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Roads and Traffic Authority
16 September

Bringelly Road Upgrade Review of Environmental Factors

Traffic and Transport Modelling Assessment

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Prepared for

Roads and Traffic Authority

Prepared by

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Executive Summary

The Roads and Traffic Authority of New South Wales (RTA) is proposing to upgrade Bringelly Road between The Northern Road and Camden Valley Way. Bringelly Road is a 10 km corridor running east-west between The Northern Road to the west and Camden Valley way to the east, providing a vital connection linking major urban and rural areas and is an integral component of the transport network in the south-west region of Sydney.

Pressure will continue to build on Bringelly Road as the major east-west connection in the SWGC between Camden Valley Way / M7 and The Northern Road to cater initially for traffic growth generated by Oran Park and Turner Road Precincts to the south of the SWGC and then progressively from the development of precincts located immediately north and south of Bringelly Road as well as Leppington Town Centre. The rate of release of these developments will have a significant impact on the timing of Bringelly Road upgrade. Extra road network capacity and new public transport services will be needed to move people within and out of the subregion efficiently.

This traffic assessment forms part of the Review of Environmental Factors (REF). The purpose of this traffic assessment is to assess the following elements:

- Mid block capacity and staging requirements of the proposed Bringelly Road upgrade.
- Operational performance of the key intersections to determine:
    - The ultimate intersection footprint required to cater for the expected traffic growth as a result of full development of SWGC.
    - The intersection staging requirements and timing to cater for all interim traffic growth scenarios in the south west region.
- Operational impacts to property access, freight transport, public transport, pedestrians and cyclists.
- Preliminary construction traffic assessment.

Mid block capacity and staging requirements

The ultimate required capacity for Bringelly Road at full development of the SWGC will be a four lane divided carriageway from The Northern Road to King Street and a six lane divided carriageway from King Street to Camden Valley Way. The road needs to be widened to six lanes through Leppington Town Centre due to the intersection requirements, as it would be impractical to taper the intersection upgrade back to four lanes between intersections.

Prior to the ultimate widening, Bringelly Road, east of King Street will require initially to be upgraded to a four lane divided carriageway to cater for the additional traffic demand generated by the initial phases of Austral and Leppington North Precincts and Leppington Town Centre as well as the opening of Leppington Station as part of the South West Rail Link (SWRL). The rest of the corridor will also be upgraded to four lanes as development proceeds towards the west.

The sections of Bringelly Road, east of King Street will require to be upgraded to six lanes in the long-term to cater for the traffic growth surrounding Leppington Town Centre.

Intersection performance and staging requirements

With substantial growth and changes being planned to adjacent land uses along Bringelly Road, traffic from the surrounding developments will only be able to access Bringelly Road at designated locations.

The concept design proposes 11 new signalised intersections along the 10km upgrade between Camden Valley Way and The Northern Road. The majority of these signalised intersections will have four approaches functioning, requiring some consolidation of both existing and new access points to Bringelly Road during precinct planning. New signalised intersections are planned to be provided at the following locations:

- Kelvin Park Drive (T-intersection)
- Jersey Road / Bringelly Link Road (4-way intersection with interim U-turn facilities at future Bringelly Link Road)
- Masterfield Street (4-way intersection)
- North Avenue (4-way intersection with interim U-turn facilities at future North Avenue extension to the south of Bringelly Road)
- King Street (4-way intersection)
- Eastwood Road (4-way intersection with interim U-turn facilities at future Eastwood Road extension to the north of Bringelly Road)
- Fourth Avenue / Dickson Road (4-way intersection)
- Edmondson Avenue / Rickard Road (4-way intersection)
- Browns Road / Byron Road (T- intersection[1])
- Cowpasture Road (T-intersection)
- Access to Western Sydney Parklands (T-intersection).

The intersections at The Northern Road will remain signalised, but will be upgraded with additional through and turning lanes to cater for further traffic growth in the future.

Using the existing intersection layouts as a starting point, each intersection along Bringelly Road was assessed under forecast traffic flows and upgraded based on known staging of Bringelly Road widening. Should the intersection have insufficient capacity to cater for forecast traffic volumes, intersection upgrades are proposed with consideration of:

- Surrounding intersection and mid-block capacity requirements.
- Footprint of ultimate intersection layout.
- An acceptable level of performance for 10 years after opening.
- Measures to allow bus priority.
- Intersection performance of LOS D or better at opening.
- 95th percentile queue lengths not to extend into upstream intersections.

Table 1 provides a summary of the staging requirements for intersection upgrades within the study area.

[1] Initially RTA will construct a T-intersection at Browns Road which will accommodate a future four way intersection to be constructed by others.

Table 1: Intersection upgrade staging

Intersection	2011	2016	2021	2026	2031	2036
The Northern Road	Existing layout	Extend turning bay lengths	Upgrade intersection - **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Kelvin Park Drive	Existing layout	-	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Jersey Road	Existing layout	-	Upgrade intersection * - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Masterfield Street	Existing layout	-	Upgrade intersection - **two lanes** on Bringelly Road approaches (priority intersection)	-	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	Ultimate layout
North Avenue	Existing layout	-	Upgrade intersection *- **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
King Street	Existing layout	-	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Eastwood Road	Existing layout	-	Upgrade intersection *- **signalisation** and **three lanes** on Bringelly Road approaches	-	-	Ultimate layout
Fourth Avenue	Existing layout	-	Upgrade intersection - **signalisation** and **three lanes** on Bringelly Road approaches	-	-	Ultimate layout
Edmondson Avenue	Existing layout	Upgrade intersection - **signalisation** and **three lanes** on Bringelly Road approaches	-	Ban northbound and southbound right turn movements	Ban eastbound right turn movement	Ultimate layout
Browns Road	Existing layout	-	Upgrade to T intersection - **signalisation** and **three lanes** on Bringelly Road approaches	-	-	Ultimate layout
Cowpasture Road	Existing layout	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Upgrade intersection - **three lanes** on Bringelly Road approaches	Ultimate layout

Source: AECOM, 2011

*- including an interim U-turn facilities to assist with local access with the upgrade of Bringelly Road to a divided carriageway

Other operational impacts

With the upgrade of Bringelly Road,

- The number of head-on crashes and likelihood of intersection crashes would be reduced with the provision of divided carriageway and signalised intersections along Bringelly Road.
- Safety and efficiency for B-double and freight access along Bringelly Road will be improved.
- There will be no operational impacts to existing bus routes (Routes 855 and 856). There may be relocation of existing bus stops as opportunities for bus stops will be provided on the departure side of each signalised intersection. This is an improvement in safety to the existing situation, which does not sufficiently allow for buses to stop adjacent to the traffic lanes.
- Risk of congestion and over saturation on the road network will be minimised. The efficiency of public transport operations and travel time reliability along Bringelly Road will be improved. Appropriate bus priority measures will also reduce bus delays at intersections.
- Access to the station and its interchange via all modes of transport will be maximised.
- Safety for pedestrians and cyclists travelling along the corridor will be improved with the provision of an off-road shared path.
- Opportunities for on-road cycling will be provided to allow for cyclists to travel adjacent to the traffic lanes.
- Left in and left out access would generally be provided at existing properties where there are no other alternatives. Three temporary U-turn facilities have been incorporated into the design, to allow for traffic movements to and from properties with only left in and left out access.

Preliminary construction traffic impacts

A detailed construction traffic impact assessment has not been undertaken because details related to construction activities and sequence of work are not known at this stage. It is recommended that the RTA undertake a detailed construction traffic impact assessment when further construction details are known following detailed design.

Impacts on traffic during construction of the Bringelly Road would be temporary in nature. Traffic impacts would occur as a result of the movement of construction and service vehicles along Bringelly Road, service and access roads, due to the haulage of construction materials. Use of Bringelly Road and access to existing properties along the road would be maintained throughout the construction phase.

Truck movements during the construction phase are expected to increase by 30 to 40 truck movements per day. Truck movements may increase to 60 to 100 truck movements per day at certain stages of construction. Truck movement numbers will be confirmed at a later stage when construction staging arrangements are more clearly defined. The additional truck movements should not have significant impacts along Bringelly Road, but may have locally concentrated impacts at construction access points.

Potential impacts caused by construction vehicle traffic would include:

- Increased travel times due to reduced speed limit around construction sites.
- Increased travel times due to increased truck and construction machinery movements.
- Temporary partial or complete closure of roads and altered property accesses during construction.

Access to individual properties may be temporarily affected by construction activities, either through the loss or alteration of existing access arrangements. However, property access would be maintained, and any impacts would be short-term.

The proposal would involve changing the access and egress functions at junctions with adjoining roads. As such, some bus routes may be modified both during and after construction. Construction would have other impacts on bus services including reduced speeds and temporary relocation of bus stops. However, buses would continue to be able to use Bringelly Road.

Construction of the South West Rail Link (SWRL) will commence in 2011 and is due for completion in 2016. The planning of the upgrade of Bringelly Road will need to consider and ensure that accessibility to the station and its interchange via all modes of transport is maintained.

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP). The TMP would include the guidelines, general requirements and procedures to be used when activities or areas of work have a potential impact on existing traffic arrangements.

1.0 Introduction

1.1 Project background

The Roads and Traffic Authority of New South Wales (RTA) is proposing to upgrade Bringelly Road between The Northern Road and Camden Valley Way - the Bringelly Road upgrade ('the proposal'). The proposal is part of the RTA's program to improve road safety, traffic efficiency and future road network performance in the South West Growth Centre (SWGC) in Sydney's south west.

Bringelly Road is a 10 km corridor running east-west between The Northern Road to the west and Camden Valley Way to the east. The road functions as an arterial road linking major urban and rural areas and is an integral component of the transport network in the south-west region of Sydney. The corridor is the main road through the suburbs of Bringelly, Rossmore, Austral and Leppington. The regional context of Bringelly Road is shown in **Figure 1**.

Figure 1 Bringelly Road upgrade – regional context

Source: RTA, 2011

The corridor currently consists of a two-lane road from The Northern Road to Camden Valley Way. It is a sealed road with a gravel verge / shoulder and no kerb or gutter. The corridor currently has limited overtaking opportunities, several junctions with local rural roads and many uncontrolled private accesses.

The concept design for the proposal would include the following key features:

- An initial upgrade from a two lane to a four lane divided road with a central median.
- The wide central median will allow for future widening to six lanes, if required in the future.
- An intended posted vehicle speed limit of 80km/h.
- A three metre wide off-road shared pedestrian/cyclist path.
- Two metre shoulders.
- Adjustments to public utilities such as gas, electricity and telephone services along the route.
- Bicycle and pedestrian crossing provisions at traffic lights.
- Bus priority capability at traffic lights and indented bus bays on both sides of Bringelly Road.
- Designated turning lanes at traffic lights.
- Existing properties on Bringelly Road would continue to have direct left in/left out access until precinct development takes place, and alternative access becomes available.

1.2 Study objectives

This traffic assessment forms part of the Review of Environmental Factors (REF). The purpose of this traffic assessment is to assess the following elements:

- Mid block capacity and staging requirements of the proposed Bringelly Road upgrade.
- Operational performance of the key intersections to determine:
    - The ultimate intersection footprint required to cater for the expected traffic growth as a result of full development of SWGC.
    - The intersection staging requirements and timing to cater for all interim traffic growth scenarios in the south west region.
- Operational impacts to property access, freight transport, public transport, pedestrians and cyclists.
- Preliminary construction traffic assessment.

1.3 Report structure

This report has been structured into the following sections:

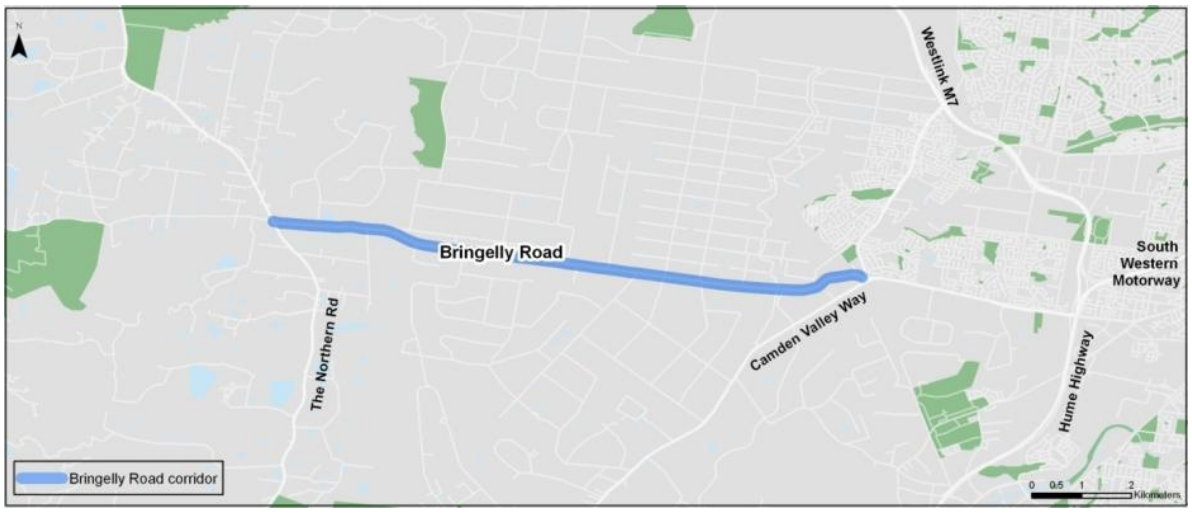
- **Section 2** of this report provides an overview of existing traffic and transport conditions, including existing operational performance of Bringelly Road.
- **Section 3** documents the traffic modelling methodology which has been adopted to predict future traffic volumes for the Bringelly Road upgrade.
- **Section 4** outlines the concept design for the proposal.
- **Section 5** provides details of the traffic impact assessment that was undertaken for different stages and scenarios including the consequence of no action, construction and operational impacts of the proposal and the management measures that have been developed to mitigate the impact of the traffic and transport issues.
- **Section 6** summarises the key outcomes of the traffic and transport modelling assessment.

2.0 Existing traffic and transport conditions

2.1 Route environment

Bringelly Road is a 10 km route linking Edmondson Park and Bringelly in the centre of the SWGC. The road acts as a strategic road link connecting major urban and rural areas. Bringelly Road is one of the main east-west corridors in the SWGC bisecting Camden and Liverpool local government areas (LGAs), and is connected to The Northern Road to the west and Camden Valley Way to the east as shown in **Figure 2**. Bringelly Road is at present a two-lane, two-way sealed road, with a gravel verge / shoulder and no kerb. There is minimal provision of pedestrian and cycling facilities along the corridor.

Figure 2 Bringelly Road upgrade project area

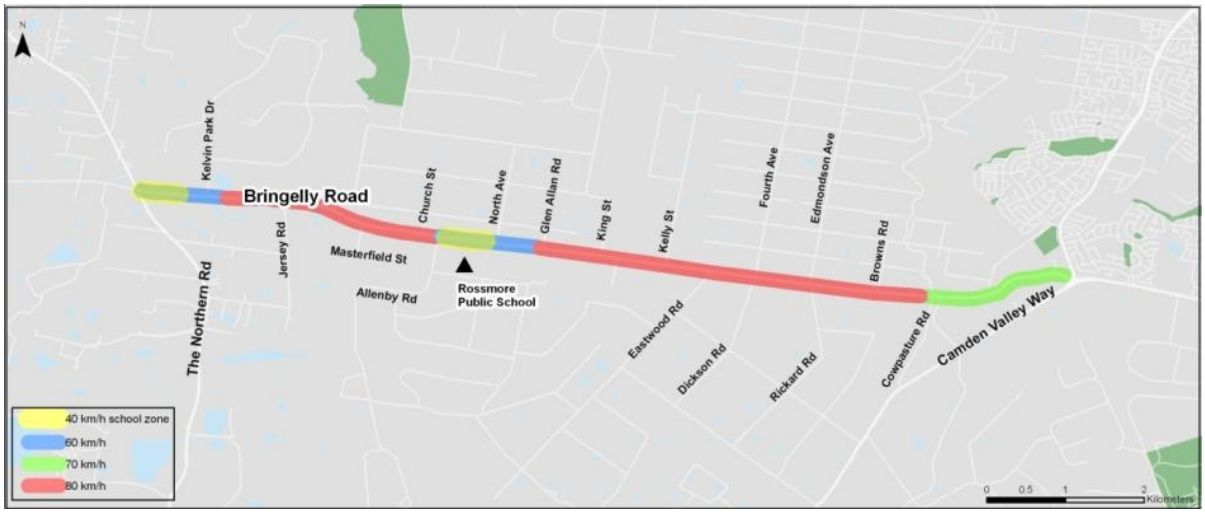


Source: AECOM, 2011

2.2 Speed environment

Figure 3 shows the posted speed limit along different sections of Bringelly Road. The road has a posted speed limit of 70 km/h east of Cowpasture Road. The posted speed limit of Bringelly Road to the west of Cowpasture Road is generally 80 km/h except the sections near Rossmore shops and Bringelly shops where the posted speed limit is 60 km/h. Two school zones are located adjacent to Bringelly and Rossmore public schools, where a 40 km/h speed restriction is in place during school start and finish times.

Figure 3 Speed zones on Bringelly Road

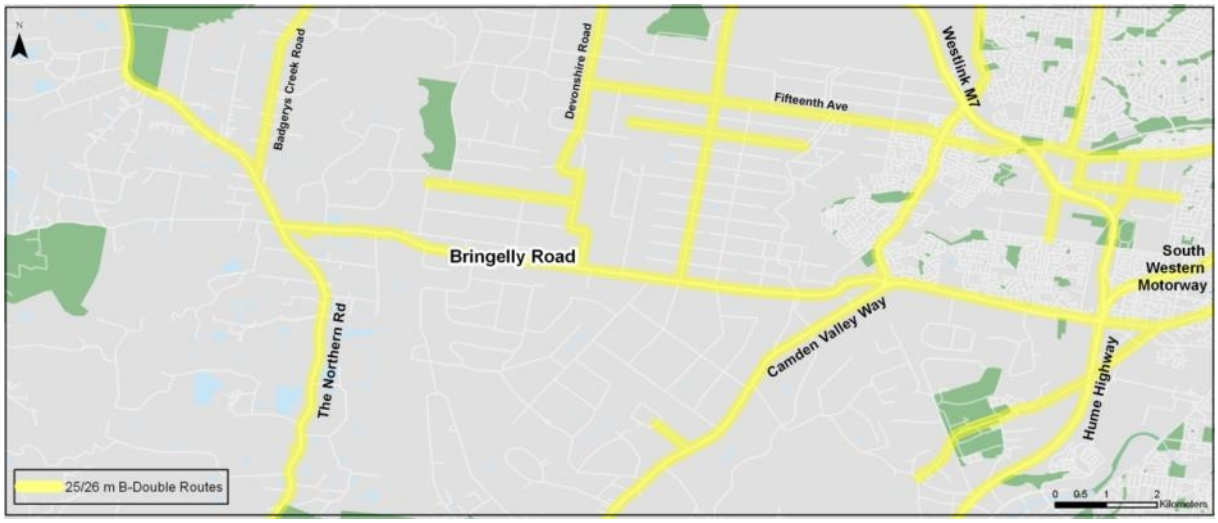


Source: AECOM, 2011

2.3 B-Double routes

Figure 4 shows designated B-Double truck routes. Bringelly Road is designated a B-Double route for trucks up to 26m in length with connections to other B-Double routes including The Northern Road, Camden Valley Way, Cowpasture Road, Devonshire Road and King Street.

Figure 4 Heavy vehicle travel restrictions



Source: RTA, 2011

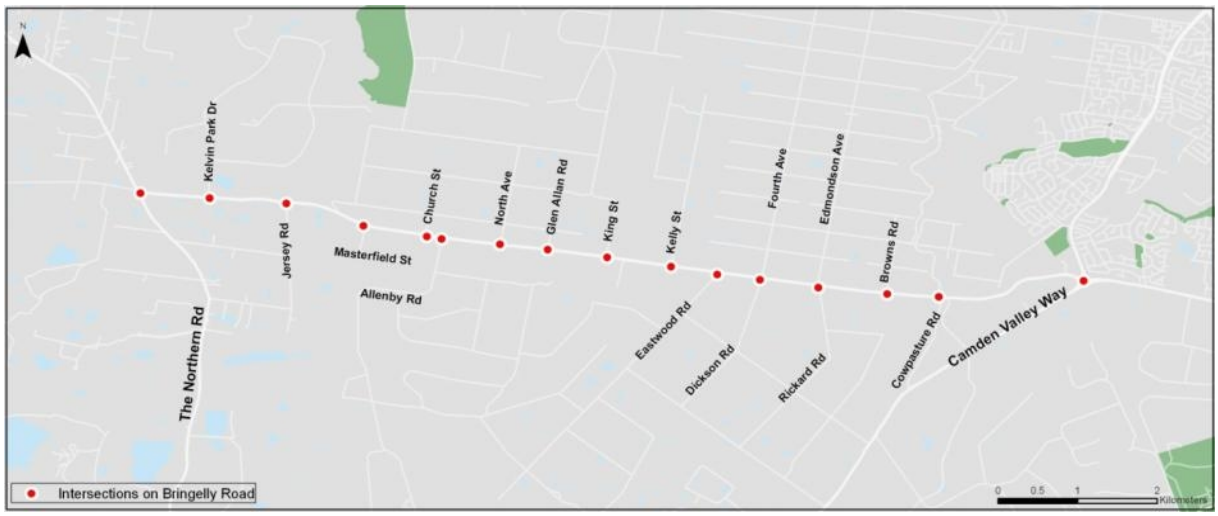
2.4 Major intersections along Bringelly Road

The existing intersections along the Bringelly Road corridor include:

- The Northern Road
- Kelvin Park Drive
- Jersey Road
- Masterfield Street
- Church Street
- Allenby Road
- North Avenue
- Glen Allan Road
- King Street
- Kelly Street
- Eastwood Road
- Fourth Avenue / Dickson Road
- Edmondson Avenue / Rickard Road
- Browns Road
- Cowpasture Road
- Camden Valley Way / Cowpasture Road.

