in a report that detailed the following:

- Constraints mapping, traffic modelling and intersection analysis to a sufficient level to inform the public consultation;
- Prepare a Community Consultation Plan for approval by the City, execute the approved consultation plan, and provide a Community Consultation Summary Report;
- Arrange project steering group meetings, agendas and minutes;
- Incorporate the 'Relevant Information' into the community consultation;
- Investigate current access arrangements for all properties accessing Kalamunda Road; and
- Other activities necessary to inform and gain engagement from the community for the community consultation.

Stage 2 (this report) involves the undertaking of the following activities:

- Complete the constraints mapping, traffic modelling, and intersection analysis;
- Confirm access arrangements through an Access Strategy;
- Confirm pedestrian and cycling facility needs and incorporate into the concept designs;
- Complete Concept Designs, Cost Estimates and the Forward Works Plan;
- Arrange project steering group meetings, agendas and minutes;
- Undertake further presentations and stakeholder liaison as part of the Community Consultation Plan;
- Identify funding sources; and
- Undertake other activities necessary to complete the works.

This report details the Stage 2 works undertaken which focuses on the development of a Concept Plan for this section of Kalamunda Road which included undertaking the relevant traffic modelling and analysis for the proposed intersection improvements along Kalamunda Road between Abernethy Road and Roe Highway, preparation of high-level cost estimate and Forward Works Plan as well as documenting the stakeholder consultation process and outcomes.

2 Constraints Mapping

Cardno has conducted a constraints mapping exercise and have identified constraints within the project area and Area of Influence (AOI) that may have a material impact on the planning for the upgrade of Kalamunda Road to accommodate the traffic growth and demand for the target year of 2041.

It should be noted that constraints are classified as being assets or attributes that will be very costly or difficult to overcome for the future plan for Kalamunda Road.

The following constraints are detailed in subsequent sections of this report:

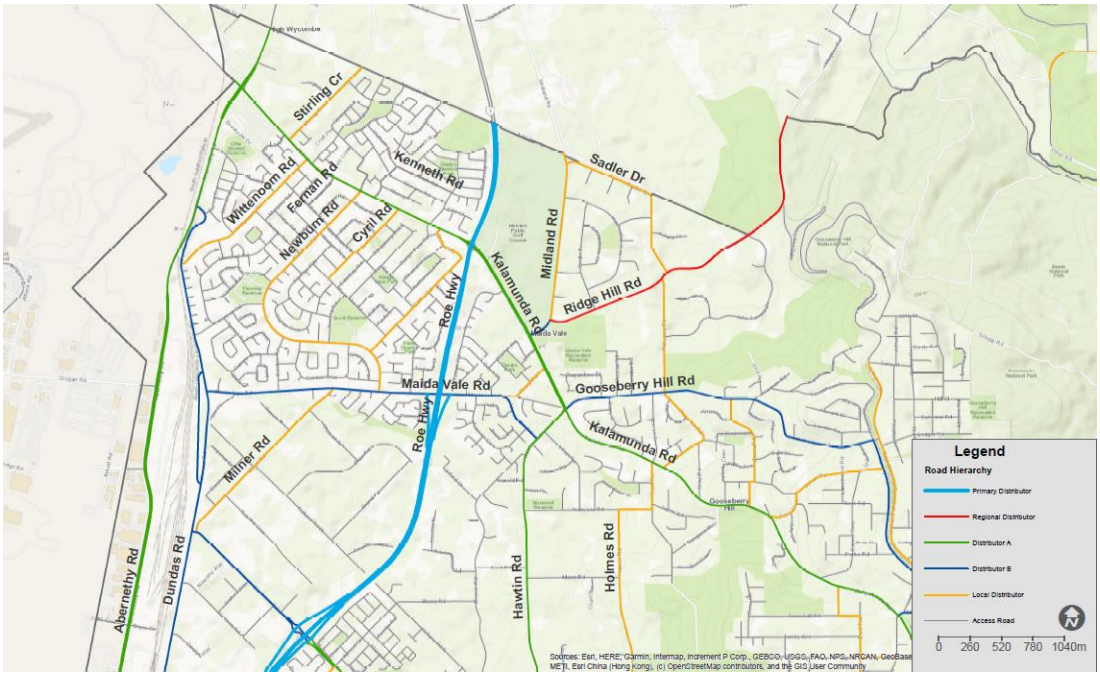
2.1 Major Public Utility Infrastructures

Existing and future public utilities including Telstra, NBN, Optus, Water Corporation, Western Power transmission lines and ATCO gas pipelines were sourced from Dial-Before-You-Dig (DBYD). The drawings showing the location of each of these utilities are included in **Appendix A** of this report.

2.2 Existing and Planned Regional Road Network

The existing road network and hierarchy in the vicinity of Kalamunda Road as classified by the Main Roads WA Metropolitan Functional Road Hierarchy is indicated in **Figure 2-1**. Besides the planned upgrading of the Roe Highway/Kalamunda Road intersection, no other regional road network improvements are being planned in the vicinity of Kalamunda Road between Abernethy Road and Roe Highway.

Figure 2-1 Existing Road Network and Hierarchy

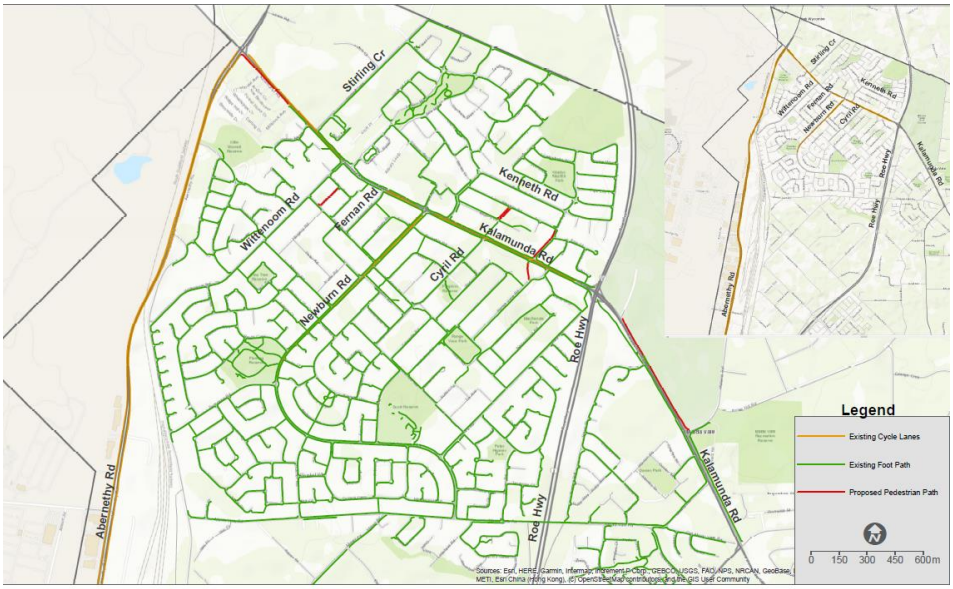


Source: City of Kalamunda

2.3 Pedestrian and Cycling Facilities

The existing footpaths and cycle lanes on Kalamunda Road and the surrounding network are illustrated in **Figure 2-2**. It is noted that the existing cycle lane is discontinuous along the entire length of Kalamunda Road and this has been reassessed as part of the concept design stage.

Figure 2-2 Existing Footpath and Cycle Lane

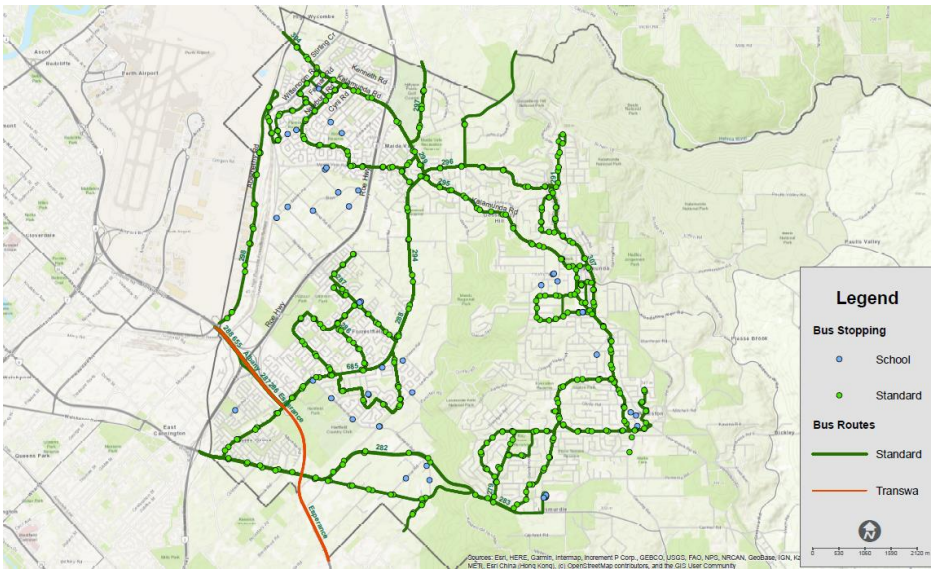


Source: City of Kalamunda

2.4 Public Transport Routes and Facilities

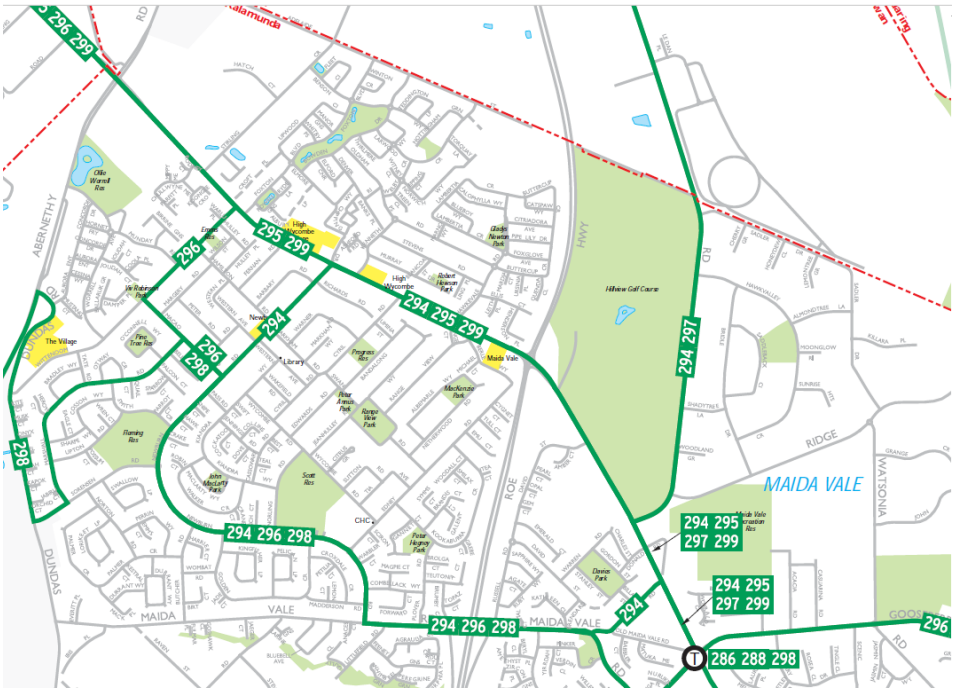
The existing bus route and stops along Kalamunda Road is shown in **Figure 2-3**. Based on information obtained from Transperth, three bus services currently operate along the section of Kalamunda Road between Abernethy Road and Roe Highway as illustrated in **Figure 2-4.**

Figure 2-3 Existing bus route and bus stops



Source: Public Transport Authority

Figure 2-4 Transperth Bus Services

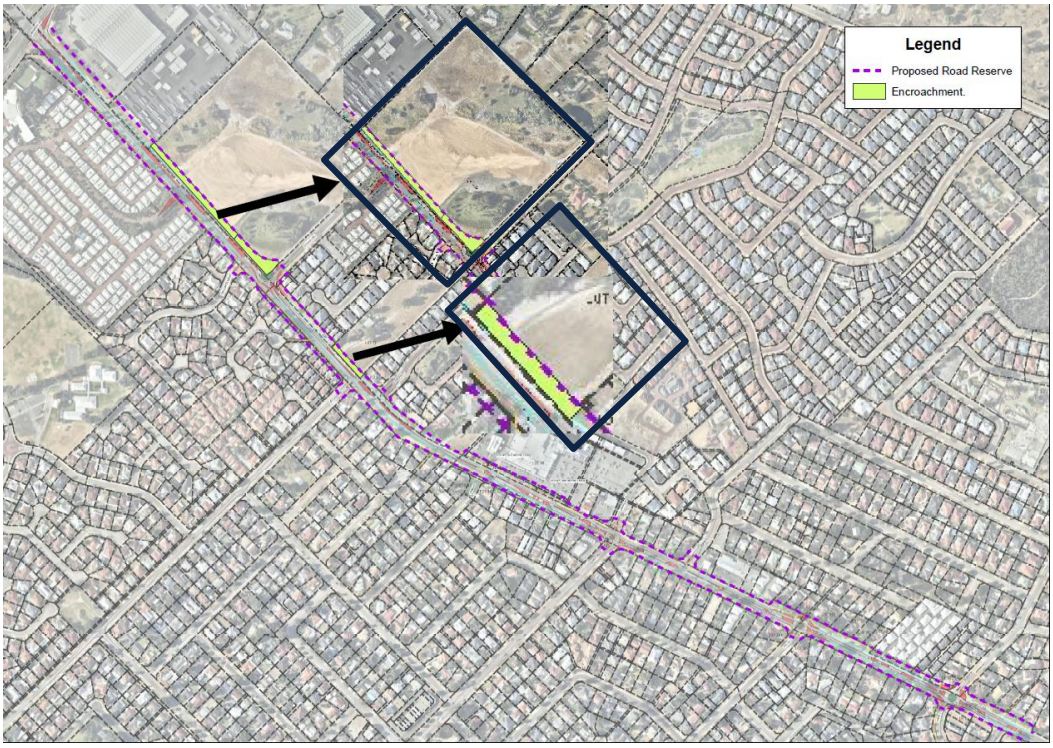


Source: Transperth

2.5 Road Reserve Width along Lot Frontages, Existing Intersecting Roads and Access Ways

The proposed road reserve and potential lot frontage encroachments for the proposed low capacity option is depicted in **Figure 2-5.**

Figure 2-5 Lot Frontage Encroachment



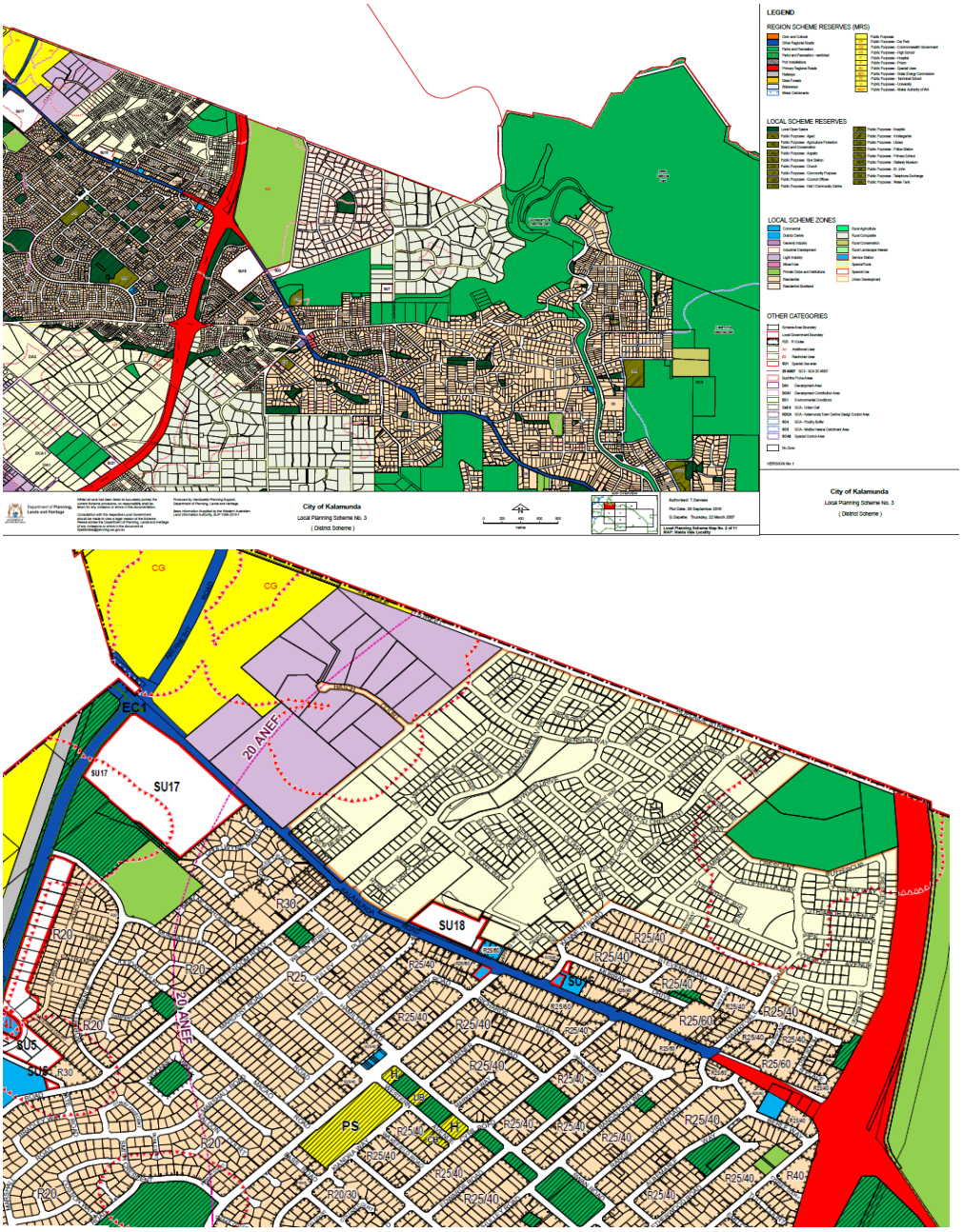
The following vacant lots have been identified to be affected by possible encroachment based on the proposed Low Capacity road concept design:

- Lot 200 - 584 Kalamunda Road, High Wycombe;
- Lot 201- 614 Kalamunda Road, High Wycombe; and
- Lot 13 - 562 Kalamunda Road, High Wycombe.

2.6 Land Use

The land use zoning adjacent to Kalamunda Road is governed by the City of Kalamunda Local Planning Scheme 3 (District Scheme) represented in **Figure 2-6**.

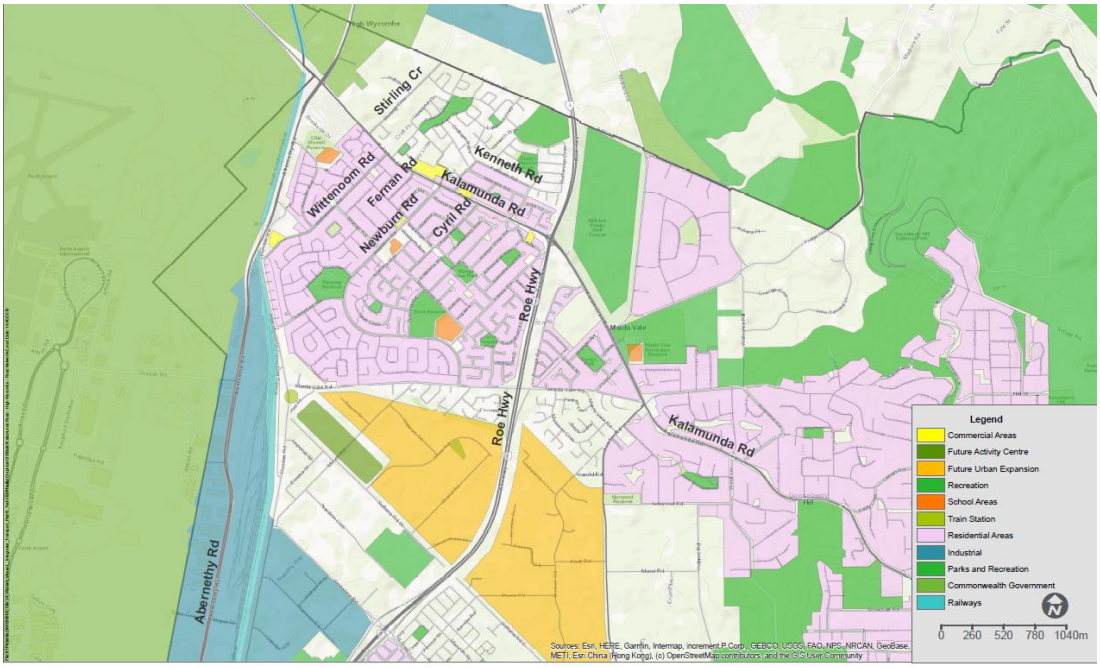
Figure 2-6 City of Kalamunda Local Town Planning Scheme 3



Source: City of Kalamunda

The zoning along Kalamunda Road between Abernethy Road and Roe Highway is predominantly residential in nature. To the northwest corner of the Kalamunda Road/Stirling Crescent intersection a parcel of land is zoned “general industry”. Further east along Kalamunda Road pockets of commercial developments as shown in **Figure 2-7** can be found.

Figure 2-7 Residential and non-residential developments



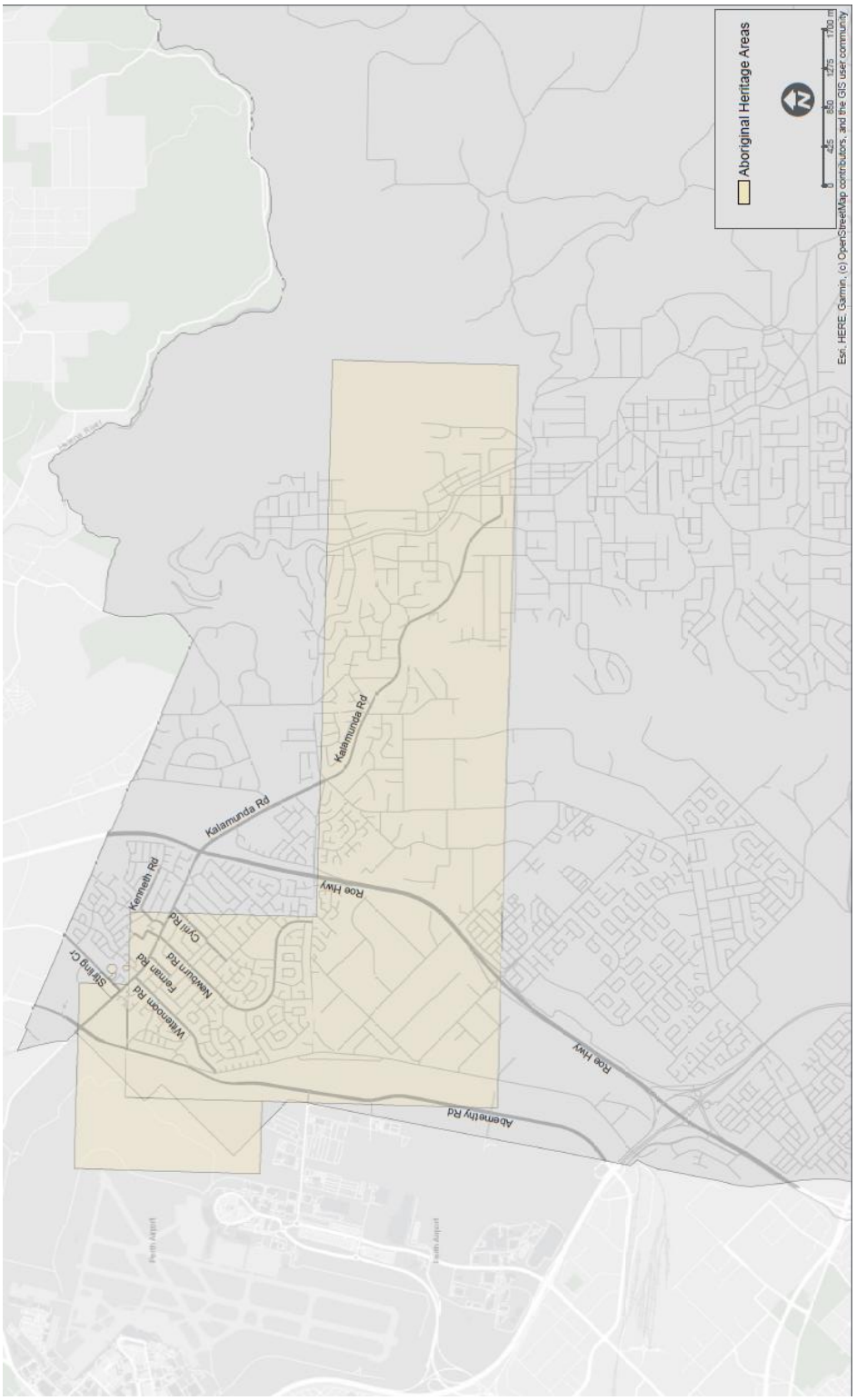
2.7 Environmentally Sensitive Areas

No environmentally sensitive areas have been identified along the Kalamunda Road corridor between Abernethy Road and Roe Highway.

2.8 Aboriginal Heritage Areas

There are no protected aboriginal areas in the Kalamunda Road corridor between Abernethy Road and Roe Highway, however the unprotected aboriginal land is illustrated in **Figure 2-8**. It should be noted that protected aboriginal land is located far south of the Kalamunda Road corridor.

Figure 2-8 Location of Aboriginal Land



3 Available Traffic Data

3.1 Traffic Volume Data

Traffic volume data were obtained from several sources, which include the following:

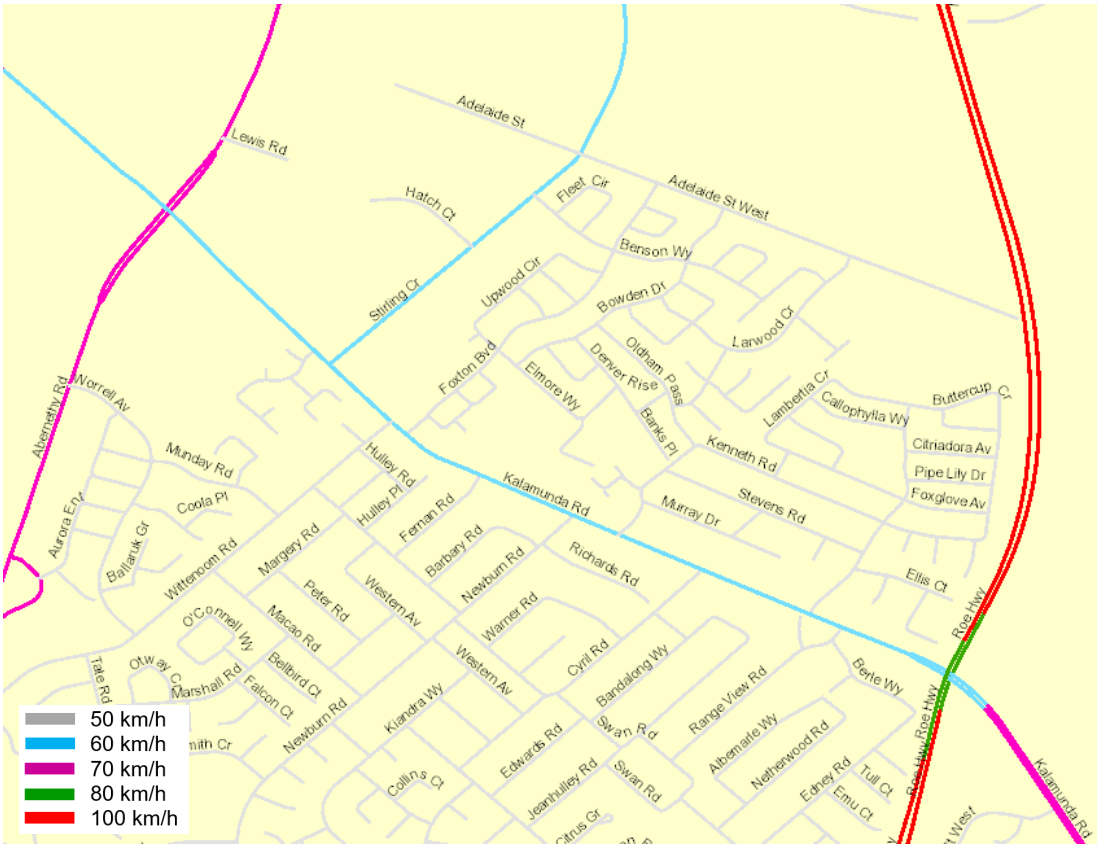
- MRWA Traffic Map midblock counts (2019/2019);
- MRWA Traffic Map SCATS data (2019);
- City of Kalamunda midblock counts (2016 to 2019); and
- Turning movement counts conducted by Cardno (2019).

These traffic data, together with growth rates are discussed in **Section 6.4**, and were used to obtain future scenario traffic volumes, turning movement splits, directional splits, and peak hour factors. Turning movement volumes for all intersections included in the study for the assessment years are presented in **Appendix C**.

3.2 Speed Limit Data

Current section speed limits within the study area are shown in **Figure 3-1**.

Figure 3-1 Speed limits long Kalamunda Road and side roads



Source: MRWA Road Information Mapping System

3.3 Signal Timing Data

No existing traffic signals are located along Kalamunda Road between Abernethy Road and Roe Highway. To model intersections as possible signalised intersections, pedestrian signal timing data from the

Kalamunda Road – Abernethy Road intersection were used. The yellow and all-red time values were calculated using the guidelines detailed in the *MRWA Operational Modelling Manual Appendix A*. Signal timing data used in the Sidra modelling is shown in **Table 3-1**.

Table 3-1 Signal timing data

Times	Value (seconds)
Pedestrian Walk Time*	6
Pedestrian Clearance Time*	6
Yellow Time	4
All-red Time	2

**From Kalamunda Road – Abernethy Road SCATS Information*

3.4 Intersection Geometry

The geometric configuration information for the existing and proposed future intersection arrangements was obtained from Nearmap aerial images and Google Streetview images and the concept designs described in more detail in **Section 4** of this report.

3.5 Crash Data Review

A search of the Main Roads WA Reporting Centre for crash data was undertaken. Crash data recorded between 1 January 2014 and 31 December 2018 was extracted for both intersections and midblock locations along Kalamunda Road between Abernethy Road and Roe Highway.

3.5.1 Intersection Crashes

Crash data for the following major intersections is reported below:

- Roe Highway and Kalamunda Road;
- Kalamunda Road, Newburn Road and Chipping Drive; and
- Kalamunda Road and Abernethy Road.

The crashes for the intersections on Kalamunda Road between Abernethy Road and Roe Highway are summarised in **Table 3-2**, **Table 3-3**, **Table 3-4**, **Table 3-5** and **Table 3-6**.

Table 3-2 Crash Data - Roe Highway and Kalamunda Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	4	26	104	55	189
Unspecified	-	-	1	1	2	4
Right Turn Thru	-	-	1	-	1	2
Right Angle	-	-	1	3	1	5

Non-Collision	-	1	-	-	-	1
Hit Object	-	-	-	3	-	3
Hit Pedestrian	1	-	-	-	-	1
Head On	-	-	-	1	-	1
Sideswipe Same Direction	-	-	-	4	-	4
Total	**1**	**5**	**29**	**116**	**59**	**210**

Table 3-3 Crash Data - Kalamunda Road, Newburn Road and Chipping Drive

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	3	7	5	15
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	1	4	1	6
Right Angle	-	-	1	10	5	16
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	2	-	2
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	-	-	-
Total	**-**	**-**	**5**	**23**	**11**	**39**

Table 3-4 Crash Data - Kalamunda Road and Abernethy Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	1	6	6	13
Unspecified	-	-	-	1	-	1
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	2	-	1	1	4
Non-Collision	-	-	-	-	1	1
Hit Object	-	-	-	1	-	1
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	1	-	1
Total	**-**	**2**	**1**	**10**	**8**	**21**

Table 3-5 Crash Data - Kalamunda Road and other minor intersections

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	-	4	2	6
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	1	3	7	1	12
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	-	-	-
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	1	-	1
Total	**-**	**1**	**3**	**12**	**3**	**19**

Table 3-6 Total Crashes at all Intersections

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	4	30	121	68	223
Unspecified	-	-	1	2	2	5
Right Turn Thru	-	-	2	4	2	8
Right Angle	-	3	5	21	8	37
Non-Collision	-	1	-	-	1	2
Hit Object	-	-	-	6	-	6
Hit Pedestrian	1	-	-	-	-	1
Head On	-	-	-	1	-	1
Sideswipe Same Direction	-	-	-	6	-	6
Total	**1**	**8**	**38**	**161**	**81**	**289**

It is not surprising that the majority of crashes recorded are at major intersections such as Roe Highway and Kalamunda Road and Kalamunda Road, Newburn Road and Chipping Drive. The proposed upgrades to the Roe Highway and Kalamunda Road intersection and the recent improvements at the Kalamunda Road, Newburn Road and Chipping Drive intersection would assist with reducing crashes currently being experienced. It should be noted one fatal pedestrian crash was recorded at the Roe Highway/Kalamunda Road intersection.

3.5.2 Midblock Crashes

The midblock crashes recorded on Kalamunda Road between Abernethy Road and Roe Highway are summarised in **Table 3-7**, **Table 3-8, Table 3-9, Table 3-10**, **Table 3-11**, **Table 3-12,** and **Table 3-13**.

