



Engineering a better future for over 20 years!

East Wanneroo Precinct 3 Local Structure Plan Transport Impact Assessment

PREPARED FOR:
Satterley

March 2025

Document history and status

Author	Revision	Approved by	Date approved	Revision type
R White	r01	B Bordbar	31/03/2025	

File name: t22280-rw-r01.docx

Author: Robin White

Project manager: Behnam Bordbar

Client: Satterley

Project: East Wanneroo Precinct 3 Local Structure Plan

Document revision: r01

Project number: t22.280

2025 Copyright in all drawings, reports, specifications, calculations and other documents provided by the Consultant in connection with the Project shall remain the property of the Consultant.

The Client alone shall have a license to use the documents referred to above for the purpose of completing the Project, but the Client shall not use, or make copies of, such documents in connection with any work not included in the Project, unless written approval is obtained from the Consultant or otherwise agreed through a separate contract.

TABLE OF CONTENTS

1	INTRODUCTION	1
2	PROPOSED LOCAL STRUCTURE PLAN	3
3	EXISTING SITUATION	5
3.1	EXISTING LAND USE.....	5
3.2	EXISTING ROAD NETWORK.....	6
3.3	EXISTING TRAFFIC VOLUMES.....	8
3.4	HEAVY VEHICLE ROUTES	8
3.5	PUBLIC TRANSPORT	10
3.6	PEDESTRIAN AND CYCLIST FACILITIES	11
3.7	CHANGES TO SURROUNDING TRANSPORT NETWORK	13
4	PROPOSED TRANSPORT NETWORK.....	15
4.1	ROAD HIERARCHY	15
4.2	PUBLIC TRANSPORT	17
4.3	PEDESTRIAN AND CYCLIST FACILITIES	17
5	INTEGRATION WITH SURROUNDING AREA.....	19
6	ANALYSIS OF THE TRANSPORT NETWORK.....	20
6.1	ASSESSMENT PERIOD	20
6.2	TRAFFIC GENERATION AND DISTRIBUTION	20
6.3	TRAFFIC FLOW FORECASTS	21
6.4	ROADS AND INTERSECTIONS	23
6.5	INTERSECTION ANALYSIS.....	25
6.6	ACCESS TO FRONTAGE PROPERTIES	26
6.7	PEDESTRIAN / CYCLE NETWORKS	26
6.8	ACCESS TO PUBLIC TRANSPORT	28
7	CONCLUSIONS	29
APPENDIX A:	LOCAL STRUCTURE PLAN	
APPENDIX B:	TYPICAL ROAD CROSS-SECTIONS	
APPENDIX C:	SIDRA INTERSECTION ANALYSIS	

REPORT FIGURES

Figure 1: Site location on East Wanneroo District Structure Plan	2
Figure 2: Local Structure Plan	3
Figure 3: Existing Land Use	5
Figure 4: Existing road hierarchy	6
Figure 5: Restricted Access Vehicles Network	9
Figure 6: Existing bus routes 467 and 468	10
Figure 7: Existing bicycle facilities	11
Figure 8: Long Term Cycle Network	12
Figure 9: East Wanneroo DSP movement network	14
Figure 10: Proposed road hierarchy	15
Figure 11: Pedestrian / Cycle Network	18
Figure 12: Future total daily traffic flows	22
Figure 13: Key intersections	24

REPORT TABLES

Table 1: Proposed land uses	4
Table 2: Existing Traffic Volumes	8

1 Introduction

This Transport Impact Assessment has been prepared by Transcore on behalf of Satterley with regard to the Local Structure Plan (LSP) for East Wanneroo Precinct 3 in the City of Wanneroo.

The subject site is located approximately 2.5 kilometres southeast of the Wanneroo town centre and is bounded by Lenore Road to the west and Benmuni Road to the east, with Elliot Road and Nicholas Road running east west within the subject site.

The subject site is Precinct 3 of the *East Wanneroo District Structure Plan* (DSP), as shown in **Figure 1**.

This report assesses the traffic flows that will be generated by the land uses proposed in the LSP and the corresponding road network requirements within the LSP area.



2 Proposed Local Structure Plan

The proposed Local Structure Plan (LSP) for East Wanneroo Precinct 3 is included at **Appendix A** and a smaller copy (without legend) is shown in **Figure 2**.

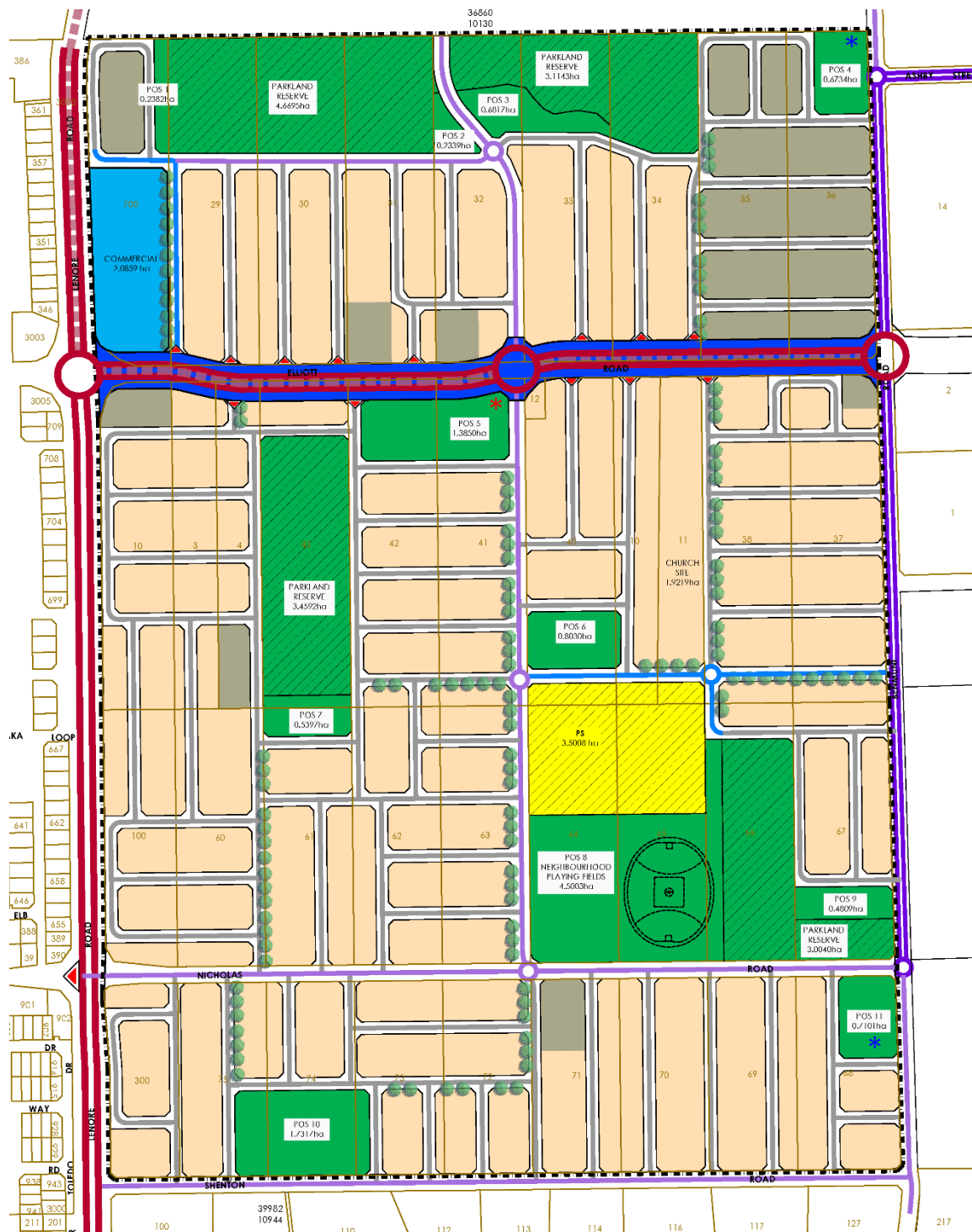


Figure 2: Local Structure Plan

The proposed land uses in the LSP area and anticipated size or quantity for the purpose of this Transport Impact Assessment, are summarised in **Table 1**.

Table 1: Proposed land uses

Land Use	Quantity
Residential	Approx. 1,750 dwellings
Local Centre	7,000m ² NLA
Primary School	540 students

The main arterial road corridors affecting the LSP area are Lenore Road along the western boundary of this precinct and Elliot Road which runs east west across this precinct.

The District Structure Plan indicates a rapid transit route along Elliott Road (east of Lenore Road through this precinct) and on Lenore and Franklin Roads (north of Elliot Road), as shown in blue on **Figure 1**.

The proposed LSP for Precinct 3 proposes a slightly different alignment for the Elliot Road arterial corridor than the DSP. The proposed alignment in the LSP follows more closely to the existing Elliot Road alignment with road widening varying on the north and south sides to minimise impact on existing properties along Elliot Road, as shown in **Figure 2**.

3 Existing Situation

3.1 Existing Land Use

The subject site currently comprises 38 separate lots. Most have a single dwelling and various outbuildings, with the rest of the lot used for various agricultural, horticultural or outdoor storage uses, or still covered by native vegetation, as shown in **Figure 3**.



Figure 3: Existing Land Use

The southern boundary of the LSP area is the unconstructed road reserve of Shenton Road.

Existing land uses to the east of Benmuni Road are similar to the subject site. North and south of the subject site are rural residential subdivisions, and west of Lenore Road is the existing residential suburb of Hocking.

3.2 Existing Road Network

The existing road network and its classification in the Main Roads WA functional road hierarchy is illustrated in **Figure 4**.



Figure 4: Existing road hierarchy

Lenore Road is classified as a District Distributor B south of Elliot Road and a Local Distributor north of Elliot Road in the Main Roads WA functional road hierarchy. The posted speed limit on this section of Lenore Road is 70km/h.

North of Elliot Road, Lenore Road is constructed as a two-lane rural road with partially sealed shoulders, adjacent to the subject site.

South of Elliot Road, Lenore Road has recently been upgraded to dual carriageway standard with two lanes each way separated by an 8m wide median. Both carriageways include an on-road cycle lane.

Elliot Road is classified as an Access Road within the LSP area in the Main Roads WA functional road hierarchy. Within the LSP area it is constructed as a two-lane rural road with sealed width of approximately 7m and unsealed shoulders. It has a posted speed limit of 60km/h within the LSP area.

Nicholas Road is classified as an Access Road within the LSP area in the Main Roads WA functional road hierarchy. It is constructed as a two-lane rural road with sealed width of approximately 6m and unsealed shoulders. It has a posted speed limit of 60km/h within the LSP area.

Benmuni Road is classified as an Access Road in the Main Roads WA functional road hierarchy. It is constructed as a two-lane rural road with sealed width of approximately 6m and unsealed shoulders. It has a posted speed limit of 60km/h south of Nicholas Road and 80km/h north of Nicholas Road.

Shenton Road forms the southern boundary of the LSP area and is currently not constructed. It does not have a classification in the Main Roads WA functional road hierarchy.

The Lenore Rd / Elliot Rd intersection is constructed as a dual lane roundabout.

The Lenore Rd / Nicholas Rd intersection is a 4-way intersection with Give Way sign control on the eastern and western approaches. The Nicholas Road eastern leg has full movements (left and right turns) permitted but the western leg of Nicholas Road is restricted to left in / left out (LILO) only, with a triangular (seagull) traffic island on the western approach.



3.3 Existing Traffic Volumes

No existing traffic counts are available within the LSP area.

Existing traffic counts are available for Lenore Road north of Ocean Reef Road from the Main Roads WA website, as documented in **Table 2**. The 2024 count is from a 24 hour video survey at the Ocean Reef Rd intersection.

For this TIA report it is anticipated that Lenore Road traffic volumes decline progressively as we move further north and would currently be around 15,000vpd at Elliott Road.

Table 2: Existing Traffic Volumes

Road Name	Location	AWT (HV)	AM Peak	PM Peak	Date
Lenore Rd	North of Ocean Reef Rd	23,085 (10.8%)	2,026vph 0730-0830	2,161vph 1545-1645	2020/21
Lenore Rd	North of Ocean Reef Rd	21,417 (5%)	1,776vph 0730-0830	1,965vph 1530-1630	Tues 27 Aug 2024

3.4 Heavy Vehicle Routes

Restricted Access Vehicle (RAV) Network routes are designated for access by large heavy vehicle combinations that require special permits for each trip. Main Roads WA manages the RAV Networks and the permits for trucks to use them. **Figure 5** shows the roads that are permitted for use by Tandem Drive RAV Networks 2 (orange), 3, (light blue) and 4 (dark blue) vehicles in the surrounding area. RAV Networks 2, 3 and 4 permit access by a number of vehicle combinations up to 27.5m long subject to relevant height, width and weight limits.

Lenore Road is currently included in Tandem Drive RAV Network 4 with access south to and from Ocean Reef Road. (This section of Lenore Road is also included in other RAV Networks including Tandem Drive Network 4 Concessional Level 3, Tri Drive Network 1 including Concessional Level 3, PBS Tandem Drive Network 1 Concessional Level 3 and 27.5m Oversize B-Double, which offer other variations on maximum load and vehicle configurations.)



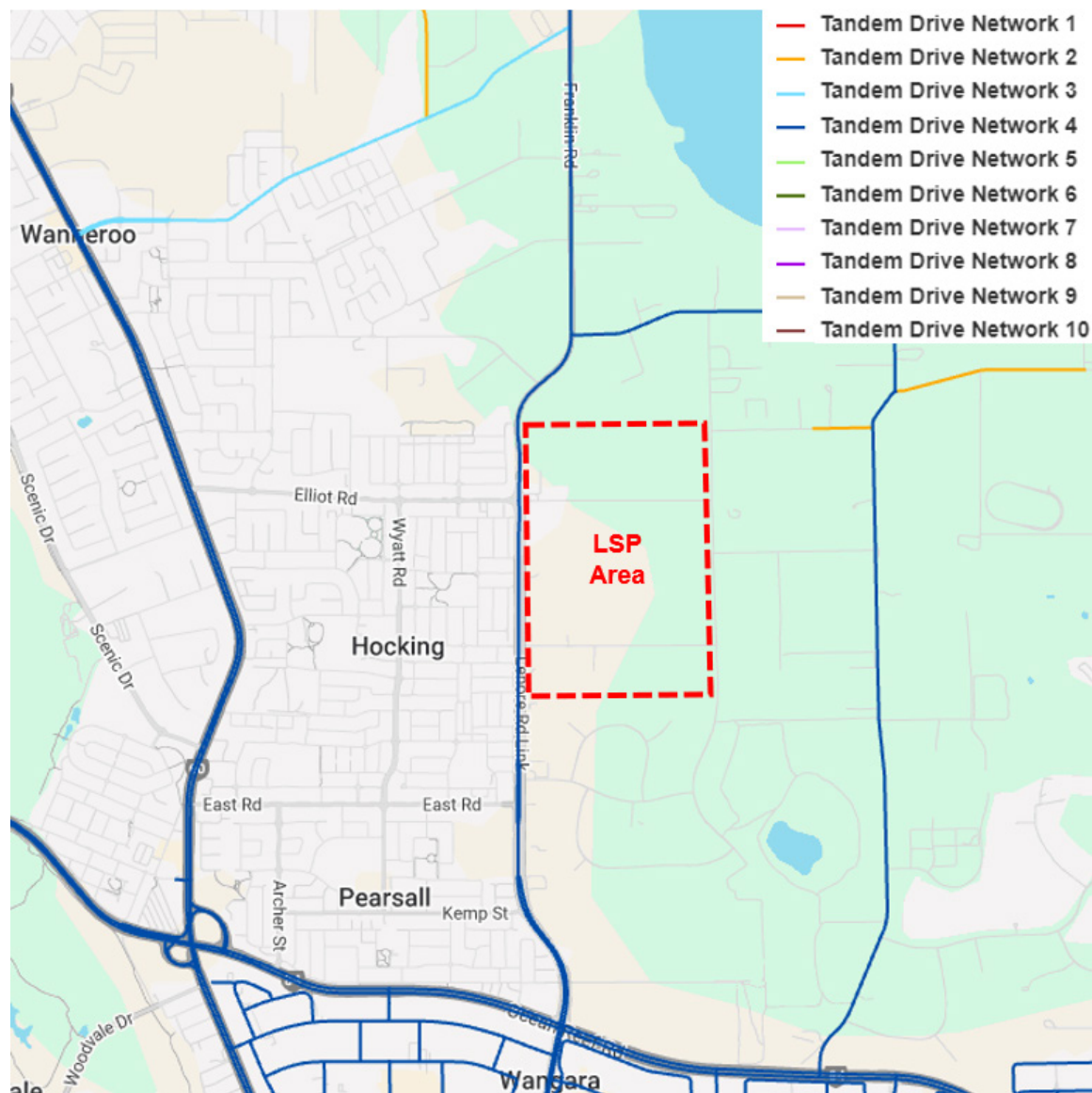


Figure 5: Restricted Access Vehicles Network

The closest existing bus route to the subject site is Route 467: Whitfords Station – Joondalup Station. The closest bus stops for route 467 are approximately 600m west of the LSP area along Wyatt Road.



