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Report

Cambridge Town Centre Road Bridges Capacity and Demand Study

Prepared for Waipa District Council

Prepared by Beca Limited

11 January 2018

Revision History

Revision Nº	Prepared By	Description	Date
1	**Craig Richards**	Draft for client review	21 December 2017
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Document Acceptance

Action	Name	Signed	Date
Prepared by	**Craig Richards**		21 December 2017
Reviewed by	**Andrew Collings**		21 December 2017
Approved by	**Joe Phillips**		11 January 2018
on behalf of	Beca Limited		

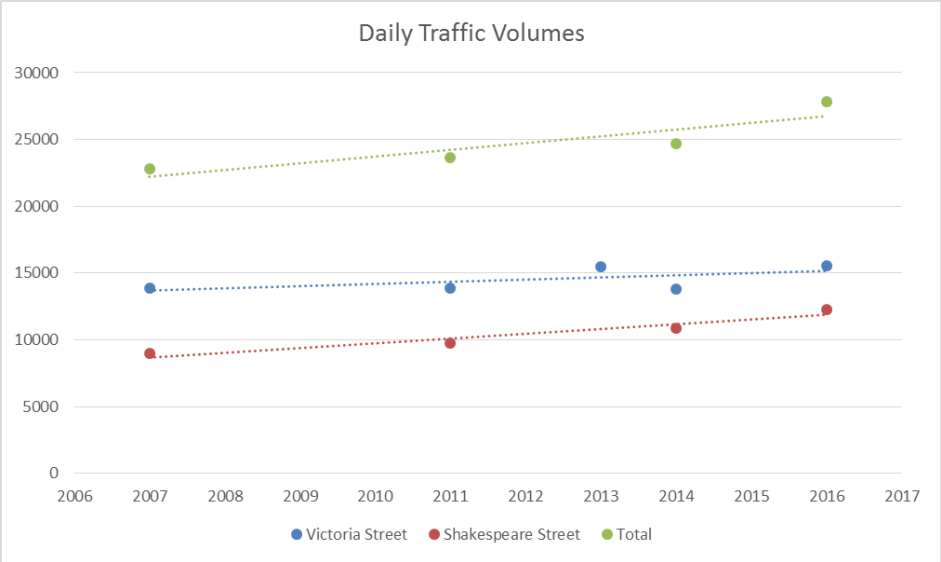
Executive Summary

There are two existing road bridges across the Waikato River in Cambridge, the Victoria Street (high level) and Shakespeare Street (low level) bridges. Approximately 28,000 vehicle movements are made across these two bridges every day. Daily traffic volumes have increased by approximately 13% since 2014. The Waipa District Council (Waipa DC) Growth Strategy (Waipa 2050) estimates that there will be 14,000 additional people living in Cambridge by 2050, with approximately 25% of these located on the southern side of the River. If traffic volumes across the two bridges increase with this residential growth then demand for vehicle crossings could exceed the capacity of the bridges in future. Waipa DC need to know if, and if so when, demand will exceed capacity so that solutions to this problem can be identified and planned for ahead of this time.

This study investigates historic and predicted traffic volumes across the two existing bridges in Cambridge to predict if and when traffic volumes could exceed the capacity of the two existing bridges in future.

The Victoria Street Bridge was built in 1907 and has a narrow carriageway which restricts the capacity of this Bridge to around half of a typical road capacity. The Shakespeare Street Bridge is wider and more modern and has higher capacity, although still less than a typical road.

The following figure shows historic daily traffic volumes across the two bridges between 2007 and 2016.



The capacity of the Victoria Street Bridge is estimated at around 900 vehicles per hour in one direction. The capacity of the Shakespeare Street Bridge is around 1,045 vehicles per hour. So the combined capacity for river crossing is around 1,945 vehicles per hour in one direction.

Traffic counts carried out in 2016 show the one way demand across the Victoria Street Bridge is just above 800 vehicles per hour. The same demand across the Shakespeare Street Bridge is less than this at around 730 vehicles per hour. So whilst existing demand for crossing the Victoria Street Bridge is near capacity there is residual capacity on the Shakespeare Street Bridge.

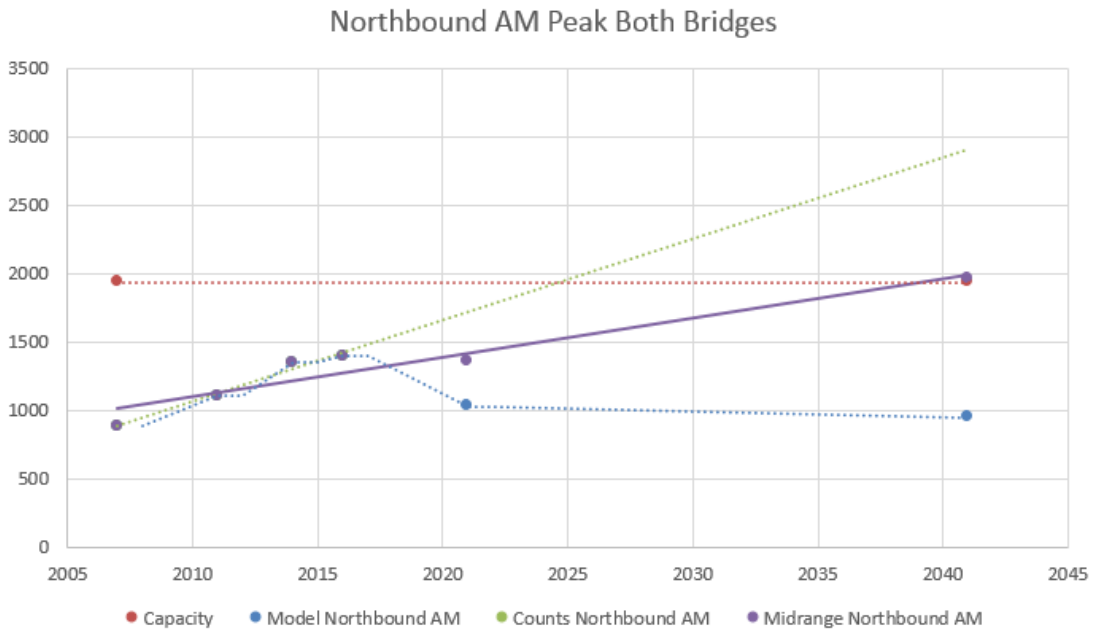
The Waikato Regional Traffic Model (WRTM) has been examined to provide an estimate of future traffic demands across the two bridges. The model outputs show very little growth in traffic volumes across these

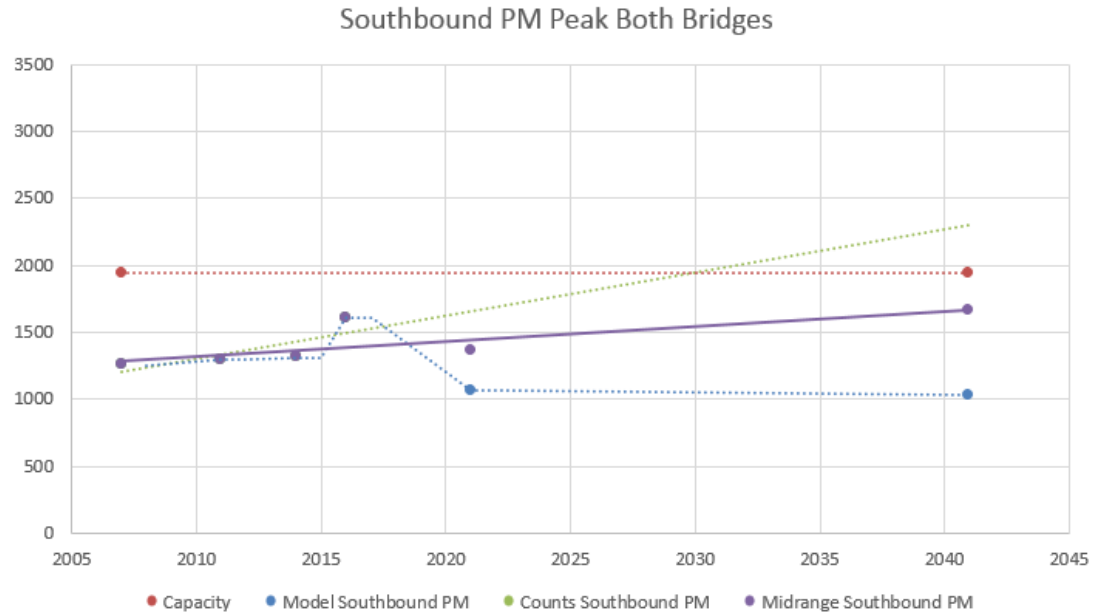
bridges in future and for some movements / time periods a reduction in volumes from existing levels to 2021, and also very little to no growth in traffic volumes between 2021 and 2041.

In addition to the WRTM, analysis of historic traffic volumes across the two bridges and the effect of projecting the historic (10 year) growth rate forward has been considered as a comparison.

Lastly, as the above two methods produced significantly different results, the range of variation between the two scenarios was defined and a midpoint traffic volume projection was also produced.

The following figures show the three traffic volume projections for the key diection / time periods (northbound on a weekday morning and southbound on a weekday afternoon). The graphs show the difference between the WRTM and historic growth projections but also that the midpoint projection remains just at or below capacity of the two bridges well into the future (to about 2040).





This analysis shows that whilst the volumes predicted by the WRTM appear low there is a high degree of extra capacity above these predicted volumes to accomodate an increase in traffic demands.

It should be noted that achieving the full available capacity will require volumes across the two bridges to be split 60% toward Shakespeare Street and 40% to Victoria Street. The existing bias is around 60% toward Victoria Street and 40% to Shakespeare Street. It is a recommendation of this study to investigate road network changes that encourage more drivers to utilise Shakespeare Street instead of Victoria Street.

In addition to the above recommendation, it is recommended that Council investigate ways to reduce demand for vehicle crossings of the River. this may include; facilities and promotion to encourage more walking and cycling, an improved bus service and possibly park and ride system, promotion and incentives to encourage more ride sharing, promotion and incentives to encourage travel outside of peak hours.

Assuming traffic volumes follow the predicted outcomes, successful implementation of the above two initiatives should result in traffic demands remaining well below capacity of the two bridges to at least 2041.

Whilst additional capacity would not appear necessary on this basis, there are two key risks; the lifespan of the Victoria Street Bridge is uncertain and there is some uncertainty around predicted traffic volumes. This report also recommends Council undertake a full investigation into the structural integrity of the Victoria Street Bridge to ascertain the likely lifespan of this asset.

On the basis that there is some uncertainty around the predicted traffic volumes, this study has also considered a number of alternative route alignments for a new bridge and recommends further investigation is given to an alignment following Hall Street, which is favoured on the basis of being reasonably central, offering wide road reserves and a connection to Council land on the southern side of the River. As a third bridge is not considered necessary, investigations would only be in regard to possibly future proofing this route should traffic projections change and a third bridge ever be required in Cambridge.

Contents

Appendices

1 Introduction

The Waikato River bisects Cambridge Town, separating the Town Centre and surrounding residential areas on the northern side of the river from the residential areas of Leamington and surrounds on the southern side of the river. There are two vehicle routes between the northern and southern sides of the river within Cambridge; these routes cross the river via the Victoria Street (high level) Bridge or the Shakespeare Street (low level) bridge. The following map shows the location of the two bridges.

Figure 1: Existing Cambridge Town Bridges

Approximately 28,000 vehicle movements are made across the two Cambridge Town bridges every day. Daily traffic volumes have increased by approximately 13% since 2014. If traffic volumes continue to increase the demand for vehicle crossings of the Waikato River will (at some stage) exceed the capacity of the two bridges, and congestion, delays and travel time variability on the surrounding road network will worsen as a result.

Waipa District Council (Waipa DC) has engaged Beca Ltd (Beca) to carry out a study of traffic demands within Cambridge to ascertain whether the two existing bridges have sufficient capacity to accommodate future traffic demands for the foreseeable future, or whether additional capacity needs to be planned for.

If the capacity of the existing bridges is not likely to be sufficient in the longer term, the study was also requested to consider options for addressing this problem including new or replacement bridges, possible alignments of such bridges. The pro's and con's of these options at a high level are also considered to derive a list of potential options for Waipa DC to take forward for further more detailed assessment in future, if necessary.

2 Background

2.1 Land Use and Growth Assumptions

The Waipa DC Growth Strategy (Waipa 2050) estimates that there will be 25,000 additional people living in the Waipa District by 2050. Of these, just over 14,000 additional residents are expected to live in Cambridge. This represents a population increase of 88% in 33 years and an average demand for new houses of 212 dwellings per year.

The majority of all new dwellings in Cambridge are expected to be located north of the Waikato River on the basis of proximity to Hamilton, community services and the Waikato Expressway. Growth on the northern side of the river will have less effect in terms of additional river crossing demand due to the location of the key origin / destinations being north of the river.

On this basis, approximately 25% of the Cambridge residential growth, roughly 3,500 residents (1,750 households or approximately 53 dwellings per year), is expected to occur on the southern side of the river. Historically growth in Leamington has averaged around 52 new dwellings per year since 2007 with the highest growth between 2010 and 2014.

2.2 Existing Bridges

2.2.1 Victoria Street

The Victoria Street Bridge connects Cook Street and Pope Terrace on the Leamington side with Victoria Street. Victoria Street routes through Cambridge Town Centre and onward to the Cambridge Expressway Interchange. The Victoria Street Bridge is over 100 years old having opened in 1907. The bridge has a 3,000kg weight limit, 2.1m width restriction and 30km/h speed limit imposed due to the age and design of the Bridge.

The bridge is 140m long and the vehicle carriageway is approximately 4.8m wide, which is narrower than typical minimum two way road carriageways. The bridge has footpaths on both sides of the carriageway that were widened to 1.5m in approximately 2013. The Bridge is a Grade 1 listed structure by Heritage New Zealand, and therefore demolishing or significantly altering the structure is not permitted.

Figure 2: Victoria Street Bridge

2.2.2 Shakespeare Street

The Shakespeare Street Bridge connects to Achilles Avenue and Tirau Road to the east of Cambridge Town Centre. Tirau Road provides a route to the Cambridge Expressway Interchange east of the town centre, although there are only south facing ramps at this Interchange.

The Shakespeare Street Bridge is 49m long and the vehicle carriageway is approximately 7m wide. There are narrow footpaths on both sides of the bridge. The speed limit across the Bridge is 50km/h.

Figure 3: Shakespeare Street Bridge

3 Traffic Volumes and Historic Growth

Traffic data is collected at the following two locations by Waipa DC as part of the Council road maintenance programme:

- Victoria Street between Williamson Street and the Bridge,
- Shakespeare Street between Addison Street and Kingsley Street.

The Victoria Street location is between the Bridge and the nearest intersection and would include all traffic crossing the Bridge. The Shakespeare Street location is one intersection away from the Bridge and provides a good indication of traffic volumes across the Bridge, but there would be some gain and loss of traffic via Addison Street. Traffic data from these counters was available for 2007, 2011, 2013 (Victoria Street only), 2014 and 2016.