The intersection of Camden Valley Way with Bringelly Road is not considered to be part of the scope of Bringelly Road Upgrade Project. The location of these intersections along Bringelly Road is shown in **Figure 5**.

Figure 5 Existing intersection locations in the project area



Source: AECOM, 2011

All of these intersections are priority give-way intersections, except for traffic signals at Camden Valley Way and The Northern Road.

2.5 Water crossings along Bringelly Road

Bringelly Road also crosses a number of creeks or water channels including:

- Sydney Catchment Authority Upper Canal
- Bonds Creek
- Scalabrini Creek
- Kemps Creek
- South Creek.

2.6 Surrounding land uses

2.6.1 Land uses

Bringelly Road currently provides direct access to suburbs including Austral, Leppington, Rossmore and Bringelly. Existing features along the Bringelly Road corridor include rural residential housing, a flower nursery, public schools, and a petrol station near the Rossmore shops. A church and cemetery are also situated off Bringelly Road on Church Street.

There is an approved Development Application for a service station, car wash and fast food outlet at 68 Kelly St Austral, on the NE corner of Bringelly Road.

2.6.2 Population and employment

The anticipated growth in population and employment in the SWGC will drive the need for the upgrade of Bringelly Road. Population and employment growth from 2006 to 2036 (forecast) are shown in **Table 2** and **Table 3**.

Table 2 Population growth forecast 2006–2036

LGAs	2006	2016	2026	2036
Camden	50,940	96,320	172,310	249,770
Campbelltown	147,440	167,480	201,570	233,760
Liverpool	170,920	201,990	259,340	324,440
Wollondilly	41,220	48,270	57,460	66,890

Source: 2009 BTS Population Forecasts

Table 3 Employment growth forecast 2006–2036

LGAs	2006	2016	2026	2036
Camden	17,320	24,250	34,850	44,980
Campbelltown	45,930	54,340	64,960	75,080
Liverpool	59,160	72,500	89,130	103,520
Wollondilly	10,920	11,970	13,480	14,880

Source: 2009 BTS Employment Forecasts

Significant growth over the next thirty years is expected in the Camden, Campbelltown, Liverpool and Wollondilly LGAs. Development of the SWGC new release areas will significantly increase the demand for travel on sections of Bringelly Road.

2.7 Modes of travel

2.7.1 Private transport

Private vehicles are the predominant mode of transport utilised in the project area. This is attributed to public transport services being limited along the Bringelly Road corridor.

The 2006 Journey to Work data provides details of the mode share of average weekday travel demand made from each LGA in NSW. The mode share for the four LGAs in the SWGC in comparison to Sydney City and Parramatta LGAs is shown in **Table 4**.

Table 4 Average weekday mode share (2006)

LGAs	Vehicle driver	Vehicle passenger	Public transport	Walk only	Other modes	Total
Camden	83%	8%	2%	3%	4%	100%
Campbelltown	80%	9%	6%	3%	2%	100%
Liverpool	78%	8%	6%	4%	4%	100%
Wollondilly	81%	6%	1%	6%	6%	100%
Parramatta	69%	6%	18%	4%	3%	100%
Sydney City	27%	4%	59%	7%	3%	100%

Source: 2006 BTS Journey to Work Dataset

Findings from the mode distribution travel survey shows that over 85 per cent of total trips on a typical weekday made in Camden, Campbelltown, Liverpool and Wollondilly are car-based compared to an average of 75 per cent in Parramatta and 30 per cent in Sydney City.

A more detailed analysis of existing road network performance is provided in **Section 2.8**.

2.7.2 Public transport

As shown in **Table 4**, public transport accounts for less than ten per cent of the mode share in each of the four LGAs within the SWGC.

Currently there is limited public transport provision in the vicinity of Bringelly Road corridor. There is no rail link to the suburbs immediately north or south of Bringelly Road. The nearest major train stations are at Glenfield or Liverpool, which are serviced by the South Line, Airport and East Hills Line and the Cumberland Line.

There are two bus routes, operated by Interline Bus Services, currently operate along certain sections of Bringelly Road. The two bus services on Bringelly Road are shown in **Figure 6**.

Route 856 operates from Liverpool to Bringelly, via Bringelly Road, Ingleburn Road and Camden Valley Way. The service operates hourly during peak periods and infrequently during non-peak times. This bus service is timed to arrive at Liverpool Station to connect with onward rail services to the City.

Route 855 operates from Austral to Liverpool, via Fifteenth Avenue, Cowpasture Road and the Hume Highway. Weekday services operate hourly between 06:00–10:00, however, only three services are provided in the afternoon.

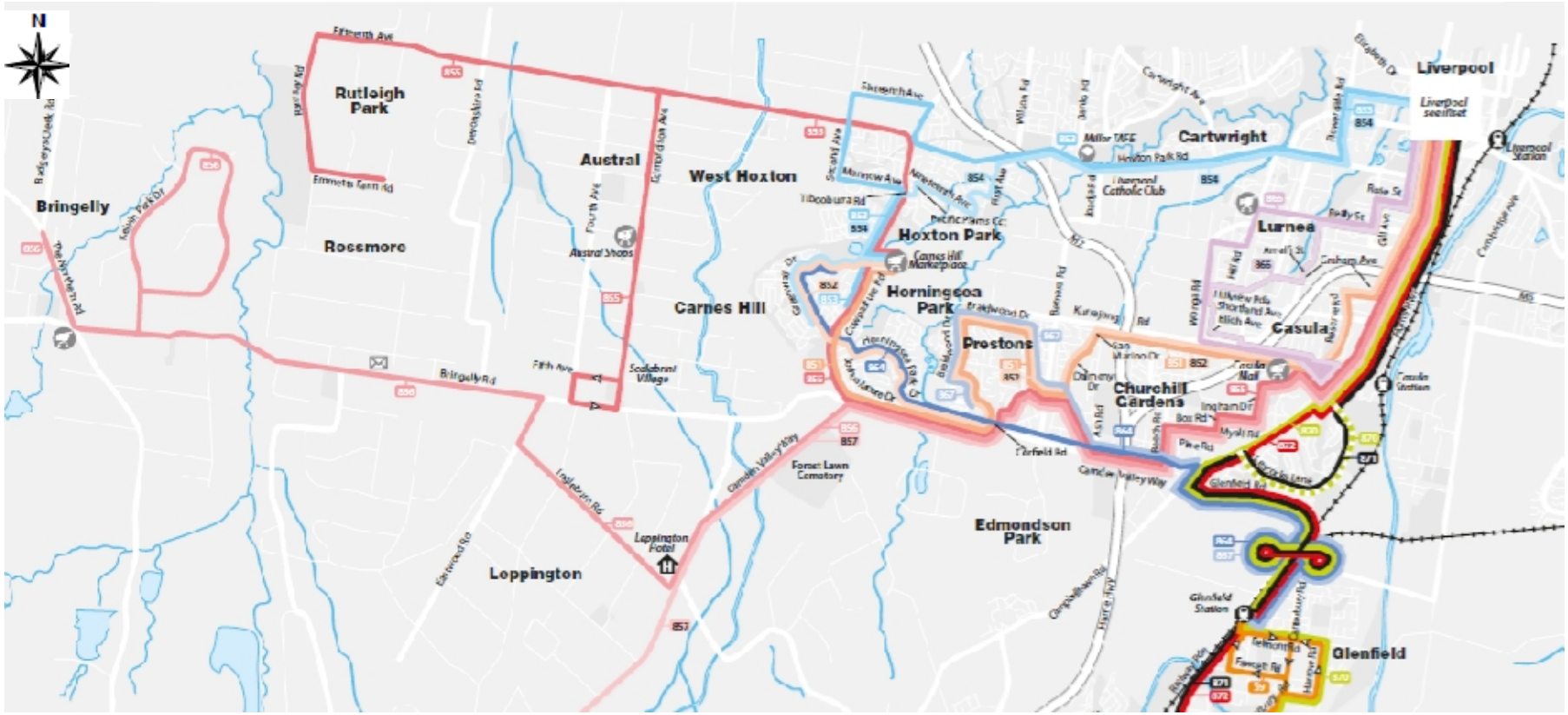
2.7.3 Walking and cycling

There are limited dedicated walking and cycling facilities along Bringelly Road. Shoulders and verges provide a means for pedestrians to travel along Bringelly Road, however, the speed of traffic on the road combined with the rural nature of the area result in very little pedestrian activity.

A pedestrian refuge is provided outside the Rossmore Public School to ensure safe crossing opportunities for pedestrians. Pedestrian crossings are also provided on the northern and western approaches of the signalised intersection at Bringelly Road / The Northern Road.

Dedicated cycle lanes are provided at all approaches of the signalised intersection at Bringelly Road / Camden Valley Way / Cowpasture Road.

Figure 6 Interline Bus Services network map (2010)



Source: Interline bus services May2010 network map

2.8 Traffic volumes

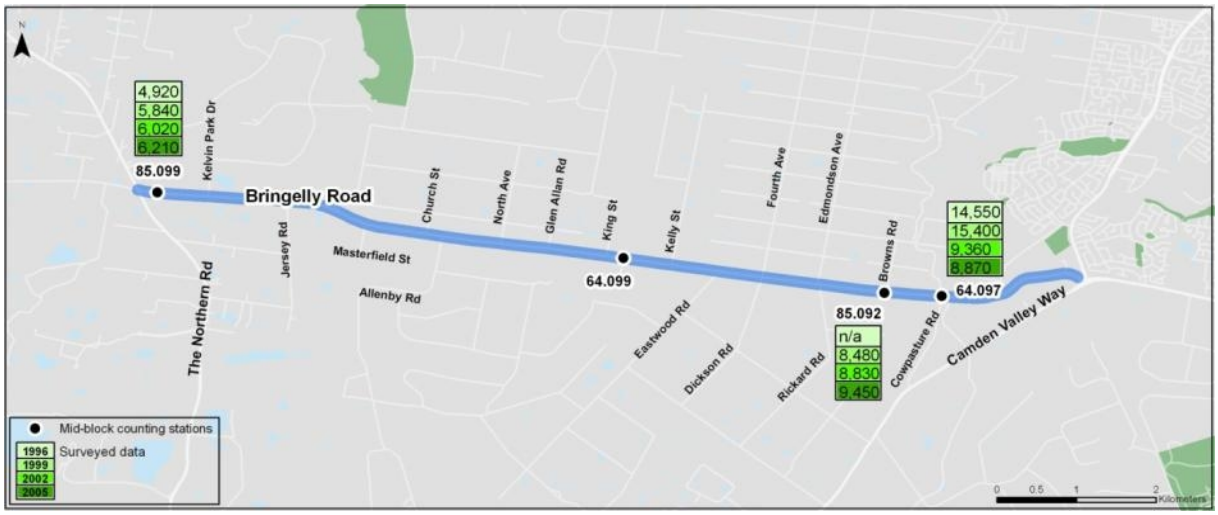
2.8.1 RTA historical traffic data

The most recent annual average daily traffic (AADT) data for Bringelly Road was collected in 2005. The data was obtained from three non-permanent mid-block counting stations located along Bringelly Road and provide AADT data in both directions. The counting stations are located at the following locations and shown in **Figure 7**:

- Bringelly Road, Bringelly - east of MR154, The Northern Road (85.099)
- Bringelly Road, Austral - east of Browns Road (85.092)
- Bringelly Road, Austral - at the Sydney Water Supply Line (64.097).

Although a fourth counting station (64.099) is illustrated in **Figure 7**, it was been omitted from the analysis due to the lack of data retrieved from the station.

Figure 7 Bringelly Road traffic counting stations



Source: RTA, 2010

As shown in **Table 5**, count station 64.097 experienced a marked drop in volume from 1999 to 2002 following the realignment of Cowpasture Road to a 4-way intersection at Camden Valley Way in 2000. As indicated by traffic counts collected at station 85.092 and 85.099, traffic volume has increased at an annual rate of 1.8 per cent and 1.0 per cent respectively, from 1999 to 2005.

Table 5 Bringelly Road AADT traffic counts (1996–2005)

Station	Location	Year				Annual growth rate from 1999 to 2005
		1996	1999	2002	2005	
85.099	Bringelly Road, Bringelly–east of MR154, The Northern Road	4,920	5,840	6,020	6,210	1.0%
85.092	Bringelly Road, Austral–east of Browns Road	n/a	8,480	8,830	9,450	1.8%
64.097	Bringelly Road, Austral–at the Sydney Water Supply Line	14,550	15,400	9,360	8,870	n/a

Source: RTA, 2010

2.8.2 Mid-block traffic counts (2010)

In addition to the three non-permanent mid-block counting stations along Bringelly Road, the RTA commissioned traffic surveys in December 2010 to measure current traffic volumes at other key locations along Bringelly Road. The automatic traffic count (ATC) tubes were located on Bringelly Road at the following locations:

- Immediately east of The Northern Road
- Immediately east of King Street
- Immediately west of Camden Valley Way.

Table 6 2010 Traffic volume summary

Location on Bringelly Road	Two-way traffic volumes			
	Average Weekday Traffic (veh/day)	Average Daily Traffic (veh/day)	AM peak hour traffic (veh/hr) (hour beginning)	PM peak hour traffic (veh/hr) (hour beginning)
Immediately east of The Northern Road	6,030	5,690	440 (07:00)	540 (17:00)
Immediately east of King Street	9,130	8,540	620 (08:00)	810 (16:00)
Immediately west of Camden Valley Way	9,520	9,090	700 (08:00)	800 (15:00)

Source: AECOM, based on traffic data collected by RTA between 10/12/10 to 16/12/10

Table 6 indicates that the highest daily volume of traffic occurs on Bringelly Road, west of Camden Valley Way, with 9,520 vehicles during an average weekday. The average weekday traffic flow on Bringelly Road, east of The Northern Road is 6,030 vehicles.

There is a difference of approximately 3,000 veh/day (300 veh/hour) recorded on the eastern and western ends of Bringelly Road, with higher traffic flows on the eastern end near Camden Valley Way.

The peak hour for traffic volumes recorded on Bringelly Road occurs between 7 and 9am in the morning and between 3 and 6pm in the afternoon.

2.8.3 Traffic distribution

The daily trip distribution pattern for Bringelly Road is summarised in **Table 7**. All surveyed sites have a 50 / 50 eastbound / westbound split of the average daily traffic distribution.

Table 7 Peak hour traffic distribution on Bringelly Road

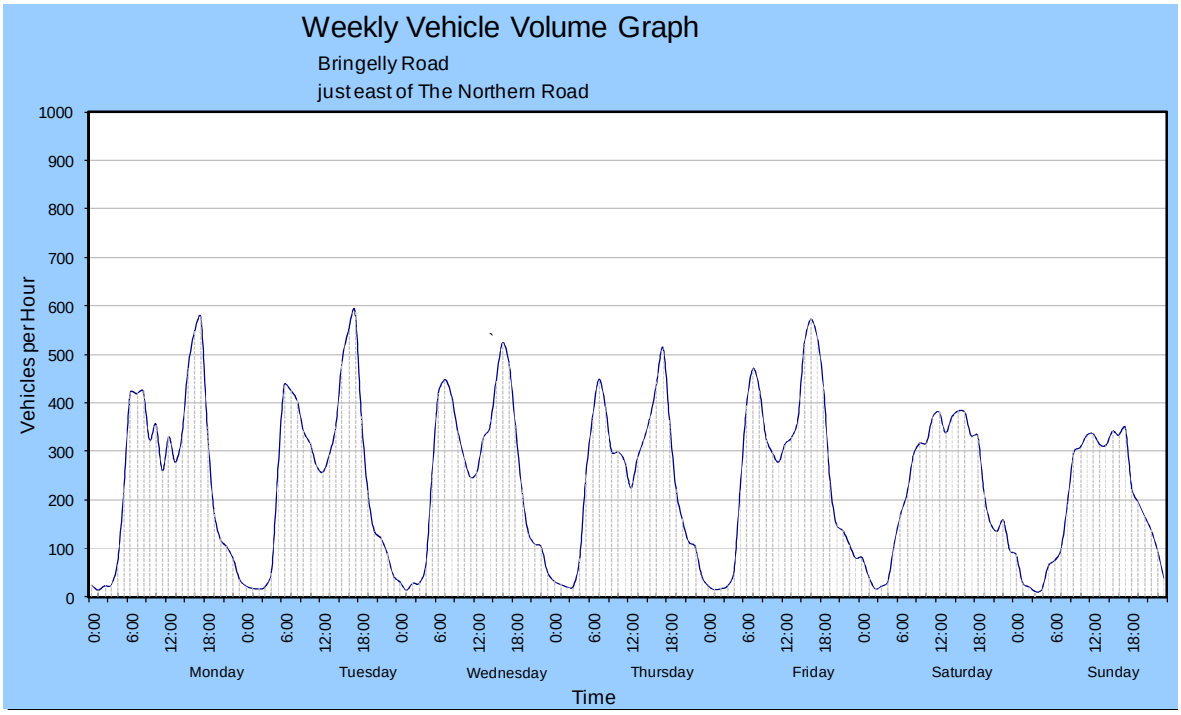
Location on Bringelly Road	ADT traffic distribution				
	ADT	EB	WB	EB %	WB %
Immediately east of The Northern Road	5,690	2,830	2,860	50%	50%
Immediately east of King Street	8,540	4,310	4,230	50%	50%
Immediately west of Camden Valley Way	9,090	4,620	4,470	51%	49%

Source: AECOM, based on traffic data collected between 10/12/10 to 16/12/10

2.8.4 Weekly traffic profile

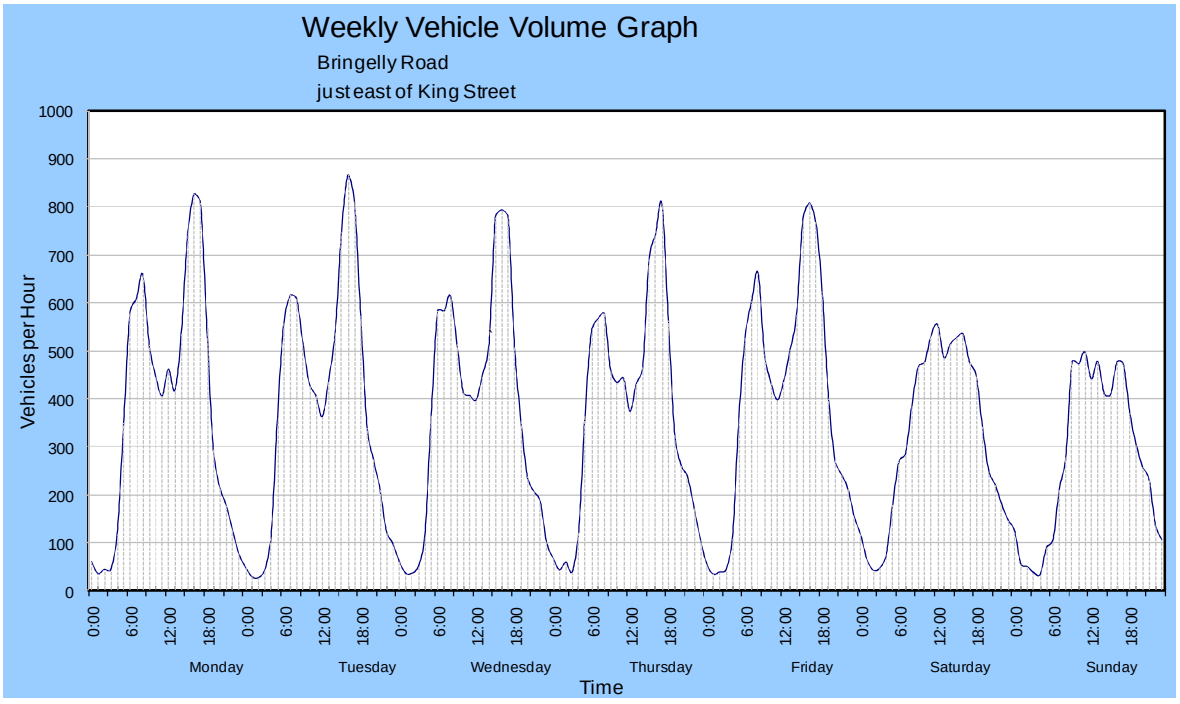
The average weekly two-way traffic profiles for all three surveyed sites are shown in **Figure 8**, **Figure 9** and **Figure 10**. The profile shows clearly defined morning and afternoon peak periods on all weekdays, with a higher PM peak than the AM peak. Traffic volumes are lower on weekends with no distinct peak periods.