3.6 Pedestrian and Cyclist Facilities

Existing bicycle facilities in the surrounding area are illustrated on the Perth Bike Maps published by the Department of Transport, as shown in **Figure 7**. That Bike Map dates back to 2016 and does not show existing facilities on Lenore Road, which has on-road bike lanes and a 2.5m shared path on the western side. There are currently no bicycle facilities on Elliot Road, Nicholas Road and Benmuni Road within the LSP area.



Figure 7: Existing bicycle facilities

High-level future planning for cycling facilities is now set out in Western Australia's Long Term Cycle Network (LTCN), which identifies an aspirational blueprint to ensure State and local governments continue to work together towards the delivery of a continuous cycling network providing additional transport options, recreational opportunities and support for tourism and commercial activity. The LTCN identifies the function of a route - primary, secondary or local - rather than the form it should

take. Function considers the type of activities that take place along a route, and the level of demand (existing and potential). A route's built form is based on the characteristics of the environment, including space availability, topography, traffic conditions (speed, volumes), primary users, and so on.

The LTCN in the East Wimmeroo area is illustrated in **Figure 8**, which shows future primary routes (red), secondary routes (blue) and local routes (green).

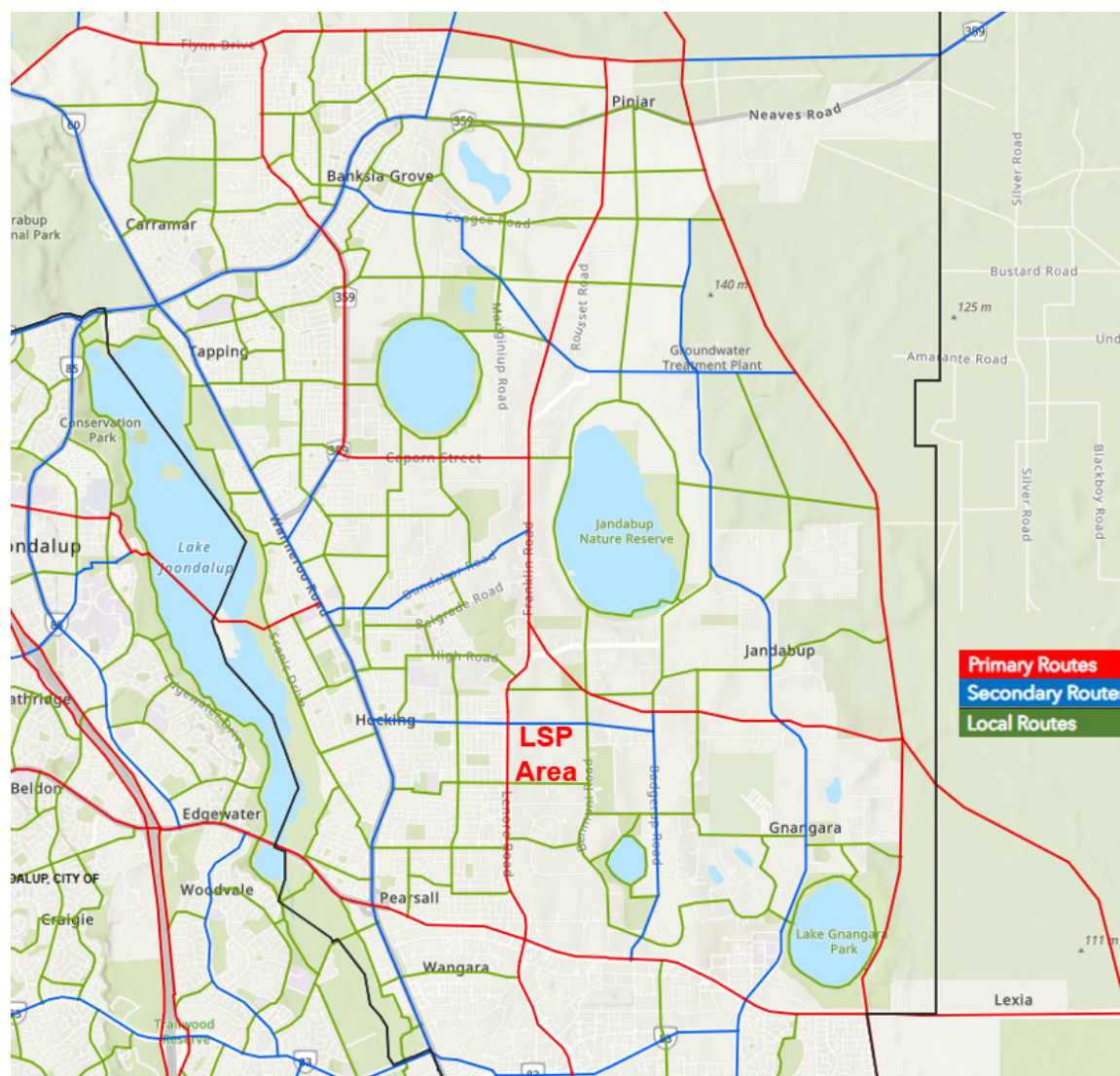


Figure 8: Long Term Cycle Network

A primary route is planned on Lenore Road on the western side of the LSP area. Elliot Road is planned as a secondary route in this area. A number of local routes are also shown in this area including Nicholas Road and Benmuni Road.

3.7 Changes to Surrounding Transport Network

The subject site is Precinct 3 of the *East Wanneroo District Structure Plan* (DSP), as shown in **Figure 1**.

The future arterial road network within the DSP area is illustrated in **Figure 9**. Key features of the future road network that are of particular relevance to Precinct 3 include:

- Whiteman Yanchep Highway (primary distributor) – a future 6-lane, controlled access highway along the eastern boundary of the DSP area;
- Lenore/Franklin Road (integrator arterial) – north south arterial road running along the western side of Precinct 3;
- Elliot Road (integrator arterial) – east west arterial road through Precinct 3 from Lenore Road to Whiteman Yanchep Highway;
- Nicholas Road (neighbourhood connector) – east west road through Precinct 3 from Lenore Road to Benmuni Road;
- Benmuni Road (neighbourhood connector) along the eastern boundary of Precinct 3; and
- A new central neighbourhood connector road running north south through Precinct 3 north of Nicholas Road.

The DSP shows a rapid transit route through Precinct 3 along Elliot Rd – Lenore Rd – Franklin Rd – Dundobar Rd (i.e. linking the existing Wanneroo town centre and the proposed district centre in the DSP area).

The DSP also shows a future railway line cutting across the northeast corner of Precinct 3 but the current status of that proposal is unclear. It is understood that current planning by the Department of Planning, Lands and Heritage (DPLH) may favour an express bus transit system instead of rail. This may take the form of bus lanes in the centre of the road along Elliot Rd – Lenore Rd – Franklin Rd (i.e. combining this section of the ‘rail’ route and rapid transit route) and may require signalised intersections instead of roundabouts to provide bus priority at key intersections. Preliminary advice indicates the number of bus stops would be limited and would not be located within Precinct 3. It should be noted that signalised intersections along this type of central median bus facility provide pedestrian access to the bus stops in the central median, so signalised intersections may not be necessary where there are no bus stops planned.

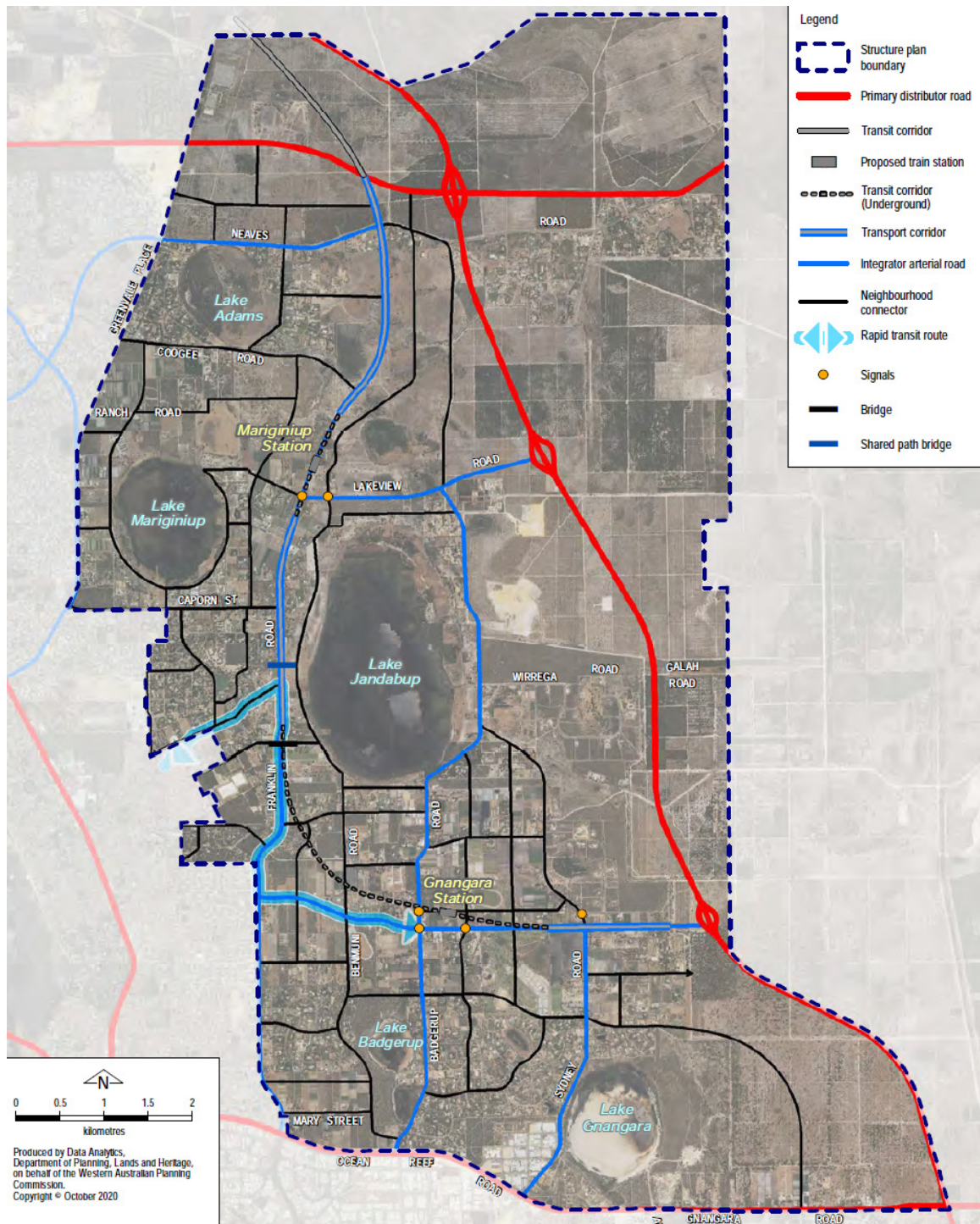


Figure 9: East Wanneroo DSP movement network

The classification of roads in **Figure 10** is based on preliminary analysis of future traffic flows at section 6.3 of this report.

Liveable Neighbourhoods indicates that Integrator A roads are suitable for traffic flows up to 35,000vpd as dual carriageway roads (two lanes each way). However, there are existing examples of equivalent dual carriageway roads (with minimal minor side road or driveway access) in the Perth metro area carrying up to 50,000vpd¹, so traffic volumes above 35,000vpd can be accommodated subject to appropriate intersection treatments.

Integrator B roads are suitable for traffic flows up to 15,000vpd and can accommodate traffic flows up to 20,000vpd with suitable intersection treatments. There are no Integrator B roads within or adjacent to the LSP area

Neighbourhood Connector A roads are suitable for up to 7000vpd but some degree of flexibility with this upper limit may be appropriate in localised situations to avoid overdesigning some lengths of road. The main difference between Integrator B and Neighbourhood Connector A cross-sections is only the width of the median (6m versus 2m) and the Liveable Neighbourhoods policy does allow for the median of an Integrator B to be reduced in width on sections that do not require right turn lanes in the median.

Neighbourhood Connector B roads are suitable for traffic flows up to 3000vpd but again some degree of flexibility with this upper limit should be considered appropriate in localised situations.

An Access Street B is suitable for traffic flows up to 3000vpd and can accommodate embayed parking on both sides. Access Street B is recommended for access streets abutting school sites but would typically only have parking on one side adjacent to the school site to avoid having students cross the road to access parked cars.

An Access Street C is suitable for traffic flows up to 3000vpd. Its 7.2m sealed width accommodates on-street parking without restricting two-way traffic flow.

An Access Street D is suitable for traffic flows up to 1000vpd. Its 6m sealed width accommodates on-street parking but parked vehicles do restrict simultaneous two-way traffic flow.

Proposed road cross-sections for the Integrator A roads are provided in the *East Wanneroo District Structure Plan Road Planning Study* report (11 Sep 2019). The standard Option 1 cross-section is included at **Appendix B**. Option 1 (outside of neighbourhood and district centres) has 6m median, four 3.5m traffic lanes and two 2m cycle lanes in a 35m road reserve.

¹ For example, Armadale Rd west of Warton Rd, dual carriageway (2 lanes each way) carried 49,342vpd average weekday traffic in 2023/24.

The Transport Corridor shown in **Figure 10** on Elliot Road (east of Lenore Road) and on Lenore Road (north of Elliot Road) is nominally widened to 45m in the LSP plan. This is basically an Integrator A with a substantially widened central median to accommodate two 3.5m bus lanes, as discussed in sections 3.7 and 4.2. The transport corridor cross-section would be subject to detailed design at a later stage of transport network planning for this area.

Standard cross-sections from the WAPC Liveable Neighbourhoods policy for the Integrator B, Neighbourhood Connectors and Access Streets are shown in **Appendix B**.