3.1 Daily Traffic Volumes

The following table shows the historic daily traffic volumes across the two Bridges.

Table 1: Daily Traffic Volumes

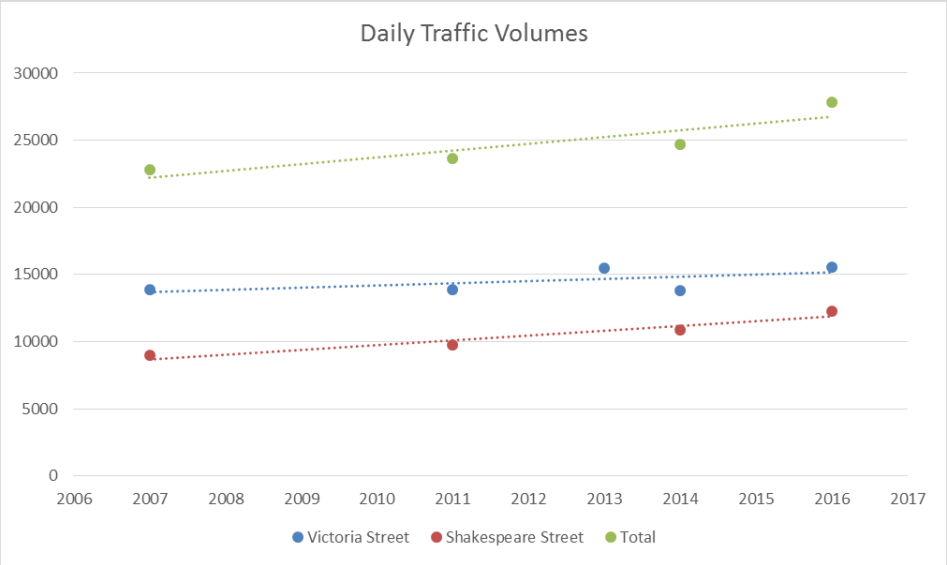
	Victoria Street			Shakespeare Street		
	Northbound	Southbound	Two Way	Northbound	Southbound	Two Way
2007	6777	7095	13872	4596	4359	8955
2008						
2009						
2010						
2011	6912	6990	13902	4984	4743	9727
2012						
2013	7745	7706	15451			
2014	6826	6993	13819	5865	5037	10902
2015						
2016	7704	7871	15575	6054	6235	12289

As shown above, the Victoria Street Bridge carries higher traffic volumes than Shakespeare Street despite the speed limit and weight restrictions on this Bridge. Given that all heavy traffic must travel via Shakespeare Street there is an obvious bias to use Victoria Street for light vehicles. This may be due to the more direct route it provides to the Town Centre and the Victoria Street Interchange, especially for vehicles travelling north, as there are no north facing ramps at the Tirau Road Interchange.

Daily traffic volumes on the Victoria Street Bridge have increased by 1,700 vehicles per day (vpd) since 2007, a 12% increase at a rate of 1.4% per year. Traffic Volumes on Shakespeare Street have increased by 3,300vpd, an increase of 37% at a rate of 4% per year. Combined, traffic volumes across the two bridges have increased by 5,000vpd since 2007, an increase of 22% at a rate of 2.5% per year.

The following graph charts daily traffic volume growth across the two bridges and both bridges combined.

Figure 4: Daily Traffic Volume Growth



3.2 Peak Period Traffic Volumes

Periods of peak demand in regard to traffic volumes occur on weekday mornings (8am to 9am) and evenings (5pm to 6pm). This is the case for both bridges. Being the periods of highest demand means traffic volumes will reach capacity sooner and more often in the peak hours than at other times of the day or week. As such our analysis focusses on these peak hours and in particular the northbound morning peak hour and southbound afternoon peak hour when one way directional volumes are highest respectively.

3.2.1 Victoria Street

The following table shows the peak hour traffic volumes across the Victoria Street Bridge from 2007 to 2016. Volumes are recorded by northbound, southbound and two-way. Northbound volumes are consistently higher in the morning peak and southbound volumes are consistently higher in the evening peak.

Table 2: Victoria Street Peak Hour Traffic Volumes

	Northbound		Southbound		Two Way	
	8am to 9am	5pm to 6pm	8am to 9am	5pm to 6pm	8am to 9am	5pm to 6pm
2007	535	452	270	772	805	1224
2008						
2009						
2010						
2011	606	472	310	785	916	1257
2012						
2013	874	509	434	821	1308	1330
2014	786	423	437	772	1223	1195
2015						
2016	810	450	469	870	1279	1320

Northbound morning peak volumes have increased by 51% at a rate of 9% per annum since 2007 with the majority of this growth occurring before 2013. Since 2013 volumes have decreased slightly. Southbound evening peak volumes have not increased so significantly, 12% in total at a rate of 1.4% per annum.

3.2.2 Shakespeare Street

Table 3 shows the peak hour traffic volumes across the Shakespeare Street Bridge from 2007 to 2016.

Northbound morning (AM) peak volumes have increased by 66% since 2007 at a rate of 7% per annum, most of this growth occurred by 2014. Southbound evening (PM) peak volumes increased by 52% at a rate of 5% per annum. More of this growth has occurred in the last two years than evident in the morning peak.

It is worth noting that the intersection of Shakespeare Street and Tirau Road was upgraded to roundabout control in 2015 and this would have made the Shakespeare Street route more attractive, particularly in the southbound PM peak direction. The right turn into Shakespeare Street would then be much easier / have less delay with the roundabout in place. This improvement may have contributed to the increase in vehicles on this route since 2014.

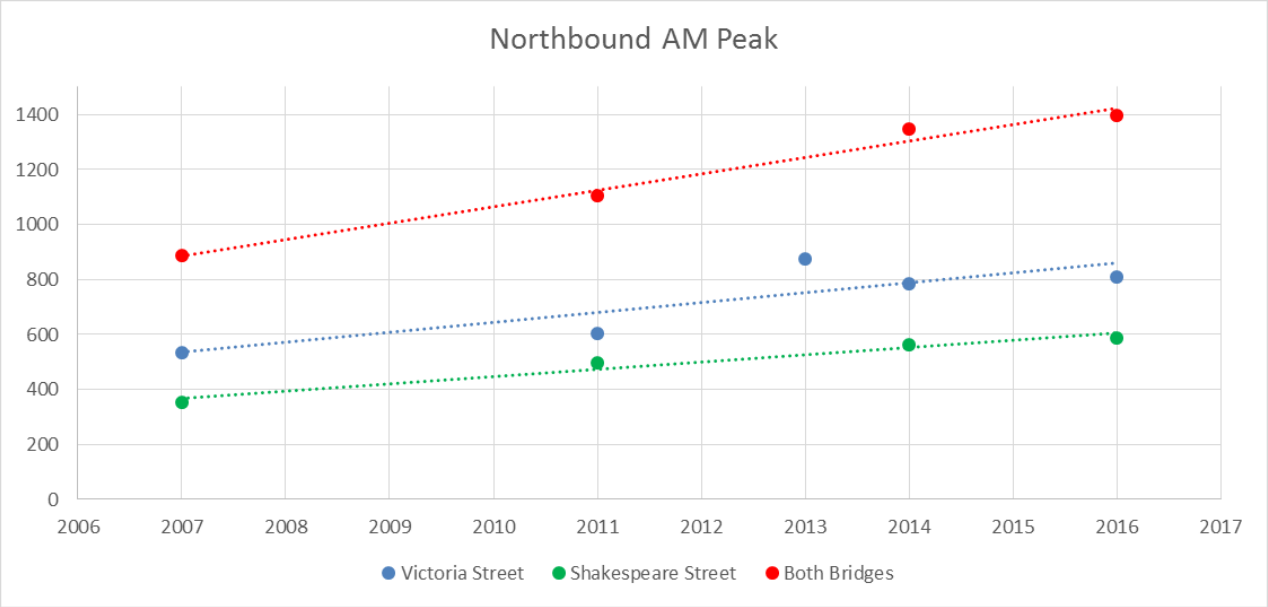
Table 3: Shakespeare Street Peak Hour Traffic Volumes

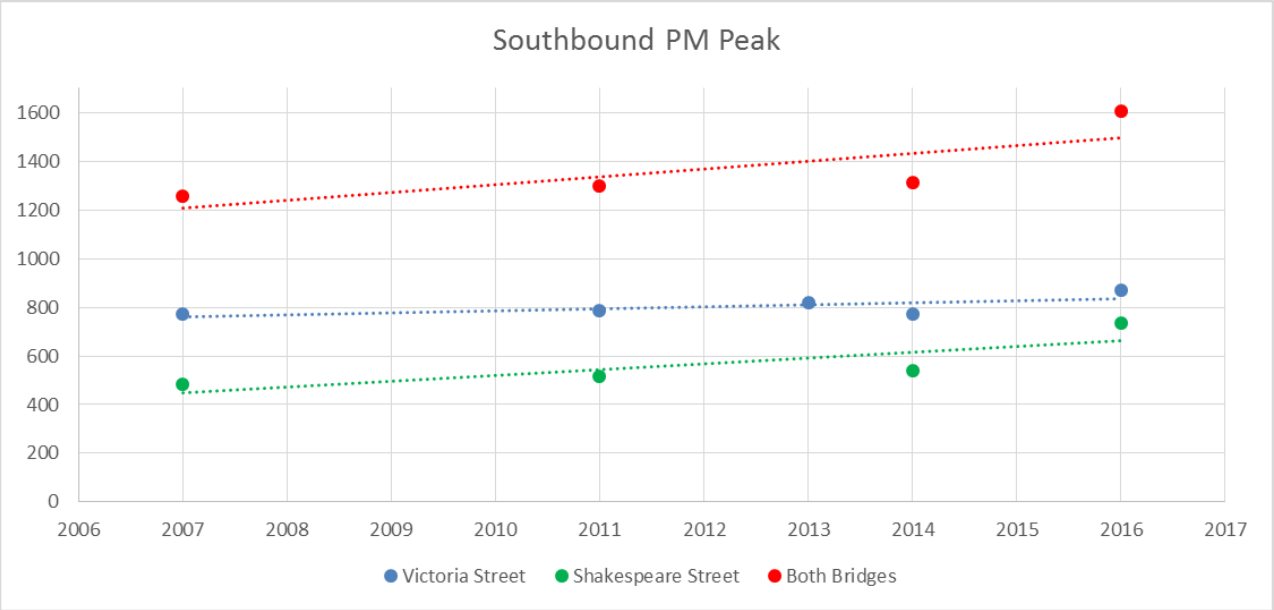
	Northbound		Southbound		Two Way	
	8am to 9am	5pm to 6pm	8am to 9am	5pm to 6pm	8am to 9am	5pm to 6pm
2007	352	283	220	483	572	766
2008						
2009						
2010						
2011	499	313	319	514	818	827
2012						
2013						
2014	563	374	325	541	888	915
2015						
2016	586	464	465	736	1051	1200

3.2.3 Both Bridges

The following graphs show peak hour traffic volumes by direction across both bridges individually and combined from 2007 to 2016.

Figure 5: Historic Peak Hour Traffic Volumes





4 Predicted Traffic Demands

Predicted traffic volume data has been sourced from the Waikato Regional Traffic Model (WRTM) (2017 update) to provide an indication of the expected change in traffic volumes across the two bridges in future.

The WRTM is a strategic land use and network model covering the whole of the Waikato region. The model forecasts traffic generation and distribution based on predicted residential and employment land use by location. Traffic volume data for the 2013, 2021 and 2041 forecast years has been obtained from the model. These model outputs are also provided in **Appendix A**.

In addition to the WRTM data, we have used the historic traffic data described in the previous chapter to estimate future traffic volumes across the two bridges should growth follow the historic 10-year average, as a sensitivity test.

4.1 Waikato Regional Traffic Model

Peak period outputs from the WRTM are two-hourly, i.e. the volumes are for the 7am to 9am and 4pm to 6pm time periods. Conversion factors have been derived from traffic count data to convert these two hourly volumes to peak hour volumes. Conversion factors were calculated for Victoria Street and Shakespeare Street in the morning and evening peak periods separately, the conversion factors are between 50 and 55%.

The table below shows the predicted WRTM traffic demands in the peak hours across the two bridges.

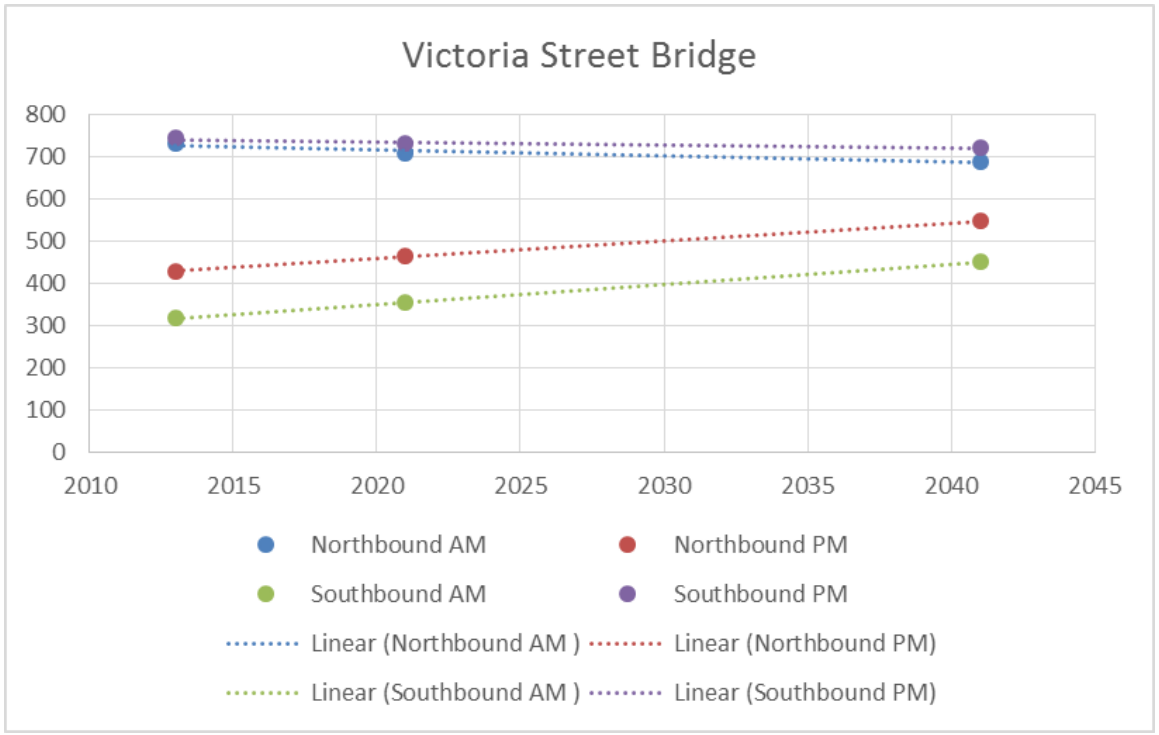
The traffic model outputs show very little growth in traffic volumes across the two bridges and in some instances reductions in traffic demands between forecast years.

