Berwick Waterways
Precinct Structure Plan
Transport Assessment

transportation planning, design and delivery

14M1235000 02/05/14

GTAconsultants

Berwick Waterways

Precinct Structure Plan

Transport Assessment

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1. Introduction

1.1 Background

The Berwick Waterways Precinct Structure Plan (PSP) is in the process of being developed for subsequent adoption into the Casey Planning Scheme via an amendment process. The PSP is currently being prepared by the Metropolitan Planning Authority (MPA previously MPA) in conjunction with Council, VicRoads, other agencies, authorities and major stakeholders.

The precinct is envisaged to cater for some 1,000 residential dwellings and a Local Town Centre (LTC).

1.2 Purpose of this Report

GTA Consultants (GTA) has been engaged to undertake strategic transport modelling and translate the outputs into traffic demands that are used to determine the road cross section and functional intersection design requirements for an interim (2026) and ultimate (2046) scenario. The layouts will then be used as input into the preparation of the Development Contributions Plan (DCP).

This report sets out the methodology undertaken to determine the demand volumes and layout plans.

1.3 Referenced Documents

In preparing this report, reference has been made to a number of sources, including:

- the City of Casey Planning Scheme
- various MPA plans for the PSP
- the MPA Victorian Integrated Transport Model (VITM) for Melbourne's South-East Growth Corridor
- various technical data as referenced in this report
- other documents as nominated.

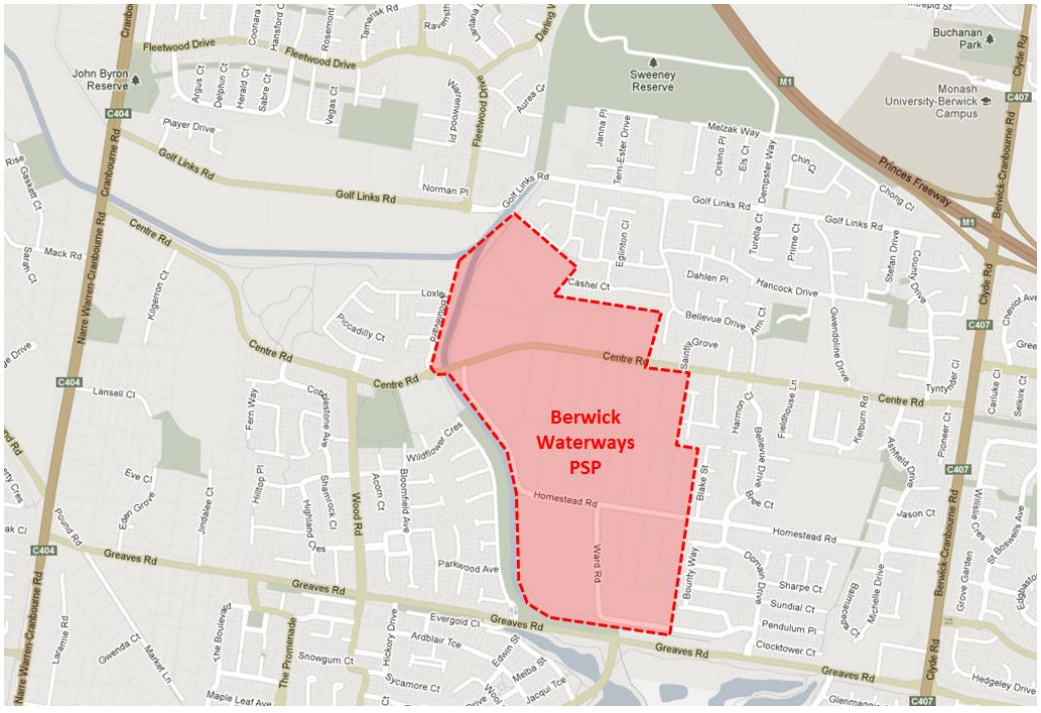
1.4 South East Growth Corridor

The location of the Berwick Waterways PSP (PSP 09) in relation to the wider South East Growth Corridor is illustrated in Figure 1.1, and the existing road network in the vicinity of the PSP is shown in Figure 1.2.

Figure 1.1: Berwick Waterways PSP Location

Source: MPA website

Figure 1.2: Site Location



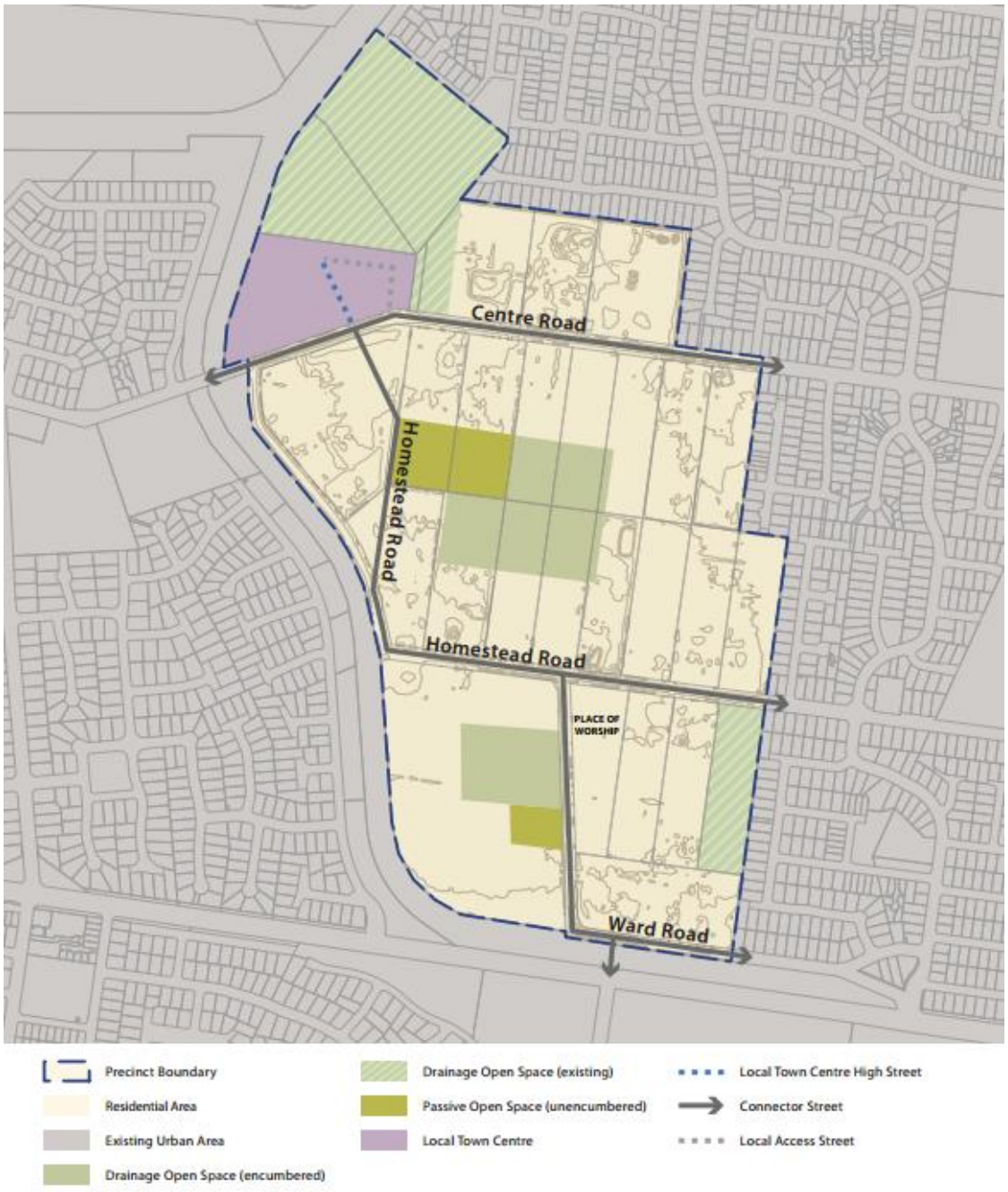
Base map courtesy of Google maps

2. PSP Overview

2.1 PSP Layout and Land Uses

The indicative Masterplan for the Berwick Waterways PSP is shown in Figure 2.1.

Figure 2.1: Indicative Masterplan



As shown in Figure 2.1, the PSP includes a Local Town Centre (LTC) which is approximately 8,500sqm in size (located to the north of Centre Road) and approximately 1,000 households. Access to the precinct is proposed via connections to Homestead Road, Ward Road, Centre Road and Greaves Road.

3. Existing and Future Road Network

3.1 Existing Traffic Volumes

The location of the PSP with respect to the wider road network is shown in Figure 1.2.

The PSP connects to the wider arterial road network via intersections with Greaves Road and Centre Road, with Homestead Road and Ward Road running through the PSP area.

Existing traffic volume data for Homestead Road, Centre Road and Greaves Road has been provided by City of Casey Council and is summarised in Table 3.1.

Table 3.1: Existing Traffic Volumes

Road	Location	AM Peak Hour [1]	PM Peak Hour [1]	Daily	Count Date
Greaves Road	East of Moondarra Drive	1,620	1,490	17,770	February 2012
Centre Road	East of County Drive	990	1,050	11,930	March 2012
Centre Road	East of Narre Warren-Cranbourne Road	1,010	860	9,660	March 2012
Homestead Drive	East of Bellevue Drive	180	200	2,030	September 2012

[1] Weekday average volume based on count data provided by MPA/Council

It is recognised that the traffic data is limited in the vicinity of the development plan area, however for the purposes of assisting with a relative comparison to projected volumes discussed later in this report.

The daily volumes outlined in Table 3.1 indicate that the surveyed roads are currently operating as the MPA classifications outlined in Table 3.2:

Table 3.2: Existing Road Classifications and Classifications based on Traffic Volumes

Road	Current Classification	MPA Classification based on Existing Traffic Volumes	Comments
Homestead Road	Collector Road (local Council)	Access Street – Level 2	Volumes are reflective of the current classification
Centre Road	Major Road (local Council)	higher order Connector Street /lower order Secondary Arterial Road	Volumes are reflective of the current classification
Greaves Road	Major Road (local Council)	Secondary Arterial Road	Existing daily volumes on Greaves Road indicate that it is nearing the capacity of a 2-lane road and will require an upgrade to a 4-lane road.

3.2 Future Road Network

3.2.1 Overview

To support ongoing growth in the South-East Growth Corridor a number of long term road network improvements are proposed, key improvements in the vicinity of the Berwick Waterways PSP are summarised in Table 3.3.

Table 3.3: Anticipated Ultimate (2046) Road Network Features

Road	Location	Existing Configuration	Ultimate Configuration
Greaves Road	Between Clyde Road and Narre Warren-Cranbourne Road	2 lanes	4 lanes
Centre Road	Between Clyde Road and Narre Warren-Cranbourne Road	2 lanes	2 lanes
Narre Warren-Cranbourne Road	North of Greaves Road	4 lanes	6 lanes
Clyde Road	North of Greaves Road	6 lanes	6 lanes

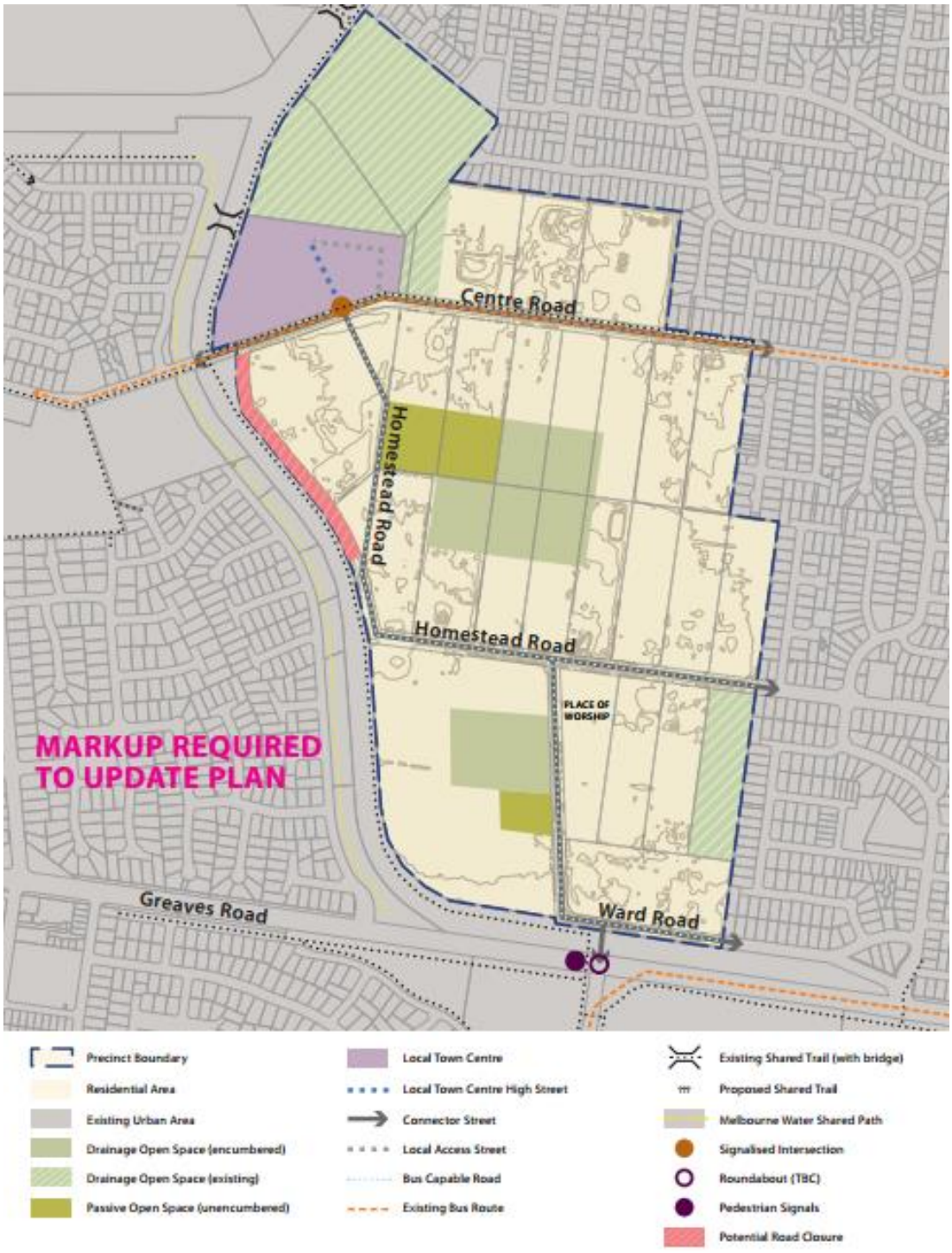
After discussion with Council, it was confirmed that Centre Road is planned to remain in its current configuration of one lane in each direction up to 2046.

4. PSP Road Network

4.1 Road Hierarchy

The anticipated road network, hierarchy and arterial road connections are illustrated in Figure 4.1.

Figure 4.1: PSP Road Network and Connections



The PSP proposes a road hierarchy that utilises existing roads where possible. Both Greaves Road will ultimately be upgraded to an arterial road and controlled by VicRoads, whilst s as outlined in Section 3.2. The interim PSP road network is anticipated to operate satisfactory given the anticipated PSP traffic generation which is discussed in Section 6.

4.2 Anticipated PSP Cross Sections

The MPA has a series of road cross sections for PSPs. These cross sections will be applied to the Berwick Waterways PSP, noting that there will be requirements for flaring/widening at intersections.

Table 4.1 sets out the proposed ultimate road reserve widths by road type and cross section name to link to MPA road cross section terminology with the appropriate Planning Scheme reference.

Table 4.1: Berwick Waterways PSP Road Cross Sections (Ultimate)

Road	No. Lanes (two way)	MPA Road Cross-Section Title	Planning Scheme Clause 56.06 Reference
Greaves Road	6	Primary Arterial Road	Arterial Road
Centre Road	2	Secondary Arterial Road	Arterial Road
Homestead Road	2	Connector Street	Connector Street – Level 2
Ward Road			
N-S Connector (between Greaves Road and Homestead Road)			
LTC Main Access Street	2	Connector Street in LTC	Connector Street – Level 2

It is highlighted that Centre Road is likely to function in accordance with an arterial road which will likely require an ultimate cross section of two lanes in each direction. Nevertheless, at the direction of Council officers, this assessment only considered the operation of the new intersection with Centre Road with one lane in each direction.