Figure 8 Average weekly two-way traffic volume at Bringelly Road, east of The Northern Road



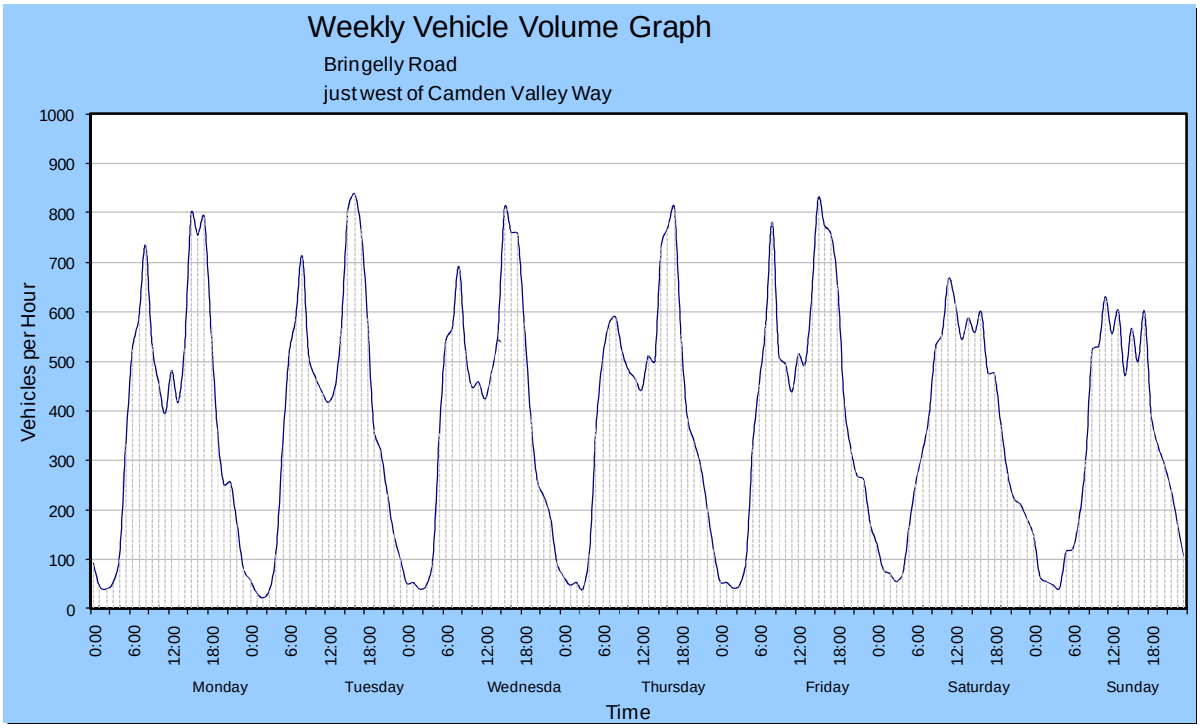
Source: AECOM, based on traffic data collected by RTA between 10/12/10 to 16/12/10

Figure 9 Average weekly two-way traffic volume at Bringelly Road, east of King Street



Source: AECOM, based on traffic data collected by RTA between 10/12/10 to 16/12/10

Figure 10 Average weekly two-way traffic volume at Bringelly Road, west of Camden Valley Way

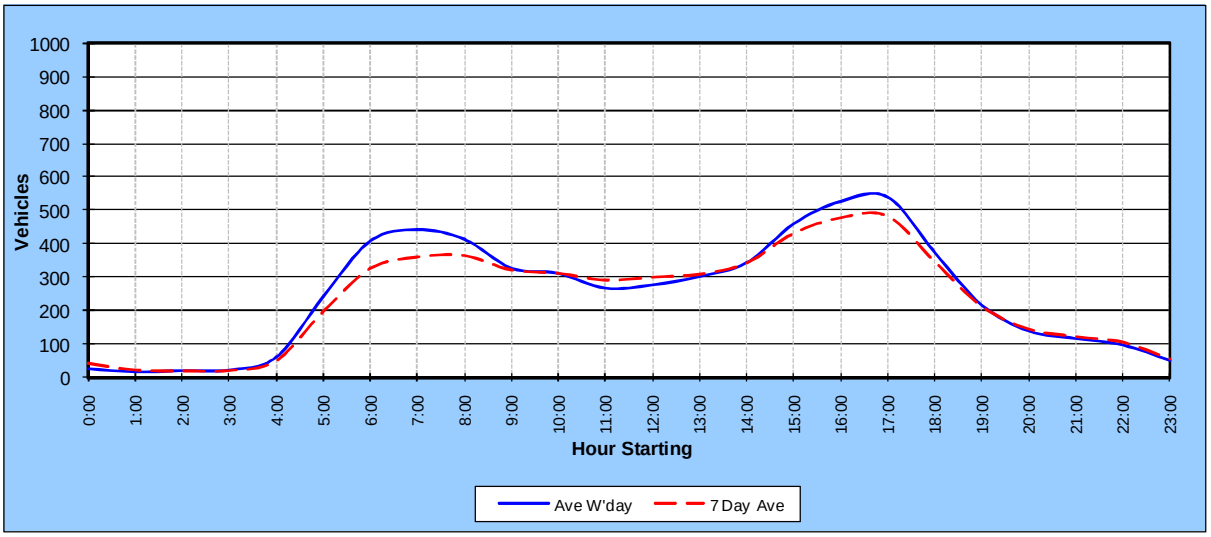


Source: AECOM, based on traffic data collected by RTA between 10/12/10 to 16/12/10

2.8.5 Daily traffic profile

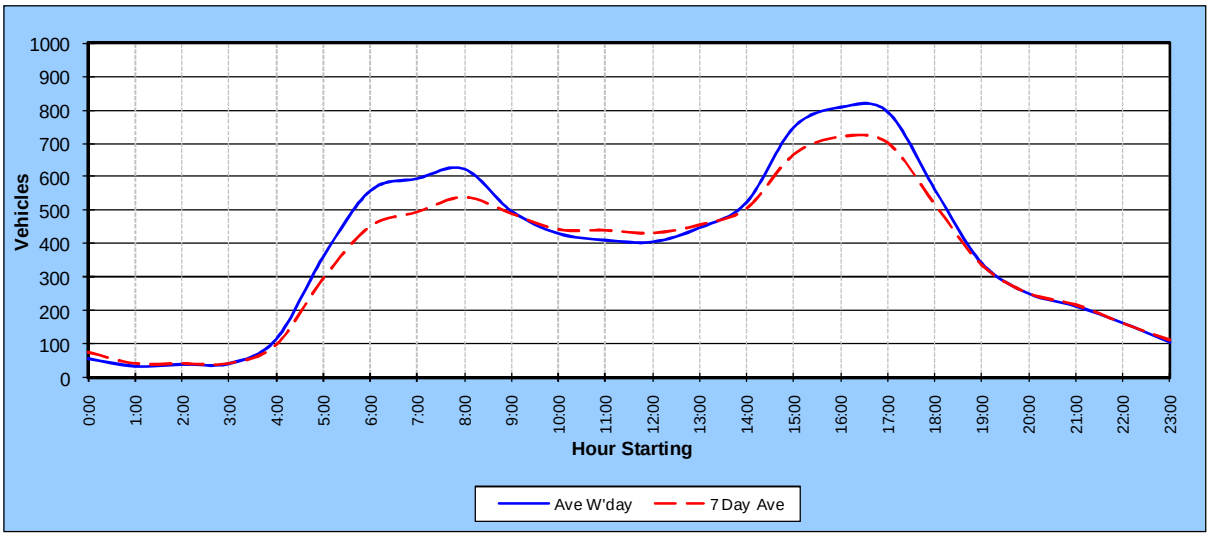
Daily traffic volume profiles for all three surveyed sites are shown in **Figure 11**, **Figure 12** and **Figure 13**. The profiles for all sites along Bringelly Road distinctly show two peak periods in the morning and the afternoon. For all sites, morning peak traffic volumes tend to peak from 6am in the morning with commuter traffic, before subsiding in the inter-peak period and increasing again to a peak in the afternoon. The afternoon peak is also higher than the morning peak at all three surveyed stations along Bringelly Road.

Figure 11 Daily traffic profile at Bringelly Road, east of The Northern Road



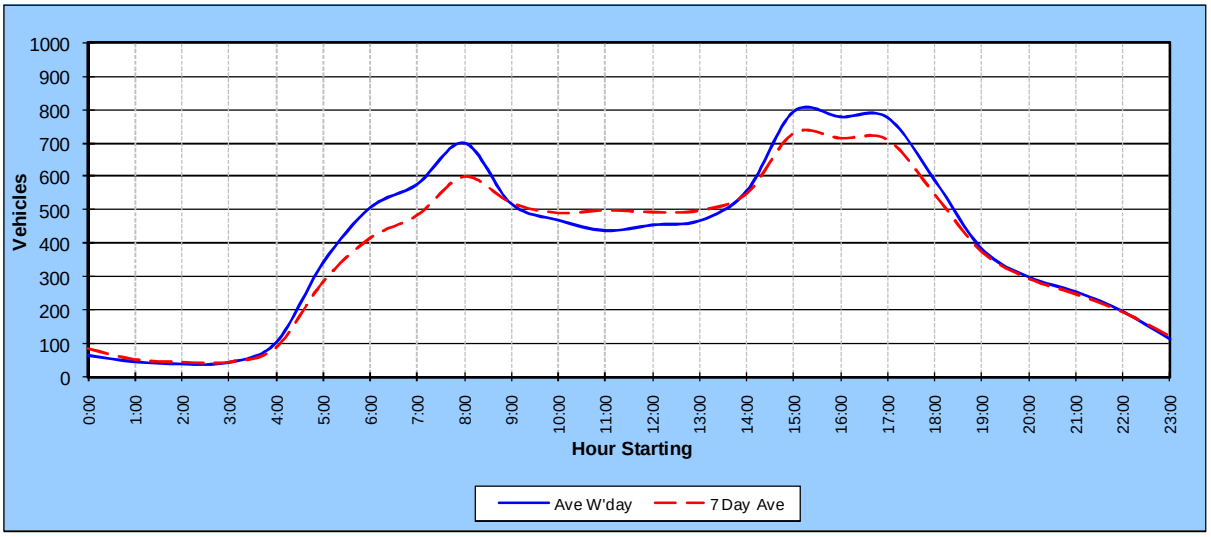
Source: AECOM, based on traffic data collected between 10/12/10 to 16/12/10

Figure 12 Daily traffic profile at Bringelly Road, east of King Street



Source: AECOM, based on traffic data collected between 10/12/10 to 16/12/10

Figure 13 Daily traffic profile at Bringelly Road, west of Camden Valley Way



Source: AECOM, based on traffic data collected between 10/12/10 to 16/12/10

2.8.6 Freight transport

Bringelly Road is classified as a B-double route between Leppington and Bringelly. Classified mid-block automatic traffic count (ATC) surveys were undertaken in December 2010 to determine heavy vehicle proportions on Bringelly Road. **Table 8** shows the proportion of heavy vehicles during typical weekday and weekend periods, illustrating the importance of Bringelly Road as a road freight route.

Heavy vehicle volumes and proportions are higher on weekdays than the weekend. In addition, heavy vehicle volumes are greater at the eastern end of the project area on Bringelly Road compared to the western end, although the proportion of heavy vehicles at the western end is larger, due to a lower amount of total traffic surveyed.

Table 8 2010 freight traffic volume summary

Location on Bringelly Road	Average weekday traffic (AWT)			Average daily traffic (ADT)		
	All vehicles	Heavy vehicles	% heavy vehicles	All vehicles	Heavy vehicles	% heavy vehicles
Bringelly Road, east of The Northern Road	6,030	760	12.6%	5,690	620	10.9%
Bringelly Road, east of King Street	9,130	1,000	10.9%	8,540	830	9.7%
Bringelly Road, west of Camden Valley Way	9,520	1,010	10.6%	9,090	840	9.2%

Source: AECOM, based on traffic data collected by the RTA between 10/12/10 to 16/12/10

2.9 Operational assessment

2.9.1 Mid-block capacity

The peak hour directional traffic flow at each of the three surveyed location are summarised in **Table 9**. Volume capacity ratios (V/C) for the peak direction traffic volumes have also been calculated assuming a capacity of 1,200 vehicles per lane per hour.

Table 9 2010 mid-block peak hour traffic flows and capacity

Location of Bringelly Road	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	Peak direction flow (Eastbound)	Volume capacity ratio	Peak direction flow (Westbound)	Volume capacity ratio
Immediately east of The Northern Road	270	0.23	320	0.27
Immediately east of King Street	410	0.34	500	0.42
Immediately west of Camden Valley Way	430	0.36	490	0.41

Source: AECOM, based on traffic data collected by RTA between 10/12/10 to 16/12/10

The results of the analysis suggest that current traffic flows on Bringelly Road are relatively low and there is reserve capacity on the corridor. However, the actual capacity of the road is reduced due to lack of overtaking opportunities.

2.9.2 Intersection performance

AECOM has undertaken intersection modelling using SIDRA Intersection 5.0 (SIDRA) with details of the geometry of the key intersections and the average peak hour traffic data collected in 2010. All 16 intersections as shown in **Figure 5** have been assessed in SIDRA.

SIDRA output data used in this study includes:

- Degree of Saturation (DoS) – a measure of the ratio between traffic volumes and capacity of the intersection.
- Level of Service (LoS) – a measure of the overall performance of the intersection.
- Average Delay – the average time in seconds that vehicles wait at the intersection.

The Level of Service is a six-point scale (A to F) measuring the extent of delay, as shown in **Table 10**.

Table 10 Level of Service Indication Table

Level of Service	Average delay per vehicle (seconds/veh)	Description
A	< 14	Good operation
B	15 – 28	Good with acceptable delay
C	29 – 42	Satisfactory
D	43 – 56	Operating near capacity
E	57 – 70	At capacity; at signals, incidents will cause excessive delays
F	> 70	Extra capacity required

Source: RTA Traffic Generating Development Guide, 2002

Table 11 and **Table 12** summarise the performance of all intersections along Bringelly Road. The analysis was undertaken based on the average peak hour flows during a typical weekday. The average peak hour intersection traffic volumes for all the intersections along Bringelly Road are presented in **Appendix A**.

For the purposes of this study, the SIDRA analysis has assumed no overtaking opportunities exist along Bringelly Road, as it currently is a two-lane, two-way road. It is assumed vehicles will not drive onto the road shoulder to overtake any turning vehicles on Bringelly Road.

All the intersections within the study area currently operate at a satisfactory level of service (LoS C or better) during the peak hours. All the priority intersections are currently operating at LoS A, minimal intersection delays and queueing on all approaches during peak hours.

The intersection of Bringelly Road / The Northern Road are currently used by much more traffic than other intersections along Bringelly Road. This intersection still operates at satisfactory level of service with acceptable intersection delays. However, queue lengths extend over 100m at some approaches to this intersection during the peak hours.

Table 11 Intersection performance along Bringelly Road (AM peak hour)

Intersections (with Bringelly Road)	Intersection traffic volumes (veh/hr)	Intersection Level of Service (LoS)	Degree of saturation (DoS)	Average intersection delays (sec)	95% Back of Queue	
					Queue lengths (m)	Worst queueing approach
The Northern Road (traffic signals)	1,377	B	0.83	24.8	135	The Northern Road (South)
Kelvin Park Drive (priority)	487	A	0.12	2.4	5	Bringelly Road (East)
Jersey Road (priority)	603	A	0.17	3.6	8	Bringelly Road (West)
Masterfield Street (priority)	612	A	0.21	2.5	12	Bringelly Road (West)
Church Street (priority)	637	A	0.22	1.8	8	Bringelly Road (East)
Allenby Road (priority)	724	A	0.23	3.9	14	Bringelly Road (West)
North Avenue (priority)	632	A	0.21	2.5	5	Bringelly Road (East)
Glen Allan Road (priority)	531	A	0.19	1.4	5	Bringelly Road (East)
King Street (priority)	647	A	0.19	3.0	7	Bringelly Road (East)
Kelly Street (priority)	650	A	0.21	1.7	8	Bringelly Road (East)
Eastwood Road (priority)	728	A	0.22	3.9	13	Bringelly Road (West)
Fourth Avenue (priority)	816	A	0.22	4.9	13	Bringelly Road (West)
Edmondson Avenue (priority)	813	A	0.22	4.3	14	Bringelly Road (East)
Browns Road (priority)	707	A	0.22	1.4	9	Bringelly Road (East)
Cowpasture Road (priority)	705	A	0.22	1.8	14	Bringelly Road (West)

Source: AECOM, 2011

Table 12 Intersection performance along Bringelly Road (PM peak hour)

Intersections (with Bringelly Road)	Intersection traffic volumes (veh/hr)	Intersection Level of Service (LoS)	Degree of saturation (DoS)	Average intersection delays (sec)	95% Back of Queue	
					Queue lengths (m)	Worst queueing approach
The Northern Road (traffic signals)	1,745	B	0.87	27	174	The Northern Road (North)
Kelvin Park Drive (priority)	679	A	0.20	2.5	12	Bringelly Road (East)
Jersey Road (priority)	844	A	0.28	3.7	10	Bringelly Road (West)
Masterfield Street (priority)	841	A	0.28	1.1	11	Bringelly Road (West)
Church Street (priority)	881	A	0.29	2.3	22	Bringelly Road (East)
Allenby Road (priority)	1016	A	0.31	5.1	16	Bringelly Road (West)
North Avenue (priority)	909	A	0.27	3.6	17	Bringelly Road (East)
Glen Allan Road (priority)	745	A	0.26	2.6	16	Bringelly Road (East)
King Street (priority)	899	A	0.29	3.2	18	Bringelly Road (East)
Kelly Street (priority)	873	A	0.28	2.1	21	Bringelly Road (East)
Eastwood Road (priority)	991	A	0.29	4.4	13	Bringelly Road (West)
Fourth Avenue (priority)	1,012	A	0.28	4.9	19	Bringelly Road (East)
Edmondson Avenue (priority)	1,052	A	0.29	5.4	19	Bringelly Road (East)
Browns Road (priority)	887	A	0.28	1.8	20	Bringelly Road (East)
Cowpasture Road (priority)	878	A	0.26	2.1	12	Bringelly Road (West)

Source: AECOM, 2011

2.9.3 Travel speed analysis

The posted speed limits for Bringelly Road vary between 60 and 80 km/h along the entire length of the corridor, except at school zones. Vehicle travel speeds along Bringelly Road have been estimated using the RTA traffic surveys commissioned in December 2010.The results of the travel speed analysis are presented in **Table 13**, which show average weekday vehicle travel speeds for eastbound and westbound movements respectively.

Table 13 2010 average weekday travel speeds

Location on Bringelly Road	Posted speed limit (km/h)	Average speed (km/h)		85th percentile speed (km/h)	
		Eastbound	Westbound	Eastbound	Westbound
Immediately east of The Northern Road	60	65.9	67	72	75
Immediately east of King Street	80	74.4	74.2	82	81
Immediately west of Camden Valley Way	70	74.2	69.1	82	77

Source: AECOM, based on traffic data collected by RTA between 10/12/10 to 16/12/10

The average speeds for both eastbound and westbound directions immediately east of The Northern Road are below 70 km/h. The marked decrease in speeds can be attributed to the posted 60 km/h speed limit for that area. The average speed at Bringelly Road near King Street is below the 80 km/h posted speed limit. However, the average speed at the eastern end of Bringelly Road is above the 70 km/h speed limit, lowered due to the topography and geometry of the road network.

The 85th percentile speeds collected at all sites are higher than the posted speed limits at the relevant locations at Bringelly Road.

2.10 Crash analysis

2.10.1 Historical crash data

A historical crash analysis has been undertaken using historical crash data provided by the RTA for a five year period from 2004–2008. Between 2004 and 2008, a total of 130 crashes have been recorded, including three crashes involving fatalities and 66 injury-related crashes. **Table 14** shows the crash statistics for this period along Bringelly Road. **Table 15** summarises annual crash incidents by casualty from 2004 to 2008.

Table 14 Crash statistics for Bringelly Road project upgrade area, 2004–2008

Section from	Section to	Section length (km)	Total crashes	Fatal crashes	Injury crashes	Non-casualty crashes
The Northern Road	Camden Valley Way	10 km	130	3	66	61

Source: AECOM, based on RTA Crash Report 2004-2008

Table 15 Historical timeline of crashes by casualty 2004–2008

	2004	2005	2006	2007	2008
Crashes	37	24	18	23	28
Casualties (including fatalities)	30	26	15	17	22

Source: AECOM, based on RTA Crash Report 2004-2008

The number of crashes that occurred along Bringelly Road between The Northern Road and Camden Valley Way has dropped by 50 per cent from 2004 to 2006, but has increased gradually since 2006 to 2008. The same trend is observed for the number of causalities involved in all the accidents. Of the 130 recorded crashes, there were 110 casualties including seven fatalities and 103 injuries.

2.10.2 Crash severity index

Crash severity indices provide an assessment of road safety based on the type and number of crashes occurring on a route. Fatal, injury and tow-away crashes carry different weightings, with traffic volumes excluded from the calculation. The following formula was used to calculate the index:

*Severity Index = [(Number of fatal crashes * 3.0) + (Number of injury crashes * 1.5) + (Number of non-injury crashes)] / Total number of crashes*

The average crash severity index along the length of the proposal area is 1.50. By comparison the severity index across NSW from 2001–2005 was 1.23, indicating Bringelly Road currently has a higher than average proportion of fatal and injury crashes than the rest of NSW.