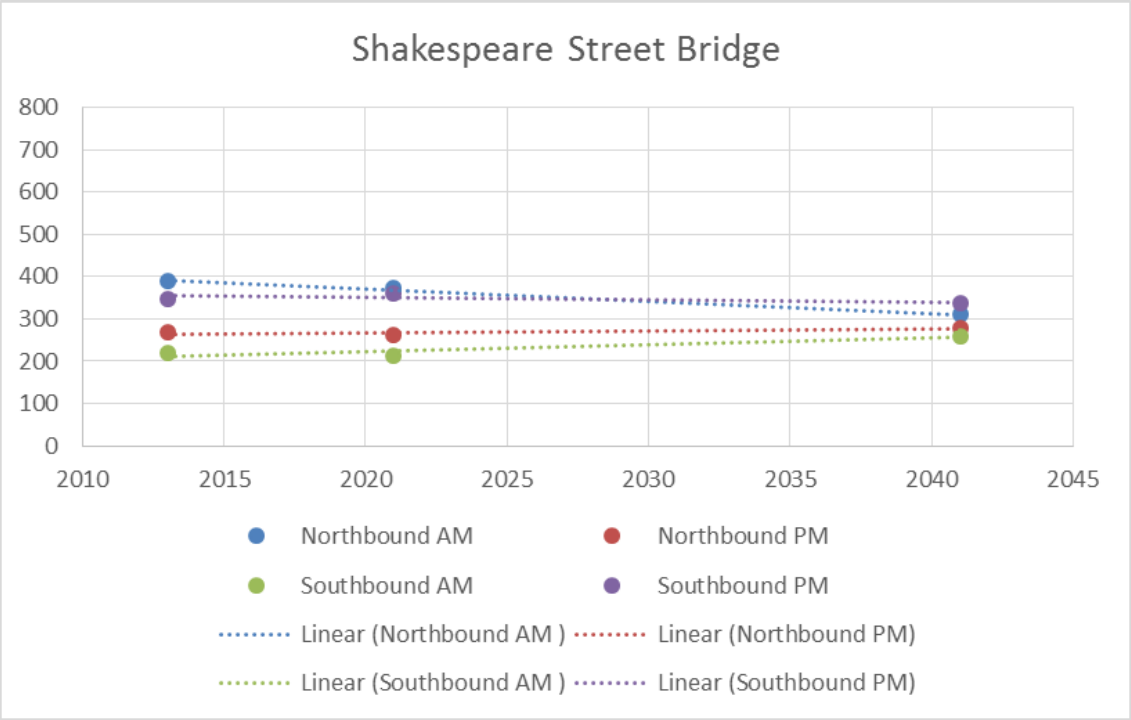
Table 4: WRTM (2017) Modelled Traffic Volume Data

2017 Model		2013 (Model)		2021 (Model)		2041 (Model)	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Victoria St	Northbound	732	429	707	466	689	547
	Southbound	319	743	355	730	451	721
	Two way	1050	1172	1061	1196	1140	1268
Shakespeare St	Northbound	390	267	373	261	310	279
	Southbound	221	349	214	359	260	336
	Two way	611	616	586	620	570	615
Both Bridges	Northbound	1122	696	1079	728	999	826
	Southbound	539	1092	569	1089	711	1057
	Two way	1661	1788	1648	1817	1710	1883

The two figures below replicate the data in **Table 4** in graph form for both bridges. It can be seen that the key movements of northbound AM peak and southbound PM peak (which carry the highest / peak direction volumes) show no future growth. The lower volume (non-peak direction) movements, southbound AM peak and northbound PM peak have moderate growth in future.

Figure 6: WRTM Predicted Peak Hour Traffic Demands across Victoria Street and Shakespeare Street



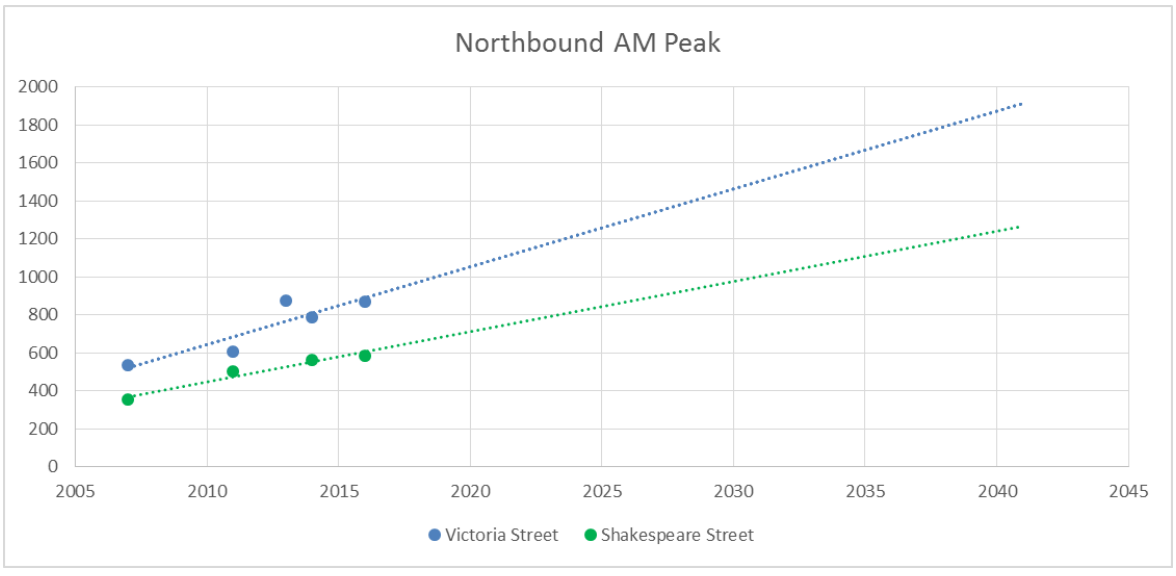


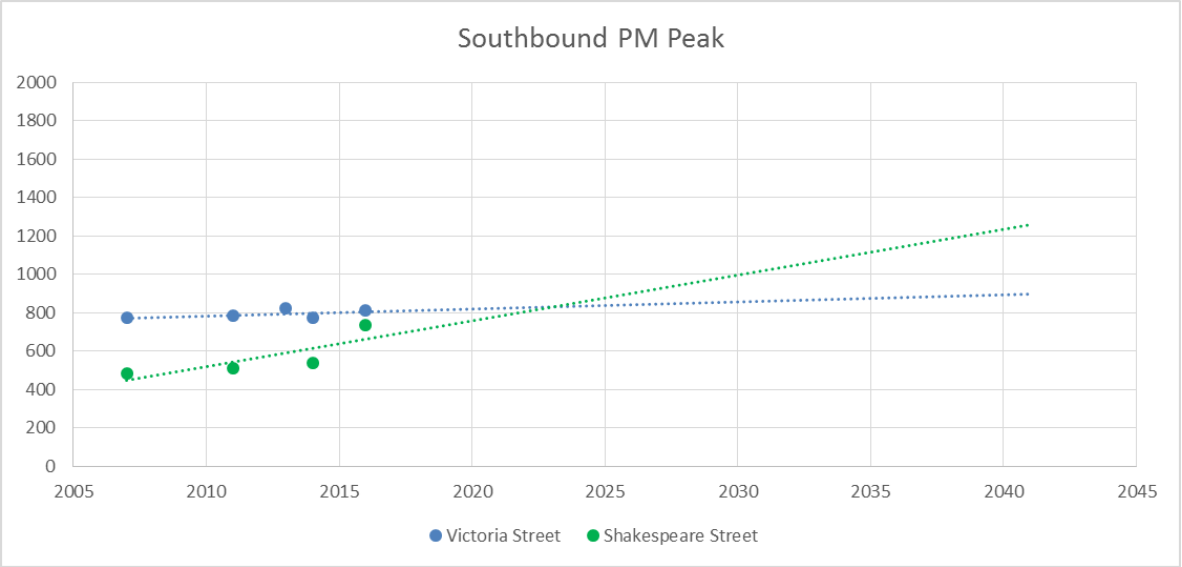
Based on the WRTM outputs, the traffic volume demand in a single direction across both bridges will peak below 1,100vph (1,079) in the 2021 northbound AM peak hour and also just below 1,100vph (1,089) in the southbound PM peak hour. Thus the total required capacity for travel in one direction per hour based on the WRTM outputs is approximately 1,100vph.

4.2 Continuing Historic Growth

By means of comparison, we have also investigated a scenario whereby demand for travel across the two bridges continues on the trajectory observed from available data over the last 10 years, see figures below.

Figure 7: Future Traffic Growth based on Historic Averages





Based on the historic 10-year average, the one-way demand across the two bridges peaks at 2041 at around 3,150 in the northbound AM peak hour and 2,150 in the 2041 southbound PM peak hour.

It is worth considering that the capacity of the Victoria Street Bridge may be restricting the level of traffic growth possible across this bridge, as peak hour volumes in the northbound AM peak and southbound PM peak do not exceed about 850 vehicles per hour and have not increased from this level in recent years. Thus the forward projection of traffic growth across this bridge (assuming some additional capacity is provided), may be lower than the scenario indicated in the figures above (particularly evident in the Southbound PM Peak plot).

5 Bridge Capacity

5.1 Methodology

An assessment of estimated bridge capacity has been undertaken using section 4.1.1 of the *Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis* - capacity assessment for a single traffic lane. This basic assessment has been adopted to assess the single lane per direction capacity of each bridge. The following extract shown in **Figure 8** below summarises the formula used in this assessment.

Figure 8: Traffic Lane Capacity Assessment Extract

The capacity of a significant length of a single traffic lane for the prevailing roadway and traffic conditions can be calculated by using the following equation:

$$C = 1800\ f_W\ f_{HV}$$

where

C = capacity in vehicles per hour under prevailing roadway and traffic conditions

f_W = adjustment factor for narrow lanes and lateral clearances, obtained from Table 4.1

f_{HV} = adjustment factor for heavy vehicles

= $1/[1+ P_{HV} (E_{HV} - 1)]$

P_{HV} = the proportion of heavy vehicles in the traffic stream, expressed as a decimal

E_{HV} = the average passenger car equivalents for heavy vehicles obtained from Table 4.2.

Figure 9: Austroads GTTM P3 Table 4.1

Table 4.1: Adjustment factors for lane width and lateral clearance

Lateral clearances on each side (m)	Lane Width		
	3.7 m	3.2 m	2.7 m
2	**1.00**	**0.90**	**0.70**
1	**0.90**	**0.80**	**0.63**
0	**0.65**	**0.60**	**0.50**

Table 4.2: Average passenger car equivalents for heavy vehicles on grades with single lane flow

Grade	Passenger car equivalents
Level	**2.00**
Moderate	**4.0**
Long sustained	**8.0**

5.1.1 Assumptions

This assessment adopted the following values for the capacity assessment:

- A base traffic lane capacity of 1,800 vehicles per hour
- F_W values as per **Figure 9** of the assessment:
  - Minimum lane widths (2.7m) across the Victoria Street Bridge, F_W value of 0.5.
  - Standard lane widths (3.5m) across the Shakespeare Street Bridge, F_W value of 0.65.
- 0% heavy vehicle volume crossing the Victoria Street Bridge (due to prohibition)
- 12% heavy vehicle volume crossing the Shakespeare Street Bridge
- Both directions have limited shoulder widths, effectively no lateral clearance
- The impacts of roundabouts in close proximity have not been considered in the calculation of capacity.

These values have been input into the various formulas in **Figure 8**, with the results of the assessment discussed in the following sections.

5.2 Victoria Street Bridge

The constrained shoulder widths, combined with reduced lane width on the Victoria Street Bridge, effectively result in a 50% reduction of a typical lane capacity (1,800 vehicles per hour). This results in an expected single lane capacity of 900 vehicles per hour per direction.

5.3 Shakespeare Street Bridge

The constrained shoulder widths, combined with standard lane widths of 3.5m, effectively result in a 65% reduction of a typical lane capacity (1,800 vehicles per hour). A further reduction is applied to allow for the 12% heavy vehicles which results in an expected single lane capacity of 1,045 vehicles per hour per direction.

5.4 Total Capacity

Combining the two bridge capacities gives a total capacity of 1,945 vehicles per hour across the two bridges, although to achieve this capacity traffic flows would need to be split 55% via Shakespeare Street and 45% via Victoria Street.

6 Volume / Capacity Analysis

The analysis in the following sections compares the existing and predicted traffic volumes with the capacities defined in the previous section.

6.1 WRTM Predicted Volumes

Applying the calculated capacities for each bridge in the previous section, **Table 5** summarises the modelled volume/capacity ratios for the 2016 (based on Traffic Count data), 2021 and 2041 years. A volume capacity ratio above 1 indicates that the demand for this movement exceeds the available capacity.

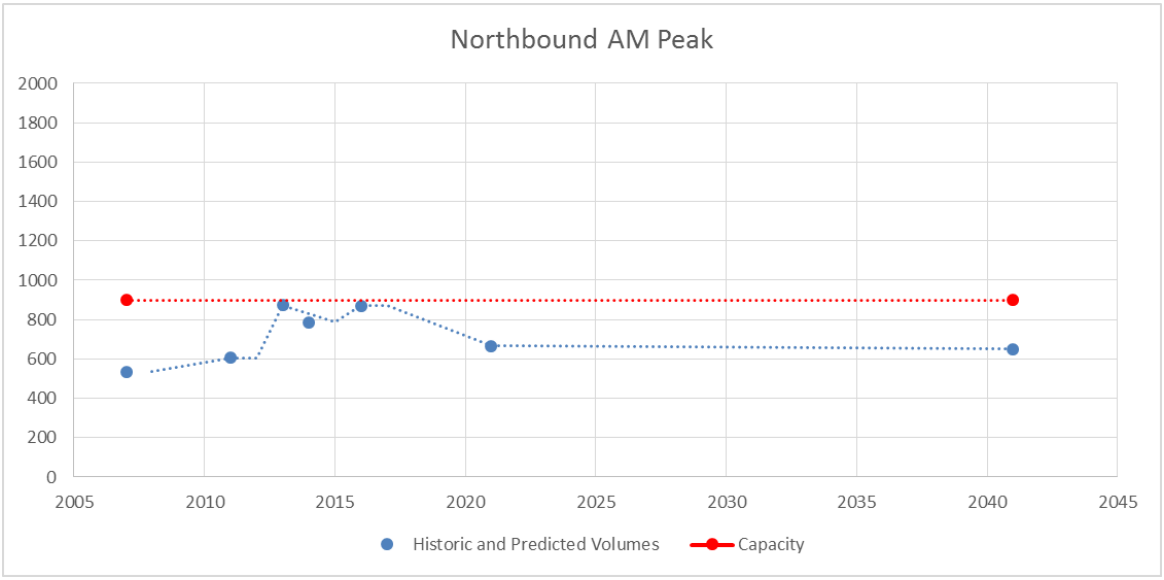
Table 5: Volume / Capacity Assessment Summary

		2016 (counts)		2021 (model)		2041 (model)	
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Victoria St	Northbound	0.97	0.63	0.79	0.52	0.77	0.61
	Southbound	0.50	0.90	0.39	0.81	0.50	0.80
	Two way	0.73	0.76	0.59	0.66	0.63	0.70
Shakespeare St	Northbound	0.56	0.40	0.36	0.25	0.30	0.27
	Southbound	0.45	0.71	0.20	0.34	0.25	0.32
	Two way	0.50	0.55	0.28	0.30	0.27	0.29

Table 5 shows that some movements across the Victoria Street Bridge are approaching capacity, but generally remain in acceptable levels in future years. There is also spare capacity on the Shakespeare Street Bridge with peak hour volumes of less than 40% capacity in future.

