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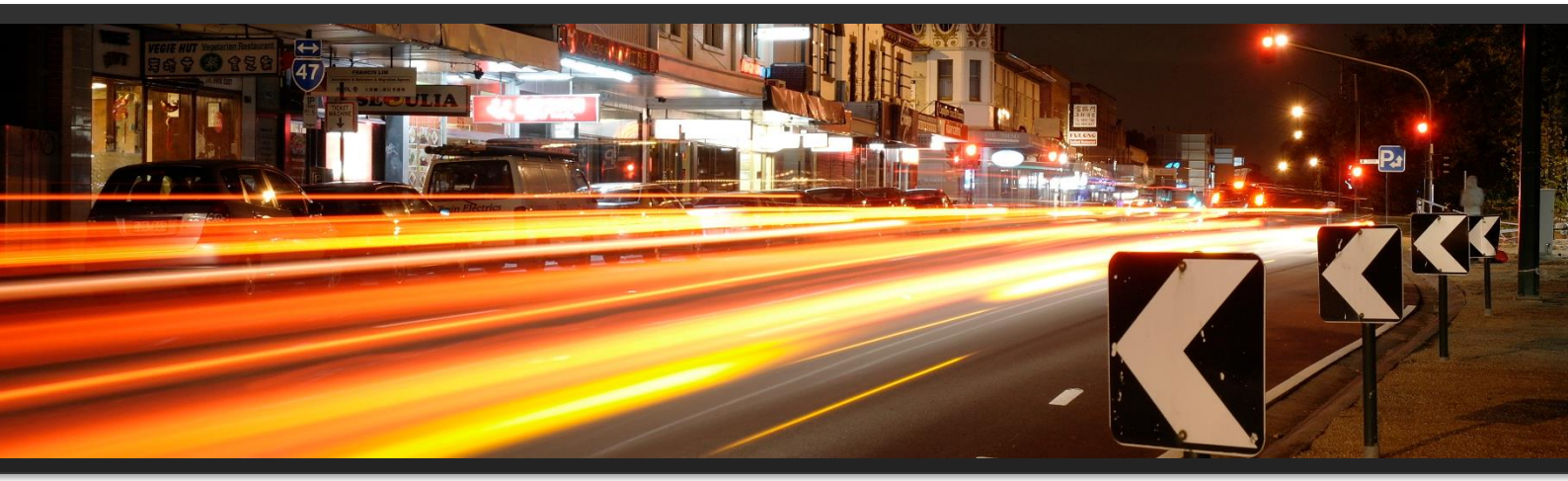
TRAFFIC ENGINEERING

Pakington Street & Gordon Avenue Urban Design Framework

Traffic Network Impact Assessment



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EXECUTIVE SUMMARY

Purpose

This report provides a high-level assessment of the future traffic growth generated by the proposed development in the Interim Final Pakington Street (Geelong West) and Gordon Avenue Urban Design Framework. A series of broad measures are outlined to manage this projected traffic growth.

Methodology

- In order to establish a baseline, traffic data was sourced from the Department of Transport for key intersections in the study area;
- In order to determine the level of additional traffic generated by the proposed development in each precinct, conservative traffic generation rates were applied to land-uses; and
- The approach taken is based on the full development of the Pakington North and Gordon Avenue precincts.

Existing Traffic Conditions

- Based on the traffic volumes, two intersections are currently operating close to theoretical capacity:
  - The Pakington Street / Church Street intersection in both the morning and afternoon peak hours; and
  - The Pakington Street / Gordon Avenue intersection in the afternoon peak hour.
- The La Trobe Terrace / Gordon Avenue intersection is operating above theoretical capacity in both the morning and afternoon peak hours; and
- Local streets were observed to be operating within daily vehicle volume capacity.

Future Traffic Conditions

- Intersection Impact:
  - The development proposed in the Interim UDF is expected to produce, at most, a 0.7% increase in traffic per year over a 20-year period, which is considered reasonable; and
  - The most significant increases in traffic movements – 13% during the morning peak hour and 10% during the afternoon peak hour – will be experienced at the Pakington Street / Gordon Avenue intersection, resulting in significant increases in queues and delays.
- Midblock Impact:
  - Significant increases in daily vehicle volumes were determined on Spring Street and Autumn Street.

Managing Future Traffic Growth

Travel Behaviour Changes

It is not expected that the predicted traffic increases will be fully realised within the 20-year timeframe, rather, over this period it is normal for travel behaviour to adapt and change over time:

- Firstly, as specific roads/streets/intersections become more congested, a redistribution of traffic naturally occurs as a proportion of drivers find alternative (quicker) routes;
- Secondly, some drivers, familiar with the area, will change when they travel to avoid the periods of peak traffic; and
- Thirdly, some drivers will change their mode of travel to access destinations across the study area.

Road Network Upgrades

Notwithstanding the aforementioned travel behaviour changes, key intersections will likely need to be upgraded to help manage future traffic growth:

- The Pakington Street / Gordon Avenue intersection, and
- The Latrobe Terrace / Gordon Avenue intersection, which has already been earmarked by the Department of Transport for future upgrading.

The predicted growth in traffic will be gradual, as new developments are delivered. As part of the planning process, proposed developments must demonstrate how the local road network can cater for the additional traffic will be generated. This is typically achieved by:

- A reduction in car parking spaces, justified on the basis that viable alternative modes are available, and
- A financial contribution to infrastructure upgrades, such as local road network upgrades.

The required upgrades are determined and funded through a development contributions plan (DCP), which is a mechanism used to levy new development to fund future community infrastructure needs. The Interim Final UDF proposes a masterplan for Gordon Avenue be undertaken, together with an infrastructure capacity assessment, to inform a DCP.

Local Traffic Management

In order to minimise the impact on residential streets, Local Area Traffic Management measures, such as traffic calming, parking restrictions and one-way traffic movements should be explored and, where appropriate, implemented.

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

onemile**grid** has been requested by Greater Geelong City Council to undertake a review of the proposed Pakington Street & Gordon Avenue Urban Design Framework (UDF) and prepare a traffic network impact assessment as a result of the proposals within the UDF.

As part of this assessment the subject site has been inspected, traffic and parking data has been sourced from Council and relevant background reports have been reviewed.

2 URBAN DESIGN FRAMEWORK

2.1 General

The Urban Design Framework (UDF) is a strategic document that has been prepared by Geelong City Council to help shape the continued development and renewal of Geelong West, with particular focus on Pakington Street and Gordon Avenue as they serve as the major road connections through the area. As part of the UDF, it is proposed to rezone certain precincts within the study area to allow for medium and high-density residential development in the future. It is envisioned that the residential dwellings will be constructed in new buildings which will provide a retail or commercial use on the ground floor and residential dwellings in the level/s above.

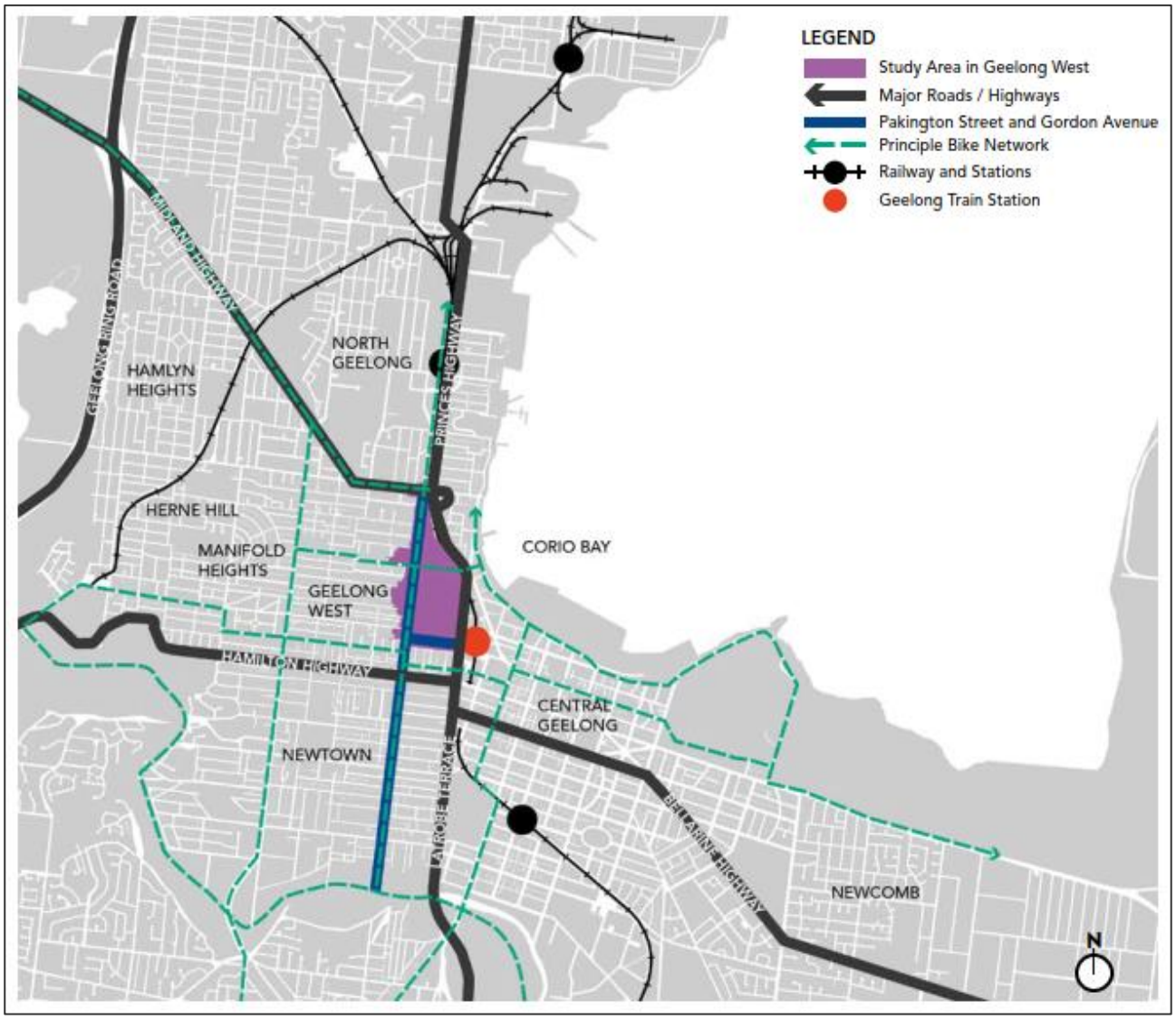
It is understood that as part of the vision of the UDF, upgrades to existing public transport and sustainable transport infrastructure are proposed to promote and encourage lower private motor vehicle trips. In addition, changes to the Pakington Street and Gordon Avenue cross sections are being considered, to shift the priority along these streets from vehicles to more sustainable transport modes.