2.10.3 Crash rates

Crash rates per 100 million vehicle kilometres (100MVKM) are shown in **Table 16**. These crash rates are calculated in relation to the volume of traffic and distance travelled along a route, therefore offering a measure of risk per kilometre travelled. The formula used to calculate a crash rate per 100 million vehicles is shown below:

*Crash rate per 100 MVKM = Number of crashes * 100,000,000 / (Number of years * 365 * length (km) * AADT)*

For the purposes of this assessment, ADT flows have supplemented AADT flows with the latest traffic data.

Based on the latest data, the Bringelly Road average crash rate is 78.4 per 100 million vehicle kilometres (MVKM) travelled in the proposal project area. The latest available RTA data[2] shows an average crash rate of 110 per 100MVKM for urban undivided road (less than 4 lanes) and 35 per 100MVKM for rural undivided road.

Table 16 Crash rates per 100 MVKM for Bringelly Road in proposal area (2010)

Section from	Section to	Section length (km)	2010 ADT (vehicle)	Crash rate per 100MVKM			
				All	Fatal	Injury	Tow-way
The Northern Road	Camden Valley Way	10 km	9,090	78.4	1.8	39.8	36.8

Source: AECOM, based on RTA Crash Report 2004-2008

The crash analysis also noted that:

- Approximately 60 per cent of crashes occurred within 10m of an intersection.
- Over 93 per cent of crashes (121 crashes) were car crashes, four per cent were motorcycle crashes (five crashes), and 12 per cent of crashes were heavy vehicle crashes (15 crashes).
- The two main manoeuvre types of crashes were rear-end and intersection / adjacent approaches with approximately 24.6 per cent and 23.8 per cent respectively.
- Approximately 77 per cent of crashes involved more than one vehicle.
- Approximately 75 per cent of crashes occurred on a weekday.
- Over 70 per cent of crashes occurred in fine and dry weather conditions.
- Of the 26 crashes where the contributing factor was known, 18 crashes were attributed to speeding.
- Approximately 62 per cent of crashes occurred in daylight and 31 per cent occurred in darkness.
- The evening time periods which experienced the highest number of crashes were 16:00–16:59 and 17:00–17:59 with 10 and 11 recorded crashes respectively. The night time periods which experienced the highest number of crashes were 20:00-21:59 and 22:00–24:00 with 11 and 12 recorded crashes respectively.

A crash summary report is included in **Appendix B** showing detailed breakdown of crashes by types, timing and other contributing factors.

[2] NSW speed zoning guidelines, 2009

3.0 Traffic modelling

Traffic models are an important step in the transportation planning process because decisions and investments are often influenced by predicted travel demand. Models are used to estimate the number of trips that would be made on a transportation system at a future date as a result of change in supply (for example, the introduction of a new or upgraded highway scheme) or a change in travel demand (for instance, the impact of a local development).

However, traffic models will only provide forecasts for those factors that are explicitly accounted for in the modelling approach. For instance, traffic models generally exclude pedestrian and bicycle trips, expressing demand only as vehicular traffic, and cannot therefore be used to assess a bicycle improvement scheme. It is critical that model assumptions, simplifications and limitations are understood before a modelling exercise is entered into.

It is important to recognise that models are underpinned by a series of assumptions and are limited by data availability.

3.1 CUBE model

AECOM maintains and develops a Sydney Strategic Model (the model) which has been used to provide traffic forecasts on key roads on the network. The model uses the software package CUBE (version 5.1.2), which covers all facets of transportation modelling.

The model can provide traffic volumes on all major links in the Sydney Metropolitan Area road network. The traffic model developed for the project is a strategic, link-based model reflecting all-vehicle demand for an average peak hour. **Figure 14** outlines the coverage of the model, as well as the screenlines to which the model is calibrated against. These screenline definitions broadly align with published RTA screenlines across the Sydney road network. Screenline counts are sourced from RTA permanent and sample sites for 2008, with supplementary counts sourced or estimated by AECOM to complete screenlines.

AECOM has used this model to provide traffic forecasts in both South West and North West Growth Centres, including Oran Park and Turner Road, and Austral and Leppington North. As such, considerable past effort has been invested in the model, ensuring the veracity of network coding, and land use assumptions in the vicinity of the Bringelly Road corridor.

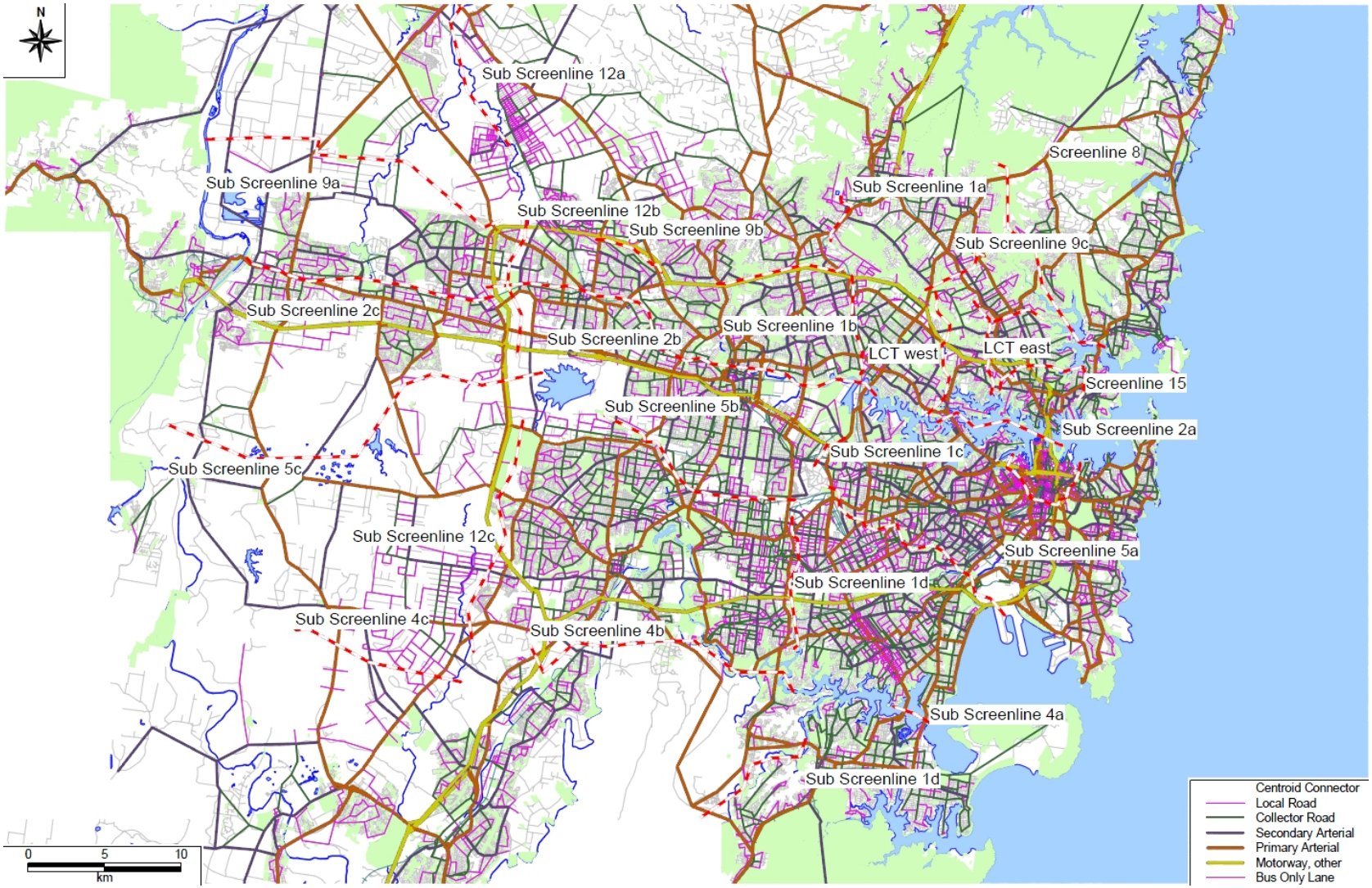
3.1.1 Road network

The highway network in the model represents the Sydney road network in 2008 (with more updated refinements in the local study area). The model network is defined based on the road hierarchy classification described below:

- Zone centroid connector - a special link which does not physically exist but is used in modelling as zone loading points for the travel demand
- Residential street - eg Parklands Ave, Lane Cove
- Collector road - eg Herring St, Macquarie Park
- Secondary arterial - eg Deepfields Road, Catherine Fields
- Primary arterial - eg Bringelly Road
- Freeway - eg F5 Freeway
- Toll road and motorways - eg the Westlink M7 Motorway

Link characteristics (capacity, free flow speed) for each link in the network are coded based on the position of the link in the road hierarchy.

Figure 14 AECOM Sydney Strategic Model Coverage and Location of Screenlines



Source: AECOM, 2010

3.1.2 Travel demand and zoning system

Trip matrices describe the number of trips travelling between pairs of zones, where the zones represent reasonably homogenous areas generally delineated by physical features such as roads, railways and rivers. The model zoning system is based on the standard Bureau of Transport Statistics (BTS) TZ06 zone system with demand associated with areas beyond the geographic extent of the model represented by external zones.

The matrix for the AM average peak includes:

- The peak period journey to work travel demands.
- Travel demands in the peak period for other purposes.
- Commercial vehicle travel demands.

These demands have been aggregated into an all vehicle demand and are represented in the model as PCU demand (passenger car unit equivalent) to account for the fact that larger vehicles, such as trucks and buses, take up more road space and are slower to accelerate and reduce road capacity.

3.1.3 Model Assignment Procedure

Assignment is the process whereby the trip matrices are loaded onto the network (via centroid connectors) and are distributed across the network to provide model flows on all links. The assignment process forms two basic functions:

- Building paths (or routes) between all pairs of origin and destination zones.
- Assigning (or loading) trips from the matrix onto the network, using the previously calculated paths.

An iterative all-or-nothing path building process determines routing through the network. At the start of an iteration, minimum cost of travel between each origin and destination are calculated. Capacity restraint is adopted using the volume averaging loading process to create multiple paths and a balanced (converged) model in terms of assigned flows and travel costs between successive iterations of the assignment process.

In the path building process, cost of travel is determined as a combination of time, distance and toll costs. The AECOM Toll Model is used with regards to toll cost to better reflect individual driver behaviour and willingness to pay. The AECOM Toll Model has been developed over numerous toll road projects in Sydney, as well as other cities within Australia and overseas.

Travel time in the network is defined using link based, speed-flow curves which represent composite link and junction capacity and delay. Speed-flow curves describe the performance of the road link in terms of link traffic speed and time, reflecting the fact that speed reduces as a result of increased traffic and increased congestion on a link. Model calibration ensures that the appropriate speed-flow curves are applied to different road links.

A generic automated approach has also been adopted that considers hierarchy of junction/link type, number of arms, conflicting movements and the geometry of the junction to generate an assumed turn capacity. This combined with assigned turning volumes at each iteration is used to estimate individual turn delays as part of the general assignment process.

3.1.4 Model Summary

The key aspects of the CUBE model are listed below:

- The model covers the whole of the Sydney Metropolitan region.
- The model defines all the main road links in the Sydney road system in terms of length, capacity and a speed/flow relationship.
- The travel demand on the network is represented as an all-vehicle PCU matrix.
- The model uses a distributed value of time to convert all tolls into generalised cost.
- Model assignment and redistribution of traffic results from changes in utility (generalised cost) as a consequence of new road schemes. This utility takes into account changes in time, distance, speed/flow relationships and toll cost.

3.2 Base year model development

3.2.1 Derivation of base year traffic patterns

As part of the Bringelly Road study, the first stage in the modelling process was to collect up-to-date weekly traffic count data for the following three key locations along the Bringelly Road corridor:

- Immediately east of The Northern Road
- Immediately east of King Street
- Immediately west of Camden Valley Way.

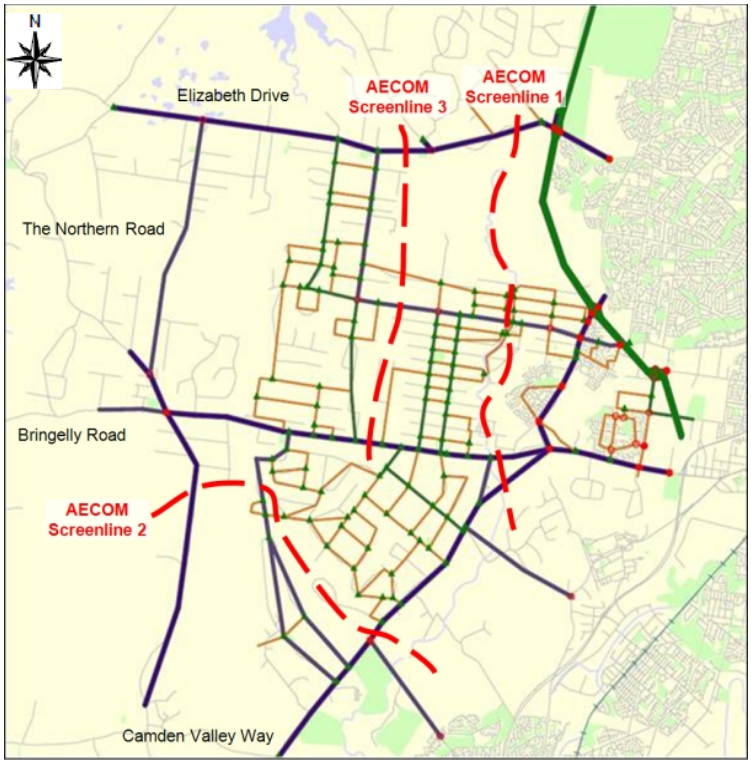
Average peak hour intersection counts were also collected at 16 intersections along Bringelly Road between The Northern Road and Camden Valley Way. **Section 2.7.2** provides details of the traffic data collected at each location along Bringelly Road. These data were used to further refine the traffic volumes and patterns along Bringelly Road in the base year model.

3.2.2 Base year model calibration

To build confidence in the model and ensure robust and reliable future year traffic forecasts are produced, the base year model was calibrated to the AM peak hour traffic volumes at key screenline locations in Sydney-wide network as well as the project specified screenlines. Model calibration is an essential stage in the modelling process to demonstrate that the modelled network reasonably reflects existing traffic conditions across the corresponding road network, particularly on Bringelly Road and other competing traffic corridors such as Fifteenth Avenue and Elizabeth Drive as well as other road network with the same hierarchy (Principal Arterials) such as Camden Valley Way and The Northern Road.

These screenline definitions broadly align with published RTA screenlines across the Sydney road network and are shown in **Figure 14**. Additional project specific screenlines within the study area have also been assessed; these are shown in **Figure 15**.

Figure 15 Location of project specific screenlines



Source: AECOM, 2010

For each screenline location, the model calibration process included a comparison of observed against modelled traffic flows and calculating the GEH value, which is a commonly used performance measure based on a chi-squared statistic as shown below.

$$GEH = \sqrt{\frac{2(M-C)^2}{M+C}}$$

where M is the modelled flow and C is the observed flow.

An acceptable level of calibration is that all (or nearly all) screenline totals are within five per cent of observed flows and have a GEH < 5.

Table 17 provides details of the base year model calibration results for grouped screenlines by direction of travel. The table shows that the base year model is calibrated as nearly all of the screenline totals are within five per cent of observed flows and have a GEH < 5, with only Screenline 12 falling just short of the desired range for the two calibration measures.

Screenline 12 crosses both the M4 and M7 Motorways where no observed count data is available. To create complete screenlines, estimates have been used for these locations, but consequently, the confidence in the screenline overall is reduced. As such, the inability of Screenline 12 to match the two calibration measures does not impede in concluding that the model overall has reached an acceptable level of calibration.

Of the three project specific screenlines, they match well with all screenlines having a GEH < 5.

The calibration results for each individual screenline by direction of travel is summarised in **Appendix C**.

The CUBE model is developed not only to provide traffic forecasts for Bringelly Road, but also to provide turning movements at all major intersections along Bringelly Road to guide the design of intersection layout at these locations. Therefore, it is critical that the base model would accurately reflect the existing turning movements along Bringelly Road.

In order to ensure that the base model turning movements are calibrated, turning flows were extracted from the model that was calibrated at the screenline level and compared to 2010 surveyed turning movements. Select link analysis was undertaken for a small number of modelled turning movements which were identified to be significant different from the surveyed data. These traffic demands were then factored up / down to match with the surveyed turning flows. The calibration summary of all the turning movements at Bringelly Road is provided in **Appendix C**.

In general, the peak hour modelled turning volumes closely matched with the observed turning flows, except the model estimated higher traffic volumes on the eastern section of Bringelly Road in the peak traffic direction when compared to the observed traffic flows. This is attributed to lower surveyed traffic volumes in December (when private schools and universities are on holidays).

Table 17 Screenline calibration summary

Screenline	Direction	Observed (veh/hr)	Modelled (veh/hr)	Difference	GEH	% Difference
1. Berowra to Sutherland	Inbound	41,289	41,198	-91	0.4	-0.2%
	Outbound	29,537	29,778	241	1.4	0.8%
2. Sydney Harbour to Penrith	Inbound	48,716	48,441	-275	1.2	-0.6%
	Outbound	40,707	40,397	-311	1.5	-0.8%
4. Taren Point to Bringelly	Inbound	20,357	20,269	-89	0.6	-0.4%
	Outbound	10,888	10,526	-363	3.5	-3.3%
5. Kogarah to Wallacia	Inbound	50,541	50,628	87	0.4	-0.2%
	Outbound	30,471	29,861	-610	3.5	-2.0%
8. Pittwater to Manly	Inbound	9,538	9,600	62	0.6	0.6%
	Outbound	5,865	5,876	11	0.1	0.2%
9. Castlereagh to St Ives	Inbound	29,407	29,414	8	0.0	0.0%
	Outbound	17,930	17,849	-81	0.6	-0.5%
12. Campbelltown to Windsor	Inbound	20,087	19,354	-733	5.2	-3.6%
	Outbound	15,051	14,146	-905	7.5	-6.0%
15. Lane Cove to North Shore	Inbound	18,332	17,813	-520	3.9	-2.8%
	Outbound	12,216	11,895	-321	2.9	-2.6%
16. West and South of the CBD	Inbound	19,497	19,828	330	2.4	1.7%
	Outbound	14,163	13,824	-340	2.9	-2.4%
AECOM Screenline 1	Inbound	3,080	2,885	-195	3.6	-6.3%
	Outbound	1,417	1,267	-150	4.1	-10.6%
AECOM Screenline 2	Inbound	2,125	2,025	-100	2.2	-4.7%
	Outbound	1,129	1,040	-89	2.7	-7.8%
AECOM Screenline 3	Inbound	1,495	1,668	173	4.4	11.6%
	Outbound	728	811	83	3.0	11.4%

Source: AECOM, 2010

3.3 Future year model development

The land use in the SWGC and Western Sydney is expected to change dramatically in the next 30 years, which will have a subsequent impact on the future demand for travel.

This section summarises the expected growth in the SWGC and the subregion, the potential increase in traffic and public transport demand as well as the planned provision of transport services and infrastructure upgrades to cater for these future developments. These changes in land use and infrastructure upgrades will be accounted for in the future year traffic models.

3.3.1 Future year land use assumptions

The Metropolitan Plan for Sydney 2036 (NSW Government, 2010) identified a need to plan for 770,000 new homes in Sydney between 2006 and 2036, with up to 170,000 of these in new release areas, including approximately 83,000 dwellings in the SWGC.

The Sydney metropolitan region is divided into 10 Subregions for strategic planning purposes. The South West Subregion covers Liverpool, Campbelltown, Camden and Wollondilly local government areas (LGAs) and includes the SWGC. The relationship between the South West Subregion and the SWGC are shown in **Figure 16**.

The SWGC comprises 18 precincts, which include approximately 17,000 hectares of land and a planned capacity of 110,000 new dwellings or approximately 300,000 people. The location of latest released precincts in the context of the SWGC is shown in **Figure 17**. Over 50% of the future residential dwelling supply estimated in the South West Subregion will be provided in the SWGC. Other growth areas are scattered throughout Camden, Campbelltown, Liverpool and Wollondilly LGAs.