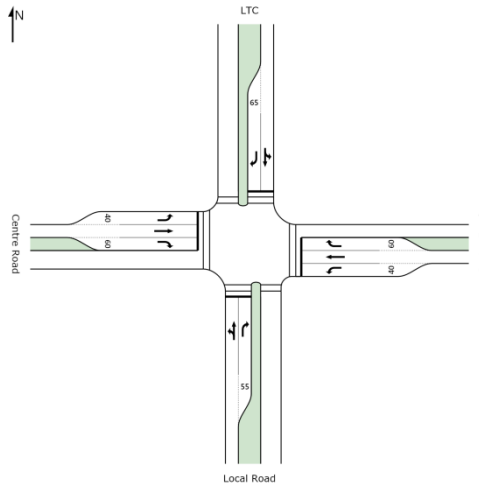
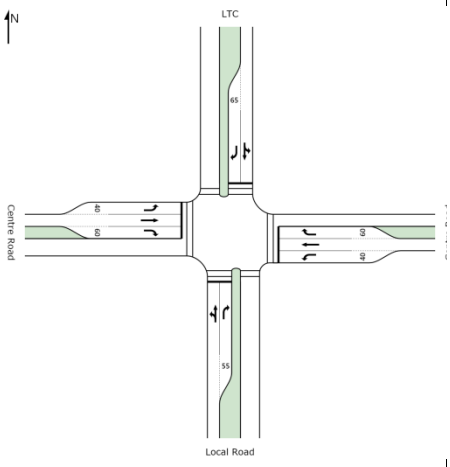
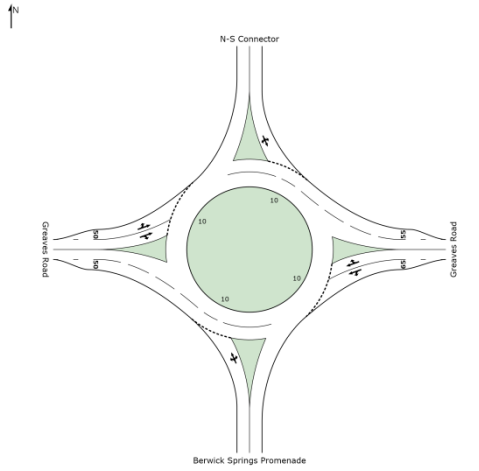
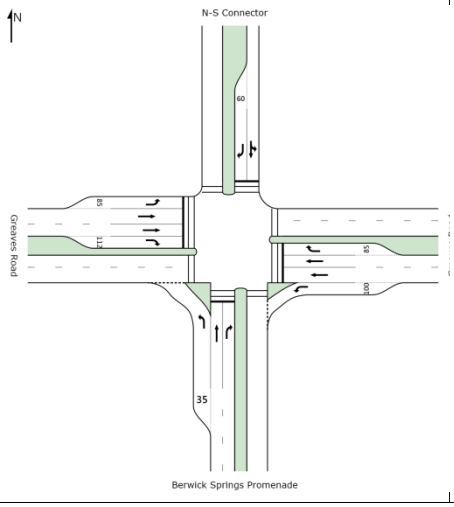
4.3 Anticipated Interim and Ultimate Intersection Provisions

4.3.1 Interim verses Ultimate Intersection Provisions

Both the ultimate and interim traffic volumes are presented in this Report (see Section 6). The interim (2026) volumes are used to inform intersection works up to the interim scenario for inclusion into the Development Contributions Plan (DCP), whilst the ultimate volumes are used to validate the provision of ultimate road reserve (including flaring) at intersections.

Table 4.2 summarises the anticipated layouts (based on SIDRA modelling outlined later in Section 7) and differences between the DCP intersections in the interim and ultimate cases.

Table 4.2: Interim and Ultimate Intersection Requirements

Intersection	Interim Layout	Ultimate Layout	Comments
Centre Road/ Homestead Road/ LTC Main Access			Centre Road is duplicated in the ultimate case. A left turn slip lane is not provided on the north approach given the anticipated pedestrian activity associated with the LTC.
Greaves Road/ Berwick Springs Promenade/ N-S Connector			Greaves Road is widened from 4 – lanes in the interim case to 6 – lanes in the ultimate case. A signalised intersection rather than a roundabout is proposed in the interim as it delivers increased capacity and pedestrian crossing facilities.

5. Transport Modelling

5.1 South-East Growth Corridor Victorian Integrated Transport Model (VITM)

In 2012 MPA commissioned AECOM to calibrate and refine the Department of Transport's (DoT) Victorian Integrated Transport Model (VITM) for Melbourne's South-East Growth Corridor. The refinements to VITM included the following:

- disaggregation of the zone system within the growth corridor
- updates to the future modelled land use yields to reflect the level of growth predicted by the MPA within the corridor
- updates to the road network within the corridor.

The purpose of the project was to provide a strategic model of the South-East Growth Corridor which could be to understand the transport needs of the MPA, Casey City Council, Cardinia City Council and VicRoads for projects (such as PSPs) within the corridor.

The result of the analysis looks at the operation of the arterial road network as a result of planned growth and is referred to as the MPA VITM hereafter.

5.2 GTA Road Network Refinements

GTA obtained a copy of MPA VITM and has used it in the assessment of the Berwick Waterways PSP. For the purposes of this assessment the following network refinements were made to the MPA VITM (both the base year and 2046 models):

- the addition of Homestead Drive
- refinement of the zone centroid connection locations for the PSP zones (i.e. zones 2337 and 2447)
- the addition of a new zone (3064) which represents the local activity centre.

The extent of the GTA network refinements are shown in Figure 5.1and Figure 5.2.

Figure 5.1: MPA VITM Coding in the Study Area

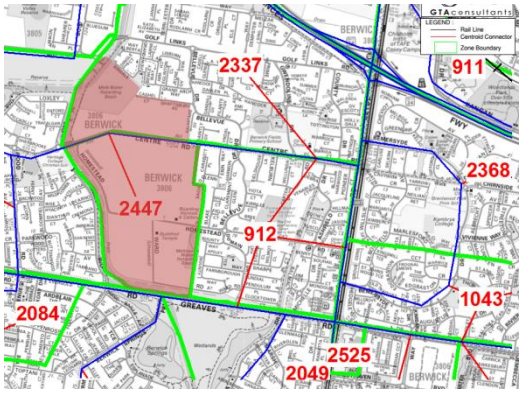
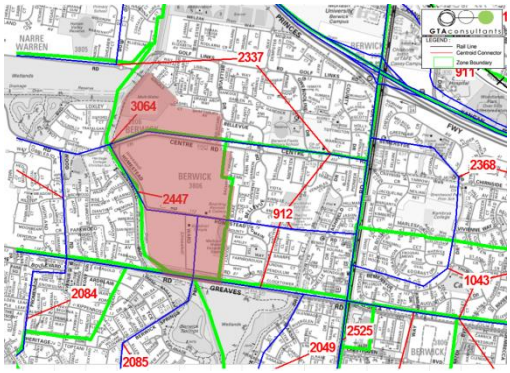


Figure 5.2: GTA VITM Coding Refinements



The GTA refinements were made to enhance how the MPA VITM reflected the likely access arrangements for the Berwick Waterways PSP. It is highlighted that the GTA refinements did not result in any noteworthy changes to the MPA base year and 2046 VITM output volumes beyond the bounds of the local study area, as this was outside of the scope of this study.

5.3 Review of Base Year VITM Volumes

In order to confirm the suitability of the model for testing the future traffic impacts of the Berwick Waterways PSP, GTA undertook an assessment of base year modelled verses surveyed traffic volumes in the vicinity of the PSP area. The findings of this assessment are summarised in Table 5.1.

Table 5.1: Modelled versus Surveyed Traffic Volumes

Road Name	Location	Surveyed Two-way Traffic Volume			VITM Two-way Traffic Volume (2011)			% Difference		
		AM Peak Hour (veh/hr)	PM Peak Hour (veh/hr)	Daily (veh/day)	AM Peak Hour [1] (veh/hr)	PM Peak Hour [1] (veh/hr)	Daily (veh/day)	AM Peak Hour (veh/hr)	PM Peak Hour (veh/hr)	Daily (veh/day)
Greaves Road	East of Moondarra Drive	1,620	1,490	17,770	1,325	1,492	14,000	-22%	0%	-27%
Centre Road	East of County Drive	990	1,050	11,930	1,086	1,238	12,600	9%	15%	5%
Centre Road	East of Narre Warren-Cranbourne Road	1,010	860	9,660	855	993	9,500	-18%	13%	-2%
Homestead Road	East of Bellevue Drive	180	200	2,030	175	207	1,800	-3%	3%	-13%

[1] 1-hour peak volume determined by factoring the 2-hour peak VITM output volumes by 0.55.

Table 5.1 shows that VITM is slightly overestimating volumes during the PM peak and is generally underestimating volumes on a daily and AM peak hour basis. It is however highlighted that VITM is a strategic model for which the base year has been calibrated/validated across the South-East Growth Corridor rather than at a local level.

The notable differences (i.e. greater than 15%) in the surveyed verses modelled volumes have been considered in the intersection assessments (outlined later in Section 7) through the process of determining intersection traffic demands. Nevertheless, from a strategic transport modelling perspective, the volumes generally represent a good correlation to existing volumes.

5.4 2046 Landuse Refinements

The land uses modelled for the Berwick Waterways zones (zones 2337 and 2447) in the MPA VITM were adjusted to reflect the level of development envisaged by the PSP. The modelled land use inputs are separated out into population, the number of residential dwellings, the number of jobs, and the number of educational enrolments. In addition, a new zone (3064) was added to the model to represent the activity and retail centre on the north side of Centre Road.

The adjustments to the land uses are summarised in Table 5.2.

Table 5.2: Modelled Land Uses

PSP	MPA VITM ZONE	MPA VITM Land Uses [1]				GTA Refined VITM Land Uses			
		Pop	HH	Emp	Enrol	Pop	HH	Emp	Enrol
Berwick Waterway (PSP 9)	2337	4,119	1,496	539	529	4,119	1,496	0	529
	2447	1,744	638	211	0	2,575	942	211	0
	3064	n/a	n/a	n/a	n/a	116	42	539	0
	Total	**5,863**	**2,134**	**750**	**529**	**6,810**	**2,480**	**750**	**529**

[1] Pop = Population, HH = number of Households, Emp = number of jobs, Enrol = number of education enrolments
[2] Enrolments are associated with the Berwick Fields Primary School adjacent to the PSP area

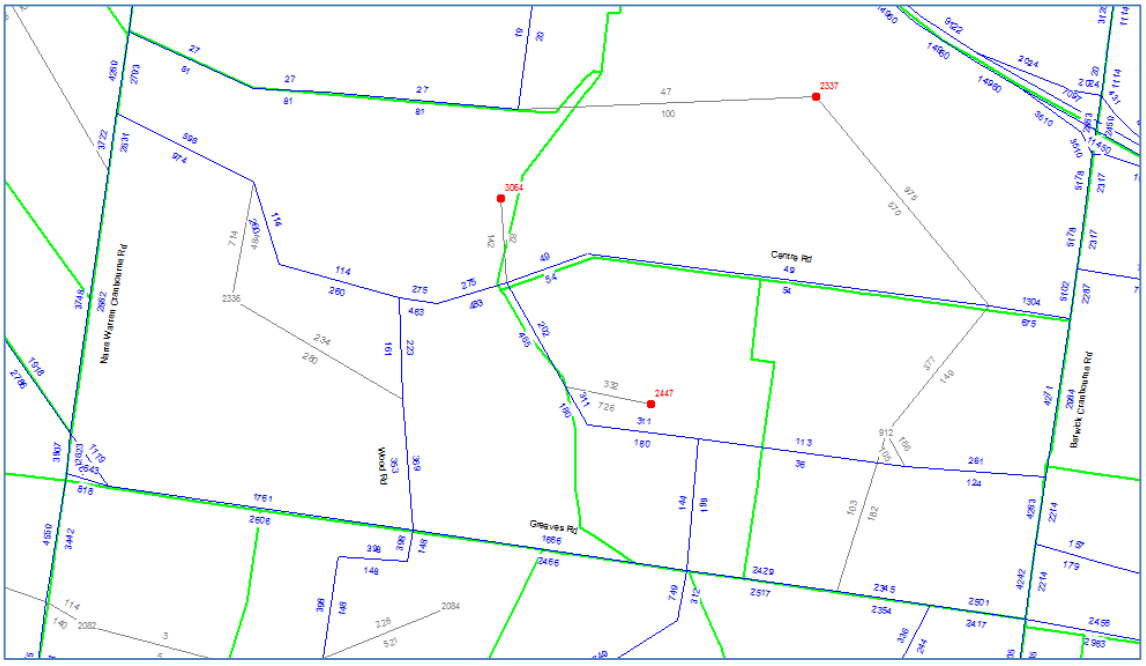
As shown in Table 5.2, the GTA land use refinements entailed increasing the number of households in Zone 2447 to reflect the number of households envisaged by the PSP. The population for the zone was also factored by 2.78 people per dwelling[1] accordingly.

The land uses for Zone 2337 (previously shown in Figure 5.2) were adjusted with zone 3066 to account for the activity centre, or local town centre. Zone 2337 also includes Berwick Felids Primary school and residential areas (comprising of some 1,500 households in 2046), which is outside of the PSP area.

5.5 2046 VITM Traffic Volume Outputs

The 2046 GTA VITM volume output maps for the 2-hour AM and PM peaks are shown in Figure 5.3 and Figure 5.4 respectively, with enlarged plots included in Appendix A.

Figure 5.3: GTA VITM Volume Output – 2046 AM 2-Hour Peak



[1] Based on the existing population density coded in VITM for the PSP zones

Figure 5.4: GTA VITM Volume Output – 2046 PM 2-Hour Peak

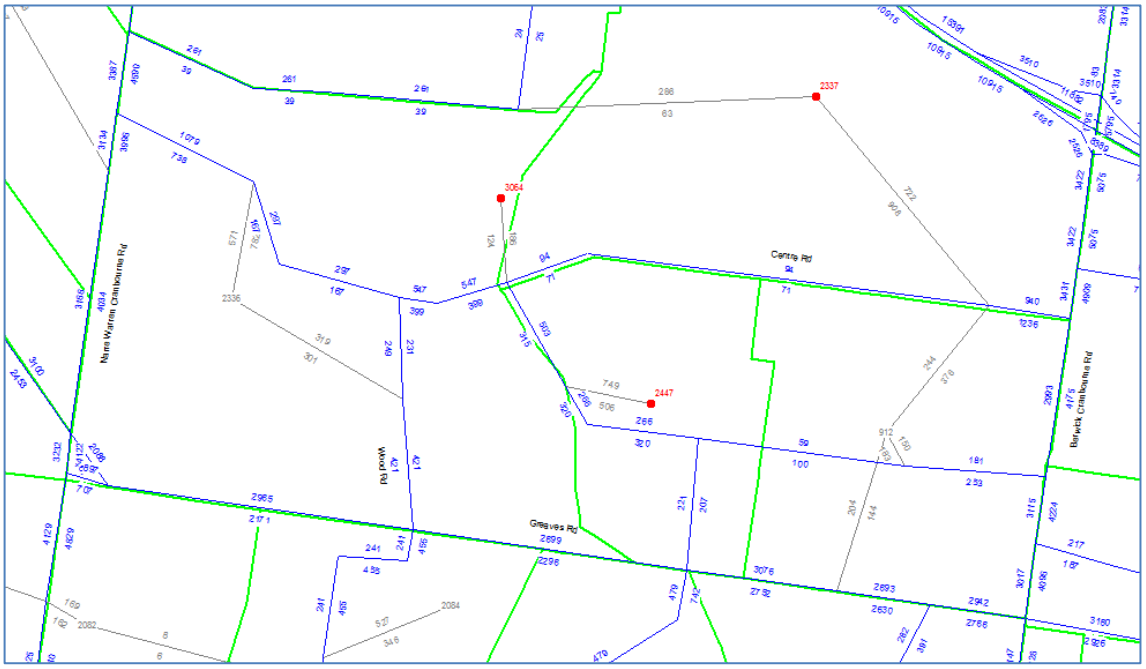


Figure 5.3 and Figure 5.4 indicate that the PSP land uses (and the existing land uses within Zone 2337) will generate some 2,974 and 3,545 vehicles for the AM and PM 2-hour peak periods respectively.