The study area is generally encompassed by three major roads: being Pakington Street to the west, Gordon Avenue to the south and La Trobe Terrace to the east. Land use in Geelong West is primarily larger commercial uses in the south and far north, whilst the central precinct (Heritage Core Precinct) is serviced by a number of retail outlets and acts as an activity core.

Geelong Railway Station is located on the east side of La Trobe Terrace, directly opposite Gordon Avenue, just outside of the study area and provides a V-Line train service to Melbourne as well as other regional Victorian areas. Bus routes currently run along Gordon Avenue, Autumn Street and Pakington Street, providing a public transport connection to the wider Geelong area.

A view of the study area in relation to the surrounding Geelong City is shown in Figure 1 below.

Figure 1 Study Area

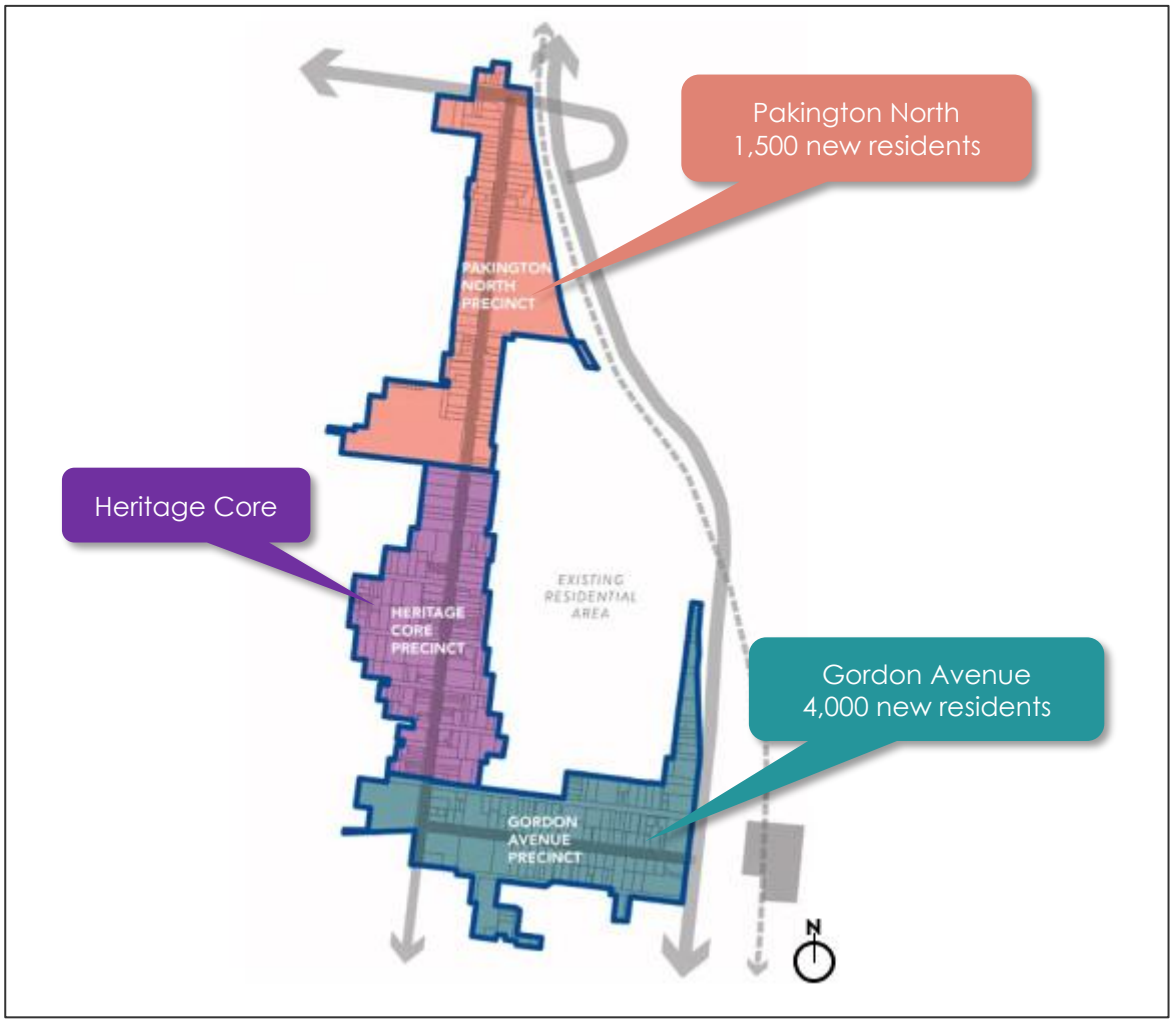


The study area is broken down into three (3) key precincts: Pakington North, Heritage Core and Gordon Avenue.

The UDF identifies that the rezoning will create capacity for an additional 1,500 residents in the Pakington North Precinct and an additional 4,000 residents in the Gordon Avenue Precinct. It is understood that the expectation is for the development of new dwellings to cater for the full provision of additional residents will take several decades (20-30 years) to materialise.

A view of the three (3) precincts within the study area is shown in Figure 2 below.

Figure 2 Precinct Breakdown

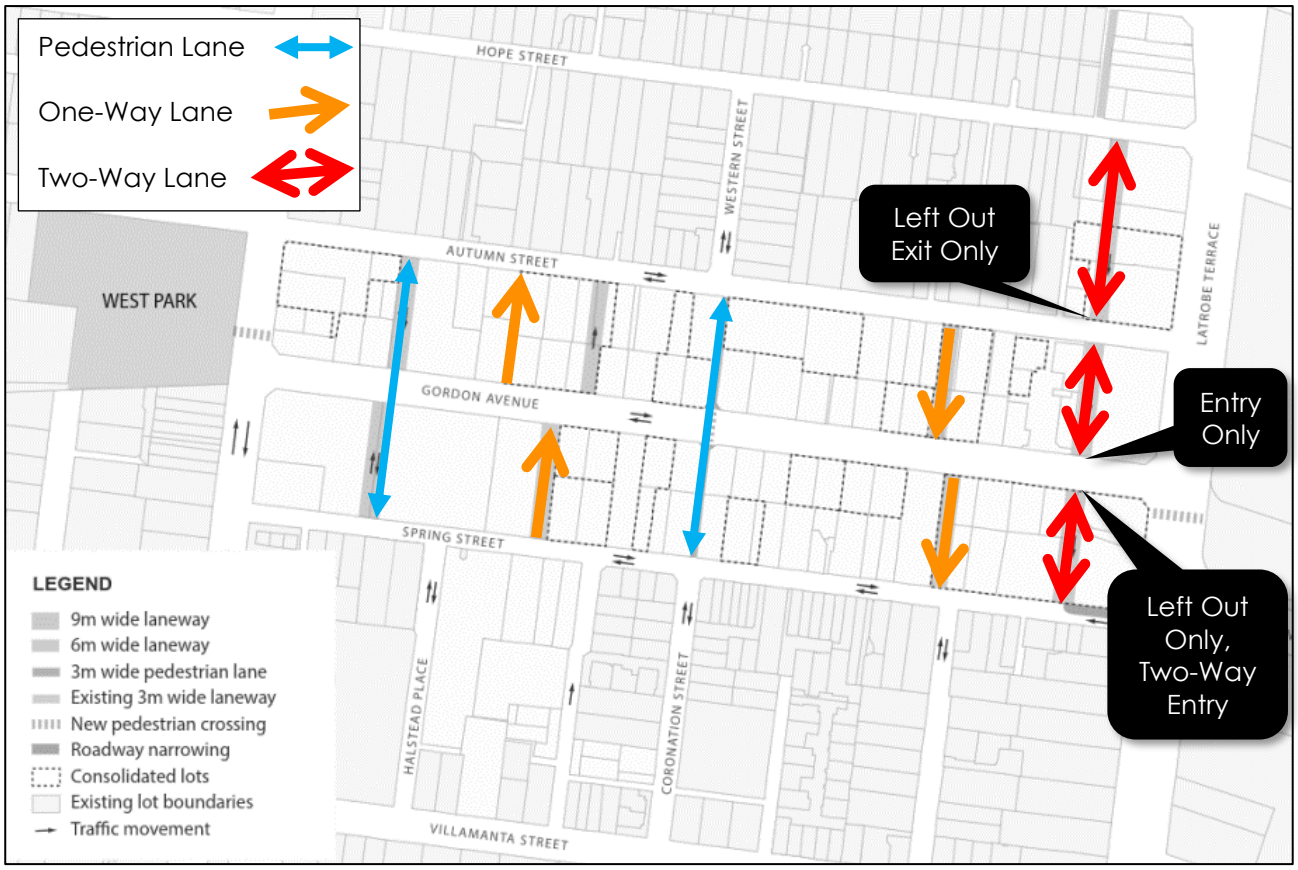


2.2 Gordon Avenue Precinct – Vehicle Laneways

As part of the UDF, it is proposed to provide additional laneway connections between Gordon Avenue, Autumn Street and Spring Street. **one**mile**grid** previously reviewed the laneway network design and provided advice on a suitable layout that would allow for connections between the local streets without having a detrimental impact on the La Trobe Terrace / Gordon Avenue intersection.

Figure 3 below, illustrates a potential laneway network layout with appropriate treatments at cross intersections for two-way laneways to ensure undesirable vehicle movements are prohibited. The potential for rat running will need to be considered with any laneway network layout through appropriate traffic management measures as required.