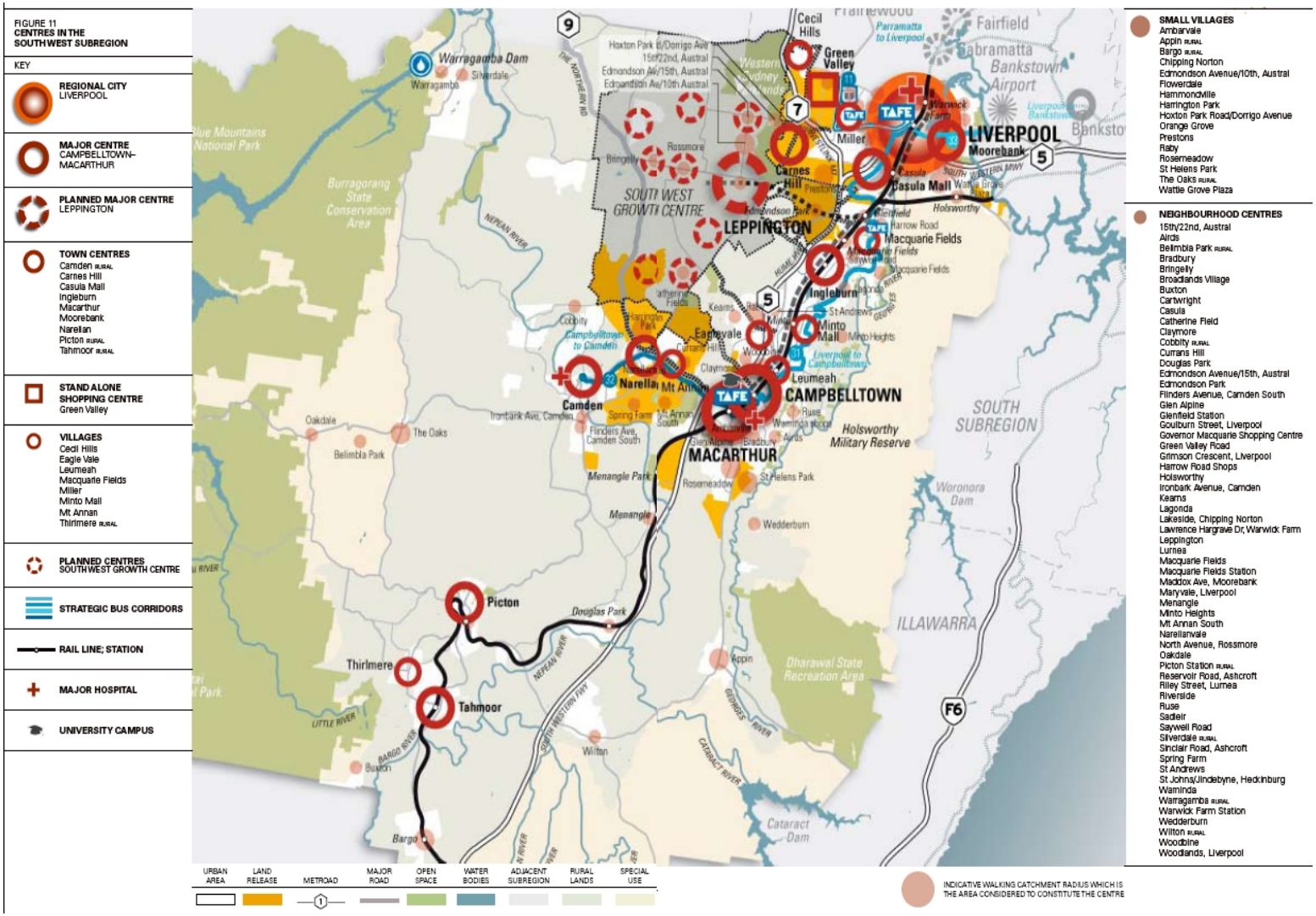
Five precincts in the SWGC have been released for development. The remaining 13 precincts will be progressively released for precinct planning. The Department of Planning and Infrastructure has supplied to AECOM forecast dwelling numbers for every five years between 2011 and 2036 for each of the precincts inside the SWGC as shown in **Table 18**.

Table 18 Cumulative Dwelling Occupation by Precinct in the Growth Centres to 2036

Precincts	2011	2016	2021	2026	2031	2036
South West Rezoned Precincts						
Edmondson Park	415	2,615	6,315	7,600	7,600	7,600
Oran Park	565	3,115	6,015	8,515	8,786	8,786
Turner Road	500	2,250	4,150	4,991	4,991	4,991
South West Released Precincts						
Austral	-	900	2,800	4,800	6,500	6,751
Leppington North	-	1,050	4,050	6,550	7,314	7,314
South West Future Release Precincts						
The Northern Road Corridor	-	750	4,400	10,100	14,473	14,663
Camden Valley Way Corridor	-	-	2,550	11,750	21,468	27,519
Bringelly Road / Elizabeth Drive Corridor	-	-	-	100	3,800	15,917

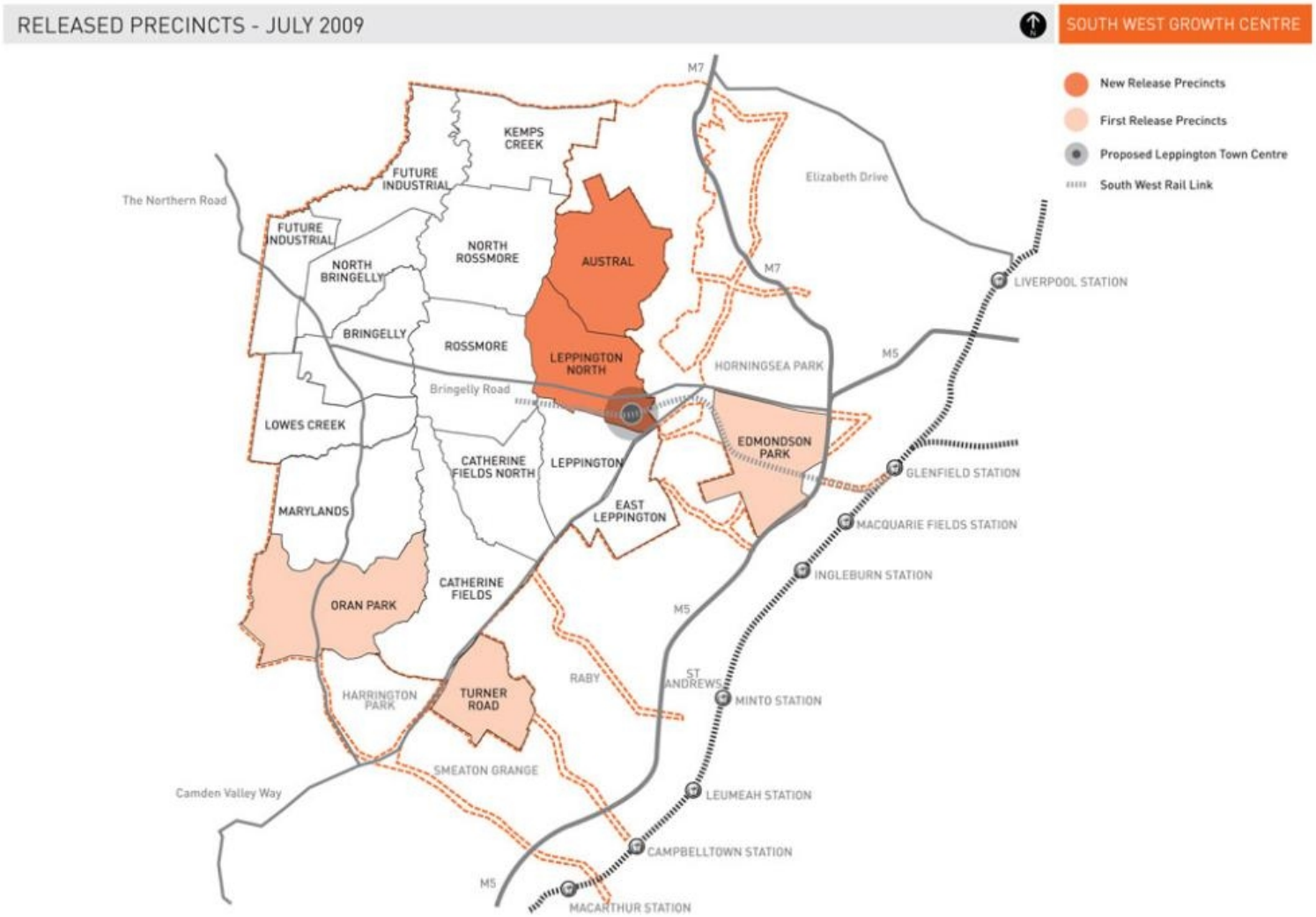
Source: Department of Planning and Infrastructure, August 2010

Figure 16 Context of south west subregion and SWGC



Source: Department of Planning and Infrastructure, South West Subregional Strategy, 2007

Figure 17 South West Growth Centre - released precincts



Source: Department of Planning and Infrastrcture, July 2010

The intention for the South West Subregion is to at least maintain, or, increase, the level of self containment to reduce the number of additional trips outside the subregion. Therefore, the delivery of proposed employment targets in major centres near the SWGC and within the subregion will assist in achieving this policy objective.

The major employment centres and additional jobs forecast in the South West Subregion and the SWGC are described in **Table 19**. Through both new development and the intensification of existing activities a rapidly growing population will be serviced, and a range of regionally important activities accommodated such as manufacturing, logistics, warehousing, high-technology industry and business park uses.

Table 19 Major centres and forecast employment in the south west subregion

Centre	Centre Type	2036 Long Term Employment Capacity Target	2006-2036 Employment Growth
Liverpool	Regional City	31,000	+15,000
Campbelltown-Macarthur	Major Centre	25,000	+11,000
Leppington	Planned Major Centre	13,000	+13,000
Total		69,000	+39,000

Source: Metropolitan Plan for Sydney 2036, December 2010

The Department of Planning and Infrastructure is currently preparing a master plan for the Leppington Town Centre and the town centre is expected to deliver a wide range of land uses to meet its long-term employment target of 13,000. The indicative scale and proposed land use of the proposed Leppington Town Centre is shown in **Figure 18**.

Bringelly Road will provide one of the main arterial road accesses to the proposed Leppington Town Centre over a distance of approximately 4km between Byron Road and Eastwood Road. The Town Centre is also anticipated to extend to Fifth Avenue to the north and Ingleburn Road to the south. Signalisation of intersections at regular intervals along Bringelly Road in the vicinity of Town Centre will be required to ensure good vehicular accessibility to the Town Centre as well as safe pedestrian movements across Bringelly Road.

The proposed residential and employment growth in the South West Subregion and the SWGC will put pressure on the existing road and transport infrastructure / network that are fast approaching capacity, especially during the peak hours. Extra road network capacity and new public transport services will be needed to move people within and out of the subregion efficiently.

Pressure will continue to build on Bringelly Road as the major east-west connection in the SWGC between Camden Valley Way / M7 and the Northern Road to cater initially for traffic growth generated by Oran Park and Turner Road Precinct to the south of the SWGC and then progressively from the development of precincts located immediately north and south of Bringelly Road as well as Leppington Town Centre. The rate of release of these developments will have a significant impact on the timing of road improvements.

Travel demand scenarios for Bringelly Road traffic modelling purposes are based on the development profile for the SWGC that is shown in **Table 18**.

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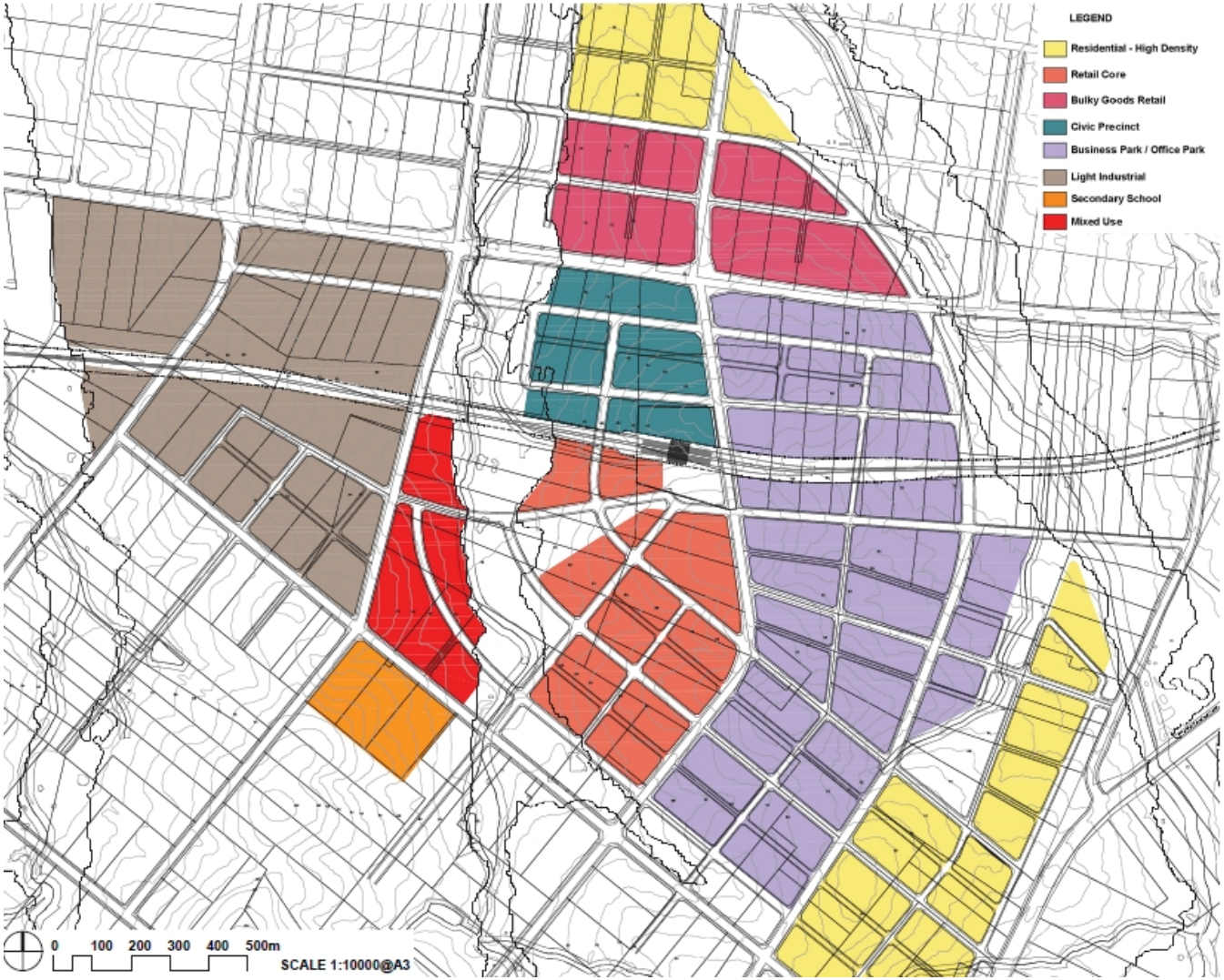
Figure 18 Proposed land uses of Leppington Town Centre (Draft)



Source: Department of Planning and Infrastrcture, December 2010

3.3.2 Public transport assumptions

In addition to employment self-containment, maximising public transport use (and walking and cycling) for commuting and other trips in the SWGC is a central objective of both land use and transport planning activities in order to achieve sustainable growth of the area.

Precinct planning for release areas along Bringelly Road will ensure the provision of appropriate direct links for buses, pedestrians and cyclists onto the Principal Arterial, enabling non-car trips both directly to adjacent suburbs and to connect with regional public transport services. Concept planning and design for Bringelly Road itself will address the need for supporting infrastructure such as a parallel cycleway, and bus priority measures that enable the establishment of good bus service connections to employment and/or rail interchange nodes including Leppington, Liverpool, Campbelltown and Camden and connection to the open space network.

The following sections highlight the key public transport infrastructure and services proposed in the SWGC including the South West Rail Link and the South West Sector Bus Servicing Plan.

3.3.2.1 South West Rail Link

In 2009, the NSW Government announced the construction of a new 11 kilometre rail line – South West Rail Link (SWRL) from Glenfield to Leppington in South West Sydney. The project includes two new stations at Edmondson Park and Leppington. The delivery of the two new stations includes bus interchanges, pedestrian and cyclist facilities as well as kiss and ride zones and commuter car parking. Construction of the SWRL will commence in 2011 and be due for completion in 2016. A map of the SWRL project is shown in **Figure 19**.

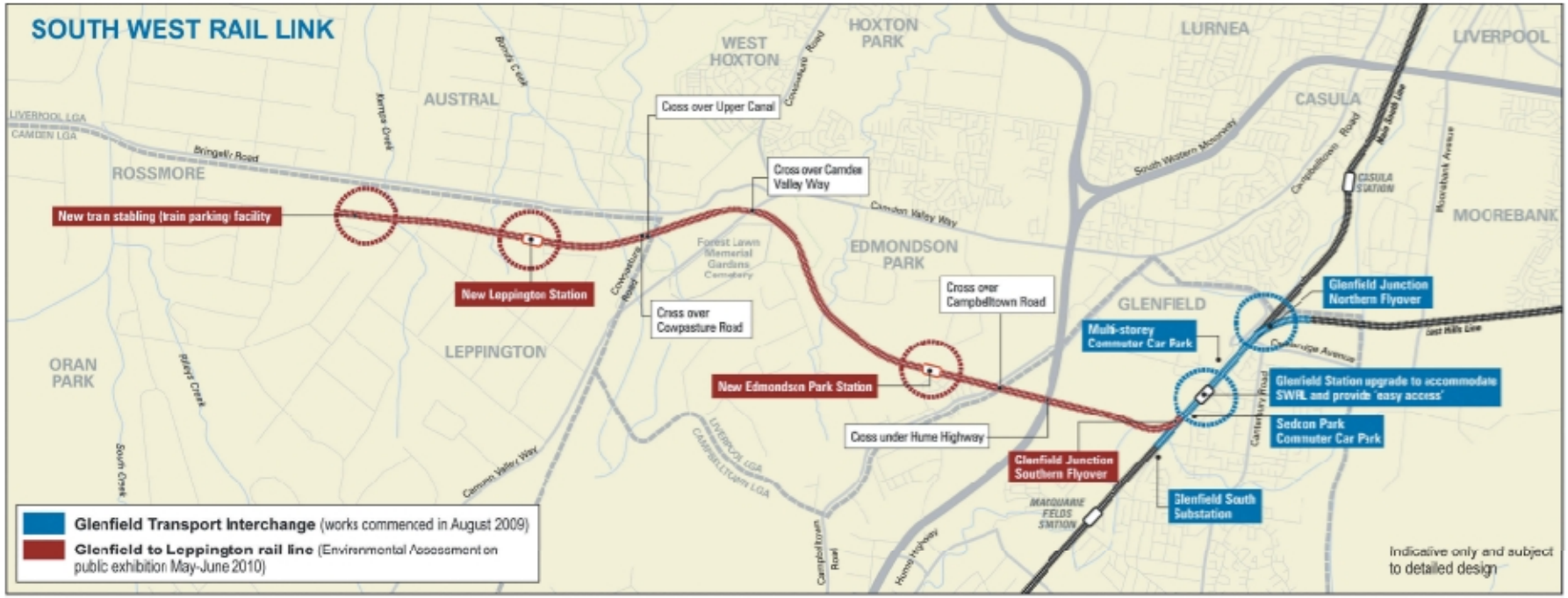
The SWRL will offer a heavy rail transport option for the future residents of SWGC by providing frequent train services to Glenfield and the rest of the CityRail network. The SWRL will provide two new stations at Leppington and Edmondson Park, which provide a major opportunity for transit-oriented and sustainable development servicing the new communities and the broader SWGC.

RailCorp proposes an initial four services per hour throughout the day with up to 12 trains per hour in peak periods (subject to change as a result of detailed design and/or the ability to meet future standards). Furthermore, the frequency of service is likely to be increased over time as demand increases and service provision is influenced by patronage demand as well operating requirements of the network. Options for a potential future extension of the project beyond Rossmore have been investigated by the NSW Government.

It is expected that Bringelly Road will be the main access arterial road to the station due to the proximity of Leppington Station and its interchange. This will require the signalisation of intersections in the vicinity of the station to provide safe access for commuters.

As part of the construction of SWRL and Leppington Station, a total of 800 commuter car parking spaces and bus stops will be provided on both sides of the station on day of opening of services. The main vehicular access to the station interchange will be provided via Rickard Road initially and additional access to the interchange will be provided via Dickson Road as the Town Centre develops. The planning of Bringelly Road upgrade will need to consider and ensure that accessibility to the station and its interchange via all modes of transport is maximised.

Figure 19 Proposed South West Rail Link



Source: Transport Construction Authority, July 2010

3.3.2.2 South west sector bus servicing plan

The Ministry of Transport (now Department of Transport) has prepared the South West Sector Bus Servicing Plan (AECOM, 2009) that provides a long-term bus servicing strategy to cater for the future urban growth in the SWGC. This strategy is developed for three phases:

- Design of a long-term (2030+) integrated bus network (for implementation upon full development of the SWGC).
- Design of a short-term (< 5 years) bus network.
- Prioritisation of intermediate bus networks together with an appropriate land release strategy to achieve easy implementation of the long-term bus network.