It is highlighted that some of the key roads surrounding the PSP are not anticipated to significantly increase in volumes above their current levels. Review of the model outputs show that these are generally consistent with the entire volumes across the entire VITM network, which are not anticipated to significantly increase.

This is due to an expected increase in mode share by 2046 as well as highlighting that a high proportion of the road network is currently approaching or will be at capacity. Nevertheless, the outputs obtained from VITM for this assessment are considered suitable for the purposes of determining intersection configurations as documented in Section 7.

6. Anticipated Traffic Volumes

6.1 GTA VITM Traffic Generation

Table 6.1 lists the inputs and outputs of the GTA VITM modelling. It shows the AM and PM 2-hour peak and daily traffic generation at the individual zone level along with the corresponding land use inputs.

Table 6.1: Updated VITM Traffic Generation

PSP	VITM Zone	Land Use			AM 2 hr Trips	PM 2 Hr Trips	Daily Vehicle Trips
		Residential (hh)	Employment (jobs)	Schools (enrolments)			
Berwick Waterways (PSP 9)	2337	1,496	0	529	1,692	1,980	10,600
	2447	942	211	n/a	1,058	1,255	6,800
	3064	42	539	0	225	310	1,600
	Total	**2,480**	**750**	**529**	**2,974**	**3,545**	**19,000**

Table 6.1 indicates an expected traffic generation of 19,000 vpd, and 2,974 and 3,545 vehicles for the AM and PM 2-hour peak periods respectively for the PSP area and established residential area to the north of Centre Road.

Adopting a typical (industry standard) two-hour to peak hour factor of 0.55, the zones representing Berwick Waterways are anticipated to generate in the order of 1,640 vehicles in the AM peak hour and 1,950 vehicles in the PM peak hour.

6.2 Validation of VITM Traffic Generation Rates

6.2.1 First Principles Generation Rates

A summary of the individual land uses and the resulting first principles traffic generation for the study area is provided in Table 6.2. This assessment compares the modelled traffic volume outputs to commonly used generation rates as confirmation that VITM is generating realistic traffic demands.

Table 6.2: First Principals Traffic Generation Assessment

Area	Land Use	Yield	Traffic Generation Rate			Reduction Factor for Internal Trips	Resultant Trips		
			AM (1hr)	PM (1hr)	Daily		AM (1hr)	PM (1hr)	Daily
Berwick Waterways PSP (Zone 2447 & 3064)	Residential [1]	984 dwellings	0.45 trips/hh	0.45 trips/hh	4.5 trips/hh	n/a	443	443	4,428
	Activity Centre (LTC)	5000 sqm	0.5 trips/100 sqm [3]	12.1 trips/100 sqm [3]	121 trips/100 sqm [3]	n/a	25	605	6,050
Surrounding areas (Zone 2337)	Residential	1496 dwellings	0.45 trips/hh	0.45 trips/hh	4.5 trips/hh	25% [4]	505	505	5,049
	School	529 enrolments	0.75 trips/ enrol [5]	0 trips/ enrol [5]	1.5 trips/ enrol [5]	n/a	397	-	794
Total							**1,369**	**1,553**	**16,321**

[1] Daily rate based on VISTA 09 data for the Casey LGA, with the peak hour rates assumed to be 10% of the daily rate.
[2] The LTC is anticipated to provide for some 270 jobs based on information provided by the MPA. The remaining 480 jobs modelled in Zone 2337 and 2447 are assumed to be related with the school, other non-residential use employment and home-based employment.

[3] Daily rate sourced from the RTANSW "Guide to Traffic Generating Developments" report (dated October 2002) with PM peak hour rate assumed to be 10% of the daily rate. An AM rate of 0.5 trips/100sqm has been adopted for service vehicle movements given that the LTC will not be fully operational during the AM peak hour.

[4] Based on Section 3.3 of the RTANSW "Guide to Traffic Generating Developments" report. It is assumed that 25% of all trips within Zone 2337 will be internal to the zone given that the zone includes a LTC and school. The reduction factor has not been applied to Zone 2447 as it includes residential uses only.

[5] Based on a first principals assessment

It is highlighted that the first principles assessment outlined in Table 6.2 takes into consideration the results of the Victorian Integrated Survey of Travel and Activity 2009 (VISTA09) undertaken by the DoT. VISTA09 is a comprehensive survey of how, when and why Victorians travel and is both more recent and locality specific than most other available empirical data sources. The average VISTA09 traffic generation rate of 4.5 movements per dwelling for the Casey LGA is lower than other empirical data sources which generally have a daily generation rate in the order of 8.0 vehicle movements per dwelling. The lower VISTA 09 generation rate can be partially attributed to a shift in mode choice away from private vehicle use, a trend that can be seen in Census data from 1996 to 2011.

6.2.2 Comparison of VITM and First Principals Volume Analysis

A comparison of the GTA VITM generation and first principles generation assessment is provided in Table 6.3.

Table 6.3: VITM verses First Principles Assessment

Traffic Volumes	AM Peak	PM Peak	Daily
VITM	1,640	1,950	19,000
First Principle Assessment	1,369	1,553	16,321
% Difference	119%	126%	116%

Table 6.3 show that the forecast GTA VTIM traffic demands are generally within -30% to those of a first principles assessment, noting that some of the land use rates and yields can vary depending on the ultimate mix and density of development, and the strategic nature of VITM. It is noted that the GTA VITM AM, PM and Daily periods produce conservatively high traffic demands when compared with the first principles assessment.

It is clear that the GTA VITM volumes are conservatively higher than the first principles assessment, as such the GTA VITM outputs **have been used for further testing** to determine the PSP generated demand on the road network at a precinct structure planning level. Utilising the VITM traffic generation, the site will exhibit comparative first principle generation rates closer to 0.6 movements per household in the AM and PM peak periods, and some 6 trips per household over the entire day.

6.3 Daily Modelled Volumes

Based on the outcomes of the GTA VITM modelling, the expected two-way daily traffic volumes on key roads in and around the study area for 2046 are summarised in Table 6.4.

Table 6.4: Summary of Ultimate Daily Volumes on Key Roads (2046)

Road Name	Location	Expected Daily Traffic Volume	Proposed Classification and No. lanes	Daily Traffic Volume Limit Associated with Classification	Austroads Capacity Limit (based on No. lanes) [1]	Proposed Classification is Considered Appropriate?
Greaves Road	West of Clyde Road	29,800	Primary Arterial (6 lanes)	Greater than 30,000vpd	54,000vpd	Yes
Greaves Road	East of Narre Warren-Cranbourne Road	27,000	Primary Arterial (6 lanes)	Greater than 30,000vpd	54,000vpd	Yes
Centre Road	West of Clyde Road	12,500	Secondary Arterial (4 lanes)	12,000 to 40,000vpd	18,000vpd	Yes – noting that VITM appears to be underestimating existing volumes on Centre Road by approximately 25%
Centre Road	East of Narre Warren-Cranbourne Road	10,000	Secondary Arterial (4 lanes)	12,000 to 40,000vpd	18,000vpd	
Homestead Road	East of Bellevue Drive	2,300	Connector Street (2 lanes)	3,000 to 7,000vpd	18,000vpd	Yes
Homestead Road	South of Centre Road	4,300	Connector Street (2 lanes)	3,000 to 7,000vpd	18,000vpd	Yes
LTC Main Access	North of Centre Road	7,420	Connector Street in Local Town Centre (2 lanes)	3,000 to 7,000vpd	18,000vpd	Yes, given that additional capacity will be provided near the intersection with Centre Road.
North South Connector	North of Greaves Road	2,500	Connector Street (2 lanes)	3,000 to 7,000vpd	18,000vpd	Yes
Clyde Road	Between Greaves Road and Centre Road	41,500	Primary Arterial (6 lanes)	Greater than 30,000vpd	54,000vpd	Yes
Narre Warren-Cranbourne Road	Between Greaves Road and Centre Road	41,400	Primary Arterial (6 lanes)	Greater than 30,000vpd	54,000vpd	Yes

[1] Capacity limits scoured from Austroads Standards "Guide to Traffic Management – Part 3 Traffic Studies and Analysis" document from Table 4.3 as follows: 2-lane road: 18,000vpd, 4–lane road: 36,000vpd, 6-lane road 54,000vpd.

[2] 30% of the traffic generated by VITM zone 2337 is assumed to be non-PSP traffic and is anticipated to use County Drive, Gwendoline Drive and Bellevue Drive to access Centre Road.

As shown in Table 6.4 the proposed road classifications align with the daily traffic volume ranges associated with the classification and Austroads based road capacity limits.

7. Intersection Assessment

7.1 Methodology

7.1.1 Overview

The VITM is a strategic network model and hence care needs to be exercised in extracting volumes on individual road links or turning flows at intersections. The approach adopted in arriving at the turning flows for the purpose of intersection modelling is as follows:

- Extract the 2046 AM and PM 2-hour turning volumes at each of the intersections and convert to peak hour volumes using the 0.55 conversion factor.
- Assess each intersection individually to check that the turning volumes are reasonable having regard for the surrounding road network, and adjacent activity nodes (schools and activity centres) and make changes where appropriate.
- Derive 2026 interim background volumes by factoring the ultimate background volumes by 0.8.
- Create SIDRA intersection models for the interim and ultimate configurations and report outputs such as level of service (LOS), degree of Saturation (DOS), queues, delays and critical approaches.
- Manual adjustments to and from the Local Town Centre have also been undertaken to account for the likely traffic and use/distributions, to the PSP.

7.1.2 Ultimate (2046) verses Interim (2026) Background Volumes

In order to determine the 2026 background volumes, the 2046 volumes have been factored by 0.8 (20% reduction) to take into account traffic growth that is likely to occur between 2026 and 2046.

It is noted that only the background volumes on the arterial road network have been factored. The traffic volumes generated by the PSP have not been reduced in the interim scenario in order to account for all the PSP generated traffic in the DCP analysis. This assumes full development of the site by 2026.

7.1.3 Anticipated Traffic Distribution

The 2046 traffic distributions (based on the zones 2447, 2337 and 3064) determined from the VITM models for the AM and PM peak periods are shown in Figure 7.1.

Figure 7.1: Anticipated PSP Traffic Distribution

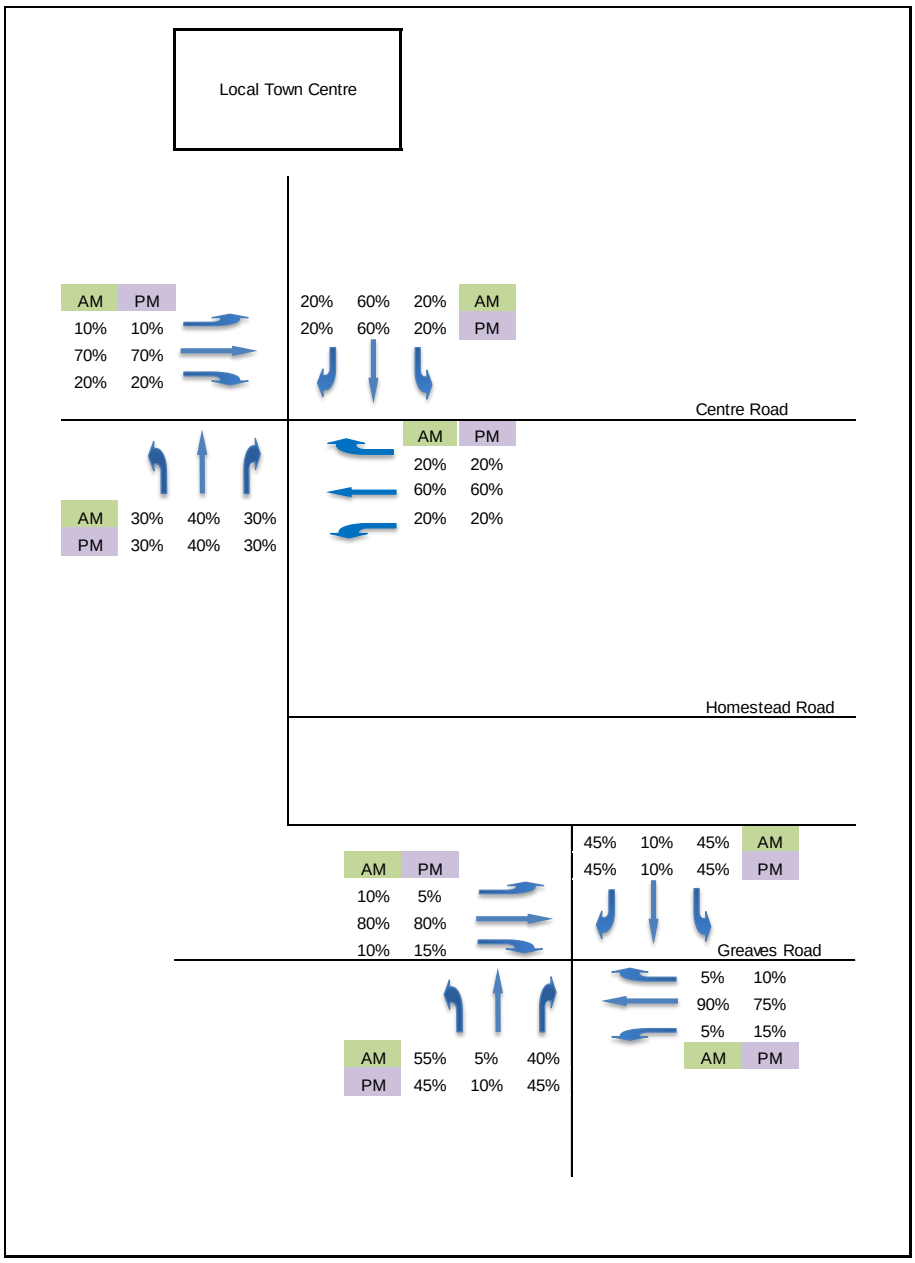
Base map sourced from Google Maps

The distributions in Figure 7.1 show that a large majority of the site generated traffic travels along Narre Warren-Cranbourne Road and Clyde Road to/from the north (towards the Princess Freeway) and to the south (towards Cranbourne).

The turning movement distribution at Centre Rd / Homestead Rd / LTC Access and Greaves Rd / North-South Connector St / Berwick Springs Promenade is outlined in Figure 7.2. It is recognised that a number of steps have been undertaken to provide a more robust level of distributions at the two intersections. This assessment is based on a number of key assumptions and factors as follows:

- turning movement splits based on the VITM model output as a "starting point"
- percentage split of the turning movements based on volumes outlined in the previous GTA report (13th March 2013)
- a degree of engineering judgement based on assigned land uses, activity centres and major roads within the vicinity of the Berwick Waterways PSP.

Figure 7.2: Turning Movement Distribution



7.2 Anticipated Interim and Ultimate Turning Volumes

Based on the methodology outlined in Section 7.1, the interim and ultimate AM and PM peak hour turning volumes at the key access intersections to the PSP have been calculated and are shown in Figure 7.3 and Figure 7.4 respectively for the AM and PM peaks.

For this assessment, in addition to the refinements outlined in Section 7.1.3, the following assumptions have been applied to develop a more robust approach to determining the intersection demands:

- It has been assumed that 30% of the traffic generated by Zone 2337 (i.e. north of Centre Road) is non-PSP related and is associated with the existing uses in the zone. This non-PSP traffic is anticipated to access the external road network via County Drive,

Gwendoline Drive and Bellevue Drive rather than use the LTC Access/Centre Road intersection.

- Adoption of the distributions outlined in Figure 7.1 with no further refinements.
- Through volumes on Centre Road have been adopted as a proportion of the existing Greaves Road volumes. The proportion is based on a comparison of daily volumes and is a factor of 0.61.