Figure 3 Potential Laneway Network Layout



2.3 Traffic Generation

The current zoning of the land in both the Pakington North Precinct and the Gordon Avenue Precinct is Commercial 2 Zone, which has been transitioning away from manufacturing and bulky goods to more fine-grained retail and commercial uses. As such, following the rezoning of the land to Commercial 1 Zone and provision of residential uses above the street level commercial/retail uses, traffic volumes generated by the commercial uses are expected to remain fairly consistent with existing conditions, with only the additional residential components contributing to increased traffic movements. Notwithstanding, sustainable transport initiatives should be encouraged for new development to reduce the reliance on private motor vehicle travel by commercial uses as well.

Medium to high density dwelling in inner areas generate traffic with rates between 3.0 and 6.0 movements per dwelling per day. Considering the location of the study area and the UDF's proposal to provide enhanced sustainable transport options in the future, it is expected that generation rates for additional dwellings will be towards the lower end of the range.

Nevertheless, for the purposes of this assessment, and to take into account the likely mix of dwelling types, a rate range of between 3 and 5 movements per dwelling per day and between 0.3 and 0.5 movements per dwelling during the peak hour will be applied to the potential residential yield.

The UDF identifies that the rezoning will create capacity for an additional 1,500 residents in the Pakington North Precinct and an additional 4,000 residents in the Gordon Avenue Precinct. Based on 2016 ABS Census data, it is understood that Geelong has on average 2.5 residents per household. However, with dwellings likely to be of a more medium and high-density nature, for the purposes of this analysis a rate of 2.3 residents per household will be adopted for the new dwellings, equating to an additional 2,391 dwellings across the entire study area as a result of a future rezoning.

Based on the above assumptions, the anticipated traffic generation for the study area is outlined in Table 1 below.

Table 1 Potential Traffic Generation

	Pakington Street North Precinct	***Gordon Avenue Precinct***	***Total***
New Residents	1,500	4,000	**5,500**
New Dwellings (2.3 residents per dwelling)	652	1,739	**2,391**
Additional Daily Traffic Movements	1,956 – 3,260	5,217 – 8,695	**7,173 – 11,955**
Additional Peak Hour Traffic Movements	196 – 326	522 – 870	**717 – 1,196**

Note: *Assumes 100% build out of dwellings to cater for additional residents.*

Based on the above, the rezoning and additional dwellings could ultimately generate between 7,173 and 11,955 additional vehicle movements per day, with 10% of those occurring in the morning and afternoon peak hours.

2.4 Traffic Distribution

GHD Consultants previously undertook a parking and traffic study in the area, which included the use of origin / destination surveys that detailed how vehicles moved throughout the study area. Based on the survey results from this report, an external traffic distribution to/from the precincts during a typical weekday can be determined.

onemile**grid** has adopted the directional distribution shown in Table 2 below, which has been derived from the GHD survey results. The distribution is considered reasonable as it would be expected that the majority of vehicle trips would occur from the north and south based on the location of the study area and surrounding road network.

Table 2 Adopted Directional Traffic Distribution

Origin/Destination	*Distribution*
North	28%
South	35%
East	21%
West	16%

The traffic distribution for the rezoning within the study area has been broken down into the two precincts, being the Pakington North Precinct and the Gordon Avenue Precinct. Motorists residing in new developments are expected to access these two Precinct via different streets and thus a separate distribution model is required for each.

From the external directional distribution, the traffic distribution has been further broken down into two components. The first is the primary distribution, which is where vehicles will take access from new developments. The second is nominated as the secondary distribution, which indicates how vehicles get to the primary distribution location (site access) from the wider road network.

It should be noted that the primary distributions come directly from the subject site, whereas the secondary distributions are a portion (in some instances the entire portion) of a primary distribution. For example, it is anticipated that 16% of the Pakington North Precinct development generated traffic will approach/depart from the west. Of that 16%; 5% is expected to utilise Isabella Street, 6% is expected to utilise Britannia Street and 5% is expected to utilise Waratah Street.

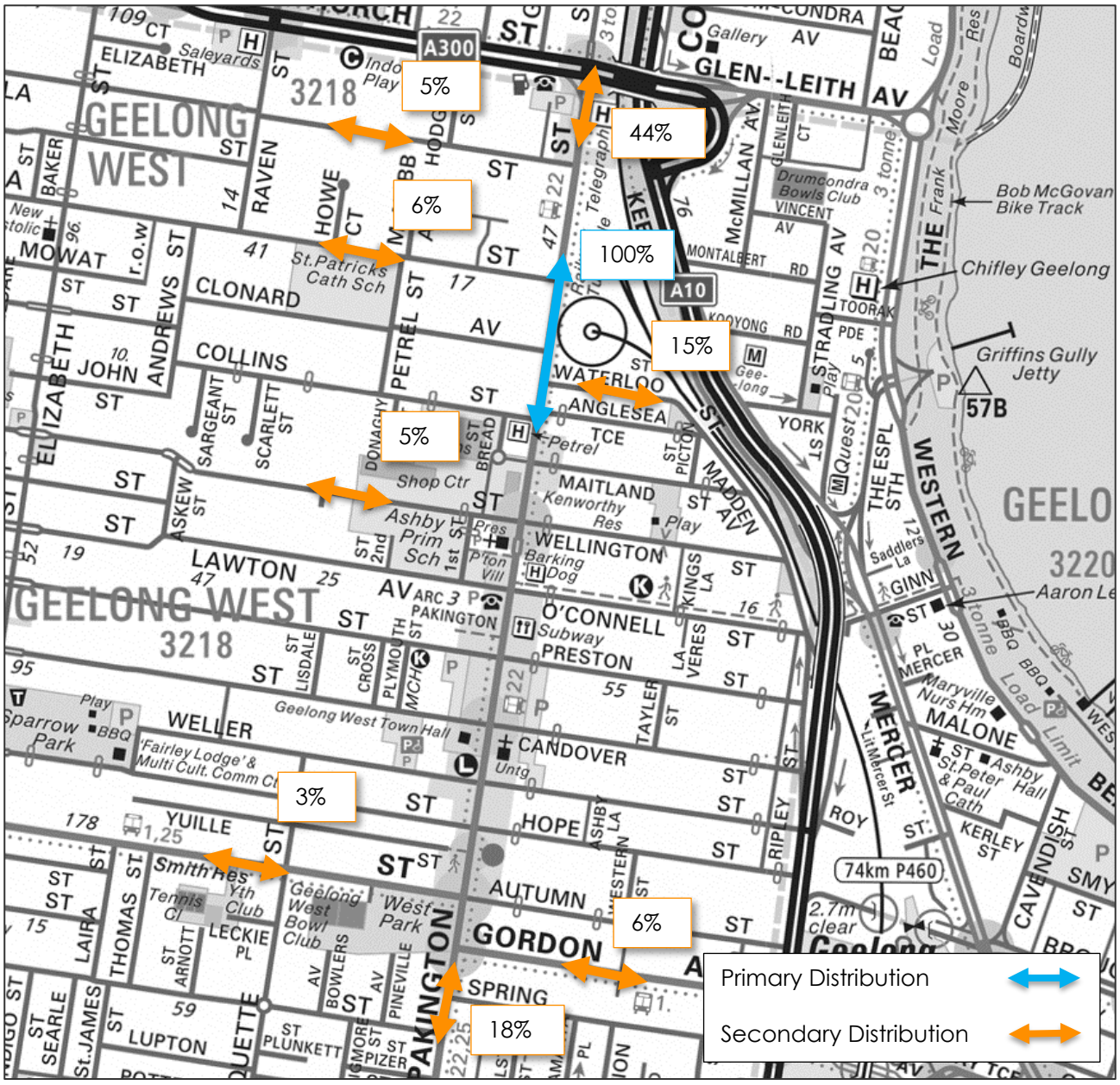
It is also worth noting that a distribution point shown in the figures below may include vehicles approaching from multiple directions. For example, it is anticipated that 15% of the Pakington North Precinct development generated traffic will approach/depart from Waterloo Street. Of that 15%, 11% is from southbound vehicles and 4% is from eastbound vehicles.

The secondary distributions area determined by a number of factors such as existing traffic volumes, proximity to site access, external road connections and logical travel routes.

The streets selected to be included as part of the distribution model cover logical access routes to the two Precincts from the arterial and connector street network and were the streets where existing traffic counts have been undertaken in the area (see Section 3.4).

A view of the traffic distribution for the Pakington North Precinct is provided in provided in Figure 4 below.

Figure 4 Pakington North Precinct Traffic Distribution



As shown above, it has been assumed that all new residential developments in the Pakington North Precinct will take access from Pakington Street. Whilst this may not ultimately be the case, it is considered a conservative assumption that ensures the potential full impact on the Pakington Street / Church Street intersection is taken into consideration.

Similarly, a view of the traffic distribution for the Gordon Avenue Precinct is provided in provided in Figure 5 below.

Figure 5 Gordon Avenue Precinct Traffic Distribution

As shown above, it has been assumed that of the new residential developments in the Gordon Avenue Precinct: 40% will take access from Autumn Street, 20% will take access from Gordon Avenue, 30% will take access from Spring Street and 10% will take access from Madden Avenue. These figures have been determined based on the preliminary rezoning plans in the UDF and general discussions with Council.

It should be noted that the laneway network connecting through Gordon Avenue and turn restrictions to/from these laneways has been taken into consideration when preparing this distribution model. It has predominantly affected the movements at the La Trobe Street intersections with Autumn Street, Gordon Avenue and Spring Street.

3 EXISTING TRAFFIC CONDITIONS

3.1 General

onemile**grid** has undertaken an independent traffic analysis of the impacts of the rezoning proposed within the UDF on the surrounding road network, including the impact on the three (3) key signalised intersections on the edge of the study area as well as the impact on the local roads within the study area.

Due to travel and trade restrictions associated with the COVID-19 pandemic, up to date traffic counts could not be undertaken as they would not provide typical results. As such, the existing conditions analysis utilises historical turning movements counts and weeklong tube count data provided by Council as well as intersection volumes sourced from Department of Transport (previously VicRoads), to approximate the existing traffic conditions as best as possible with the data available.