4.2 Public Transport

Public transport planning in the DSP is discussed in section 3.7. As discussed, that public transport planning is currently unclear.

The LSP provides a 45m wide Transport Corridor along the Lenore Road / Elliot Road to accommodate potential bus lanes in the central median in accordance with most recent advice available from DPLH.

Those express bus lanes along Lenore Road / Elliot Road may not include any bus stops within the LSP area, so local bus services may also be required within the LSP area.

All of the proposed neighbourhood connectors and integrator arterial roads shown on **Figure 10** would be of suitable standard to accommodate bus services through this area, providing suitable options for future local bus routes to the neighbourhood centre and district centre to service this area. This allows suitable flexibility for the Public Transport Authority to plan future bus routes within this area.

4.3 Pedestrian and Cyclist Facilities

All of the proposed neighbourhood connectors and integrator arterial roads shown on **Figure 10** would have paths on both sides in accordance with Liveable Neighbourhoods guidelines, including a shared path on one side.

Paths would be required on at least one side of all roads in accordance with Liveable Neighbourhoods guidelines.

On-street cycle lanes are normally included only on Neighbourhood Connector A roads and above, due to traffic flows above 3000vpd on these categories of roads.

The resultant path network associated with the road network within the LSP area is indicated in **Figure 11**. This does not include paths outside of the road network, such as within public open space, which will be addressed by other consultants for this LSP.

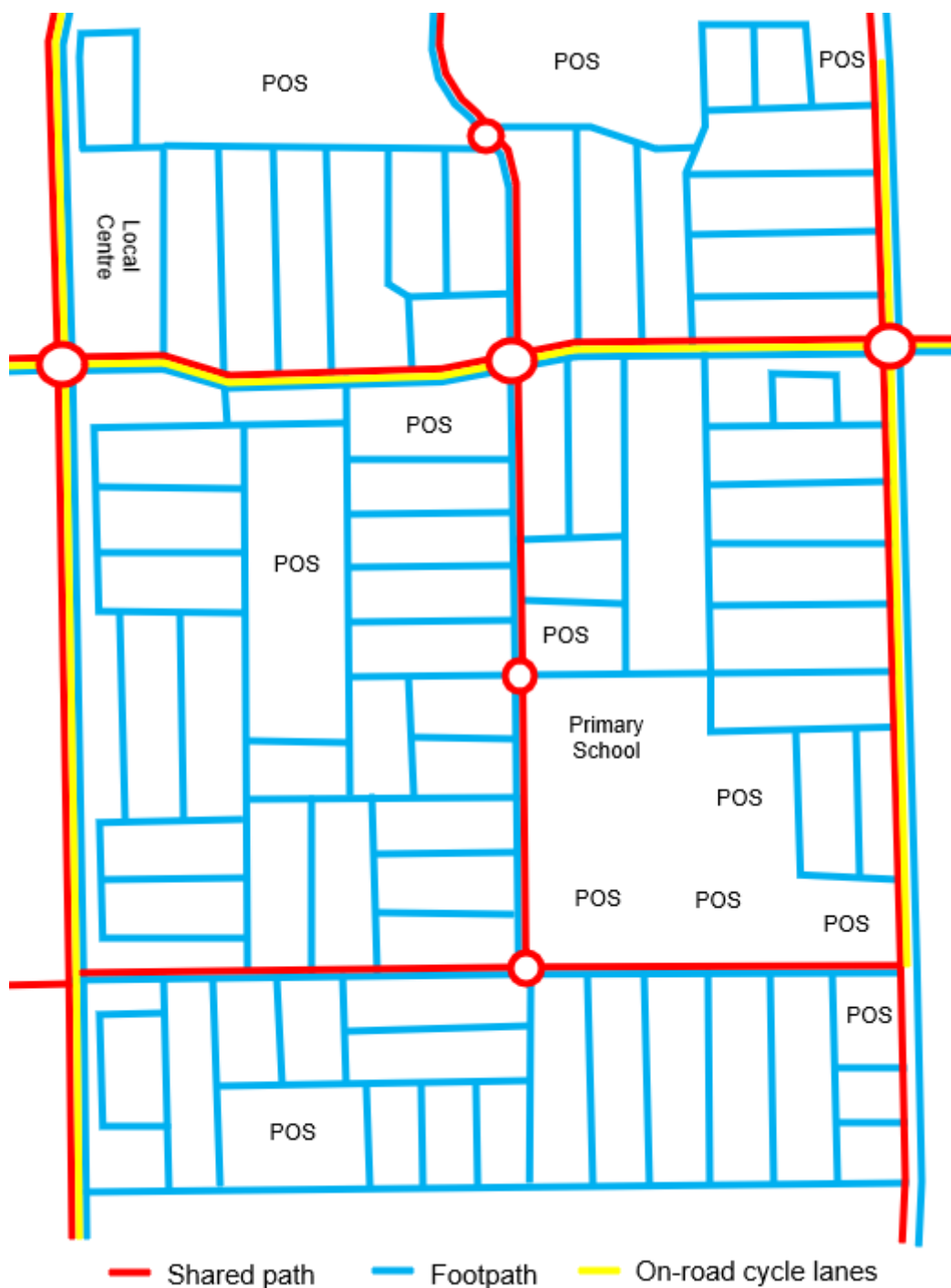


Figure 11: Pedestrian / Cycle Network

5 Integration with Surrounding Area

The *East Wanneroo District Structure Plan* (DSP) provides an overall plan to ensure coordination of future development of the subject site and the surrounding area. The proposed local structure plan for the subject site respects the principles and external connections of the DSP to ensure that good connectivity and integration with the surrounding area are achieved.



6 Analysis of the Transport Network

6.1 Assessment Period

The traffic assessment undertaken for the subject site is guided by the 2051 traffic projections reported for the arterial road network of the DSP area in the *East Wanneroo District Structure Plan Road Planning Study* report (2019) with full development of all land uses within the DSP area.

6.2 Traffic Generation and Distribution

The residential daily traffic generation rate used in the LSP area is 8 vehicle trips per day (vpd) per dwelling, which corresponds to peak hour trip generation rates of 0.8vph per dwelling recommended in the Western Australian Planning Commission (WAPC) *Transport Impact Assessment Guidelines* (2016). The anticipated yield of approximately 1,750 dwellings in the LSP area will therefore generate approximately 14,000vpd.

Information provided in the Department of Education's *Primary School Brief* indicates a daily trip rate of 2.6vpd per student is appropriate for new schools, with 1.0vph per student during before and after school peak periods. This is consistent with peak hour trip rates for schools in the WAPC TIA Guidelines. Therefore, the proposed primary school (540 students) is anticipated to generate approximately 1,400vpd.

The NSW *Transport Impact Assessment Guidelines* (2024) provides trip rate formulae for shopping centres in various size ranges. The trip rates for a small suburban shopping centre of 6,000 – 10,000m² GLFA have been utilised for the proposed local centre in Precinct 3. For 7,000m² GLFA with a major tenant of 3,500m² GLFA the estimated daily traffic generation is 7,180vpd with 528vph in the site's AM peak hour and 921vph in the site's PM peak hour of traffic generation.

It should be noted that some of the trips calculated above will be internal trips within the LSP area, so the total trips generated within the LSP area is not simply the sum of traffic generations listed above. For example, a trip from home to the local centre would be a single, combined trip rather than separate residential and shopping centre trips.

The sum of traffic generations listed above is approximately 22,580 trip ends within the LSP area, with approximately 20,230 of those being internal-to-external trips or external-to-internal trips across the LSP area boundary.

Trip distribution of these external trips for the LSP area has been modelled to approximately reproduce the same overall trip pattern evidenced by the DSP traffic projections in the *East Wanneroo District Structure Plan Road Planning Study* report. The resultant external traffic distribution of traffic to and from the LSP area is as follows:

- 21.2% North (Lenore Rd and Benmuni Rd)
- 3.3% West (Elliot Rd)
- 41.0% East (Elliot Rd and local roads)
- 34.5% South (Lenore Rd and Benmuni Rd)

6.3 Traffic Flow Forecasts

Daily traffic flows generated by the LSP area and through traffic through this precinct generated by the rest of the DSP area have been assigned on the LSP area road network and existing through traffic on Lenore Road has been added to determine future, full development, daily traffic flows on the LSP area road network.

The resultant total daily traffic flows on the LSP area road network are shown in **Figure 12**. The component of these total traffic flows that has an origin or destination within the LSP area is shown in brackets.

For comparison, the *East Wanneroo District Structure Plan Road Planning Study* (2019) modelled 2051 daily traffic volumes of 47,000vpd on Lenore Rd (between Ocean Reef Rd and Elliot Rd) and 15,000vpd on Elliot Rd (between Lenore Rd and Badgerup Rd).



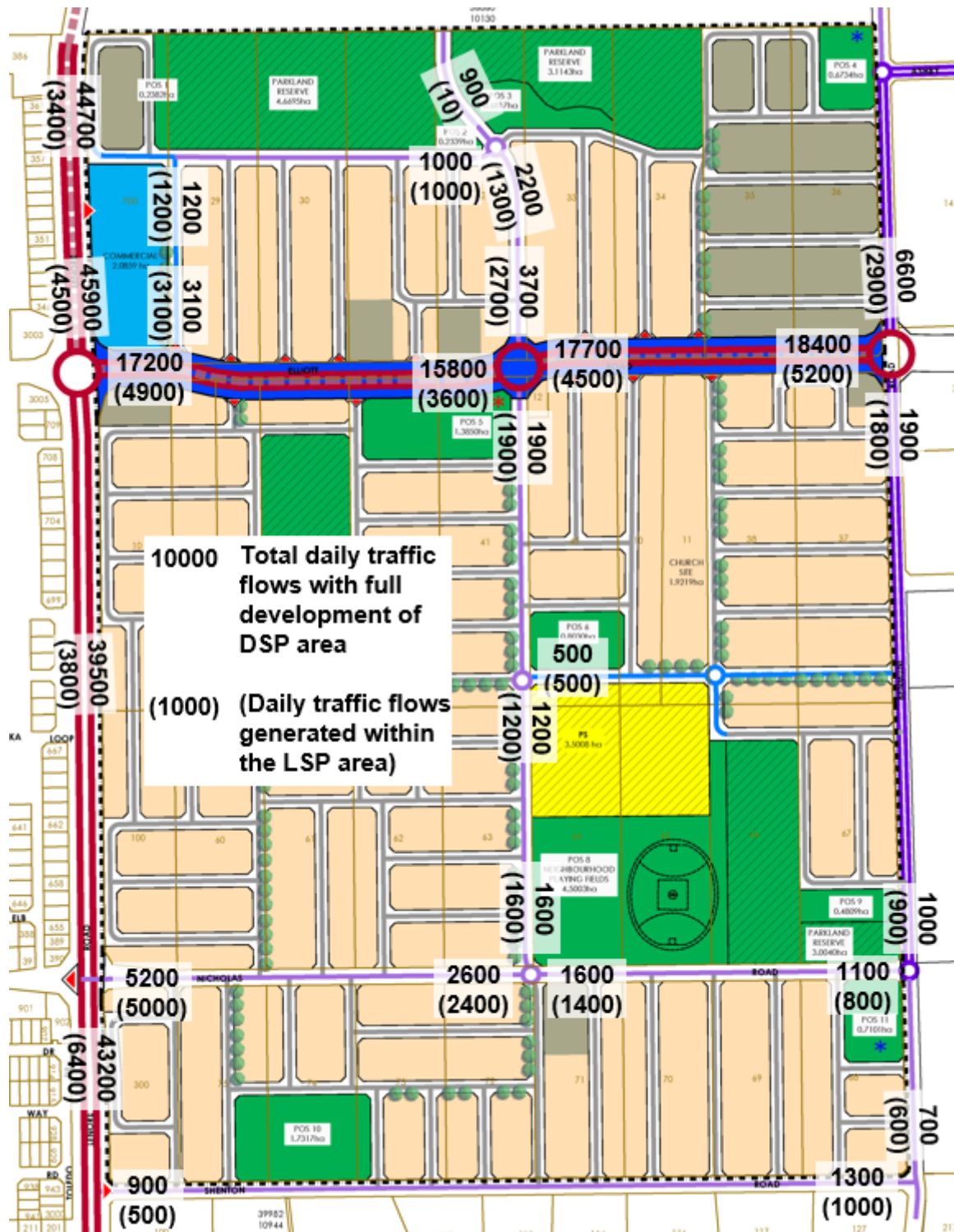


Figure 12: Future total daily traffic flows

6.4 Roads and Intersections

The anticipated future road network around the subject site has been detailed in section 4 of this transport impact assessment, including discussion of the proposed road hierarchy in section 4.1.

Advice on current planning from the Department of Planning, Lands and Heritage (DPLH) indicates they are looking at an express bus transit system (instead of rail) with bus lanes in the centre of the road along Elliot Rd – Lenore Rd – Franklin Rd.

The *East Wanneroo District Structure Plan Road Planning Study* report (2019) identifies the Lenore Road / Elliot Road 4-way intersection as a future roundabout or signalised intersection. The *East Wanneroo District Structure Plan* report (2021, figure 2.12) does identify a number of future signalised intersections within the DSP area but does not indicate a signalised intersection at the Lenore Road / Elliot Road intersection.

Accordingly, the Precinct 3 LSP anticipates the Lenore Road / Elliot Road intersection will remain as a multi-lane roundabout. Advice on current planning from DPLH in December 2024 indicated they were looking at grade-separation of bus lanes over the roundabout so express buses would have no delays at this major intersection.

The two neighbourhood connector intersections along Elliot Road through the LSP area (at the central north south neighbourhood connector and at Benmuni Road) are proposed as multi-lane roundabouts in the Precinct 3 LSP. Right turn traffic from Elliot Road (and U-turn traffic on Elliot Road) would need to merge right into the central median bus lanes on approach to these roundabouts (similar to the way left turn traffic is allowed to merge left into the more conventional kerbside bus lanes about 50m before each intersection on a number of other major roads throughout the Perth metropolitan area). This system would still provide significant priority for buses at these roundabouts.

All other access street intersections along this section of Lenore Road would be restricted to left in / left out only, with U-turns accommodated at the three roundabouts.

Lenore Road is currently being upgraded to dual carriageway (two lanes each way) adjacent to the LSP area including channelisation of the Lenore Road / Nicholas Road intersection. The eastern approach is being constructed to accommodate full movements including right turns, whereas the western approach is restricted to left in / left out only. It is anticipated that this intersection would be upgraded in future with traffic signals to facilitate those right turn movements when required as traffic volumes increase in future.

Other four-way intersections on lower order roads (mainly along the neighbourhood connectors) are proposed as single-lane roundabouts in this LSP area.

The location and type of intersection treatment of key intersections are shown in **Figure 13**.