Figure 7.3: Anticipated 2026 and 2046 AM Peak-Hour Turning Volumes

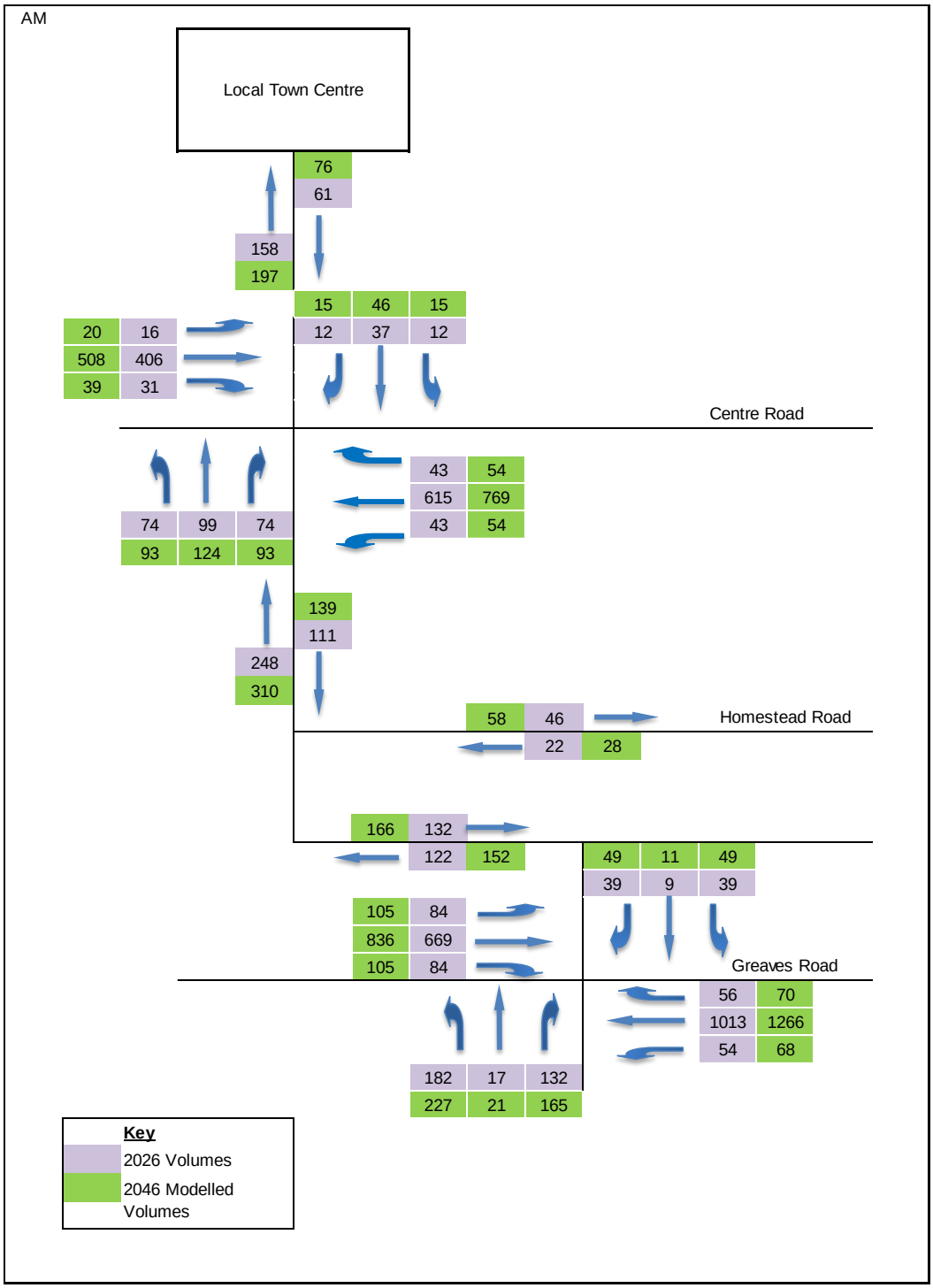
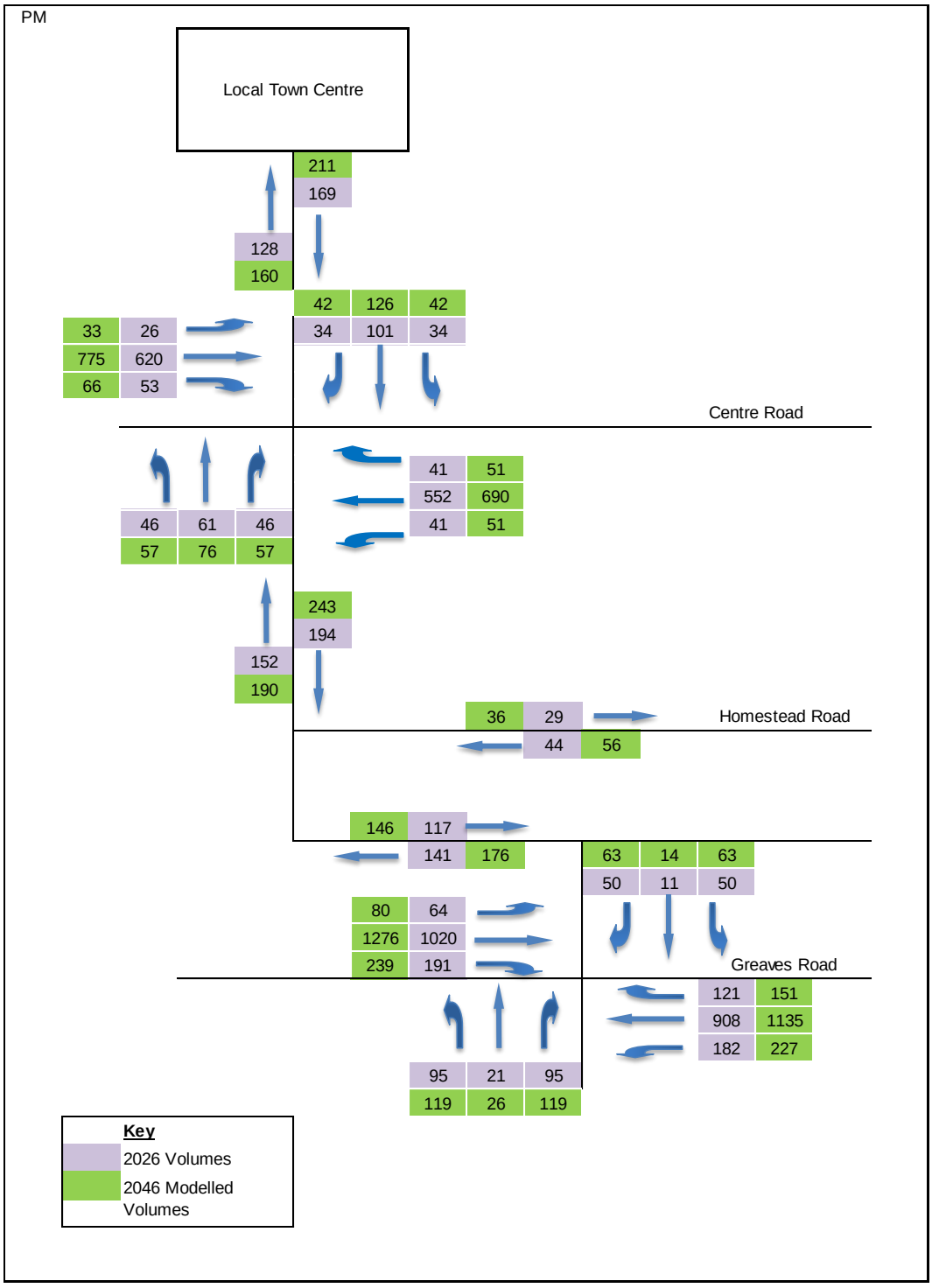


Figure 7.4: Anticipated 2026 and 2046 PM Peak-Hour Turning Volumes



The resultant volumes are considered suitable for assessing the operation of the intersections at the interim and ultimate layout configurations, detailed in Section 4. The volumes are considered a 'worst case' or conservative assessment in that they take into consideration wider 'through' traffic demands and are comparable to higher generation rates than they VISTA average for the City of Casey.

7.3 Anticipated Intersection Operation

7.3.1 Overview

The operation of each external intersection has been assessed using *SIDRA INTERSECTION 5.1*[2], a computer based modelling package which calculates intersection performance.

The commonly used measure of intersection performance is referred to as the *Degree of Saturation (DOS)*. The DOS represents the flow-to-capacity ratio for the most critical movement on each leg of the intersection.

For signalised intersections, a DOS of around 0.95 has been typically considered the 'ideal' limit, beyond which queues and delays increase disproportionately[3]. For unsignalised intersections a DOS of 0.90 is considered the 'ideal' limit.

The following information is provided in Appendix B (interim case) and Appendix C (ultimate case) for each of the assessed intersections for interim and ultimate layouts:

- degree of saturation (DOS) and level of service (LOS)
- intersection average delay across all approaches
- 95%ile queue in terms of the length in metres followed by the approach (E,W, N, S) and movement (L, T, R)
- indicative phase times (noting that the VicRoads desired cycle time of 120s has been adopted in the analysis of all signalised intersections).

7.3.2 Summary of Anticipated Operation

A summary of the anticipated operation of each of the intersections is presented in Table 7.1 (with the full SIDRA outputs included in Appendix B and C).

[2] Program used under license from Akcelik & Associates Pty Ltd.

[3] SIDRA INTERSECTION 4.0 adopts the following criteria for Level of Service assessment:

LOS		Intersection Degree of Saturation (DOS) or X value	
		Unsignalised Intersection	Signalised Intersection
A	Excellent	<=0.50	<=0.60
B	Very Good	0.50-0.70	0.60-0.75
C	Good	0.70-0.80	0.75-0.90
D	Acceptable	0.80-0.90	0.90-0.95
E	Poor	0.90-1.00	0.95-1.00
F	Very Poor	>=1.0	>=1.0

Table 7.1: Summary of Anticipated Intersection Operation

Intersection	Peak Hour	Intersection Performance		
		DOS	Average Delay (s)	95th Percentile Queue (m)
Interim Analysis				
Centre Road / LTC Access / Homestead Road	AM	0.48	16	104
	PM	0.48	15	102
Greaves Road / North-South Connector Street/Berwick Springs Promenade	AM	0.64	10	45
	PM	0.81	12	88
Ultimate Analysis				
Centre Road / LTC Access / Homestead Road	AM	0.60	16.7	149
	PM	0.60	16.2	146
Greaves Road / North-South Connector Street/Berwick Springs Promenade	AM	0.77	31	218
	PM	0.85	37	259

As shown in Table 7.1 both external intersections to the PSP area are generally anticipated to operate with acceptable delays and queues in both the interim and ultimate cases.

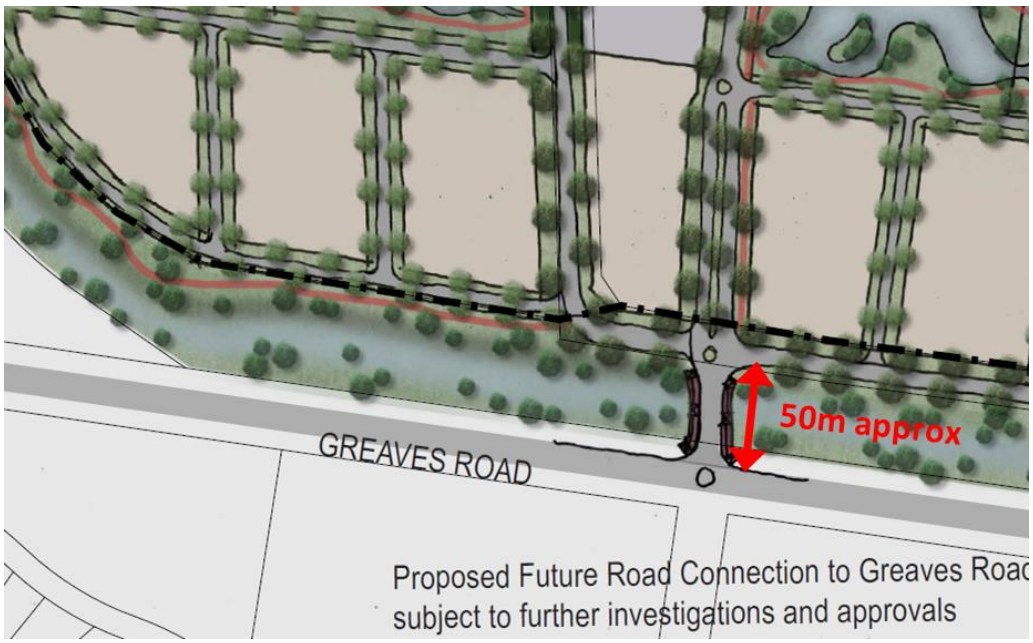
It is highlighted that pedestrians phases have been included in the analysis such that they are called every phase throughout the peak period. Pedestrian phases across both Centre Road and Greaves Road require longer green times than the north south traffic and as such reduce the available green time for the key east-west movements. In reality, the queue lengths depicted on Greaves Road in particular will likely be overstated.

Nevertheless, the results do indicate that this conservative approach demonstrates that the intersections will be able to accommodate the anticipated demands for both the interim and ultimate scenarios.

7.4 Review of Internal Intersection Spacing

It is highlighted that there is a proposed roundabout approximately 50m north of Greaves Road/North-South Connector/ Berwick Springs Promenade intersection. The location of this roundabout and its proximity to the Greaves Road signalised intersection is shown in Figure 7.5.

Figure 7.5: Internal intersection - Spacing near Greaves Road



In order to assess the impacts of the internal roundabout on the Greaves Road access intersection operation turning volumes for the internal roundabout have been derived and are summarised in Figure 7.6 and Figure 7.7.

Figure 7.6: Internal Roundabout AM Peak Volumes

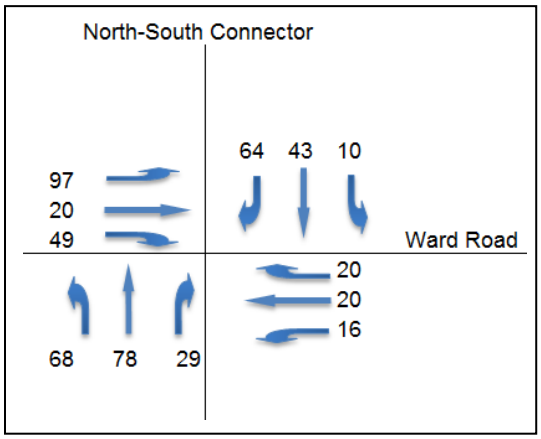
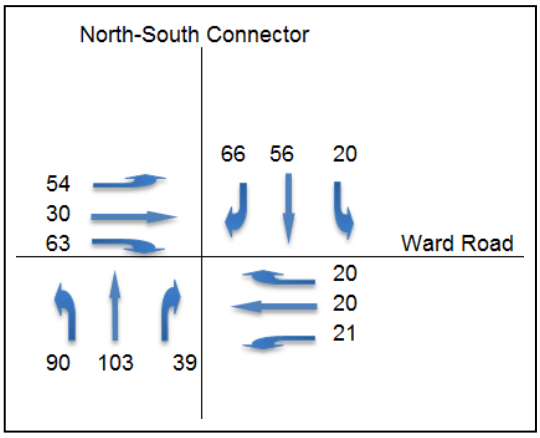


Figure 7.7: Internal Roundabout PM Peak Volumes



Note: the turning volumes are a combination of VITM modelled volumes and an approximation of dwelling yields.

The SIDRA modelling outputs for internal roundabout are included in Appendix D and the results for the critical approach (i.e. the south approach) of the internal roundabout and its interaction with the north approach of the Greaves Road access intersection are summarised in Table 7.2.

Table 7.2: Internal Roundabout and Greaves Road Access Intersection Interaction

Intersection	Critical Approach	DOS		95th Percentile Queue (m)	
		AM Peak	PM Peak	AM Peak	PM Peak
Interim Analysis					
Internal Roundabout	South Approach	0.11	0.14	3.9	5.2
Greaves Road/ Berwick Springs Promenade/North-South Connector	North Approach	0.12	0.25	3.7	9.2
Ultimate Analysis					
Internal Roundabout	South Approach	0.14	0.18	5.0	6.9
Greaves Road/ Berwick Springs Promenade/North-South Connector	North Approach	0.22	0.45	21.1	27.4

As shown in Table 7.2, the queues on the south approach of the internal roundabout are anticipated to be minimal and therefore are not anticipated to impact on the operation of the Greaves Road/North-South Connector/Berwick Springs Promenade intersection. Likewise the queuing on the north approach of the Greaves Road/North-South Connector/Berwick Springs Promenade intersection is not anticipated in impact on the operation of the internal roundabout.