In the absence of suitable up to date traffic data, this methodology is considered acceptable and is outlined in more detail in the following Sections.

3.2 Intersection Traffic Volumes

As previously mentioned, the three (3) key intersection providing access to and from the study area are to be analysed to determine the impact the proposed rezoning within the UDF will have on traffic conditions. The three (3) key intersections are:

- Pakington Street / Church Street;
- Pakington Street / Gordon Avenue; and
- La Trobe Terrace / Gordon Avenue.

As previously, due to travel and trade restrictions associated with the COVID-19 pandemic, up to date turning movement counts at the abovementioned intersections were not undertaken as they would not provide results that could be considered typical.

Therefore, in order to establish baseline turning movements of these intersections, traffic volumes were obtained from the Department of Transport (VicRoads)' SCATS data at the following signalised intersections on the specific days mentioned below (prior to COVID-19 related restrictions):

- Pakington Street / Church Street, on Thursday 20th November 2019; and
- La Trobe Terrace / Gordon Avenue, on Thursday 27th November 2019.

It is noted that the SCATS data obtained for the two intersections were not on the same date. This is due to incomplete data within the system at both intersections on either date, therefore data for each specific intersection was taken from the date with complete data sets.

In addition, it should also be noted that SCATs data has some limitations in that movements from a lane that permits more than one movement are not distinguished from one another. For example, the left lane on the eastern leg of the Pakington Street / Church Street intersection permits both a through movements and a left turn movement. The SCATs data does not differentiate between left turning and through movements at the intersection, just how many vehicles travelled in that particular lane. As such, some general assumptions around turning movements based on tube count data along adjacent streets has been utilised to create the 'existing' peak hour turning movements at these intersections.

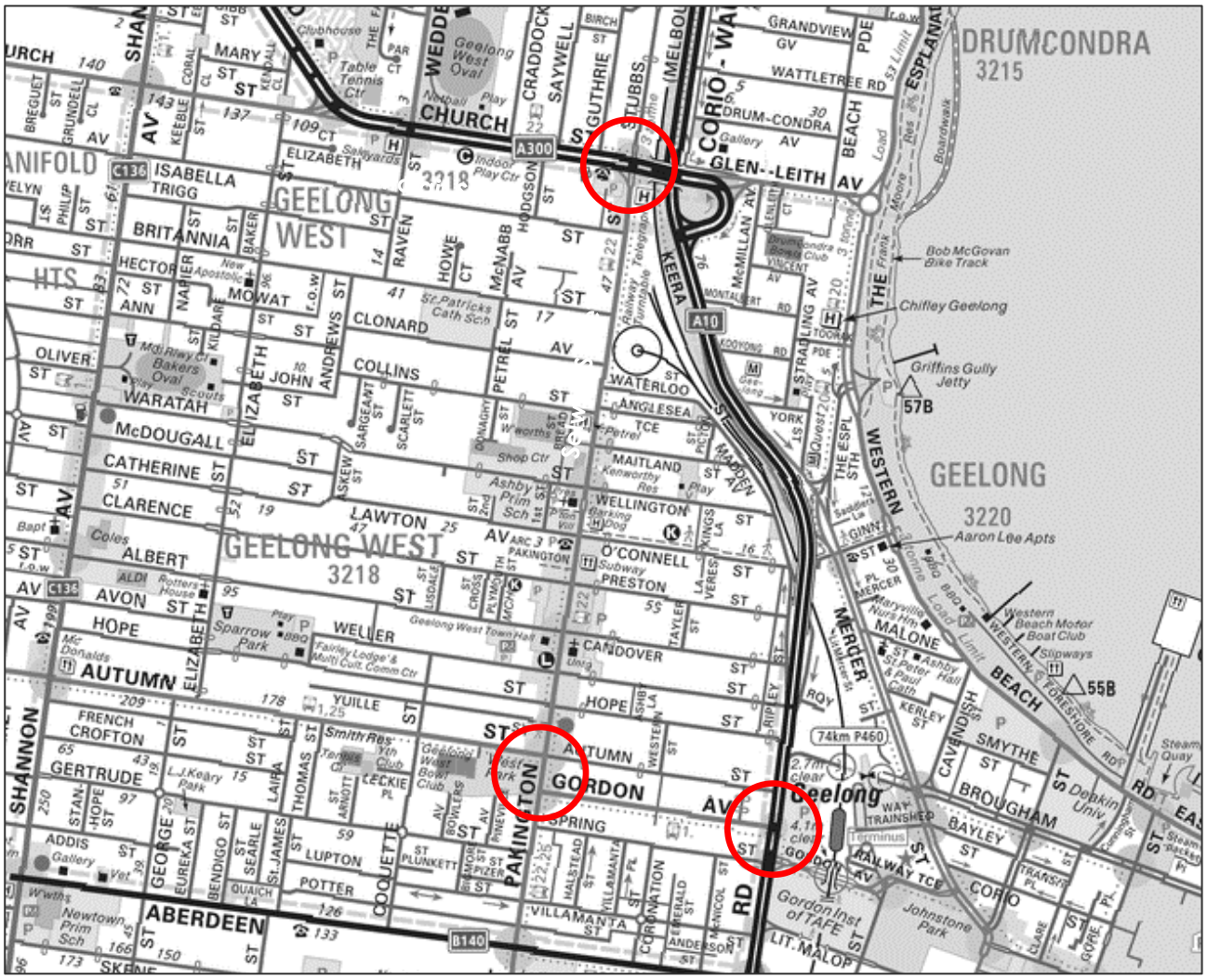
Unfortunately, no SCATS data was available at the intersection of Pakington Street / Gordon Avenue, nor was SCATS data available at either of the signalised intersections along Pakington Street between Gordon Avenue and Church Street (Albert Street / Candover Street and Waratah Street / Wellington Street) for comparative purposes.

As such, in order to establish existing conditions volumes at the intersection of Pakington Street / Gordon Avenue, turning movements counts from 2009 at the intersection provided by Council were utilised with a growth factor of 1% per year over 10 years added to establish the anticipated movements during the morning and afternoon peak hours. This growth factor was determined by reviewing historical DoT SCATs data at signalised intersections in the area over several years. In addition, traffic data from the daily tube counts along Gordon Avenue was utilised to determine the movements for this leg of the intersection.

The approach taken to determine the turning movements at these three (3) intersections is considered acceptable as the purpose of this report is to understand the impact the rezoning within the UDF will have on the intersections. Therefore, whilst the 'existing conditions' volumes may not be the exact existing volumes at the intersections, it is considered to be a fair approximation based on reasonable assumptions. In addition, the additional volumes created by the rezoning are known and with these anticipated existing conditions volumes, the impact on the intersections can be determined.

A view of the location of the three (3) key intersections is provided in Figure 6 below.

Figure 6 Key Intersection Locations



Based on the turning movements, the 'existing conditions' show the intersections servicing the following number of vehicle movements during the morning and afternoon peak hours:

- Pakington Street / Church Street:
  - AM – 2,541 vehicle movements
  - PM – 2,698 vehicle movements
- Pakington Street / Gordon Avenue:
  - AM – 1,404 vehicle movements
  - PM – 2,010 vehicle movements
- La Trobe Terrace / Gordon Avenue:
  - AM – 4,401 vehicle movements
  - PM – 4,613 vehicle movements

It is of note that at the Pakington Street / Gordon Avenue intersection, the total intersection volumes are significantly higher during the afternoon peak hour (2,010) than during the morning peak hour (1,404). This is most likely attributed to the after school pick-up period, which typically generates a more concentrated peak period than the morning drop-off period as parents are collecting students from school at the same time rather than dropping them off at any time prior to the beginning of school. This is further supported by the afternoon peak hour for the Pakington Street / Gordon Avenue intersection occurring between 3:15pm and 4:15pm.

The afternoon peak hours of the other two intersection occur after the school pick-up period, starting at 4:45pm (Pakington St / Church St) and 4:15pm (La Trove Terrace / Gordon Ave), indicating that commuters along the arterial road network make up the vast majority of vehicles during the peak hours – making the results more in line with the morning commuter peak hour.

The existing conditions peak hour turning movements at each of the three (3) intersections is attached in Appendix A.

3.3 Intersection Operations

To assess the operation of the intersections, the 'existing' traffic volumes have been input into SIDRA Intersection, a traffic modelling software package.

The SIDRA Intersection software package has been developed to provide information on the capacity of an intersection with regard to a number of parameters. Those parameters considered relevant are, Degree of Saturation (DoS), 95th Percentile Queue, and Average Delay as described below.

Table 3 SIDRA Intersection Parameters

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>Degree of Saturation (DoS)</td><td>The DoS represents the ratio of the traffic volume making a particular movement compared to the maximum capacity for that particular movement. The value of the DoS has a corresponding rating depending on the ratio as shown below.
<table>
<tr><th>Degree of Saturation</th><th>Rating</th></tr>
<tr><td>Up to 0.60</td><td>Excellent</td></tr>
<tr><td>0.61 – 0.70</td><td>Very Good</td></tr>
<tr><td>0.71 – 0.80</td><td>Good</td></tr>
<tr><td>0.81 – 0.90</td><td>Fair</td></tr>
<tr><td>0.91 – 1.00</td><td>Poor</td></tr>
<tr><td>Above 1.00</td><td>Very Poor</td></tr>
</table>
It is noted that whilst the range of 0.91 – 1.00 is rated as 'poor', it is acceptable for critical movements at an intersection to be operating within this range during high peak periods, reflecting actual conditions in a significant number of suburban signalised intersections.</td></tr>
<tr><td>Average Delay (seconds)</td><td>Average delay is the time delay that can be expected for all vehicles undertaking a particular movement in seconds.</td></tr>
<tr><td>95th Percentile (95%ile) Queue</td><td>95%ile queue represents the maximum queue length in metres that can be expected in 95% of observed queue lengths in the peak hour</td></tr>
</table>

As previously noted, the turning movement numbers utilised for this 'existing' conditions analysis are not a representation of the exact existing traffic movements at each of the three intersections. Due to a lack of current data and travel restrictions as a result of COVID-19, these turning movements have been determined based on historical data provided by Council, SCATs data sourced from Department of Transport and a number of assumptions, and are to serve as a baseline only to assess the impact of the additional volumes generated by the rezoning proposed in the UDF. See the previous Section for further detail.