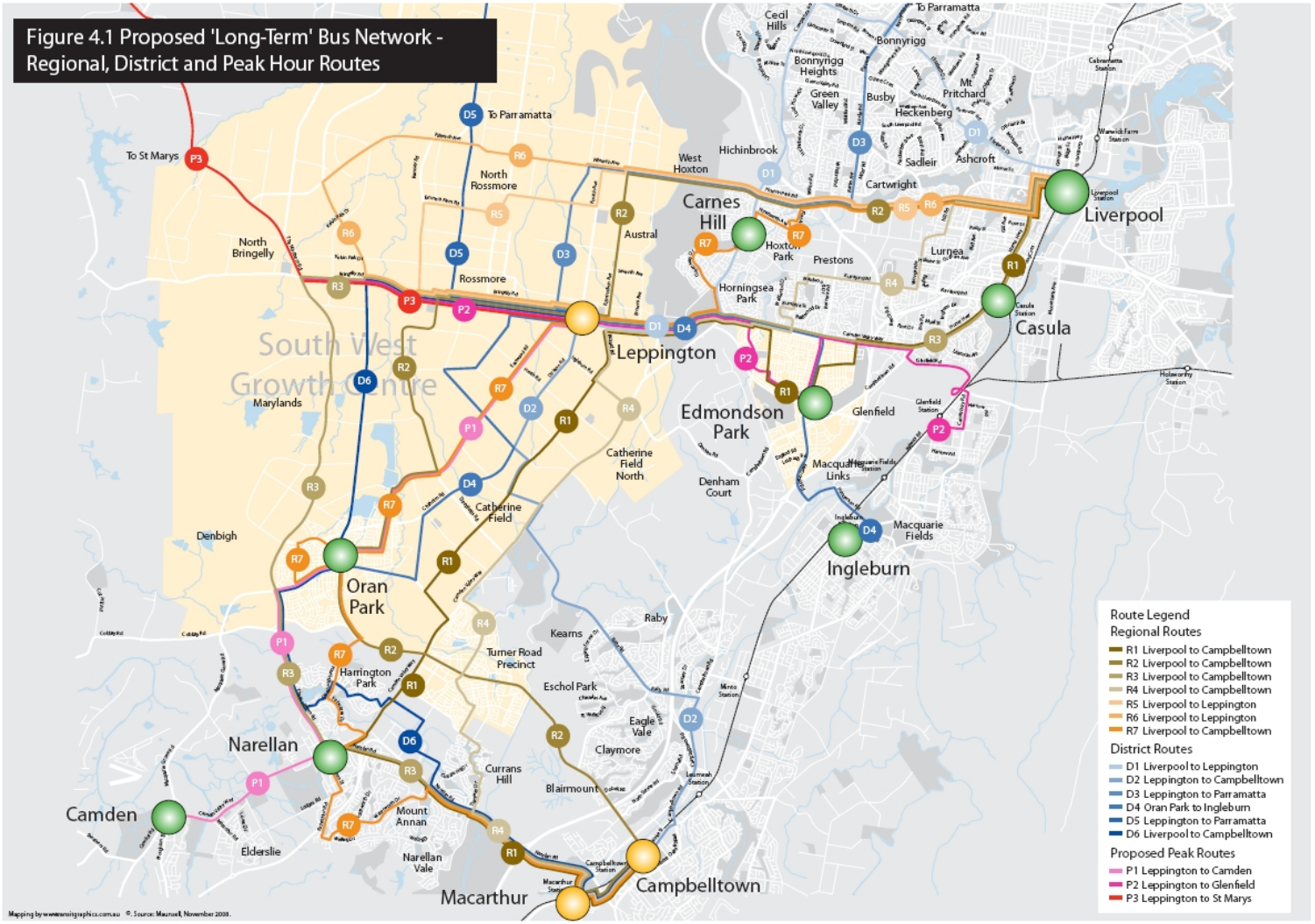
The aim of the strategy is to ensure that new residents moving into the area have a travel choice that includes public transport and that the orderly staging of precinct releases is consistent from a public transport efficiency perspective. The study focuses on the SWGC but also gives consideration to suburbs and centres which are located adjacent and beyond in order to ensure integration of the bus networks within the wider South Western Sydney area.

The 'long-term' bus network proposal consists of seven regional, six district and three peak hour only bus routes to provide a network that links the proposed major centres (Liverpool, Campbelltown, Parramatta, Oran Park and Leppington) and supports accessibility to each of the SWGC precincts. The 'long-term' bus network plan is shown in **Figure 20**.

The South West Sector Bus Servicing Plan provides a guide to the potential bus networks that would be operating along Bringelly Road. As the bus network rolls out over the next 30 years, Bringelly Road will be envisaged as the most significant east-west bus corridor as the majority of proposed bus routes will be travelling on sections of Bringelly Road connecting Campbelltown, Oran Park, Leppington and Liverpool. Given its significance as a bus corridor, some form of bus priority measures along its entire length should be planned for during the development of the corridor to cater for the increasing number of buses and shorter travel times for buses, with a particular focus into Leppington Town Centre and Station.

The likely peak hour headway will be 30 minutes for District Bus Routes and 15 minutes for Regional and Peak Bus Routes. There will be 26 planned bus routes serving Leppington Station in the long-term, with a peak hour bus flow of approximately 80 to 90 buses to Leppington Station via Bringelly Road.

Figure 20 Long-term' South west sector bus servicing plan



Source: AECOM, 2009

3.3.3 Future Road Network Upgrades

The RTA has prepared a draft Road Network Strategy for the SWGC in order to enable greater certainty in planning, design and construction of the future regional road network in the SWGC and to cater for the future expected increase in population and employment growth in the region. The draft Road Network Strategy is shown in **Figure 21**.

The objective of the strategy is to establish a strategic level of integrated land use and road planning for the area. The focus is to ensure that the wider (proposed) SWGC road network coordinates with the existing State Road Network (in particular Camden Valley Way, Bringelly Road and The Northern Road) in a way that maintains the efficient performance of the arterial roads whilst promoting the development of communities with a legible, high quality, built environment and public domain. This will facilitate and enhance the growth of active, vibrant and safe centres which are convenient to access across multiple transport modes.

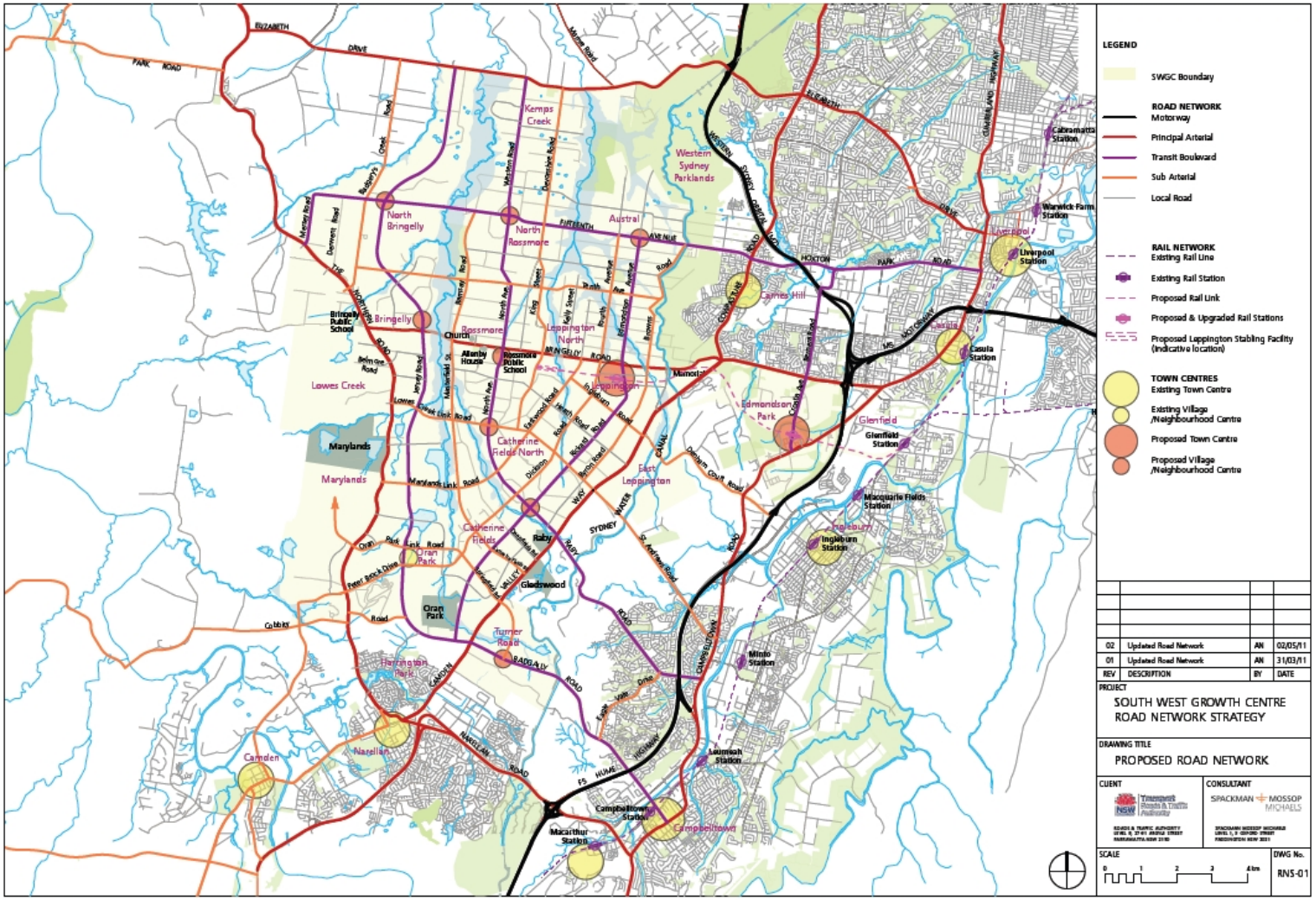
According to the draft Road Network Strategy, Bringelly Road is classified as a **Principal Arterial** connecting to other major arterial roads including The Northern Road, Camden Valley Way and Cowpasture Road.

The potential road upgrades in the SWGC and other major potential road upgrades in Sydney will be reflected in the strategic model based on information published by the RTA and other motoring bodies. The strategic model has been altered at each of the modelling years to accommodate assumed network upgrades and changes agreed with RTA planning.

To cater for changing land uses, the road network will also need to be augmented. In the AECOM model, future year network schemes are coded based on assumptions regarding:

- Upgrade timing
- Connectivity and alignment
- Speed/flow relationships
- Toll cost.

Figure 21 Draft SWGC road network strategy



Source: Spackman Mossop Michaels, 2011

3.3.4 Traffic forecasting methodology

AECOM have taken the calibrated base year demand tables for the AM average peak hour and rebalanced them to future year trip ends. Future year trip ends haven been calculated using the AECOM Trip End Modification Model (TEMM). The TEMM has been developed by AECOM to generate different future year trip ends based on:

- Average trip rates by SLA for developed and residential areas.
- Population and employment projections produced by BTS (released Oct 2009).
- The latest information regarding dwelling and employment numbers proposed within the Growth Centres (Aug 2010).

The model has accounted for major road improvements, such as the upgrade of Camden Valley Way, at a strategic level. In order to provide the necessary detail for the study such as more accurate turning movements at all intersections along Bringelly Road, a cordon was created around the SWGC, and a local area model has been extracted.

The coverage of the local area model is shown in **Figure 22**.

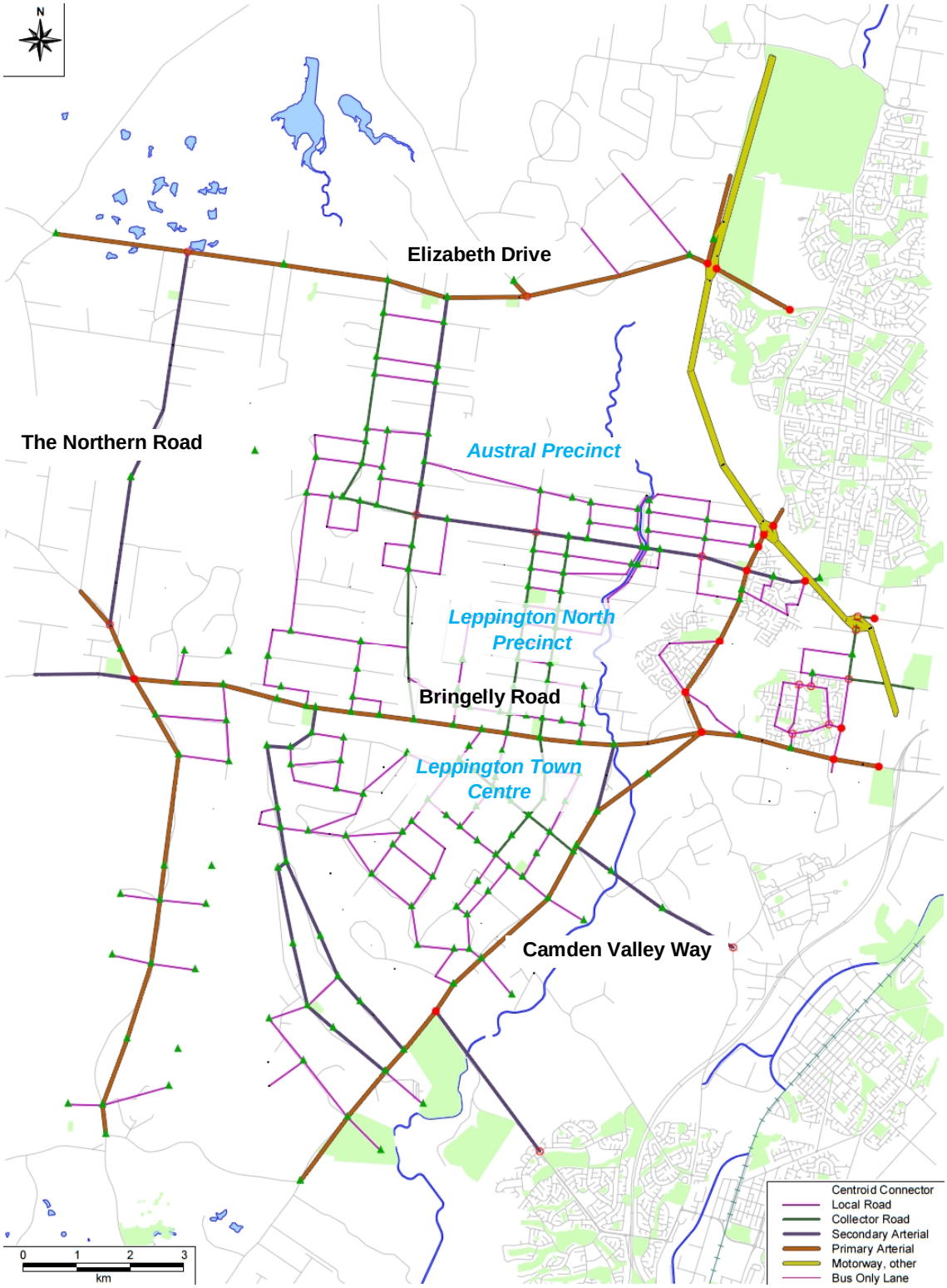
Figure 23 shows the location of zone boundaries and centroid connectors in relation to the road network, as well as more clearly identifying the current intersection locations coded in the local area model. The model covers the wider SWGC, as well as the Leppington Town Centre and the Leppington Station as part of the South West Rail Link.

AECOM has examined the trip generation rates and distribution effects of both the completion of the South West Rail Link and Leppington Station, as well as the proposed Leppington Town Centre. The local area model has been refined to better reflect changes on a smaller, more local level. These changes include:

- Coding of lower order local roads and adjustment to centroid connector loading points to better distribute traffic from zones onto the network.
- Coding of intersection delay algorithms to better represent delay on individual turning movements.
- Adjustment of future year trip ends to incorporate the new Leppington train station which will have significant park and ride facilities. By 2036, it is estimated that 4,190 people will use the new Leppington Train station as part of their commute, half of which will use Park and Ride or Kiss and Ride facilities.
- Adjustment of the trip distribution to reflect the creation of a new town centre at Leppington. Allowance of a retail peak during the PM peak hour assignment based on the current understanding of retail mix in the Leppington Town Centre. The PM trip table is derived by transposing the AM trip table and rebalancing to achieve a better origin/destination mix to the town centre. Overall this results in an increase of 4% in traffic flows, most of which is assigned to and from the town centre.

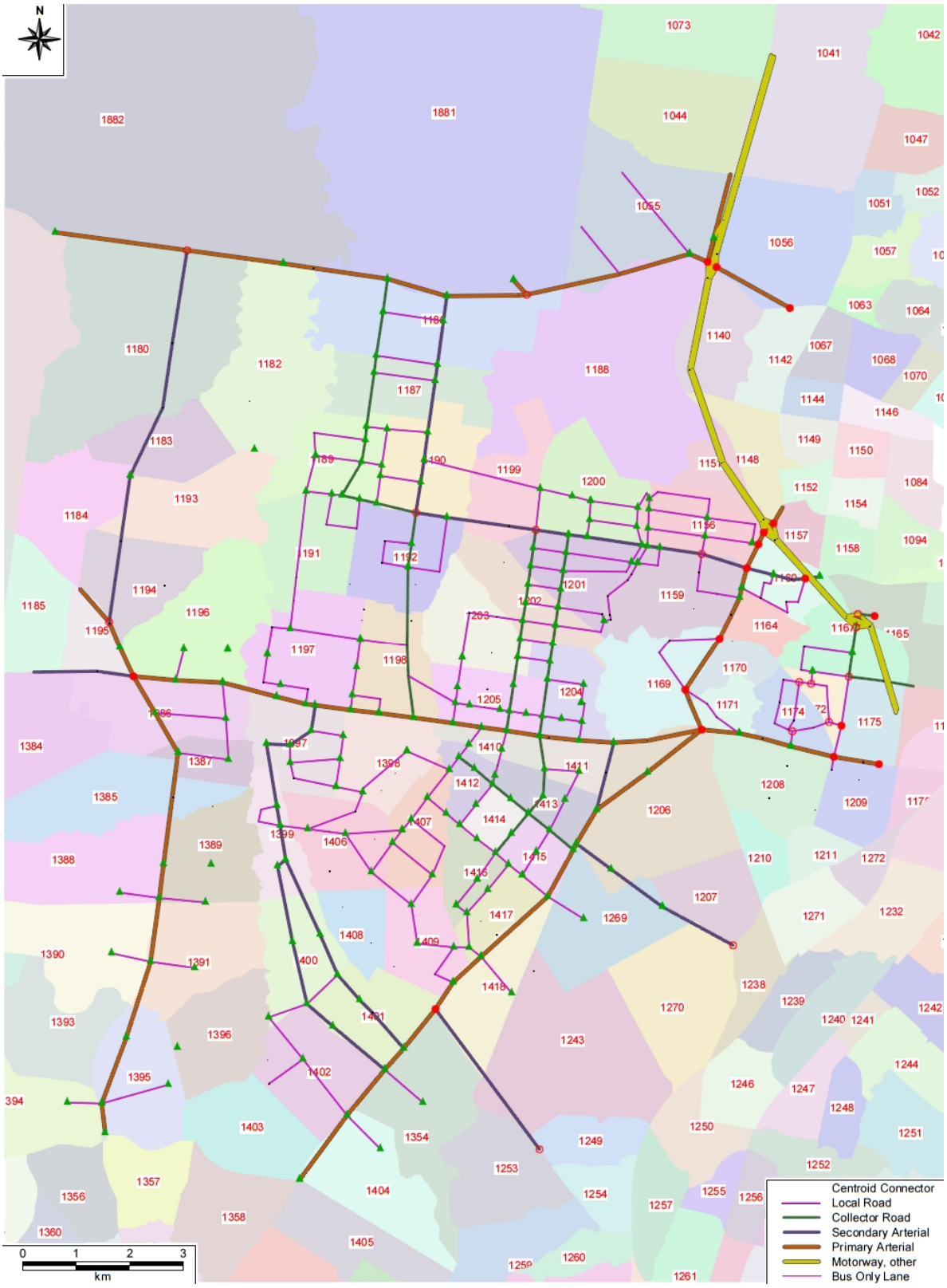
Traffic generation details by zone for each of the forecast years (2011, 2016, 2021, 2026, 2031 and 2036) are provided in **Appendix D**.

Figure 22 Coverage of the Local Area Model



Source: AECOM, 2010

Figure 23 Zone boundaries and connectors in the vicinity of Bringelly Road



Source: AECOM, 2010

4.0 The proposal

The draft SWGC Road Network Strategy identifies Bringelly Road as an east-west Principal Arterial through the heart of the SWGC having a similar strategic road hierarchy / function to The Northern Road, Camden Valley Way and Elizabeth Drive in the long-term future. Given the hierarchy and function of Bringelly Road within the SWGC and its proximity to the proposed Leppington Town Centre, the road will be expected to carry increasing volumes of traffic as the SWGC and Leppington Town Centre develop over the next 30 years.

In order to cater for the increasing traffic flows and to improve safety of the corridor, the proposal involves upgrading the approximately 10km section of Bringelly Road between The Northern Road, Bringelly and Camden Valley Way, Leppington from a two-lane to four-lane divided road.

The concept design for the proposal would include the following key features:

- An initial upgrade from a two lane to a four lane divided road with a central median.
- The wide central median will allow for future widening to six lanes, if required in the future.
- An intended posted vehicle speed limit of 80km/h.
- A three metre wide off-road shared pedestrian/cyclist path.
- Two metre shoulders.
- Adjustments to public utilities such as gas, electricity and telephone services along the route.
- Bicycle and pedestrian crossing provisions at traffic lights.
- Bus priority capability at traffic lights and indented bus bays on both sides of Bringelly Road.
- Designated turning lanes at traffic lights.
- Existing properties on Bringelly Road would continue to have direct left in/left out access until precinct development takes place, and alternative access becomes available.