The following figures present this data in a different format showing the historic and predicted volumes along with the capacities of each bridge in the peak directions.

Figure 10: Historic and Predicted Traffic Peak Direction Volumes across Victoria Street Bridge



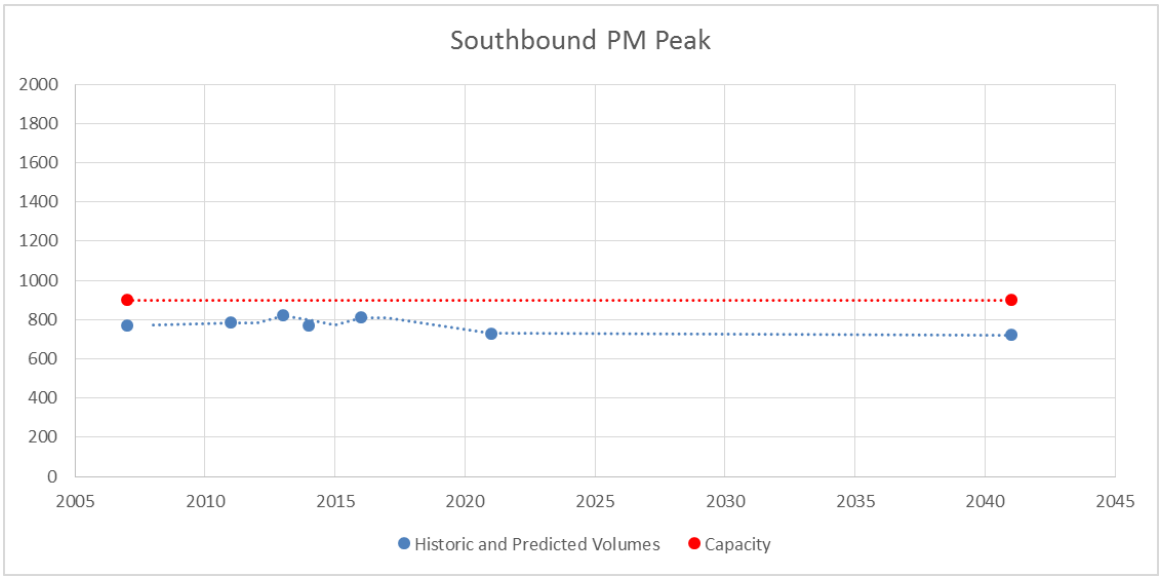
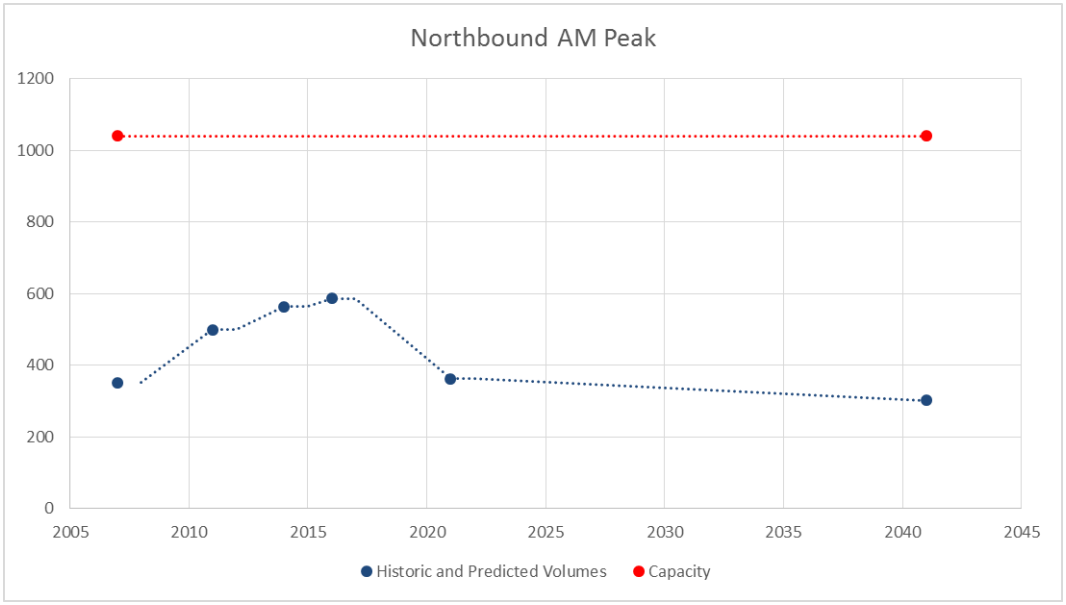


Figure 11: Historic and Predicted Peak Direction Traffic Volumes across Shakespeare Street Bridge



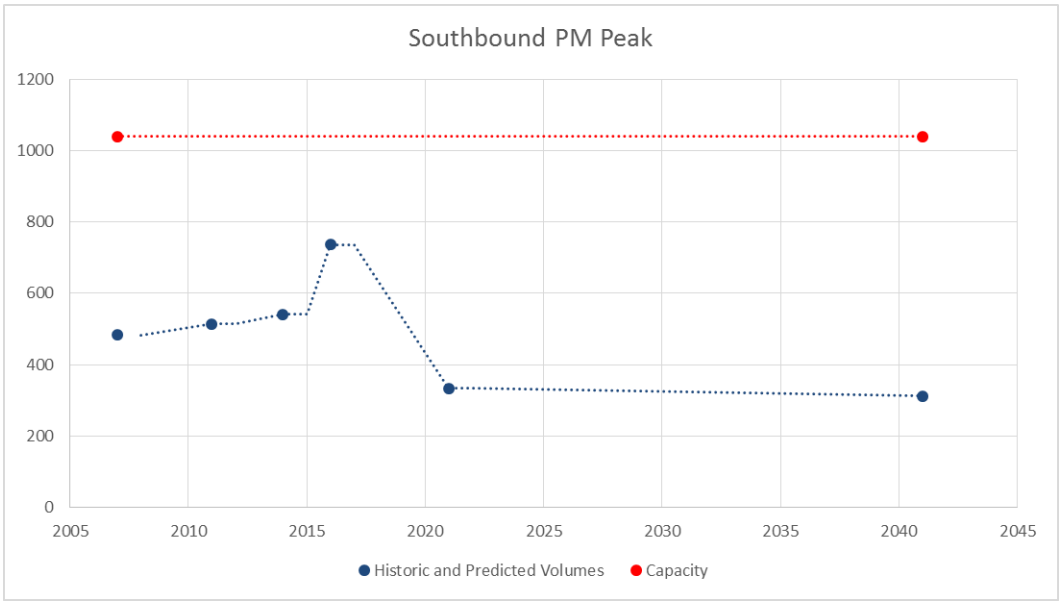
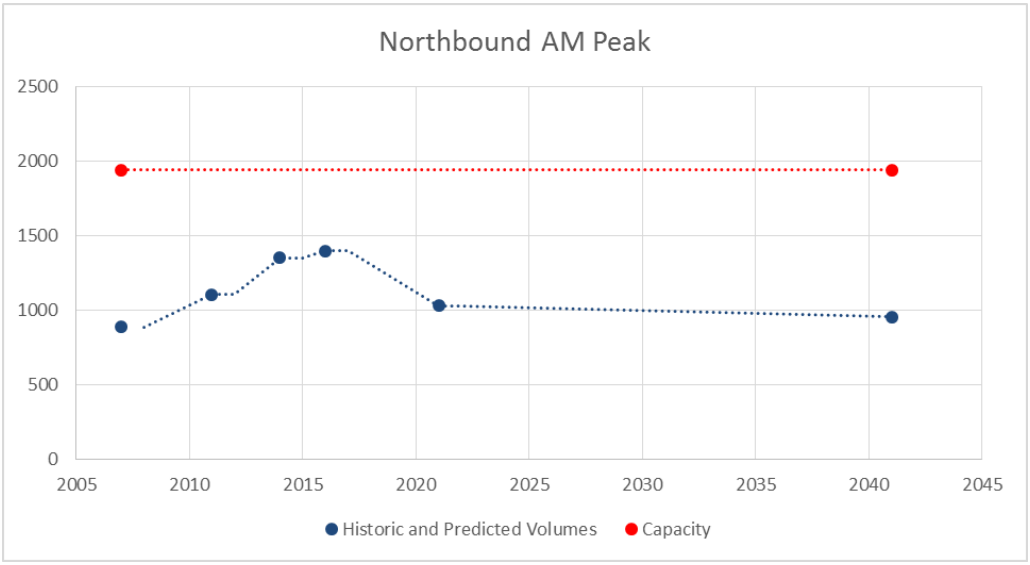
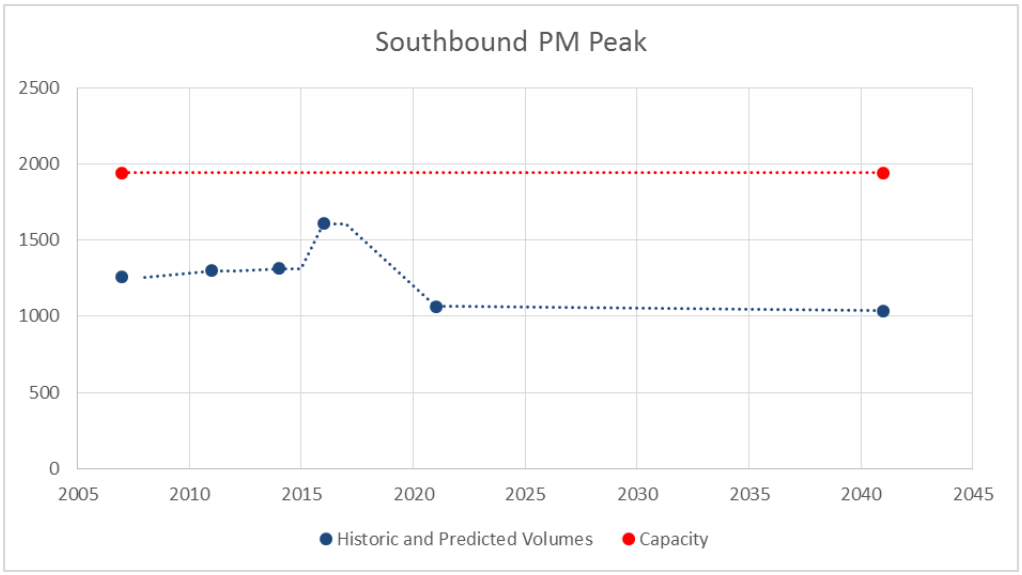


Figure 12: Historic and Predicted Peak Direction Traffic Volumes across Both Bridges Combined





As the above graphs show, based on WRTM predicted demands, the traffic volume across the Victoria Street Bridge is effectively at capacity at present, but regional model outputs show demands across the Bridge reducing in future. Traffic demands across the Shakespeare Street Bridge are well below capacity and remain below capacity to 2041.

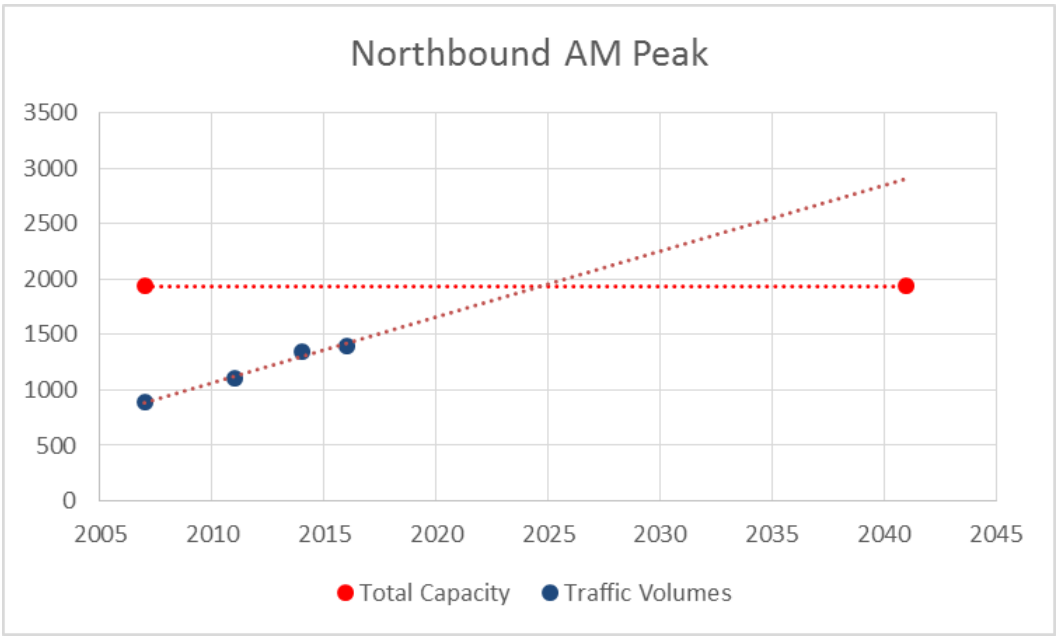
As such collectively demands across the two bridges, are not predicted to surpass capacity in future as traffic volumes in the times and directions of peak demands are not predicted to increase between 2021 and 2041.

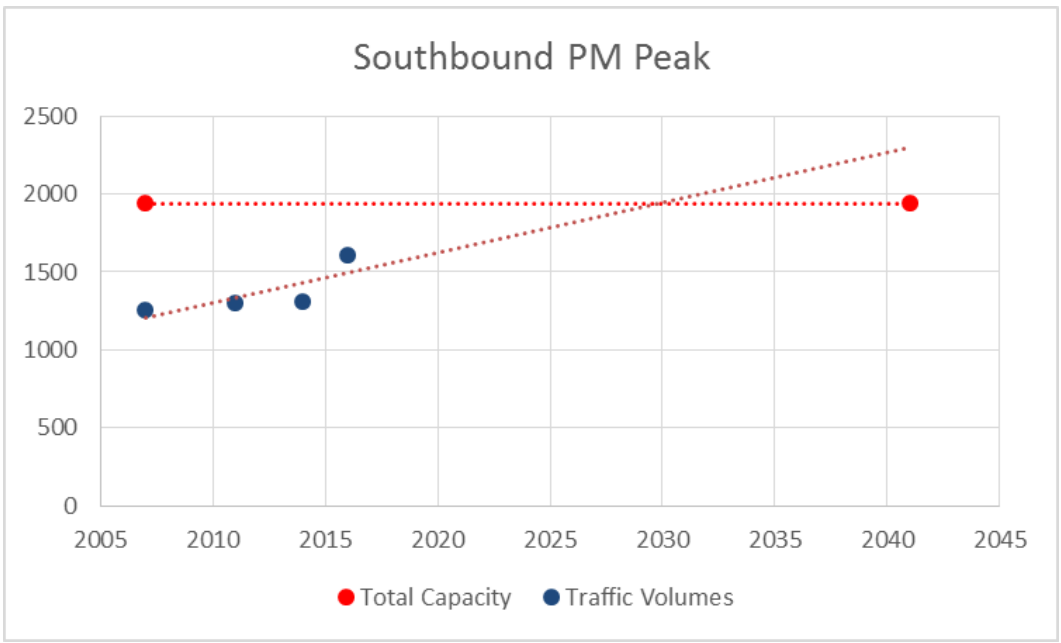
6.2 Historic Traffic Growth

If traffic volumes continue to grow at a rate similar to the historic average over the last 10 years, then the capacity of the two bridges combined is exceeded by around 2025 in the morning peak and 2030 in the evening peak. This assumes that the 'attractiveness' of the Shakespeare Street Bridge will increase in the future, as additional demand occurs for the Victoria Street Bridge, which is already close to capacity. Total volumes by 2041 are much higher than predicted in the WRTM.