7.5 Wider Network Impact

It has been requested by VicRoads that the wider impact of the PSP be reviewed. Whilst technically not part of this scope of works, a review of the anticipated proportion of PSP traffic on the following key roads has been assessed:

- Berwick - Cranbourne Road, south of the Princes Freeway
- Berwick - Cranbourne Road, south of Greaves Road
- Narre Warren Road, South of Princess Freeway
- Narre Warren Road, South of Greaves Road

The proportion of traffic from the two key PSP zones of 3064 and 2447at the nominated locations Two way link volumes in VITM and are presented in Table 7.4.

Table 7.4: 2046 AM and PM Traffic Distribution and Proportion

Road Name & Location	AM Peak (2hr)			PM peak (2hr)		
	Total 2 Way Volume	Volume From PSP	%	Total 2 Way Volume	Volume From PSP	%
Berwick - Cranbourne Road, south of the Princes Freeway	7,495	926	12%	8,498	991	12%
Berwick - Cranbourne Road, south of Greaves Road	6,190	376	6%	7,273	456	6%
Narre Warren Road, South of Princess Freeway	7,124	459	6%	8,134	681	8%
Narre Warren Road, South of Greaves Road	7,991	234	3%	8,958	271	3%

As stated previously within this report, the south east corridor strategic model developed by DTPLI (formerly DoT) has been used for this assessment. The proportion of traffic on the four sections of road nominated in Table 7.4 show that anticipated proportion of trips from the PSP is less than 10% except for Berwick – Cranbourne Road south of the Princes Freeway, which is 12%. It is highlighted that these volumes are strategic in nature and have been used to demonstrate the outputs of the model and distribution from the PSP as a whole.

Furthermore, as stated in Section 6, the VITM volumes are reflective of traffic generation rates higher than the VISTA average for the City of Casey. Should two way volumes on any of the nominated roads actually be higher than the VITM outputs, then it is likely that the proportion of traffic from this PSP is overstated.

8. Conclusions

This report addresses the land use inputs, traffic demands and resulting road network layout for the Berwick Waterways PSP. It is a thorough review of the outputs of VITM against a 'first principles' assessment and provides a robust base for determining the operation of the interim (2026) and ultimate (2046) intersection layouts.

The following conclusions are provided in relation to the information presented within this report:

i The Berwick Waterways PSP is anticipated to generate some 19,000 daily vehicle movements onto the external road network.

ii A range of conservative assumptions have been made to determine the anticipated intersection turning movements and layouts. A second set of assumptions have been made in relation to signal timings, pedestrian phases and movements and lane lengths. Further and more detailed analysis may be required as part of the detailed design process, however the analysis is sufficient enough in determining the operation of the intersection for the nominated layouts.

iii The interim intersection layouts at both Centre Road and Greaves Road contained within this report are considered suitable for incorporation in the DCP.

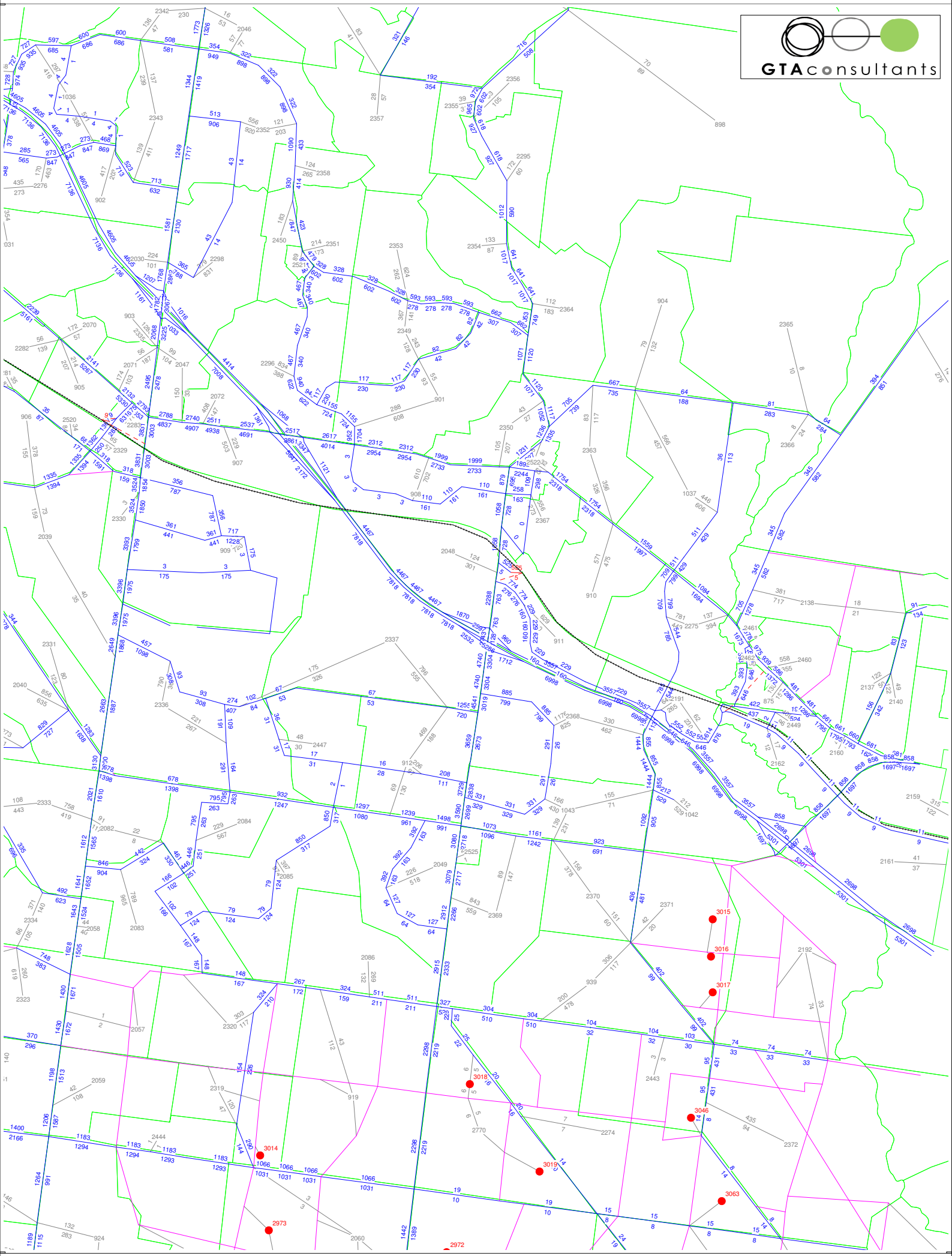
iv The intersection analysis presented in this report indicates that the ultimate intersection layouts are appropriate to cater for the anticipated demands and land should be set aside to cater for these layouts.

v The minimum 50m setback of the internal roundabout from Greaves Road is considered to operate suitably and will not adversely impact on surrounding intersections.

Appendix A

VITM Volume Plots

VITM 2011 South East Model
2 Hrs AM Total Volume Private Vehicle Year 2011 GAA SE Model Rev A



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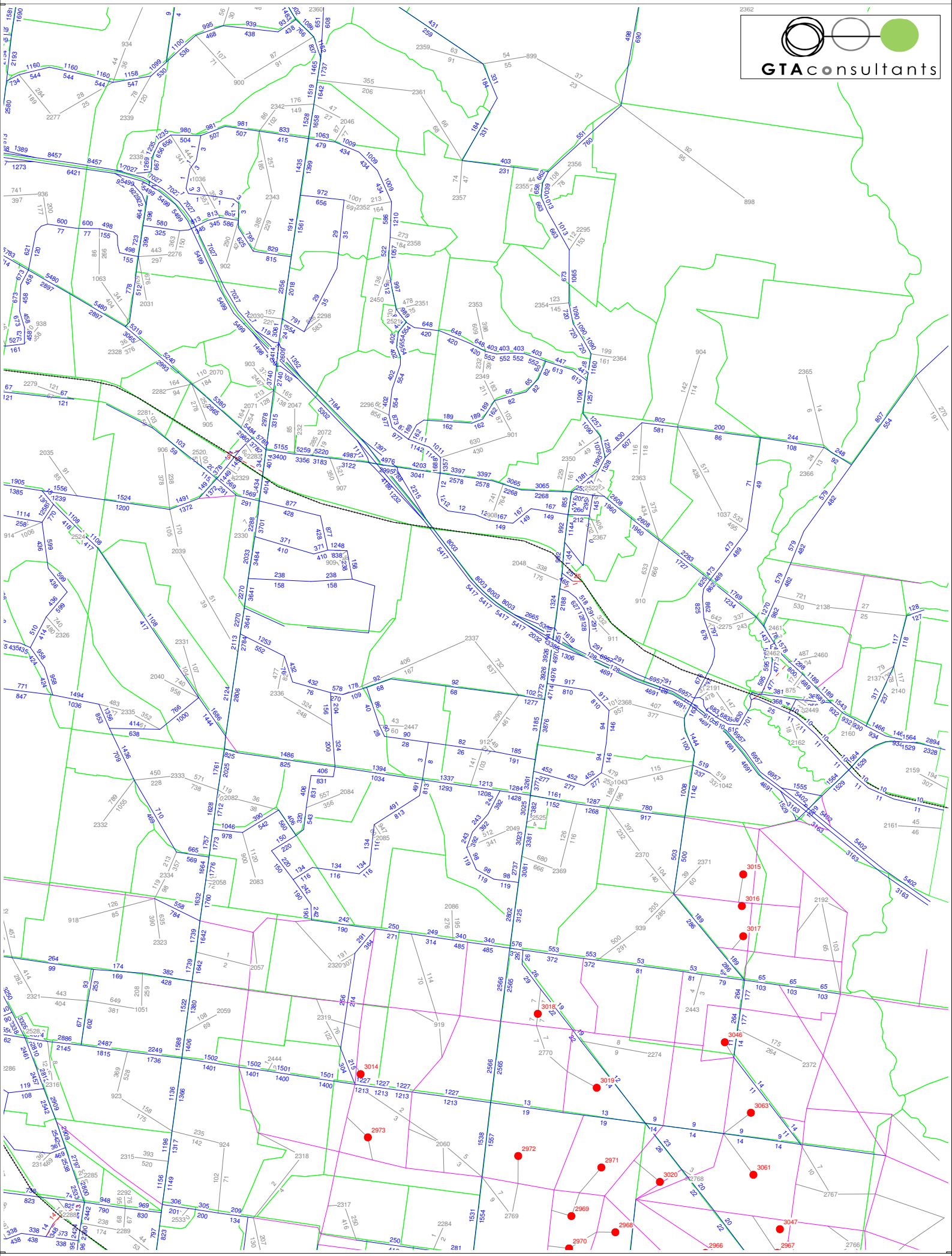
2/21/2013

cube

VITM 2011 South East Model
2 Hrs PM Total Volume Private Vehicle Year 2011 GAA SE Model Rev A



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2/21/2013

cube

VITM 2011 South East Model
2 Hr AM Volume Year 2046

GTAconsultants

Princes Fwy
9122
14960

Narre Warren Cranbourne Rd

Centre Rd
49
54

Wood Rd

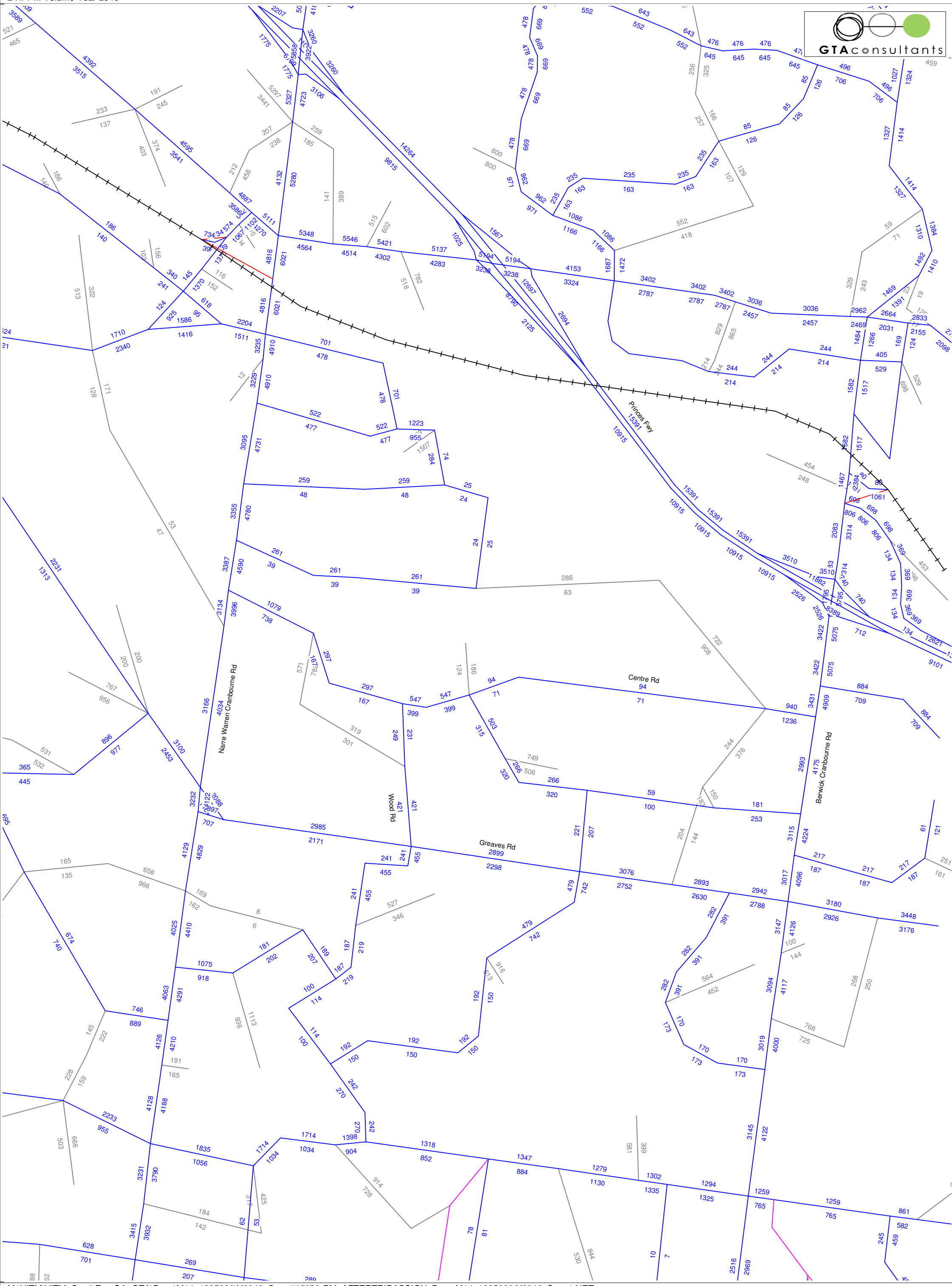
Greaves Rd
1886
2466

Berwick Cranbourne Rd

M:\VITM\VITM_SouthEastGA_GTA\Base\M14_1235000\Y2046_Scen1\HWY_AM_AFTERTRIPASSIGN_Base.M14_1235000.Y2046_Scen1.NET
2/14/2014