Table 3-7 Crashes Between Abernethy Road and Wittenoom Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	-	1	2	3
Unspecified	-	-	-	1	-	1
Right Turn Thru	-	-	-	-	-	-

Right Angle	-	-	-	-	-	-
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	-	-	-
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	1	-	1
Sideswipe Same Direction	-	-	-	-	2	2
Total	**-**	**-**	**-**	**3**	**4**	**7**

Table 3-8 Crashes Between Wittenoom Road and Fernan Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	-	2	-	2
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	-	-	-	-	-
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	-	-	-
Hit Pedestrian	-	-	-	-	1	1
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	1	-	1
Total	**-**	**-**	**-**	**3**	**1**	**4**

Table 3-9 Crashes Between Fernan Road and Newburn Road/Chipping Drive

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	-	2	-	2
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	-	-	4	1	5
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	1	-	1	2
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	1	-	1
Total	**-**	**-**	**1**	**7**	**2**	**10**

Table 3-10 Crashes Between Newburn Road/Chipping Drive and Kenneth Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	-	-	2	2
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	-	-	-	-	-
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	2	-	2
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	-	-	-
Total	**-**	**-**	**-**	**2**	**2**	**4**

Table 3-11 Crashes Between Kenneth Road and Cyril Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	2	1	-	3
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	-	-	1	1	2
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	1	-	1
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	-	-	-
Total	**-**	**-**	**2**	**3**	**1**	**6**

Table 3-12 Crashes between Roe Highway and Cyril Road

Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	1	3	1	5
Unspecified	-	-	-	-	-	-
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	1	-	-	1	2
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	-	-	-	-
Hit Pedestrian	-	-	-	-	-	-
Head On	-	-	-	-	-	-
Sideswipe Same Direction	-	-	-	-	-	-
Total	**-**	**1**	**1**	**3**	**2**	**7**

Table 3-13 Total Midblock Crashes

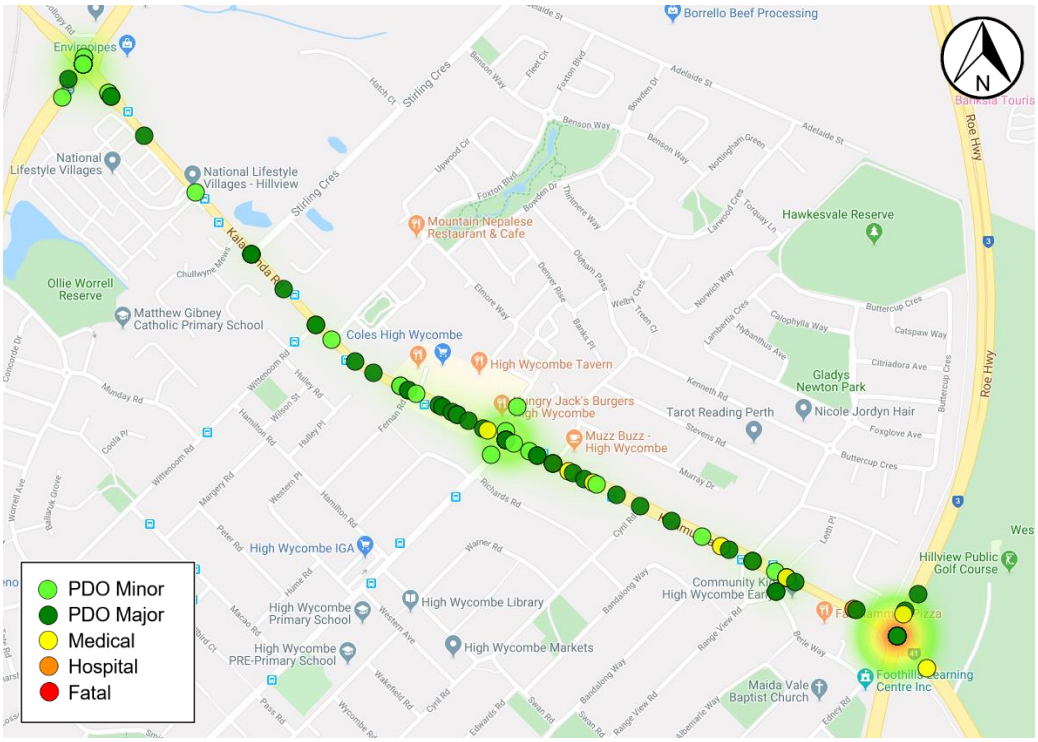
Type	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Rear End	-	-	3	9	5	17
Unspecified	-	-	-	1	-	1
Right Turn Thru	-	-	-	-	-	-
Right Angle	-	1	-	5	3	9
Non-Collision	-	-	-	-	-	-
Hit Object	-	-	1	3	1	5
Hit Pedestrian	-	-	-	-	1	1
Head On	-	-	-	1	-	1
Sideswipe Same Direction	-	-	-	2	2	4
Total	**-**	**1**	**4**	**21**	**12**	**38**

The majority of midblock crashes recorded on Kalamunda Road project study area occurred between Fernan Road and Newburn Road/Chipping Drive and between Roe Highway and Cyril Road. It is noticeable that the midblock crashes on Kalamunda Road are concentrated in areas where there is high vehicular activity i.e. in the vicinity of the High Wycombe Village Shopping Centre and Roe Highway. Only 1 pedestrian related crash was recorded between Wittenoom Road and Fernan Road.

3.5.3 Crash Heat Map

All crashes recorded along Kalamunda Road and on side roads about 100 metres away from Kalamunda Road are plotted in the heat map shown in **Figure 3-2**. Crash severity are colour-coded as shown in the legend.

Figure 3-2 Crash Heat Map



4 Concept Designs

4.1 Design Considerations

4.1.1 Scope

The scope of the concept designs includes the following as a minimum:

- Identify constraints that impact the outcomes;
- Road safety considerations e.g. Blackspot locations or identified high risk locations;
- Improvements needed to road sections and intersections over time related to forecast traffic demand;
- Pedestrian and cycling facilities;
- Primary Street and pedestrian lighting;
- Identifying existing public utility services and those services requiring relocation through “Dial-before-you-dig”, site observations and City advice; and
- Identify road reserve widths and changes that may be required.

4.1.2 Constraints

The cross section for the concept design for this section of Kalamunda Road was determined and supported through an extensive stakeholder consultation process undertaken during Stage 1 of this project. The City of Kalamunda endorsed the design of a Low Capacity road with a typical cross section as illustrated in **Figure 4-1.**

Figure 4-1 Low Capacity Road Cross Section

The road would generally comprise of a 3.5-metre-wide lane, a 2-metre-wide bike lane, a 2-metre-wide pedestrian footpath on either side of the road and a 4-metre-wide median separator.

The proposed cross section and current traffic volumes are characteristic of an Integrator B road according to the Draft Liveable Neighbourhoods 2015 and hence the concept design was designed to constrain traffic flows at 15,000vpd for this section of Kalamunda Road.

Furthermore, at the inception meeting held on 12 September 2019, the City of Kalamunda suggested the following be considered in developing the proposed concept design:

- The closure of Rangeview Road intersection and converting Hawkevale Road to a 4-legged roundabout controlled intersection;
- Providing a roundabout at the Kalamunda Road/Cyril Road intersection;
- Full movements to be provided at the Kenneth Road intersection;
- Any pedestrian facility proposed at the Kalamunda Road/Newburn Road/Chipping Drive intersection should be located on the western side of the Newburn Road/Chipping Drive intersection for safety and permeability reasons;
- The concept designs should take into consideration the safety and traffic operations at the existing accesses to the High Wycombe Shopping Centre;
- Consider closure of Fernan Road and providing a signalised pedestrian crossing in this proximity;
- Provide full movements at the Wittenoom Road intersection;
- Consider providing a pedestrian crossing facility between Stirling Crescent and Wittenoom Road;
- The concept design is to accommodate “as of right” vehicles since the future role of Stirling Crescent is for light traffic serving residential and industrial land uses, but not for heavy vehicles; and
- Footpaths are to be located against property boundaries where practically possible.

4.1.3 Applicable Standards and Manuals

The concept design has been developed in accordance with the following guidelines:

- Guide to Road Design Part 4A Unsignalized and Signalised Intersections;
- Guide to Road Design Part 4B Roundabouts;
- Main Roads WA Supplement to Austroads Guide to Road Design – Part 4;
- Liveable Neighbourhoods 2009; and
- Draft 2015 Liveable Neighbourhoods.

4.2 Concept Road Design

The functional environment of Kalamunda Road between Abernethy Road and Roe Highway can be divided into three distinctive sections:

- Section 1- The section between Abernethy Road and Wittenoom Road. Section 1A extends between Abernethy Rd and Stirling Crescent and Section 1B between Stirling Crescent and Wittenoom Road;
- Section 2 - The section comprising the High Wycombe Shopping Centre between Wittenoom Road and Cyril Road. Section 2A extends between Wittenoom Road and Newburn Road/Chipping Drive and Section 2B between Newburn Road/Chipping Drive and Cyril Road; and
- Section 3 - The section between Cyril Road and Roe Highway.

The details of the proposed concept design have also been described in this technical report in terms of the abovementioned sections.

4.2.1 Section 1 (Abernethy Road to Wittenoom Road)

This section comprises the following intersections:

- Kalamunda Road/Access to the National Lifestyle Villages;
- Kalamunda Road/Chullwyne Mews;
- Kalamunda Road/Stirling Crescent; and
- Kalamunda Road/Wittenoom Road.

The proposed concept design for this section of Kalamunda Road is shown in Drawing no. CW1063000-TR-001. Footpaths and bicycle lanes are proposed on both sides of the roadway. According to Austroads Guide to Road Design Part 4B Roundabouts, roundabouts may not be as safe for cyclists as other road users.

Based on this, the on-street bicycle lanes in the eastbound direction terminates just west of Chullwyne Mews and converges with the footpath to become a shared path. Similarly, the on-street bicycle lane in the westbound direction commences just west of Chullwyne Mews. Beyond the Stirling Crescent intersection, the on-street bicycle lane continues in an easterly direction towards Abernethy Road.


SECTION A-A
PROPOSED PROPERTY BOUNDARY
PROPERTY BOUNDARY
2.0 m FOOT PATH
4.1 m VERGE
2.0 m BIKE LANE
3.5 m LANE
3.5 m AUXILIARY LANE
2.5 m MEDIAN
3.5 m LANE
2.0 m BIKE LANE
5.5 m VERGE
2.0 m FOOT PATH
1.0 m
ABERNETHY RD
LOT 200
STIRLING CRES
LOT 100
LOT 13
WITTENOOM RD
SECTION B-B
6.0 m MEDIAN
3.5 m AUXILIARY LANE
4.9 m VERGE
LEGEND
PROPOSED KERB AND MEDIAN
CADASTRAL
BIKE LANE
FOOTPATH
BUS EMBAYMENT
PROPERTY DRIVEWAY
SOLID MEDIAN
ROUNDABOUT ISLAND
REVISION IN PROGRESS
NORTH
CHECK PRINT ONLY
PRELIMINARY
FINAL
MARKUP
BACKDRAFTED / CORRECTED
CONFIRMED
SELF CHECK
Drawn Joey Huang 29/01/2020
Checked Desmond Ho 29/01/2020
Designed
Verified
Approved
Client City of Kalamunda
Project KALAMUNDA ROAD FUNCTIONAL REVIEW AND UPGRADE ROAD CONCEPT DESIGN
Title Layout Plan
Kalamunda Rd between Abernethy Rd and Wittenoom Rd
Status PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
Scale NTS
Size A3
Drawing Number CW1063000-TR-001
Revision B

The proposed cross section in Section 1A (between Abernethy Road and Stirling Crescent) is illustrated in **Figure 4-2** and **Figure 4-3.**

Figure 4-2 Cross Section A-A

Figure 4-3 Cross Section B-B

The following utilities and services within Section 1 are anticipated to be relocated:

- Western Power- Overhead cables run along Kalamunda Road in this section. It's anticipated that the overhead cables would be relocated and replaced with underground cables;
- Watercorp- It is anticipated that modification works to the 250mm diameter cast iron watermain would be required. Similarly, modification works to the 150mm diameter sewer i.e. modifying line and level of the sewer is also required;
- ATCO Gas- It is anticipated that modification to the 70Kpa low pressure gas main would be required but not for the high-pressure gas main;
- Telstra;
- Optus; and
- NBN.

a) Stirling Crescent intersection treatment

A roundabout is proposed for this intersection. The dimensions associated with the proposed roundabout are detailed in **Table 4-1.**

Table 4-1 Dimensions for Proposed Roundabout at Kalamunda Road & Stirling Crescent

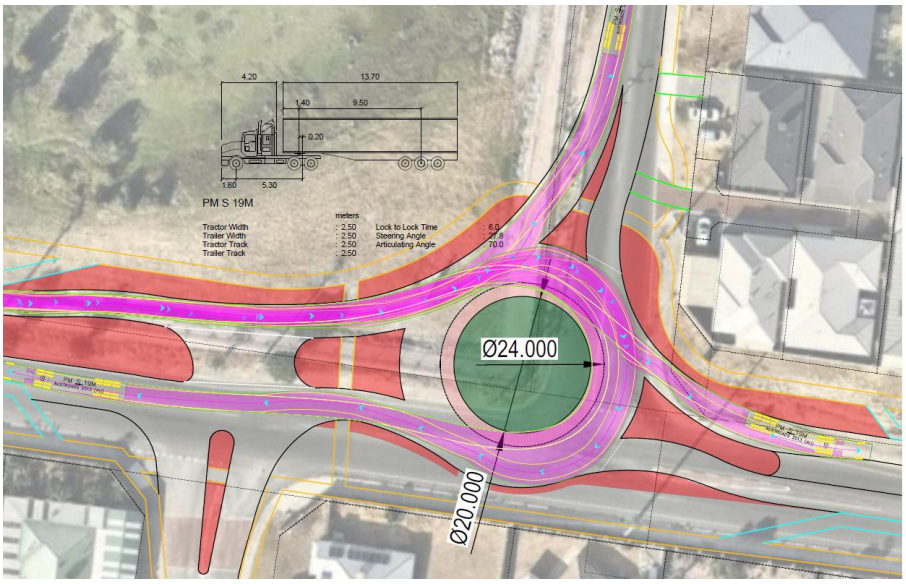
Intersection	Inner Radius (m)	Outer Radius (m)	Width of Circulating Lane (m)
Kalamunda Road and Stirling Crescent	12	18	6

It should be noted that the proposed roundabout would encroach into vacant Lot 200- 584 Kalamunda Road, High Wycombe as shown in **Section 2.5** of this report. The City of Kalamunda is to ensure that the future road reservation for the proposed concept design and roundabout is reserved through the town planning application and approval process.

The proposed roundabout has been designed to cater for “as of right” vehicles. According to Main Roads WA Supplement to Austroads Guide to Road Design – Part 4, a 19 m Prime Mover and Semi-Trailer right of way vehicle is typically used as the design vehicle.

The swept path analysis shows that the 19m design vehicle would manoeuvre successfully through this intersection as illustrated in **Figure 4-4.**

Figure 4-4 Swept path analysis at proposed Kalamunda Rd/Stirling Crescent intersection



b) Wittenoom Road intersection treatment

It is proposed that a full movement T-junction be maintained at this intersection. A right turn pocket is proposed on the western approach of the Kalamunda Road/Wittenoom Road intersection as illustrated in Drawing no. CW1063000-TR-001 and **Figure 4-5** below. The turn pocket length has been designed in accordance with the Austroads Guide to Road Design.

Figure 4-5 Proposed Kalamunda Rd/Wittenoom Road intersection

4.2.2 Section 2 (Wittenoom Road to Cyril Road)

This section comprises the following intersections:

- Kalamunda Road/Foxton Boulevard;
- Kalamunda Road/Fernan Road;
- Kalamunda Road/High Wycombe shopping centre accesses;
- Kalamunda Road/Newburn Road/Chipping Drive; and
- Kalamunda Road/Kenneth Road.

The proposed concept design for this section of Kalamunda Road is shown in Drawing no. CW1063000-TR-002. Footpaths and bicycle lanes are proposed on both sides of the roadway. The on-street bicycle lane in the eastbound direction continues from Stirling Crescent intersection and terminates just east of one of the entrances into the High Wycombe shopping centre and converges with the footpath to become a shared path. Similarly, the on-street bicycle lane in the westbound direction commences just west of Newburn Road/Chipping Drive intersection and continues along Kalamunda Road and terminates before the Stirling Crescent intersection.

It is proposed that Fernan Road be converted to a cul-de-sac at its intersection with Kalamunda Road and a new 6-metre-wide pedestrian crossing with traffic signals be installed in the proximity of this intersection as shown in Drawing no. CW1063000-TR-002.

REVISION IN PROGRESS

Rev	Date	Description	Des.	Verif.	Appd.

CHECK PRINT ONLY

PRELIMINARY FINAL | INITIAL | DATE | INITIAL | DATE

MARKUP

BACKDRAFTED / CORRECTED

CONFIRMED

SELF CHECK

Drawn Joey Huang Date 29/01/2020
Checked Desmond Ho Date 29/01/2020
Designed Date
Verified Date
Approved

Client City of Kalamunda

Project KALAMUNDA ROAD FUNCTIONAL REVIEW AND UPGRADE ROAD CONCEPT DESIGN

Title Layout Plan Kalamunda Rd between Wittenoom Rd and Cyril Rd ####

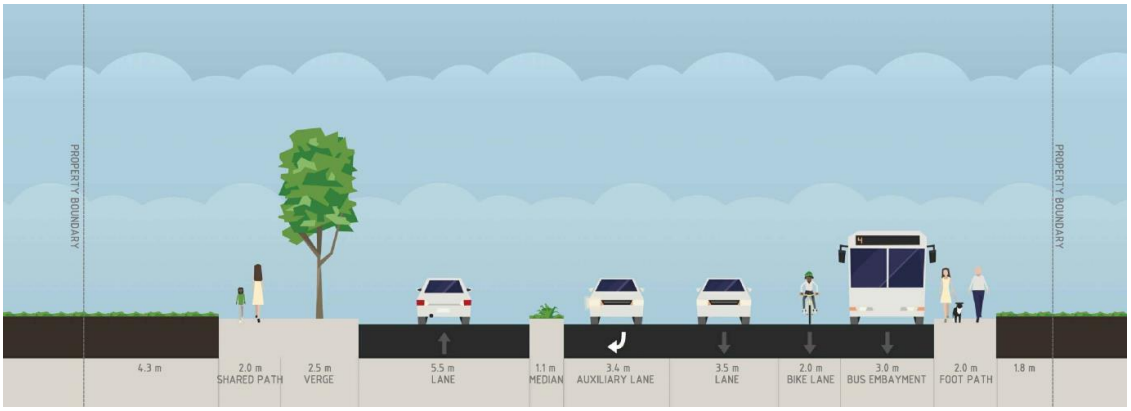
Status PRELIMINARY NOT TO BE USED FOR CONSTRUCTION PURPOSES

Scale NTS Size A3

Drawing Number CW1063000-TR-002 Revision B

The proposed cross section in the vicinity of the High Wycombe Shopping Centre is illustrated in **Figure 4-6.**

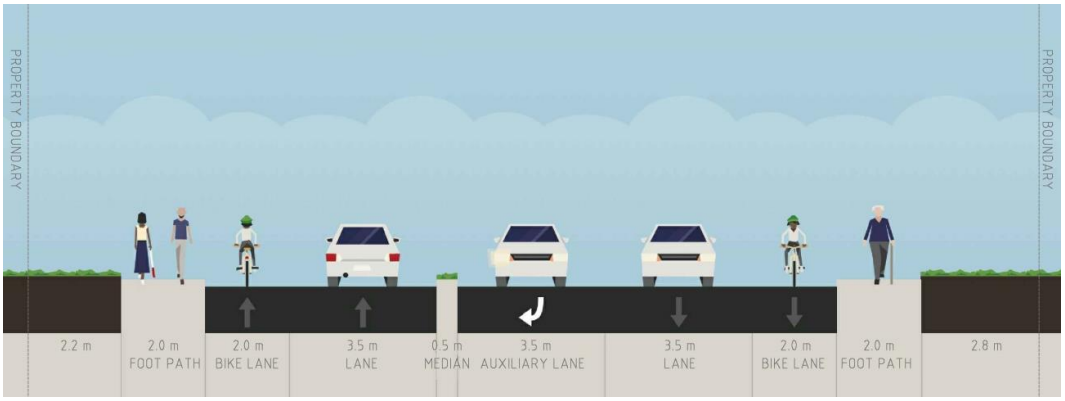
Figure 4-6 Cross Section C-C



East of the Kalamunda Road/Newburn Road/Chipping Drive intersection, the on-street bicycle lane is proposed to continue from east of Kenneth Road intersection in the eastbound direction and terminates and converges with the footpath to become a shared path just before reaching the proposed roundabout at the Cyril Road intersection. Similarly, the on-street bicycle lane in the westbound direction commences just west of the Cyril Road intersection and terminates before the Newburn Road/Chipping Drive intersection.

The proposed cross section east of Kenneth Road is illustrated in **Figure 4-7 .**

Figure 4-7 Cross Section D-D



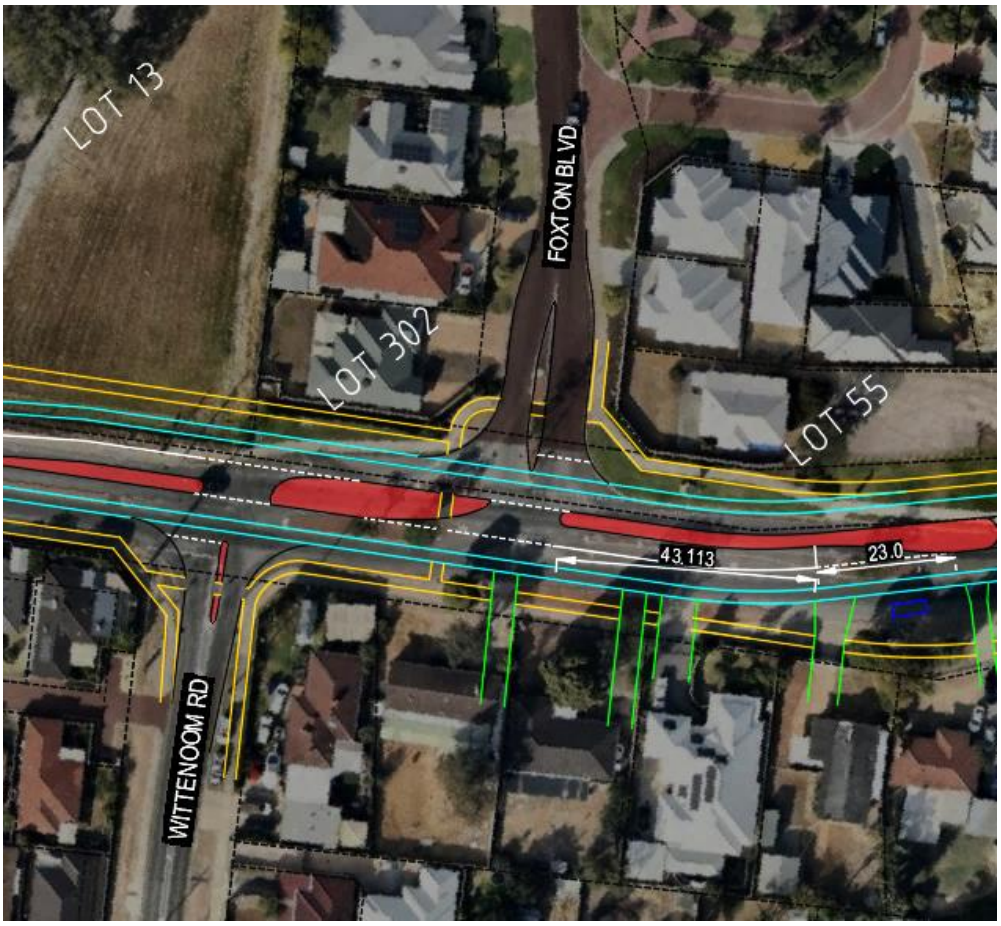
The following utilities and services within Section 2 are anticipated to be relocated:

- Western Power- It is anticipated that the existing overhead power poles are to be relocated;
- Watercorp- It is anticipated that modification works to the 250mm diameter cast iron watermain would be required. Similarly, modification works to the 150mm diameter sewer i.e. modifying line and level of the sewer is also required;
- ATCO Gas- It is anticipated that modification to the 70Kpa low pressure gas main would be required but not for the high-pressure gas main;
- Telstra; and
- NBN.

a) Foxton Boulevard intersection treatment

It is proposed that a full movement T-junction be maintained at this intersection. A right turn pocket is proposed on the eastern approach of the Kalamunda Road/Foxton Boulevard intersection as illustrated in Drawing no. CW1063000-TR-002 and **Figure 4-8** below. The turn pocket length has been designed in accordance with the Austroads Guide to Road Design.

Figure 4-8 Proposed Kalamunda Road/Foxton Boulevard intersection



b) High Wycombe Shopping Centre Access intersection treatment

There are currently four access points on Kalamunda Road to enter and exit the High Wycombe Shopping Centre as illustrated in Drawing no. CW1063000-TR-002. The configuration of the accesses located on Kalamunda Road on the eastern and western extremities of the shopping centre property boundary is expected to remain to a large extent unchanged.

Minor changes have been proposed at Access 2 and Access 3 to the High Wycombe Shopping Centre. The central island is proposed to be extended to prevent right turning movements on exiting the shopping centre (as currently experienced at these locations) as illustrated in **Figure 4-9** and **Figure 4-10.** The central island is proposed to be extended approximately 2m at Access 2. To accommodate the bicycle lane on the southern side of Kalamunda Road the central island located at Access 3 is proposed to be relocated slightly north and extended by approximately 2.3m (compared to the existing island) to prevent right turning movements on exiting the shopping centre. Furthermore, the left turn pocket at Access 3 is to be reduced by about 4m.

Figure 4-9 Proposed Access 2 to High Wycombe Shopping Centre

Figure 4-10 Proposed Access 3 to High Wycombe Shopping Centre

The extension of the centre islands at Access 2 and Access 3 would suggest that an 8.8m design vehicle would be able to adequately undertake the right turn manoeuvre from the east. The swept path analyses for the right turn movement undertaken by an 8.8m design vehicle at Access 2 and Access 3 are illustrated in **Figure 4-11** and **Figure 4-12** respectively.

Figure 4-11 Swept path analysis at proposed Kalamunda Road/Access 2 intersection - 8.8m design vehicle

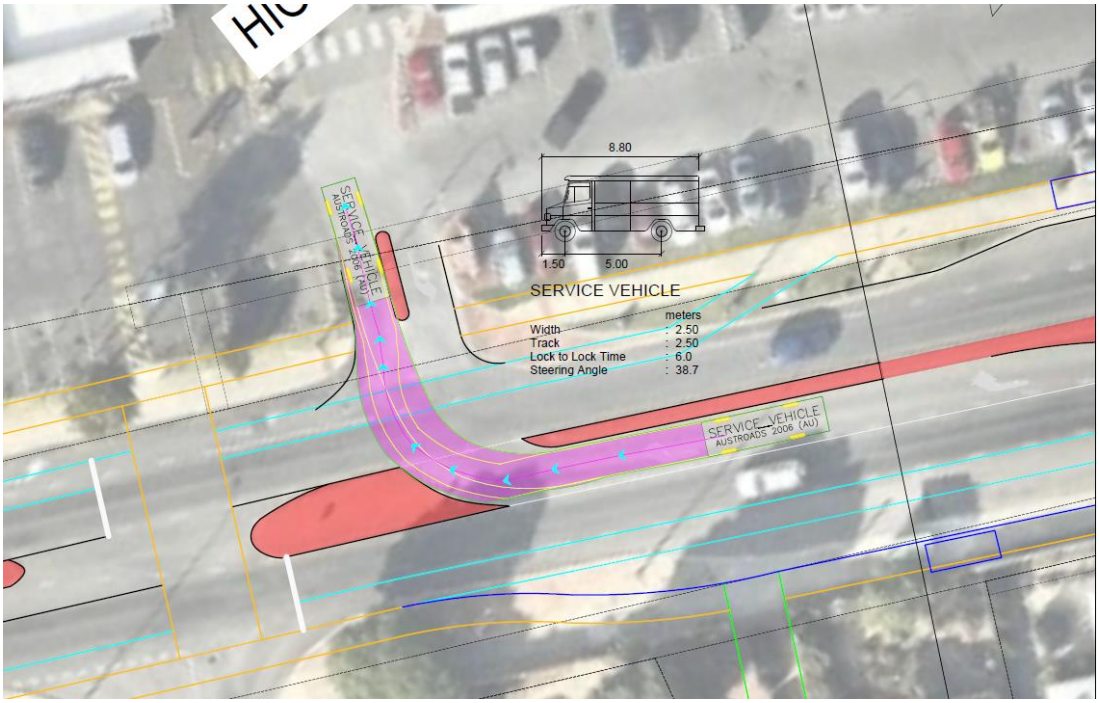
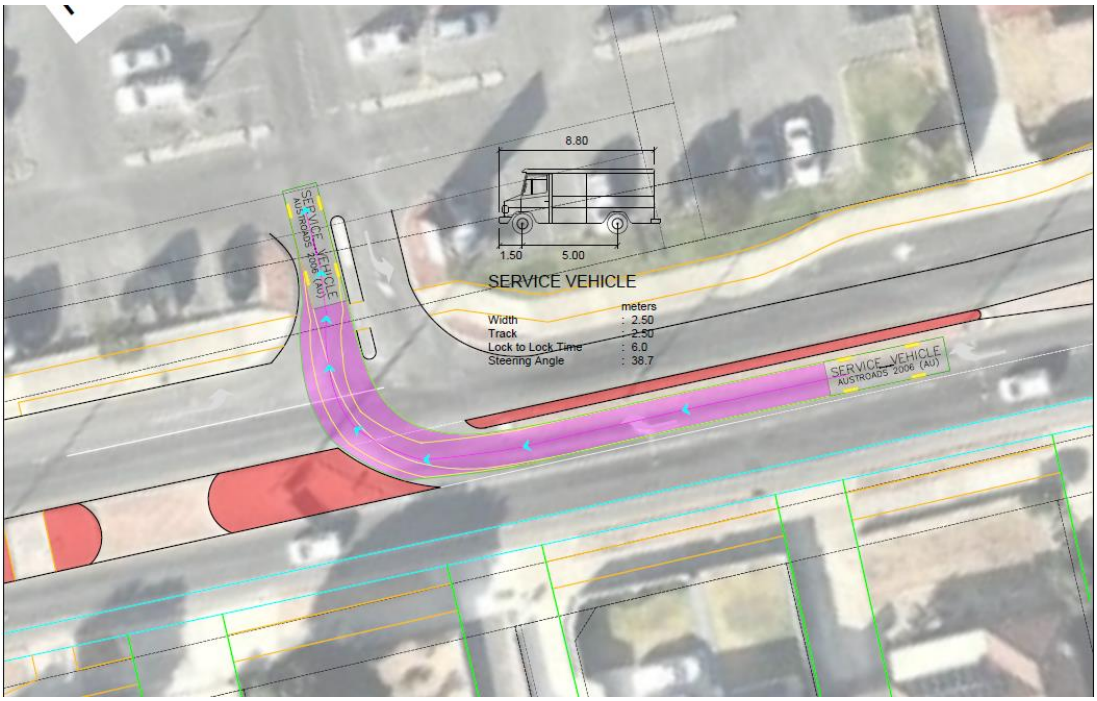


Figure 4-12 Swept path at analysis at proposed Kalamunda Road/Access 3 intersection - 8.8m design vehicle

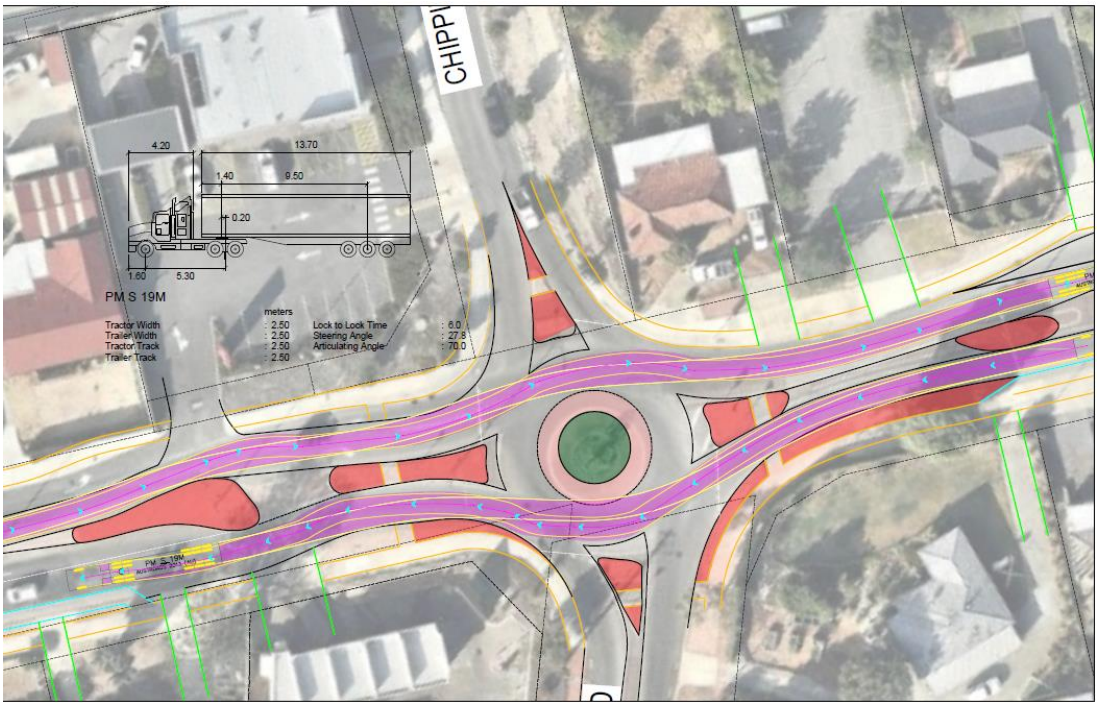


c) Newburn Road/Chipping Drive intersection treatment

Upgrades to the Newburn Road/Chipping Drive intersection including the removal of the right turn lane on the western approach and converting the roundabout to a single circulating lane only were completed in 2019.

The concept design does not propose any further changes and the intersection is to remain unchanged. The swept path analysis suggests that a 19m vehicle would be able to manoeuvre successfully through this intersection as illustrated in **Figure 4-13**.