The following graphs show the predicted demand and capacity for travel across the two bridges combined, assuming the overall growth rate observed over the last 10 years continues in future.

Figure 13: Historic and Predicted Peak Direction Traffic Volumes across Both Bridges based on Historic Average Growth





6.3 Projecting Existing Volumes with Model Growth

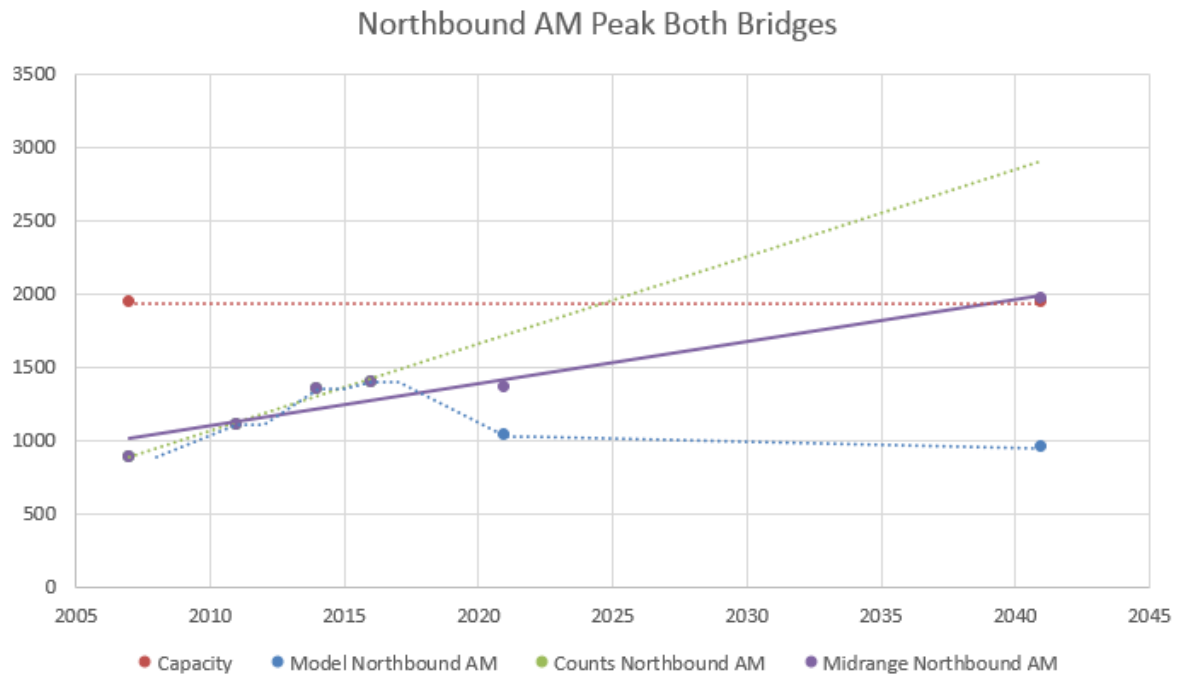
The above described two methods of projecting future traffic result in significantly different outcomes.

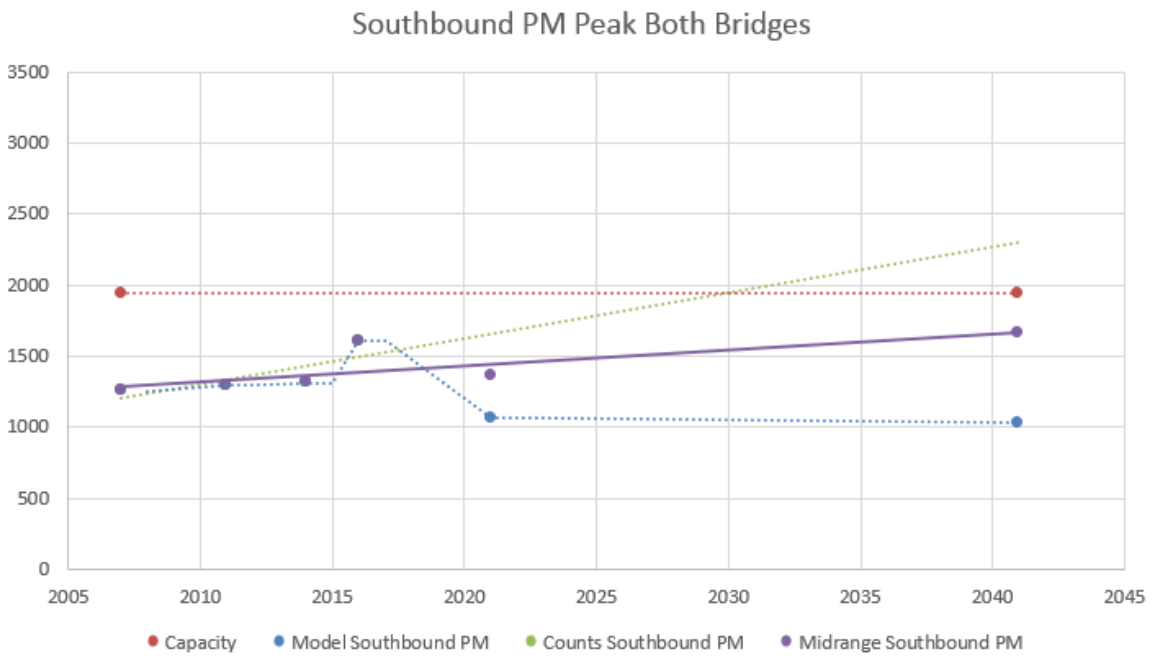
The outputs of the WRTM appear to suggest an unlikely scenario, whereby the projected volumes are less than existing volumes. It is known that residential growth, particularly on the southern side of the River, will increase traffic demand at the river crossing. Projecting historic traffic growth levels is also likely to be overly conservative (i.e. higher than likely traffic demands) as future traffic growth is not anticipated to continue on recent, post financial crisis and low fuel cost, levels.

In reality, it is considered that there would be a range of potential outcomes in terms of the growth in traffic demand that could eventuate, somewhere between these two scenarios. The following graphs show the two forecast scenarios, together with a mid-range value between the two scenarios, compared with the predicted bridge capacity for the combined bridges.

This shows that, even if future traffic volumes are significantly higher than current model projections, the total predicted demand for river crossing is likely to be below or only just reaching capacity by 2041. This again assumes the 'attractiveness' of the Shakespeare Street Bridge will increase in the future, as additional demand occurs for the Victoria Street Bridge, which is already close to capacity.

Figure 14: Projected Future Peak Direction Growth - Mid-Range Value





6.4 Summary of Capacity Assessment

The WRTM indicates that demand for River crossings in Cambridge during peak periods does not increase from existing levels. On this basis, there is significant available capacity particularly if more traffic can be diverted to the higher capacity Shakespeare Street Bridge. However, projecting historic growth rates into the future indicates that volumes could potentially exceed the capacity of the two bridges by around 2025 / 2030.

In reality, it is considered that there would be a range of potential outcomes in terms of the growth in traffic demand that could eventuate, somewhere between these two scenarios. As such, some confidence in the capacity of the existing two bridges being sufficient is gained by the mid-range projection. This indicates that, even if the model demands increase significantly above the expected volumes, then total river crossing demand only reaches capacity in one direction by about 2041. It is noted that this assumes the 'attractiveness' of the Shakespeare Street Bridge will increase in the future, as additional demand occurs for the Victoria Street Bridge, which is already close to capacity.

Given the above, it is considered that the capacity assessment indicatives that there would not be a need for an additional bridge across the River in Cambridge any time soon. Even if traffic demands reach capacity approaching 2041, demand management techniques, such as public transport, walking and cycling and peak spreading approaches can be utilised to manage demand in accordance with total bridge capacity.

7 Other Lifespan Factors

Whilst not a matter specifically addressed in this study, the resilience of the Victoria Street Bridge should be investigated. The existing bridge is a key weight restriction (3-tonne gross mass limit) on the network, and aside from regular inspections, there are no records of investigations of the bridges resilience to seismic, wind, foundation scour, or accidental overloads. A separate more detailed and specific study of the Victoria Street Bridge is recommended, as this may influence Council decisions in regard to the provision of additional vehicle capacity across the River.

8 Option Analysis

Analysis of historic and predicted traffic volumes indicates that traffic volumes are not likely to exceed the capacity of the two bridges in future and thus an additional bridge is not likely to be required. However, given the uncertainty regarding future traffic predictions, a number of options have been considered (at a high level at this stage) for addressing a future river crossing capacity constraint.

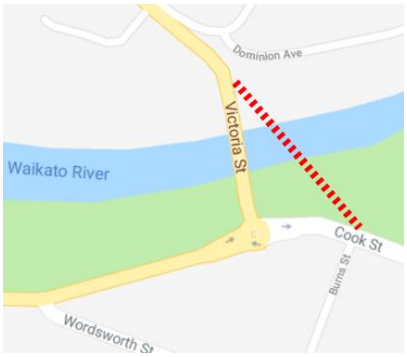
These options are summarised below:

- Local road changes to attract more traffic to Shakespeare Street and better distribute demand with capacity.
- Improvements for non-single vehicle transport modes, e.g. walking, cycling, public transport, ride sharing and peak spreading to reduce the number of vehicles seeking to cross the Bridges during peak hours.
- Implement a one-way system with Victoria Street operating one way for traffic movement on a tidal basis (northbound in the morning and southbound in the afternoon).
- Construct a new bridge near the existing Victoria Street Bridge and convert the existing bridge to walking and cycling only. The new bridge would have higher capacity than the existing Victoria Street Bridge.
- Construct a new additional bridge elsewhere and retain the Victoria Street and Shakespeare Street Bridges as well (a three bridge option).

The following table provides our initial high level consideration of feasibility and effectiveness on each of the above options.

Table 6: Initial High Level Option Comparison

Approach	Initial Considerations	Effectiveness
Improve traffic flow on the Shakespeare Street Bridge route to encourage more traffic to travel via Shakespeare Street instead of Victoria Street.	This option is necessary for all scenarios to best utilise the available capacity of Shakespeare Street and better balance traffic demands across the two bridges. If the Shakespeare Street route to Cambridge and surrounds is improved this could encourage more trip redistribution from Victoria Street and achieve better utilisation of available capacity. North facing ramps at the Cambridge East Interchange may be an improvement to investigate, but would have a high cost. Minor improvements to local roads may also help to encourage more drivers to travel via Shakespeare Street.	This could be effective in mitigating the existing poor level of service on the Victoria Street bridge and better utilising the available capacity at Shakespeare Street.
Investigate and implement improvements for non-single occupancy car travel to reduce the demand for vehicle travel across the two bridges in the peak hours.	A mixture of increased bus use, walking and cycling and ride sharing plus some peak spreading would reduce vehicle demands for bridge crossing. Park and ride sites, improved cycleways and walkways, priority for high occupancy vehicles on parts of the network and car priority parking for high occupancy vehicles would all be options that could be considered.	Effectiveness would need to be tested as specific interventions are developed but as per the previous option this could be effective in mitigating the existing poor level of service at the Victoria Street Bridge.

Approach	Initial Considerations	Effectiveness
Convert Victoria Street Bridge to a one-way tidal system during Weekdays.	Operating the Victoria Street Bridge as one way, alternating between northbound in the morning and southbound in the afternoon would increase the capacity of the bridge in the direction / time of highest demands. This would be expected to increase one-way capacity from 900 to around 1,400vph and increase the total capacity of the two bridges to over 2,800vph. This would, however, redistribute approximately 460vph to Shakespeare Street, which it is predicted should be accommodated by the capacity of this bridge. However, there may be issues elsewhere on the network that would need to be investigated and mitigated prior to implementation. Implementation would require a traffic signal system or similar to implement safely.	This could be effective in mitigating the existing poor level of service at the Victoria Street Bridge if the surrounding road network can accommodate the redistributed traffic flows. This option could be undertaken as a trial.
Retain the Victoria Street Bridge as a pedestrian and cyclist connection only and construct a new bridge between Victoria Street and Cook Street.	Under this option, there would still be two bridges, but the new Victoria Street Bridge could be built with a higher capacity design bringing the total capacity of the two Bridges above 2,800vph, which is higher than forecast demands. The following image shows the approximate alignment of a replacement Victoria Street Bridge. The existing bridge would not be modified. Permission to build next to the grade 1 listed structure, and potentially impact on views to the bridge would need to be investigated / confirmed.  This option would be influenced by the structural integrity of the existing Victoria Street Bridge and the likely lifespan of this Bridge. Should this bridge need to be replaced in future, then this may be a suitable replacement that also provides additional capacity.	Effectiveness is likely to be adequate assuming the new bridge can be designed to accommodate higher flows than the existing bridge.
Construct a new bridge on a different alignment.	Constructing a new bridge would result in three river crossings and provide significant additional capacity. Assuming the new bridge was designed with tylical lane	Effectiveness will be good assuming three bridges are provided. However current traffic data forecasts indicate

Approach	Initial Considerations	Effectiveness
	capacity, the resulting total one way capacity across the three bridges would likely be around 3,700vph. A new bridge would redistribute traffic movements and may increase volumes on sensitive parts of the network, such as local residential areas. Further analysis would be necessary to determine the necessary associated upgrades.	that three bridges are not required therefore this would potentiall be an oversupply of capacity.

Existing traffic volumes indicate that whilst Shakespeare Street offers more capacity than Victoria Street this route is less favoured and has spare capacity whilst the Victoria Street capacity is largely filled by existing demands. Achieving a more even split in demands will improve the efficiency of the two bridges and the first option above “encourage more traffic to travel via Shakespeare Street” is recommended.

It is reasonable to predict that single occupant vehicle demand for crossing the bridges in the peak hour could be reduced through Travel Demand Management measures, such as walking and cycling improvements (potentially a cycle Bridge linked to a wider off road cycle network), public transport services, ride sharing initiatives and some peak spreading. A programme to implement such measures is recommended as this will reduce demand across the bridges, and in particular assist in addressing the existing poor level of service at the Victoria Street bridge, but also reduce traffic congestion in other parts of Cambridge as well as reducing parking demand.