The results show the Pakington Street / Church Street intersection in both peak hours and the Pakington Street / Gordon Avenue intersection in the afternoon peak hour are operating close to capacity. The results also show that the La Trobe Terrace / Gordon Avenue intersection is operating above capacity in both the morning and the afternoon peak hours.

It should be noted that in a letter (dated 7 May 2020) to City of Greater Geelong regarding their comments towards the Urban Design Framework, Department of Transport (DoT) acknowledged the each of the three intersections outlined previously present challenges under both existing and future conditions. A short extract of their comments on each of the intersections is as follows:

- **Pakington Street / Church Street**: *The Pakington Street intersection with Church Street provides the primary access from the north and is already at capacity, for right turning into Pakington Street.*
- **Pakington Street / Gordon Avenue**: *the intersection of Pakington Street / Gordon Avenue / Autumn Street is a bottleneck for buses and treatments to improve efficiency at this intersection should be considered.*
- **La Trobe Terrace / Gordon Avenue**: *the current configuration of the Latrobe Terrace / Gordon Avenue Intersection prevents efficient movements for all users and proposes the idea of realigning Gordon Avenue as an option to improve access. While the Department acknowledges this issue, any proposals to change access to the station will need to be considered as part of the planning for the future redevelopment of the Geelong Station.*

3.4 Daily Traffic Volumes

onemile**grid** were provided historical weeklong traffic volume, speed and classification data for a number of streets within the study area by Council. The collection dates of this data spanned from counts between 2012 to 2021 and a view of the location of these counts is shown in Figure 7 below.

From the data provided, the most suitable dates / surveys were selected to represent the baseline conditions of the road. In some cases, this has been slightly older survey dates as these represented higher daily traffic volumes which allows for a more conservative analysis.

It is noted that traffic counts in two locations that form part of the distribution model, being Pakington Street (south of Gordon Avenue) and Madden Avenue, do not have existing daily traffic counts. These locations have been marked as not available on the figure below.

Figure 7 Daily Traffic Survey Locations

Details of the daily traffic volumes along the surveyed streets are provided in Table 4 below.

Table 4 Daily Traffic Volume Surveys (7 Day Average) – Existing

Location	*Survey Date*	*Traffic Volume (vpd)*	*Indicative Capacity (vpd)*	*% of Capacity*
Pakington Street – North	Oct 2015	12,120	N/a	**N/a**
Pakington Street – South	Not available	Not available	N/a	**N/a**
Gordon Avenue	Aug 2018	6,229	10,000	**62%**
Autumn Street – West	Oct 2019	6,772	10,000	**68%**
Autumn Street – East	Feb 2012	1,246	2,000	**62%**
Spring Street	Dec 2019	774	2,000	**39%**
Britannia Street	Feb 2019	1,432	5,000	**29%**
Waterloo Street	Mar 2021	3,075	5,000	**62%**
Wellington Street	Nov 2014	1,321	2,000	**66%**
Waratah Street	Jan 2016	1,730	5,000	**35%**
Isabella Street	May 2019	1,362	2,000	**68%**
Madden Avenue	Not available	Not available	5,000	**-**

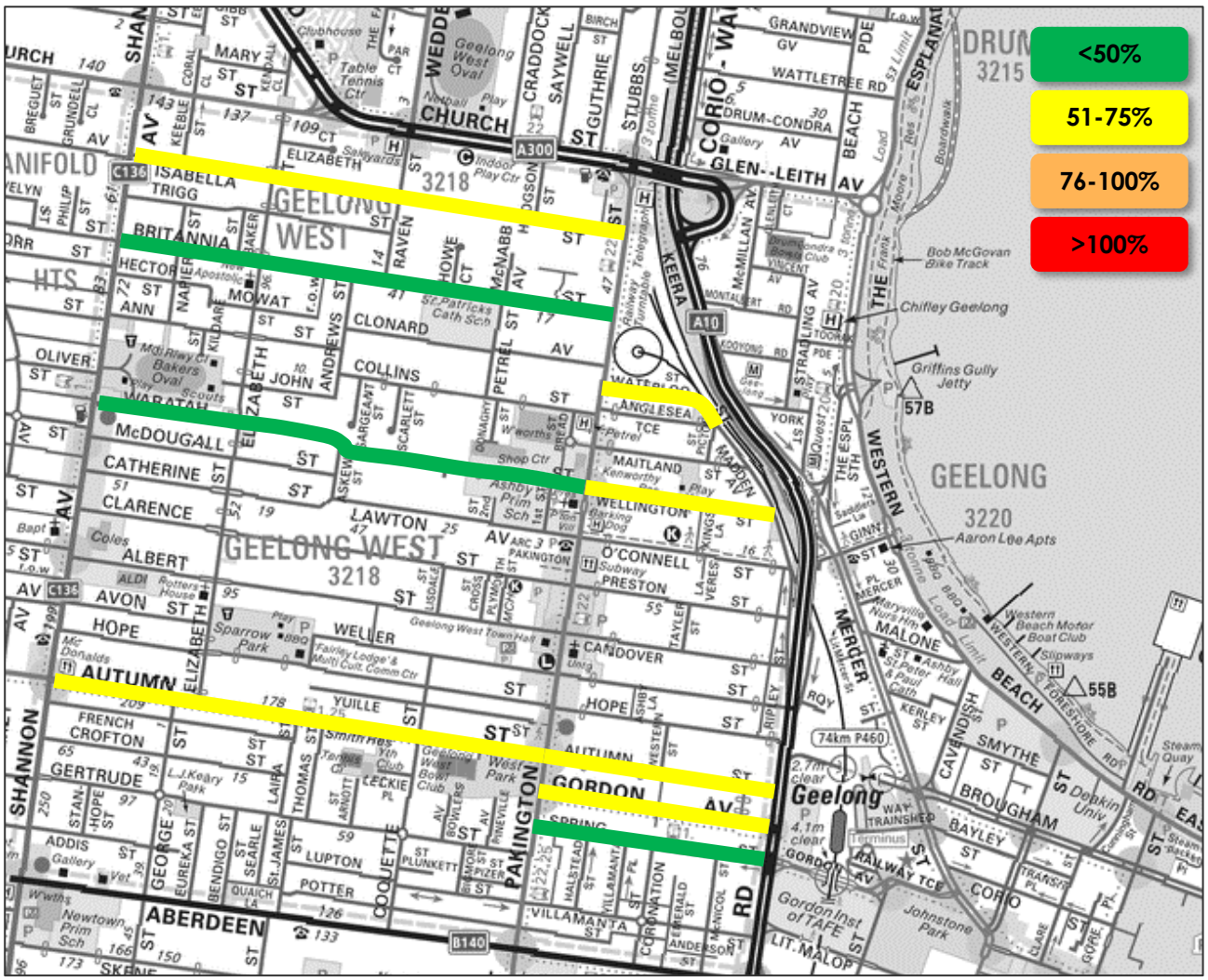
Note – *Volumes provided by City of Greater Geelong.*

The road capacities are defined within The City of Greater Geelong Manipal Road Management Plan (Version 8.00, 25 May 2021) and within the Greater Geelong Road Register.

It is noted that Pakington Street is nominated as a Category 4 Main Distributor Urban Road, which can typically carry up to 10,000 vehicles per day. However, Pakington Street provides a key north-south link through Geelong West and it is not uncommon for these types of roads to carry in excess of 10,000 vehicles per day. It is therefore not considered necessary or appropriate to compare the daily traffic volumes against an indicative capacity of the road.

Figure 8 below provides an illustrated view of the existing traffic volumes in comparison to the capacity of each road surveyed.

Figure 8 Daily Traffic Volume Capacity – Existing



4 FUTURE TRAFFIC CONDITIONS

4.1 Peak Hour Intersections

As previously mentioned in Section 2.3, a traffic generation rate of between 0.3 and 0.5 movements per dwelling during the peak hour is anticipated to the potential residential yield. For the purposes of the future intersection analysis, a rate of 0.3 movements per dwelling has been adopted to take into account future mode shifts to sustainable transport modes.

In order to determine the future intersection volumes, the generated traffic volumes have been distributed as per the two precinct distribution models outlined in Section 2.4 and the additional volumes have been added to the 'existing' traffic volumes at each of the intersections. A view of the generated traffic volumes is provided in Appendix B.

Table 5 outlines the existing total volumes at each of the three intersections during the morning and afternoon peak hours (as determined in Section 3.2) and details the increase in volumes at each of the intersections based on the future traffic volumes.

Table 5 Increased Intersection Volumes

Intersection	*Existing*	*Additional*	*% Increase*
AM Peak Hour			
Pakington Street / Church Street	2,541	128	5%
Pakington Street / Gordon Avenue	1,404	192	13.7%
La Trobe Terrace / Gordon Avenue	4,401	230	5.2%
PM Peak Hour			
Pakington Street / Church Street	2,698	128	4.7%
Pakington Street / Gordon Avenue	2,010	192	9.6%
La Trobe Terrace / Gordon Avenue	4,613	230	5%

As shown above, the Pakington Street / Church Street intersection and the La Trobe Terrace / Gordon Avenue intersection are expected to experience a 5% increase in the peak hours as a result of the rezoning. The Pakington Street / Gordon Avenue intersection is expected to carry more traffic with an increase of in excess of 13% during the morning peak hour and close to 10% in the afternoon peak hour. Considering the scale of the development and the likely timeframe of the full build out, these percentage increases are considered reasonable and presents at most a 0.7% per year increase over 20 years.

The future intersection volumes were then input into SIDRA Intersection, a traffic modelling software package, to determine the future performance of the intersection. It is noted that the analysis has been undertaken with no modifications to the layout or signal phasing of each of the three (3) intersections.

As previously mentioned, the turning movement numbers utilised for this 'future conditions' analysis are not a representation of the exact projected traffic movements at each of the three intersections but rather a representation of the impact the generated volumes will have on each of the intersections.