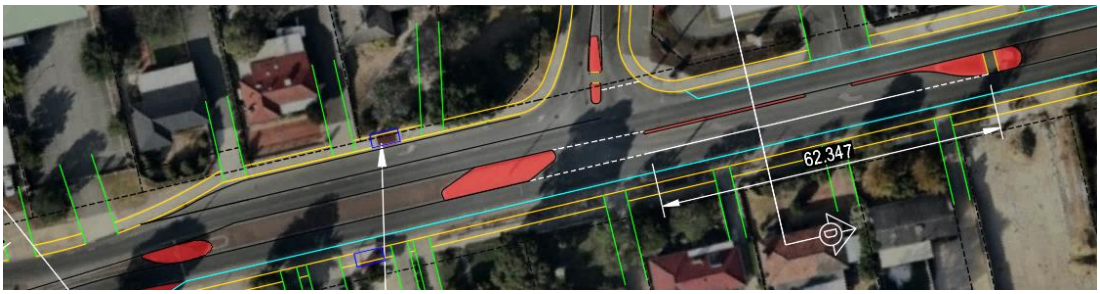
Figure 4-13 Swept path at analysis at proposed Kalamunda Road/Newburn Road/Chipping Drive intersection - 19m design vehicle



d) Kenneth Road intersection treatment

It is proposed that a full movement T-junction be maintained at this intersection as illustrated in Drawing no. CW1063000-TR-002 and **Figure 4-14** below.

Figure 4-14 Proposed Kalamunda Road/Kenneth Road intersection

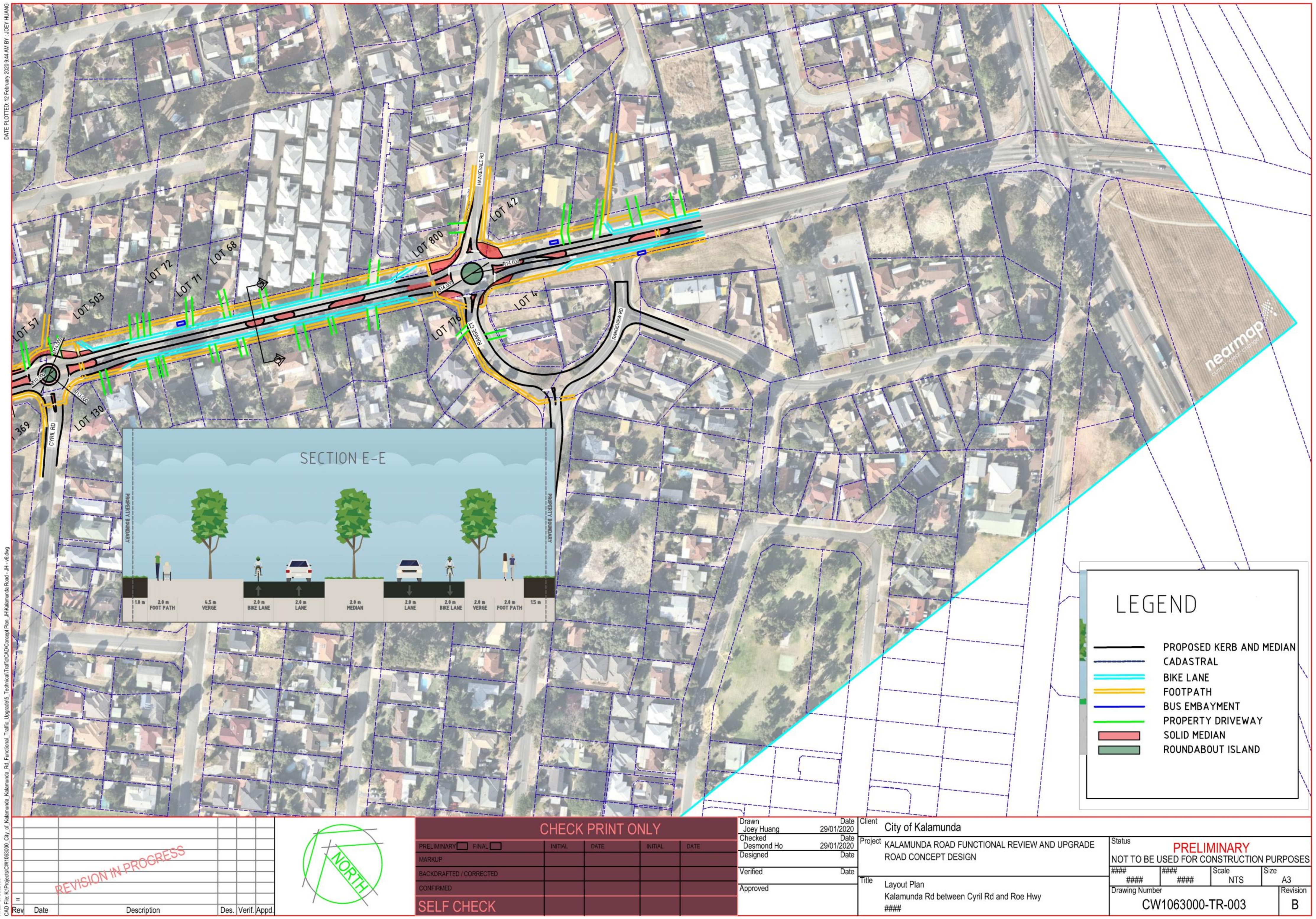


The concept design does not propose any major changes and the intersection is to remain unchanged apart from modifications to the central islands.

4.2.3 Section 3 (Cyril Road to Roe Highway)

The proposed concept design for this section of Kalamunda Road is shown in Drawing no. CW1063000-TR-003. Footpaths and bicycle lanes are proposed on both sides of the roadway. To the east of the Kalamunda Road/Cyril Road intersection, the on-street bicycle lane is proposed to continue in the eastbound direction and terminates and converges with the footpath to become a shared path just before reaching the proposed roundabout at the Hawkevale Road intersection. The bicycle lane then continues along Kalamunda Road east of the Kalamunda Road/Hawkvale Road intersection and connects with the existing bicycle lane east of Kalamunda Road/Rangeview Road intersection. Similarly, the on-street bicycle lane in the westbound direction commences west of the Cyril Road intersection and terminates in close proximity of the Newburn Road/Chipping Drive intersection.

It is also proposed that the existing Kalamunda Road/Rangeview Road intersection be closed and a new 4-legged roundabout controlled intersection be introduced at the Kalamunda Road/Hawkevale Road/Range Court intersection. This treatment would remove the staggered intersections that currently exists between Rangeview Road and Hawkevale Road which will improve safety and traffic operations.


SECTION E-E
LEGEND
PROPOSED KERB AND MEDIAN
CADASTRAL
BIKE LANE
FOOTPATH
BUS EMBAYMENT
PROPERTY DRIVEWAY
SOLID MEDIAN
ROUNDABOUT ISLAND
NORTH
REVISION IN PROGRESS
CHECK PRINT ONLY
SELF CHECK
Drawn Joey Huang Date 29/01/2020
Checked Desmond Ho Date 29/01/2020
Client City of Kalamunda
Project KALAMUNDA ROAD FUNCTIONAL REVIEW AND UPGRADE ROAD CONCEPT DESIGN
Title Layout Plan
Kalamunda Rd between Cyril Rd and Roe Hwy
Status PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
Scale NTS
Size A3
Drawing Number CW1063000-TR-003
Revision B

The proposed cross section in Section 3 is illustrated in **Figure 4-15**.

Figure 4-15 Cross Section E-E

The following utilities and services within Section 3 are anticipated to be relocated:

- Western Power-- It is anticipated that the existing overhead power poles are to be relocated;
- Watercorp - It is anticipated that modification works to the 250mm diameter cast iron watermain would be required. Similarly, modification works to the 150mm diameter sewer i.e. modifying line and level of the sewer is also required;
- ATCO Gas- It is anticipated that modification to the 70Kpa low pressure gas main would be required but not for the high-pressure gas main;
- Telstra; and
- NBN.

a) Cyril Road intersection treatment

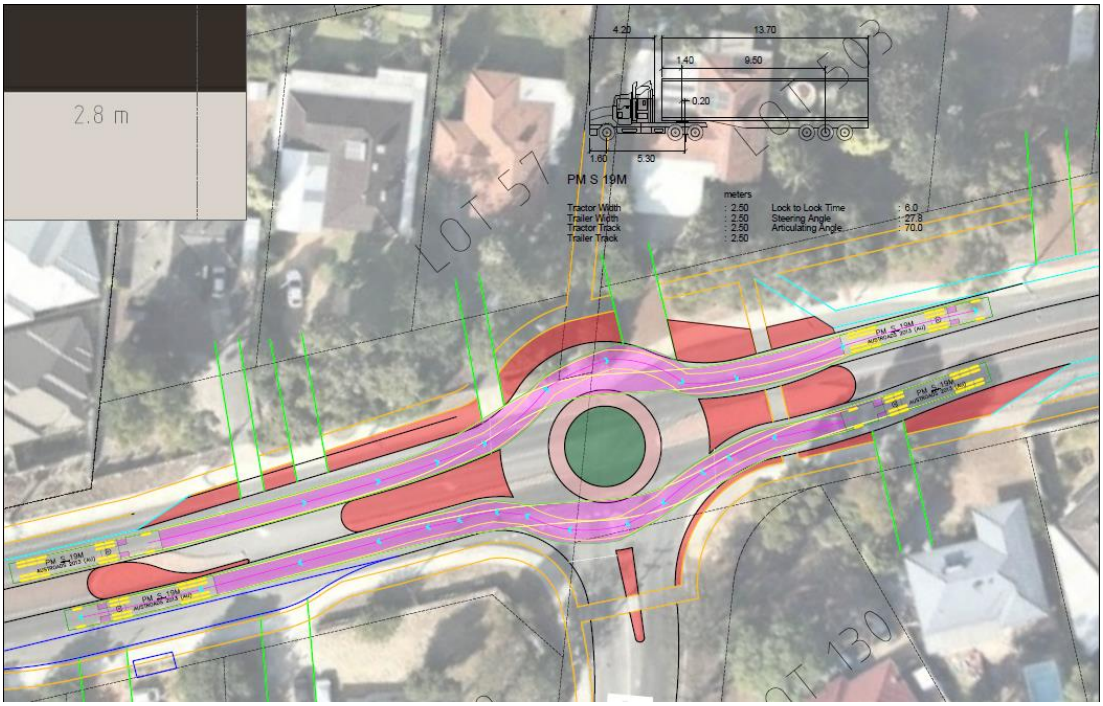
A roundabout is proposed for this intersection. The dimensions associated with the proposed roundabout are detailed in **Table 4-2.**

Table 4-2 Dimensions of Proposed Roundabout at Kalamunda Road/Cyril Road

Intersection	Inner Radius (m)	Outer Radius (m)	Width of Circulating Lane (m)
Kalamunda Road and Cyril Road	7	13	6

The swept path analysis shows that the 19m design vehicle appears to manoeuvre successfully through this intersection as illustrated in **Figure 4-16.**

Figure 4-16 Swept path analysis at proposed Kalamunda Rd/Cyril Road intersection



b) Hawkevale Road intersection treatment

The existing three-legged intersection is proposed to be converted into a four-legged roundabout by connecting Range Court to Kalamunda Road. The existing intersection of Kalamunda Road and Range View Road will be closed by converting the north end of Range View Road into a cul-de-sac as detailed in **Figure 4-17**. The dimensions associated with the proposed roundabout are detailed in **Table 4-3.**

Figure 4-17 Proposed Kalamunda Road/Hawkevale Road/Range Court intersection

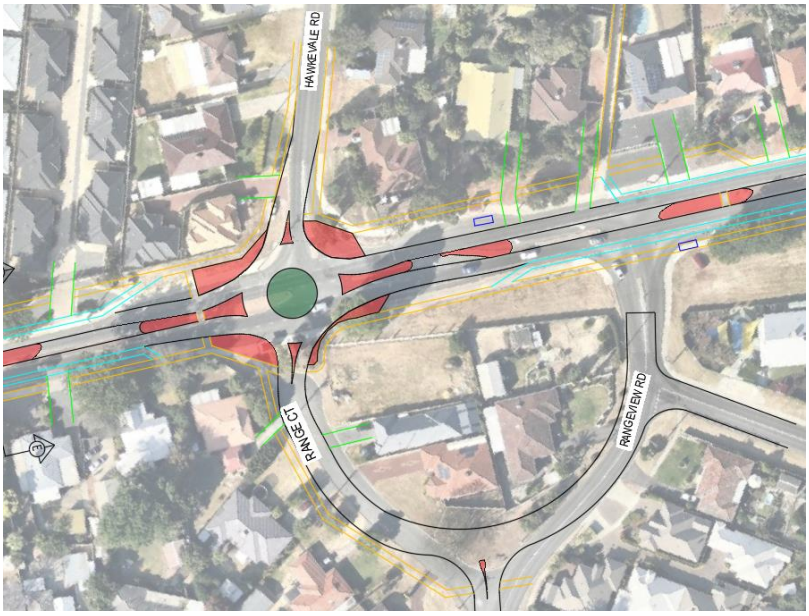
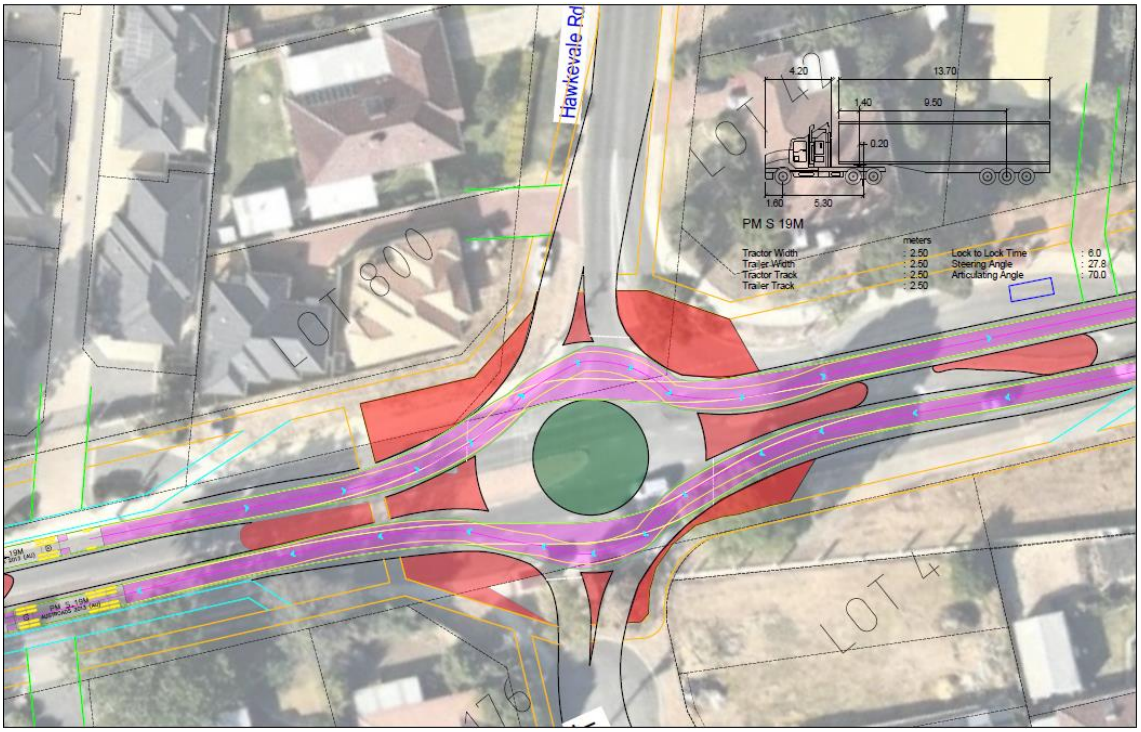


Table 4-3 Dimensions of Proposed Roundabout at Kalamunda Road/Hawkevale Road

Intersection	Inner Radius (m)	Outer Radius (m)	Width of Circulating Lane (m)
Kalamunda Road, Hawkevale Road and Range Court	7	14	7

The swept path analysis shows that the 19m design vehicle appears to manoeuvre successfully through this intersection as illustrated in **Figure 4-18.**

Figure 4-18 Swept path analysis at proposed Kalamunda Rd/Hawkevale Road intersection



4.3 Bus Embayments and Bus Stops

As part of the Stakeholder Consultation process for Stage 2 of this project, the Public Transport Authority (PTA) has advised that ideally bus stops would be located in bus bays only where buses may be contractually required to dwell if running early or where there is a significant attractor such as a shopping centre, or where it is known or expected that there would be heavy passenger loadings. The PTA have also indicated that they would support the removal of bus bays at all bus stops along this section of Kalamunda Road, except those at the shopping centre. Buses stopping in the lane of traffic have been used in several situations to assist with road calming measures.

It is proposed that a bus embayment be provided on the westbound carriageway opposite the High Wycombe Shopping Centre. In the eastbound direction the bus stop will be located adjacent to the left turn pocket as per the existing situation. All bus embayments along this section of road, except for the one located west of Cyril Road (westbound direction), are proposed to be removed and buses are proposed to stop in the roadway. It should be noted it is recommended that the proposed bus embayment to the west of Cyril Road (westbound direction) be retained in order to reduce the potential impact of this bus stop on traffic operations at the Kalamunda Rd/Cyril Road intersection.

The bus stops are proposed to be located at existing locations along Kalamunda Road between Abernethy Road and Roe Highway except for two bus stops which are required to be relocated as a result of the proposed concept design. The existing bus stops at Cyril Road (eastbound direction) and Range Court (westbound direction) would have to be relocated due to the new roundabout treatments proposed at these intersections (refer to Drawing no. CW1063000-TR-003 for proposed locations).

5 Access Strategy

Current access arrangements for all business and residential properties accessing Kalamunda Road between Abernethy Road and Roe Highway were considered in the development of the concept design for the low capacity road function adopted by the City. It is anticipated that all properties will be able to retain direct access to Kalamunda Road. It should be noted that access to Lot 57 and Lot 503 is suggested to access directly into the new roundabout proposed at the Kalamunda Road/Cyril Road intersection as shown in **Figure 5-1**.

Figure 5-1 Access for Lot 57 and Lot 503

6 Intersection Analysis

6.1 Modelling Assumptions

For the purpose of this assessment, the following assumptions were made.

- Heavy vehicle volumes are based on the existing heavy vehicles percentages obtained from the traffic counts for all scenarios;
- The Kalamunda Road/Abernethy Road and Kalamunda Road/Roe Highway intersections will not be assessed;
- For intersections where turning movement counts are not available, a simple gravity model has been used to determine the turning movement distribution. The simple gravity model generates the turning movement volumes based on the inbound and outbound traffic proportions on each leg of the intersection;
- The traffic counts conducted along Kenneth Road may not have accounted for the traffic generated by the High Wycombe Shopping Centre development as the traffic counter was located further up Kenneth Road. Therefore, a trip generation assessment was conducted to calculate the additional traffic generated by this development at the Kalamunda Road/Kenneth Road intersection;
- ROM24 forecasts generally focus on arterial road and normally do not include traffic forecasts for access roads. Therefore, for the purpose of this assessment, the traffic growth rate on Wittenoom Road (shown in **Table 6-1**) has been used for access roads not included in the ROM24 model due to their similarity in road functions. This growth rate has been applied to the following roads;
  - Newburn Road/Chipping Drive;
  - Kenneth Road;
  - Cyril Road; and
  - Hawkevale Road/Range View Road.
- Assumed hourly pedestrian volumes for each signalised intersection to be 20; and
- Single-lane approaches which are wide enough to allow two vehicles to stop side-by-side were modelled as one full-length lane with an adjacent short lane (lane length varying between 6m and 25 metres).

6.2 Intersections Assessed

The following intersections were analysed:

- Kalamunda Road/Stirling Crescent;
- Kalamunda Road/Wittenoom Road;
- Kalamunda Road/High Wycombe Village Shopping Centre Access (3 Accesses);
- Kalamunda Road/Newburn Road/Chipping Drive;
- Kalamunda Road/Kenneth Road;
- Kalamunda Road/Cyril Road; and
- Kalamunda Road/Hawkevale Road/Range Court.

6.3 Analysis Scenarios

Peak times selected are 7AM to 8 AM and 4 PM to 5 PM respectively for the morning and afternoon peak periods on weekdays. The following scenarios were analysed using the Sidra intersection analysis software:

- **Scenario 1**: 2019 Base Scenario;
- **Scenario 2**: 2031 Traffic, without cul-de-sac treatment in Stirling Crescent;
- **Scenario 3**: 2031 Traffic, with cul-de-sac treatment in Stirling Crescent;
- **Scenario 4**: 2041 Traffic, without cul-de-sac treatment in Stirling Crescent; and
- **Scenario 5**: 2041 Traffic, with cul-de-sac treatment in Stirling Crescent.

6.4 Growth Rates

ROM24 volumes between 2016 and 2041 were used to obtain the linear growth rate of vehicles along Kalamunda Road and intersecting roads. These growth rates were applied to the 2019 existing traffic to obtain 2031 and 2041 projected traffic (See **Appendix C**). **Table 6-1** shows a summary of the growth rates that were used.

Table 6-1 ROM24 Growth Rates between 2016 and 2041

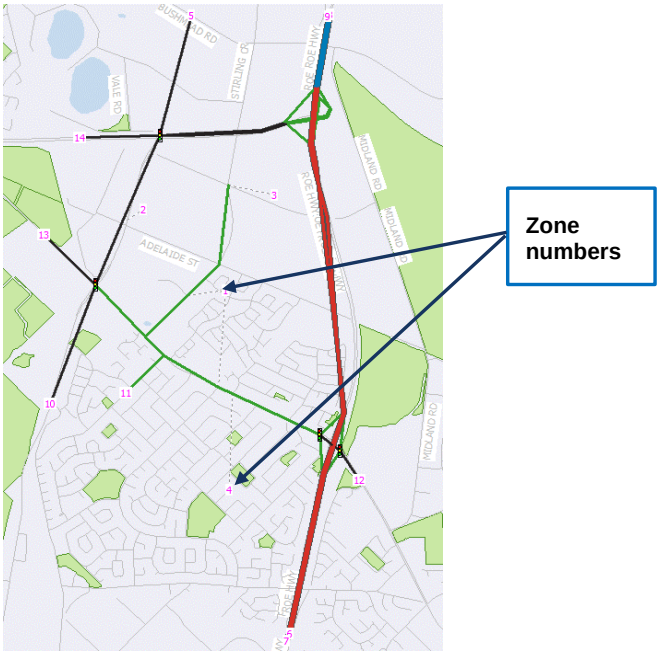
Road Name	Section	Growth % from 2016 to 2041 (per year)	
		Eastbound/ Northbound	Westbound/ Southbound
Abernethy Road	North of Kalamunda Road	8.4%	6.7%
	South of Kalamunda Road	4.8%	3.0%
Kalamunda Road	West of Abernethy Road	3.6%	3.2%
	Between Abernethy Road and Stirling Crescent	5.5%	2.8%
	Between Stirling Crescent and Wittenoom Road	0.6%	-0.2%
	Between Wittenoom Road and Newburn Road/Chipping Drive	1.3%	0.0%
	Between Newburn Road/Chipping Drive and Kenneth Road	4.9%	2.2%
	Between Kenneth Road and Cyril Road	6.8%	3.6%
	Between Cyril Road and Roe Highway	5.1%	2.3%
Stirling Crescent	North of Kalamunda Road	1.2%	0.8%
Wittenoom Road	South of Kalamunda Road	1.4%	1.2%
Newburn Road*	South of Kalamunda Road	1.3%	1.3%
Chipping Drive*	North of Kalamunda Road	1.3%	1.3%
Kenneth Road*	North of Kalamunda Road	1.3%	1.3%
Cyril Road*	South of Kalamunda Road	1.3%	1.3%
Hawkevale Road*	North of Kalamunda Road	1.3%	1.3%
Range View Road*	South of Kalamunda Road	1.3%	1.3%

**Growth rates for both directions are assumed to be equal to the average growth rate in Wittenoom Road*

6.5 Network Model Development

To model Kalamunda Road as a lower capacity main street, the maximum vehicle volume along the road was constrained to 15,000 vehicles per day (vpd). Based on projected 2031 and 2041 traffic volumes, certain sections of Kalamunda Road are expected to exceed 15,000 vpd. A spreadsheet-based network model was developed in order to estimate the volume of traffic anticipated to be diverted from Kalamunda Road to appropriate alternative routes. The network model extent is based on the ROM24 Sub-Area network shown in **Figure 6-1** and takes into consideration the proposed cul-de-sac on both sides of Stirling Crescent at its intersection with Great Eastern Highway Bypass as a result of the proposed Roe Highway/Great Eastern Highway Bypass grade separation in the future and the proposed extension of Adelaide Street to Abernethy Road.

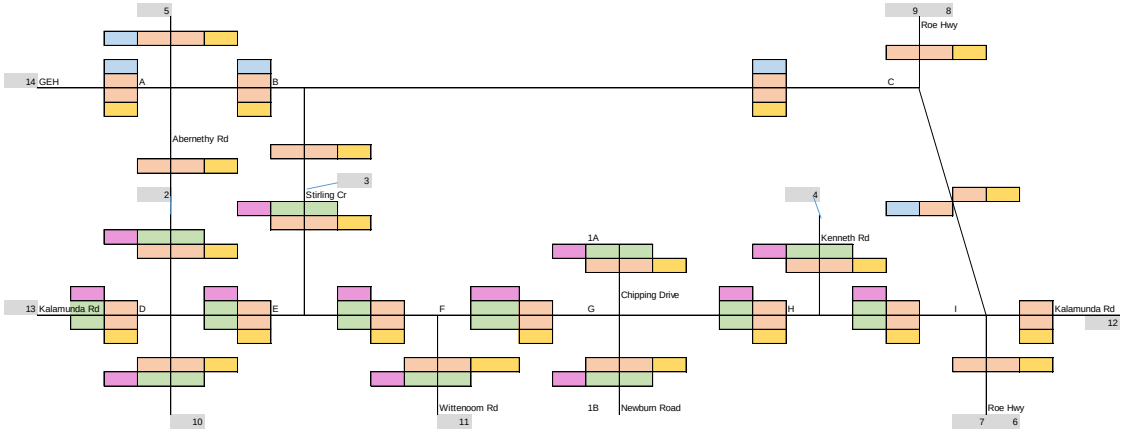
Figure 6-1 ROM24 Sub-area network



(Source: Main Roads WA)

The network model developed is shown in **Figure 6-2**. Zones were labelled according to ROM24 zone numbers while intersections (or nodes) were labelled in capital letters. Midblocks (or sections) were named based on the two nodes or zones at either ends (e.g., Section AB), while routes were named based on all the nodes it passed through (e.g., Route ABCI).

Figure 6-2 Network Model



The objective of the network model was to calculate the volume of traffic along each section of the network. To achieve this, the volume between an origin zone and a destination zone was distributed along all possible routes between them based on the total route length (assuming that the proportion of vehicles diverted to a certain route is inversely proportional to the route length). The total volumes along each section was then obtained by summing up the volumes contributed to each origin-destination (O-D) by each route.

The process discussed above was undertaken using the ROM24 Sub-area matrix for 2041, which was adjusted to reflect the 2031 and 2041 projected traffic volumes. The matrices were adjusted by applying a factor to the ROM24 subarea matrix such that the difference between the midblock volumes generated by the model and the calculated projected volumes (based on existing traffic counts) is minimised. The resulting matrices are included in **Appendix D** of this report.

6.6 Estimated Diverted Volumes

The concept design has been developed such that traffic along Kalamunda Road between Abernethy Road and Roe Highway is constrained to 15,000 vehicles per day. Hence, excess forecasted traffic was redistributed to alternative routes by using the same network model discussed in the previous section. This was undertaken by reducing the percentage of O-D volumes passing through Kalamunda Road and increasing the percentage of the same O-D volumes which would potentially take alternative routes. The resulting restricted midblock traffic volumes for 2031 and 2041 design years for the "with" and "without" the cul-de-sac treatment at Stirling Crescent are included in **Appendix D** of this report.

The volume of diverted traffic was estimated by subtracting the resulting traffic volumes from the original forecasted midblock volumes estimated for the surrounding road network. The resulting diverted volumes for 2031 and 2041 design years for the "with" and "without" the cul-de-sac treatment at Stirling Crescent are included in **Appendix D** of this report. **Table 6-2** shows the estimated maximum daily volumes diverted away from Kalamunda Road to Roe Highway/Great Eastern Highway Bypass.

Table 6-2 Maximum Estimated Diverted Daily Volumes from Kalamunda Road to Roe Highway/Great Eastern Highway Bypass

	Horizon Year	
	2031	2041
Without cul-de-sac	3072	6707
With cul-de-sac	4823	8811

For both horizon years, the volume of vehicles to be diverted away from Kalamunda Road is higher for the "with" the cul-de-sac scenario. With the closure of the intersection of Stirling Crescent and Great Eastern Highway, a higher volume along Kalamunda Road is expected, as vehicles originating from the north (i.e. Zones 5 and 9 from **Figure 6-1**) can no longer use the Great Eastern Highway Bypass to reach the centroid of the subarea (i.e. Zones 1, 4 and 11 from **Figure 6-1**).

6.7 SIDRA Analysis Input

6.7.1 Traffic Volumes

Peak hour factors for road sections within the study area were calculated from tube count data obtained from the City of Kalamunda. These factors were applied to the restricted daily midblock traffic volumes indicated in the network model to estimate the AM and PM peak hour midblock volumes for each road section. A simple gravity model was used to derive the turning movement traffic volumes for each intersection which are included in **Appendix C** of this report.

The percentage of heavy vehicles for each approach at each intersection was extracted from the City's tube counts and Main Roads WA Traffic Map data.

6.7.2 Intersection Layout and Geometry

Existing intersection geometry information was obtained from the latest Nearmap aerial images, while the proposed future geometry for intersections along Kalamunda Road between Abernethy Road and Roe Highway was based on the concept designs discussed in **Section 4** of this report**.**

6.7.3 Phasing and Timing

For the purposes of comparison, existing and proposed roundabout controlled intersections in the concept design were also modelled as traffic signalled controlled intersections in the event that this treatment was considered to be an appropriate measure for pedestrian safety. Signal timing parameters used in the models are as discussed in **Section 3.3**. For all intersections analysed as traffic signal-controlled, the practical cycle time was used. The signal phase sequences adopted for each intersection are shown in **Appendix B**.

6.7.4 Speed Limit

Approach and exit cruise speeds in the models were based on the posted speed limit data obtained from the MRWA Road Information Mapping System discussed in **Section 3.2**.

6.8 Sidra Intersection Performance

Sidra results for each approach are presented below in the form of Degree of Saturation (DOS), Average Delay, Level of Service (LOS) and 95th Percentile Queue. These characteristics are defined as follows:

- **Degree of Saturation (DOS)**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The theoretical intersection capacity is exceeded for an un-signalized intersection where DOS > 0.80;
- **95% Queue**: is the statistical estimate of the queue length up to or below 95% of all observed queues that would be expected;
- **Average Delay**: is the average of all travel time delays for vehicles through the intersection. An unsignalised intersection can be considered to be operating at capacity when the average delay exceeds 40 seconds for any movement; and
- **Level of Service (LOS)**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. The different levels of service can generally be defined as shown in **Table 6-3.**

Table 6-3 Level of Service (LOS) Performance Criteria

LOS	Description	Signalised Intersection	Unsignalised Intersection
A	Free-flow operations (best condition)	≤10 sec	≤10 sec
B	Reasonable free-flow operations	10-20 sec	10-15 sec
C	At or near free-flow operations	20-35 sec	15-25 sec
D	Decreasing free-flow levels	35-55 sec	25-35 sec
E	Operations at capacity	55-80 sec	35-50 sec
F	A breakdown in vehicular flow (worst condition)	≥80 sec	≥50 sec

6.9 Sidra Analysis Results

This section details the results of the Sidra analysis for each scenario and different control types for each of the identified intersections during the AM and PM peak hour periods. Results for ‘Scenario 1’ are based on the layout and control type of the existing intersection (illustrated in Layout ‘A’ in the following diagrams).

6.9.1 Kalamunda Road/Stirling Crescent Intersection

For the intersection of Kalamunda Road and Stirling Crescent, the intersection performance was assessed for the following control types: (1) yield sign-controlled; (2) signal-controlled; and (3) roundabout. Sidra layouts are presented in **Figure 6-3** and the analysis results are presented in **Table 6-4** to **Table 6-7**.