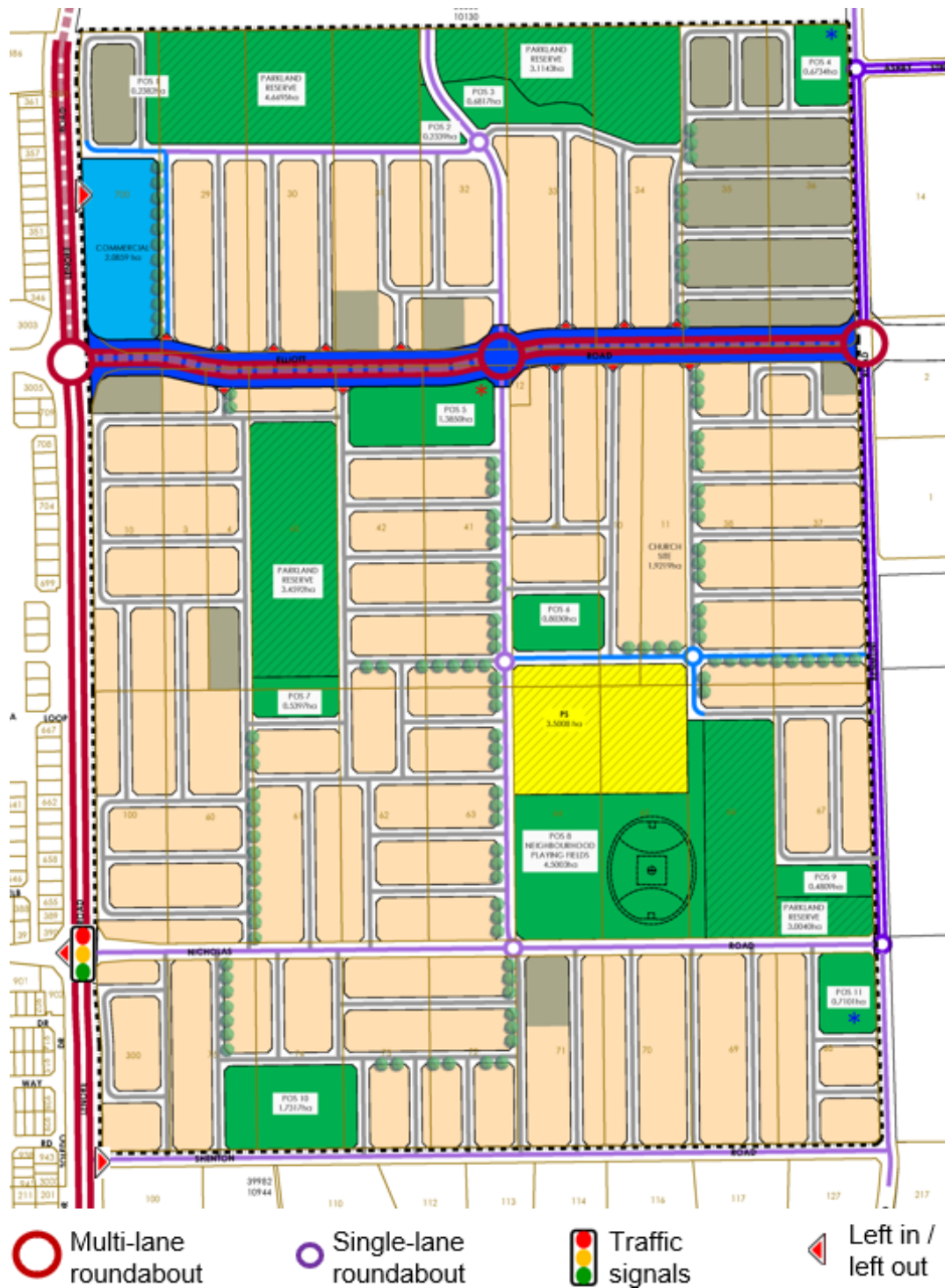


Figure 13: Key intersections

6.5 Intersection Analysis

Intersection capacity analysis has been undertaken for five key intersections along Lenore Road and Elliot Road for the weekday AM peak and PM peak hour flows that correspond to the modelled 2051 daily traffic flows in **Figure 12**. The peak hours adopted for this analysis are 8-9AM and 3-4PM to include before and after school peak traffic, which is anticipated to be a particularly significant factor in determining peak periods in this vicinity. Nominal express bus lane flows of 60 buses per hour each way are assumed in the Elliot Road bus lanes for this analysis.

The key intersections analysed are as follows:

- Lenore Rd / Elliot Rd roundabout;
- Lenore Rd / Nicholas Rd signalised intersection (western leg LILLO only);
- Lenore Rd / Shenton Rd T-intersection (LILLO);
- Elliot Rd / central neighbourhood connector roundabout (with bus lanes); and
- Elliot Rd / Benmuni Rd roundabout (with bus lanes).

Capacity analysis of these intersections has been undertaken using SIDRA Network analysis in the SIDRA computer software package. SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- Degree of Saturation is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for infrequent traffic flow up to one for saturated flow or capacity.
- Level of Service is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- Average Delay is the average of all travel time delays for vehicles through the intersection.
- 95% Queue is the queue length below which 95% of all observed queue lengths fall.

The results of the SIDRA analysis are summarised in **Appendix C**. Each of the intersections along Lenore Road will have some minor movements that will experience some degree of congestion commensurate with the relatively high 2051 traffic volumes on Lenore Road, but all three intersections will have sufficient capacity to accommodate the modelled 2051 traffic flows.

The two roundabouts with central bus lanes on Elliott Road both operate satisfactorily with very good level of service A or B for all movements.

Schematic diagrams from the SIDRA analysis of the five intersections assessed are shown in **Appendix C**, including a mark-up of the Lenore Rd / Elliot Rd roundabout with grade-separated bus lanes to help visualise that concept. Note that these

diagrams are not to scale and are not design drawings. They are purely intended to illustrate the number and arrangement of traffic lanes required at each intersection to accommodate the modelled future traffic flows.

6.6 Access to Frontage Properties

The WAPC Liveable Neighbourhoods policy requires that *“Development along integrator B and neighbourhood connector streets with ultimate vehicle volumes over 5,000 vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access.”*

There is to be no direct driveway access to residential development on zoned land within the LSP area from the Integrator A roads – Lenore Road and Elliot Road.

It is anticipated that a left in / left out driveway crossover would be provided on Lenore Road for the proposed Local Centre.

The only other road within the LSP area carrying more than 5,000vpd is Benmuni Road north of Elliot Road. It is proposed that residential lots along the western side of that section of Benmuni Road would be oriented towards the side streets and have driveway access from those side streets to avoid driveway access on this section of Benmuni Road.

All of the other roads in the LSP area are expected to carry less than 5,000vpd, so no restriction on vehicular access is required.

6.7 Pedestrian / Cycle Networks

The proposed network of footpaths and shared paths for pedestrians and cyclists is described in section 4.3 of this Transport Impact Assessment. This network of paths will provide an excellent level of accessibility and permeability for pedestrians and cyclists within the LSP area, and connections to neighbouring precincts at strategic locations.

The WAPC *Transport Impact Assessment Guidelines* (2016) provides guidance on the levels of traffic volumes that are likely to affect the ability for pedestrians to cross various types of road. Based on that guidance an undivided two-lane road should be acceptable for pedestrians crossing traffic volumes of up to approximately 11,000 vpd and this threshold can be increased to around 28,000 vpd by adding a central median or pedestrian refuge islands. On a four-lane road, because of its greater carriageway width, this threshold is lower; even with a median island the threshold is only around 16,000 vpd.

Only Lenore Road and Elliot Road are expected to carry future traffic flows above these levels.



The future signalised intersection at Lenore Rd / Nicholas Rd will include appropriate pedestrian phasing to assist pedestrians and cyclists crossing Lenore Road at that location.

An additional pedestrian crossing facility should be provided on Lenore Road north of Elliot Road to assist pedestrian and cyclist movements from residential areas west of Lenore Road to access the local centre. This could be in the form of a signalised pedestrian crossing when traffic and pedestrian numbers meet the warrants for that type of facility, or potentially a pedestrian overpass or underpass if required.

A suitable pedestrian crossing facility should also be provided on Elliot Road east of the local centre to assist pedestrian and cyclist movements from residential areas west of Lenore Road to access the local centre. This could be in the form of a signalised pedestrian crossing when traffic and pedestrian numbers meet the warrants for that type of facility. The location of that facility should be subject to future investigation in conjunction with public transport planning along Elliot Road to ensure it also serves bus passengers that will need to cross Elliot Road.

It is anticipated that a guard-controlled school crossing would be appropriate at the primary school site to assist students crossing the adjacent neighbourhood connector road before and after school. Guard-controlled school crossings can easily be accommodated on that neighbourhood connector at any location that suits the internal and external access routes of the school at detailed design stage.

Information from the 2002-2006 Perth & Regions Travel Survey (PARTS) indicated that 25.4% of primary school students walk or cycle to school and 26.7% walk or cycle home from school. Therefore a 540-student primary school would typically have about 140 students walking or cycling.

The Children's Crossings and Road Safety Committee documents *Application for a Type A Children's Crossing* and *Application for a Type B Children's Crossing* indicate "the warrant criteria for a children's crossing are contained in the Main Roads WA publication *Planning and Designing for Pedestrians: Guidelines* (version 4 dated 30 November 2011). Generally, the warrant criteria of minimum student pedestrian numbers and vehicle numbers must be met for an application for a new [Type A or] Type B children's crossing to be viewed favourably by the Committee; however environmental factors, risk factors and local conditions will also be considered by the Committee."

Warrant criteria indicate that a Type A Children's Crossing may be provided where a minimum of 20 students and 200 vehicle movements occur within the hour immediately before and immediately after school, for a primary school. The warrants are lower for a Type B Children's Crossing at 10 students and 100 vehicle movements.

Such facilities can only be applied for by a School Principal or the President / Secretary of the relevant school/parent organisation (eg. P&C or P&F). The anticipated numbers of primary students crossing the Neighbourhood Connector road on the western side of the primary school would potentially meet these warrants in future so it would be expected that the school would apply for this type of facility when future student numbers and movements meet those warrants..

6.8 Access to Public Transport

As noted in section 3.7, it is understood that current planning by DPLH may favour an express bus transit system instead of rail. This may take the form of bus lanes in the centre of the road along Elliot Rd – Lenore Rd – Franklin Rd (i.e. combining this section of the ‘rail’ route and rapid transit route). Preliminary advice indicates the number of bus stops would be limited and would not be located within Precinct 3.

Accordingly, other local bus services would be required to provide public transport access for residents of the LSP area.

At this stage of the structure planning process those local bus routes are not known. As noted in section 4.2, all of the proposed neighbourhood connectors and integrator arterial roads shown on **Figure 10** would be of suitable standard to accommodate bus services through this area, providing suitable options for future feeder bus routes to the district centre where they would also have access to that express bus transit system for longer trips. This allows suitable flexibility for the Public Transport Authority to plan future bus routes within this area.



7 Conclusions

This Transport Impact Assessment relates to the Local Structure Plan (LSP) for Precinct 3 of the East Wanneroo District Structure Plan in the City of Wanneroo.

The subject site is located approximately 2.5 kilometres southeast of the Wanneroo town centre and is bounded by Lenore Road to the west and Benmuni Road to the east, with Elliot Road and Nicholas Road running east west within the subject site.

The DSP shows a future railway line cutting across the northeast corner of Precinct 3 but the current status of that proposal is unclear. It is understood that current planning by the Department of Planning, Lands and Heritage (DPLH) may favour an express bus transit system instead of rail. This may take the form of bus lanes in the centre of the road along Elliot Rd – Lenore Rd – Franklin Rd.

Preliminary advice indicates the number of bus stops on this express bus route would be limited and would not be located within Precinct 3, so it is anticipated that additional local bus services would be provided in future. All of the proposed neighbourhood connectors and integrator arterial roads in the LSP area would be of suitable standard to accommodate bus services, providing suitable options for local bus routes to the district centre. This allows suitable flexibility for the Public Transport Authority to plan future bus routes within this area.

Precinct 3 will include residential neighbourhoods for approximately 1,750 dwellings, a local activity centre and a primary school.

The traffic flows generated within the LSP area will result in approximately 20,230vpd of internal-to-external trips or external-to-internal trips across the LSP area boundary, as well as internal traffic flows between land uses within the LSP area.

The main arterial roads within the LSP area are Lenore Road running north south along the western boundary and Elliot Road running east west through the middle of the LSP area. Ultimately, traffic volumes in the order of 40,000 to 46,000vpd are forecast on this section of Lenore Road and 15,000 to 18,000vpd on Elliot Road.

Five key intersections along Lenore Road and Elliot Road within the LSP area have been analysed to determine likely future intersection requirements.

A comprehensive network of paths and on-road cycle lanes are planned on the LSP area road network in accordance with *Liveable Neighbourhoods* policy guidelines.

The proposed signalised intersection on Lenore Road and Nicholas Road will assist pedestrians and cyclists crossing Lenore Road at that location but additional pedestrian facilities should be planned across Lenore Road and Elliott Road in the vicinity of the proposed local centre.

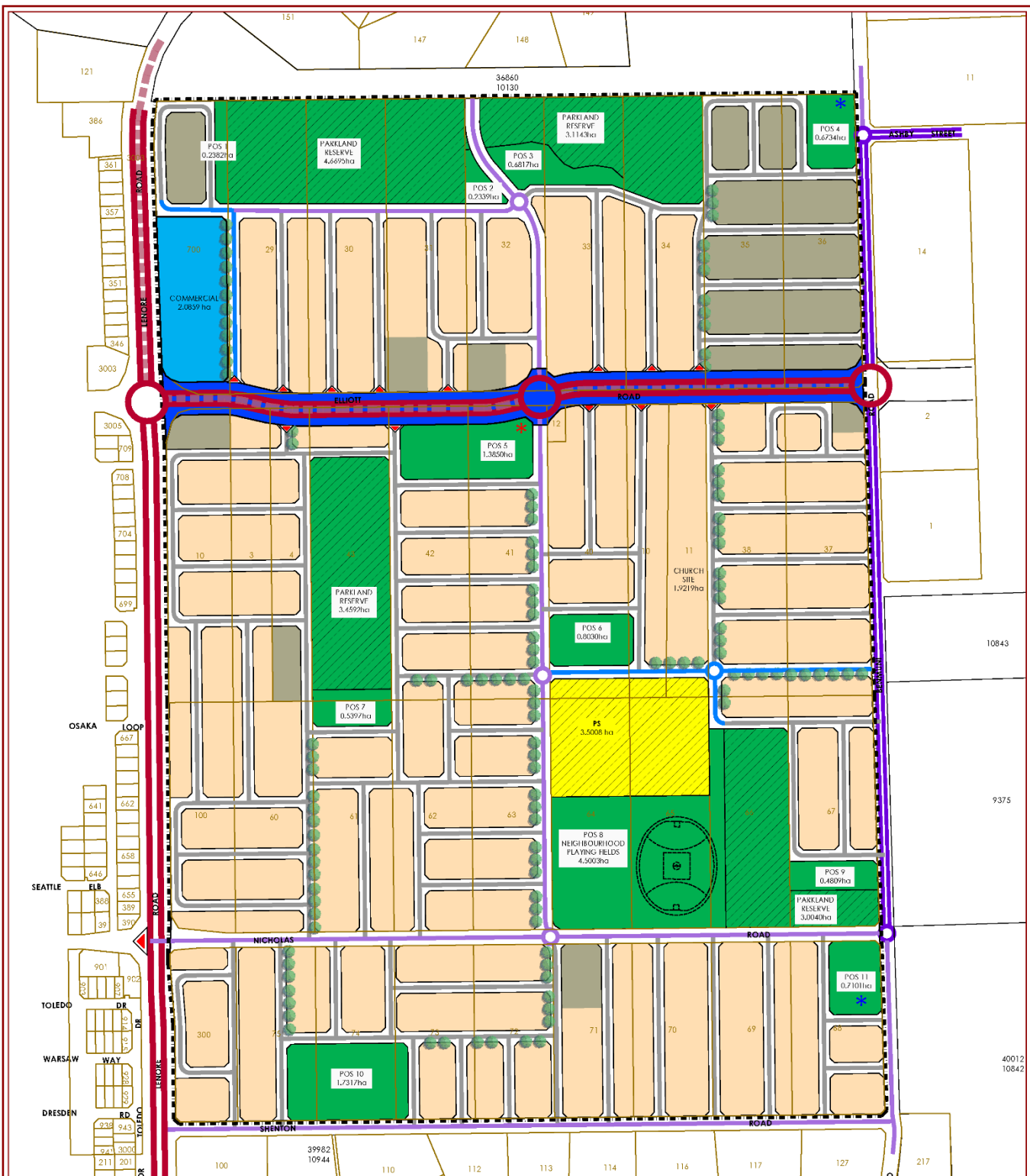
A guard-controlled school crossing would be anticipated on the north south neighbourhood connector road adjacent to the primary school site in future.