The impact on the intersections has been assessed in relation to increased delays and queues from the 'existing' conditions, as detailed in Table 6 – Table 8 below.

Table 6 Traffic Impact – Pakington Street / Church Street

Approach	Delay (sec)			95th Percentile Queue (m)		
	Existing	Future	Increase	Existing	Future	Increase
Weekday AM Peak Hour						
Pakington Street (S)	23	22	**-1**	39	46	**7**
Church Street (E)	35	41	**6**	93	104	**11**
Stubbs Avenue (N)	38	39	**1**	52	55	**3**
Church Street (W)	20	21	**1**	94	97	**3**
Weekday PM Peak Hour						
Pakington Street (S)	31	33	**2**	84	99	**15**
Church Street (E)	45	51	**6**	214	248	**34**
Stubbs Avenue (N)	55	71	**16**	87	115	**28**
Church Street (W)	24	27	**3**	81	100	**19**

Table 7 Traffic Impact – Pakington Street / Gordon Avenue

Approach	Delay (sec)			95th Percentile Queue (m)		
	Existing	Future	Increase	Existing	Future	Increase
Weekday AM Peak Hour						
Pakington Street (S)	10	10	**0**	20	21	**1**
Gordon Avenue (E)	22	23	**1**	15	18	**3**
Autumn Street (E)	27	28	**1**	7	14	**7**
Pakington Street (N)	15	15	**0**	17	21	**4**
Autumn Street (W)	30	31	**1**	27	30	**3**
Weekday PM Peak Hour						
Pakington Street (S)	36	239	**203**	75	405	**330**
Gordon Avenue (E)	45	242	**197**	34	118	**84**
Autumn Street (E)	39	375	**336**	13	93	**80**
Pakington Street (N)	45	159	**114**	101	294	**193**
Autumn Street (W)	55	304	**249**	48	212	**164**

Table 8 Traffic Impact – La Trobe Terrace / Gordon Avenue

Approach	Delay (sec)			95th Percentile Queue (m)		
	Existing	Future	Increase	Existing	Future	Increase
Weekday AM Peak Hour						
La Trobe Terrace (S)	18	19	**1**	130	127	**-3**
Gordon Avenue (E)	59	61	**2**	44	48	**4**
Station Car Park (E)	76	76	**0**	3	3	**0**
La Trobe Terrace (N)	169	200	**31**	413	450	**37**
Gordon Avenue (W)	78	209	**131**	48	149	**101**
Weekday PM Peak Hour						
La Trobe Terrace (S)	21	23	**2**	18	134	**116**
Gordon Avenue (E)	64	64	**0**	11	93	**82**
Station Car Park (E)	158	158	**0**	40	40	**0**
La Trobe Terrace (N)	210	219	**9**	465	481	**16**
Gordon Avenue (W)	80	144	**64**	52	98	**46**

It should be noted that the above results are based on the full build out of dwellings to cater for the proposed additional residents in the UDF area, which as previously mentioned, could take up to 20-30 years to be completely realised. In that time, a number of changes are likely to occur in people's travel behaviours and a shift to more sustainable transport modes is expected based on the initiatives within the UDF.

It should be noted that the existing conditions results show the Pakington Street / Gordon Avenue intersection in the afternoon peak hour operating close to capacity. This is further reflected in the baseline traffic volumes at the intersection being much larger in the afternoon peak compared with the morning peak. With the spare capacity available at the intersection in the morning peak hour, the additional volumes have very little impact on the queue and delays experienced by motorists. However, in the afternoon peak hour, the additional volumes have a greater impact as the intersection has exceeded its theoretical capacity with additional delays and queue lengths experienced on all legs of the intersection.

This is also reflected on the western leg (Gordon Avenue) of the La Trobe Terrace / Gordon Avenue intersection in both the morning and afternoon peak hours. With a large portion of the Gordon Avenue Precinct traffic accessing the area via this intersection, as well as it being the only intersection to turn right and head south along La Trobe Terrace from the development access streets, the delays and queues are expected to be noticeable impacted for this movement.

It is typically seen that when an intersection begins to reach practical capacity during the peak hours, motorists familiar with the area (i.e., residents, commuters) opt to avoid the intersection all together and naturally disperse around the intersection to find a quicker route. In the instance of the Pakington Street / Gordon Avenue intersection, there are alternative east-west and north-south routes on both the arterial and connector road network that could become comparable in journey time and therefore may become more attractive to motorists, thus removing some existing vehicles from the intersection as development occurs.

Notwithstanding, as the three (3) key intersections within the study area are already operating close to, or in some cases in excess of, their theoretical capacity – the impact that additional traffic volumes have on the network will result in some form of upgrades at these intersections being required. The extent of the upgrades is to be determined in the future and will be subject to future analysis. These upgrades could be staggered over time to suit the level of development as it occurs, and a mechanism enables the upgrade of the intersection/s to a suitable ultimate arrangement should be investigated and resolved prior to the rezoning.

There are some minor physical changes to the Pakington Street / Gordon Avenue intersection that could be explored which may improve the operation of the intersection. These changes should be carefully considered, and an ultimate arrangement should be established to ensure future developers do not avoid contributing (if applicable) to necessary upgrades that are required. These minor changes are as follows

- Increasing Gordon Avenue approach lane length (southern lane);
- Increasing Pakington Street south approach lane length (western lane);
- Increasing Autumn Street west approach lane length (northern leg); and
- Allow right turn movements from the northern lane on the Autumn Street west approach.

It should be acknowledged that each new development must go through the planning process and demonstrate its anticipated impact on the road network prior to a planning permit being issued. It is considered that through this process, the appropriate improvements to the intersection/s (if required) can be determined.

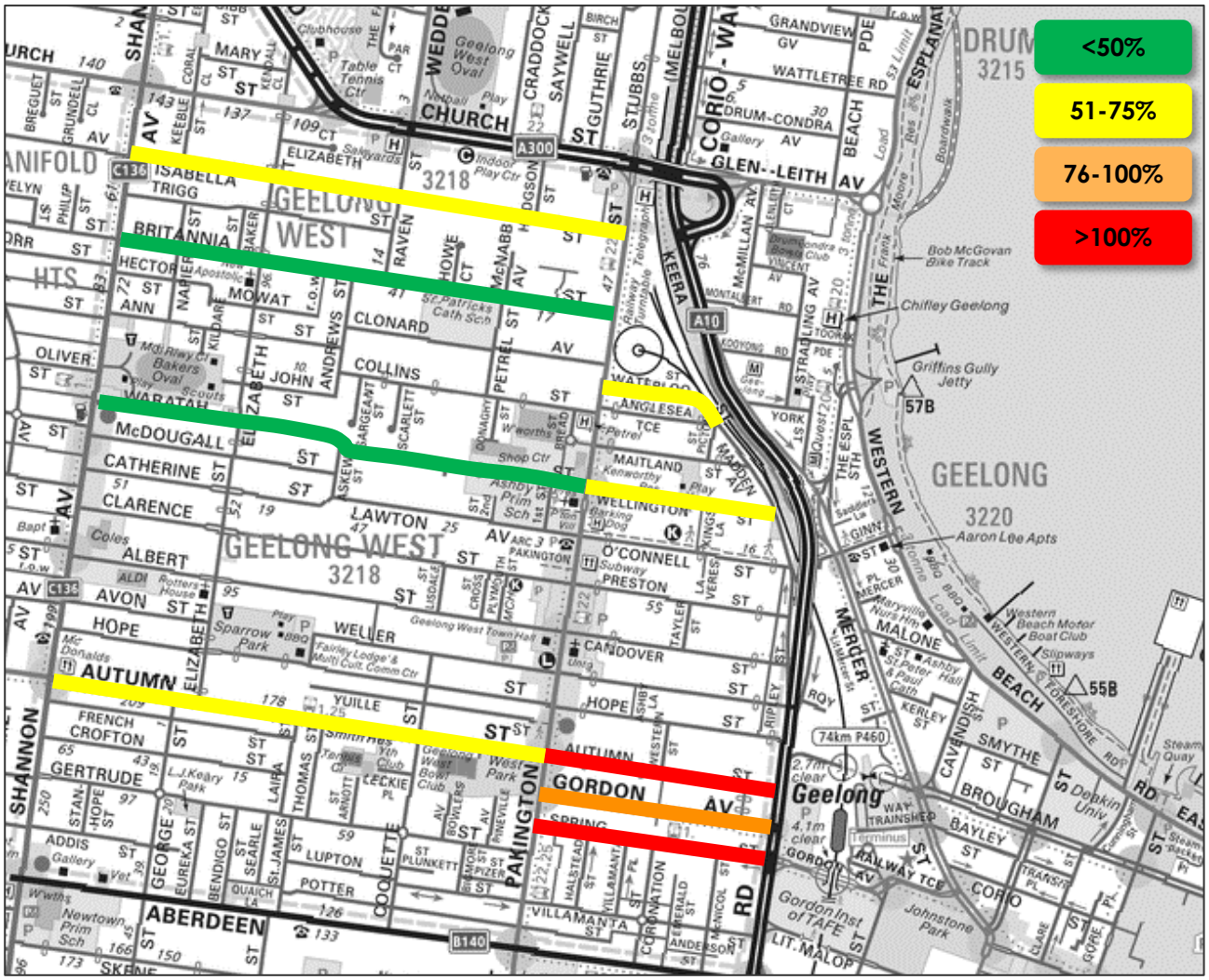
4.2 Daily Road Volumes

Similar to the intersection volumes, the generated traffic volumes have been distributed as per the two precinct distribution models outlined in Section 2.4 and the additional volumes have been added to the baseline traffic volumes along each of the roads within the model. The forecast future volumes have been compared against the environmental capacity of the road and are shown in Table 9 and Figure 9 below.