cube

VITM 2011 South East Model
2 Hr PM Volume Year 2046



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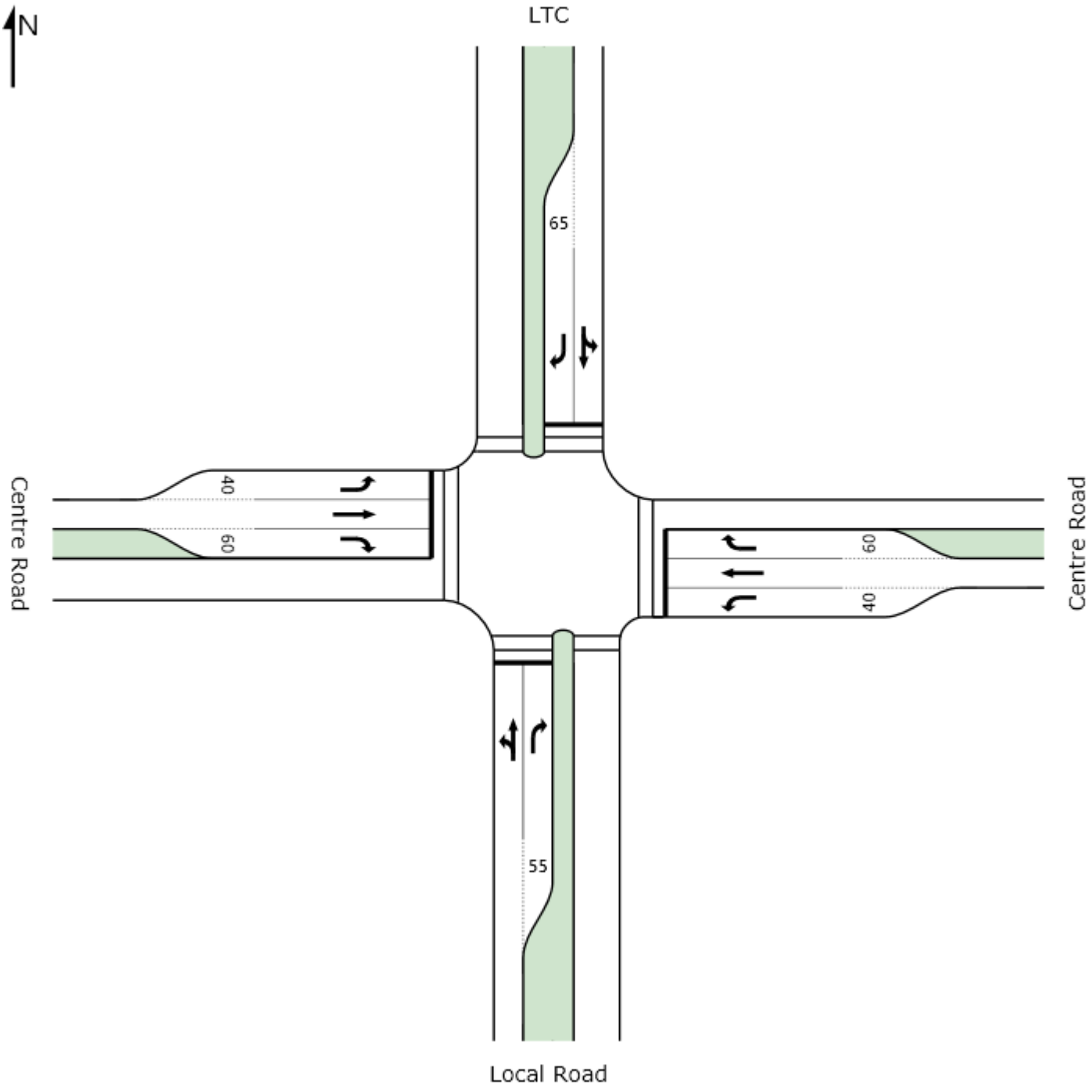
2/14/2014

Appendix B

2026 SIDRA INTERSECTION Results


N
LTC
65
Centre Road
40
60
60
40
Centre Road
55
Local Road

MOVEMENT SUMMARY

Site: AM Peak 2026 - updated 1/5/14

Centre Road/LTC
Signals - Fixed Time Cycle Time = 100 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Local Road											
1	L	74	0.0	0.472	47.2	LOS D	7.7	53.7	0.94	0.81	25.6
2	T	99	0.0	0.472	39.6	LOS D	7.7	53.7	0.94	0.77	24.3
3	R	74	0.0	0.281	47.5	LOS D	3.2	22.7	0.91	0.77	25.2
Approach		247	0.0	0.472	44.3	LOS D	7.7	53.7	0.93	0.78	25.0
East: Centre Road											
4	L	43	0.0	0.091	13.9	LOS B	0.6	4.5	0.33	0.71	46.9
5	T	615	10.0	0.482	7.6	LOS A	13.7	104.3	0.50	0.45	54.2
6	R	43	0.0	0.103	17.2	LOS B	0.9	6.0	0.43	0.72	43.7
Approach		701	8.8	0.482	8.6	LOS A	13.7	104.3	0.49	0.49	53.0
North: LTC											
7	L	12	0.0	0.132	44.2	LOS D	2.0	14.0	0.87	0.76	26.6
8	T	37	0.0	0.132	36.6	LOS D	2.0	14.0	0.87	0.65	25.4
9	R	12	0.0	0.069	50.8	LOS D	0.5	3.8	0.92	0.69	24.4
Approach		61	0.0	0.132	40.9	LOS D	2.0	14.0	0.88	0.68	25.4
West: Centre Road											
10	L	16	0.0	0.034	13.8	LOS B	0.2	1.7	0.32	0.69	47.0
11	T	406	10.0	0.318	6.5	LOS A	7.7	58.8	0.43	0.38	56.0
12	R	31	0.0	0.090	20.5	LOS C	0.7	5.1	0.50	0.72	40.8
Approach		453	9.0	0.318	7.7	LOS A	7.7	58.8	0.43	0.41	54.4
All Vehicles		1462	7.0	0.482	15.7	LOS B	13.7	104.3	0.56	0.52	43.5

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	9.2	LOS A	0.1	0.1	0.43	0.43
P3	Across E approach	53	42.3	LOS E	0.1	0.1	0.92	0.92
P5	Across N approach	53	9.2	LOS A	0.1	0.1	0.43	0.43
P7	Across W approach	53	43.2	LOS E	0.1	0.1	0.93	0.93
All Pedestrians		212	26.0	LOS C			0.68	0.68

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: PM Peak 2026 - updated 1/5/14

Centre Road/LTC
Signals - Fixed Time Cycle Time = 100 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

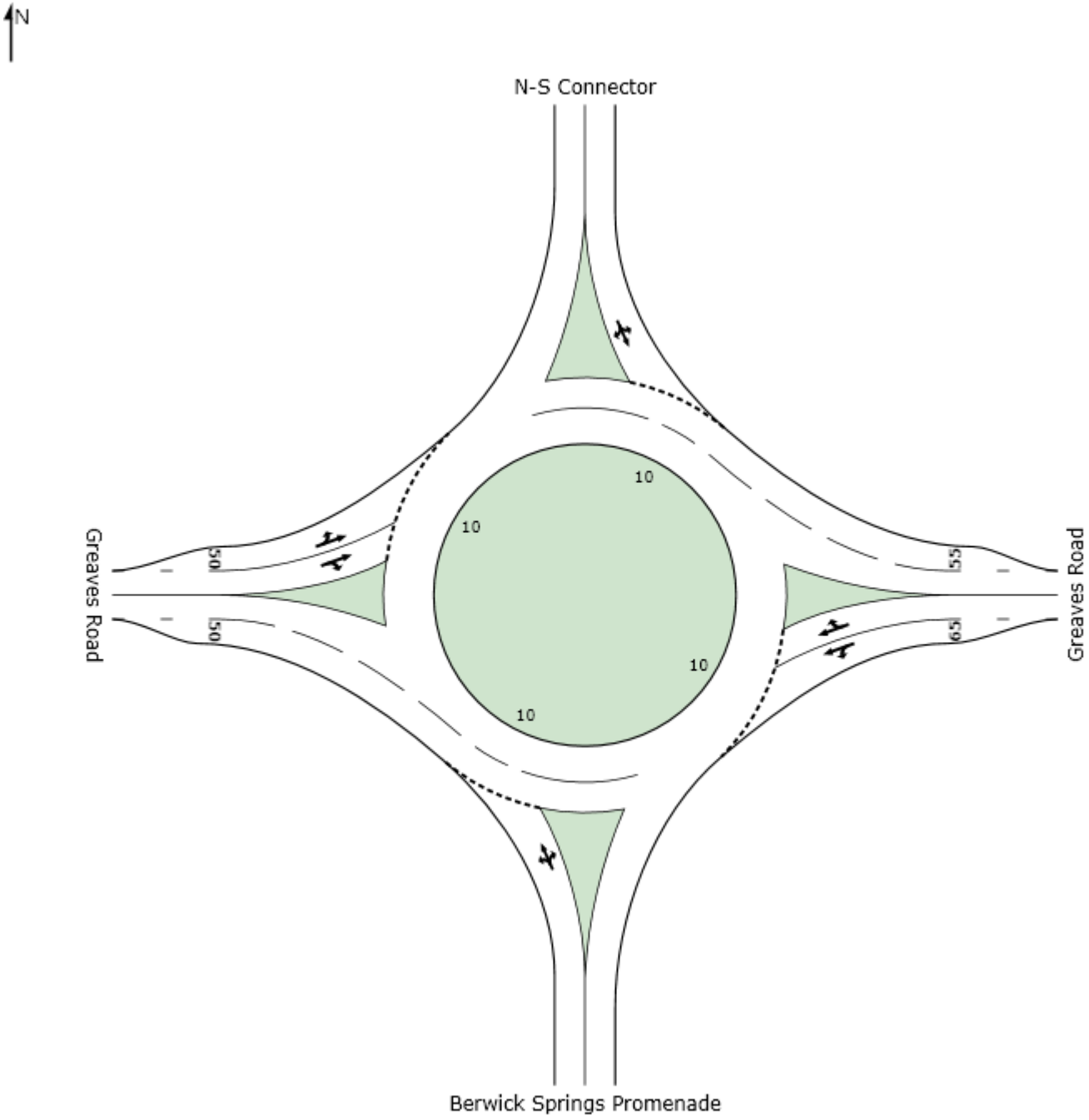
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Local Road											
1	L	46	0.0	0.308	46.7	LOS D	4.6	32.3	0.91	0.79	25.7
2	T	61	0.0	0.308	39.0	LOS D	4.6	32.3	0.91	0.72	24.5
3	R	46	0.0	0.245	52.2	LOS D	2.1	14.9	0.94	0.75	24.0
Approach		153	0.0	0.308	45.3	LOS D	4.6	32.3	0.92	0.75	24.7
East: Centre Road											
4	L	41	0.0	0.084	13.5	LOS B	0.6	4.2	0.32	0.70	47.3
5	T	552	10.0	0.426	6.8	LOS A	11.3	86.1	0.46	0.41	55.5
6	R	41	0.0	0.117	20.3	LOS C	1.0	6.7	0.50	0.73	41.0
Approach		634	8.7	0.426	8.1	LOS A	11.3	86.1	0.45	0.45	53.8
North: LTC											
7	L	34	0.0	0.385	47.3	LOS D	5.9	41.5	0.93	0.80	25.7
8	T	101	0.0	0.385	39.7	LOS D	5.9	41.5	0.93	0.74	24.4
9	R	34	0.0	0.164	49.6	LOS D	1.5	10.6	0.91	0.73	24.7
Approach		169	0.0	0.385	43.2	LOS D	5.9	41.5	0.92	0.75	24.7
West: Centre Road											
10	L	26	0.0	0.053	13.5	LOS B	0.4	2.6	0.32	0.70	47.3
11	T	620	10.0	0.479	7.2	LOS A	13.4	102.1	0.49	0.44	54.8
12	R	53	0.0	0.143	18.8	LOS B	1.2	8.2	0.47	0.73	42.2
Approach		699	8.9	0.479	8.3	LOS A	13.4	102.1	0.48	0.47	53.5
All Vehicles		1655	7.1	0.479	15.2	LOS B	13.4	102.1	0.56	0.52	44.0

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	8.8	LOS A	0.1	0.1	0.42	0.42
P3	Across E approach	53	43.2	LOS E	0.1	0.1	0.93	0.93
P5	Across N approach	53	8.8	LOS A	0.1	0.1	0.42	0.42
P7	Across W approach	53	44.2	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		212	26.3	LOS C			0.68	0.68

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.


N
N-S Connector
Greaves Road
Greaves Road
Berwick Springs Promenade
10
10
10
10
50
50
55
65

MOVEMENT SUMMARY

Site: AM Peak 2026 - updated 1/5/14

Greaves Road/N-S Connector/Berwick Springs Promenade
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Berwick Springs Promenade											
1	L	182	0.0	0.548	14.7	LOS B	3.5	24.3	0.80	1.00	42.5
2	T	17	0.0	0.548	13.9	LOS B	3.5	24.3	0.80	0.98	42.7
3	R	132	0.0	0.548	18.2	LOS B	3.5	24.3	0.80	1.04	40.5
Approach		331	0.0	0.548	16.1	LOS B	3.5	24.3	0.80	1.01	41.7
East: Greaves Road											
4	L	54	0.0	0.229	9.3	LOS A	1.3	9.0	0.39	0.69	47.9
5	T	1013	0.0	0.642	7.7	LOS A	6.4	45.0	0.50	0.57	47.8
6	R	56	0.0	0.642	11.9	LOS B	6.4	45.0	0.52	0.73	45.9
Approach		1123	0.0	0.642	8.0	LOS A	6.4	45.0	0.50	0.58	47.7
North: N-S Connector											
7	L	39	0.0	0.124	10.5	LOS B	0.5	3.7	0.60	0.80	46.4
8	T	9	0.0	0.124	9.7	LOS A	0.5	3.7	0.60	0.76	46.8
9	R	39	0.0	0.124	14.0	LOS B	0.5	3.7	0.60	0.87	43.8
Approach		87	0.0	0.124	12.0	LOS B	0.5	3.7	0.60	0.83	45.2
West: Greaves Road											
10	L	84	0.0	0.198	9.9	LOS A	1.1	7.6	0.48	0.71	47.3
11	T	669	0.0	0.524	8.0	LOS A	4.4	30.8	0.55	0.61	47.5
12	R	84	0.0	0.524	12.2	LOS B	4.4	30.8	0.56	0.76	45.8
Approach		837	0.0	0.524	8.6	LOS A	4.4	30.8	0.55	0.64	47.3
All Vehicles		2378	0.0	0.642	9.5	LOS A	6.4	45.0	0.56	0.67	46.6

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: PM Peak 2026 - updated 1/5/14