4.1 Design Criteria

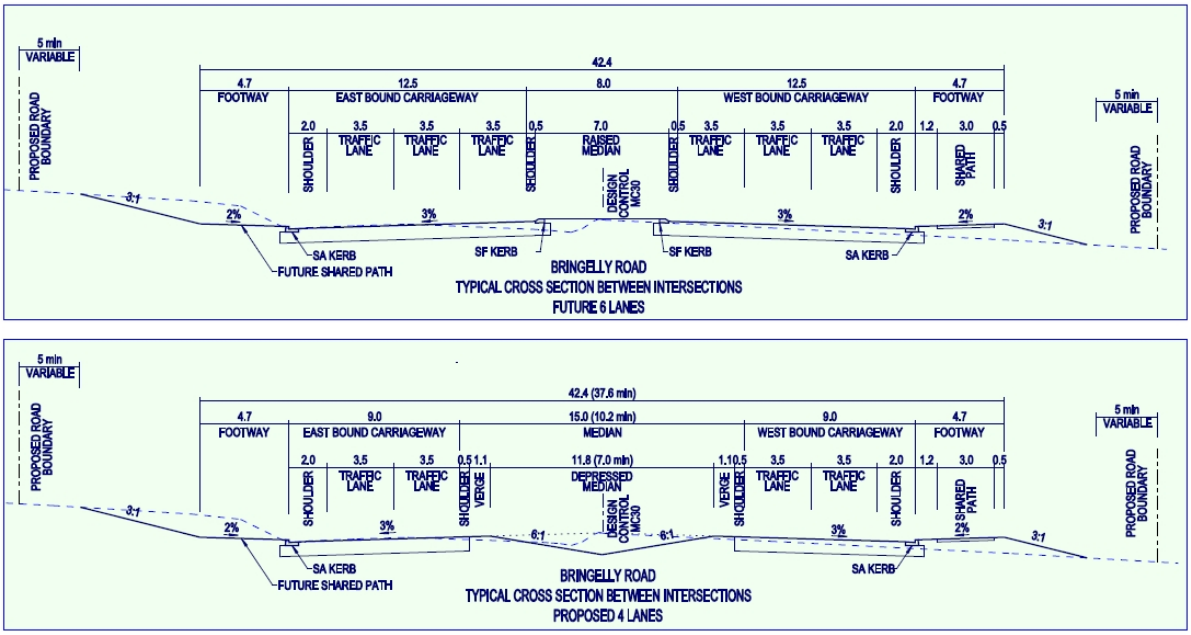
4.1.1 Design Speed

As a Principal Arterial, Bringelly Road will have an anticipated design speed of 90km/h. The proposal would result in a signposted speed limit of 80 km/h along the majority of its length except for the section between North Avenue to Allenby Road where a 60km/h speed limit will be implemented to adapt to urban environment of the proposed Rossmore Town Centre.

4.1.2 Cross-section

A typical cross-section of Bringelly Road would consist of four 3.5 metre wide lanes (two lanes in each direction), with a wide central median to allow widening to six lanes (two additional 3.5m lanes) in the future. Provision would be made for landscaping in the median where feasible and practical. The median at major intersections would be wide enough to accommodate dual right turn bays. No parking will be permitted on Bringelly Road with the future upgrade. A typical cross-section for Bringelly Road is shown in **Figure 24**.

Figure 24 Typical cross-section of Bringelly Road

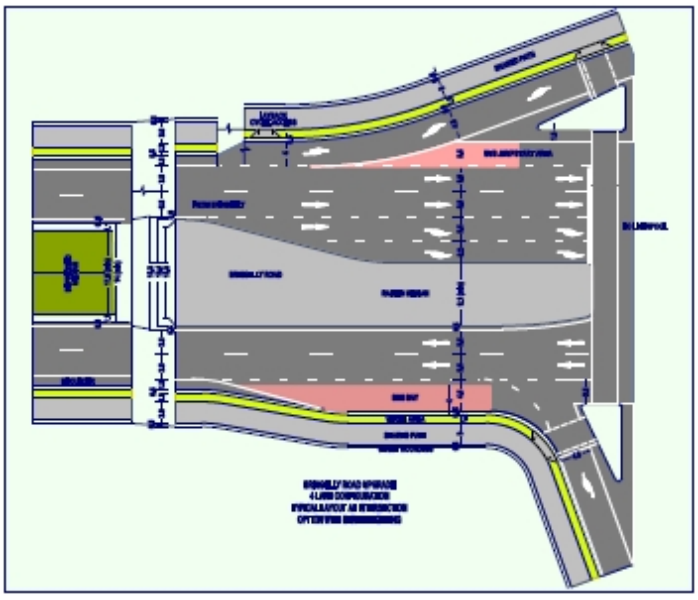


Source: RTA, 2011

Two metre wide shoulders along both carriageways in each direction would be provided to allow for breakdown vehicles and on-road cyclists. A three metre wide off-road shared pedestrian/cycle path would also be provided on the northern side of the upgraded road between Camden Valley Way and Eastwood Road. A shared path will be provided on the southern side of the upgraded road between The Northern Road and Cowpasture Road. Provision would be made for a possible future shared path on the northern side of Bringelly Road between The Northern Road and Cowpasture Road, which would be landscaped in the interim.

Bus facilities would be included through provision of short 'bus only' lanes at the approaches to signalised intersections along with bus bays on the departure side. A typical lane configuration at the approach to an intersection is shown in **Figure 25**.

Figure 25 Typical layout at an intersection approach on Bringelly Road



Source: RTA, 2011

4.1.3 Access strategy

With substantial growth and changes being planned to adjacent land uses along Bringelly Road, traffic from surrounding developments will only be able to access Bringelly Road at designated locations. All these intersection will be controlled by traffic signals to ensure safe turning movements into and out of adjacent precincts.

The proposed intersections have been located to firstly ensure access to future precinct developments and secondly, maintain the flow of traffic on Bringelly Road. The intersections are generally consistent with the SWGC Structure Plan and they utilise existing roads where possible.

The concept design proposes 11 new signalised intersections along the 10km upgrade between Camden Valley Way and The Northern Road. The majority of these signalised intersections will have four approaches functioning, requiring some consolidation of both existing and new access points to Bringelly Road during precinct planning. New signalised intersections are planned to be provided at the following locations:

- Kelvin Park Drive (T-intersection)
- Jersey Road / Bringelly Link Road (4-way intersection with interim U-turn facilities at future Bringelly Link Road)
- Masterfield Street (4-way intersection)
- North Avenue (4-way intersection with interim U-turn facilities at future North Avenue extension to the south of Bringelly Road)
- King Street (4-way intersection)
- Eastwood Road (4-way intersection with interim U-turn facilities at future Eastwood Road extension to the north of Bringelly Road)
- Fourth Avenue / Dickson Road (4-way intersection)
- Edmondson Avenue / Rickard Road (4-way intersection)
- Browns Road / Byron Road (T- intersection[3])
- Cowpasture Road (T-intersection)
- Access to Western Sydney Parklands (T-intersection).

The intersections at The Northern Road will remain signalised, but will be upgraded with additional through and turning lanes to cater for further traffic growth in the future.

A number of existing streets will be retained as left in/left out intersections with Bringelly Road:

- Church Street
- Allenby Road
- Glen Allan Road
- Kelly Street.

A limited number of additional left in/left out intersections located between the signalised intersections may be considered as part of the precinct planning process.

[3] Initially RTA will construct a T-intersection at Browns Road which will accommodate a future four way intersection to be constructed by others.

5.0 Traffic assessment

This chapter provides details of the traffic impact assessment that was undertaken at different stages and scenarios, including the consequence of no action, construction and operational impacts of the proposal.

5.1 Consequence of no action

The development of the SWGC over the next several decades will see Bringelly Road transformed from a rural road to a heavily trafficked urban corridor, estimated to be able to accommodate between 24,000 and 55,000 vehicles per day. The current road corridor (two lane undivided road) with priority controlled intersections will not be able to cater for the significant amount of additional traffic.

Delays would be caused by local traffic conflicting with major through traffic movements along Bringelly Road. Travel times on Bringelly Road would increase as the level of congestion increases.

Long delays would result in social impacts as future residents spend more time travelling by car and impose limitations to future growth in the SWGC due to its restricted accessibility via a constrained road network. Increased in travel times on Bringelly Road could also reduce the attractiveness of the proposed Leppington Town Centre to commercial business and the region may suffer economically. Congestion on Bringelly Road would also limit the accessibility to the proposed Leppington Station, reducing the attractiveness of public transport for future residents.

The potential for crashes is likely to increase with additional traffic, especially at major intersections along the route. More rear-end crashes would also be likely to occur as delays on Bringelly Road continue to increase. Access to and from local and private roads are expected to be more difficult with increased volumes of traffic on Bringelly Road. Motorists may take greater risks to turn onto Bringelly Road as gaps in the flow of traffic would be less frequent.

Therefore, it is critical to consider the upgrade of Bringelly Road to initially four lanes and ultimately six lanes with the closure of direct private property accesses and minor side street intersections, and the redirection of side street access (and hence entry to properties) to suitable existing and new classified roads at proposed signalised intersections.

5.2 Operational impacts

5.2.1 Forecast traffic volumes

The CUBE model was used to forecast traffic volumes along Bringelly Road based on the proposed land use changes in the SWGC as discussed in **Section 4.3.1** and proposed road network changes (**Section 4.3.3**). Public transport use for commuting has also been accounted for by discounting the trip rates to reflect the reduction in general vehicle use on Bringelly Road.

Peak hour traffic forecasts for each mid-block sections between major intersections along Bringelly Road for 2011 to 2036 at five-year intervals are provided in **Table 20**. It should be noted that the 2036 traffic forecasts represent an ultimate SWGC development scenario and this scenario may not occur by 2036. Full network modelling plots are provided in **Appendix E**.

Table 20 Forecast peak hour mid-block traffic flows

Road sections	Dir	2011		2016		2021		2026		2031		2036	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Section 1 - The Northern Road to Kelvin Park Drive	EB	433	194	769	316	1,041	683	1,359	1,138	1,204	842	1,223	1,353
	WB	189	457	306	779	640	1,100	1,063	1,339	706	1,326	1,150	1,370
Section 2 - Kelvin Park Drive to Jersey Road	EB	455	192	788	316	1,071	689	1,383	1,138	1,226	857	1,346	1,388
	WB	184	483	301	802	644	1,131	1,060	1,364	720	1,342	1,182	1,475
Section 3 - Jersey Road to Barry Avenue	EB	491	201	848	333	1,222	698	1,526	1,165	1,611	804	1,820	1,297
	WB	193	523	318	876	654	1,280	1,087	1,602	744	1,730	1,053	1,965
Section 4 - Barry Avenue to Church Street	EB	491	201	848	333	1,222	698	1,526	1,165	1,673	721	2,068	1,018
	WB	193	523	318	876	654	1,280	1,087	1,602	601	1,783	897	2,194
Section 5 - Church Street to Allenby Road	EB	503	222	861	359	1,231	729	1,542	1,182	1,673	721	2,069	1,018
	WB	217	536	346	888	685	1,291	1,121	1,619	601	1,783	897	2,194
Section 6 - Allenby Road to North Avenue	EB	536	161	957	188	1,269	727	1,626	981	1,673	721	2,069	1,018
	WB	155	570	175	990	685	1,330	1,092	1,705	601	1,783	897	2,194
Section 7 - North Avenue to Glen Allan Road	EB	529	159	950	187	1,290	353	1,441	559	1,730	549	2,320	856
	WB	153	563	174	982	276	1,264	439	1,314	501	1,815	792	2,319
Section 8 - Glen Allan Road to King Street	EB	529	159	950	187	1,290	353	1,441	559	1,730	549	2,320	856
	WB	153	563	174	982	276	1,264	439	1,314	501	1,815	792	2,319
Section 9 - King Street to Kelly Street	EB	593	206	991	276	1,428	508	1,687	744	2,019	742	2,783	1,046
	WB	201	639	228	1,041	392	1,412	605	1,562	687	2,107	806	2,969
Section 10 - Kelly Street to Eastwood Road	EB	561	201	926	259	1,429	508	1,692	743	2,132	663	2,930	926
	WB	195	607	211	968	373	1,412	530	1,499	578	1,982	684	2,828

Road sections	Dir	2011		2016		2021		2026		2031		2036	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Section 11 - Eastwood Road to Fourth Avenue	EB	576	290	1,008	286	1,736	576	1,833	804	2,412	903	3,333	1,194
	WB	215	622	236	1,031	450	1,854	610	1,824	719	2,694	885	3,292
Section 12 - Fourth Avenue to Edmondson Avenue	EB	532	332	946	283	1,589	459	1,859	655	2,224	639	3,112	767
	WB	276	600	250	925	374	1,611	434	1,508	510	2,416	588	3,136
Section 13 - Edmondson Avenue to Browns Road	EB	534	480	831	468	1,533	618	1,706	720	2,376	740	3,245	926
	WB	610	664	522	954	453	1,562	698	1,993	648	2,613	787	3,342
Section 14 - Browns Road to Old Cowpasture Road	EB	534	480	831	468	1,579	776	1,742	834	2,402	886	3,266	1,023
	WB	610	664	522	954	992	1,864	1,231	2,400	1,253	3,139	1,228	3,709
Section 15 - Old Cowpasture Road to Cowpasture Road	EB	555	437	1,075	765	1,752	1,039	2,154	1,258	2,855	1,296	3,719	1,408
	WB	577	727	685	1,136	945	1,728	1,213	2,321	1,323	2,958	1,274	3,889

Source: AECOM, 2011

5.2.2 Mid-block capacity and staging

Mid-block capacity requirements for Bringelly Road have been ascertained based on Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1 and explanatory notes. The typical mid-block capacities for various types of urban roads with interrupted flow, with unflared major intersections and with interruptions from cross and turning traffic at minor intersections are shown in **Table 21**.

Table 21 Typical mid-block capacities for urban roads with interrupted flow

Type of lane	One-way mid-block capacity (veh/h)
Median or inner lane	
Divided road	1,000
Undivided road	900
Median lane (of a 3 lane carriageway)	
Divided road	900
Undivided road	1,000
Kerb lane	
Adjacent to parking lane	900
Occasional parked vehicles	600
Clearway conditions	900

Source: Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1

Explanatory Notes: Peak period mid-block traffic volumes may increase to 1,200 to 1,400 vehicles per lane per hour on any approach road when the following conditions exist or can be implemented:

- Adequate flaring at major upstream intersections.
- Uninterrupted flow from a wider carriageway upstream of an intersection approach and flowing at capacity.
- Control or absence of crossing or entering traffic at minor intersections by major road priority controls.
- Control or absence of parking.
- Control or absence of right turns by banning turning at difficult intersections.
- High volume flows of traffic from upstream intersections during more than one phase of a signal cycle.
- Good co-ordination of traffic signals along the route.

In general, the upgrade of Bringelly Road will provide sufficient capacity at the intersections with adequate flaring and parking will not be permitted with the future upgrade. Therefore, a peak hour mid-block capacity of 1,200 vehicles per lane per hour has been adopted for the capacity assessment.

Using the adopted peak hour mid-block capacity, the ultimate required capacity for Bringelly Road at full development of the SWGC, will be a four-lane divided carriageway from The Northern Road to King Street and a six-lane divided carriageway from King Street to Camden Valley Way.

Based on the traffic forecasts shown in **Table 20**, the progressive upgrading and widening requirements for each section of Bringelly Road are represented in **Table 22**.

Prior to the ultimate widening, Bringelly Road, east of King Street will require initially to be upgraded to a four lane divided carriageway by 2021. The rest of the corridor will also require upgrading to four lanes in 2026. The sections of Bringelly Road east of Eastwood Road will be required to be upgraded to six lanes by 2031 and the section between King Street and Eastwood Road finally upgraded to six lanes to cater for the traffic growth.

It should be noted that the mid-block analysis does not account for intersection capacity constraints and localised widening on some of the approaches to intersections may be required prior to full widening of the mid-block sections. This will be further discussed in **Section 6.2.3**.

Table 22 Bringelly Road staged mid-block upgrade requirements

Road sections	2011	2016	2021	2026	2031	2036
Section 1 - The Northern Road to Kelvin Park Drive	two lane undivided carriageway	two lane undivided carriageway	two lane undivided carriageway	four lane divided carriageway	four lane divided carriageway	four lane divided carriageway
Section 2 - Kelvin Park Drive to Jersey Road						
Section 3 - Jersey Road to Barry Avenue						
Section 4 - Barry Avenue to Church Street						
Section 5 - Church Street to Allenby Road						
Section 6 - Allenby Road to North Avenue						
Section 7 - North Avenue to Glen Allan Road						
Section 8 - Glen Allan Road to King Street						
Section 9 - King Street to Kelly Street			four lane divided carriageway			six lane divided carriageway
Section 10 - Kelly Street to Eastwood Road					six lane divided carriageway	
Section 11 - Eastwood Road to Fourth Avenue						
Section 12 - Fourth Avenue to Edmondson Avenue						
Section 13 - Edmondson Avenue to Browns Road						
Section 14 - Browns Road to Old Cowpasture Road						
Section 15 - Old Cowpasture Road to Cowpasture Road						

Source: AECOM, 2011

5.2.3 Intersection performance

With substantial growth and changes being planned to adjacent land uses along Bringelly Road, traffic from the surrounding developments will only be allowed to access Bringelly Road at designated intersections. The number of intersections and their locations as proposed in the access strategy will provide an optimal access arrangement along Bringelly Road.

Turning movements of all intersections along Bringelly Road between The Northern Road and Camden Valley Way have been extracted from the CUBE model for each of the forecast future year Intersection. As the base year modelled turn movements matched quite closely to the observed traffic data, no post-modelling adjustments have been made to the forecast turning flows before intersection modelling is undertaken.

A summary for all forecast turning movements is provided in **Appendix F**.

SIDRA modelling has been undertaken using all future year forecast turning movements to determine the optimum intersection layout for each design year. Options assessed considered the impacts of banning turning movements and provision of signalised pedestrian crossings to intersection and network performance, in order to provide the optimal network performance for all road users.

Using the existing intersection layouts as a starting point, each intersection along Bringelly Road was assessed under forecast traffic flows and upgraded based on known staging of Bringelly Road widening. Should the intersection have insufficient capacity to cater for forecast traffic volumes, intersection upgrades are proposed with consideration of:

- Surrounding intersection and mid-block capacity requirements.
- Footprint of ultimate intersection layout.
- An acceptable level of performance for 10 years after opening.
- Measures to allow bus priority.
- Intersection performance of LOS D or better at opening.
- 95^{th} percentile queue lengths not to extend into upstream intersections.
-

Table 23 provides a summary of the staging requirements for intersection upgrades within the study area.

Table 23 Intersection upgrade staging

Intersection	2011	2016	2021	2026	2031	2036
The Northern Road	Existing layout	Extend turning bay lengths	Upgrade intersection - **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Kelvin Park Drive	Existing layout	-	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Jersey Road	Existing layout	-	Upgrade intersection * - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Masterfield Street	Existing layout	-	Upgrade intersection - **two lanes** on Bringelly Road approaches (priority intersection)	-	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	Ultimate layout
North Avenue	Existing layout	-	Upgrade intersection * - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
King Street	Existing layout	-	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Ultimate layout
Eastwood Road	Existing layout	-	Upgrade intersection *- **signalisation** and **three lanes** on Bringelly Road approaches	-	-	Ultimate layout
Fourth Avenue	Existing layout	-	Upgrade intersection - **signalisation** and **three lanes** on Bringelly Road approaches	-	-	Ultimate layout
Edmondson Avenue	Existing layout	Upgrade intersection - **signalisation** and **three lanes** on Bringelly Road approaches	-	Ban northbound and southbound right turn movements	Ban eastbound right turn movement	Ultimate layout
Browns Road	Existing layout	-	Upgrade to T intersection - **signalisation** and **three lanes** on Bringelly Road approaches	-	-	Ultimate layout
Cowpasture Road	Existing layout	Upgrade intersection - **signalisation** and **two lanes** on Bringelly Road approaches	-	-	Upgrade intersection - **three lanes** on Bringelly Road approaches	Ultimate layout

Source: AECOM, 2011

*- including an interim U-turn facilities to assist with local access with teh upgrade of Bringelly Road to a divided carriageway

In order to meet forecast peak hour demands, the intersections of Bringelly Road with The Northern Road, Edmondson Avenue and Cowpasture Road require upgrading by 2016.

The intersection analysis confirms that the intersection at The Northern Road will need local upgrades (extending turning bays) by 2016 and two lanes are required on the Bringelly Road approach in 2021.

For intersections between Kelvin Park Drive and King Street, intersection upgrades are required in 2021 with signalisation of intersection and local widening of Bringelly Road to two lanes each direction to cater for forecast traffic growth. Signalisation of Masterfield Street is not required until 2031.

For intersections surrounding the Leppington Town Centre along Bringelly Road between Eastwood Road and Browns Road, while the intersection of Bringelly Road / Edmondson Road requires upgrading by 2016, the remaining intersections require upgrading by 2021. Adopting the ten year design life approach, 2031 forecast traffic flows were used as a basis for determining intersection upgrade requirements at these locations. In order to allow continuity and minimise weaving between adjacent intersections, whilst 2021 mid-block flows warrant only two lanes in each direction, upgrade to three lanes in each direction is recommended between Eastwood Road and Browns Road.

Left turn slip lanes and / or extending turning bay lengths are required for the majority of intersections along Bringelly Road to cater for the increased traffic volumes under the ultimate development scenario. All proposed slip lanes will be signalised in order to facilitate safe and efficient pedestrian and cyclist movements, where applicable.