Table 9 Daily Traffic Volume Surveys (7 Day Average) – Future

Location	*Existing Volumes (vpd)*	*Additional Volumes (vpd)*	*Future Volumes (vpd)*	*Indicative Capacity (vpd)*	*% of Capacity*	
Pakington Street – North	12,120	2,249 – 3,748	14,369 – 15,868	N/a	**N/a**	
Pakington Street – South	Not provided	1,255 – 2,092	N/a	N/a	**N/a**	
Gordon Avenue	6,229	2,009 – 3,348	8,238 – 9,577	10,000	**82%**	**96%**
Autumn Street – West	6,772	695 – 1,158	7,467 – 7,930	10,000	**75%**	**79%**
Autumn Street – East	1,246	2,087 – 3,478	3,333 – 4,724	2,000	**167%**	**236%**
Spring Street	774	1,565 – 2,609	2,339 – 3,383	2,000	**117%**	**169%**
Britannia Street	1,432	125 – 209	1,557 – 1,641	5,000	**31%**	**33%**
Waterloo Street	3,075	288 – 479	3,363 – 3,554	5,000	**67%**	**71%**
Wellington Street	1,321	0	1,321	2,000	**66%**	**66%**
Waratah Street	1,730	303 – 504	2,033 – 2,234	5,000	**41%**	**47%**
Isabella Street	1,362	94 – 157	1,456 – 1,519	2,000	**73%**	**76%**
Madden Avenue	Not provided	522 – 870	N/a	5,000	**-**	

Figure 9 Daily Traffic Volume Capacity – Future



As previously mentioned, the above results are based on the full build out of all dwellings to cater for the proposed additional residents in the UDF area, which as previously mentioned, could take up to 20-30 years to be completely realised. In that time, a number of changes are likely to occur in people's travel behaviours and a shift to more sustainable transport modes is expected based on the guiding principle of the UDF.

From the analysis presented above, the major increase in daily vehicle volumes is shown on both Spring Street and Autumn Street as they provide access to a large portion of the future residential developments. At the lower end of the traffic generation projections (3 vehicle trips per dwelling per day), Autumn Street east of Pakington Street is expected to ultimately operate 67% above indicative capacity whilst Spring Street is expected to ultimately operate 17% above indicative capacity.

As the developments come online, some mitigating works may be required along Autumn Street east of Pakington Street to ensure the street is not adversely affected. Local Area Traffic Management measures such a speed humps or 'Local Traffic Only' signage can act as a deterrent to ensure Autumn Street is not utilised for non-local trips. The removal of on-street parking on one side of the road could also allow for greater traffic flow along the street and less congestion when opposing vehicles meet, particularly during peak times. That said, any mitigating works should be balanced against the travel demand model which in congested periods acknowledges that traffic will self-regulate.

There is also a strong possibility that some new developments will take access from rear laneways and not travel along either Autumn Street or Spring Street at all. As the understanding of how the future developments will be accessed evolves, so will the understanding of the likely traffic distribution from these developments.

5 CONCLUSIONS & RECOMMENDATIONS

5.1 Limitations

The analysis presented above does contain some limitations, which are outlined throughout the analysis and summarised below:

- There is limited existing conditions traffic volumes available;
- No existing traffic within the study area has been removed as part of the analysis. However, it is considered highly likely that some vehicles that currently travel through the area no longer will as a result of the new land uses, thus reducing the impact of the additional traffic volumes;
- It is not yet fully understood from which streets the future developments will take access from. The current assumptions are considered reasonable based on the information available at this time, however changes to the access will have a flow on effect to the likely routes taken from the wider network by residents and therefore could change the distribution model and future impacts; and
- Local Area Traffic Management measure such as turn bans, speed humps, one-way arrangements, etc. are not yet fully determine. These aspects of the local road network may change the distribution model and future impacts.

As mentioned, the analysis presented takes into the consideration the full scale of the development – which is likely to take several decades to be fully realised. As such, the analysis may benefit from a more staged approach, by looking at what impact a 25%, 50% and 75% build out might have on the road network.

Further information is required as to which Precincts and/or which areas within the Precincts are likely to be developed first to better understand the impact in 5 or 10 years' time.

5.2 Sustainable Transport Initiatives

The Pakington Street and Gordon Avenue UDF presents an aspiration for the priority of both Pakington Street and Gordon Avenue to be given to pedestrians, cyclists and public transport over private motor vehicles. The UDF proposes a number of sustainable transport initiatives to provide viable and quality alternatives to a private motor vehicle thereby reducing the need for car parking and vehicle trips. These initiatives include:

- Public Transport:
  - Upgrades to bus stops along Pakington Street.
  - Consideration of kerb outstand bus stops at strategic locations along Pakington Street as this arrangement reduces the impact to on-street parking and speeds up bus travel times by virtue of buses not having to pull out the traffic lane when collecting / dropping off passengers.
  - Advocate for increased frequency of bus services.
- Active Transport:
  - Increase bicycle lane visibility through painted treatments.
  - Potential for bicycle lanes to be provided along Gordon Avenue.
  - Bike start boxes at signalised intersection along Pakington Street to assist in making cyclists more visible at intersections, in particular for vehicles looking to turn left into side streets or for cyclists wishing to turn right at signalised intersections.
  - Additional publicly accessible bicycle parking spaces.
  - Improved pedestrian connections along/through Pakington Street and Gordon Avenue.

5.3 Intersection Impact

Considering the scale of the development and the likely timeframe of the full build out, the percentage increases at the three (3) key intersections during the weekday peak hours are considered reasonable and present at most a 0.7% per year increase over 20 years.

The results of the SIDRA analysis demonstrates that delays and queues will increase as a result of rezoning, in particular at the intersection of Pakington Street / Gordon Avenue and at the intersection of La Trobe Terrace / Gordon Avenue. However, it is typically seen that when an intersection operates at or above capacity during the peak hours, motorists familiar with the area (i.e., residents, commuters) will change travel behaviour avoid congested intersections all together. There is alternative east-west and north-south routes on both the arterial and connector road network that could remove some existing vehicles from the key precinct intersections as the development of residential dwellings occurs.

Notwithstanding, as the three (3) key intersections within the study area are already operating close to, or in some cases in excess of, their theoretical capacity – the impact that additional traffic volumes have on the network will result in some form of upgrades at these intersections being required. The extent of the upgrades is to be determined in the future and will be subject to future analysis and these upgrades may be staggered over time to suit the level of development as it occurs.

The required upgrades are determined and funded through a development contributions plan (DCP), which is a mechanism used to levy new development to fund future community infrastructure needs. The Interim Final UDF proposes a masterplan for Gordon Avenue be undertaken, together with an infrastructure capacity assessment, to inform a DCP.

5.4 Midblock Impact

All roads except for Autumn Street (east of Pakington Street) and Spring Street are expected to operate within capacity under future conditions. As the developments come online, some mitigating works may be required along Autumn Street east of Pakington Street and Spring Street to ensure the streets are not adversely affected by the traffic growth. Local Area Traffic Management measures such a speed humps or 'Local Traffic Only' signage can act as a deterrent to ensure Autumn Street and Spring Street are not utilised for non-local trips. The removal of on-street parking on one side of the road could also allow for greater traffic flow along the street and less congestion when opposing vehicles meet, particularly during peak times. That said, any mitigating works should be balanced against the travel demand model which in congested periods acknowledges that traffic will self-regulate.

5.5 Council Considerations

It is considered paramount to ensure that sustainable transport options are promoted within Geelong West as the area is developed into the future. The UDF aims to provide improved sustainable transport infrastructure, improved public transport services and connections to these services as well as reduce car parking provisions for new developments. In addition, the UDF study area should aim to create a neighbourhood with good pedestrian access to amenities such as supermarkets, employment and recreation facilities to ensure typical day-to-day activities can be achieved by walking rather than driving. All these factors will help contribute to a reduced reliance on private motor vehicles and therefore reduce the traffic generated by new residential developments constructed in the precincts.

It is recommended that Council be supportive of parking provisions that align with census data (or lower) rather than the statutory requirements outlined within Clause 52.06. In addition, Council should be thorough in their assessment of the provision of bicycle parking and end of trip facilities in all new developments in the area and should encourage the provision of facilities over and above the statutory requirements.

Future developments should maintain a balance between providing car parking and shared resources / promoting sustainable transport options.