Appendix A

LOCAL STRUCTURE PLAN



Engineering a better future for over 20 years!



LEGEND

STRUCTURE PLAN AREA

MRS RESERVES

PARKS AND RECREATION

LOCAL SCHEME

RESIDENTIAL R30-R60
 RESIDENTIAL R40-R80
 PUBLIC OPEN SPACE

PS PUBLIC PURPOSES - PRIMARY SCHOOL

PERMANENT WWPS

TEMPORARY WWPS

COMMERCIAL

MOVEMENT NETWORK

TRANSPORT CORRIDOR (45m)

INTEGRATOR A (35m)

NEIGHBOURHOOD CONNECTOR A (25m)

NEIGHBOURHOOD CONNECTOR B (20m)

ACCESS STREET B (17.9m)

ACCESS STREET D (15.4m)**

ROUNDABOUT INTERSECTION***

LEFT IN/LEFT OUT INTERSECTION***

OTHER

GREEN STREET*

NOTES:

*REFER TO STRUCTURE PLAN REPORT FOR DETAIL

**MAY BE REDUCED TO 13m ADJACENT TO PUBLIC OPEN SPACE (EXCLUDING AREAS IDENTIFIED FOR CONSERVATION PURPOSES), OR 10m WHERE USED AS A CONTROLLED ACCESS PLACE.

***ALL OTHER INTERSECTIONS TO BE PRIORITY CONTROLLED.



All areas and dimensions are subject to survey, engineering and detailed design and may change without notice. © Copyright of Burgess Design Group.



0 50 100 150
SCALE 1:5,000 (A3)

LOCAL STRUCTURE PLAN
EAST WANNEROO PRECINCT 3
WANNEROO
CITY OF WANNEROO

BURGESS DESIGN GROUP
 TOWN PLANNING • URBAN DESIGN

PO Box 8779, Perth Business Centre 6849
 www.burgessdesigngroup.com.au

P (08) 9328 6411
 F (08) 9328 4062

Plan No: SAT P03 03-07-01 Client: SAT
 Date: 18.03.25 Planner: JB

Appendix B

TYPICAL ROAD CROSS SECTIONS



Engineering a better future for over 20 years!



Integrator B - arterial streets

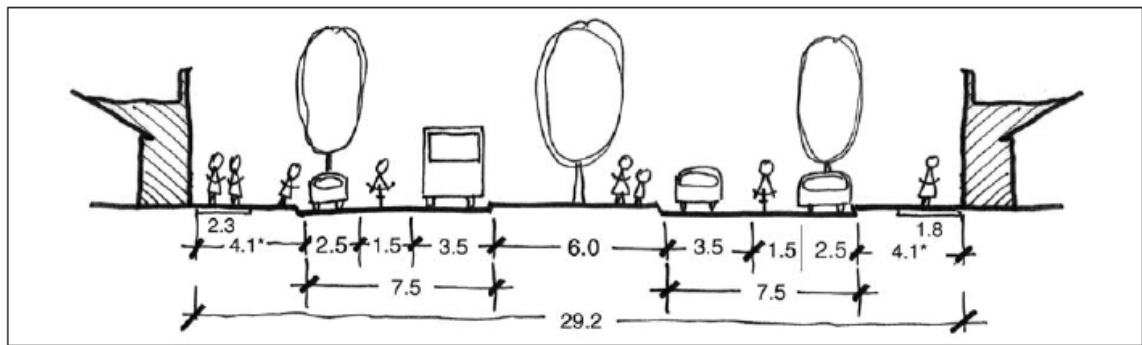


Figure 15: Integrator B – outside centres – 60 km/hr (up to 15 000 vehicles per day - see note 2).

Two lanes, central median, buses, cycle lanes and parking. Development fronting, forward vehicle exiting.

Note: 1. Central median may be reduced along sections where right-hand turn lanes are not required.

2. Traffic volumes up to 20 000 vehicles per day may be acceptable provided that detailed design addresses intersections, parking, access and bus movement (table 1).

3. The 6.0 m median is required for staged vehicle crossings and for clearance to trees.

4. The 2.5 m parking bays may be indented into the verge. If parking is indented, then the verge may be increased to 5.5 m minimum including parking, and reserve width may be decreased as a result, to 27 m.

* Where a wider shared path, extensive street furniture or provision for reversing into parking lane is required, the verge width will need to be widened. Typically verges may be up to 4.5 m and total reserve width 30 m.

Neighbourhood connector streets

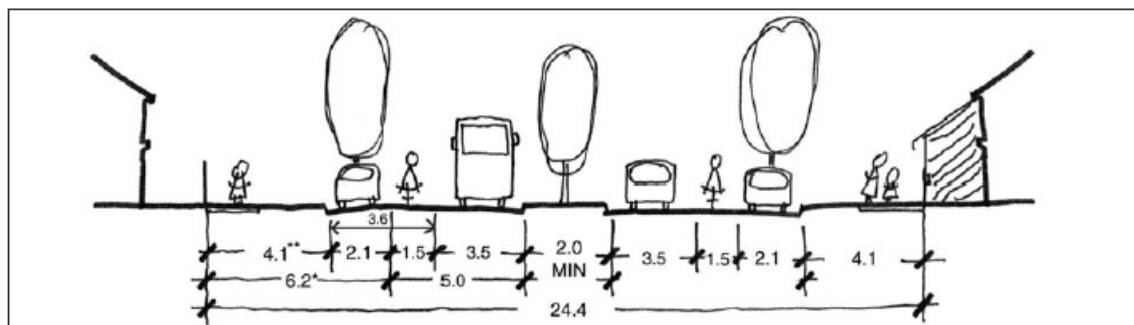


Figure 17: Neighbourhood connector A – 50 km/hr (up to 7000 vehicles per day, with >3000 vehicles per day preferred).

Central median, buses, cycle lanes and parking. Bus stops are normally in travel lane against kerb extensions in parking lane.

Note: 1. * For volumes less than 3000 vehicles per day and the street is not ever likely to be a bus route, the road pavement may be reduced from 5.0 m to 4.0 m with no marked cycle lane, and the total reserve width reduced to 22.4 m.

2. Reversing out from abutting dwellings is acceptable if less than 5000 vehicles per day. For 5000-7000 vehicles per day, protected reversing spaces may be used for larger lots using paired driveway crossovers with ability to reverse into the parking lane.

3. Median will need appropriately located breaks to allow U-turns to frontage-access properties.

4. ** Verge width (including parking) can often be reduced from 6.2 m to 5.5 m with indented parking, to reduce overall reserve width to 23.0 m.

5. For larger trees, central median widths of 2.5-4 m are preferred. For medians with drainage swales, a minimum median width of 6 m is suggested.

6. Where a visually narrower carriageway is needed to assist with speed control, or where parking turnover is high, the parking lane may be widened to 2.3 m and the cycle lane narrowed to 1.2 m.

7. In some circumstances the median may be omitted. On these sections, indented parking should normally be used to assist in visually narrowing the carriageway. If parking is indented, then the reserve width will be 22.4 m.

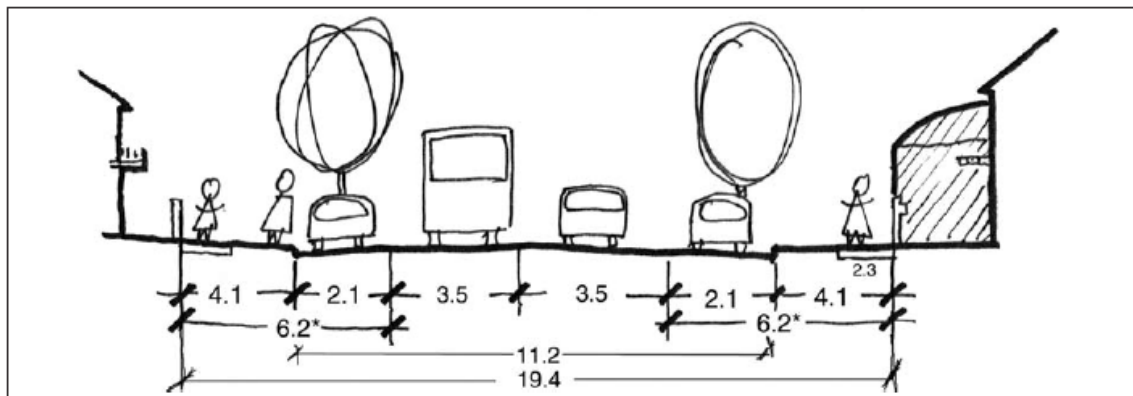


Figure 18: Neighbourhood connector B – 50 km/hr (<3000 vehicles per day).

Lower volume neighbourhood connector, bus route, no cycle lanes, parking. Typically a residential environment with low parking turnover. Detailing of design to visually narrow street (eg including trees in parking lane, painted parking line), together with other speed control mechanisms to limit typical operating speeds to less than 50 km/hr. Bus stops in travel lane against kerb extension in parking lane. A2-2.3 m shared path provided on at least one verge in lieu of on-street cycle lane.

Note: * Verge width (including parking) can often be reduced from 6.2 m to 5.5 m with indented parking, to reduce overall reserve width to 18.0 m.

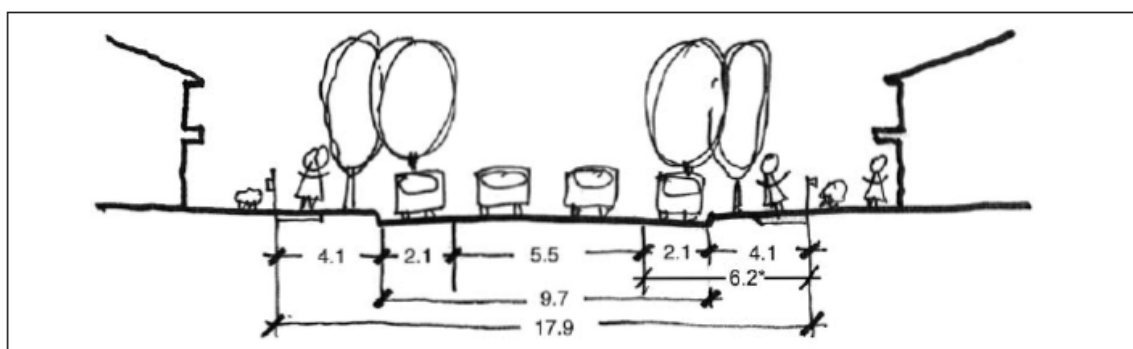


Figure 20: Access street B – wider access street Target speed 40 km/hr (< 3000 vehicles per day).

Wider access street suited to higher density residential areas (typically R30–R40+, or where dwelling density is greater than around 1 per 250 m²) with higher parking demand. Extensive parking, no bike lane, no buses, trees in verge, with additional trees in parking lane if required.

Note: 1. May reduce verge adjacent to park to 1.0 m when fronting public parkland.

2. Trees may be in verge and/or in parking lane.

3. * Verge and parking lane as shown (6.2 m) can often be reduced to 5.5 m if parking is indented, and total street width reduced to 16.5 m.

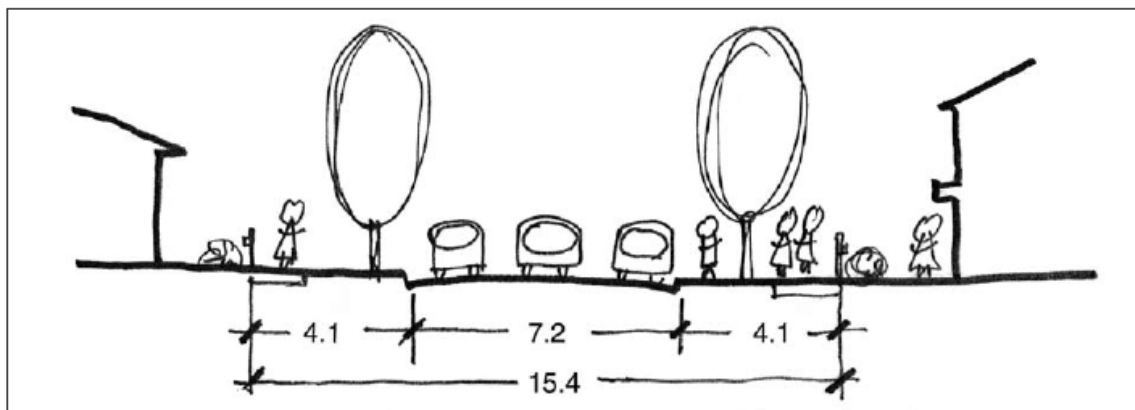


Figure 21: Access street C – yield (or give way) street – Target speed 40 km/hr (< 3000 vehicles per day).

Standard access street or yield (or give way) street. Relatively frequent parking on both sides of street (on the pavement) desirable and needed as part of speed control. No buses, no bike lane. This is likely to be the most common residential street in densities up to and often including R30 - R35 (or a typical lot size down to 250-300 m²).

Note: May reduce verge adjacent to park to 1.0 m when fronting public parkland.

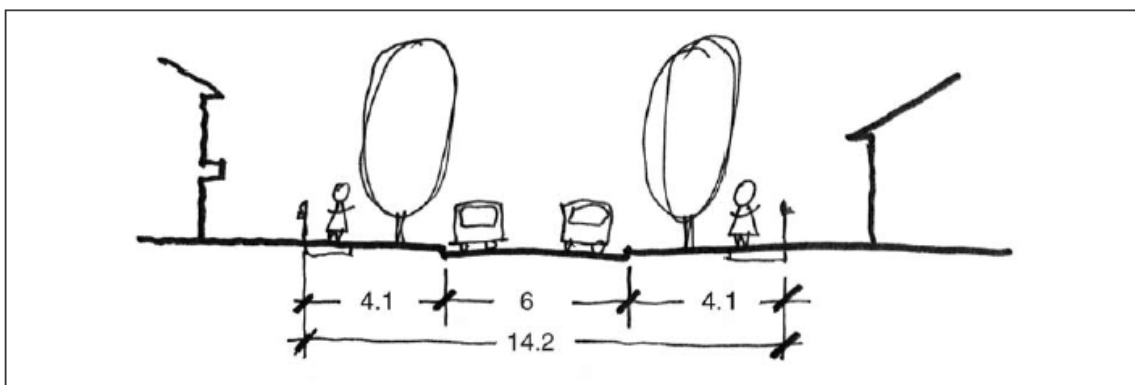


Figure 22: Access street D – narrow yield (or give way) street – Target speed 30 km/hr (< 1000 vehicles per day).