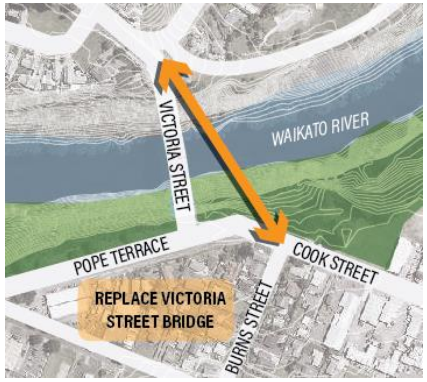
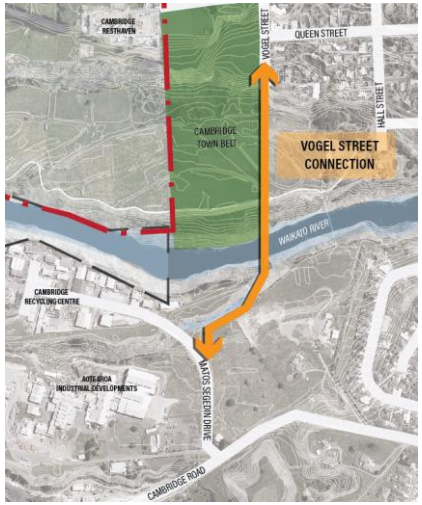
A full investigation into the structural integrity of the Victoria Street Bridge is recommended. If this bridge can be retained for the foreseeable future, then the two initiatives discussed above should provide sufficient relief in traffic demands for the existing two bridges to provide adequate capacity. If the use of the Victoria Street Bridge will need to be prohibited on safety grounds in future, then constructing a new Bridge on a similar alignment (but with wider lanes and as such more capacity) would be recommended.

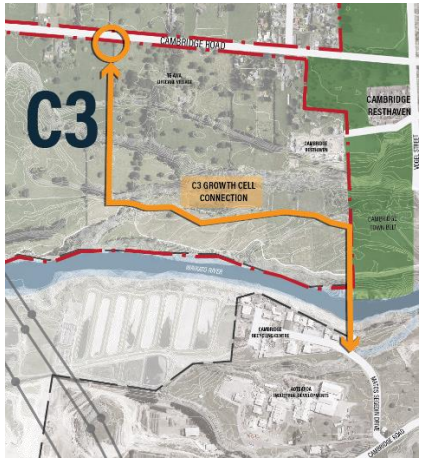
Whilst our assessment has not indicated that three bridges will ever be required in Cambridge, we have considered possible third bridge alignments below, so that a Waipa DC can potentially consider a corridor that can be protected should the need for a third bridge ever arise in future, e.g. future traffic volume predictions change.

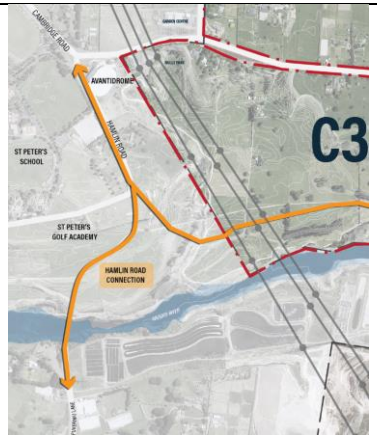
8.1 New Bridge Alignment Options

Five possible alignments for a new bridge in the Cambridge are described in the following table along with high level consideration of Pro’s and Con’s of each option. These options have been identified and considered via desk top and on site analysis by our Beca and Waipa District Council project team but the analysis of each option is at a high level.

Table 7: High-Level Review of Possible Additional Bridge Alignments

Option	Description	Pro's	Con's
Replace Victoria Street Bridge 	Construct new bridge to the east of existing Victoria Street bridge connecting to Cook Street. Victoria Street bridge would be retained for pedestrian / cycles only – not cars.	The new bridge would be wider than the existing Victoria Street bridge, so would provide some increase in capacity The new bridge would be seismically stronger than the existing Victoria Street bridge and thus offer greater protection against natural hazards. Traffic continues to use the existing arterial road network, no impact on other roads / land uses.	Does not provide as much capacity as a third river crossing would achieve. Still, only two routes across the river, if one bridge is damaged / closed then only one route will remain.
Vogel Street Connection 	Extend Vogel Street south to the river, construct a new bridge across the river and a road connection to Matos Segedin Drive.	A third bridge provides an alternative river crossing in the event that one of the existing bridges is closed. The new bridge could be built to accommodate pedestrians and cyclists providing a connection to the Te Awa river path and to the north. The alignment is central to development to the north and south thus the route should attract travel demand from both existing bridges.	The level difference between Vogel Street and the river is approximately 14m. So the extension of Vogel Street would require approx. 140m of fill (@10%) with embankments on both sides. Vogel Street has a 20m road reserve which may be insufficient for a Collector Road that would typically be at least 25m wide. Therefore some road widening may be necessary with impacts on surrounding land use (requires land purchase). Also requires land purchase to south of the river for bridge connection to Matos Segedin Drive. Existing residents on Vogel Street (approx. 71 dwellings plus retirement home beds) and potentially Queen Street will be impacted by higher traffic volumes.

Option	Description	Pro's	Con's
C3 Connection 	Construct a new bridge to the west of the green belt from the C3 growth area to Matos Segedin Drive. Connect to the proposed road network within C3 leading to Hamilton Road.	Similar to Vogel Street option, the additional bridge provides increased capacity, improved resilience and an additional walk/cycle connection. Connecting to the road network within the C3 growth area means roads can be designed to a higher standard (no widening of existing roads), although this may impact on an already approved planning application (also discussed in Con's section). The route would tie in with a proposed roundabout / signalised intersection on Hamilton Road, which will likely provide a safe intersection and good level of service for turning movements.	The route between Cambridge Road and Hamilton Road is indirect and may not be an attractive alternative (many drivers will still use Victoria Street). Connecting to the road network within the C3 growth area will impact on the approved Te Awa design / consent. This may rule out this option. Providing a Collector standard road (with relatively high traffic volumes) through the C3 growth area may detract from the design aspirations of this residential growth area. Initial advice from the Beca planning team is that, while Waipa DC has a right to pursue a designation for the third bridge route through the Te Awa site, there would likely be significant risks associated with time, cost and appeals given the recent granting of resource consent. This may include the need for compulsory acquisition or buying out further land than required if the landowner's development plans were perceived to be compromised.
Hamlin Road Connection	Extend Hamlin Road (adjacent to St Peters / Avantidrome) to the river and construct a new bridge with a connection to Pukerimu Lane.	The additional bridge provides increased capacity, improved resilience and an additional walk/cycle connection. Connects with a proposed roundabout on Hamilton Road, which will likely provide a safe intersection and good level of service for turning movements.	The connection is in the far west part of Cambridge town centre and is unlikely to be used by drivers travelling to/from Cambridge. Therefore the option may not sufficiently alleviate congestion / demand on existing bridges. Will require land from St Peters, potentially unacceptable to St Peters.

Option	Description	Pro's	Con's
			Will increase traffic volumes on Hamlin Road (impacting on St Peters) and Pukerimu Lane (impacting on existing residential properties in this area).
Hall Street Connection 	Construct bridge from the southern end of Hall Street to connect in with Council reserve on the southern side of the river and provide road link to Cambridge Road (south), possibly with a roundabout at Cambridge Road.	The additional bridge provides increased capacity, improved resilience and an additional walk/cycle connection. The connection is reasonably direct and aligns with growth area on southern side of the river. Hall Road has a 30m wide road reserve, so road widening is not likely to be necessary. Appears to be sufficient Council owned land available between Cambridge Road (south of river) and the river to make a road connection and provide a roundabout, i.e. property purchase may not be required. The intended purpose of this land is unclear – it appears to be a storm water reserve – so will need further investigation.	Likely to require relocation / alteration of water treatment facility. The level difference between the end of Hall Street and the river is approximately 14m. Waipa DC has advised the extension would require approx. 140m of fill or bridge (@10%). Note it may be possible to bridge over the Alpha Street / Repertory Society access, albeit at higher cost. Existing residents on Hall Street (approx. 53 dwellings) would be impacted by increased traffic volumes (would also increase traffic volumes on Queen Street, as a route to the town centre). Road and traffic volumes may impact on existing residential properties adjacent to Council land south of the river (approx. 18 dwellings).

The assessment provided in the previous table indicates that the preference for a third bridge alignment, if a third bridge was required, would be the Hall Street route for the following reasons:

- The route is well positioned reasonably close to Cambridge Town Centre and close to the growth areas on the southern side of the river making the route quite direct and as such an attractive alternative to the existing Bridges.
- Hall Street has a wide road reserve (30m), which is wider than the Vogel Street route.
- There is an existing stormwater reserve on the southern side of the River on this alignment, which may provide a suitable road corridor that does not require property purchase.

There are a number of issues that would need to be overcome if a bridge was ever progressed on this route including how the bridge crossed the water treatment facility and how the tie into Hall Street and subsequently the intersection with Cambridge Road was designed.

To be clear, based on WRTM outputs and higher mid-range forecasts, a total of three road bridges does not appear necessary, and significantly advancing work on a third bridge is not recommended. However, should Waipa DC wish to consider how they can future proof for a route, then the Hall Street route would be preferred. This requires significantly more analysis and investigation on possible bridge designs and tie-ins, plus other technical matters, to future proof this route for a bridge connection, if it is ever required.

Figure 15: Indicative Hall Street Bridge Alignment

9 Conclusions and Next Steps

WRTM volume outputs show demand for vehicle crossings the Waikato River will not exceed the capacity of the two existing bridges. Even with a significant uplift in volumes above current model projections the volume of traffic crossing the River remains below capacity of the two existing bridges until around 2041.

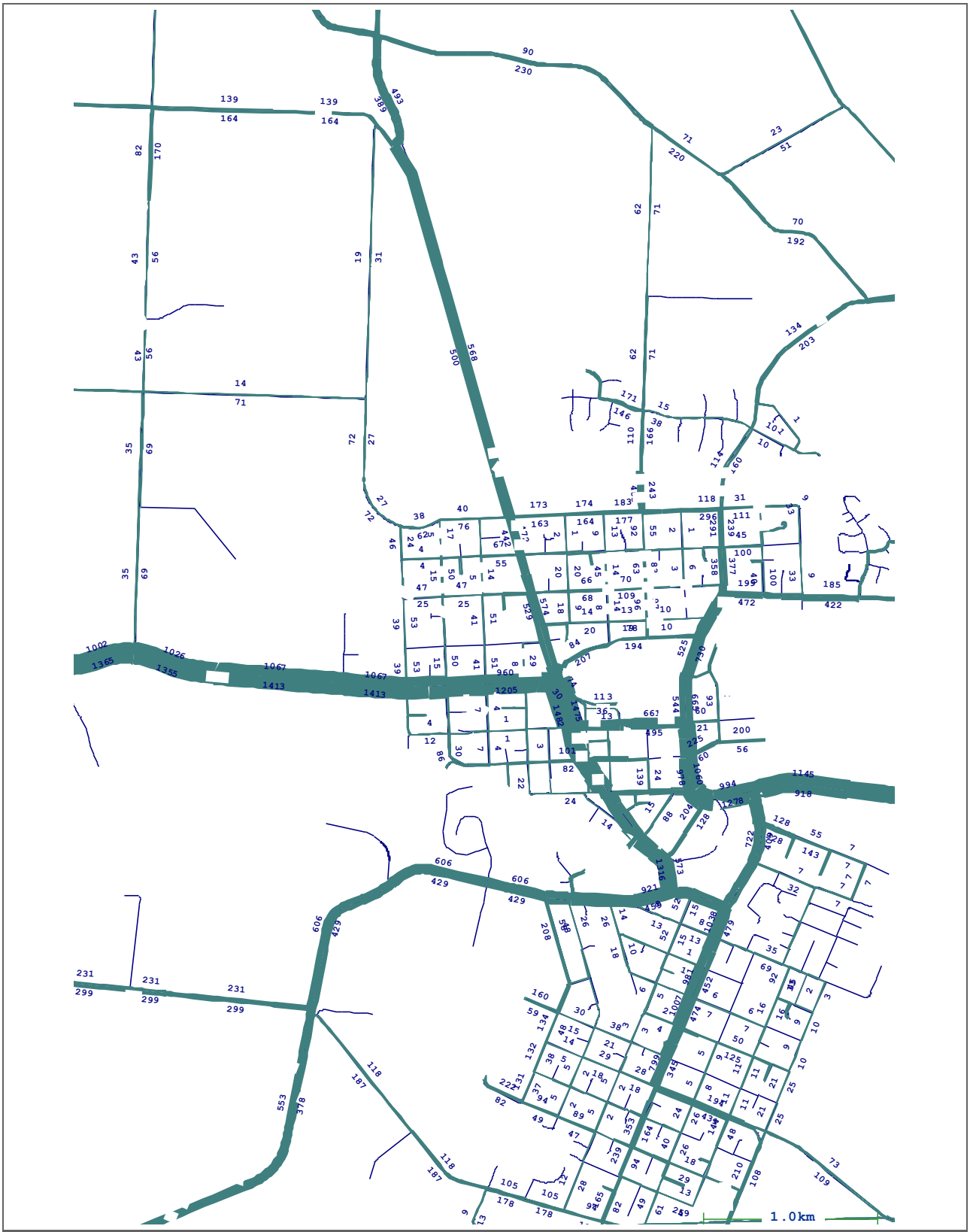
Network improvements and travel demand management should be capable of retaining future demands below capacity; this would likely be a much cheaper option to building a new Bridge. Key to this will be promoting the use of Shakespeare Street and achieving more uptake of walking, cycling, public transport use, ride sharing and off-peak travel. This is considered a priority.

The Council may need to consider replacing the Victoria Street Bridge in future if the structure becomes compromised. In which case, a new Bridge on a similar alignment may be necessary. Council should progress a structural assessment for this Bridge as a priority.

There may be a benefit in exploring the Hall Street Bridge alignment option as a means of future-proofing this corridor for a potential new Bridge if a third Bridge is ever necessary for Cambridge.