Greaves Road/N-S Connector/Berwick Springs Promenade
Roundabout

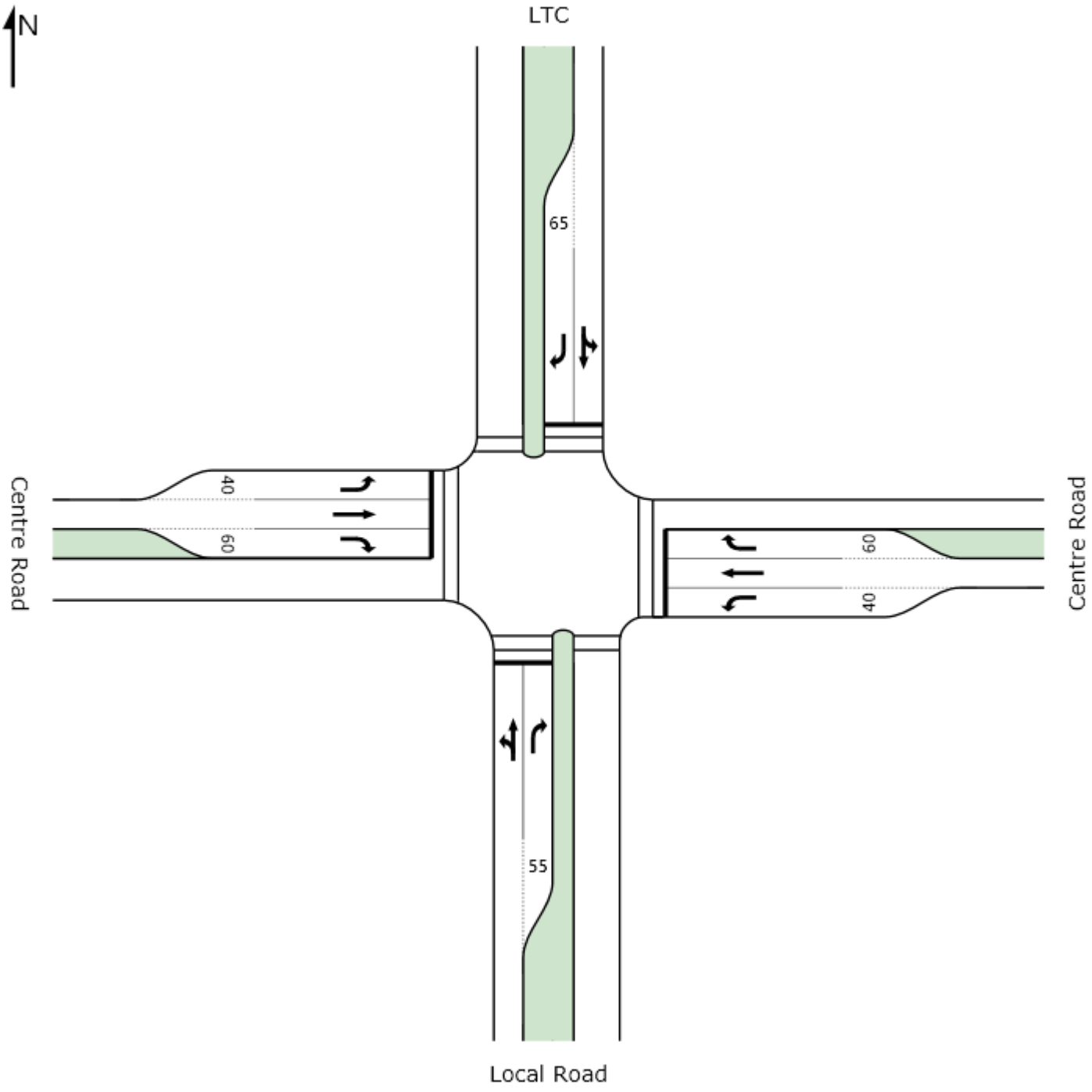
Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Berwick Springs Promenade											
1	L	95	0.0	0.424	14.6	LOS B	2.6	18.4	0.84	0.98	42.6
2	T	21	0.0	0.424	13.8	LOS B	2.6	18.4	0.84	0.96	42.8
3	R	95	0.0	0.424	18.1	LOS B	2.6	18.4	0.84	1.01	40.6
Approach		211	0.0	0.424	16.1	LOS B	2.6	18.4	0.84	0.99	41.7
East: Greaves Road											
4	L	182	0.0	0.284	10.5	LOS B	1.7	11.7	0.56	0.73	46.5
5	T	908	0.0	0.796	10.9	LOS B	12.3	86.4	0.87	0.77	45.8
6	R	121	0.0	0.796	15.3	LOS B	12.3	86.4	0.88	0.81	43.5
Approach		1211	0.0	0.796	11.3	LOS B	12.3	86.4	0.82	0.77	45.7
North: N-S Connector											
7	L	50	0.0	0.252	13.6	LOS B	1.3	9.2	0.81	0.93	43.4
8	T	11	0.0	0.252	12.8	LOS B	1.3	9.2	0.81	0.91	43.6
9	R	50	0.0	0.252	17.2	LOS B	1.3	9.2	0.81	0.96	41.4
Approach		111	0.0	0.252	15.1	LOS B	1.3	9.2	0.81	0.94	42.5
West: Greaves Road											
10	L	64	0.0	0.305	10.5	LOS B	1.8	12.5	0.54	0.75	47.0
11	T	1020	0.0	0.806	10.6	LOS B	12.6	88.4	0.80	0.74	46.1
12	R	191	0.0	0.806	15.2	LOS B	12.6	88.4	0.86	0.80	43.5
Approach		1275	0.0	0.806	11.3	LOS B	12.6	88.4	0.80	0.75	45.7
All Vehicles		2808	0.0	0.806	11.8	LOS B	12.6	88.4	0.81	0.78	45.2

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

Appendix C

2046 SIDRA INTERSECTION Results


N
LTC
65
Centre Road
40
60
60
40
Centre Road
55
Local Road

MOVEMENT SUMMARY

Site: AM Peak 2046 - updated 1/5/14

Centre Road/LTC
Signals - Fixed Time Cycle Time = 100 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Local Road											
1	L	93	0.0	0.592	48.3	LOS D	9.9	69.2	0.96	0.82	25.3
2	T	124	0.0	0.592	40.7	LOS D	9.9	69.2	0.96	0.80	23.9
3	R	93	0.0	0.366	48.3	LOS D	4.2	29.1	0.93	0.78	25.0
Approach		310	0.0	0.592	45.3	LOS D	9.9	69.2	0.95	0.80	24.7
East: Centre Road											
4	L	54	0.0	0.114	13.9	LOS B	0.8	5.7	0.33	0.71	46.9
5	T	769	10.0	0.602	8.7	LOS A	19.6	149.2	0.58	0.53	52.5
6	R	54	0.0	0.141	18.8	LOS B	1.2	8.3	0.47	0.73	42.2
Approach		877	8.8	0.602	9.7	LOS A	19.6	149.2	0.55	0.55	51.4
North: LTC											
7	L	15	0.0	0.165	44.5	LOS D	2.5	17.6	0.87	0.77	26.5
8	T	46	0.0	0.165	36.9	LOS D	2.5	17.6	0.87	0.67	25.3
9	R	15	0.0	0.105	54.4	LOS D	0.7	4.9	0.95	0.70	23.5
Approach		76	0.0	0.165	41.8	LOS D	2.5	17.6	0.89	0.69	25.1
West: Centre Road											
10	L	20	0.0	0.042	13.8	LOS B	0.3	2.1	0.33	0.69	47.0
11	T	508	10.0	0.398	7.0	LOS A	10.4	79.2	0.46	0.41	55.2
12	R	39	0.0	0.133	25.0	LOS C	1.1	7.7	0.59	0.74	37.5
Approach		567	9.0	0.398	8.5	LOS A	10.4	79.2	0.46	0.44	53.3
All Vehicles		1830	7.0	0.602	16.7	LOS B	19.6	149.2	0.61	0.57	42.6

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	9.2	LOS A	0.1	0.1	0.43	0.43
P3	Across E approach	53	42.3	LOS E	0.1	0.1	0.92	0.92
P5	Across N approach	53	9.2	LOS A	0.1	0.1	0.43	0.43
P7	Across W approach	53	43.2	LOS E	0.1	0.1	0.93	0.93
All Pedestrians		212	26.0	LOS C			0.68	0.68

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: PM Peak 2046 - updated 1/5/14

Centre Road/LTC
Signals - Fixed Time Cycle Time = 100 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

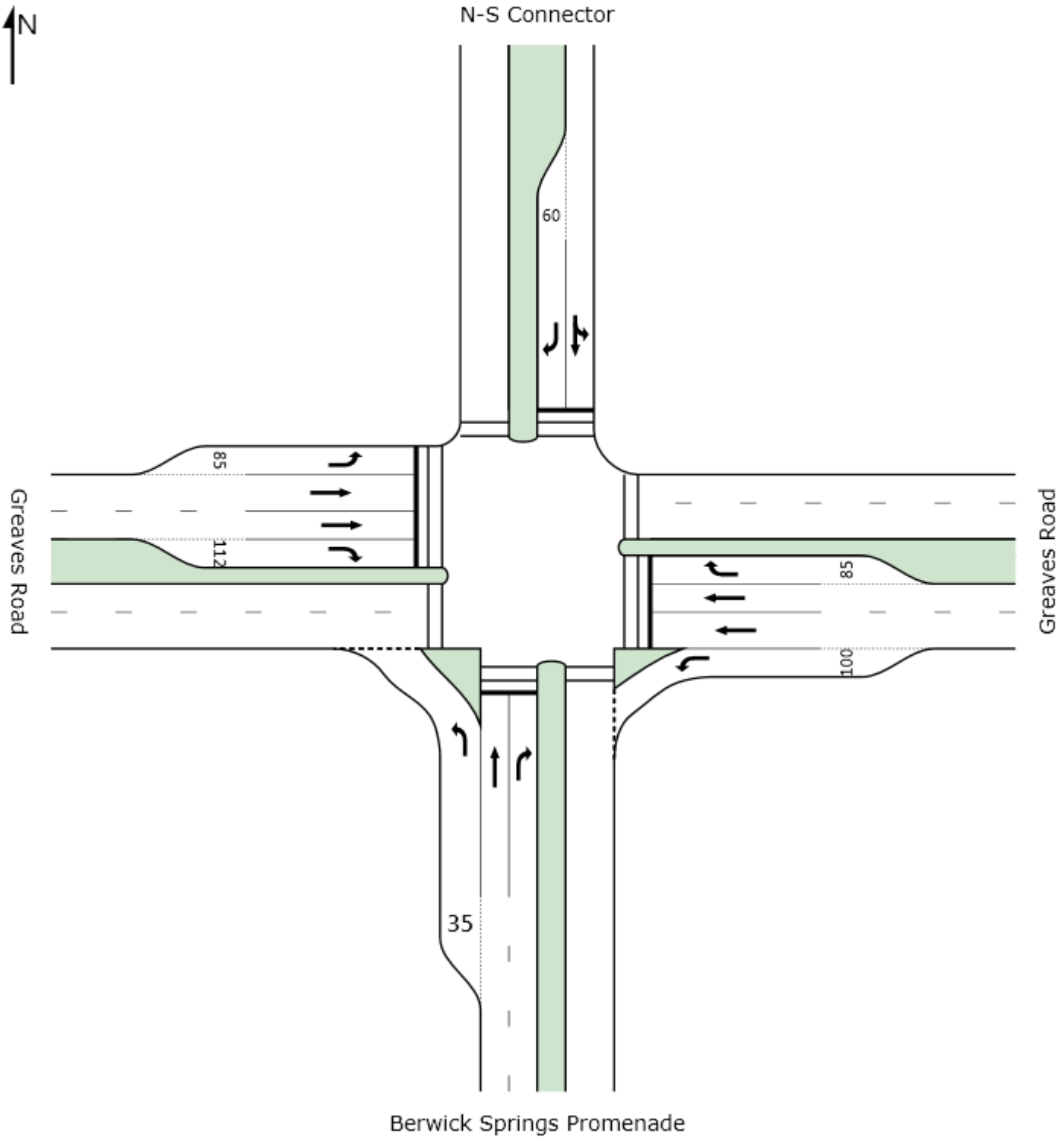
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Local Road											
1	L	57	0.0	0.383	47.3	LOS D	5.8	40.8	0.93	0.80	25.6
2	T	76	0.0	0.383	39.7	LOS D	5.8	40.8	0.93	0.74	24.3
3	R	57	0.0	0.346	54.1	LOS D	2.7	19.0	0.96	0.76	23.5
Approach		190	0.0	0.383	46.3	LOS D	5.8	40.8	0.94	0.76	24.4
East: Centre Road											
4	L	51	0.0	0.105	13.6	LOS B	0.7	5.2	0.32	0.71	47.2
5	T	690	10.0	0.533	7.6	LOS A	15.9	120.6	0.52	0.47	54.1
6	R	51	0.0	0.170	24.2	LOS C	1.4	9.9	0.58	0.75	38.1
Approach		792	8.7	0.533	9.1	LOS A	15.9	120.6	0.51	0.50	52.4
North: LTC											
7	L	42	0.0	0.480	48.1	LOS D	7.5	52.6	0.95	0.81	25.5
8	T	126	0.0	0.480	40.5	LOS D	7.5	52.6	0.95	0.77	24.2
9	R	42	0.0	0.223	52.0	LOS D	1.9	13.5	0.94	0.74	24.1
Approach		210	0.0	0.480	44.3	LOS D	7.5	52.6	0.94	0.77	24.4
West: Centre Road											
10	L	33	0.0	0.068	13.5	LOS B	0.5	3.3	0.32	0.70	47.3
11	T	775	10.0	0.598	8.2	LOS A	19.2	146.3	0.56	0.51	53.1
12	R	66	0.0	0.204	22.0	LOS C	1.7	11.9	0.55	0.75	39.7
Approach		874	8.9	0.598	9.5	LOS A	19.2	146.3	0.55	0.54	51.7
All Vehicles		2066	7.1	0.598	16.2	LOS B	19.2	146.3	0.61	0.57	43.0

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	8.8	LOS A	0.1	0.1	0.42	0.42
P3	Across E approach	53	43.2	LOS E	0.1	0.1	0.93	0.93
P5	Across N approach	53	8.8	LOS A	0.1	0.1	0.42	0.42
P7	Across W approach	53	44.2	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		212	26.3	LOS C			0.68	0.68

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.


N
N-S Connector
60
85
112
Greaves Road
85
100
Greaves Road
35
Berwick Springs Promenade

MOVEMENT SUMMARY

Site: AM Peak 2046 - updated 1/5/14

Greaves Road/N-S Connector/Berwick Springs Promenade
Signals - Fixed Time Cycle Time = 120 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Berwick Springs Promenade											
1	L	227	0.0	0.754	25.5	LOS C	7.2	50.1	0.50	0.80	36.8
2	T	21	0.0	0.061	44.4	LOS D	1.0	7.2	0.86	0.62	26.0
3	R	165	0.0	0.754	68.0	LOS E	10.0	70.0	1.00	0.88	22.0
Approach		413	0.0	0.754	43.5	LOS D	10.0	70.0	0.72	0.82	28.6
East: Greaves Road											
4	L	68	0.0	0.044	8.9	LOS A	0.1	1.0	0.05	0.64	53.6
5	T	1266	10.0	0.770	26.5	LOS C	28.7	217.8	0.82	0.74	36.9
6	R	70	0.0	0.497	69.2	LOS E	4.1	28.6	0.99	0.76	21.7
Approach		1404	9.0	0.770	27.8	LOS C	28.7	217.8	0.79	0.73	36.2
North: N-S Connector											
7	L	49	0.0	0.181	54.7	LOS D	3.0	21.1	0.89	0.76	25.1
8	T	11	0.0	0.181	45.8	LOS D	3.0	21.1	0.89	0.68	24.6
9	R	49	0.0	0.224	61.5	LOS E	2.7	18.7	0.94	0.75	23.4
Approach		109	0.0	0.224	56.9	LOS E	3.0	21.1	0.91	0.75	24.3
West: Greaves Road											
10	L	105	0.0	0.187	27.6	LOS C	2.8	19.3	0.48	0.74	36.7
11	T	836	10.0	0.508	22.6	LOS C	14.8	112.8	0.64	0.56	39.8
12	R	105	0.0	0.746	72.1	LOS E	6.4	45.1	1.00	0.83	21.1
Approach		1046	8.0	0.746	28.0	LOS C	14.8	112.8	0.66	0.61	36.4
All Vehicles		2972	7.1	0.770	31.1	LOS C	28.7	217.8	0.74	0.70	34.4

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	25.4	LOS C	0.1	0.1	0.65	0.65
P3	Across E approach	53	52.3	LOS E	0.2	0.2	0.93	0.93
P5	Across N approach	53	24.7	LOS C	0.1	0.1	0.64	0.64
P7	Across W approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		212	39.1	LOS D			0.79	0.79

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

MOVEMENT SUMMARY

Site: PM Peak 2046 - updated 1/5/14

Greaves Road/N-S Connector/Berwick Springs Promenade
Signals - Fixed Time Cycle Time = 120 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Berwick Springs Promenade											
1	L	119	0.0	0.398	15.5	LOS B	2.5	17.5	0.42	0.71	43.7
2	T	26	0.0	0.075	44.6	LOS D	1.3	8.9	0.87	0.63	26.0
3	R	119	0.0	0.846	76.3	LOS E	7.7	54.0	1.00	0.94	20.4
Approach		264	0.0	0.846	45.8	LOS D	7.7	54.0	0.73	0.80	27.6
East: Greaves Road											
4	L	227	0.0	0.167	9.2	LOS A	0.6	4.2	0.06	0.64	53.2
5	T	1135	10.0	0.748	29.5	LOS C	26.3	199.7	0.84	0.75	35.1
6	R	151	0.0	0.536	60.7	LOS E	8.1	56.8	0.94	0.80	23.7
Approach		1513	7.5	0.748	29.6	LOS C	26.3	199.7	0.73	0.74	35.2
North: N-S Connector											
7	L	63	0.0	0.232	55.2	LOS E	3.9	27.4	0.90	0.77	25.0
8	T	14	0.0	0.232	46.3	LOS D	3.9	27.4	0.90	0.70	24.5
9	R	63	0.0	0.448	68.6	LOS E	3.7	26.0	1.00	0.76	21.9
Approach		140	0.0	0.448	60.4	LOS E	3.9	27.4	0.94	0.76	23.4
West: Greaves Road											
10	L	80	0.0	0.153	30.4	LOS C	2.3	16.0	0.52	0.74	35.0
11	T	1276	10.0	0.841	34.7	LOS C	34.1	259.1	0.91	0.86	32.4
12	R	239	0.0	0.849	68.8	LOS E	14.8	103.4	1.00	0.91	21.8
Approach		1595	8.0	0.849	39.6	LOS D	34.1	259.1	0.91	0.86	30.4
All Vehicles		3512	6.9	0.849	36.6	LOS D	34.1	259.1	0.82	0.80	31.7

Level of Service (LOS) Method: Delay (HCM 2000).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