Narrower access street for shorter lengths, low parking demand, serving larger lots. No buses, no bike lanes, no indented parking. Staggered parking on both sides of street as part of speed control, low speed. Not through route, low traffic volume.

Note: 1. May reduce verge adjacent to park to 1.0 m when fronting public parkland.

2. Where the street is short and vehicle volume is less than 150 vehicles per day, pavement may be reconfigured as a slow speed, comprehensively-designed street, with a 3.4 m travel lane and 2.1 m embayed parking spaces. Passing bays are to be provided every 70-80 m, and maximum length 150 m. If a street is comprehensively designed and designated as a shared space for pedestrians and vehicles and target speed is <20 km/hr, no footpath may be required.

3. A pavement width of 5.5 m may be considered, subject to the agreement of the local authority. The reserve should remain at 14.2 m to allow for future flexibility.

Appendix C

SIDRA INTERSECTION ANALYSIS



Engineering a better future for over 20 years!

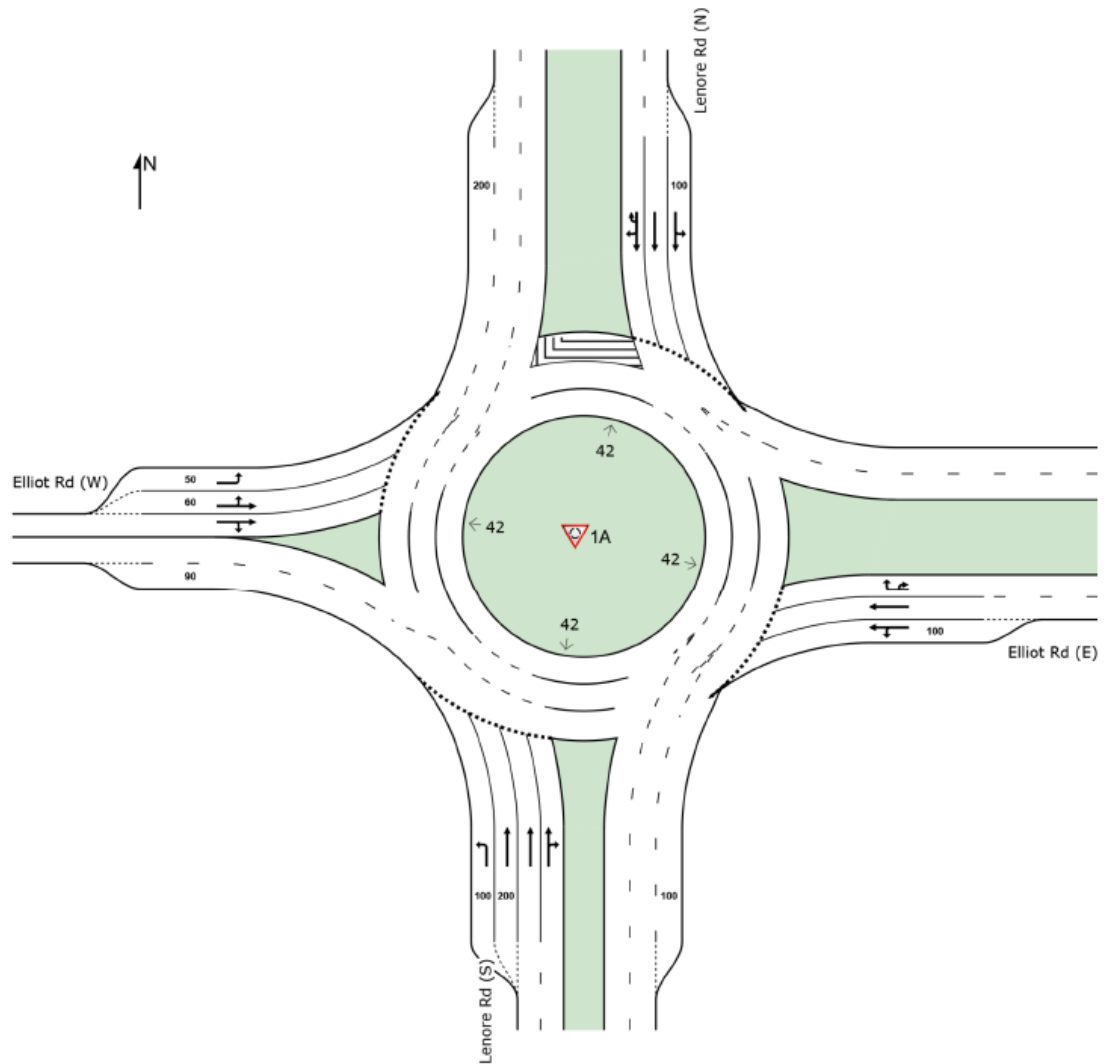
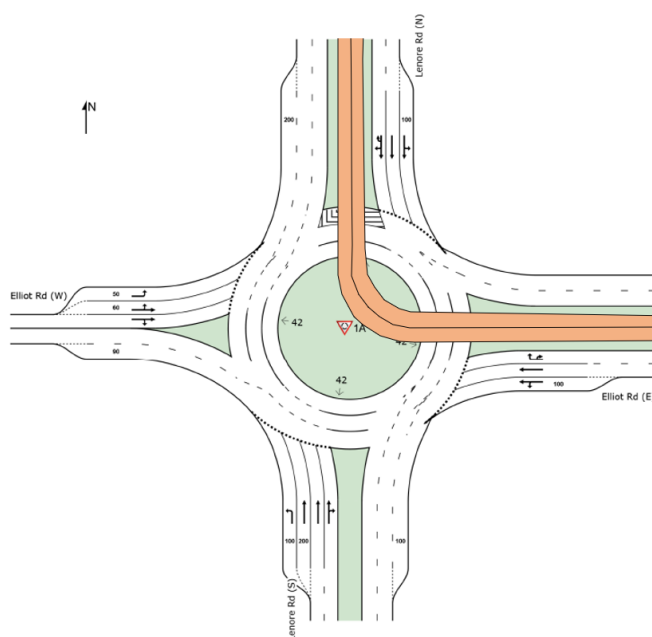


Figure C1. Lenore Rd / Elliot Rd roundabout layout analysed in SIDRA



Note: The roundabout is proposed to have bus lanes in the central median on the east and north approaches and grade-separated on a bridge over the roundabout. This does not affect the operation of the roundabout and has not been modelled in SIDRA.

**Table C1a. SIDRA results – Lenore Rd / Elliot Rd roundabout – 2051 weekday
8-9AM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV] veh/h %		Arrival Flows [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh Dist] veh m		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Lenore Rd (S)															
10	L2	All MCs	76	3.3	76	3.3	0.105	7.9	LOS A	0.4	3.2	0.62	0.66	0.62	54.8
11	T1	All MCs	1144	5.5	1144	5.5	0.483	8.0	LOS A	2.8	22.1	0.74	0.65	0.82	58.7
12	R2	All MCs	62	5.5	62	5.5	0.483	14.2	LOS B	2.6	19.9	0.73	0.71	0.83	54.6
Approach			1282	5.4	1282	5.4	0.483	8.3	LOS A	2.8	22.1	0.73	0.65	0.81	58.3
East: Elliot Rd (E)															
1	L2	All MCs	44	5.5	44	5.5	0.640	31.2	LOS C	3.8	29.0	0.92	1.07	1.33	40.5
2	T1	All MCs	528	3.3	528	3.3	0.853	23.8	LOS C	6.7	51.1	0.95	1.20	1.73	39.1
3	R2	All MCs	293	5.5	293	5.5	0.621	23.1	LOS C	5.2	40.2	1.00	1.08	1.45	44.3
3u	U	All MCs	48	3.3	48	3.3	0.621	25.7	LOS C	5.2	40.2	1.00	1.08	1.45	43.0
Approach			914	4.1	914	4.1	0.853	24.0	LOS C	6.7	51.1	0.96	1.15	1.61	41.3
North: Lenore Rd (N)															
4	L2	All MCs	164	5.5	164	5.5	0.553	6.7	LOS A	3.8	30.1	0.66	0.62	0.72	54.3
5	T1	All MCs	2125	5.5	2125	5.5	0.686	10.1	LOS B	6.3	49.2	0.70	0.65	0.80	52.7
6	R2	All MCs	167	3.3	167	3.3	0.686	14.7	LOS B	6.2	47.8	0.75	0.76	0.89	49.4
6u	U	All MCs	19	3.3	19	3.3	0.686	17.7	LOS B	6.2	47.8	0.75	0.76	0.89	55.4
Approach			2476	5.3	2476	5.3	0.686	10.3	LOS B	6.3	49.2	0.70	0.66	0.80	52.6
West: Elliot Rd (W)															
7	L2	All MCs	324	3.3	324	3.3	0.324	6.8	LOS A	1.7	13.2	0.77	0.63	0.78	51.2
8	T1	All MCs	221	3.3	221	3.3	0.324	4.4	LOS A	1.5	11.1	0.73	0.63	0.77	48.7
9	R2	All MCs	159	3.3	159	3.3	0.324	10.8	LOS B	1.5	11.1	0.73	0.81	0.77	36.5
Approach			704	3.3	704	3.3	0.324	6.9	LOS A	1.7	13.2	0.75	0.67	0.77	48.1
All Vehicles			5376	4.9	5376	4.9	0.853	11.7	LOS B	6.7	51.1	0.76	0.74	0.94	51.2

**Table C1b. SIDRA results – Lenore Rd / Elliot Rd roundabout – 2051 weekday
3-4PM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows		Arrival Flows		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			[Total HV]	%	[Total HV]	%	v/c	sec		[Veh. veh	Dist]				km/h
South: Lenore Rd (S)															
10	L2	All MCs	116	3.3	116	3.3	0.171	8.7	LOS A	0.7	5.5	0.62	0.77	0.62	54.8
11	T1	All MCs	2085	5.5	2085	5.5	0.982	48.0	LOS D	23.3	181.7	0.99	1.70	3.12	45.1
12	R2	All MCs	171	5.5	171	5.5	0.982	41.1	LOS D	19.0	148.3	0.99	1.67	3.11	41.9
Approach			2372	5.4	2372	5.4	0.982	45.6	LOS D	23.3	181.7	0.97	1.65	3.00	45.1
East: Elliot Rd (E)															
1	L2	All MCs	26	5.5	26	5.5	0.236	12.2	LOS B	1.3	9.9	0.86	0.76	0.86	47.4
2	T1	All MCs	268	3.3	268	3.3	0.314	8.1	LOS A	1.7	12.8	0.86	0.77	0.87	48.1
3	R2	All MCs	339	5.5	339	5.5	0.811	24.9	LOS C	8.1	63.1	1.00	1.21	1.73	43.3
3u	U	All MCs	154	3.3	154	3.3	0.811	27.5	LOS C	8.1	63.1	1.00	1.21	1.73	42.1
Approach			787	4.3	787	4.3	0.811	19.2	LOS B	8.1	63.1	0.95	1.04	1.41	44.4
North: Lenore Rd (N)															
4	L2	All MCs	355	5.5	355	5.5	0.572	8.1	LOS A	4.1	32.3	0.78	0.79	0.93	53.9
5	T1	All MCs	1447	5.5	1447	5.5	0.710	8.9	LOS A	7.1	55.3	0.83	0.81	1.05	51.0
6	R2	All MCs	267	3.3	267	3.3	0.710	16.6	LOS B	6.3	48.9	0.86	0.93	1.14	47.2
6u	U	All MCs	89	3.3	89	3.3	0.710	19.6	LOS B	6.3	48.9	0.86	0.93	1.14	53.1
Approach			2159	5.1	2159	5.1	0.710	10.2	LOS B	7.1	55.3	0.83	0.83	1.05	51.2
West: Elliot Rd (W)															
7	L2	All MCs	129	3.3	129	3.3	0.423	51.7	LOS E	2.6	20.2	0.97	1.01	1.16	43.1
8	T1	All MCs	371	3.3	371	3.3	0.758	36.5	LOS D	8.1	61.9	0.99	1.32	1.85	32.8
9	R2	All MCs	123	3.3	123	3.3	0.758	38.1	LOS D	5.2	39.7	0.97	1.24	1.68	21.1
Approach			623	3.3	623	3.3	0.758	39.9	LOS D	8.1	61.9	0.98	1.24	1.67	32.8
All Vehicles			5941	4.9	5941	4.9	0.982	28.6	LOS C	23.3	181.7	0.91	1.23	1.94	45.1