Appendix A

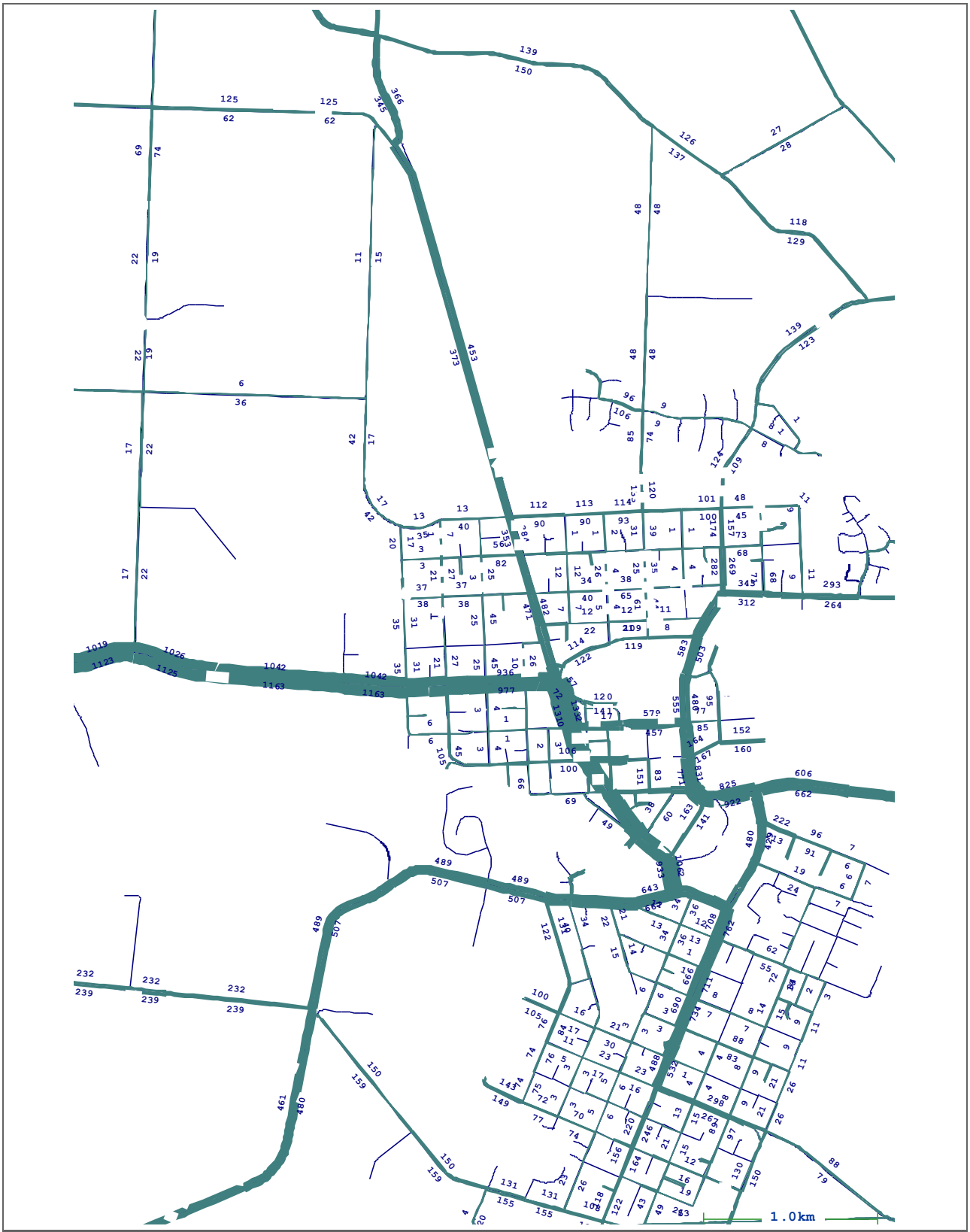
WRTM Data Outputs



2013 Morning Peak – Volume Plot Cambridge (2-hour)

TDG

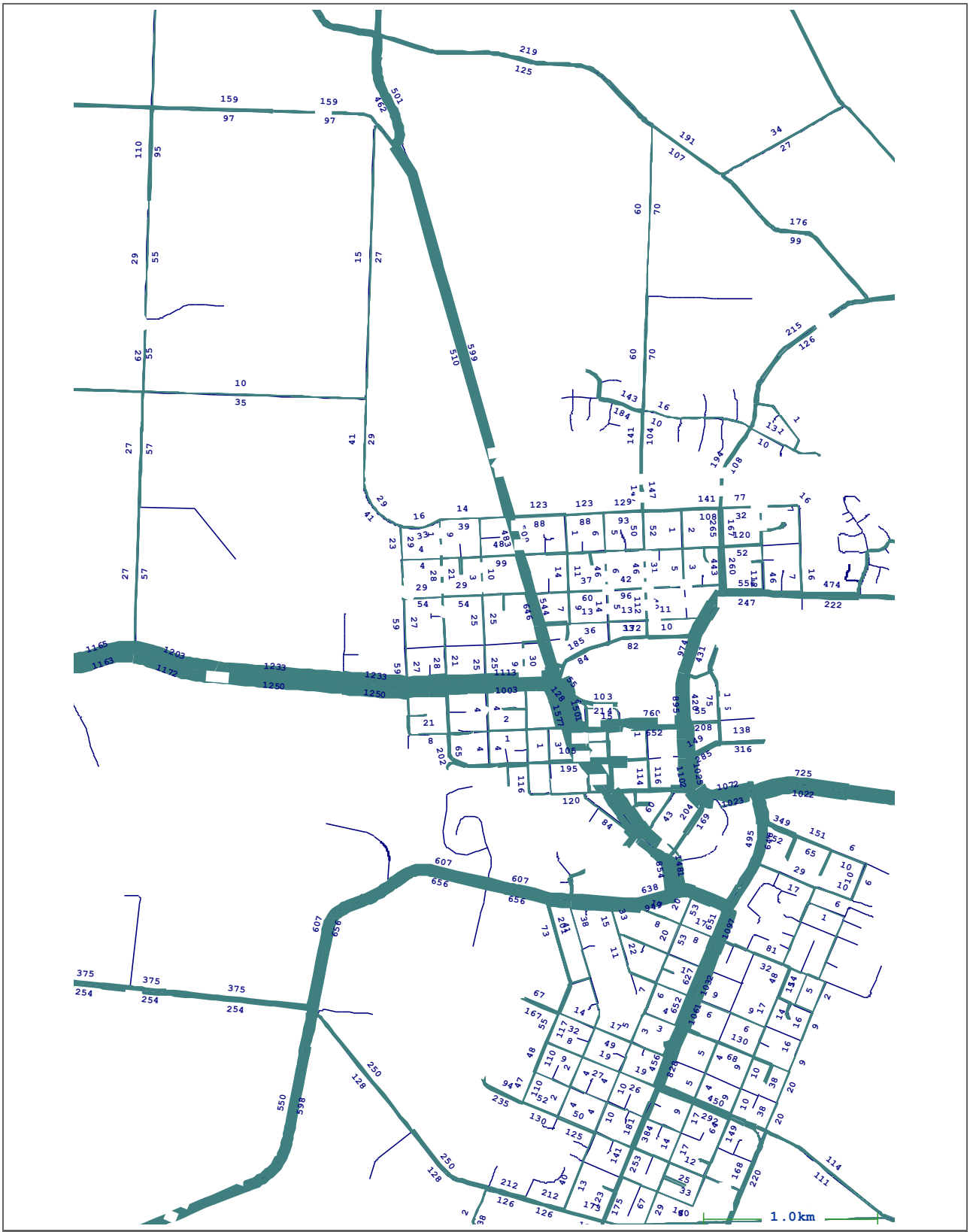
1



2013 Interpeak – Volume Plot Cambridge (2-hour)

TDG

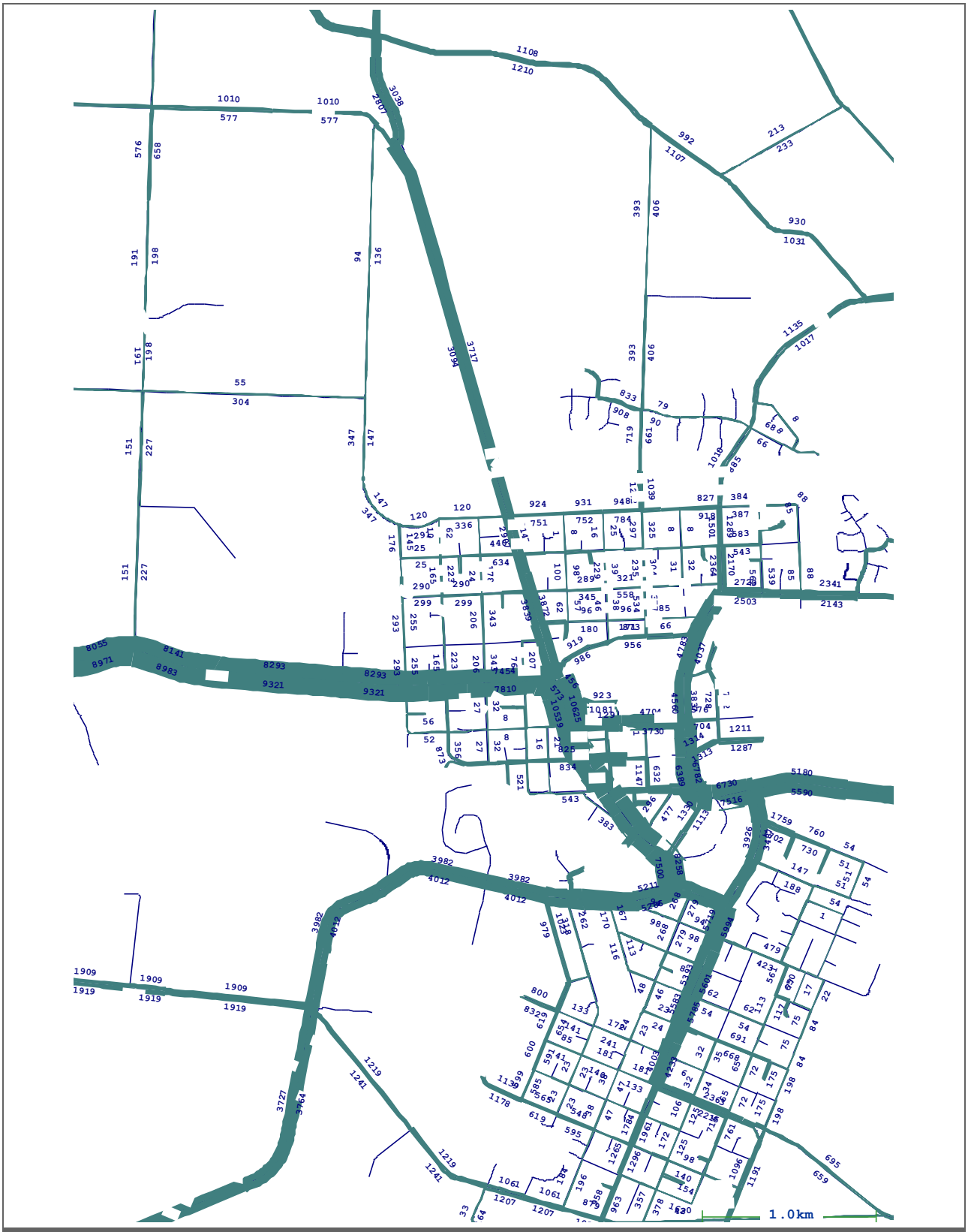
2



2013 Evening Peak – Volume Plot Cambridge (2-hour)

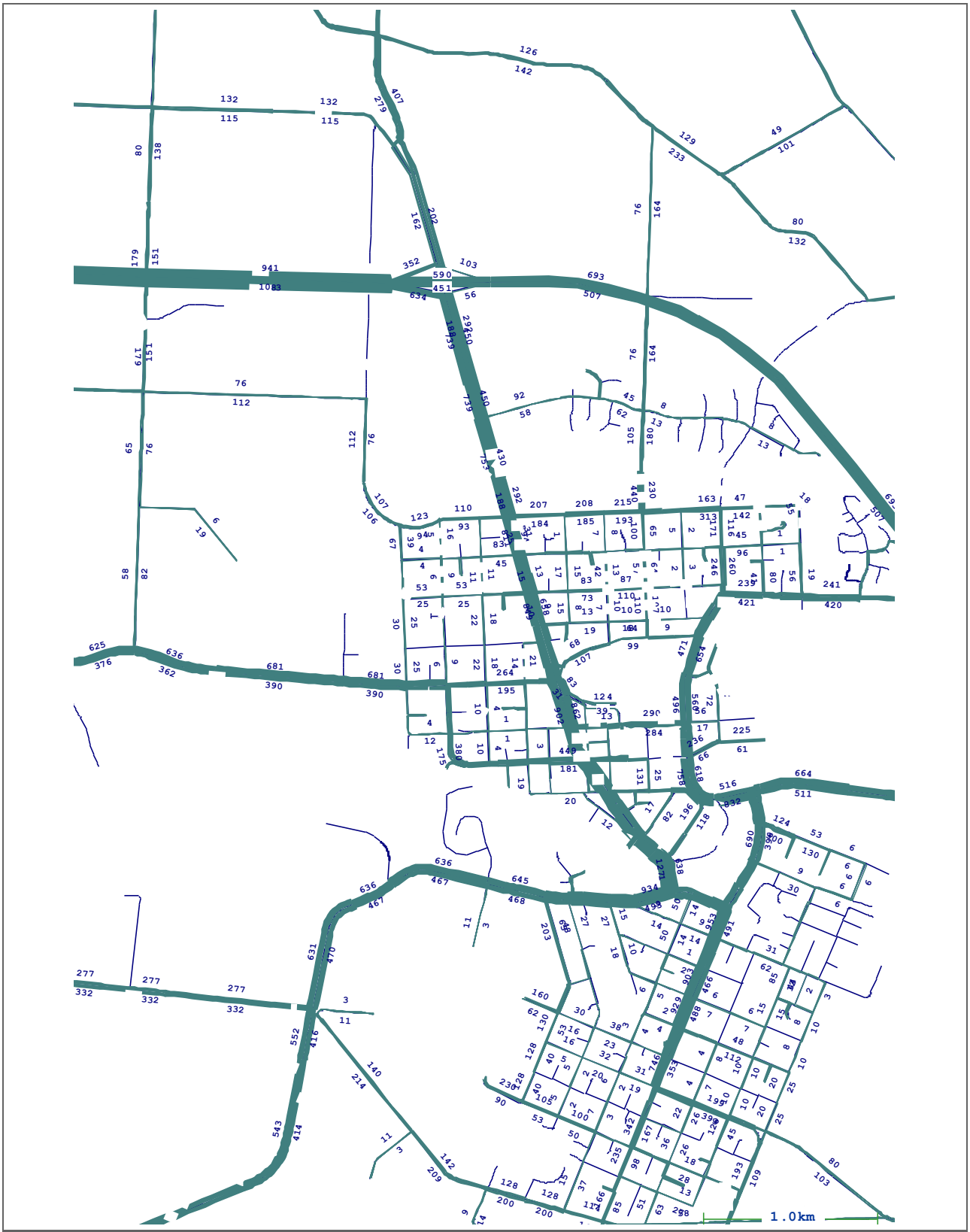
TDG

3



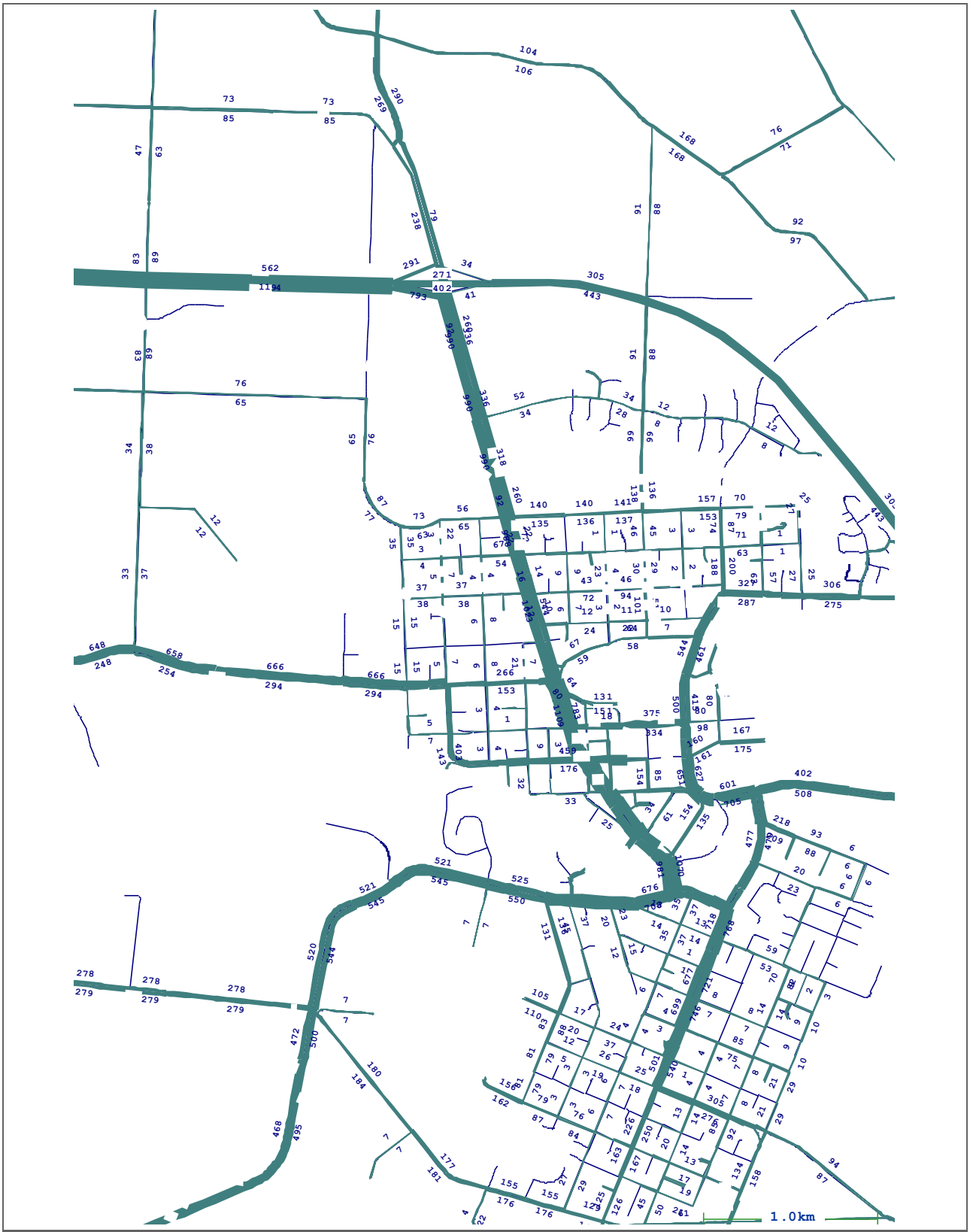
2013 24 Hour - Volume Plot Cambridge (2-hour)

4



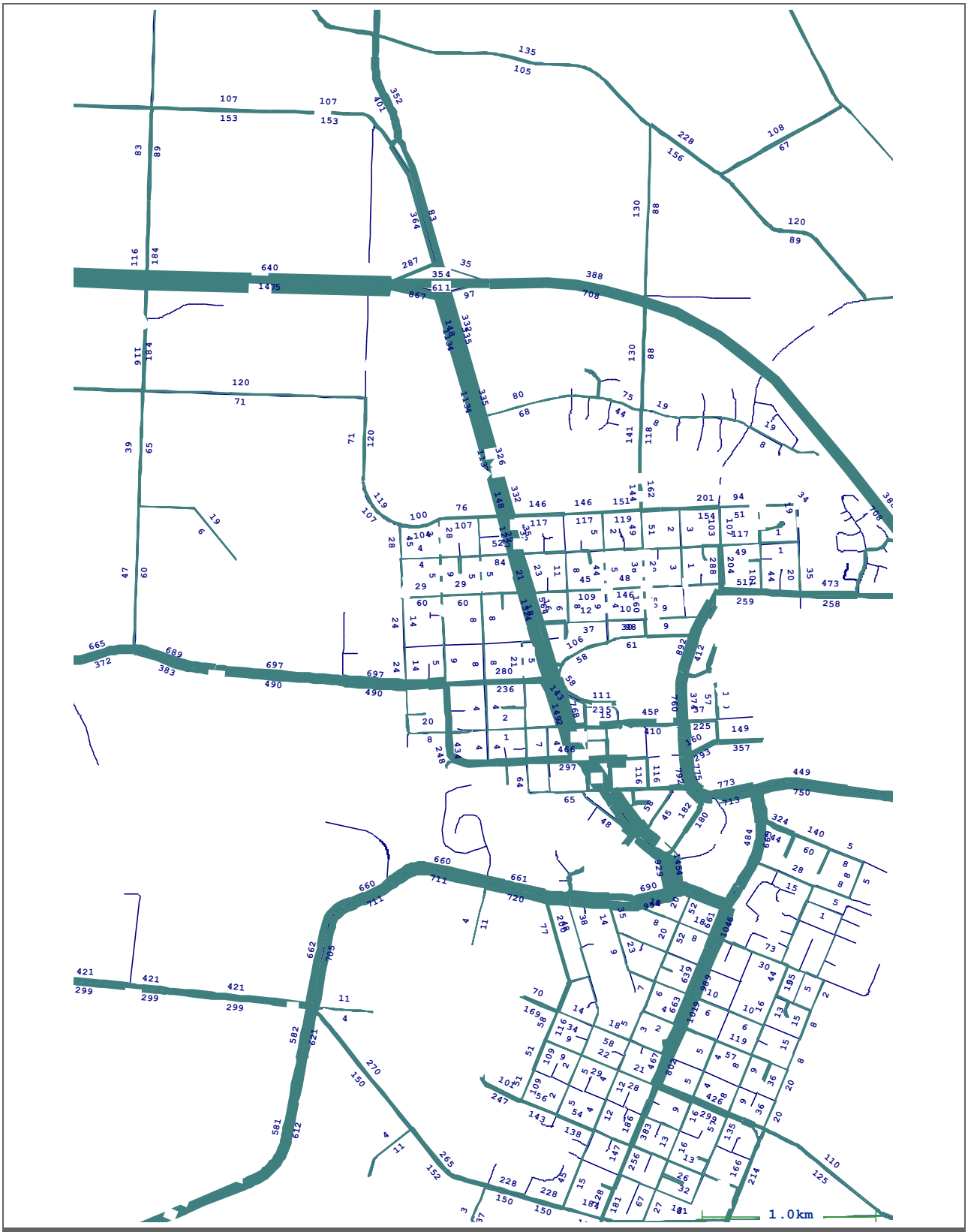