Figure 6-3 Sidra Layouts for Kalamunda Road – Stirling Crescent Intersection

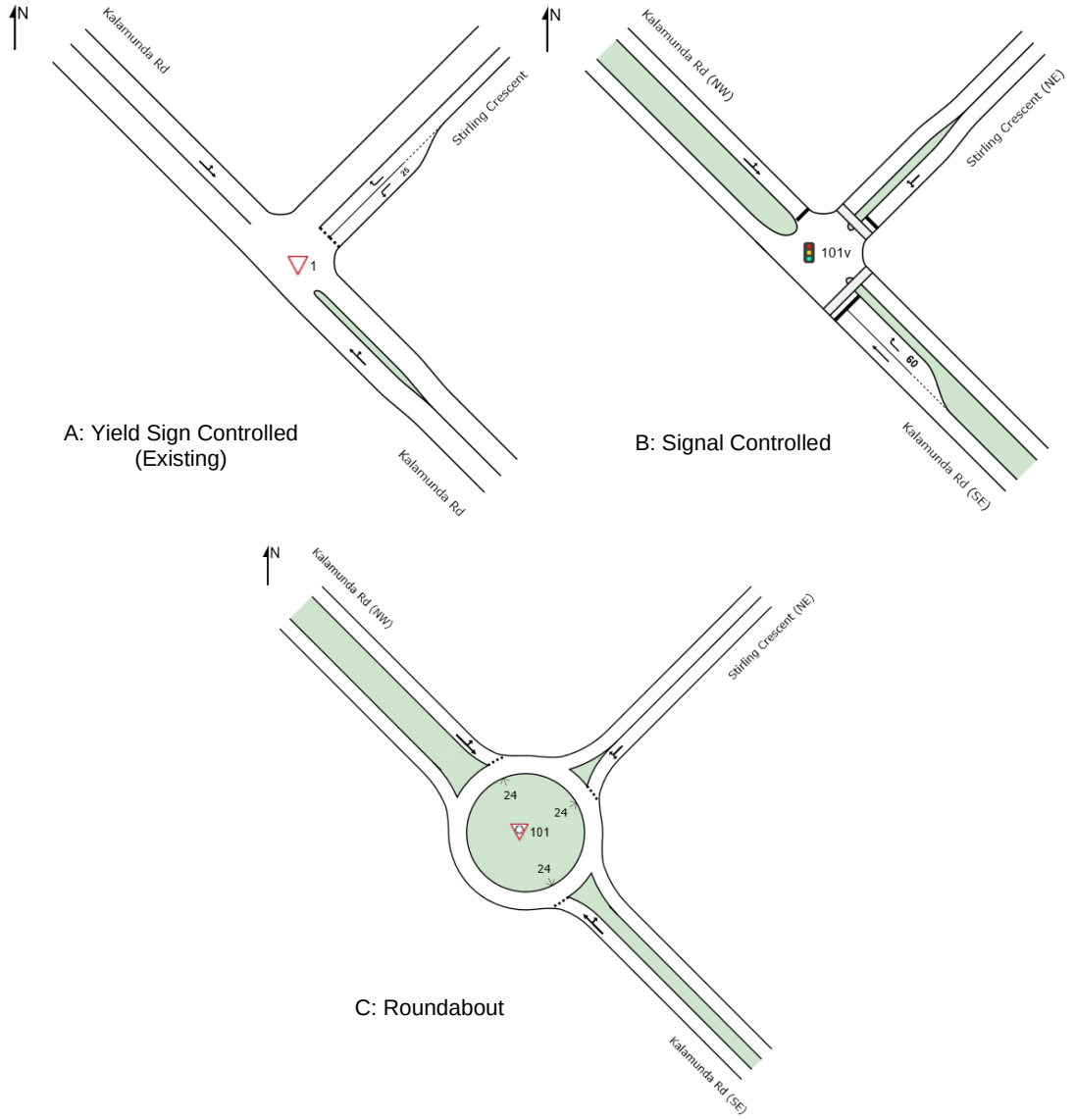


Table 6-4 AM Peak: Signal Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	T	0.478	0.4	A	14.4	0.671	7.5	A	73.7	0.572	5.6	A	70.0	0.675	7.6	A	74.8	0.660	7.2	A	71.2
	R	0.478	6.8	A	14.4	0.693	25.9	C	29.2	0.421	22.1	C	32.4	0.637	25.2	C	26.2	0.511	21.3	C	27.8
NorthEast: Stirling Crescent	L	0.019	5.9	A	0.5	0.696	25.2	C	32.4	0.370	25.5	C	20.0	0.671	24.9	C	30.4	0.301	20.5	C	14.9
	R	0.240	17.1	C	5.8	0.696	25.1	C	32.4	0.370	25.4	C	20.0	0.671	24.8	C	30.4	0.301	20.4	C	14.9
NorthWest: Kalamunda Rd	L	0.091	5.7	A	0	0.61	21.3	C	38.1	0.434	23.9	C	30.6	0.610	21.3	C	38.1	0.576	23.6	C	26.8
	T	0.091	0	A	0	0.61	15.6	B	38.1	0.434	18.2	B	30.6	0.610	15.6	B	38.1	0.576	18.0	B	26.8
All vehicles		0.478	2.7	NA	14.4	0.696	14.9	B	73.7	0.572	12.6	B	70.0	0.675	14.5	B	74.8	0.660	12.8	B	71.2

Table 6-5 AM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	T	0.478	0.4	A	14.4	0.669	5.5	A	57.1	0.580	4.2	A	47.7	0.659	5.4	A	55.3	0.576	4.2	A	46.8
	R	0.478	6.8	A	14.4	0.669	10.7	B	57.1	0.580	9.4	A	47.7	0.659	10.6	B	55.3	0.576	9.4	A	46.8
NorthEast: Stirling Crescent	L	0.019	5.9	A	0.5	0.179	4.8	A	8.6	0.103	4.7	A	4.6	0.169	4.8	A	8	0.098	4.6	A	4.4
	R	0.240	17.1	C	5.8	0.179	10	B	8.6	0.103	9.9	A	4.6	0.169	10	B	8	0.098	9.9	A	4.4
NorthWest: Kalamunda Rd	L	0.091	5.7	A	0	0.236	5	A	12.3	0.166	5	A	7.6	0.231	4.9	A	12	0.160	5	A	7.2
	T	0.091	0	A	0	0.236	5	A	12.3	0.166	5.1	A	7.6	0.231	4.9	A	12	0.160	5	A	7.2
All vehicles		0.478	2.7	NA	14.4	0.669	6.6	A	57.1	0.580	5.5	A	47.7	0.659	6.5	A	55.3	0.576	5.5	A	46.8

Table 6-6 PM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	T	0.266	1.5	A	8.7	0.240	7	A	44.7	0.201	3.4	A	19.6	0.241	6.6	A	44.3	0.207	3.8	A	20.8
	R	0.266	10.2	B	8.7	0.714	66.5	E	30.2	0.662	36.9	D	27.7	0.607	65.1	E	25.2	0.633	36.6	D	26.3
NorthEast: Stirling Crescent	L	0.164	8.5	A	4.8	0.814	54.5	D	133.3	0.503	28.9	C	37.2	0.812	55.3	E	126.5	0.468	27.9	C	35.1
	R	0.289	15.9	C	7.5	0.814	54.5	D	133.3	0.503	28.8	C	37.2	0.812	55.2	E	126.5	0.468	27.8	C	35.1
NorthWest: Kalamunda Rd	L	0.327	5.7	A	0	0.817	26.7	C	276.1	0.642	17.7	B	95.5	0.805	25	C	265.4	0.647	18.3	B	95
	T	0.327	0	A	0	0.817	21.1	C	276.1	0.642	12	B	95.5	0.805	19.3	B	265.4	0.647	12.7	B	95
All vehicles		0.327	3.5	NA	8.7	0.817	28	C	276.1	0.662	15.6	B	95.5	0.812	26.4	C	265.4	0.647	15.7	B	95

Table 6-7 PM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	T	0.266	1.5	A	8.7	0.319	4.9	A	18.1	0.255	3.9	A	14.5	0.316	4.9	A	17.9	0.254	3.9	A	14.3
	R	0.266	10.2	B	8.7	0.319	10.1	B	18.1	0.255	9.1	A	14.5	0.316	10.1	B	17.9	0.254	9.1	A	14.3
NorthEast: Stirling Crescent	L	0.164	8.5	A	4.8	0.472	11	B	28.5	0.233	7.5	A	11.1	0.442	10.4	B	25.2	0.220	7.3	A	10.4
	R	0.289	15.9	C	7.5	0.472	16.2	B	28.5	0.233	12.8	B	11.1	0.442	15.6	B	25.2	0.220	12.6	B	10.4
NorthWest: Kalamunda Rd	L	0.327	5.7	A	0	0.595	4.4	A	48.8	0.448	4.6	A	26.2	0.585	4.3	A	47.8	0.433	4.6	A	25.1
	T	0.327	0	A	0	0.595	4.4	A	48.8	0.448	4.7	A	26.2	0.585	4.3	A	47.8	0.433	4.6	A	25.1
All vehicles		0.327	3.5	NA	8.7	0.595	6.7	A	48.8	0.448	5.6	A	26.2	0.585	6.5	A	47.8	0.433	5.5	A	25.1

6.9.2 Kalamunda Road/Wittenoom Road

For the intersection of Kalamunda Road and Wittenoom Road, the intersection performance was assessed for the following control types: (1) stop sign-controlled (existing); (2) signal-controlled; and (3) stop sign-controlled staged crossing. Sidra layouts are presented in **Figure 6-4** and the analysis results are presented in **Table 6-8** to **Table 6-11**.

Figure 6-4 Sidra Layouts for Kalamunda Road – Wittenoom Road Intersection

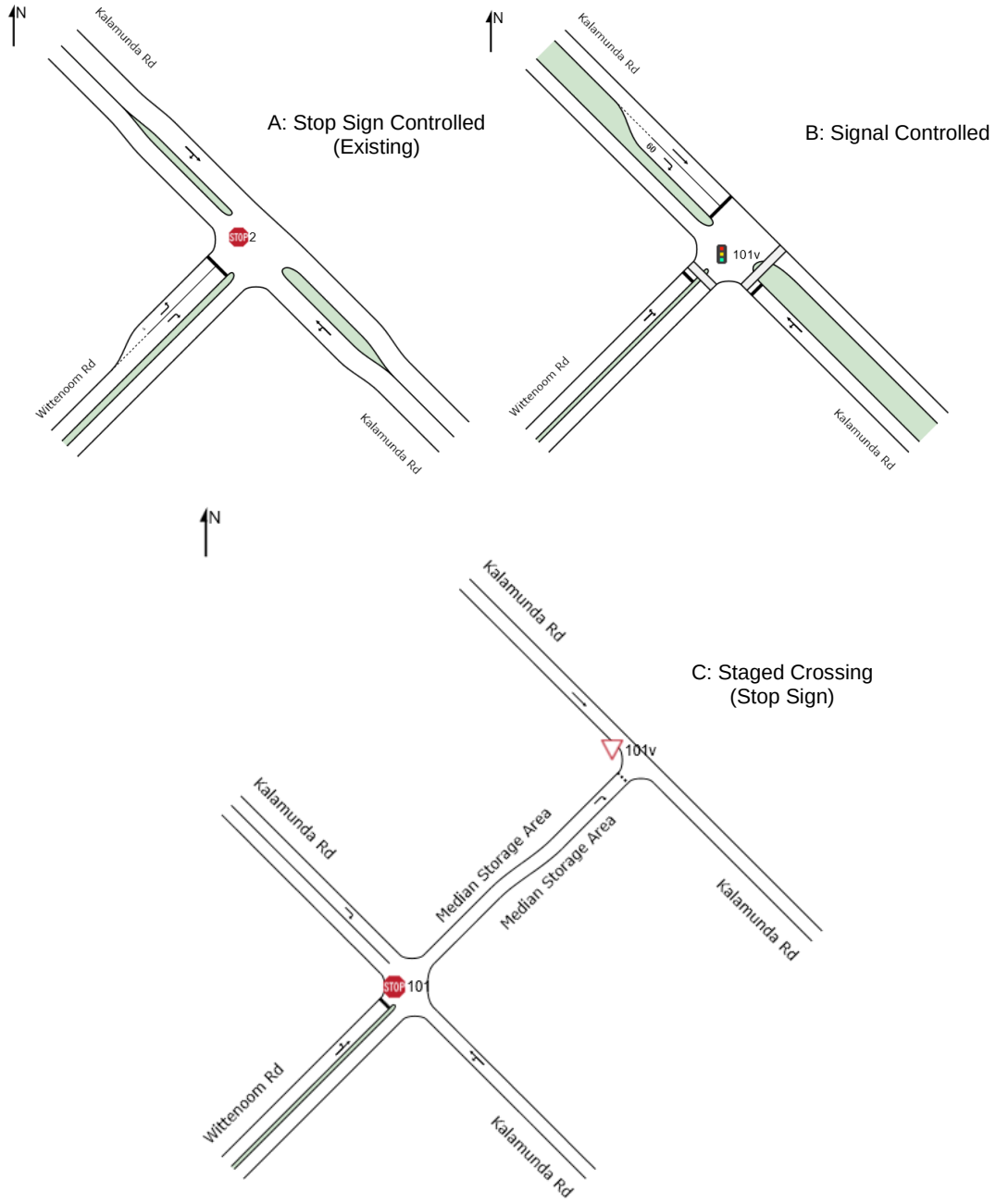


Table 6-8 AM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.426	5.7	A	0	0.806	19.7	B	188.7	0.824	21.2	C	202.2	0.793	18.7	B	178.9	0.809	20	B	190.8
	T	0.426	0	A	0	0.806	16.3	B	188.7	0.824	17.7	B	202.2	0.793	15.3	B	178.9	0.809	16.5	B	190.8
NorthWest: Kalamunda Rd	T	0.099	2.6	A	3.7	0.136	2.7	A	13.2	0.132	2.7	A	12.8	0.115	2.7	A	11	0.117	2.7	A	11.2
	R	0.099	12.2	B	3.7	0.318	40.7	D	12.2	0.318	40.7	D	12.2	0.434	41.2	D	16.9	0.369	40.9	D	14.3
SouthWest: Wittenoom Rd	L	0.218	15.7	C	6	0.557	35.8	D	35.1	0.551	35.7	D	35	0.771	40	D	54.7	0.657	37.1	D	43.8
	R	0.136	19.4	C	3	0.557	35.8	D	35.1	0.551	35.7	D	35	0.771	40	D	54.7	0.657	37.1	D	43.8
All vehicles		0.426	2.8	NA	6	0.806	17.7	B	188.7	0.824	18.8	B	202.2	0.793	19.4	B	178.9	0.809	19	B	190.8

Table 6-9 AM Peak: Staged Crossing

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.426	5.7	A	0	0.466	3.4	A	0	0.476	3.4	A	0	0.458	3.4	A	0	0.467	3.4	A	0
	T	0.426	0	A	0	0.466	0	A	0	0.476	0	A	0	0.458	0	A	0	0.467	0	A	0
NorthWest: Kalamunda Rd	T	0.099	2.6	A	3.7	0.101	0	A	0	0.098	0	A	0	0.085	0	A	0	0.087	0	A	0
	R	0.099	12.2	B	3.7	0.082	11.3	B	0.9	0.085	11.6	B	1	0.109	11.1	B	1.2	0.096	11.4	B	1.1
SouthWest: Wittenoom Rd	L	0.218	15.7	C	6	0.310	15.7	C	3.7	0.321	16	C	3.8	0.403	15.7	C	5.5	0.363	15.7	C	4.6
	R	0.136	19.4	C	3	0.310	19.2	C	3.7	0.321	17.5	C	3.8	0.403	19.6	C	5.5	0.363	17.5	C	4.6
All vehicles		0.426	2.8	NA	6	0.466	2.6	NA	3.7	0.476	3.1	NA	3.8	0.458	3.5	NA	5.5	0.467	3.5	NA	4.6

Table 6-10 PM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.222	5.7	A	0	0.791	22.8	C	58.6	0.810	23.5	C	61.4	0.778	22.3	C	56.6	0.795	22.9	C	59.1
	T	0.222	0	A	0	0.791	19.4	B	58.6	0.810	20.1	C	61.4	0.778	18.9	B	56.6	0.795	19.5	B	59.1
NorthWest: Kalamunda Rd	T	0.386	0.9	A	12.2	0.620	6.8	A	63.9	0.603	6.7	A	61.3	0.546	6.4	A	52.9	0.546	6.4	A	52.9
	R	0.386	8.8	A	12.2	0.370	23.5	C	13.8	0.370	23.5	C	13.8	0.509	24	C	19.5	0.437	23.7	C	16.5
SouthWest: Wittenoom Rd	L	0.065	9.8	A	1.9	0.446	21	C	20.4	0.444	21	C	20.4	0.632	22.4	C	31	0.529	21.4	C	25
	R	0.353	25.2	D	9.1	0.446	21	C	20.4	0.444	21	C	20.4	0.632	22.4	C	31	0.529	21.4	C	25
All vehicles		0.386	3.5	NA	12.2	0.791	13.6	B	63.9	0.810	13.9	B	61.4	0.778	14.7	B	56.6	0.795	14.4	B	59.1

Table 6-11 PM Peak: Staged Crossing

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.222	5.7	A	0	0.200	3.4	A	0	0.204	3.4	A	0	0.197	3.4	A	0	0.201	3.4	A	0
	T	0.222	0	A	0	0.200	0	A	0	0.204	0	A	0	0.197	0	A	0	0.201	0	A	0
NorthWest: Kalamunda Rd	T	0.386	0.9	A	12.2	0.341	0	A	0	0.332	0	A	0	0.300	0	A	0	0.300	0	A	0
	R	0.386	8.8	A	12.2	0.081	7	A	1	0.082	7	A	1.1	0.111	7	A	1.5	0.096	7	A	1.2
SouthWest: Wittenoom Rd	L	0.065	9.8	A	1.9	0.175	9.8	A	2	0.176	9.6	A	2	0.246	9.7	A	2.9	0.209	9.5	A	2.4
	R	0.353	25.2	D	9.1	0.175	15.3	C	2	0.176	10.7	B	2	0.246	15.2	C	2.9	0.209	10.8	B	2.4
All vehicles		0.386	3.5	NA	12.2	0.341	2.1	NA	2	0.332	3.9	NA	2	0.300	2.8	NA	2.9	0.300	4.3	NA	2.4

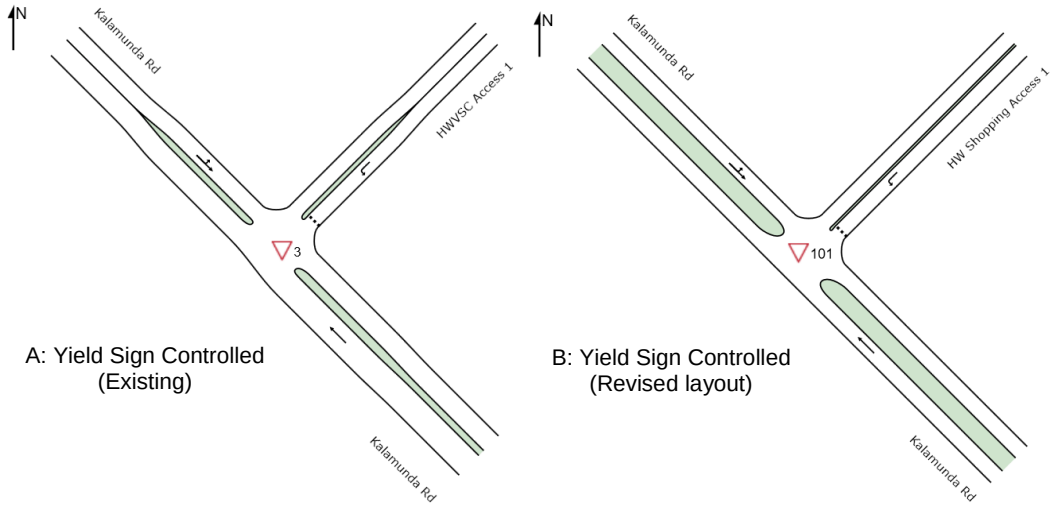
6.9.3 Kalamunda Road/High Wycombe Village Shopping Centre (HWVSC) Access (3 Accesses)

For the three accesses of the development, only the PM peak scenario was modelled since it is expected that traffic generation and attraction of such development is highest during the evening peak. All accesses and scenarios were analysed for yield sign controls.

6.9.3.1 Access 1

Sidra layouts are presented in **Figure 6-5** and analysis results are presented in **Table 6-12**.

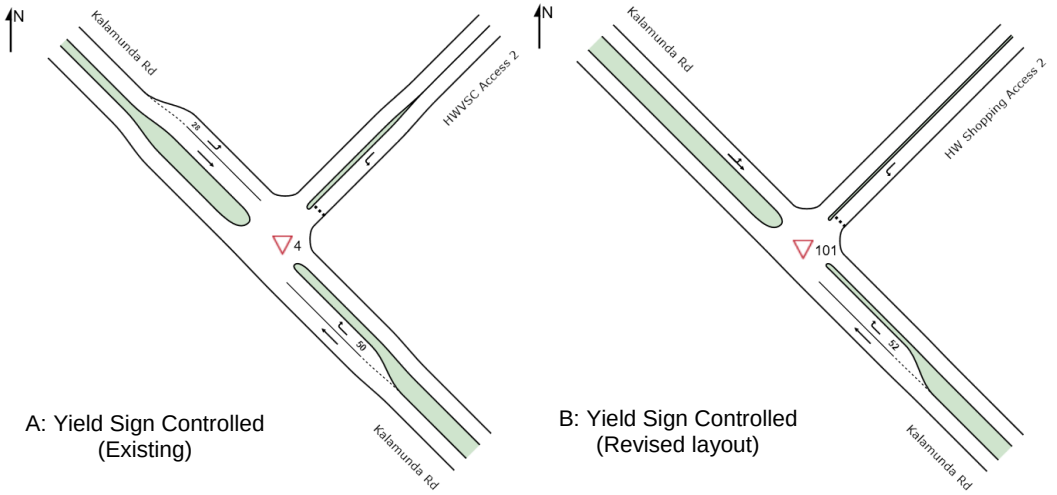
Figure 6-5 Sidra Layout for Kalamunda Road – HWVSC Access 1 Intersection



6.9.3.2 Access 2

Sidra layouts are presented in **Figure 6-6** while analysis results are presented in **Table 6-13**.

Figure 6-6 Sidra Layout for Kalamunda Road – HWVSC Access 2 Intersection



6.9.3.3 Access 3

Sidra layouts are presented in **Figure 6-7** while analysis results are presented in **Table 6-14**.

Figure 6-7 Sidra Layout for Kalamunda Road – HWVSC Access 3 Intersection

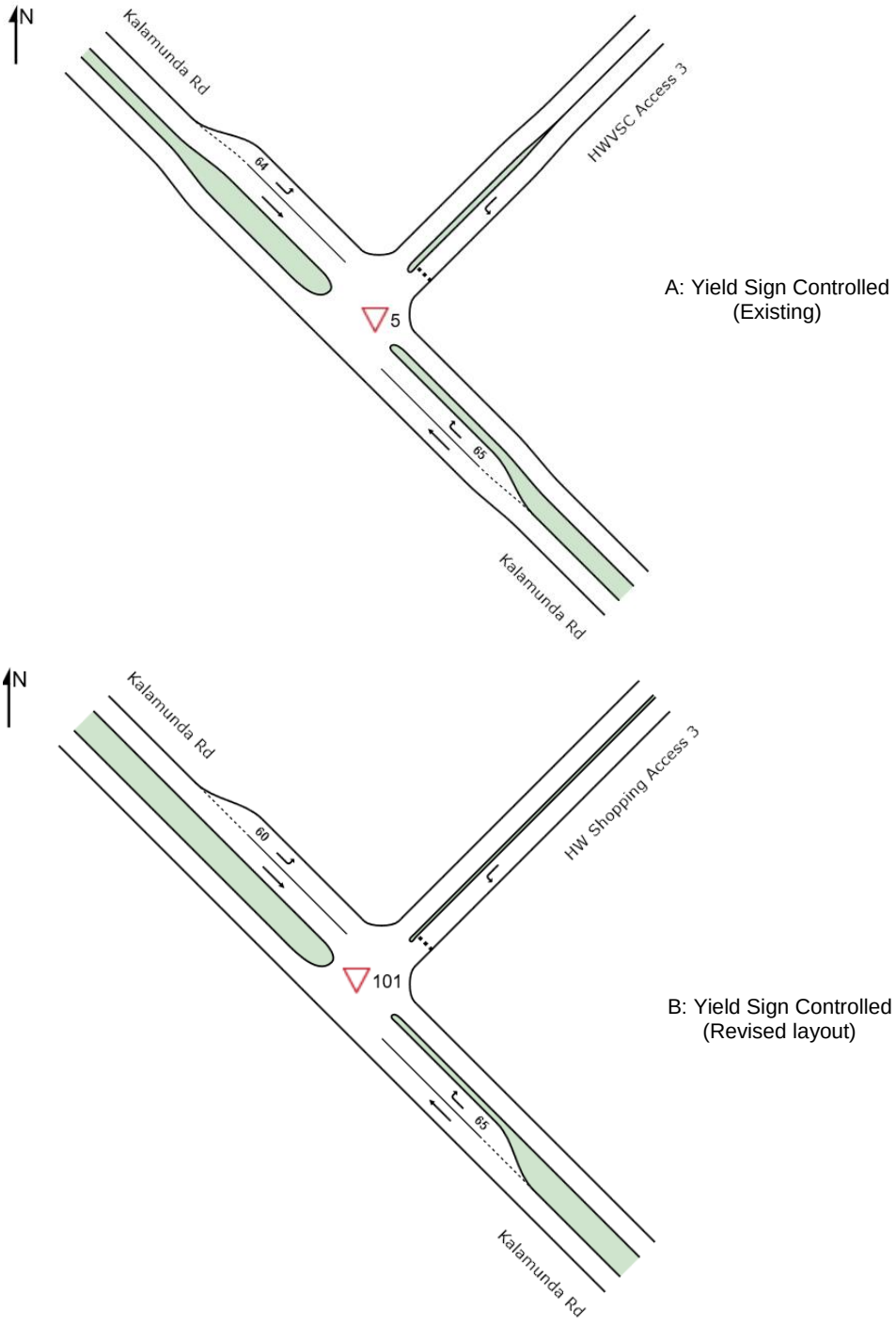


Table 6-12 Access 1 - PM Peak with Revised Layout

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SoutEast: Kalamunda Rd	T	0.220	0	A	0	0.232	0	A	0	0.237	0	A	0	0.228	0	A	0	0.233	0	A	0
NorthEast: HWV Shopping Access 1	L	0.011	6.2	A	0.3	0.012	8.7	A	0.3	0.012	8.5	A	0.3	0.012	8.3	A	0.3	0.011	8.2	A	0.3
NorthWest: Kalamunda Rd	L	0.353	5.6	A	0	0.378	5.6	A	0	0.369	5.6	A	0	0.356	5.5	A	0	0.346	5.5	A	0
	T	0.353	0	A	0	0.378	0	A	0	0.369	0	A	0	0.356	0	A	0	0.346	0	A	0
All vehicles		0.353	0.2	NA	0.3	0.378	0.3	NA	0.3	0.369	0.3	NA	0.3	0.356	0.3	NA	0.3	0.346	0.3	NA	0.3

Table 6-13 Access 2 - PM Peak with Revised Layout

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SoutEast: Kalamunda Rd	T	0.236	0	A	0	0.218	0	A	0	0.224	0	A	0	0.214	0	A	0	0.219	0	A	0
	R	0.042	9.2	A	1.1	0.039	9.2	A	1.1	0.037	8.8	A	1.1	0.036	8.6	A	1	0.035	8.4	A	1
NorthEast: HW Shopping Access 2	L	0.111	7	A	2.6	0.096	8.6	A	2.5	0.090	8.3	A	2.3	0.087	8.1	A	2.3	0.085	8	A	2.2
NorthWest: Kalamunda Rd	L	0.036	3.7	A	0	0.372	2.4	A	0	0.350	2.4	A	0	0.338	2.4	A	0	0.329	2.4	A	0
	T	0.304	0	A	0	0.372	0	A	0	0.350	0	A	0	0.338	0	A	0	0.329	0	A	0
All vehicles		0.304	0.9	NA	2.6	0.372	0.9	NA	2.5	0.350	0.9	NA	2.3	0.338	0.9	NA	2.3	0.329	0.9	NA	2.2

Table 6-14 Access 3 - PM Peak with Revised Layout

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SoutEast: Kalamunda Rd	T	0.255	0	A	0	0.196	0	A	0	0.202	0	A	0	0.191	0	A	0	0.197	0	A	0
	R	0.210	9.8	A	5.7	0.188	9.3	A	5.7	0.236	10.4	B	7	0.176	9	A	5.4	0.221	9.8	A	6.4
NorthEast: HW Shopping Access 3	L	0.277	7.6	A	7.8	0.229	8.6	A	6.4	0.293	9.9	A	8.5	0.217	8.3	A	6.1	0.276	9.3	A	7.8
NorthWest: Kalamunda Rd	L	0.043	5.5	A	0	0.359	5.5	A	0	0.044	5.5	A	0	0.338	5.5	A	0	0.044	5.5	A	0
	T	0.301	0	A	0	0.359	0	A	0	0.306	0	A	0	0.338	0	A	0	0.284	0	A	0
All vehicles		0.301	2.2	NA	7.8	0.359	2.5	NA	6.4	0.306	2.8	NA	8.5	0.338	2.5	NA	6.1	0.284	2.8	NA	7.8

6.9.4 Kalamunda Road/Newburn Road/Chipping Drive

For the intersection of Kalamunda Road, Newburn Road and Chipping Drive, the intersection performance was assessed for the following control types: (1) signal-controlled; and (2) roundabout. Sidra layouts are presented in **Figure 6-8** and the analysis results are presented in **Table 6-15** to **Table 6-18**.

Figure 6-8 Sidra Layout for Kalamunda Road – Newburn Road/Chipping Drive Intersection

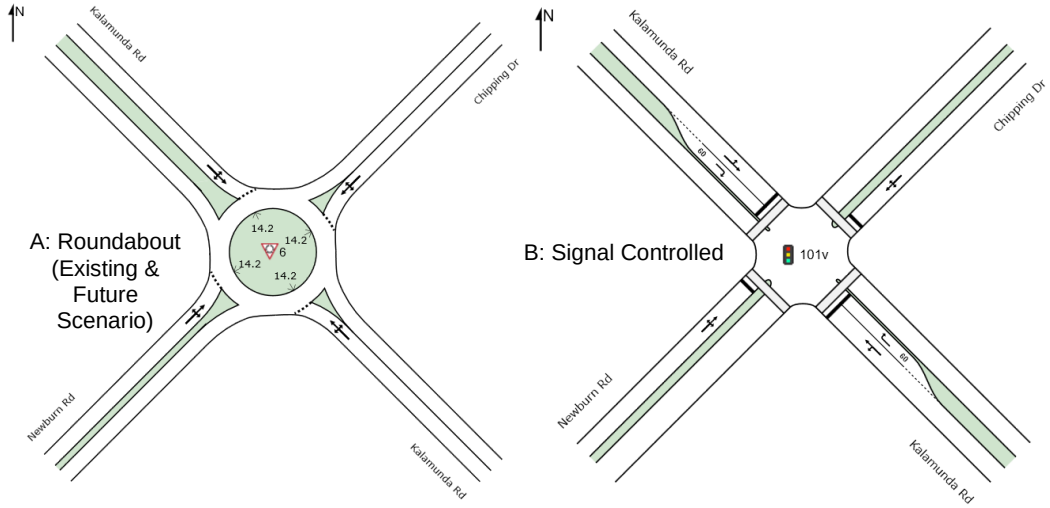


Table 6-15 AM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.554	5.1	A	37.7	0.863	43.8	D	182.9	0.882	46.4	D	194	0.873	51	D	219.5	0.870	49.9	D	221.7
	T	0.554	5.2	A	37.7	0.863	38.2	D	182.9	0.882	40.8	D	194	0.873	45.4	D	219.5	0.870	44.3	D	221.7
	R	0.554	9.1	A	37.7	0.401	47.9	D	24.1	0.375	46.7	D	24.4	0.409	57	E	29.3	0.459	58.4	E	30.6
NorthEast: Chipping Dr	L	0.067	5.4	A	2.5	0.780	53.2	D	45.4	0.880	59.8	E	48.5	0.825	64	E	66.2	0.826	64.1	E	66.2
	T	0.067	5.3	A	2.5	0.780	48.7	D	45.4	0.880	55.2	E	48.5	0.825	59.5	E	66.2	0.826	59.5	E	66.2
	R	0.067	9.1	A	2.5	0.780	53.2	D	45.4	0.880	59.8	E	48.5	0.825	64	E	66.2	0.826	64.1	E	66.2
NorthWest: Kalamunda Rd	L	0.258	4.8	A	12.8	0.519	31.2	C	87.7	0.507	31	C	85.2	0.488	36.1	D	99	0.462	35.1	D	94.2
	T	0.258	4.9	A	12.8	0.519	25.6	C	87.7	0.507	25.4	C	85.2	0.488	30.5	C	99	0.462	29.5	C	94.2
	R	0.258	8.8	A	12.8	0.161	46.4	D	9.3	0.141	45.1	D	8.8	0.152	55.1	E	10.4	0.159	56.3	E	10.1
SouthWest: Newburn Rd	L	0.302	8.8	A	13.9	0.784	43.4	D	92.5	0.780	42.8	D	91.4	0.828	52.7	D	144.7	0.826	53	D	144.2
	T	0.302	8.7	A	13.9	0.784	38.7	D	92.5	0.780	38.2	D	91.4	0.828	48	D	144.7	0.826	48.3	D	144.2
	R	0.302	12.6	B	13.9	0.784	43.3	D	92.5	0.780	42.8	D	91.4	0.828	52.6	D	144.7	0.826	52.9	D	144.2
All vehicles		0.554	6.2	A	37.7	0.863	39.2	D	182.9	0.882	40.6	D	194	0.873	47.5	D	219.5	0.870	47.2	D	221.7

Table 6-16 AM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.554	5.1	A	37.7	0.472	5.1	A	26.2	0.480	5.1	A	27	0.481	5.2	A	27.1	0.490	5.2	A	27.9
	T	0.554	5.2	A	37.7	0.472	5.1	A	26.2	0.480	5.1	A	27	0.481	5.2	A	27.1	0.490	5.2	A	27.9
	R	0.554	9.1	A	37.7	0.472	9	A	26.2	0.480	9	A	27	0.481	9.1	A	27.1	0.490	9.1	A	27.9
NorthEast: Chipping Dr	L	0.067	5.4	A	2.5	0.160	6.3	A	6.7	0.157	6.2	A	6.5	0.193	6.5	A	8.2	0.191	6.4	A	8.1
	T	0.067	5.3	A	2.5	0.160	6.2	A	6.7	0.157	6.1	A	6.5	0.193	6.4	A	8.2	0.191	6.3	A	8.1
	R	0.067	9.1	A	2.5	0.160	10.1	B	6.7	0.157	10	A	6.5	0.193	10.3	B	8.2	0.191	10.2	B	8.1
NorthWest: Kalamunda Rd	L	0.258	4.8	A	12.8	0.366	6.2	A	18.9	0.357	6.2	A	18.3	0.365	6.6	A	18.7	0.354	6.5	A	18
	T	0.258	4.9	A	12.8	0.366	6.3	A	18.9	0.357	6.3	A	18.3	0.365	6.7	A	18.7	0.354	6.6	A	18
	R	0.258	8.8	A	12.8	0.366	10.2	B	18.9	0.357	10.1	B	18.3	0.365	10.5	B	18.7	0.354	10.5	B	18
SouthWest: Newburn Rd	L	0.302	8.8	A	13.9	0.404	7.3	A	19.1	0.408	7.4	A	19.4	0.488	8.3	A	26.9	0.494	8.5	A	27.6
	T	0.302	8.7	A	13.9	0.404	7.2	A	19.1	0.408	7.3	A	19.4	0.488	8.2	A	26.9	0.494	8.4	A	27.6
	R	0.302	12.6	B	13.9	0.404	11	B	19.1	0.408	11.1	B	19.4	0.488	12	B	26.9	0.494	12.2	B	27.6
All vehicles		0.554	6.2	A	37.7	0.472	6.8	A	26.2	0.480	6.8	A	27	0.488	7.3	A	27.1	0.494	7.4	A	27.9

Table 6-17 PM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.543	6.8	A	33.2	0.762	38.2	D	169.7	0.797	38.9	D	169.1	0.795	44	D	193	0.828	47.6	D	207.6
	T	0.543	6.9	A	33.2	0.762	32.6	C	169.7	0.797	33.4	C	169.1	0.795	38.4	D	193	0.828	42	D	207.6
	R	0.543	10.8	B	33.2	0.385	56.7	E	27.6	0.426	53.5	D	26	0.560	66.8	E	31.8	0.512	65.3	E	31.8
NorthEast: Chipping Dr	L	0.383	12.3	B	20.4	0.841	63.2	E	83.3	0.826	57.3	E	75.4	0.843	66	E	107.6	0.839	65.6	E	106.7
	T	0.383	12.2	B	20.4	0.841	58.6	E	83.3	0.826	52.8	D	75.4	0.843	61.4	E	107.6	0.839	61	E	106.7
	R	0.383	16	B	20.4	0.841	63.2	E	83.3	0.826	57.3	E	75.4	0.843	65.9	E	107.6	0.839	65.6	E	106.7
NorthWest: Kalamunda Rd	L	0.754	7.5	A	75.3	0.885	50.7	D	251.2	0.889	49.4	D	229.8	0.868	51.9	D	246.5	0.865	52.1	D	239.4
	T	0.754	7.6	A	75.3	0.885	45.2	D	251.2	0.889	43.8	D	229.8	0.868	46.3	D	246.5	0.865	46.5	D	239.4
	R	0.754	11.5	B	75.3	0.282	55.9	E	19.9	0.295	52.6	D	17.7	0.385	65.6	E	21.5	0.339	64.1	E	20.7
SouthWest: Newburn Rd	L	0.366	7.3	A	17.5	0.840	60	E	118.7	0.842	55.5	E	108.6	0.840	62.9	E	156.7	0.839	62.4	E	156.3
	T	0.366	7.2	A	17.5	0.840	55.3	E	118.7	0.842	50.9	D	108.6	0.840	58.3	E	156.7	0.839	57.8	E	156.3
	R	0.366	11	B	17.5	0.840	59.9	E	118.7	0.842	55.5	E	108.6	0.840	62.9	E	156.7	0.839	62.4	E	156.3
All vehicles		0.754	8.6	A	75.3	0.885	47.2	D	251.2	0.889	45.2	D	229.8	0.868	51.6	D	246.5	0.865	52.4	D	239.4

Table 6-18 PM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.543	6.8	A	33.2	0.516	5.8	A	28.9	0.523	5.8	A	29.6	0.526	6	A	29.9	0.533	6	A	30.5
	T	0.543	6.9	A	33.2	0.516	5.9	A	28.9	0.523	5.9	A	29.6	0.526	6	A	29.9	0.533	6	A	30.5
	R	0.543	10.8	B	33.2	0.516	9.8	A	28.9	0.523	9.8	A	29.6	0.526	9.9	A	29.9	0.533	9.9	A	30.5
NorthEast: Chipping Dr	L	0.383	12.3	B	20.4	0.340	9.4	A	16.6	0.331	9.1	A	16	0.417	10.6	B	22.1	0.404	10.1	B	21
	T	0.383	12.2	B	20.4	0.340	9.2	A	16.6	0.331	9	A	16	0.417	10.5	B	22.1	0.404	10	A	21
	R	0.383	16	B	20.4	0.340	13.1	B	16.6	0.331	12.9	B	16	0.417	14.3	B	22.1	0.404	13.9	B	21
NorthWest: Kalamunda Rd	L	0.754	7.5	A	75.3	0.650	7.9	A	48.9	0.634	7.6	A	45.9	0.662	9.2	A	52.2	0.645	8.9	A	49
	T	0.754	7.6	A	75.3	0.650	8	A	48.9	0.634	7.7	A	45.9	0.662	9.3	A	52.2	0.645	9	A	49
	R	0.754	11.5	B	75.3	0.650	11.8	B	48.9	0.634	11.6	B	45.9	0.662	13.1	B	52.2	0.645	12.9	B	49
SouthWest: Newburn Rd	L	0.366	7.3	A	17.5	0.372	6.6	A	17.5	0.376	6.7	A	17.7	0.452	7	A	22.9	0.455	7.2	A	23.3
	T	0.366	7.2	A	17.5	0.372	6.5	A	17.5	0.376	6.6	A	17.7	0.452	6.9	A	22.9	0.455	7.1	A	23.3
	R	0.366	11	B	17.5	0.372	10.3	B	17.5	0.376	10.4	B	17.7	0.452	10.7	B	22.9	0.455	10.9	B	23.3
All vehicles		0.754	8.6	A	75.3	0.650	7.8	A	48.9	0.634	7.7	A	45.9	0.662	8.6	A	52.2	0.645	8.5	A	49

6.9.5 Kalamunda Road/Kenneth Road

The Kalamunda Road – Kenneth Road intersection was analysed for yield sign controls. Sidra layouts are presented in **Figure 6-9** and the analysis results are presented in **Table 6-19** to **Table 6-20**.