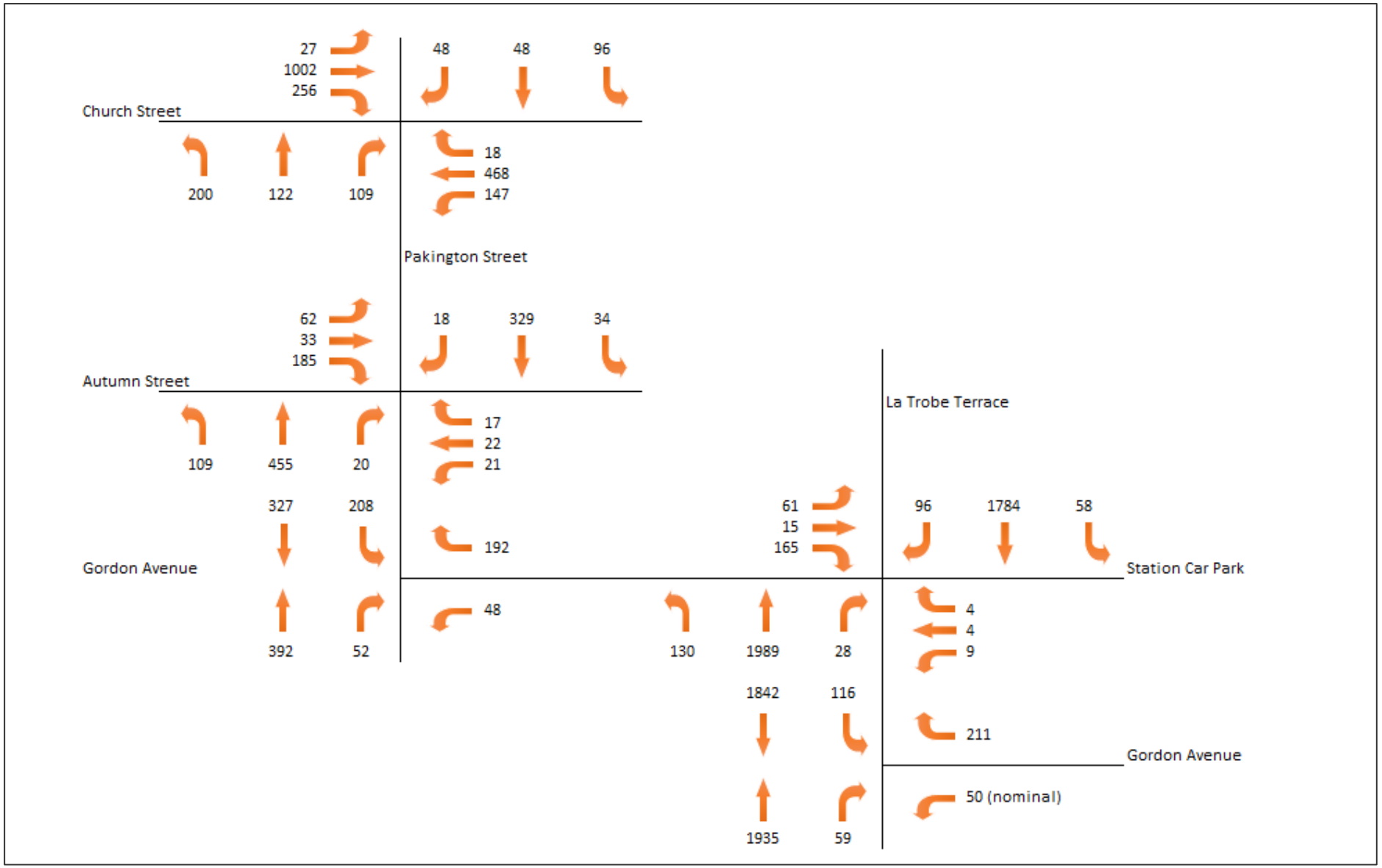
5.6 Key Recommendations

The following key recommendations are provided:

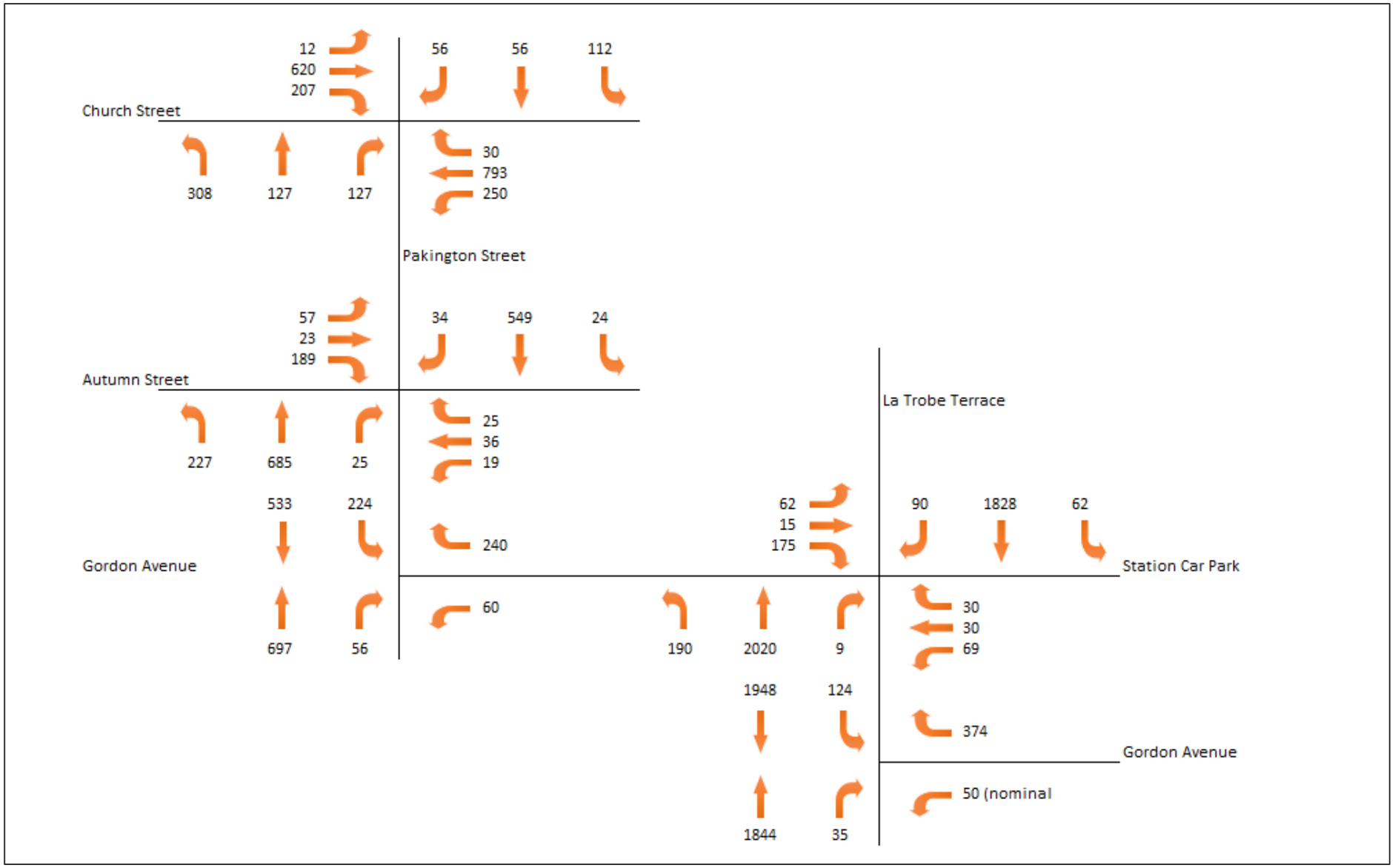
- Undertake further investigation to understand the extent of future development in terms of timeframes (5 years, 10 years, etc.) to help inform the priority and timing of road network upgrades;
- Prepare an infrastructure contributions arrangement to support the land use rezoning to ensure the road network can cater for the projected future traffic volumes as they occur; and
- Support and encourage new developments with reduced car parking provision and enhanced sustainable transport infrastructure.

Appendix A Peak Hour Intersection Volumes – Existing Conditions

Weekday AM Peak Hour Volumes

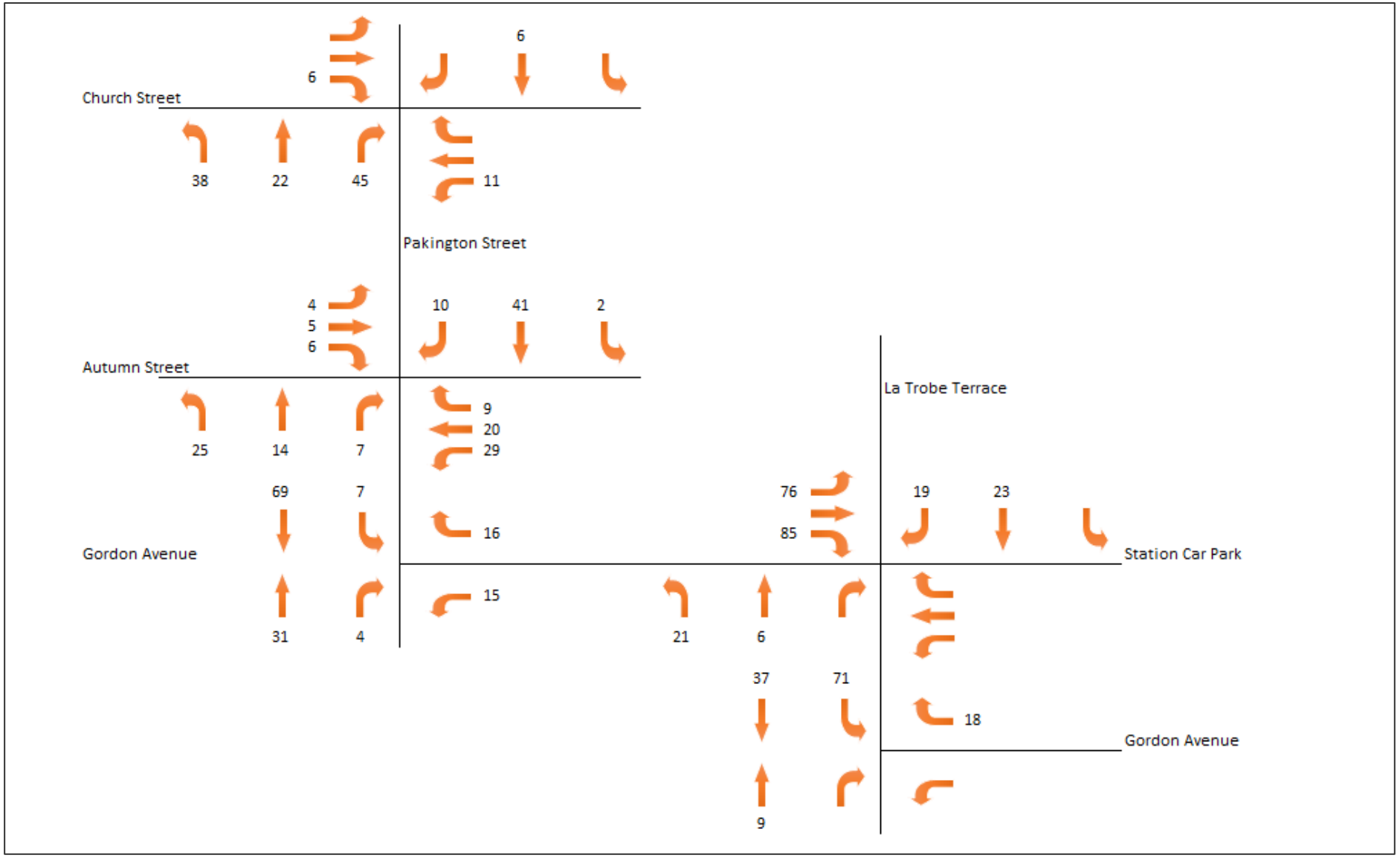


Weekday PM Peak Hour Volumes



Appendix B Peak Hour Intersection Volumes – UDF Generated Volumes

Weekday AM Peak Hour Volumes



Weekday PM Peak Hour Volumes