2021 Morning Peak – Volume Plot Cambridge (2-hour)

5



2021 Interpeak – Volume Plot Cambridge (2-hour)

6

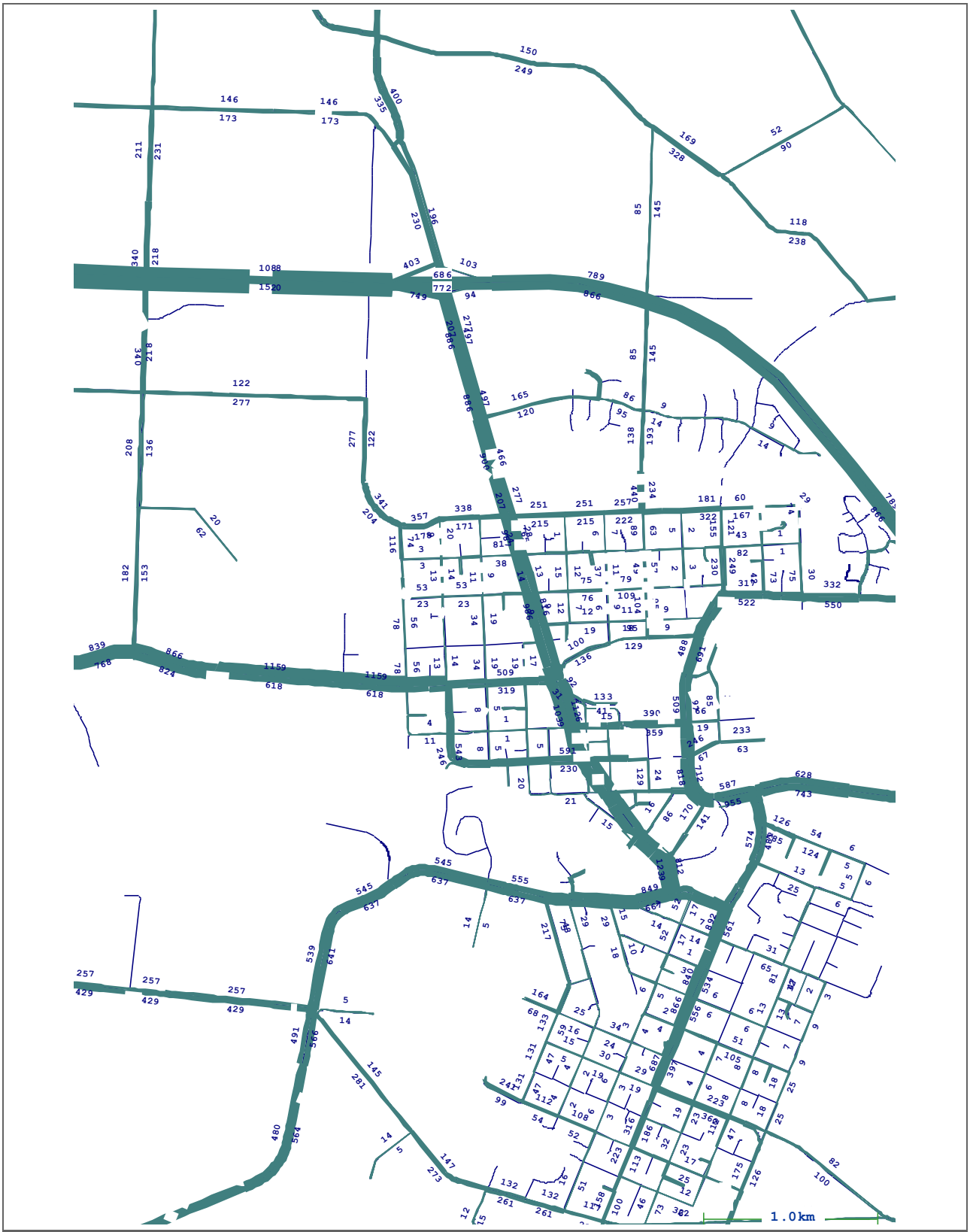


2021 Evening Peak – Volume Plot Cambridge (2-hour)

7

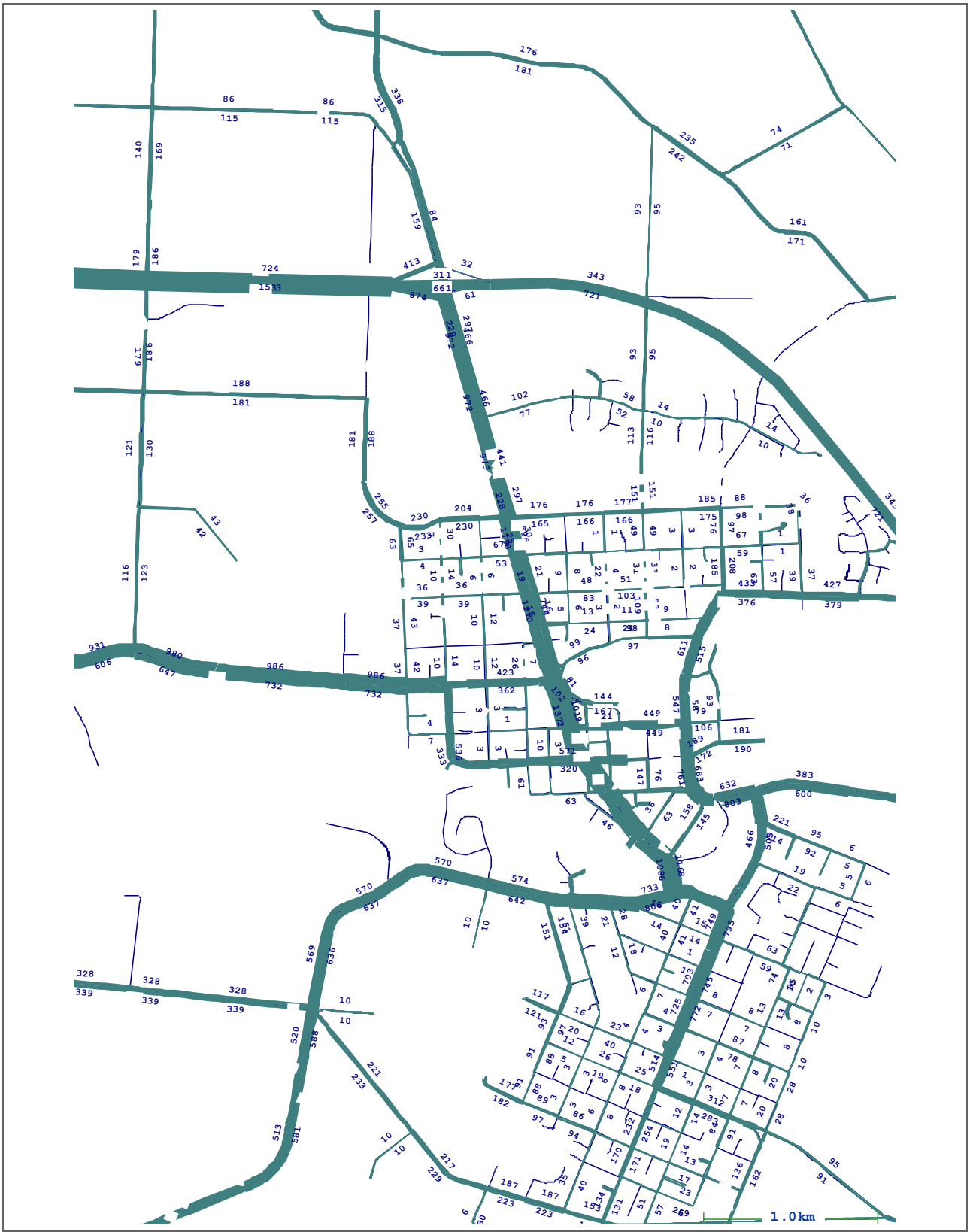
2021 24 Hour – Volume Plot Cambridge (2-hour)

8



2041 Morning Peak – Volume Plot Cambridge (2-hour)

13



2041 Interpeak – Volume Plot Cambridge (2-hour)

14

2041 Evening Peak – Volume Plot Cambridge (2-hour)

15

2041 24 Hour – Volume Plot Cambridge (2-hour)

16