Figure 6-9 Sidra Layout for Kalamunda Road – Kenneth Road Intersection

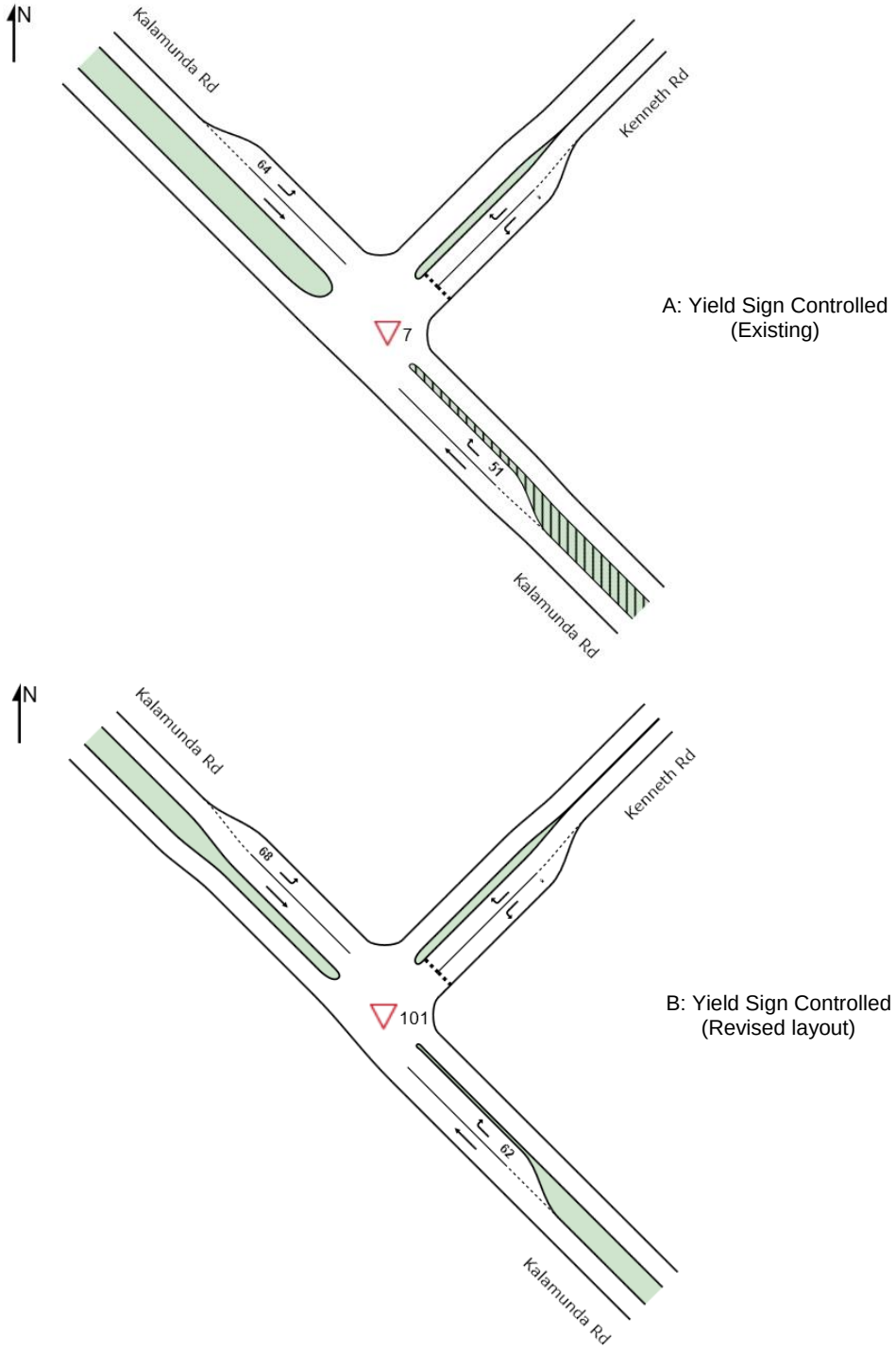


Table 6-19 AM Peak: Yield Sign-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	T	0.328	0	A	0	0.267	0	A	0	0.272	0	A	0	0.256	0	A	0	0.268	0	A	0
	R	0.030	7.7	A	0.9	0.022	8.1	A	0.6	0.022	8	A	0.6	0.043	8.1	A	1.2	0.032	8	A	0.9
NorthEast: Kenneth Rd	L	0.021	6.4	A	0.5	0.025	6.9	A	0.6	0.026	6.8	A	0.7	0.023	6.9	A	0.6	0.025	6.8	A	0.6
	R	0.191	23.1	C	4.7	0.072	18.9	C	1.8	0.063	19	C	1.5	0.142	19.2	C	3.5	0.103	19.2	C	2.5
NorthWest: Kalamunda Rd	L	0.007	5.6	A	0	0.011	5.6	A	0	0.011	5.6	A	0	0.011	5.6	A	0	0.011	5.6	A	0
	T	0.197	0	A	0	0.238	0	A	0	0.233	0	A	0	0.238	0	A	0	0.233	0	A	0
All vehicles		0.328	1.2	NA	4.7	0.267	0.7	NA	1.8	0.272	0.7	NA	1.5	0.256	1.2	NA	3.5	0.268	0.9	NA	2.5

Table 6-20 PM Peak: Yield Sign-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	T	0.299	0	A	0	0.351	0	A	0	0.359	0	A	0	0.337	0	A	0	0.353	0	A	0
	R	0.055	10.9	B	1.5	0.036	12.4	B	0.9	0.035	12.1	B	0.9	0.089	12.7	B	2.3	0.058	12.2	B	1.5
NorthEast: Kenneth Rd	L	0.064	9.2	A	1.5	0.075	11.5	B	1.8	0.072	11.2	B	1.7	0.075	11.5	B	1.8	0.072	11.2	B	1.7
	R	0.196	36.9	E	4.5	0.554	89.1	F	13.5	0.399	74.4	F	9.2	0.545	86.8	F	13.3	0.396	73.7	F	9.1
NorthWest: Kalamunda Rd	L	0.026	5.6	A	0	0.020	5.6	A	0	0.020	5.6	A	0	0.020	5.6	A	0	0.020	5.6	A	0
	T	0.352	0	A	0	0.433	0	A	0	0.424	0	A	0	0.433	0	A	0	0.424	0	A	0
All vehicles		0.352	1.3	NA	4.5	0.554	2.5	NA	13.5	0.424	1.8	NA	9.2	0.545	2.7	NA	13.3	0.424	1.8	NA	9.1

6.9.6 Kalamunda Road/Cyril Road

For the intersection of Kalamunda Road and Cyril Road, the intersection performance was assessed for the following control types: (1) yield sign-controlled; (2) signal-controlled; and (3) roundabout. Sidra layouts are presented in **Figure 6-10** while analysis results are presented in **Table 6-21** to **Table 6-24**.

Figure 6-10 Sidra Layout for Kalamunda Road – Cyril Road Intersection

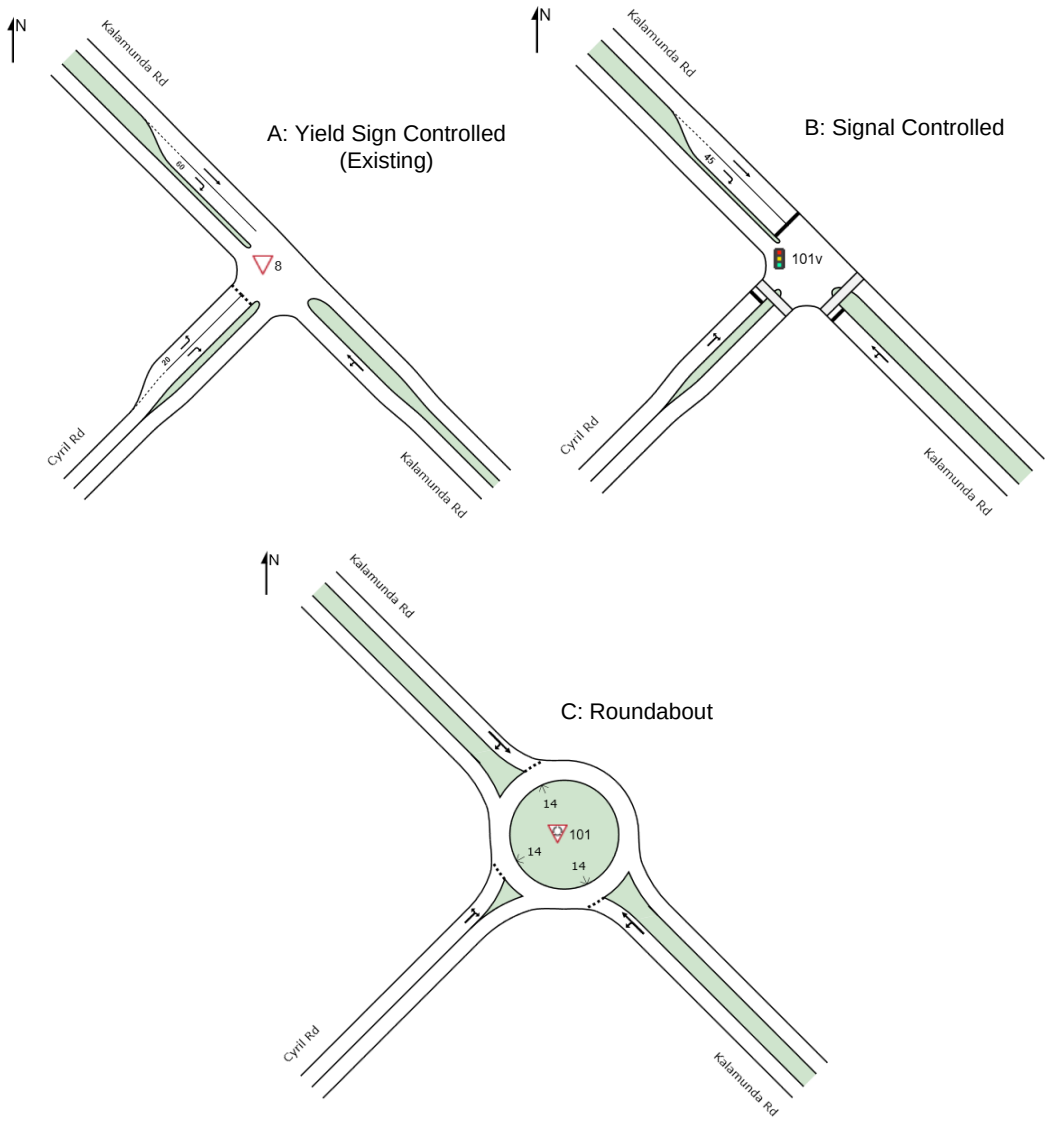


Table 6-21 AM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.334	5.7	A	0	0.685	20.1	C	79.8	0.698	20.5	C	82.7	0.682	20.1	C	79.2	0.697	20.4	C	82.4
	T	0.334	0	A	0	0.685	14.5	B	79.8	0.698	14.8	B	82.7	0.682	14.4	B	79.2	0.697	14.8	B	82.4
NorthWest: Kalamunda Rd	T	0.204	0	A	0	0.428	4.9	A	45.5	0.418	4.8	A	44.2	0.423	4.8	A	44.9	0.414	4.8	A	43.5
	R	0.006	8.8	A	0.2	0.150	28.4	C	5.5	0.145	28.4	C	5.3	0.160	28.5	C	5.8	0.160	28.5	C	5.8
SouthWest: Cyril Rd	L	0.025	7.5	A	0.7	0.250	25.1	C	12.6	0.242	25.1	C	12.3	0.279	25.3	C	14.1	0.270	25.2	C	13.8
	R	0.051	17.7	C	1.2	0.250	25.9	C	12.6	0.242	25.9	C	12.3	0.279	26.1	C	14.1	0.270	26	C	13.8
All vehicles		0.334	0.5	NA	1.2	0.685	11.2	B	79.8	0.698	11.4	B	82.7	0.682	11.3	B	79.2	0.697	11.5	B	82.4

Table 6-22 AM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.334	5.7	A	0	0.347	4.5	A	19.8	0.352	4.5	A	20.2	0.348	4.5	A	19.9	0.355	4.5	A	20.4
	T	0.334	0	A	0	0.347	4.7	A	19.8	0.352	4.7	A	20.2	0.348	4.8	A	19.9	0.355	4.8	A	20.4
NorthWest: Kalamunda Rd	T	0.204	0	A	0	0.382	4.8	A	25.1	0.372	4.8	A	24.2	0.384	4.9	A	25.2	0.376	4.8	A	24.4
	R	0.006	8.8	A	0.2	0.382	8.7	A	25.1	0.372	8.7	A	24.2	0.384	8.7	A	25.2	0.376	8.7	A	24.4
SouthWest: Cyril Rd	L	0.025	7.5	A	0.7	0.098	6.8	A	4.9	0.097	6.9	A	4.8	0.109	6.8	A	5.5	0.108	6.9	A	5.4
	R	0.051	17.7	C	1.2	0.098	14.2	B	4.9	0.097	14.3	B	4.8	0.109	14.2	B	5.5	0.108	14.3	B	5.4
All vehicles		0.334	0.5	NA	1.2	0.382	5.2	A	25.1	0.372	5.2	A	24.2	0.384	5.2	A	25.2	0.376	5.2	A	24.4

Table 6-23 PM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.317	5.7	A	0	0.711	18.8	B	113.8	0.726	19.3	B	119.1	0.709	18.7	B	113	0.724	19.2	B	118.3
	T	0.317	0	A	0	0.711	13.1	B	113.8	0.726	13.6	B	119.1	0.709	13.1	B	113	0.724	13.6	B	118.3
NorthWest: Kalamunda Rd	T	0.356	0	A	0	0.515	4.6	A	67.8	0.505	4.5	A	65.6	0.510	4.5	A	66.8	0.500	4.5	A	64.6
	R	0.037	8.7	A	1.1	0.175	34.2	C	6.5	0.175	34.2	C	6.5	0.193	34.2	C	7.2	0.193	34.2	C	7.2
SouthWest: Cyril Rd	L	0.022	7.1	A	0.6	0.333	34	C	12.7	0.339	34	C	13	0.370	34.1	C	14.2	0.376	34.2	C	14.5
	R	0.135	27.5	D	3.1	0.333	34	C	12.7	0.339	34	C	13	0.370	34.1	C	14.2	0.376	34.2	C	14.5
All vehicles		0.356	0.9	NA	3.1	0.711	10.5	B	113.8	0.726	10.8	B	119.1	0.709	10.7	B	113	0.724	11	B	118.3

Table 6-24 PM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.317	5.7	A	0	0.449	4.5	A	29.2	0.458	4.5	A	30.1	0.452	4.5	A	29.5	0.461	4.5	A	30.5
	T	0.317	0	A	0	0.449	4.7	A	29.2	0.458	4.7	A	30.1	0.452	4.8	A	29.5	0.461	4.8	A	30.5
NorthWest: Kalamunda Rd	T	0.356	0	A	0	0.479	4.7	A	36.3	0.470	4.7	A	35.2	0.482	4.7	A	36.6	0.473	4.7	A	35.5
	R	0.037	8.7	A	1.1	0.479	8.6	A	36.3	0.470	8.6	A	35.2	0.482	8.6	A	36.6	0.473	8.6	A	35.5
SouthWest: Cyril Rd	L	0.022	7.1	A	0.6	0.090	8.3	A	3.8	0.092	8.5	A	3.9	0.099	8.3	A	4.2	0.102	8.5	A	4.3
	R	0.135	27.5	D	3.1	0.090	12.2	B	3.8	0.092	12.3	B	3.9	0.099	12.2	B	4.2	0.102	12.3	B	4.3
All vehicles		0.356	0.9	NA	3.1	0.479	5	A	36.3	0.470	5	A	35.2	0.482	5.1	A	36.6	0.473	5.1	A	35.5

6.9.7 Kalamunda Road/Hawkevale Road/Range Court

The existing intersection of Kalamunda Road and Range View Road has three approaches, whereas the proposed layout for the future scenarios has four. The intersection performance was assessed for the following control types: (1) yield sign-controlled; (2) signal-controlled; and (3) roundabout. Sidra layouts are presented in **Figure 6-11** and analysis results are presented in **Table 6-25** to **Table 6-28**.

Figure 6-11 Sidra Layout for Kalamunda Road – Hawkevale Road – Range Court Intersection

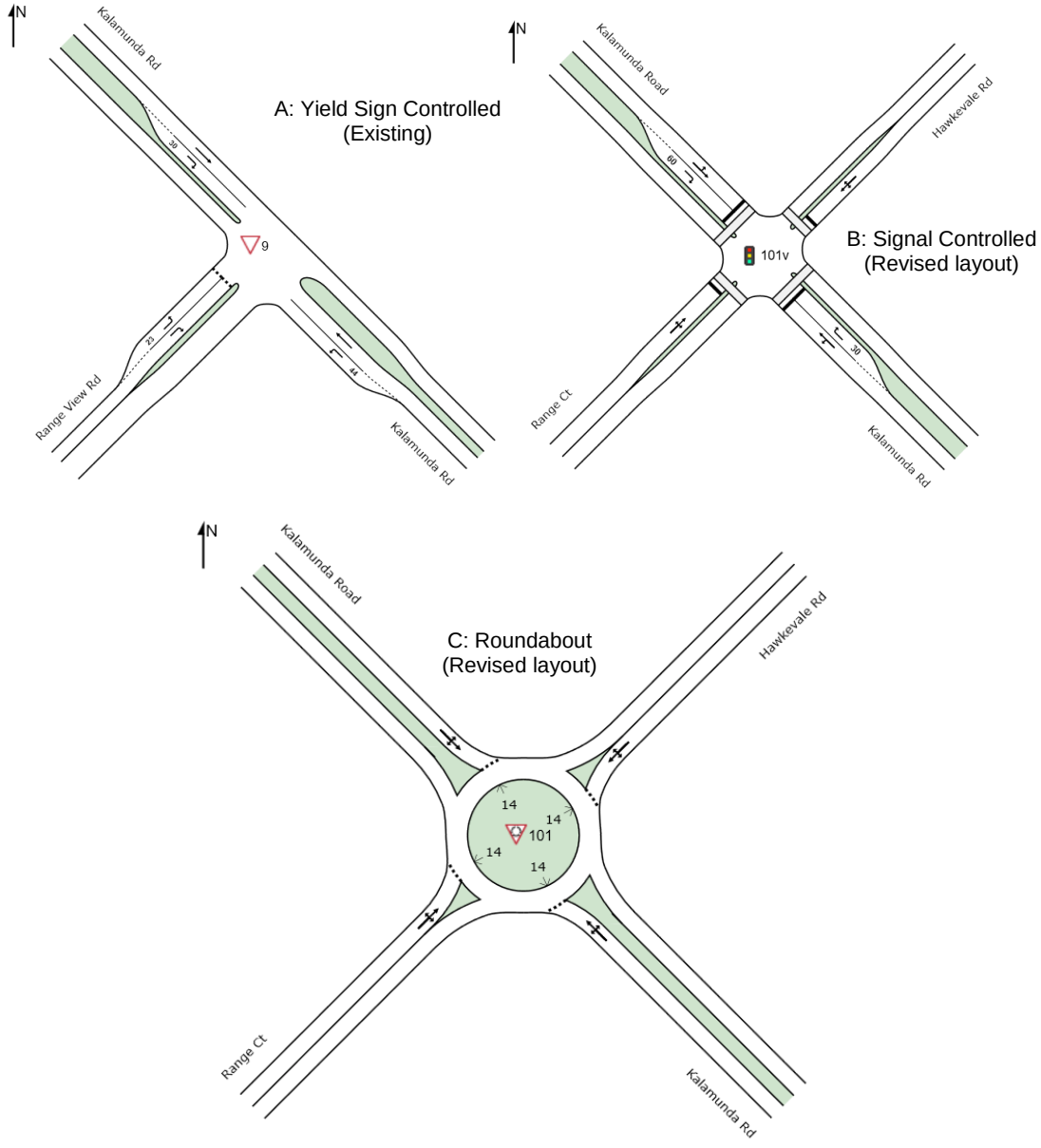


Table 6-25 AM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.004	5.7	A	0	0.830	31.9	C	150.4	0.847	33.5	C	158.7	0.826	31.5	C	147.2	0.842	33	C	154.7
	T	0.324	0	A	0	0.830	26.2	C	150.4	0.847	27.9	C	158.7	0.826	25.8	C	147.2	0.842	27.3	C	154.7
	R	-	-	-	-	0.304	40.6	D	11.7	0.319	40.7	D	12.2	0.333	40.7	D	12.8	0.355	40.8	D	13.7
NorthEast: Hawkevale Rd	L	-	-	-	-	0.741	43.1	D	30.8	0.741	43.1	D	30.8	0.824	45.5	D	35.7	0.824	45.5	D	35.7
	T	-	-	-	-	0.741	38.5	D	30.8	0.741	38.5	D	30.8	0.824	40.9	D	35.7	0.824	40.9	D	35.7
	R	-	-	-	-	0.741	43.2	D	30.8	0.741	43.2	D	30.8	0.824	45.5	D	35.7	0.824	45.5	D	35.7
NorthWest: Kalamunda Road	L	-	-	-	-	0.819	31.1	C	153.7	0.803	30	C	146.2	0.815	30.8	C	151.3	0.799	29.7	C	144.5
	T	0.210	0	A	0	0.819	25.5	C	153.7	0.803	24.3	C	146.2	0.815	25.2	C	151.3	0.799	24.1	C	144.5
	R	0.007	9.7	A	0.2	0.087	39.4	D	3.2	0.087	39.4	D	3.2	0.101	39.5	D	3.8	0.094	39.4	D	3.5
SouthWest: Range Ct	L	0.028	8.4	A	0.7	0.193	39	D	7.5	0.193	39	D	7.5	0.214	39.1	D	8.3	0.207	39	D	8
	T	-	-	-	-	0.193	34.3	C	7.5	0.193	34.3	C	7.5	0.214	34.4	C	8.3	0.207	34.4	C	8
	R	0.055	21.4	C	1.3	0.193	39	D	7.5	0.193	39	D	7.5	0.214	39.1	D	8.3	0.207	39.1	D	8
All vehicles		0.324	0.5	NA	1.3	0.830	28.4	C	153.7	0.847	28.7	C	158.7	0.826	28.6	C	151.3	0.842	28.8	C	154.7

Table 6-26 AM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.004	5.7	A	0	0.457	4.9	A	31.5	0.464	4.9	A	32.4	0.464	5	A	32	0.470	5	A	32.8
	T	0.324	0	A	0	0.457	5.2	A	31.5	0.464	5.2	A	32.4	0.464	5.3	A	32	0.470	5.3	A	32.8
	R	-	-	-	-	0.457	9.1	A	31.5	0.464	9.1	A	32.4	0.464	9.2	A	32	0.470	9.1	A	32.8
NorthEast: Hawkevale Rd	L	-	-	-	-	0.155	7.6	A	6.7	0.154	7.5	A	6.7	0.172	7.6	A	7.6	0.171	7.5	A	7.5
	T	-	-	-	-	0.155	7.6	A	6.7	0.154	7.5	A	6.7	0.172	7.6	A	7.6	0.171	7.5	A	7.5
	R	-	-	-	-	0.155	11.4	B	6.7	0.154	11.3	B	6.7	0.172	11.4	B	7.6	0.171	11.3	B	7.5
NorthWest: Kalamunda Road	L	-	-	-	-	0.456	4.8	A	29.5	0.449	4.9	A	28.8	0.460	4.9	A	30	0.454	4.9	A	29.3
	T	0.210	0	A	0	0.456	5.1	A	29.5	0.449	5.1	A	28.8	0.460	5.2	A	30	0.454	5.2	A	29.3
	R	0.007	9.7	A	0.2	0.456	9	A	29.5	0.449	9	A	28.8	0.460	9.1	A	30	0.454	9.1	A	29.3
SouthWest: Range Ct	L	0.028	8.4	A	0.7	0.044	8	A	1.9	0.045	8.1	A	2	0.050	8.1	A	2.2	0.048	8.2	A	2.1
	T	-	-	-	-	0.044	8.1	A	1.9	0.045	8.2	A	2	0.050	8.1	A	2.2	0.048	8.2	A	2.1
	R	0.055	21.4	C	1.3	0.044	11.9	B	1.9	0.045	12	B	2	0.050	12	B	2.2	0.048	12.1	B	2.1
All vehicles		0.324	0.5	NA	1.3	0.457	5.8	A	31.5	0.464	5.8	A	32.4	0.464	5.9	A	32	0.470	5.9	A	32.8

Table 6-27 PM Peak: Signal-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.011	5.7	A	0	0.596	21.5	C	110.7	0.610	21.6	C	113.3	0.606	22.2	C	111	0.620	22.3	C	113
	T	0.309	0	A	0	0.596	15.9	B	110.7	0.610	16	B	113.3	0.606	16.6	B	111	0.620	16.6	B	113
	R	-	-	-	-	0.551	53.3	D	22	0.596	53.7	D	24	0.596	53.7	D	24	0.659	54.4	D	26.9
NorthEast: Hawkevale Rd	L	-	-	-	-	0.762	53.3	D	41.6	0.762	53.3	D	41.6	0.756	52.2	D	45.9	0.756	52.2	D	45.9
	T	-	-	-	-	0.762	48.7	D	41.6	0.762	48.7	D	41.6	0.756	47.6	D	45.9	0.756	47.6	D	45.9
	R	-	-	-	-	0.762	53.3	D	41.6	0.762	53.3	D	41.6	0.756	52.2	D	45.9	0.756	52.2	D	45.9
NorthWest: Kalamunda Road	L	-	-	-	-	0.736	23.9	C	168.8	0.721	23.7	C	163.8	0.749	24.8	C	171.5	0.733	24.5	C	165.6
	T	0.359	0	A	0	0.736	18.3	B	168.8	0.721	18.1	B	163.8	0.749	19.2	B	171.5	0.733	18.8	B	165.6
	R	0.033	9.6	A	0.9	0.208	51.4	D	8	0.199	51.3	D	7.6	0.235	51.6	D	9.1	0.217	51.4	D	8.3
SouthWest: Range Ct	L	0.020	8.1	A	0.5	0.409	51.3	D	16.6	0.409	51.3	D	16.6	0.459	51.5	D	18.7	0.451	51.5	D	18.4
	T	-	-	-	-	0.409	46.7	D	16.6	0.409	46.7	D	16.6	0.459	46.9	D	18.7	0.451	46.9	D	18.4
	R	0.130	35.4	E	2.9	0.409	51.3	D	16.6	0.409	51.3	D	16.6	0.459	51.5	D	18.7	0.451	51.5	D	18.4
All vehicles		0.359	0.8	NA	2.9	0.762	24	C	168.8	0.762	24	C	163.8	0.756	25.2	C	171.5	0.756	25.2	C	165.6

Table 6-28 PM Peak: Roundabout-Controlled

		2019				2031								2041							
		Base Scenario (Scenario 1)				Without cul-de-sac (Scenario 2)				With cul-de-sac (Scenario 3)				Without cul-de-sac (Scenario 4)				With cul-de-sac (Scenario 5)			
		DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
SouthEast: Kalamunda Rd	L	0.011	5.7	A	0	0.436	5	A	28	0.442	4.9	A	28.7	0.444	5.1	A	28.5	0.448	5	A	29.1
	T	0.309	0	A	0	0.436	5.2	A	28	0.442	5.2	A	28.7	0.444	5.4	A	28.5	0.448	5.3	A	29.1
	R	-	-	-	-	0.436	9.1	A	28	0.442	9.1	A	28.7	0.444	9.2	A	28.5	0.448	9.2	A	29.1
NorthEast: Hawkevale Rd	L	-	-	-	-	0.182	8.4	A	8.4	0.181	8.3	A	8.3	0.202	8.4	A	9.4	0.201	8.3	A	9.4
	T	-	-	-	-	0.182	8.5	A	8.4	0.181	8.4	A	8.3	0.202	8.4	A	9.4	0.201	8.4	A	9.4
	R	-	-	-	-	0.182	12.3	B	8.4	0.181	12.2	B	8.3	0.202	12.3	B	9.4	0.201	12.2	B	9.4
NorthWest: Kalamunda Road	L	-	-	-	-	0.556	5.2	A	39.6	0.552	5.3	A	38.8	0.564	5.4	A	40.4	0.561	5.4	A	39.5
	T	0.359	0	A	0	0.556	5.5	A	39.6	0.552	5.6	A	38.8	0.564	5.6	A	40.4	0.561	5.7	A	39.5
	R	0.033	9.6	A	0.9	0.556	9.4	A	39.6	0.552	9.5	A	38.8	0.564	9.5	A	40.4	0.561	9.6	A	39.5
SouthWest: Range Ct	L	0.020	8.1	A	0.5	0.071	7.5	A	3	0.071	7.6	A	3	0.080	7.6	A	3.4	0.079	7.6	A	3.4
	T	-	-	-	-	0.071	7.5	A	3	0.071	7.6	A	3	0.080	7.6	A	3.4	0.079	7.7	A	3.4
	R	0.130	35.4	E	2.9	0.071	11.3	B	3	0.071	11.4	B	3	0.080	11.4	B	3.4	0.079	11.5	B	3.4
All vehicles		0.359	0.8	NA	2.9	0.556	6.2	A	39.6	0.552	6.2	A	38.8	0.564	6.3	A	40.4	0.561	6.4	A	39.5