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

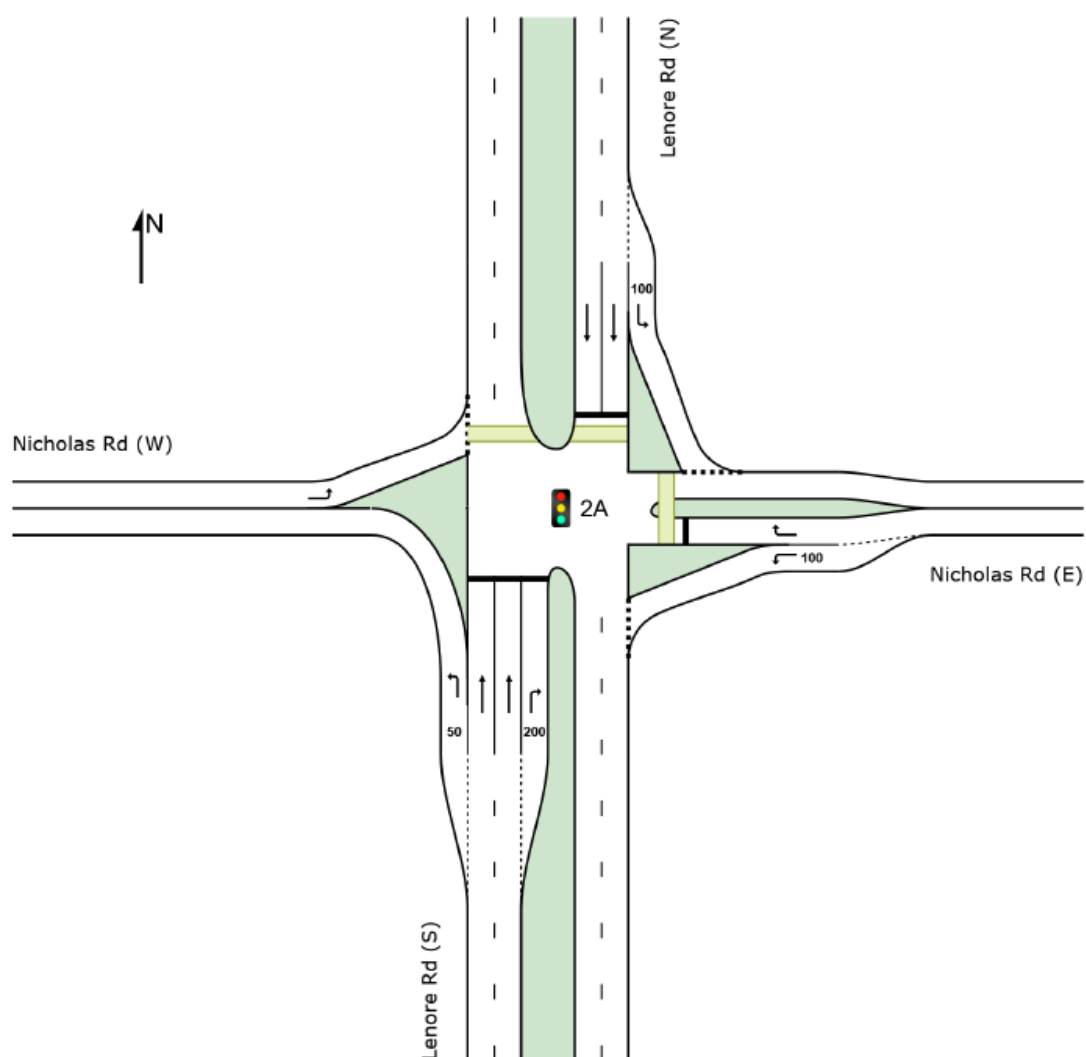


**Figure C2. Lenore Rd / Nicholas Rd signalised intersection layout analysed in
SIDRA**

**Table C2a. SIDRA results – Lenore Rd / Nicholas Rd signalised intersection –
2051 weekday 8-9AM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		[Veh. veh	Dist] m				km/h
South: Lenore Rd (S)															
10	L2	All MCs	31	3.3	31	3.3	0.017	6.9	LOS A	0.0	0.0	0.00	0.57	0.00	47.2
11	T1	All MCs	1219	5.5	1219	5.5	0.428	7.2	LOS A	15.1	117.6	0.38	0.34	0.38	47.8
12	R2	All MCs	233	3.3	233	3.3	*0.920	92.4	LOS F	19.6	149.2	1.00	0.99	1.31	19.8
Approach			1482	5.1	1482	5.1	0.920	20.6	LOS C	19.6	149.2	0.47	0.45	0.51	31.5
East: Nicholas Rd (E)															
1	L2	All MCs	316	3.3	316	3.3	0.663	76.5	LOS E	19.2	146.7	0.95	1.05	0.95	20.7
3	R2	All MCs	63	3.3	63	3.3	*0.874	111.8	LOS F	5.2	39.7	1.00	0.93	1.39	14.9
Approach			379	3.3	379	3.3	0.874	82.4	LOS F	19.2	146.7	0.96	1.03	1.03	16.6
North: Lenore Rd (N)															
4	L2	All MCs	346	3.3	346	3.3	0.237	23.8	LOS C	5.2	39.4	0.25	0.66	0.25	54.7
5	T1	All MCs	2301	5.5	2301	5.5	*0.922	34.0	LOS C	78.0	608.8	0.93	0.88	0.97	40.2
Approach			2647	5.2	2647	5.2	0.922	32.7	LOS C	78.0	608.8	0.84	0.85	0.88	38.1
West: Nicholas Rd (W)															
7	L2	All MCs	11	3.3	11	3.3	0.014	7.4	LOS A	0.1	1.1	0.24	0.55	0.24	27.2
Approach			11	3.3	11	3.3	0.014	7.4	LOS A	0.1	1.1	0.24	0.55	0.24	27.2
All Vehicles			4519	5.0	4519	5.0	0.922	32.8	LOS C	78.0	608.8	0.72	0.74	0.77	33.7
Pedestrian Movement Performance															
Mov ID	Crossing		Dem. Flow	Aver. Delay	Level of Service	AVERAGE BACK OF QUEUE		Prop. Que	Eff. Stop Rate	Travel Time	Travel Dist.	Aver. Speed			
			ped/h	sec		[Ped ped	Dist] m			sec	m	m/sec			
East: Nicholas Rd (E)															
P1	Full		53	9.4	LOS A	0.1	0.1	0.35	0.35	26.1	20.0	0.77			
North: Lenore Rd (N)															
P21	Stage 1		53	49.7	LOS E	0.2	0.2	0.82	0.82	66.4	20.0	0.30			
P22	Stage 2		53	69.3	LOS F	0.2	0.2	0.96	0.96	85.9	20.0	0.23			
All Pedestrians			158	42.8	LOS E	0.2	0.2	0.71	0.71	59.5	20.0	0.34			

**Table C2b. SIDRA results – Lenore Rd / Nicholas Rd signalised intersection –
2051 weekday 3-4PM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		[Veh. veh	Dist] m				km/h
South: Lenore Rd (S)															
10	L2	All MCs	66	3.3	66	3.3	0.037	7.2	LOS A	0.0	0.0	0.00	0.57	0.00	47.2
11	T1	All MCs	2326	5.5	2326	5.5	*0.855	18.4	LOS B	52.3	408.0	0.76	0.70	0.76	36.1
12	R2	All MCs	389	3.3	389	3.3	0.755	57.5	LOS E	24.5	186.9	0.97	0.87	0.99	26.7
Approach			2782	5.1	2782	5.1	0.855	23.8	LOS C	52.3	408.0	0.77	0.72	0.78	28.8
East: Nicholas Rd (E)															
1	L2	All MCs	243	3.3	243	3.3	0.312	27.4	LOS C	10.7	81.5	0.70	0.84	0.70	32.1
3	R2	All MCs	45	3.3	45	3.3	*0.585	82.2	LOS F	3.3	25.0	1.00	0.77	1.06	16.6
Approach			288	3.3	288	3.3	0.585	36.0	LOS D	10.7	81.5	0.75	0.83	0.76	28.0
North: Lenore Rd (N)															
4	L2	All MCs	112	3.3	112	3.3	0.088	21.1	LOS C	2.1	15.7	0.32	0.66	0.32	53.5
5	T1	All MCs	1485	5.5	1485	5.5	0.762	31.0	LOS C	40.3	314.6	0.85	0.78	0.85	40.8
Approach			1597	5.3	1597	5.3	0.762	30.3	LOS C	40.3	314.6	0.81	0.77	0.81	38.9
West: Nicholas Rd (W)															
7	L2	All MCs	11	3.3	11	3.3	0.029	25.2	LOS C	0.4	2.9	0.59	0.63	0.59	13.0
Approach			11	3.3	11	3.3	0.029	25.2	LOS C	0.4	2.9	0.59	0.63	0.59	13.0
All Vehicles			4678	5.1	4678	5.1	0.855	26.7	LOS C	52.3	408.0	0.78	0.74	0.79	33.2
Pedestrian Movement Performance															
Mov ID	Crossing		Dem. Flow	Aver. Delay	Level of Service	AVERAGE BACK OF QUEUE		Prop. Que	Eff. Stop Rate	Travel Time	Travel Dist.	Aver. Speed			
			ped/h	sec		[Ped ped	Dist] m			sec	m	m/sec			
East: Nicholas Rd (E)															
P1	Full		53	18.6	LOS B	0.1	0.1	0.52	0.52	35.2	20.0	0.57			
North: Lenore Rd (N)															
P21	Stage 1		53	31.0	LOS D	0.1	0.1	0.67	0.67	47.6	20.0	0.42			
P22	Stage 2		53	64.3	LOS F	0.2	0.2	0.96	0.96	80.9	20.0	0.25			
All Pedestrians			158	37.9	LOS D	0.2	0.2	0.71	0.71	54.6	20.0	0.37			

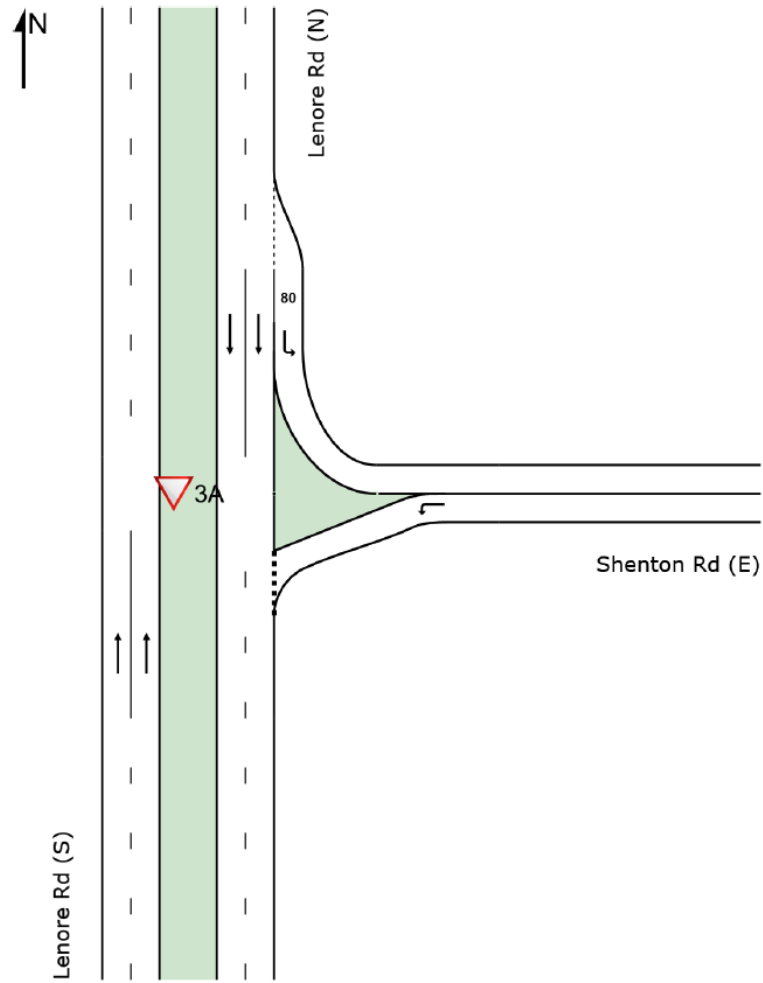


Figure C3. Lenore Rd / Shenton Rd LIFO intersection layout analysed in SIDRA

**Table C3a. SIDRA results – Lenore Rd / Shenton Rd LILO intersection – 2051
weekday 8-9AM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows		Arrival Flows		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			[Total HV]	%	[Total HV]	%	v/c	sec		[Veh. veh	Dist] m				km/h
South: Lenore Rd (S)															
11	T1	All MCs	1482	5.5	1482	5.5	0.399	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.7
Approach			1482	5.5	1482	5.5	0.399	0.1	NA	0.0	0.0	0.00	0.00	0.00	69.7
East: Shenton Rd (E)															
1	L2	All MCs	148	3.0	148	3.0	0.701	43.4	LOS E	3.9	29.8	0.94	1.21	1.79	33.8
Approach			148	3.0	148	3.0	0.701	43.4	LOS E	3.9	29.8	0.94	1.21	1.79	33.8
North: Lenore Rd (N)															
4	L2	All MCs	11	3.0	11	3.0	0.006	6.7	LOS A	0.0	0.0	0.00	0.57	0.00	55.5
5	T1	All MCs	2616	5.5	2616	5.5	0.704	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	68.9
Approach			2626	5.5	2626	5.5	0.704	0.2	NA	0.0	0.0	0.00	0.00	0.00	68.8
All Vehicles			4257	5.4	4257	5.4	0.704	1.7	NA	3.9	29.8	0.03	0.04	0.06	65.3

**Table C3b. SIDRA results – Lenore Rd / Shenton Rd LILO intersection – 2051
weekday 3-4PM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows		Arrival Flows		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			[Total HV]		[Total HV]					[Veh. veh	Dist] m				km/h
			veh/h	%	veh/h	%	v/c	sec							
South: Lenore Rd (S)															
11	T1	All MCs	2783	5.5	2783	5.5	0.749	0.5	LOS A	3.2	25.3	0.00	0.00	0.00	68.6
Approach			2783	5.5	2783	5.5	0.749	0.5	NA	3.2	25.3	0.00	0.00	0.00	68.6
East: Shenton Rd (E)															
1	L2	All MCs	64	3.0	64	3.0	0.134	12.5	LOS B	0.5	3.8	0.66	0.85	0.66	48.9
Approach			64	3.0	64	3.0	0.134	12.5	LOS B	0.5	3.8	0.66	0.85	0.66	48.9
North: Lenore Rd (N)															
4	L2	All MCs	11	3.0	11	3.0	0.006	6.7	LOS A	0.0	0.0	0.00	0.57	0.00	55.5
5	T1	All MCs	1728	5.5	1728	5.5	0.465	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	69.6
Approach			1739	5.5	1739	5.5	0.465	0.1	NA	0.0	0.0	0.00	0.00	0.00	69.5
All Vehicles			4586	5.5	4586	5.5	0.749	0.5	NA	3.2	25.3	0.01	0.01	0.01	68.3

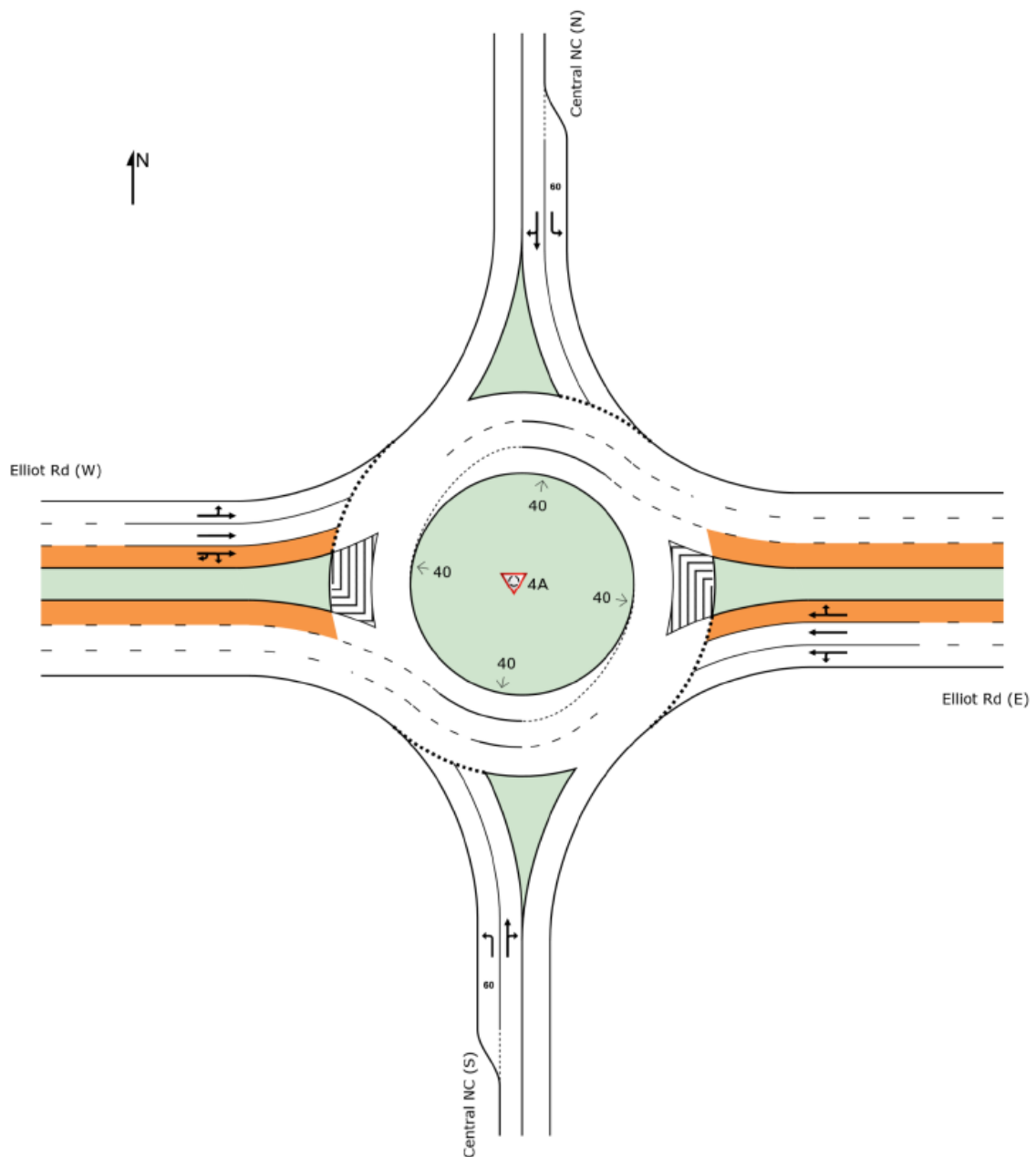


Figure C4. Elliot Rd / central neighbourhood connector roundabout layout analysed in SIDRA