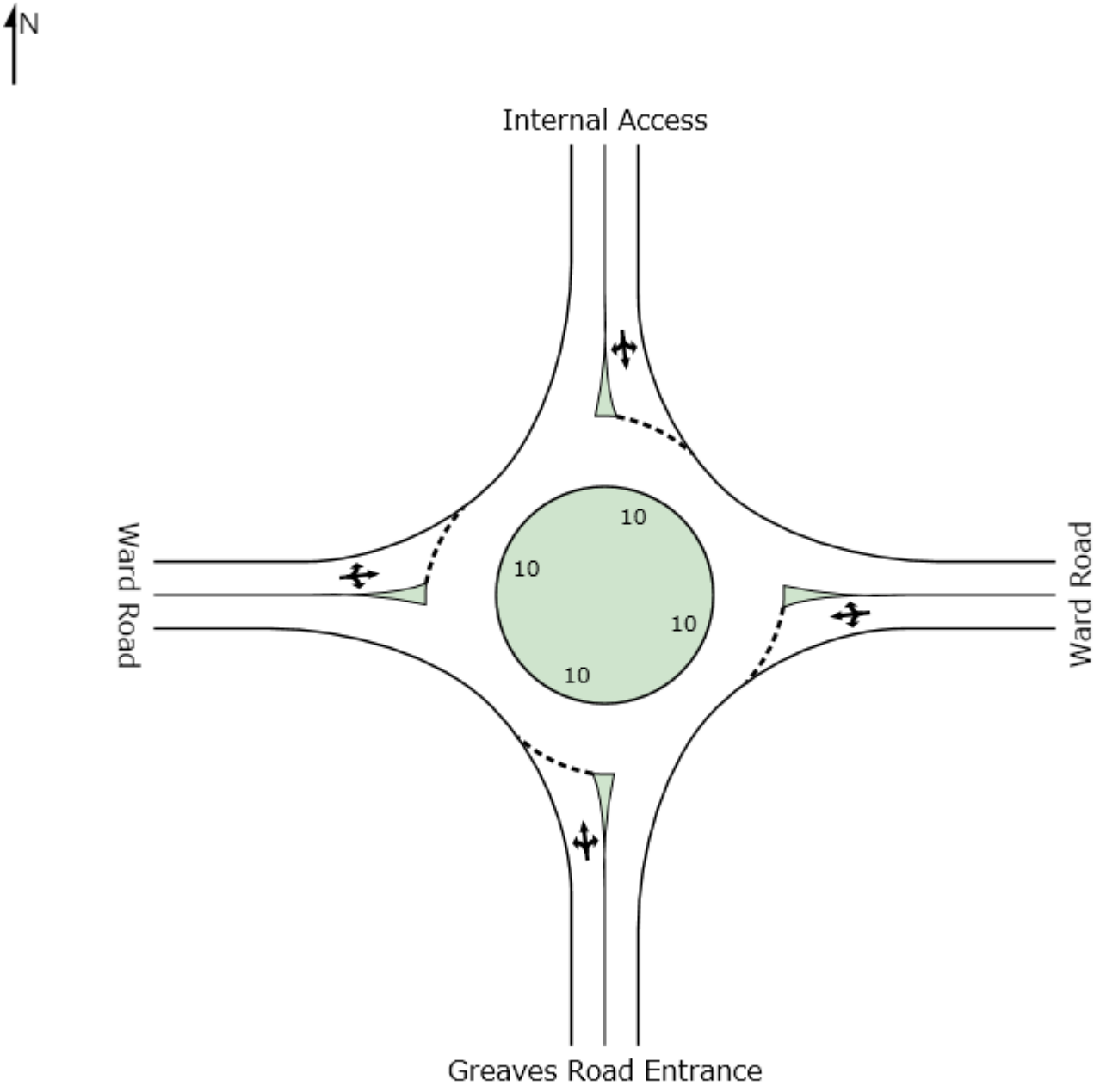
Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	Across S approach	53	28.0	LOS C	0.1	0.1	0.68	0.68
P3	Across E approach	53	52.3	LOS E	0.2	0.2	0.93	0.93
P5	Across N approach	53	27.3	LOS C	0.1	0.1	0.68	0.68
P7	Across W approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		212	40.4	LOS E			0.81	0.81

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Appendix D

Internal Roundabout SIDRA INTERSECTION Results


N
Internal Access
Ward Road
Ward Road
10
10
10
10
Greaves Road Entrance

MOVEMENT SUMMARY

Site: Internal Roundabout 2026 - AM - Updated 02/05/2014

Internal Roundabout
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Greaves Road Entrance											
1	L	55	0.0	0.111	7.6	LOS A	0.6	3.9	0.23	0.58	48.9
2	T	63	0.0	0.111	6.8	LOS A	0.6	3.9	0.23	0.50	49.4
3	R	23	0.0	0.111	11.3	LOS B	0.6	3.9	0.23	0.75	46.0
Approach		141	0.0	0.111	7.9	LOS A	0.6	3.9	0.23	0.57	48.6
East: Ward Road											
4	L	13	0.0	0.044	7.7	LOS A	0.2	1.4	0.27	0.57	48.7
5	T	20	0.0	0.044	7.0	LOS A	0.2	1.4	0.27	0.50	49.1
6	R	20	0.0	0.044	11.5	LOS B	0.2	1.4	0.27	0.72	45.8
Approach		53	0.0	0.044	8.9	LOS A	0.2	1.4	0.27	0.60	47.7
North: Internal Access											
7	L	10	0.0	0.071	7.5	LOS A	0.3	2.4	0.21	0.56	49.0
8	T	34	0.0	0.071	6.8	LOS A	0.3	2.4	0.21	0.48	49.5
9	R	47	0.0	0.071	11.3	LOS B	0.3	2.4	0.21	0.72	45.9
Approach		91	0.0	0.071	9.2	LOS A	0.3	2.4	0.21	0.62	47.5
West: Ward Road											
10	L	84	0.0	0.108	7.7	LOS A	0.5	3.8	0.27	0.57	48.6
11	T	10	0.0	0.108	6.9	LOS A	0.5	3.8	0.27	0.50	49.1
12	R	39	0.0	0.108	11.4	LOS B	0.5	3.8	0.27	0.71	45.8
Approach		133	0.0	0.108	8.8	LOS A	0.5	3.8	0.27	0.61	47.8
All Vehicles		418	0.0	0.111	8.6	LOS A	0.6	3.9	0.24	0.60	48.0

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

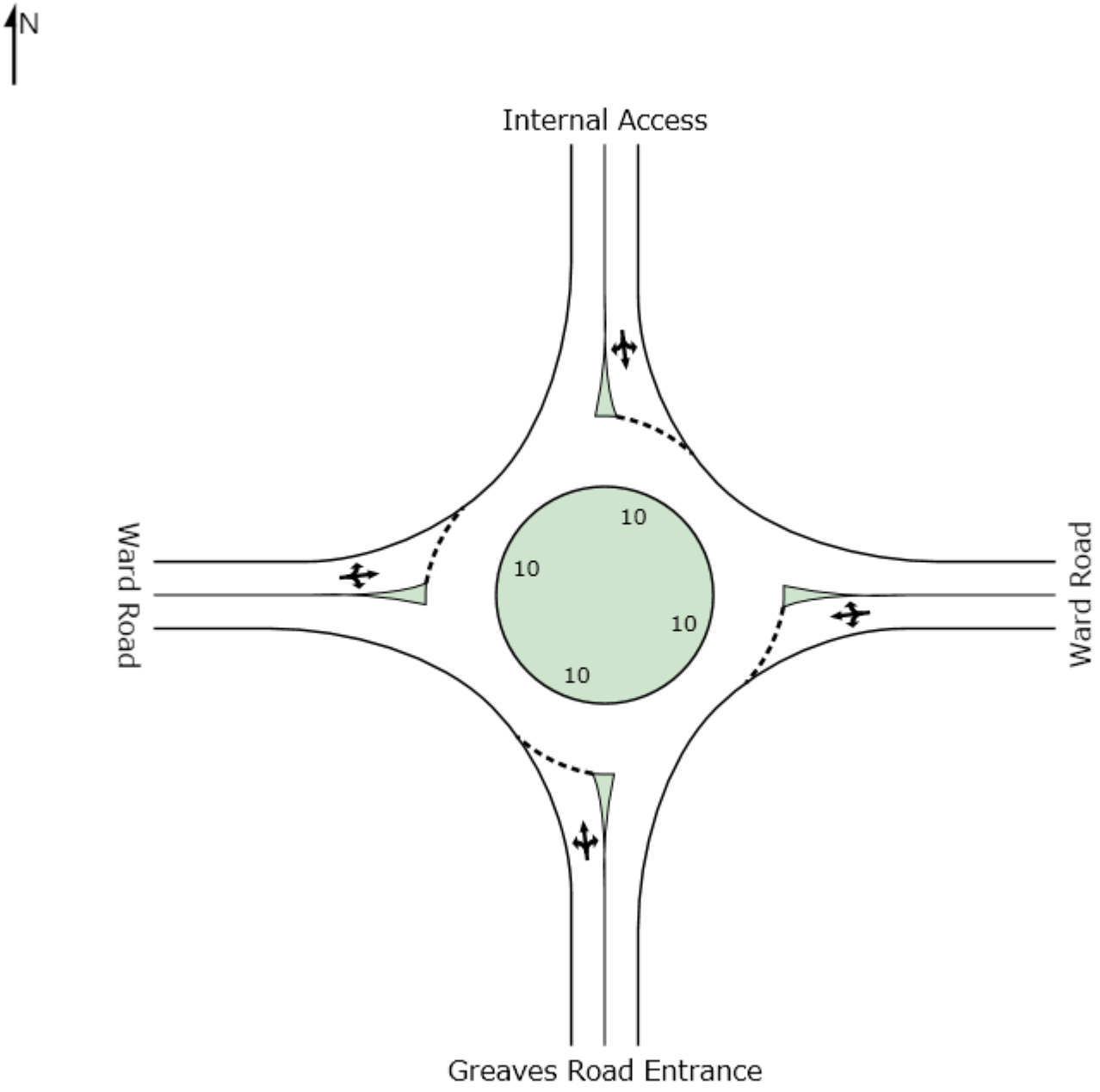
MOVEMENT SUMMARY

Site: Internal Roundabout 2026 - PM - Updated 02/05/2014

Internal Roundabout
Roundabout

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Greaves Road Entrance											
1	L	72	0.0	0.141	7.6	LOS A	0.7	5.2	0.23	0.58	48.9
2	T	82	0.0	0.141	6.8	LOS A	0.7	5.2	0.23	0.50	49.4
3	R	31	0.0	0.141	11.3	LOS B	0.7	5.2	0.23	0.75	46.0
Approach		185	0.0	0.141	7.9	LOS A	0.7	5.2	0.23	0.57	48.6
East: Ward Road											
4	L	17	0.0	0.031	7.9	LOS A	0.1	1.0	0.30	0.57	48.5
5	T	10	0.0	0.031	7.1	LOS A	0.1	1.0	0.30	0.50	48.9
6	R	10	0.0	0.031	11.6	LOS B	0.1	1.0	0.30	0.71	45.8
Approach		37	0.0	0.031	8.7	LOS A	0.1	1.0	0.30	0.59	47.8
North: Internal Access											
7	L	20	0.0	0.100	7.7	LOS A	0.5	3.5	0.26	0.57	48.7
8	T	45	0.0	0.100	6.9	LOS A	0.5	3.5	0.26	0.50	49.2
9	R	59	0.0	0.100	11.4	LOS B	0.5	3.5	0.26	0.72	45.8
Approach		124	0.0	0.100	9.2	LOS A	0.5	3.5	0.26	0.62	47.4
West: Ward Road											
10	L	47	0.0	0.097	7.8	LOS A	0.5	3.4	0.29	0.57	48.5
11	T	20	0.0	0.097	7.0	LOS A	0.5	3.4	0.29	0.50	48.9
12	R	50	0.0	0.097	11.5	LOS B	0.5	3.4	0.29	0.71	45.7
Approach		117	0.0	0.097	9.3	LOS A	0.5	3.4	0.29	0.62	47.3
All Vehicles		463	0.0	0.141	8.6	LOS A	0.7	5.2	0.26	0.60	47.9

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.


N
Internal Access
Ward Road
Ward Road
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Greaves Road Entrance

MOVEMENT SUMMARY

Site: Internal Roundabout 2046 - AM - Updated 02/05/2014

Internal Roundabout
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Greaves Road Entrance											
1	L	68	0.0	0.139	7.7	LOS A	0.7	5.0	0.27	0.59	48.7
2	T	78	0.0	0.139	6.9	LOS A	0.7	5.0	0.27	0.51	49.2
3	R	29	0.0	0.139	11.4	LOS B	0.7	5.0	0.27	0.75	45.9
Approach		175	0.0	0.139	8.0	LOS A	0.7	5.0	0.27	0.58	48.4
East: Ward Road											
4	L	16	0.0	0.048	7.9	LOS A	0.2	1.6	0.31	0.58	48.5
5	T	20	0.0	0.048	7.1	LOS A	0.2	1.6	0.31	0.51	48.8
6	R	20	0.0	0.048	11.6	LOS B	0.2	1.6	0.31	0.72	45.7
Approach		56	0.0	0.048	9.0	LOS A	0.2	1.6	0.31	0.60	47.6
North: Internal Access											
7	L	10	0.0	0.094	7.7	LOS A	0.5	3.3	0.25	0.57	48.7
8	T	43	0.0	0.094	6.9	LOS A	0.5	3.3	0.25	0.49	49.2
9	R	64	0.0	0.094	11.4	LOS B	0.5	3.3	0.25	0.72	45.8
Approach		117	0.0	0.094	9.4	LOS A	0.5	3.3	0.25	0.62	47.2
West: Ward Road											
10	L	97	0.0	0.137	7.8	LOS A	0.7	5.0	0.30	0.58	48.5
11	T	20	0.0	0.137	7.1	LOS A	0.7	5.0	0.30	0.51	48.8
12	R	49	0.0	0.137	11.6	LOS B	0.7	5.0	0.30	0.72	45.7
Approach		166	0.0	0.137	8.9	LOS A	0.7	5.0	0.30	0.61	47.6
All Vehicles		514	0.0	0.139	8.7	LOS A	0.7	5.0	0.28	0.60	47.8

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: Internal Roundabout 2046 - PM - Updated 02/05/2014

Internal Roundabout
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Greaves Road Entrance											
1	L	90	0.0	0.182	7.7	LOS A	1.0	6.9	0.28	0.59	48.7
2	T	103	0.0	0.182	7.0	LOS A	1.0	6.9	0.28	0.51	49.1
3	R	39	0.0	0.182	11.5	LOS B	1.0	6.9	0.28	0.75	45.9
Approach		232	0.0	0.182	8.0	LOS A	1.0	6.9	0.28	0.58	48.4
East: Ward Road											
4	L	21	0.0	0.053	8.1	LOS A	0.3	1.8	0.34	0.59	48.3
5	T	20	0.0	0.053	7.3	LOS A	0.3	1.8	0.34	0.52	48.6
6	R	20	0.0	0.053	11.8	LOS B	0.3	1.8	0.34	0.72	45.7
Approach		61	0.0	0.053	9.0	LOS A	0.3	1.8	0.34	0.61	47.5
North: Internal Access											
7	L	20	0.0	0.118	7.9	LOS A	0.6	4.3	0.30	0.58	48.5
8	T	56	0.0	0.118	7.1	LOS A	0.6	4.3	0.30	0.51	48.9
9	R	66	0.0	0.118	11.6	LOS B	0.6	4.3	0.30	0.72	45.7
Approach		142	0.0	0.118	9.3	LOS A	0.6	4.3	0.30	0.62	47.3
West: Ward Road											
10	L	54	0.0	0.126	8.0	LOS A	0.7	4.6	0.34	0.59	48.3
11	T	30	0.0	0.126	7.2	LOS A	0.7	4.6	0.34	0.52	48.6
12	R	63	0.0	0.126	11.7	LOS B	0.7	4.6	0.34	0.72	45.6
Approach		147	0.0	0.126	9.5	LOS A	0.7	4.6	0.34	0.63	47.1
All Vehicles		582	0.0	0.182	8.8	LOS A	1.0	6.9	0.31	0.61	47.7

Level of Service (LOS) Method: Delay (HCM 2000).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

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