6.10 Summary of Analysis Results

The Sidra analysis results for all vehicles at each intersection for different parameters are summarised in **Table 6-29** to **Table 6-32.**

Table 6-29 Sidra Results Summary – Degree of Saturation (DOS)

Road Name and Control Type	DOS									
	2019		2031				2041			
	Base Scenario		Without cul-de-sac		With cul-de-sac		Without cul-de-sac		With cul-de-sac	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Kalamunda Rd - Stirling Crescent										
Signal	0.478	0.327	0.696	0.817	0.572	0.662	0.675	0.812	0.660	0.647
Roundabout	0.478	0.327	0.669	0.595	0.580	0.448	0.659	0.585	0.576	0.433
Kalamunda Rd - Wittenoom Rd										
Signal	0.426	0.386	0.806	0.791	0.824	0.810	0.793	0.778	0.809	0.795
Staged Crossing (Stop)	0.426	0.386	0.466	0.341	0.476	0.332	0.458	0.300	0.467	0.300
Kalamunda Rd - HWVSC Access										
Access 1 (Yield)	-	0.353	-	0.378	-	0.369	-	0.356	-	0.346
Access 2 (Yield)	-	0.304	-	0.372	-	0.350	-	0.338	-	0.329
Access 3 (Yield)	-	0.301	-	0.359	-	0.306	-	0.338	-	0.284
Kalamunda Rd - Newburn Rd - Chipping Drive										
Signal	0.554	0.754	0.863	0.885	0.882	0.889	0.873	0.868	0.870	0.865
Roundabout	0.554	0.754	0.472	0.650	0.480	0.634	0.488	0.662	0.494	0.645
Kalamunda Rd - Kenneth Rd										
Yield	0.328	0.352	0.267	0.554	0.272	0.424	0.256	0.545	0.268	0.424
Kalamunda Rd - Cyril Rd										
Signal	0.334	0.356	0.685	0.711	0.698	0.726	0.682	0.709	0.697	0.724
Roundabout	0.334	0.356	0.382	0.479	0.372	0.470	0.384	0.482	0.376	0.473
Kalamunda Rd - Hawkevale Rd - Range Court										
Signal	0.324	0.359	0.830	0.762	0.847	0.762	0.826	0.756	0.842	0.756
Roundabout	0.324	0.359	0.457	0.556	0.464	0.552	0.464	0.564	0.470	0.561

Table 6-30 Sidra Results Summary – Average Delay

Road Name and Control Type	Delay (sec)									
	2019		2031				2041			
	Base Scenario		Without cul-de-sac		With cul-de-sac		Without cul-de-sac		With cul-de-sac	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Kalamunda Rd - Stirling Crescent										
Signal	2.7	3.5	14.9	28	12.6	15.6	14.5	26.4	12.8	15.7
Roundabout	2.7	3.5	6.6	6.7	5.5	5.6	6.5	6.5	5.5	5.5
Kalamunda Rd - Wittenoom Rd										
Signal	2.8	3.5	17.7	13.6	18.8	13.9	19.4	14.7	19	14.4
Staged Crossing (Stop)	2.8	3.5	0	2.1	3.1	3.9	3.5	2.8	3.5	4.3
Kalamunda Rd - HWVSC Access										
Access 1 (Yield)	-	0.2	-	0.3	-	0.3	-	0.3	-	0.3
Access 2 (Yield)	-	0.9	-	0.9	-	0.9	-	0.9	-	0.9
Access 3 (Yield)	-	2.2	-	2.5	-	2.8	-	2.5	-	2.8
Kalamunda Rd - Newburn Rd - Chipping Drive										
Signal	6.2	8.6	39.2	47.2	40.6	45.2	47.5	51.6	47.2	52.4
Roundabout	6.2	8.6	6.8	7.8	6.8	7.7	7.3	8.6	7.4	8.5
Kalamunda Rd - Kenneth Rd										
Yield	1.2	1.3	0.7	2.5	0.7	1.8	1.2	2.7	0.9	1.8
Kalamunda Rd - Cyril Rd										
Signal	0.5	0.9	11.2	10.5	11.4	10.8	11.3	10.7	11.5	11
Roundabout	0.5	0.9	5.2	5	5.2	5	5.2	5.1	5.2	5.1
Kalamunda Rd - Hawkevale Rd - Range Court										
Signal	0.5	0.8	28.4	24	28.7	24	28.6	25.2	28.8	25.2
Roundabout	0.5	0.8	5.8	6.2	5.8	6.2	5.9	6.3	5.9	6.4

Table 6-31 Sidra Results Summary – Level of Service (LOS)

Road Name and Control Type	LOS									
	2019		2031				2041			
	Base Scenario		Without cul-de-sac		With cul-de-sac		Without cul-de-sac		With cul-de-sac	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Kalamunda Rd - Stirling Crescent										
Signal	NA	NA	B	C	B	B	B	C	B	B
Roundabout	NA	NA	A	A	A	A	A	A	A	A
Kalamunda Rd - Wittenoom Rd										
Signal	NA	NA	B	B	B	B	B	B	B	B
Staged Crossing (Stop)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kalamunda Rd - HWVSC Access										
Access 1 (Yield)		NA		NA		NA		NA		NA
Access 2 (Yield)		NA		NA		NA		NA		NA
Access 3 (Yield)		NA		NA		NA		NA		NA
Kalamunda Rd - Newburn Rd - Chipping Drive										
Signal	A	A	D	D	D	D	D	D	D	D
Roundabout	A	A	A	A	A	A	A	A	A	A
Kalamunda Rd - Kenneth Rd										
Yield	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Kalamunda Rd - Cyril Rd										
Signal	NA	NA	B	B	B	B	B	B	B	B
Roundabout	NA	NA	A	A	A	A	A	A	A	A
Kalamunda Rd - Hawkevale Rd - Range Court										
Signal	NA	NA	C	C	C	C	C	C	C	C
Roundabout	NA	NA	A	A	A	A	A	A	A	A

Table 6-32 Sidra Results Summary – 95% Queue

Road Name and Control Type	95% Queue (m)									
	2019		2031				2041			
	Base Scenario		Without cul-de-sac		With cul-de-sac		Without cul-de-sac		With cul-de-sac	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Kalamunda Rd - Stirling Crescent										
Signal	14.4	8.7	73.7	276.1	70	95.5	74.8	265.4	71.2	95
Roundabout	14.4	8.7	57.1	48.8	47.7	26.2	55.3	47.8	46.8	25.1
Kalamunda Rd - Wittenoom Rd										
Signal	6	12.2	188.7	63.9	202.2	61.4	178.9	56.6	190.8	59.1
Staged Crossing (Stop)	6	12.2	3.7	2	3.8	2	5.5	2.9	4.6	2.4
Kalamunda Rd - HWVSC Access										
Access 1 (Yield)	-	0.3	-	0.3	-	0.3	-	0.3	-	0.3
Access 2 (Yield)	-	2.6	-	2.5	-	2.3	-	2.3	-	2.2
Access 3 (Yield)	-	7.8	-	6.4	-	8.5	-	6.1	-	7.8
Kalamunda Rd - Newburn Rd - Chipping Drive										
Signal	37.7	75.3	182.9	251.2	194	229.8	219.5	246.5	221.7	239.4
Roundabout	37.7	75.3	26.2	48.9	27	45.9	27.1	52.2	27.9	49
Kalamunda Rd - Kenneth Rd										
Yield	4.7	4.5	1.8	13.5	1.5	9.2	3.5	13.3	2.5	9.1
Kalamunda Rd - Cyril Rd										
Signal	1.2	3.1	79.8	113.8	82.7	119.1	79.2	113	82.4	118.3
Roundabout	1.2	3.1	25.1	36.3	24.2	35.2	25.2	36.6	24.4	35.5
Kalamunda Rd - Hawkevale Rd - Range Court										
Signal	1.3	2.9	153.7	168.8	158.7	163.8	151.3	171.5	154.7	165.6
Roundabout	1.3	2.9	31.5	39.6	32.4	38.8	32	40.4	32.8	39.5

From the results of the analysis, the following was observed:

- For all intersections evaluated, for both traffic signal and roundabout controlled, the roundabout intersection control resulted in better overall performances.

  All the proposed roundabout control intersections operated at LOS A for 2031 and 2041 design years. The analysis showed that converting these intersections to a traffic signal control would result to the intersections operating between LOS B and LOS D

- Intersection performance is generally worse in the PM peak hour except for the Kalamunda Rd-Wittenoom Road intersection.

- The analysis shows that the Kalamunda Road/Stirling Crescent and Kalamunda Road/Newburn Road/Chipping Drive intersections will experience the highest delays, longest queues, and highest degrees of saturation of all the intersections along this corridor.

7 Forward Works Plan

7.1 Background

As part of Stage 2 of this project Cardno has developed a Forward Works Plan (FWP) for various work packages that will include details on the broad-brush cost estimates for the proposed concept design.

The FWP also includes subtotals by year (2019 to 2031) and overall for all longer-term projects to 2041 (based on ROM24 traffic growth) to assist the City with its future year budgeting exercises. The forward works has been developed in terms of the three work package sections discussed in Section 4.2, with the addition of Section 2C, comprising the signalised pedestrian crossing, cul-de-sac of Fernan Road & minor improvements to the existing access to the High Wycombe Shopping Centre.

7.2 Cost Estimate Assumptions

7.2.1 Assumptions

The following assumptions were made in developing the preliminary cost estimate:

7.2.1.1 Wastewater

An allowance has been made for modification works to the 150mm diameter sewer i.e. Modifying line and level of the sewer.

7.2.1.2 Water

An allowance has been made for modification works to the 250mm diameter cast iron watermain.

7.2.1.3 Gas

It is anticipated that modification to the 70Kpa low pressure gas main would be required but not for the high-pressure gas main. Allowance for the modification to the 70Kpa low pressure gas main has been included in the cost estimates.

7.2.1.4 Power

Overhead cables run along Kalamunda Road in Section one (1), a cost has been attributed to undergrounding the overhead cables. Allowance has also been made for relocating existing overhead power poles in Sections two (2) and three (3).

Allowances have also been made for relocating existing street lights in all three sections. This allowance includes upgrading the streetlights to compliant infrastructure.

Other power infrastructure within all three sections, such as property connections has not been allowed for in the cost estimates.

7.2.1.5 Communications

Modifications to the existing Telstra, NBN and Optus infrastructure have been assumed.

7.2.1.6 Drainage

Underlying soil conditions are assumed to allow management of the nominated rainfall events and resulting flows within the catchment area, and as such no works have been allowed to facilitate connection to City drainage infrastructure.

7.2.1.7 Roads

An allowance has been made for upgrading Kalamunda Road between Abernethy Road and Roe Highway, please refer to Cardno's concept plans for further details.

7.2.1.8 Contingency

A 40% contingency has been applied to account for uncertainties.

7.3 Total Cost Estimate

The total preliminary order magnitude of cost estimated for the road upgrades proposed in the concept design for Kalamunda Road is approximately **$17,256,450.40 including GST** as shown in **Table 7-1**.

Table 7-1 Project Costs

Item	Estimate Cost					
	Section 1A	**Section 1B**	**Section 2A**	**Section 2B**	**Section 2C**	**Section 3**
Preliminaries and Site Costs	$1,049,993	$390,413	$256,460	$212,512	$63,096	$424,393
Earthworks	$126,706	$31,740	$26,258	$40,120	$17,662	$63,383
Demolition	$340,390	$169,390	$154,640	$68,200	$20,800	$75,900
Roads	$1,182,624	$379,270	$431,441	$284,528	$26,920	$224,144
Road Drainage	$-	$-	$20,000	$20,000	$10,000	$20,000
Power Diversion	$288,000	$105,000	$20,000	$188,000	$-	$235,000
Water Corp Water/Sewer/ Drainage	$125,750	$77,750	$184,500	$82,200	$-	$123,000
Telstra	$19,000	$27,000	$30,000	$18,000	$-	$24,000
Optus	$-	$24,000	$-	$-	$-	$-
Driveway Construction	$-	$10,000	$130,000	$125,000	$-	$105,000
Land take (*Estimated *expropriation cost where land cannot be ceded as part of the development application process*)	$2,030,000	$700,000	$-	$-	$-	$-
NBN	$14,000	$6,000	$21,000	$12,000	$27,000	$25,000
ATCO Gas	$73,500	$31,500	$8,000	$12,000	$-	$21,000
Pedestrian Traffic Lights	$-	$-	$-	$-	$150,000	$-
Sub Total	$5,249,963	$1,952,063	$1,282,298	$1,062,560	$315,478	$1,341,320
40% Contingency	$2,100,000	$781,000	$513,000	$426,000	$127,000	$537,000
Total (excl GST)	$7,349,963.40	$2,733,062.50	$1,795,298.30	$1,488,560.00	$442,478.00	$1,878,320.00
Total (incl GST)	$8,084,959.80	$3,006,368.80	$1,974,828.10	$1,637,416.00	$486,725.80	$2,066,151.90
Overall Total (incl GST)						**$17,256,450.40**

7.4 Funding Sources

7.4.1 MRWA Funding Categories

On an annual basis, a fraction of State road funds is to be allocated to Local Government roads. The available funding is classed into two categories:

i) Local Government Managed Programs (Category 1 – approximately 66%), and

ii) Main Roads Western Australia Managed Programs (Category 2 – approximately 34%)

7.4.2 Local Government Managed Programs

7.4.2.1 Road Improvement programs

The road improvement program funds are distributed to Metropolitan Regional Road Group. These funds are generally used in:

i) Preservation work.

ii) Road related projects.

iii) Commodity routes.

iv) Road and Bridge Condition Data Collection.

7.4.2.2 Direct Grant

Direct Grants are allocated for routine maintenance on Local Government roads

7.4.2.3 State Black Spot

State Black Spot funding are allocated to Local Government roads, aiming to improve the safety of roads with a proven crash history or high-risk locations.

7.4.2.4 Strategic and Technical Support

- Municipal Infrastructure Needs, Development, Evaluation & Research (WALGA);
- The provision and analysis of crash statistics and road safety data for the Regional Road Groups;
- WALGA RoadWise Program;
- WA Local Government Grants Commission support;
- Nudge (formerly The Roads Foundation); and
- Other activities as identified or agreed by SAC.

7.5 Forward Works Plan

7.5.1 General

A review of the existing traffic volume data has observed the following daily traffic flows;

- Section 1 – +/- 13,900 vehicles per day (vpd);
- Section 2 – between 8,500 and 13,000 vehicles per day (vpd); and
- Section 3 – 15,000 vehicles per day(vpd).

As highlighted in **Section 6.5** of this report, the existing network is to be restricted to 15,000 vehicles per day and Section 3 (between Cyril Road and Roe Highway) has already achieved this threshold target. The intersection between Kalamunda Road and Roe Highway is expected to be grade separated within the next two years and hence it is likely that the treatments identified for Section 3 (between Cyril Road and Roe Highway) will need to be considered for implementation to constrain the traffic to achieve the desired road function.

At present the current demand on Section 1A (Abernethy Road to Stirling Crescent) is approximately 13,900 vehicles per day only, however, a review of 2031 demand forecasts have highlighted that traffic volumes are expected to increase to approximately 15,900 vehicles per day between Abernethy Road and Stirling Crescent and over 20,000 vehicles per day on Section 2B (between Newburn Road/Chipping Drive and Cyril Road).

Similarly, it is estimated that about 14,300 vehicles per day would use Section 1B (Stirling Crescent to Wittenoom Road) by 2041.

In Section 2A (Wittenoom Road to Newburn Road/Chipping Drive), current demand ranges between 8,500vpd and 13,000 vpd. A review of 2041 traffic forecasts indicate that an increase in demand of between 9,600vpd and 14,600 vpd is anticipated for this section of Kalamunda Road.

7.5.2 Conclusions

A review of the existing vehicle usage data has identified that Section 3 (between Cyril Road and Roe Highway) has already reached the restricted demand of 15,000 vpd to accomplish the proposed function of this section of Kalamunda Road. Furthermore, it has been identified by Main Roads WA that the Roe Highway and Kalamunda Road interchange is to be a grade separated interchange. The reason for this upgrade is to improve:

- Congestion;
- Road safety by enabling Roe Highway through traffic to flow freely;
- Access and reduce journey times in to Perth's eastern suburbs; and
- More efficient, reliable freight movements.

A review of Main Roads WA strategic projects has identified that this interchange is expected to be upgraded by early 2021. Hence, Section 3 (between Cyril Road and Roe Highway) of the proposed concept design will need to be upgraded by the end of 2022.

Section 1 Kalamunda Road upgrade works will be driven primarily by the development of Lot 200. At present there is no current structure /development plans in place for the development of this lot. A review of current vehicle demand has revealed that about 10,800 vehicles use Section 1A (Abernethy Road to Stirling Crescent). Vehicle demand between Abernethy Road and Stirling Crescent is expected to increase to about 15,900vpd by 2031 and Section 2A (between Wittenoom Road and Newburn Road/Chipping Drive) to 14,600 vpd by 2041. Therefore, it is envisaged that the upgrade of these sections will be undertaken in stages.

Current vehicle demand for Section 2A (Wittenoom Road to Newburn Road/Chipping Drive) ranges between 8,500vpd and 13,000 vpd. Demand forecast has revealed that the traffic for this section is expected to increase to between 9,600vpd and 14,600 vpd beyond 2041. Similarly, Current vehicle demand for Section 2B (between Newburn Road/Chipping Drive and Cyril Road) is around 14,500 vpd. Demand forecasts have revealed that the traffic for this section is expected to increase to over 20,600 vpd beyond 2031. It is recommended that the City of Kalamunda consider upgrading Section 2B (between Newburn Road/Chipping Drive and Cyril Road) at approximately the same time as Section 3 (between Cyril Road and Roe Highway) for ease of constructability, traffic management and reducing inconvenience to the local communities.

Based on present and future demand forecasts there is no requirement to upgrade Section 2A (Wittenoom Road to Newburn Road/Chipping Drive) by 2041. However, pedestrian facilities to the existing shopping centre is limited and there is a desire from the local community for the provision of a new pedestrian crossing to improve connectivity and safety. Cardno recommends closing off Fernan Road and installing a new signalised pedestrian crossing across Kalamunda Road. Fernan Road will need to be converted into a cul de sac to enable the construction of this signalised pedestrian crossing. It is envisaged that these works and minor improvements at the shopping centre access can be undertaken independently within the next few years even though the upgrade of Section 2A (Wittenoom Road to Newburn Road/Chipping Drive) is only required beyond 2041.

Based on the above findings, a draft forward works plan with associated costings and timings has been prepared and is shown in **Table 7-2**.

Table 7-2 Forward Works Programme

	Works Description	Estimated Project Value	2021		2022		2023		2024		2025		2026		2027		2028		2029		2030		2031	
			Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4
Kalamunda Road Traffic Upgrade	**Section 1A** **Abernethy Road to Stirling Crescent**																							
	Design	$277k																						
	Land Acquisition	$2.03m																						
	Construction/ Delivery	$3.7m																						
	Section 1B **Stirling Crescent to Wittenoom Road**																							
	Design	$																						
	Land Acquisition	$0.7m																						
	Construction/ Delivery	$2.7m																						
	Section 2A **Wittenoom Road to Newburn Road/Chipping Dr**																							
	Design	$219k																						
	Construction/ Delivery (exc. traffic lights)	$3m																						
	Section 2B **Newburn Road/Chipping Dr to Cyril Road**																							
	Design –	$123k																						

	Construction –	$1.64m																					
	Section 2C **Shopping Centre Access minor improvement/ Signalised Pedestrian crossing/cul de sac Fernan Road**																						
	Design –	$36.5k																					
	Construction –	$486k																					
	Section 3 **Cyril Road to Roe Highway**																						
	Design	$141k																					
	Construction/ Delivery	$1.9m																					

	Works Description	Estimated Project Value	2032		2033		2034		2035		2036		2037		2038		2039		2040		2041		2042	
			Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4
Kalamunda Road Traffic Upgrade	**Section 1A** **Abernethy Road to Stirling Crescent**																							
	Design	$277k																						
	Land Acquisition	$2.03m																						
	Construction/ Delivery	$3.7m																						
	Section 1B **Stirling Crescent to Wittenoom Road**																							
	Design	$202.5k																						
	Land Acquisition	$0.7m																						
	Construction/ Delivery	$2.7m																						
	Section 2A **Wittenoom Road to Newburn Road/Chipping Dr**																							
	Design	$148k																						
	Construction/ Delivery	$1.97m																						
	Section 2B **Newburn Road/Chipping Dr to Cyril Road**																							

	Design	$123k																				
	Construction/Delivery	$1.64m																				
	Section 2C **Shopping Centre Access minor improvement/ Signalised Pedestrian crossing/cul de sac Fernan Road**																					
	Design	$36.5k																				
	Construction/ Delivery	$486k																				
	Section 3 **Cyril Road to Roe Highway**																					
	Design	$141k																				
	Construction/ Delivery	$1.9m																				

8 Key Stakeholder Consultation

8.1 Consultation Process

Key stakeholders were consulted to obtain feedback on the preliminary concept design for this corridor. Two meetings for the key government/industry/local government stakeholders, grouped by their interest in the project, were arranged and held in December 2019. The stakeholders were grouped as follows:

i) Planning group (Meeting 1)
- Main Roads WA;
- Department of Planning, Lands and Heritage;
- Department of Transport; and
- Public Transport Authority.

ii) Neighbouring land managers and utilities group (Meeting 2)
- City of Swan;
- Perth Airport; and
- Utilities.

Emergency Services and the Police were contacted separately via phone and email to consult with them on this project. The Stakeholder engaged in Stage 2 of this project is summarised in **Table 8-1**.

Table 8-1 Stage 2 Stakeholder Engagement

Activity	Stakeholders involved	Communication Tool	Date of meeting/ Date of email response
'Government' stakeholder meeting ('Planning' group)	Main Roads WA	Meeting	11 December 2019
	Department of Planning, Lands and Heritage		
	Department of Transport		
	Public Transport Authority	Email (unable to attend the meeting)	17 December 2019
'Government' stakeholder meeting ('Neighbouring land managers and utilities' group)	City of Swan	Meeting	18 December 2019
	Telstra		
	ATCO Gas		
	Vocus Group		
	Perth Airport	Email on 7 January 2020	6 January 2020
	Water Corporation		10 January 2020
	NBN		18 December 2020
	Optus		No response received
	APA Group		21 November 2019

	DBNGP (Dampier to Bunbury Natural Gas Pipeline)		5 December 2019
	Western Power		6 January 2020
Emergency services and police	Forrestfield Police (local police)	Forrestfield Police consulted via telephone/email on 6 January 2020.	No response received
	Department of Fire and Emergency Services (DFES)	DFES consulted via telephone/email on 6 January 2020.	No response received

8.2 Stakeholder Consultation Feedback

Comments and feedback provided by the key stakeholders are summarised in **Table 8-2** below.

Table 8-2 Key Stakeholder Consultation Outcomes

Stakeholder	Consultation Method	Comments/Concerns
Department of Planning, Lands and Heritage	Meeting	DPLH advised that few subdivision or DA applications have been received by DPLH for Kalamunda Road. Given the functionality of this section of road is being proposed to be changed to a Neighbourhood Connector type road and serve a local function, this road should not be considered a “Blue” road in accordance with the MRS.
Department of Transport	Meeting	The DOT commented that the Cyril Road roundabout would seem to be unnecessary as it would slow buses down and the deflection of the bus would create discomfort to passengers.
Main Roads WA	Meeting	Main Roads WA raised concerns on the expected traffic demand on the regional road network in particular on Maida Vale Road. The City of Kalamunda confirmed that microsimulation traffic modelling was not undertaken as part of this project and the future traffic demand cannot be quantified at this stage. Main Roads WA advised that as part of the Roe Highway/Kalamunda Road grade separation, Stirling Crescent would have to be closed on either side of the Great Eastern Highway Bypass and hence Adelaide Street would be required to connect to Abernethy Road in the future.
Public Transport Authority	Email	PTA supported providing bus embayments along Kalamunda Road in the vicinity of the High Wycombe shopping centre. PTA advised that bus stops on the roadway could be considered elsewhere along this corridor.
City of Swan	Meeting	The City of Swan advised that in terms of the proposed Lloyd Street Extension, there are currently discussions with regard to duplicating the bridge over the rail line and the Lloyd St extension is anticipated around late 2023. It was stated that the main concerns were related to the provision of access to the South Hazelmere area with the proposed closure of Stirling Crescent at the Great Eastern Highway (GEH) Bypass.

		Currently most of Lloyd Street has been constructed except for the bridge over the river and the connection to Abernethy Road are to be reconstructed. Main Roads WA is wanting to include the closing of Stirling Crescent with their works on the proposed GEH Bypass grade separation in the future. Hence the need for extending Adelaide Street westwards towards Abernethy Road. It is envisaged that Adelaide Street would then provide for RAV 7 access.
Perth Airport	Email	Perth Airport raised no concerns.
Western Power	Online enquiry, Email, Phone call	Western Power stated that they don't generally comment on proposed plans, but can be engaged if information is sought about the potential options for the concept design. Western Power's comment provided relates to the potential impact from the proposed road modifications (new roundabouts, etc.) on Western Power's existing assets. The assets include the Guildford Terminal to Forrestfield 132kV transmission line and various distribution (22kV and 415V) assets. Some of these assets may need to be relocated.
Water Corporation	Online enquiry, Email	Water Corporation advised that they had no objection to the concept however more information is required to determine asset protection requirements. The following preliminary comments were provided: > Excavations involved in the road construction to take into consideration the numerous shallow water services crossing under the road; > Water mains running parallel under the road pavement to be relocated to standard alignments (e.g. the 255CI water main at the west end); > Water hydrants and valves to be in safe, accessible locations > Pits and lids (water, sewer and drainage) to be adjusted by Water Corporation via works requests forms. > Currently there are no long-term assets planned in the works area.
Telstra	Meeting	Telstra stated that they have two sets of networks i.e. a distribution network located 0.6m-1.2m and another alignment located 3m-4.2m which could be used by Vocus and other utilities. Telstra generally request that pits and manholes are normally located a minimum of 1.2m from the back of kerb to avoid damage and for health and safety reasons. Telstra also advised that the distribution cabling network is being transitioned to NBN code. Hence where the Telstra services need to be adjusted, there is a two-stage process to be followed. Telstra is to be contacted to shift the pipe network and NBN is to be engaged separately to adjust their cabling.
NBN	Email	Responded that NBN assets are contained within Telstra pits.
ATCO Gas	Meeting	No comments.
Optus	Online enquiry	No response received

APA Group	Email	APA group utilities advised that they might not be within the scope of the road upgrade and they would be happy to review concept drawings.
DBNGP (Dampier to Bunbury Natural Gas Pipeline)	Email	DBNGP responded that inquiries were to go through the Department of Planning, Land and Heritage and they would be happy to review any draft concept plans where there is interaction with the DBNGP.
Vocus Group	Meeting	Vocus advised that their primary customers are the businesses in the area and Vocus services are generally located 0.6m-1.3m from the property boundary.
Department of Fire and Emergency Services (DFES)	Email	No response received
Forrestfield Police (local police)	Email	No response received

9 Risk Management

Table 9-1 Identified Risk and mitigation

Identified Risk	Mitigation of Risk
Potentially PTA will not accept the removal of existing bus stops and relocation thereof	Further consultation with PTA during the planning and detailed design stages for the upgrading of Kalamunda Road between Abernethy Road and Roe Highway
Land expropriation may be required in the vicinity of Kalamunda Road/Stirling Crescent and Kalamunda Road/Wittenoom Road intersections	The City of Kalamunda to ensure that the necessary land and truncations required for the development of the proposed concept plan are ceded, where possible, through the planning and development application process.
Planning of future road network (proposed closure of Stirling Crescent and extension of Adelaide Road)	City of Kalamunda to engage with Main Roads WA, City of Swan and Department of Planning, Land and Heritage with regard to anticipated future development in the area and the planning of proposed network changes and timing thereof.
Relocation of Utilities	Relevant service providers of utilities are to be consulted early during future planning, detail design and construction stages to mitigate against impact of relocation of respective services.
Possibility of installing underground Western Power services	Consult with Western Power early during future planning and detail design stages of this road. Recommend requesting Western Power to undertake a feasibility study for the installation of underground services during the future planning and detail design stages.

10 Conclusions and Recommendations

Cardno has developed a Concept Plan for Kalamunda Road between Abernethy Road and Roe Highway. This included undertaking the relevant traffic modelling and analysis for the proposed intersection treatments, preparation of high-level cost estimate and Forward Works Plan as well as documenting the stakeholder consultation process and outcomes.

The following is concluded:

- The cross section for the concept design for a Low Capacity functional road for this section of Kalamunda Road (determined and supported through an extensive stakeholder consultation process undertaken during Stage 1 of this project and endorsed by the City of Kalamunda) typically comprises a 3.5-metre-wide lane, a 2-metre-wide bike lane, a 2-metre-wide pedestrian foot path on either side of the road and a 4-metre-wide median separator. The cross section varies throughout this section of Kalamunda Road. The proposed cross section and current traffic volumes are characteristic of an Integrator B road according to the Draft Liveable Neighbourhoods 2015 and hence the concept design was designed to cap traffic flows at 15000vpd for this section of Kalamunda Road.
- The concept design proposes three new roundabout controlled intersections at the following intersections:
  - Kalamunda Road/Stirling Crescent;
  - Kalamunda Road/Cyril Road; and
  - Kalamunda Road/ Hawkevale Road/Range Court.

  In addition, it is proposed that Fernan Road is converted to a cul de sac and Rangeview Road be closed at its intersection with Kalamunda Road. Furthermore, a pedestrian signalised crossing in the proximity of Fernan Road is proposed.

  Minor changes have been proposed at Access 2 and Access 3 to the High Wycombe Shopping Centre. The central island is proposed to be extended to prevent right turning movements on exiting the shopping centre (as currently experienced at these locations). It is proposed that the central island be extended approximately 2m at Access 2. To accommodate the bicycle lane on the southern side of Kalamunda Road the central island located at Access 3 is proposed to be relocated slightly north and extended by approximately 2.3m (compared to the existing island) to prevent right turning movements on exiting the shopping centre.
- It is proposed that a bus embayment be provided on the westbound carriageway opposite the High Wycombe Shopping Centre. In the eastbound direction the bus stop will be located adjacent to the left turn pocket as per the existing situation. All bus embayments along this section of road, except for the one located west of Cyril Road (westbound direction), are proposed to be removed and buses are proposed to stop in the roadway. It is recommended that the proposed bus embayment to the west of Cyril Road (westbound direction) be retained in order to reduce the potential impact of this bus stop on traffic operations at the Kalamunda Rd/Cyril Road intersection.

  Bus stops are proposed to be located at existing locations along Kalamunda Road between Abernethy Road and Roe Highway, although the bus stops located at Cyril Road (eastbound direction) and Range Court (westbound direction) are required to be relocated due to the new roundabout treatments proposed at the current locations.
- The following utilities and services are anticipated to be relocated between Abernethy Road and Roe Highway:
  - Western Power- Overhead cables run along Kalamunda Road between Abernethy Road and Wittenoom Road. It's anticipated that these overhead cables would be relocated and replaced with underground cables. Similarly, it is anticipated that the existing overhead power poles are to be relocated between Cyril Road and Roe Highway;
  - Watercorp- It is anticipated that modification works to the 250mm diameter cast iron watermain would be required. Similarly, modification works to the 150mm diameter sewer i.e. modifying line and level of the sewer is also required;
  - ATCO Gas- It is anticipated that modification to the 70Kpa low pressure gas main would be required but not for the high-pressure gas main;
  - Telstra;

- Optus; and
- NBN.

> The SIDRA modelling concluded the following:
  - For all the new intersection controls evaluated (both traffic signal and roundabout controlled), the roundabout controlled intersections provided better overall performance results. All the proposed roundabout control intersections operated at LOS A for 2031 and 2041 design years. The analysis indicated that converting these intersections to a traffic signal control would result in intersections operating between LOS B and LOS D.
  - Intersection performance is generally worse in the PM peak hour except for the Kalamunda Rd-Wittenoom Road intersection.
  - The analysis shows that the Kalamunda Road/Stirling Crescent and Kalamunda Road/Newburn Road/Chipping Drive intersections will experience the highest delays, longest queues, and highest degrees of saturation of all the intersections along this corridor.

> Land expropriation may be required in the vicinity of Kalamunda Road/Stirling Crescent and Kalamunda Road/Wittenoom Road intersections. The City of Kalamunda to ensure that the necessary land and truncations required for the development of the proposed concept plan are ceded, where possible, through the planning and development application process.

> A key risk is the possibility of installing underground Western Power services between Abernethy Road and Wittenoom Road intersection with Kalamunda Road. It is recommended that the City of Kalamunda request for Western Power to undertake a feasibility study in this regard during the future planning and detail design stages.

> A review of the existing vehicle usage data has identified that Section 3 (Cyril Road to Roe Highway) has already reached the restricted demand of 15,000 vpd to accomplish the proposed function of this section of Kalamunda Road. Main Roads WA strategic projects has identified that the Roe Highway/Kalamunda Road grade separated interchange is expected to be upgraded by early 2021 Hence, Section 3 (Cyril Road to Roe Highway) of the proposed concept design will need to be upgraded by the end of 2022.

> Section 1 Kalamunda Road upgrade works will be driven primarily by the development of Lot 200. At present there is no current structure /development plans in place for the development of this lot. Vehicle demand on Section 1A (between Abernethy Road and Stirling Crescent) is expected to increase to about 15,900vpd by 2031 and Section 2A (between Wittenoom Road and Newburn Road/Chipping Drive) to 14,600 vpd by 2041. Therefore, it is envisaged that the upgrade of these sections will be undertaken in individual stages.

> Current vehicle demand for Section 2A (Wittenoom Rd to Newburn Rd/Chipping Drive) ranges between 8,500vpd and 13,000 vpd. Demand forecast has revealed that the traffic for this section is expected to increase to between 9,600vpd and 14,600 vpd beyond 2041. Similarly, current vehicle demand for Section 2B (Newburn Rd/Chipping Drive to Cyril Rd) is around 14,500 vpd. Demand forecasts have revealed that the traffic for this section is expected to increase to over 20,600 vpd beyond 2031. It is recommended that the City of Kalamunda consider upgrading Section 2B (Newburn Rd/Chipping Drive to Cyril Rd) at approximately the same time as Section 3 (Cyril Road to Roe Highway) for ease of constructability, traffic management and reducing inconvenience to the local communities.