**Table C4a. SIDRA results – Elliot Rd / central neighbourhood connector
roundabout – 2051 weekday 8-9AM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Central NC (S)															
10	L2	All MCs	19	3.3	19	3.3	0.032	7.1	LOS A	0.1	0.7	0.50	0.69	0.50	52.5
11	T1	All MCs	16	3.3	16	3.3	0.094	5.9	LOS A	0.3	2.3	0.47	0.74	0.47	55.7
12	R2	All MCs	78	3.3	78	3.3	0.094	12.7	LOS B	0.3	2.3	0.47	0.74	0.47	51.9
Approach			113	3.3	113	3.3	0.094	10.8	LOS B	0.3	2.3	0.48	0.73	0.48	52.5
East: Elliot Rd (E)															
1	L2	All MCs	43	3.3	43	3.3	0.264	3.9	LOS A	1.7	13.2	0.33	0.35	0.33	56.6
2	T1	All MCs	819	13.2	819	13.2	0.264	3.7	LOS A	1.7	13.2	0.34	0.37	0.34	50.9
3	R2	All MCs	47	3.3	47	3.3	0.117	10.2	LOS B	0.6	6.4	0.36	0.49	0.36	54.4
Approach			909	12.2	909	12.2	0.264	4.1	LOS A	1.7	13.2	0.34	0.37	0.34	51.4
North: Central NC (N)															
4	L2	All MCs	187	3.3	187	3.3	0.170	5.4	LOS A	0.5	4.1	0.40	0.57	0.40	56.4
5	T1	All MCs	38	3.3	38	3.3	0.129	5.9	LOS A	0.4	3.0	0.41	0.68	0.41	56.7
6	R2	All MCs	81	3.3	81	3.3	0.129	12.6	LOS B	0.4	3.0	0.41	0.68	0.41	49.9
Approach			306	3.3	306	3.3	0.170	7.4	LOS A	0.5	4.1	0.40	0.61	0.40	54.6
West: Elliot Rd (W)															
7	L2	All MCs	1	3.3	1	3.3	0.136	2.6	LOS A	0.8	6.1	0.29	0.20	0.29	53.0
8	T1	All MCs	473	18.9	473	18.9	0.136	2.2	LOS A	0.8	6.1	0.31	0.24	0.31	51.4
9	R2	All MCs	20	3.3	20	3.3	0.095	8.0	LOS A	0.5	5.4	0.35	0.45	0.35	53.8
9u	U	All MCs	5	3.3	5	3.3	0.095	12.7	LOS B	0.5	5.4	0.35	0.45	0.35	50.8
Approach			499	18.1	499	18.1	0.136	2.5	LOS A	0.8	6.1	0.31	0.25	0.31	51.5
All Vehicles			1827	11.8	1827	11.8	0.264	4.6	LOS A	1.7	13.2	0.35	0.40	0.35	52.0

**Table C4b. SIDRA results – Elliot Rd / central neighbourhood connector
roundabout – 2051 weekday 3-4PM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Queue Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Central NC (S)															
10	L2	All MCs	24	3.3	24	3.3	0.036	6.6	LOS A	0.1	0.8	0.47	0.67	0.47	52.7
11	T1	All MCs	22	3.3	22	3.3	0.075	5.8	LOS A	0.2	1.8	0.45	0.70	0.45	56.4
12	R2	All MCs	54	3.3	54	3.3	0.075	12.6	LOS B	0.2	1.8	0.45	0.70	0.45	52.5
Approach			100	3.3	100	3.3	0.075	9.6	LOS A	0.2	1.8	0.46	0.70	0.46	53.4
East: Elliot Rd (E)															
1	L2	All MCs	79	3.3	79	3.3	0.248	3.9	LOS A	1.5	12.0	0.30	0.35	0.30	56.7
2	T1	All MCs	745	14.0	745	14.0	0.248	3.7	LOS A	1.5	12.0	0.32	0.37	0.32	51.0
3	R2	All MCs	97	3.3	97	3.3	0.148	10.1	LOS B	0.8	7.6	0.33	0.52	0.33	54.0
Approach			921	12.0	921	12.0	0.248	4.3	LOS A	1.5	12.0	0.32	0.38	0.32	51.8
North: Central NC (N)															
4	L2	All MCs	73	3.3	73	3.3	0.086	6.2	LOS A	0.3	2.1	0.50	0.64	0.50	56.0
5	T1	All MCs	34	3.3	34	3.3	0.076	6.0	LOS A	0.2	1.9	0.48	0.68	0.48	57.1
6	R2	All MCs	40	3.3	40	3.3	0.076	12.7	LOS B	0.2	1.9	0.48	0.68	0.48	50.2
Approach			146	3.3	146	3.3	0.086	7.9	LOS A	0.3	2.1	0.49	0.66	0.49	54.5
West: Elliot Rd (W)															
7	L2	All MCs	15	3.3	15	3.3	0.274	2.8	LOS A	1.7	13.3	0.35	0.23	0.35	52.6
8	T1	All MCs	863	12.8	863	12.8	0.274	2.2	LOS A	1.7	13.3	0.36	0.26	0.36	51.0
9	R2	All MCs	45	3.3	45	3.3	0.127	8.2	LOS A	0.6	6.7	0.38	0.51	0.38	52.5
9u	U	All MCs	13	3.3	13	3.3	0.127	12.9	LOS B	0.6	6.7	0.38	0.51	0.38	49.6
Approach			936	12.1	936	12.1	0.274	2.7	LOS A	1.7	13.3	0.37	0.28	0.37	51.0
All Vehicles			2103	11.0	2103	11.0	0.274	4.1	LOS A	1.7	13.3	0.36	0.37	0.36	51.7

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.

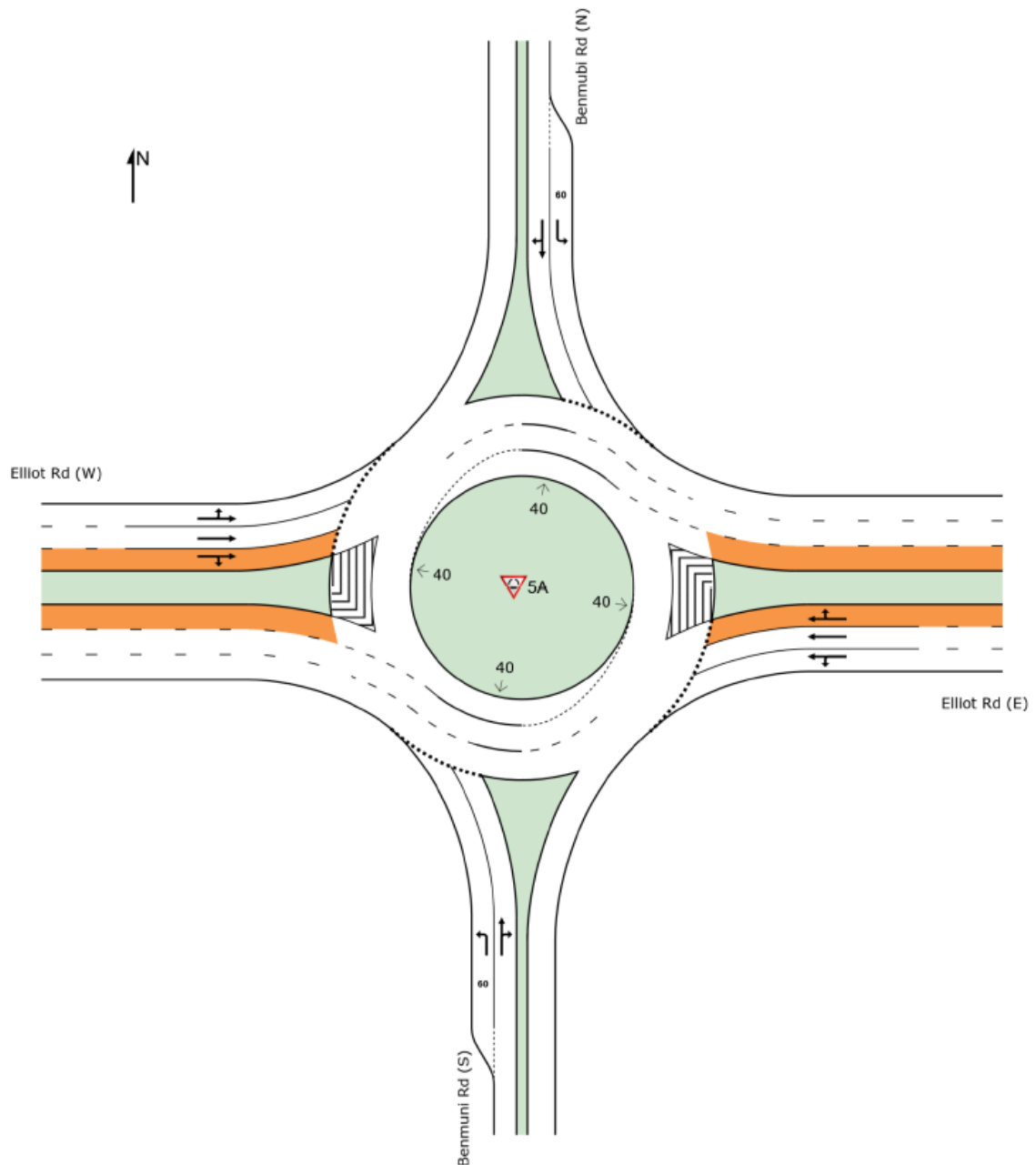


Figure C5. Elliot Rd / Benmuni Rd roundabout layout analysed in SIDRA



**Table C5a. SIDRA results – Elliot Rd / Benmuni Rd roundabout – 2051 weekday
8-9AM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV]		Arrival Flows [Total HV]		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue [Veh. Queue Dist]		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			veh/h	%	veh/h	%	v/c	sec		veh	m				km/h
South: Benmuni Rd (S)															
10	L2	All MCs	1	3.3	1	3.3	0.002	7.2	LOS A	0.0	0.0	0.54	0.59	0.54	52.4
11	T1	All MCs	35	3.3	35	3.3	0.086	6.2	LOS A	0.3	2.3	0.53	0.70	0.53	56.8
12	R2	All MCs	43	3.3	43	3.3	0.086	12.9	LOS B	0.3	2.3	0.53	0.70	0.53	52.8
Approach			79	3.3	79	3.3	0.086	9.9	LOS A	0.3	2.3	0.53	0.69	0.53	54.5
East: Elliot Rd (E)															
1	L2	All MCs	32	3.3	32	3.3	0.227	4.4	LOS A	1.5	11.7	0.48	0.40	0.48	55.7
2	T1	All MCs	644	15.3	644	15.3	0.241	4.4	LOS A	1.5	13.1	0.49	0.43	0.49	50.2
3	R2	All MCs	186	3.3	186	3.3	0.241	10.9	LOS B	1.5	13.1	0.52	0.59	0.52	52.7
Approach			862	12.3	862	12.3	0.241	5.8	LOS A	1.5	13.1	0.50	0.47	0.50	50.9
North: Benmubi Rd (N)															
4	L2	All MCs	160	3.3	160	3.3	0.195	6.2	LOS A	0.7	5.0	0.49	0.65	0.49	56.0
5	T1	All MCs	16	3.3	16	3.3	0.279	5.9	LOS A	1.0	7.9	0.50	0.75	0.50	55.0
6	R2	All MCs	268	3.3	268	3.3	0.279	12.7	LOS B	1.0	7.9	0.50	0.75	0.50	48.6
Approach			444	3.3	444	3.3	0.279	10.1	LOS B	1.0	7.9	0.50	0.71	0.50	51.2
West: Elliot Rd (W)															
7	L2	All MCs	131	3.3	131	3.3	0.270	3.1	LOS A	1.8	13.8	0.45	0.31	0.45	52.1
8	T1	All MCs	681	14.8	681	14.8	0.270	2.8	LOS A	1.8	13.8	0.47	0.33	0.47	50.6
9	R2	All MCs	5	3.3	5	3.3	0.094	8.6	LOS A	0.5	5.8	0.48	0.47	0.48	54.0
Approach			817	12.9	817	12.9	0.270	2.9	LOS A	1.8	13.8	0.47	0.33	0.47	50.9
All Vehicles			2202	10.4	2202	10.4	0.279	5.7	LOS A	1.8	13.8	0.49	0.47	0.49	51.1

**Table C5b. SIDRA results – Elliot Rd / Benmuni Rd roundabout – 2051 weekday
3-4PM peak**

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV] veh/h %		Arrival Flows [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. Dist] veh m		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Benmuni Rd (S)															
10	L2	All MCs	1	3.3	1	3.3	0.002	7.3	LOS A	0.0	0.0	0.55	0.60	0.55	52.3
11	T1	All MCs	42	3.3	42	3.3	0.101	6.3	LOS A	0.4	2.8	0.56	0.70	0.56	56.8
12	R2	All MCs	47	3.3	47	3.3	0.101	13.0	LOS B	0.4	2.8	0.56	0.70	0.56	52.8
Approach			91	3.3	91	3.3	0.101	9.8	LOS A	0.4	2.8	0.56	0.70	0.56	54.6
East: Elliot Rd (E)															
1	L2	All MCs	41	3.3	41	3.3	0.256	4.4	LOS A	1.7	13.6	0.49	0.40	0.49	55.7
2	T1	All MCs	712	14.4	712	14.4	0.275	4.4	LOS A	1.7	15.1	0.50	0.44	0.50	50.1
3	R2	All MCs	226	3.3	226	3.3	0.275	10.9	LOS B	1.7	15.1	0.54	0.60	0.54	52.5
Approach			979	11.4	979	11.4	0.275	5.9	LOS A	1.7	15.1	0.51	0.47	0.51	50.9
North: Benmubi Rd (N)															
4	L2	All MCs	177	3.3	177	3.3	0.223	6.4	LOS A	0.8	6.1	0.54	0.66	0.54	55.8
5	T1	All MCs	47	3.3	47	3.3	0.284	6.1	LOS A	1.1	8.5	0.55	0.75	0.55	55.4
6	R2	All MCs	227	3.3	227	3.3	0.284	12.8	LOS B	1.1	8.5	0.55	0.75	0.55	48.9
Approach			452	3.3	452	3.3	0.284	9.6	LOS A	1.1	8.5	0.54	0.72	0.54	52.1
West: Elliot Rd (W)															
7	L2	All MCs	211	3.3	211	3.3	0.345	3.4	LOS A	2.4	19.0	0.53	0.36	0.53	51.8
8	T1	All MCs	776	13.6	776	13.6	0.345	3.1	LOS A	2.4	19.0	0.54	0.37	0.54	50.2
9	R2	All MCs	12	3.3	12	3.3	0.103	8.9	LOS A	0.5	6.2	0.52	0.51	0.52	53.3
Approach			998	11.3	998	11.3	0.345	3.2	LOS A	2.4	19.0	0.54	0.37	0.54	50.6
All Vehicles			2519	9.6	2519	9.6	0.345	5.6	LOS A	2.4	19.0	0.53	0.48	0.53	51.1