> Based on present and future demand forecasts there is no requirement to upgrade Section 2A (Wittenoom Rd to Newburn Rd/Chipping Drive) by 2041. However, pedestrian facilities to the existing shopping centre is limited and there is a desire from the local community for the provision of a new pedestrian crossing to improve connectivity and safety. Cardno recommends closing off Fernan Road and installing a new signalised pedestrian crossing across Kalamunda Road. Fernan Road will need to be converted into a cul de sac to enable the construction of this signalised pedestrian crossing. It is envisaged that these works and improvements to the shopping centre access can be undertaken independently within the next few years even though the upgrade of Section 2A (Wittenoom Rd to Newburn Rd/Chipping Drive) is only required beyond 2041.

APPENDIX A

EXISTING & FUTURE UTILITIES

Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Level 9, The Forum, 203 Pacific Highway
St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

City of Kalamunda
Communications
NBN
Telstra
Optus

Datum	Date	Scale	Size
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Drawing Number: C 1-2
Revision: A

Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Level 9, The Forum, 203 Pacific Highway
St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

City of Kalamunda
Communications
NBN
Telstra
Optus

Datum	Date	Scale	Size
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Revision: A

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Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
Level 9, The Forum, 203 Pacific Highway
St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

City of Kalamunda
Gas
ATCO
70kPa
1900kPa

Datum	Date	Scale	Size
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Drawing Number: G 1-2
Revision: A

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Level 9, The Forum, 203 Pacific Highway
St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

City of Kalamunda
Gas
ATCO
70kPa
1900kPa

Datum	Date	Scale	Size
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Revision: A

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St. Leonards, NSW 2065
Tel: 02 9496 7700 Fax: 02 9439 5170
Web: www.cardno.com.au

City of Kalamunda
Western Power
HVLV
Overhead

Datum	Date	Scale	Size
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Drawing Number: WP 1-2
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Cardno

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Web: www.cardno.com.au

City of Kalamunda
Western Power
HVLV
Overhead

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Cardno (NSW/ACT) Pty Ltd | ABN 95 001 145 035
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Web: www.cardno.com.au

City of Kalamunda
Water Corp
Water Mains
Sewer

Datum	Date	Scale	Size
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Drawing Number: WC 1-2
Revision: A

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City of Kalamunda
Water Corp
Water Mains
Sewer

Datum	Date	Scale	Size
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Drawing Number	Revision
WC 2-2	A

APPENDIX B

TRAFFIC SIGNAL PHASE SEQUENCE

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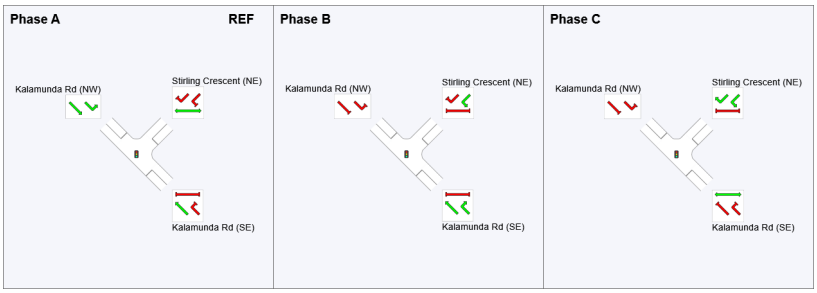

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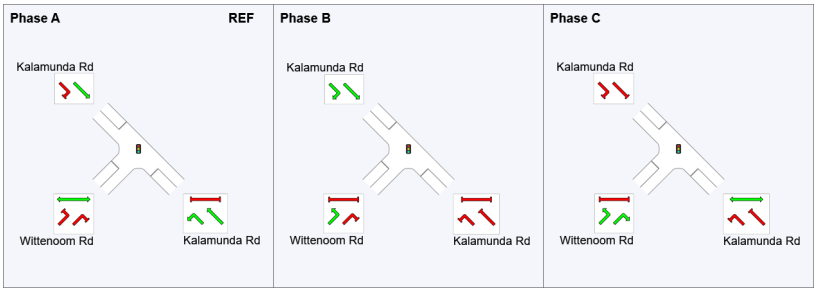

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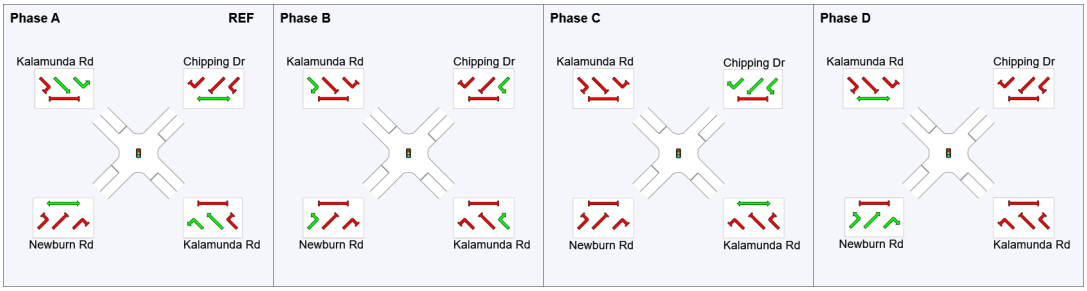

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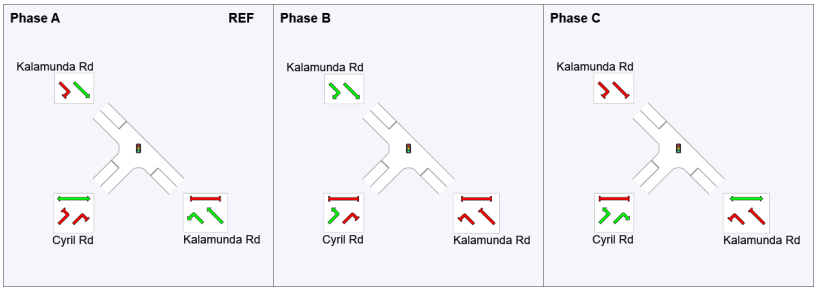
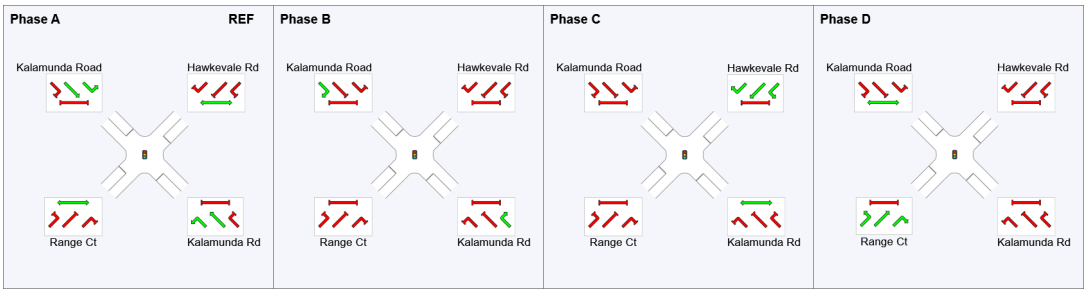


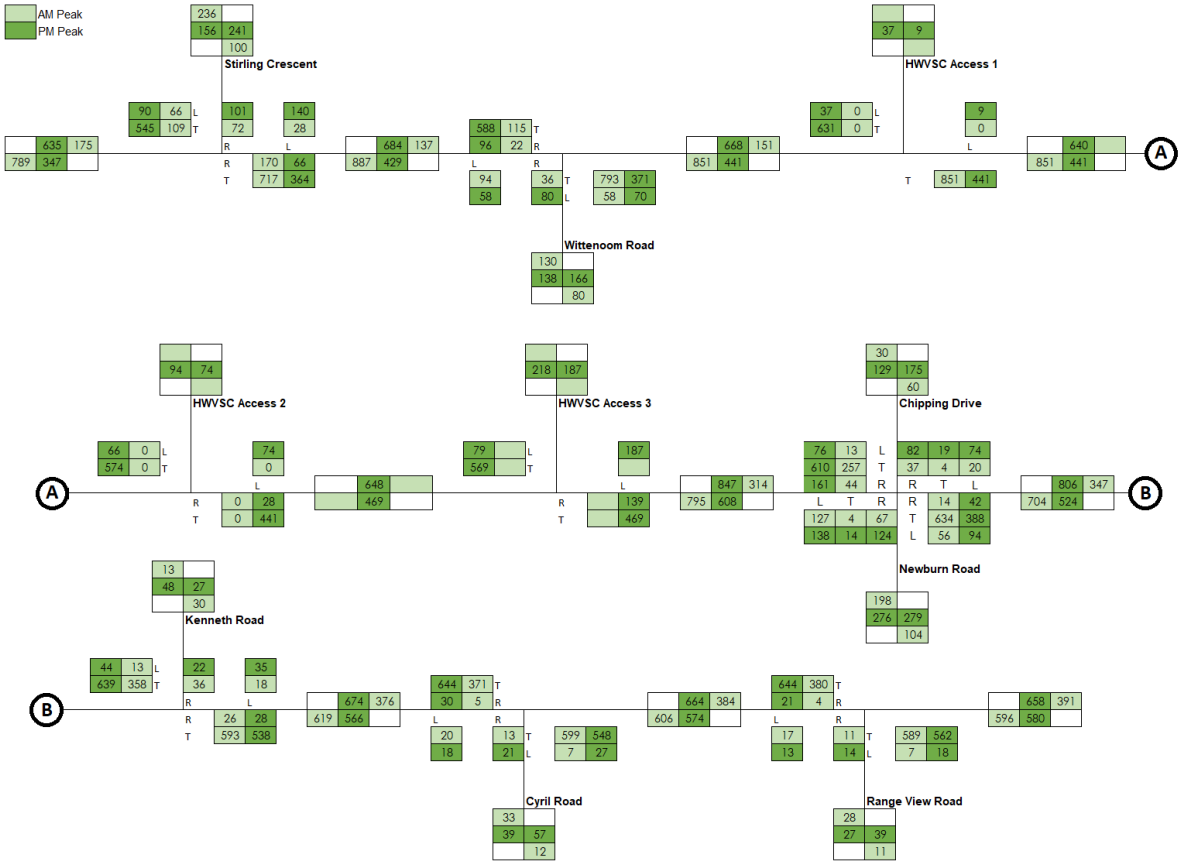
Kalamunda Rd - Hawkevale Rd



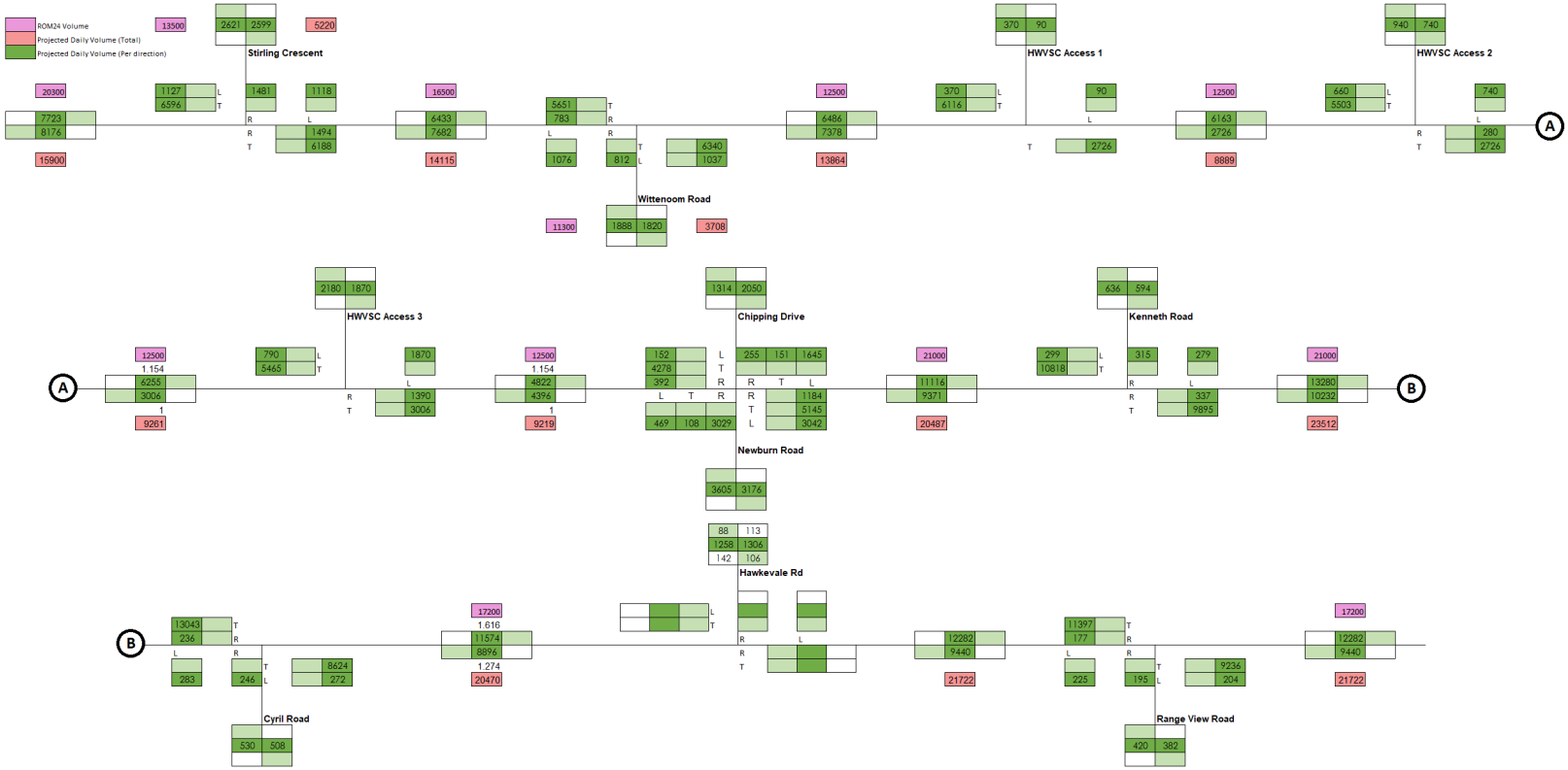
APPENDIX C

TURNING TRAFFIC VOLUMES

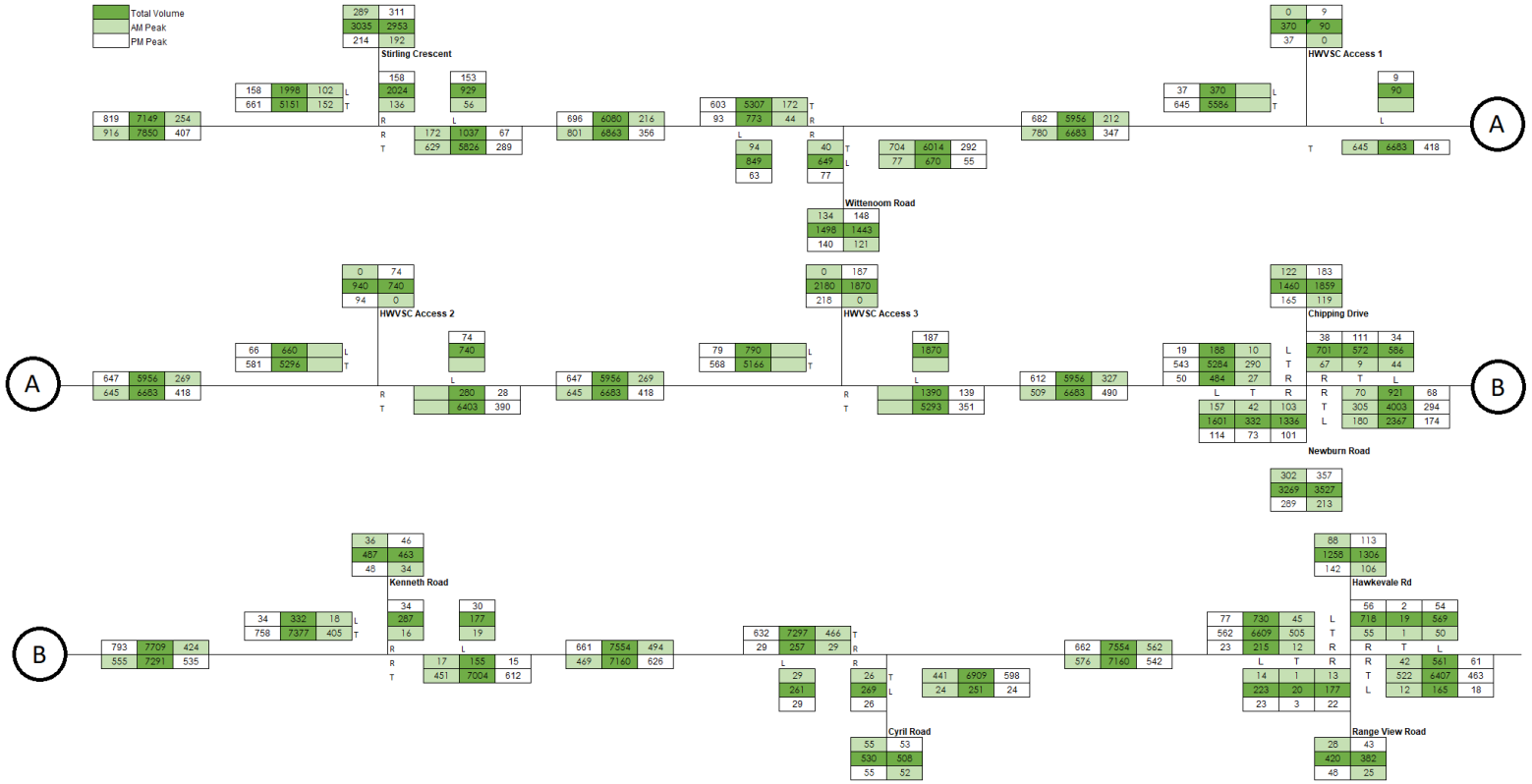
2019 Base Scenario (Scenario 1: Base Scenario)



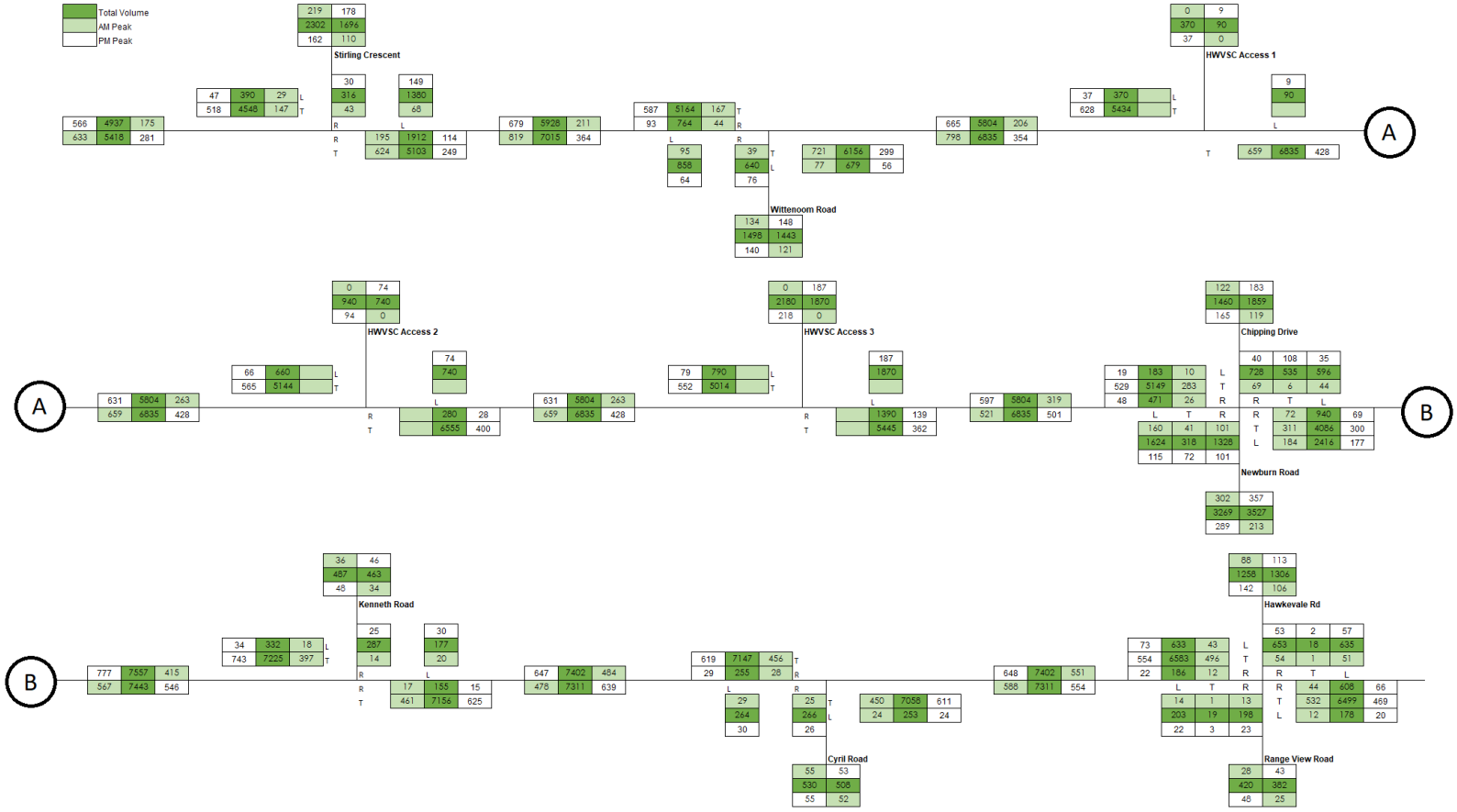
2031 Turning Traffic without Volume Restriction



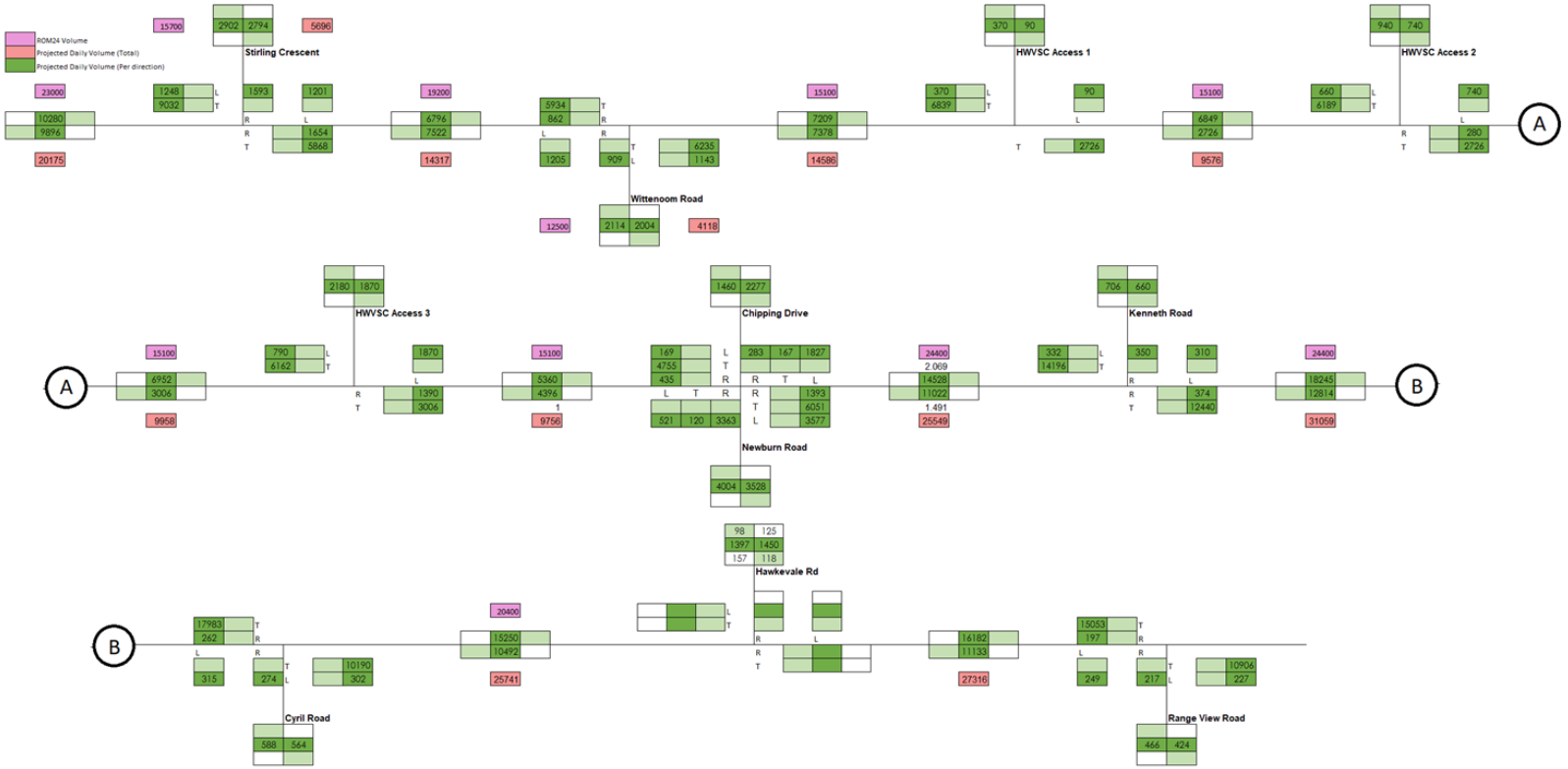
2031 Turning Traffic with Volume Restriction (Scenario 2: without cul-de-sac on Stirling Crescent)



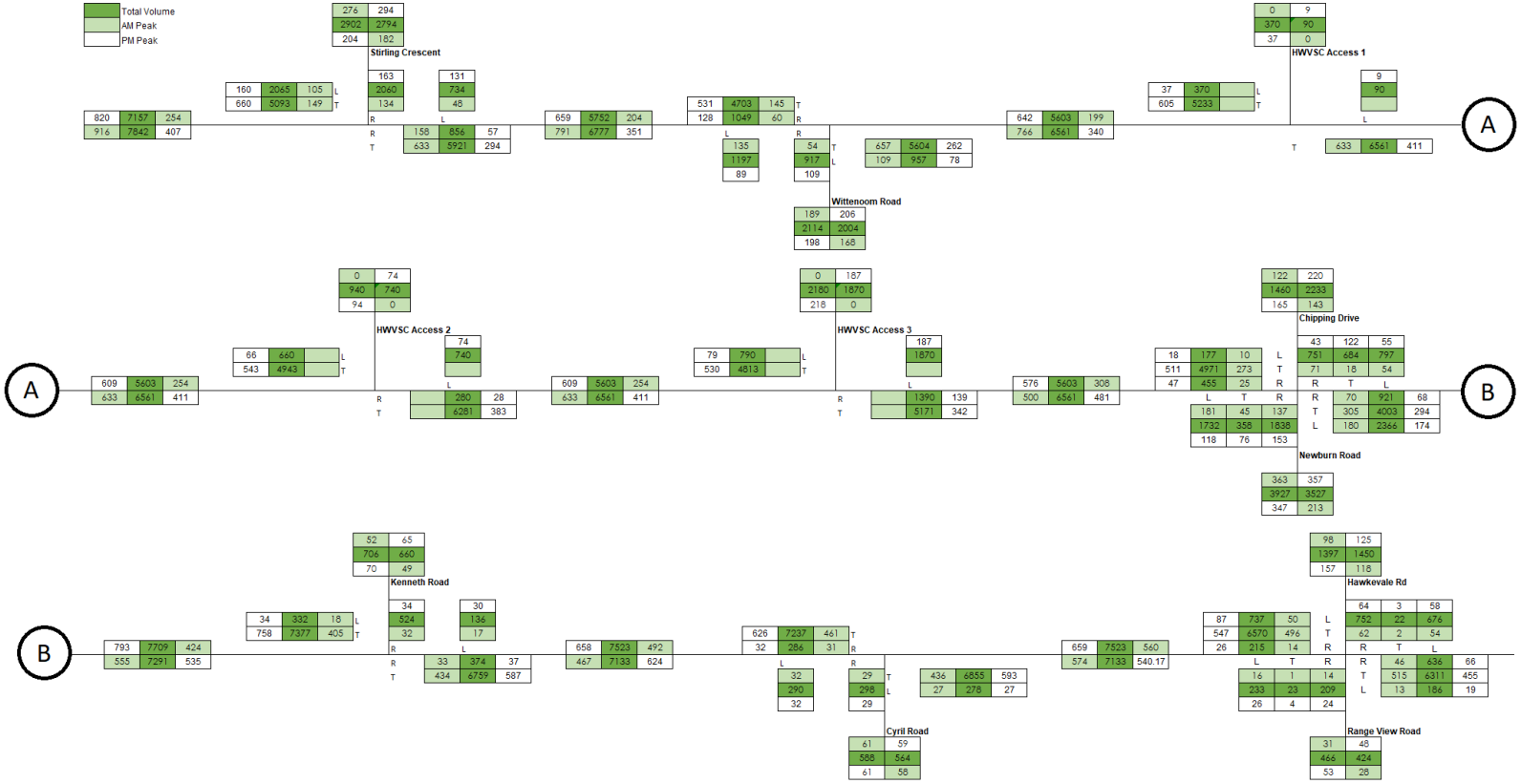
2031 Turning Traffic with Volume Restriction (Scenario 3: with cul-de-sac on Stirling Crescent)



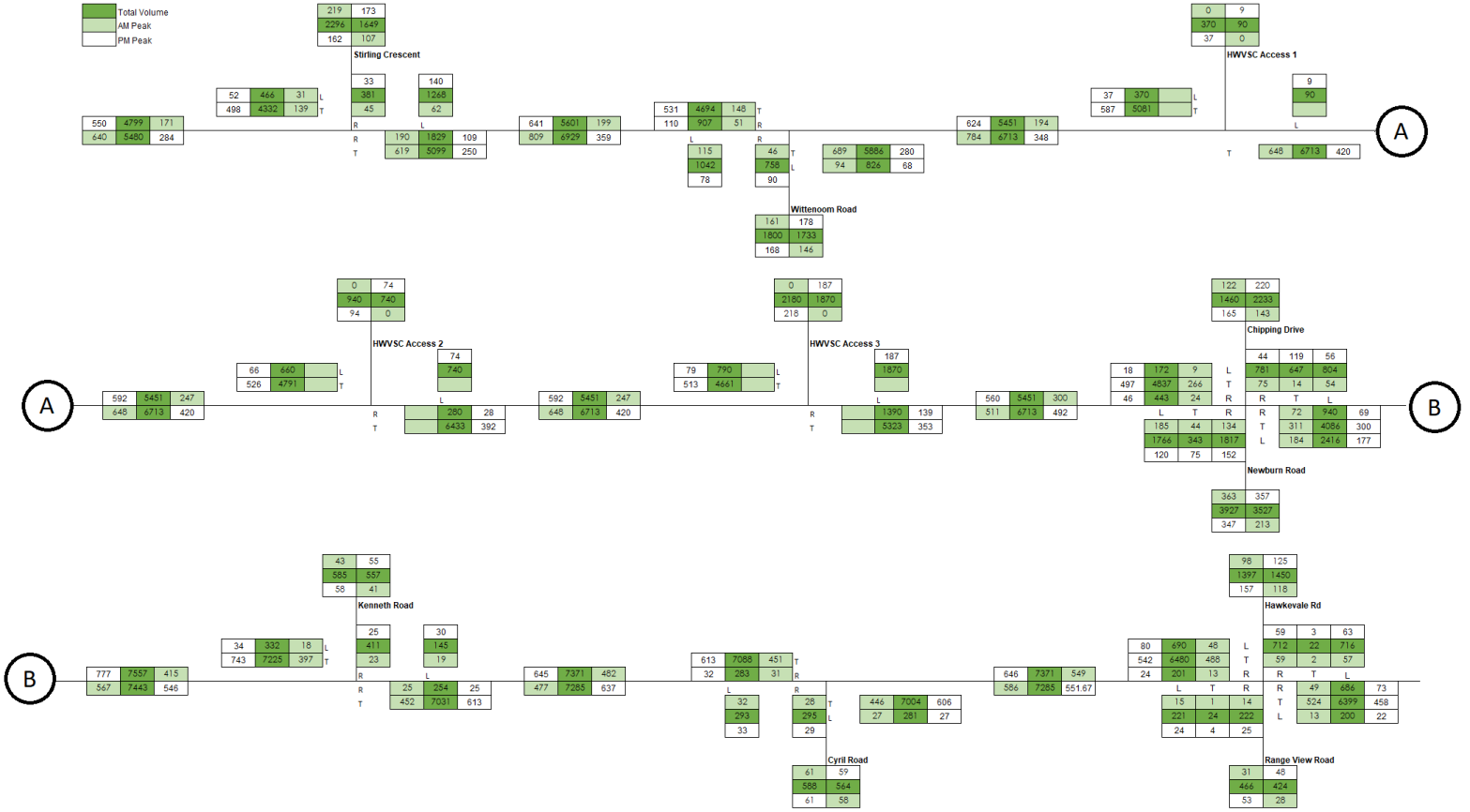
2041 Turning Traffic without Volume Restriction



2041 Turning Traffic with Volume Restriction (Scenario 4: without cul-de-sac on Stirling Crescent)



2041 Turning Traffic with Volume Restriction (Scenario 5: with cul-de-sac on Stirling Crescent)



APPENDIX D

NETWORK MODEL

ROM24 2041 Sub-Area Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1	0	26	101	867	362	1580	0	0	1677	1022	970	1014	1783	208	**9611**	**1**
2	56	0	5	28	189	17	0	0	314	416	23	65	156	121	**1389**	**2**
3	112	6	0	47	117	1121	0	0	425	493	338	289	590	22	**3558**	**3**
4	833	28	43	0	283	0	0	0	1298	241	552	8	1006	218	**4509**	**4**
5	834	212	146	492	0	1605	0	0	119	5525	772	6	6	5922	**15642**	**5**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**6**
7	1774	122	1225	0	1777	0	0	0	45375	0	762	418	317	1043	**52812**	**7**
8	1047	336	396	1044	160	41712	0	0	0	3951	852	8220	47	10599	**68365**	**8**
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**9**
10	661	332	306	21	4474	0	0	0	3543	0	0	1	5342	442	**15122**	**10**
11	1015	45	359	501	686	3	0	0	1061	0	0	395	1504	201	**5771**	**11**
12	936	81	345	46	13	406	0	0	5593	152	662	0	1179	129	**9542**	**12**
13	1982	63	687	1008	14	156	0	0	75	4488	1572	1511	0	0	**11558**	**13**
14	191	232	26	201	5812	1120	0	0	10203	407	213	104	0	0	**18510**	**14**
	9442	**1482**	**3638**	**4255**	**13888**	**47721**	**0**	**0**	**69683**	**16694**	**6717**	**12032**	**11930**	**18907**	**216391**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**		

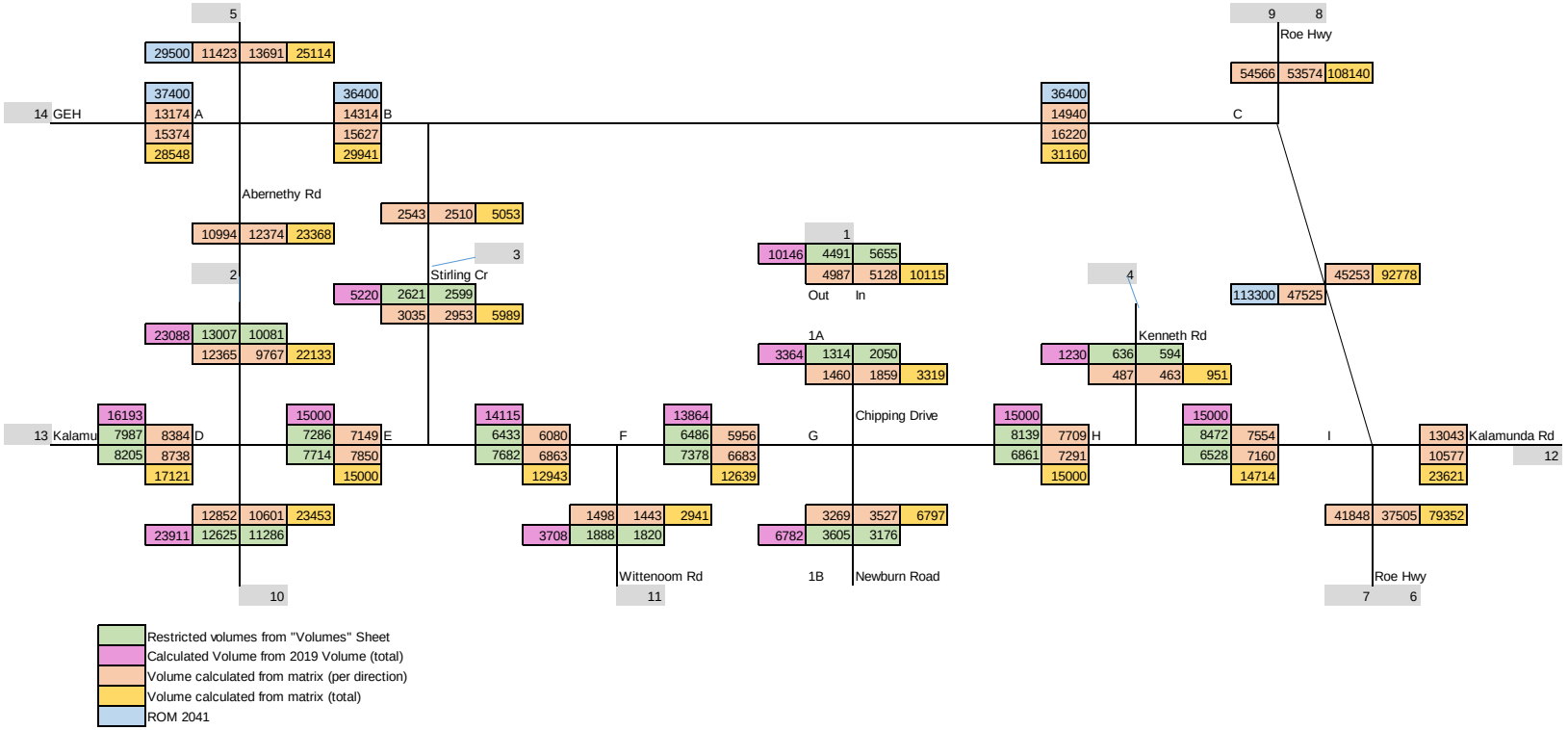
2031 Origin-Destination Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1	0	85	44	57	168	1190	0	0	748	307	117	1531	687	194	**5128**	**1**
2	0	0	5	4	183	120	0	0	304	261	6	2396	125	100	**3504**	**2**
3	49	5	0	7	120	40	0	0	439	330	91	40	505	19	**1645**	**3**
4	49	3	6	0	39	0	0	0	181	22	20	1	116	26	**463**	**4**
5	382	203	148	75	0	1597	0	0	128	3864	216	6	1597	5475	**13691**	**5**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**6**
7	1029	3194	16	0	399	0	0	0	36421	0	159	298	211	120	**41848**	**7**
8	274	294	365	145	157	33450	0	0	0	2518	217	7189	38	8927	**53574**	**8**
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**9**
10	263	277	270	3	4192	0	0	0	3328	0	0	1	4163	356	**12852**	**10**
11	147	14	115	24	233	1	0	0	362	0	0	120	425	59	**1498**	**11**
12	857	3194	40	6	12	294	0	0	4968	87	153	0	869	98	**10577**	**12**
13	872	58	668	147	1597	132	0	0	78	3015	423	1393	0	0	**8384**	**13**
14	60	154	18	21	4323	681	0	0	7609	197	41	69	0	0	**13174**	**14**
	4987	**7482**	**1693**	**487**	**11423**	**37505**	**0**	**0**	**54566**	**10601**	**1443**	**13043**	**8738**	**15374**	**167342**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**		

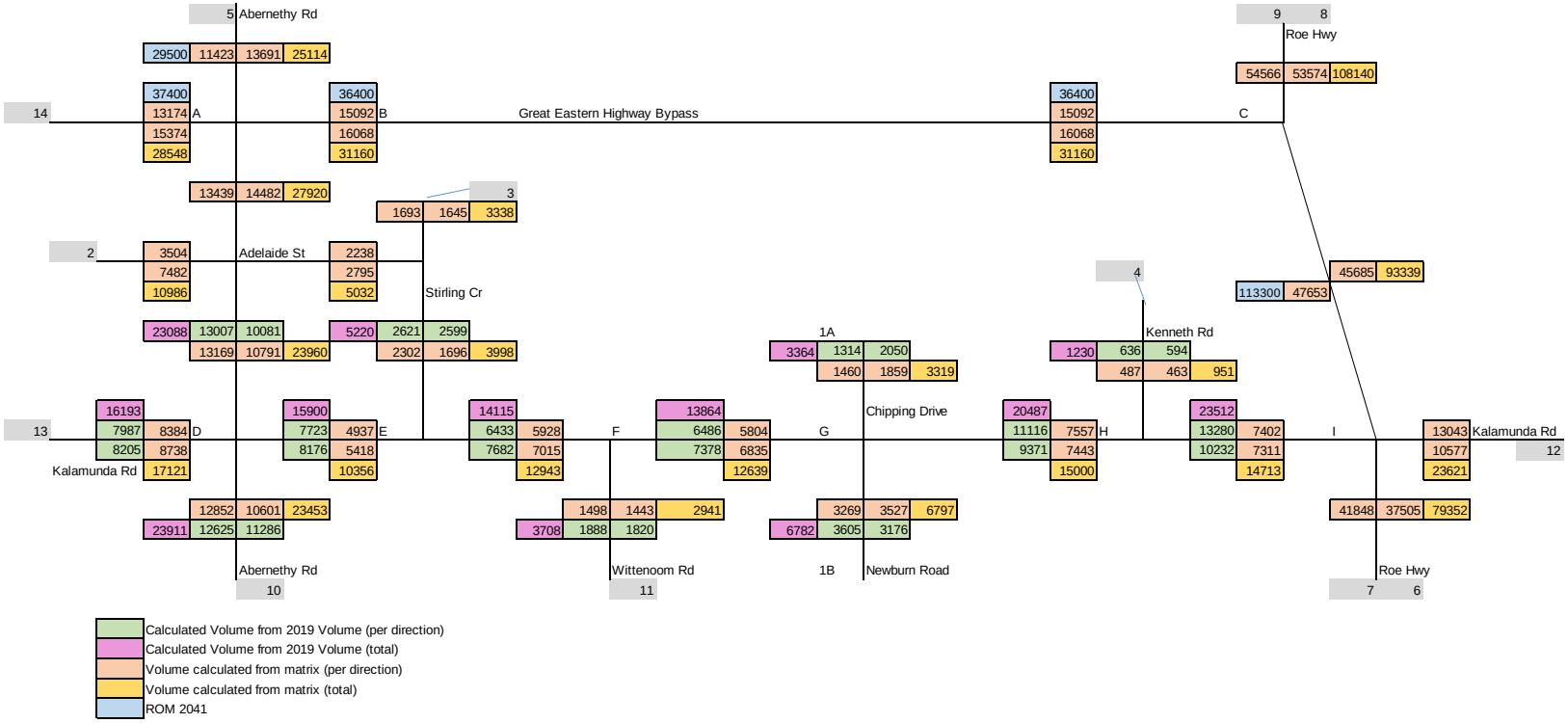
2041 Origin-Destination Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
1	0	102	53	68	201	1430	0	0	899	369	140	1838	825	233	**6160**	**1**
2	0	0	5	5	219	144	0	0	366	314	7	2878	151	121	**4209**	**2**
3	59	7	0	8	145	48	0	0	527	396	109	48	607	23	**1976**	**3**
4	59	4	7	0	47	0	0	0	217	26	24	1	140	31	**557**	**4**
5	459	244	177	90	0	1918	0	0	154	4641	260	7	1918	6576	**16445**	**5**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**6**
7	1236	3837	19	0	480	0	0	0	43747	0	191	358	254	144	**50265**	**7**
8	330	353	439	174	189	40178	0	0	0	3024	261	8635	46	10723	**64350**	**8**
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**9**
10	316	333	324	3	5035	0	0	0	3998	0	0	1	5001	427	**15437**	**10**
11	176	16	138	29	280	1	0	0	434	0	0	144	511	70	**1800**	**11**
12	1030	3837	48	7	14	353	0	0	5967	105	183	0	1044	118	**12705**	**12**
13	1047	70	802	177	1918	158	0	0	93	3622	508	1674	0	0	**10070**	**13**
14	73	185	22	25	5193	818	0	0	9140	236	50	83	0	0	**15824**	**14**
	4987	**8987**	**2034**	**585**	**13721**	**45049**	**0**	**0**	**65542**	**12733**	**1733**	**15667**	**10495**	**18467**	**200000**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**		

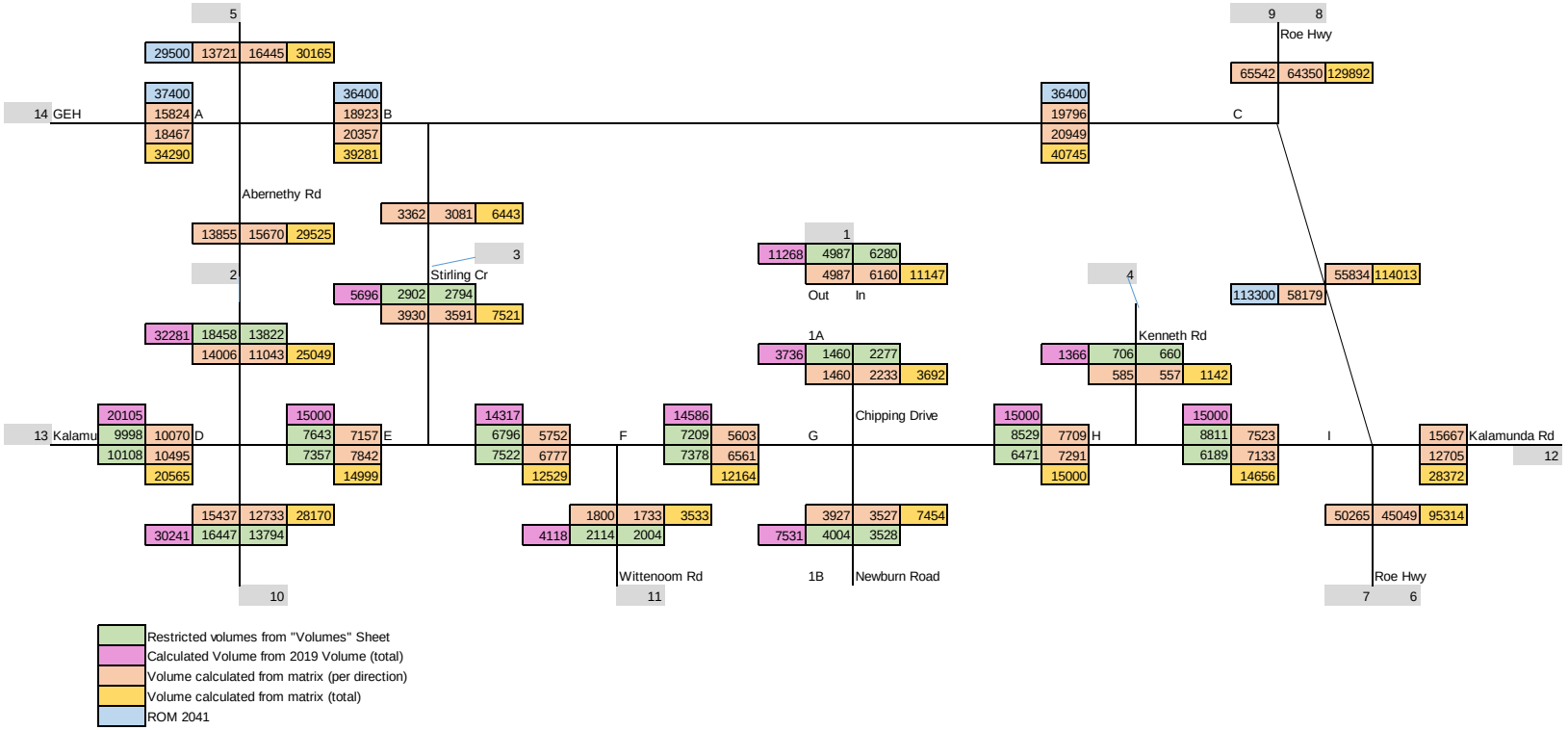
Scenario 2 (2031, without cul-de-sac on Stirling Crescent) Network Volumes



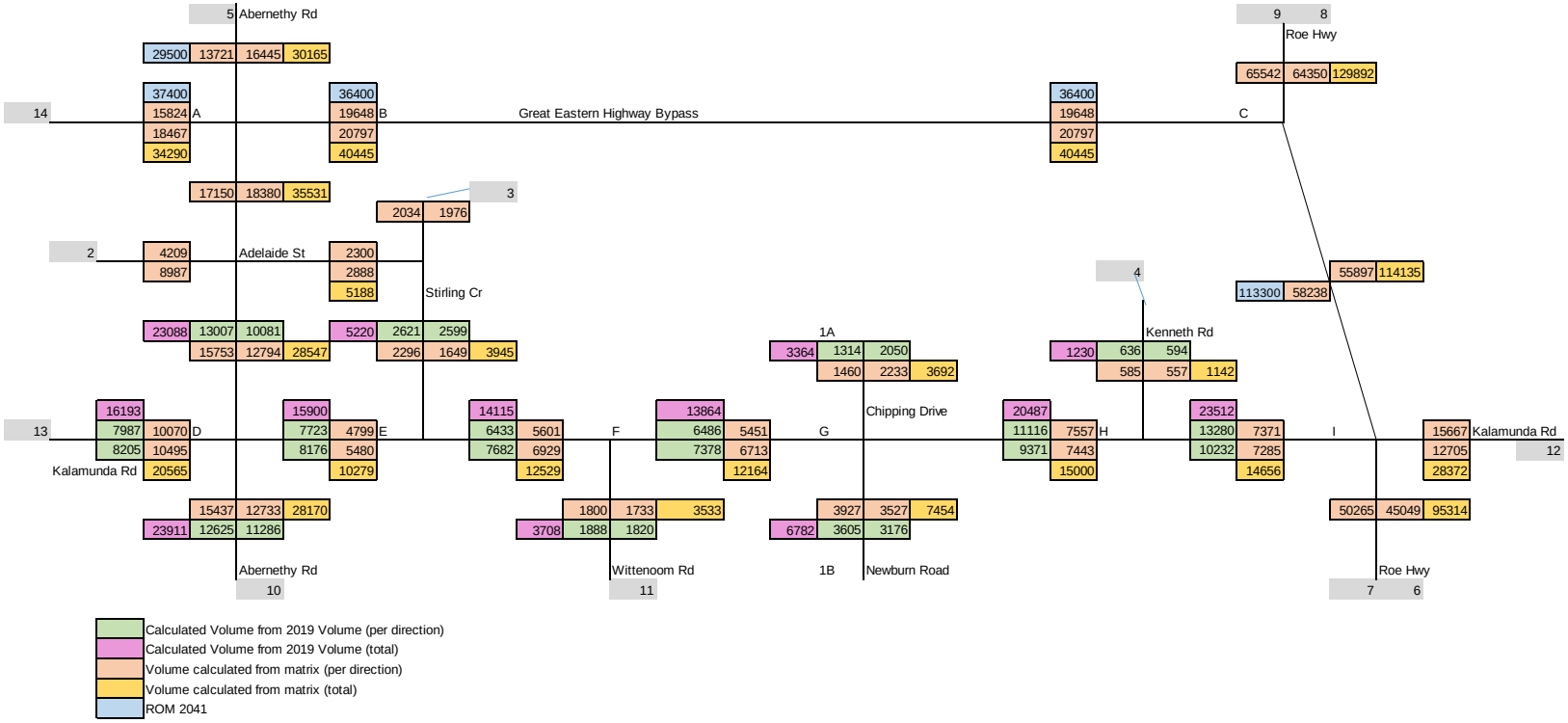
Scenario 3 (2031, with cul-de-sac on Stirling Crescent) Network Volumes



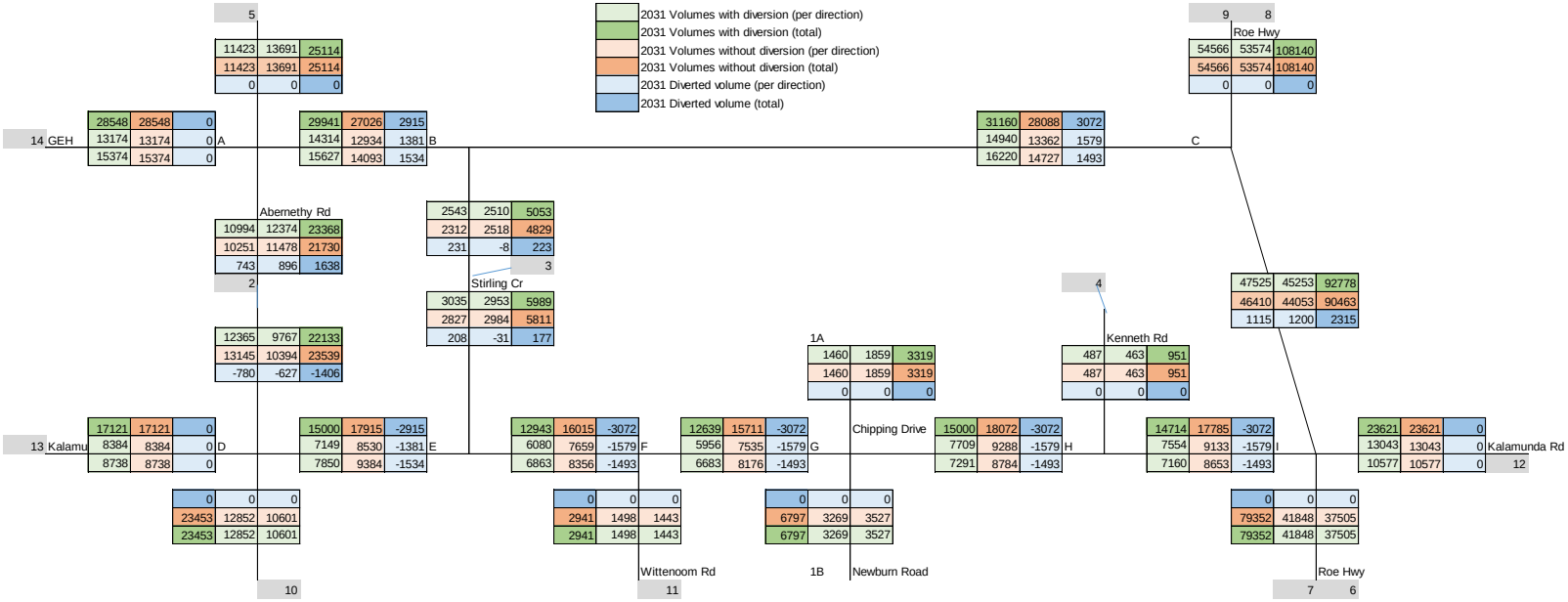
Scenario 4 (2041, without cul-de-sac on Stirling Crescent) Network Volumes



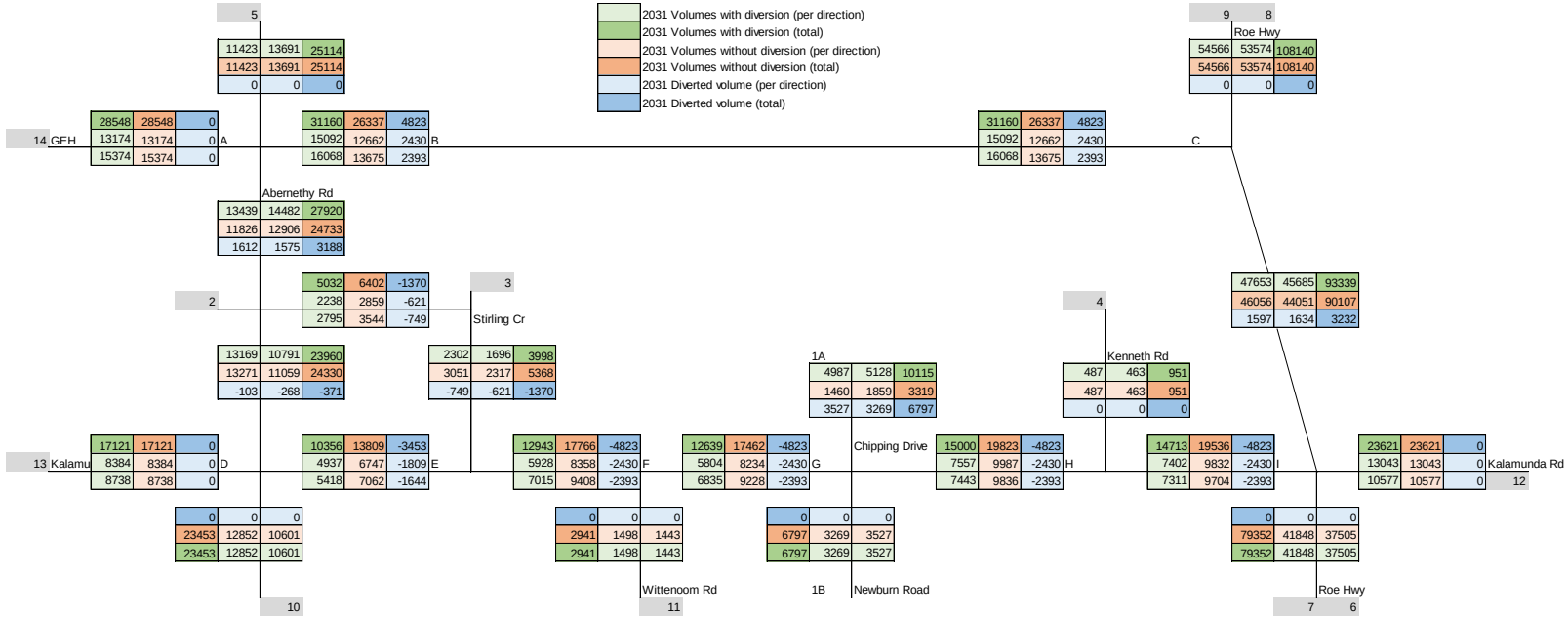
Scenario 5 (2041, with cul-de-sac on Stirling Crescent) Network Volumes



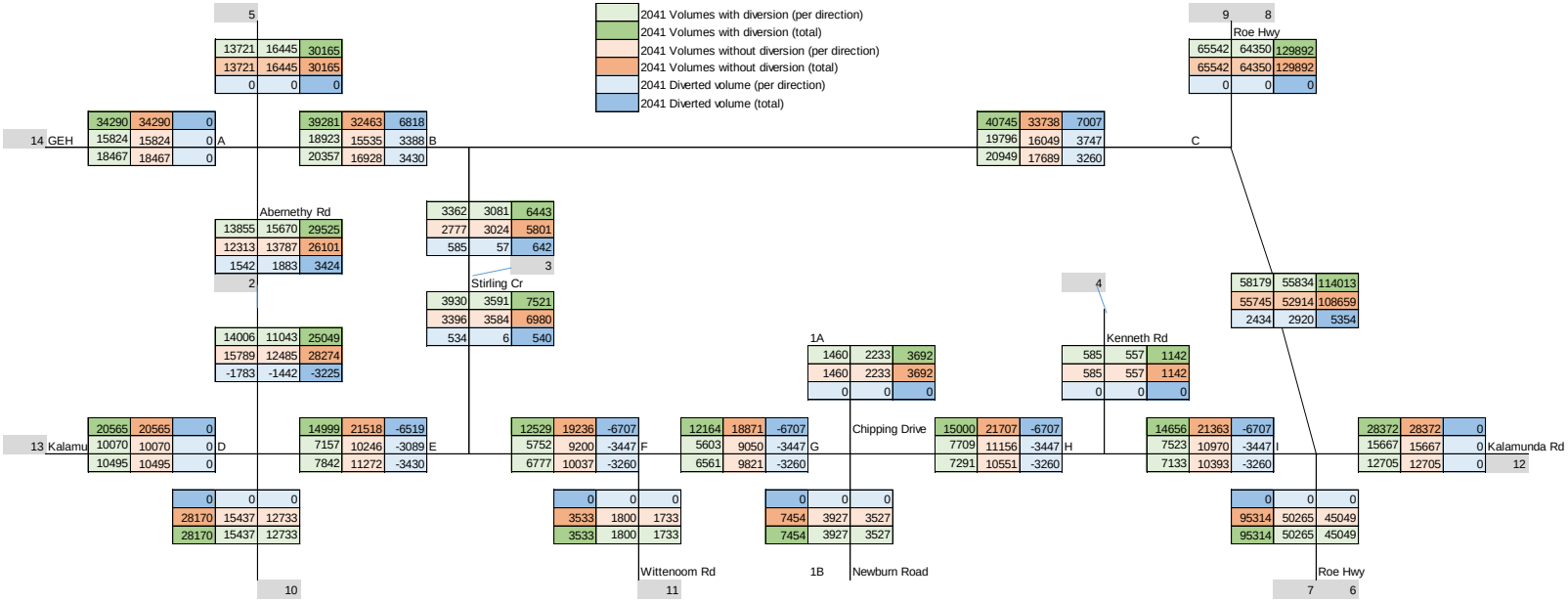
Scenario 2 (2031, without cul-de-sac on Stirling Crescent) Diverted Volumes



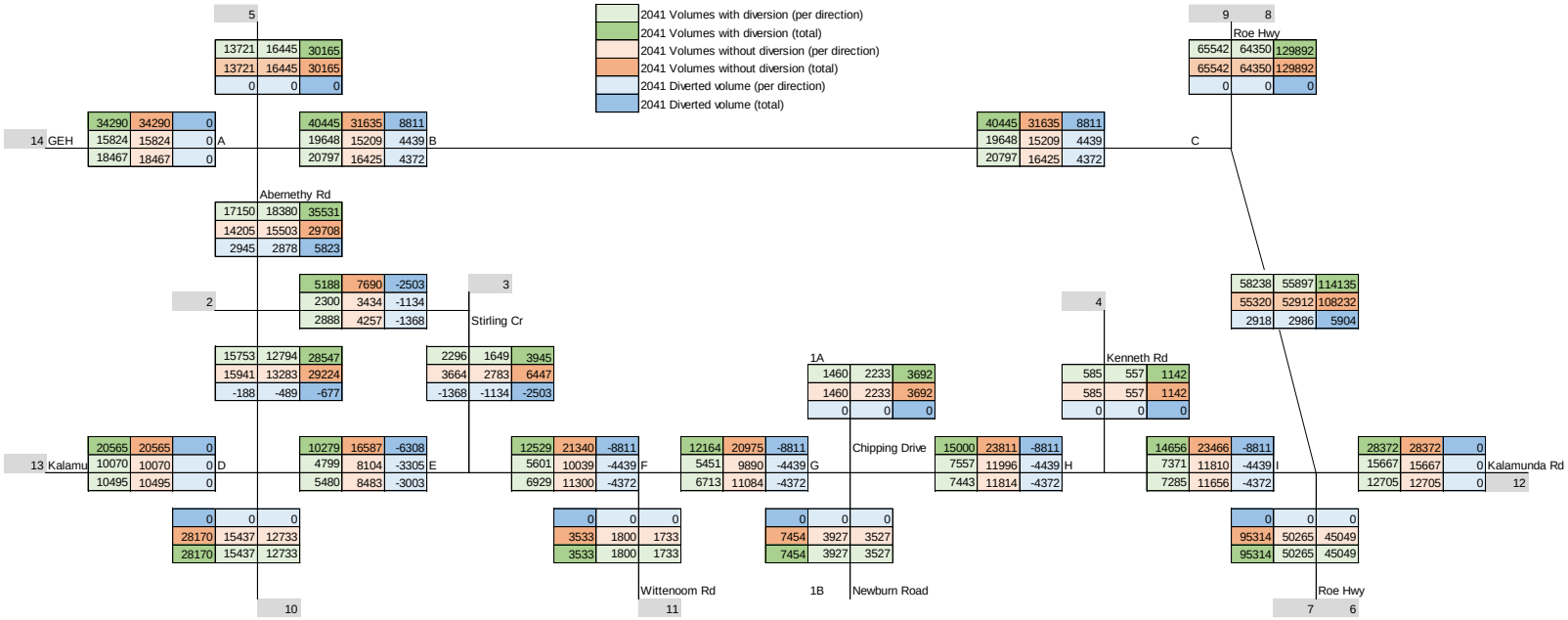
Scenario 3 (2031, with cul-de-sac on Stirling Crescent) Diverted Volumes



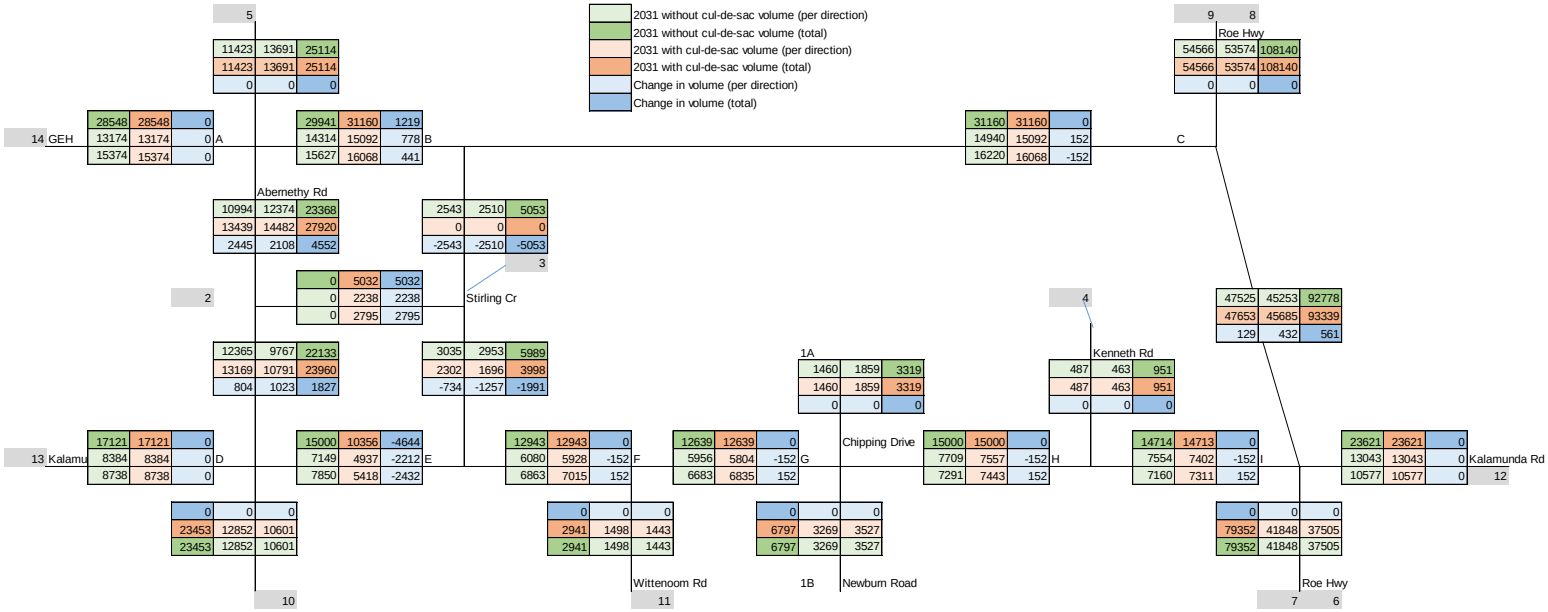
Scenario 4 (2041, without cul-de-sac on Stirling Crescent) Diverted Volumes



Scenario 5 (2041, with cul-de-sac on Stirling Crescent) Diverted Volumes



Midblock volumes with and without cul-de-sac on Stirling Crescent (2031)



Midblock volumes with and without cul-de-sac on Stirling Crescent (2041)