In regard to permitted turning movements, a number of options were considered as part of the development of the preferred network scenario. The preferred ultimate network scenario permits all movements at all signalised intersections, except at the intersection of Bringelly Road / Edmondson Road. The ultimate intersection layout for this intersection permits right turning movements from Bringelly Road westbound into Edmondson Avenue and for buses only from Rickard Road into Bringelly Road. Within interim years, banned movements are instated in a staged manner with the right turning movements from Rickard Road and Edmondson Road banned in 2026, and then the right turn movement from Bringelly Road eastbound banned in 2031.

All proposed intersection layouts provide signalised pedestrian crossing across all arms, with the exception of the intersection of Bringelly Road / Cowpasture Road. At this intersection, only one signalised crossing is provided across Bringelly Road on the western leg, which is located towards the town centre and likely to follow preferred pedestrian desire lines.

Table 24 provides a summary of the expected level of service for all proposed intersections. Intersection layout and performance summaries for 2011, 2016, 2021, 2026, 2031 and 2036 are provided in **Appendix F**.

Table 24 Intersection level of service summary

Intersections with Bringelly Road	2011		2016		2021		2026		2031		2036	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
The Northern Road	B	B	C	C	C	D	C	D	C	C	D	D
Kelvin Park Drive	A	A	A	A	B	C	A	A	A	A	B	B
Jersey Road	A	A	A	A	B	C	B	B	D	C	D	C
Masterfield Street	A	A	A	A	A	A	A	A	B	B	B	C
North Avenue	A	A	A	A	C	C	C	D	C	C	D	D
King Street	A	A	A	A	C	B	D	C	C	C	D	C
Eastwood Road	A	A	A	A	C	C	C	C	D	D	C	B
Fourth Avenue	A	A	A	A	C	B	C	C	C	D	D	C
Edmondson Avenue	A	A	C	C	C	C	D	C	C	C	D	C
Browns Road	A	A	A	A	C	C	C	D	D	D	D	D
Cowpasture Road	A	A	B	B	B	B	B	B	B	C	C	C

Source: AECOM, 2011

The above analysis confirmed that three approach lanes are required at intersections between Eastwood Road and Browns Road inclusive along Bringelly Road (post-2016) in order to maintain acceptable level of service during the peak hours.

A sensitivity analysis has been undertaken to test the implications on the performance of these intersections in the vicinity of the Leppington Town Centre, if only two lanes are provided on the Bringelly Road approaches. The analysis showed that the level of service for these intersections will deteriorate gradually from 2021 to unacceptable level of service and all these intersections would be performing unsatisfactorily (with level of service worse than D and / or degree of saturation exceeding 0.9) during the peak hours.

The results of the sensitivity analysis for intersections between Eastwood Road and Browns Road inclusive along Bringelly Road are provided in **Appendix G**.

5.2.4 Crashes and safety

With the construction of two divided carriageways, the proposal is likely to reduce the number of head-on crashes, which accounted for 3.8 per cent of the crashes recorded in the five-year period. The likelihood of intersection crashes, which accounted for 61.5 per cent of all recorded crashes, would also be reduced with the provision of deceleration/slip lanes along Bringelly Road and signalised intersections being introduced.

The proposal would be designed to the RTA's design guide and would be reviewed by the RTA's road safety section.

5.2.5 B-double and freight transport

The upgrade of Bringelly Road will provide improved safety and efficiency for B-double and freight access along Bringelly Road.

The proposed traffic signals along Bringelly Road will provide safe and efficient access to approved B-double routes at The Northern Road, King Street / Devonshire Road, Fourth Avenue, Camden Valley Way and Cowpasture Road.

5.2.6 Public transport

There will be no impacts to existing bus routes (Routes 855 and 856) with the upgrade of Bringelly Road. There may be relocation of existing bus stops as opportunities for bus stops will be provided on the departure side of each signalised intersection. This is an improvement in safety when compared to the existing situation, which does not sufficiently allow for buses to stop adjacent to through traffic lanes.

It is expected that additional bus routes would be implemented to service the development of precincts adjacent to Bringelly Road. Increasing the capacity of Bringelly Road will minimise risk of congestion and over saturation on the road network. This will improve the efficiency of public transport operations and travel time reliability along Bringelly Road. Intersections are also designed with appropriate bus priority measures to further reduce bus delays at intersections.

Bringelly Road will be the main access arterial road to Leppington Station and its interchange. The upgrade of Bringelly Road and its intersections with bus priority measure and improved pedestrian / cyclist access will provide good and efficient access to the station and its interchange via all modes of transport.

5.2.7 Pedestrian and cyclists

A three metre wide off-road shared pedestrian and cycle path will form part of the upgrade. This arrangement would formalise pedestrian and cyclist movements along the Bringelly Road corridor, which currently does not have sufficient facilities for cyclists and pedestrians. This new path would result in an increase in safety for pedestrians and cyclists travelling along the corridor.

The proposal would also see the construction of wide shoulders along both carriageways, which would provide cyclists with an alternate path to travel along the road corridor. This is an improvement in safety to the existing situation, which does not sufficiently allow for cyclists to travel adjacent to through traffic lanes.

5.2.8 Private property access

The road widening would affect access during and after construction. Left in and left out access would generally be provided at existing properties where there are no other alternatives, until land redevelopment occurs. Three temporary U-turn facilities have been incorporated into the design, to allow for traffic movements to and from properties with only left in and left out access.

5.3 Preliminary construction traffic impacts

A detailed construction traffic impact assessment has not been undertaken because details related to construction activities and sequence of work are insufficiently known at this stage. It is recommended that the RTA undertake a detailed construction traffic impact assessment when further construction details are known.

Impacts on traffic during construction of the Bringelly Road would be temporary in nature. Traffic impacts would occur as a result of the movement of construction and service vehicles along Bringelly Road and access roads, for the haulage of construction materials. General use of Bringelly Road and access to existing properties along the road would be maintained throughout the construction phase.

Truck movements during the construction phase are expected to increase by approximately 30 to 40 truck movements per day. Truck movements may increase to 60 to 100 truck movements per day at certain stages of construction. Truck movement numbers will be confirmed at a later stage when construction staging arrangements are more clearly defined.

Bringelly Road currently experiences varied heavy vehicle movements along its corridor. Based on traffic data collected from 10 December 2010 to 16 December 2010, there are on average between 600 and 1,000 heavy vehicle movements per day on different sections of Bringelly Road. The additional truck movements are unlikely to have a significant effct along Bringelly Road, but may have locally concentrated impacts at construction accesses.

Potential impacts caused by construction vehicle traffic would include:

- Increased travel times due to reduced speed limit around construction sites.
- Increased travel times due to increased truck and construction machinery movements.
- Temporary partial or complete closure of roads and altered property accesses during construction.

The concept design should seek to minimise the restriction to traffic flow by constructing the carriageway outside of the footprint of the existing road prior to undertaking works on the existing roadway. The concept design should also consider minimising the number of traffic switches from one carriageway of Bringelly Road to the other during construction to help minimise traffic disruption. However, traffic switching during the construction phase would likely be required in areas involving alignment with the footprint of the existing road surface.

5.3.1 Property and local access

Access to individual properties would be temporarily affected by construction activities, either through the loss of existing access arrangements, or the alteration of access arrangements. However, property access would be maintained at all times, and any impacts would be short-term. Access to existing public schools, flower nursery and petrol station located along Bringelly Road will be maintained during construction. Traffic and access requirements to all existing properties along Bringelly Road will be included as part of the detailed traffic management plan.

Construction at intersections of Bringelly Road and adjoining roads may result in temporary impacts upon access. Traffic management plans would be developed during the detailed design phase to minimise traffic disruption.

5.3.2 Bus services

The proposal would involve changing the access and egress functions at junctions with adjoining roads.

As such, some bus routes would need to be modified both during and after construction. Construction would have other impacts on bus services including reduced speeds and temporary relocation of bus stops. However, buses would continue to be able to use Bringelly Road.

5.3.3 SWRL

Construction of the South West Rail Link (SWRL) will commence in late 2011 and is due for completion in 2016. The project includes two new stations at Edmondson Park and Leppington. It is expected that Bringelly Road will be the main access arterial road to Leppington Station due to the proximity of the station and its interchange.

The planning of the upgrade of Bringelly Road will need to consider and ensure that accessibility to the station and its interchange via all modes of transport is maintained.

5.3.4 Management of construction traffic impacts

A detailed traffic management plan (TMP) would be prepared as part of the construction environmental management plan (CEMP) during the detailed design phase. The TMP would include the guidelines, general requirements and procedures to be used when activities or areas of work have a potential impact on existing traffic arrangements. The TMP would be submitted in stages to reflect the progress of work and would:

- Identify the traffic management requirements during construction.
- Describe the general approach and procedures to be adopted when producing specific traffic control plans.
- Ensure the continuous, safe and efficient movement of traffic for both the public and construction workers.
- Maintain the capacity of local roads.
- Determine temporary speed restrictions to ensure safe driving environment around work zones.
- Minimise impacts on existing Bringelly Road and local traffic.
- Provide access to local roads and properties, including the use of temporary turn-around bays.
- Provide temporary works and traffic signals.
- Determine the number and width of traffic lanes in operation.
- Identify traffic barrier requirements and placement.
- Include methods for implementing the traffic management plan.
- Include methods for minimising road user delays.
- Provide appropriate warning and advisory signposting.
- Consider other developments such as the South West Rail Link and South West Growth Centre precincts that may also be under construction, to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic.

6.0 Summary and recommendations

The RTA has engaged AECOM to prepare a traffic and transport modelling assessment to forecast future year traffic volumes on Bringelly Road based on the best available land use development information to determine the interim and ultimate requirements for mid-block section and intersection upgrades along Bringelly Road. This traffic and transport study forms part of the Review of Environmental Factors (REF).

6.1 Mid block capacity and staging requirements

The ultimate required capacity for Bringelly Road at full development of the SWGC will be a four lane divided carriageway from The Northern Road to King Street and a six lane divided carriageway from King Street to Camden Valley Way. The road needs to be widened to six lanes through Leppington Town Centre due to the intersection requirements as specified in **Table 23**, as it would be impractical to taper the intersection upgrade back to four lanes between intersections.

Prior to the ultimate widening, Bringelly Road, east of King Street will require initially to be upgraded to four lanes divided carriageway to cater for the additional traffic demand generated by the initial phases of Austral and Leppington North Precincts and Leppington Town Centre as well as the opening of Leppington Station as part of the South West Rail Link (SWRL). The rest of the corridor will be upgraded to four lanes as development proceeds towards the west.

The sections of Bringelly Road, east of King Street will require to be upgraded to six lanes in the long-term to cater for the traffic growth surrounding Leppington Town Centre.

6.2 Intersection performance and staging requirements

With substantial growth and changes being planned to adjacent land uses along Bringelly Road, traffic from the surrounding developments will only be able to access Bringelly Road at designated locations.

The concept design proposes 11 new signalised intersections along the 10km upgrade between Camden Valley Way and The Northern Road. The majority of these signalised intersections will have four approaches functioning, requiring some consolidation of both existing and new access points to Bringelly Road during precinct planning. New signalised intersections are planned to be provided at the following locations:

- Kelvin Park Drive (T-intersection)
- Jersey Road / Bringelly Link Road (4-way intersection with interim U-turn facilities at future Bringelly Link Road)
- Masterfield Street (4-way intersection)
- North Avenue (4-way intersection with interim U-turn facilities at future North Avenue extension to the south of Bringelly Road)
- King Street (4-way intersection)
- Eastwood Road (4-way intersection with interim U-turn facilities at future Eastwood Road extension to the north of Bringelly Road)
- Fourth Avenue / Dickson Road (4-way intersection)
- Edmondson Avenue / Rickard Road (4-way intersection)
- Browns Road / Byron Road (T- intersection[4])
- Cowpasture Road (T-intersection)
- Access to Western Sydney Parklands (T-intersection).

The intersections at The Northern Road will remain signalised, but will be upgraded with additional through and turning lanes to cater for further traffic growth in the future.

[4] Initially RTA will construct a T-intersection at Browns Road which will accommodate a future four way intersection to be constructed by others.

In order to meet forecast peak hour demands, the intersections of Bringelly Road with The Northern Road, Edmondson Avenue, Cowpasture Road and Camden Valley Way require upgrading by 2016.

For intersections between Kelvin Park Drive and King Street, intersection upgrades are required in 2021 with signalisation of intersections and local widening of Bringelly Road to two lanes each direction to cater for forecast traffic growth. Signalisation of Masterfield Street is not required until 2031.

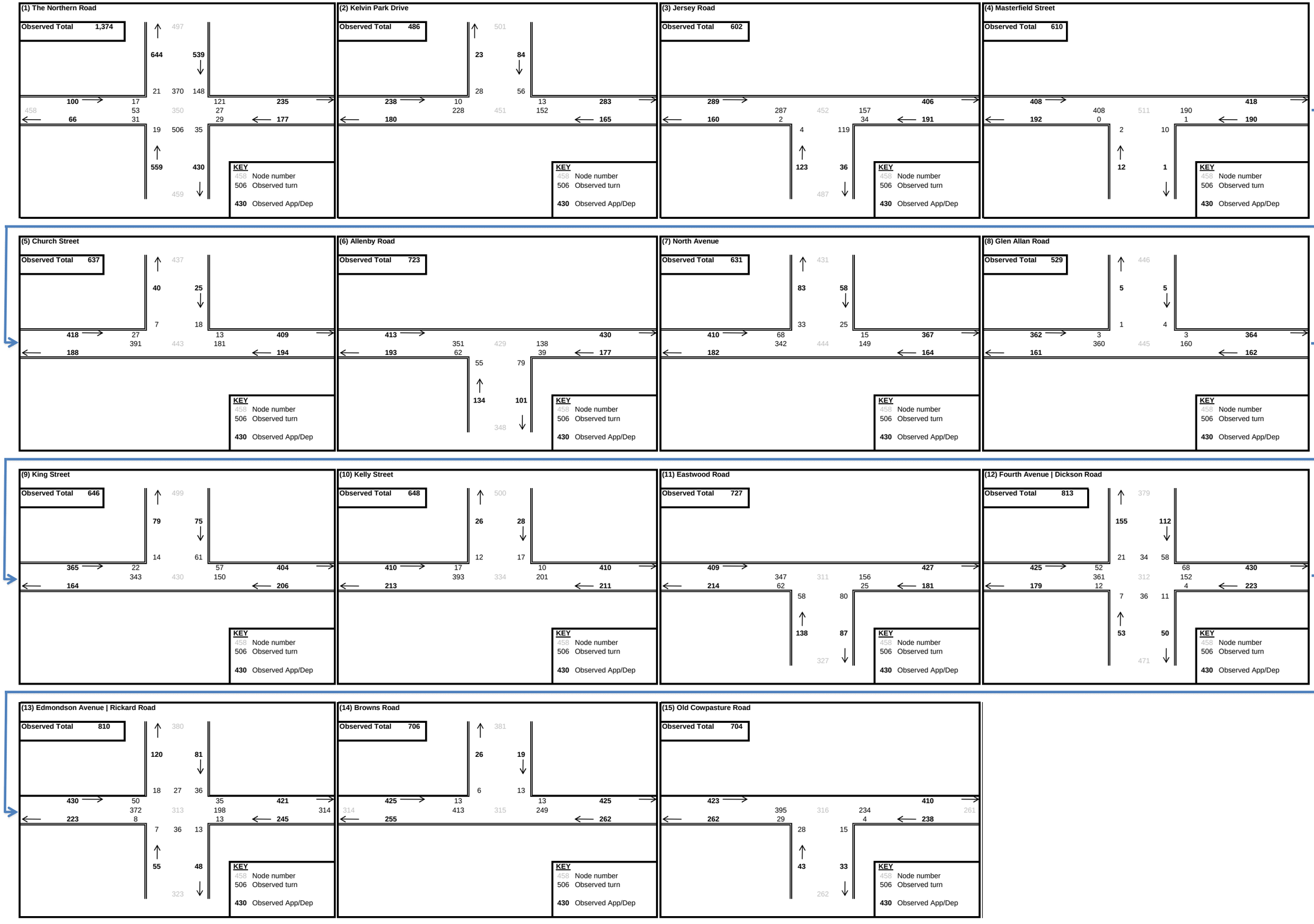
For intersections surrounding the Leppington Town Centre along Bringelly Road between Eastwood Road and Browns Road, while the intersection of Bringelly Road / Edmondson Road requires to be upgraded by 2016, the remaining intersections require upgrading by 2021. In order to allow continuity and minimise weaving between adjacent intersections, whilst 2021 mid-block flows warrant only two lanes in each direction, upgrade to three lanes in each direction is recommended between Eastwood Road and Browns Road.

Left turn slip lanes and / or extending turning bay lengths are required for the majority of intersections along Bringelly Road to cater for the increased traffic volumes under the ultimate development scenario. All proposed slip lanes will be signalised in order to facilitate safe and efficient pedestrian and cyclist movements, where applicable.

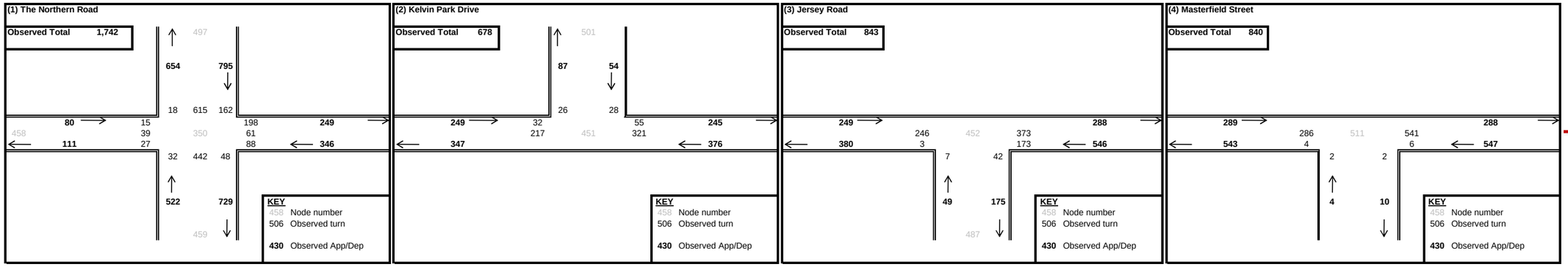
Appendix A

Base Year Intersection Traffic

Roads and Traffic Authority
Bringelly Road Traffic Assessment
2008 AM Average Peak one hour Surveyed Intersection Flow



Roads and Traffic Authority
Bringelly Road Traffic Assessment
2008 PM Average Peak one hour Surveyed Intersection Flow



Appendix B

Crash History Summary

Summary Crash Report

# Crash Type		
Car Crash	121	93.1%
Light Truck Crash	19	14.6%
Rigid Truck Crash	9	6.9%
Articulated Truck Crash	6	4.6%
'Heavy Truck Crash	(15)	(11.5%)
Bus Crash	1	0.8%
"Heavy Vehicle Crash	(15)	(11.5%)
Emergency Vehicle Crash	2	1.5%
Motorcycle Crash	5	3.8%
Pedal Cycle Crash	0	0.0%
Pedestrian Crash	0	0.0%

' Rigid or Artic. Truck " Heavy Truck or Heavy Bus
These categories are NOT mutually exclusive

Location Type		
*Intersection	80	61.5%
Non intersection	50	38.5%

* Up to 10 metres from an intersection
~ 07:30-09:30 or 14:30-17:00 on school days

Collision Type		
Single Vehicle	29	22.3%
Multi Vehicle	101	77.7%

Road Classification		
Freeway/Motorway	0	0.0%
State Highway	0	0.0%
Other Classified Road	14	10.8%
Unclassified Road	116	89.2%

Contributing Factors		
Speeding	18	13.8%
Fatigue	6	4.6%
Alcohol	2	1.5%

Weather		
Fine	95	73.1%
Rain	19	14.6%
Overcast	11	8.5%
Fog or mist	3	2.3%
Other	0	0.0%

Road Surface Condition		
Wet	29	22.3%
Dry	101	77.7%
Snow or ice	0	0.0%

Natural Lighting		
Dawn	5	3.8%
Daylight	81	62.3%
Dusk	4	3.1%
Darkness	40	30.8%

Crash Movement		
Intersection, adjacent approaches	31	23.8%
Head-on (not overtaking)	5	3.8%
Opposing vehicles; turning	16	12.3%
U-turn	1	0.8%
Rear-end	32	24.6%
Lane change	3	2.3%
Parallel lanes; turning	1	0.8%
Vehicle leaving driveway	1	0.8%
Overtaking; same direction	5	3.8%
Hit parked vehicle	0	0.0%
Hit railway train	0	0.0%
Hit pedestrian	0	0.0%
Permanent obstruction on road	0	0.0%
Hit animal	2	1.5%
Off road, on straight	2	1.5%
Off road on straight, hit object	10	7.7%
Out of control on straight	0	0.0%
Off road, on curve	1	0.8%
Off road on curve, hit object	11	8.5%
Out of control on curve	0	0.0%
Other crash type	9	6.9%

Speed Limit				
40 km/h or less	0	0.0%	80 km/h zone	70	53.8%
50 km/h zone	3	2.3%	90 km/h zone	0	0.0%
60 km/h zone	29	22.3%	100 km/h zone	0	0.0%
70 km/h zone	28	21.5%	110 km/h zone	0	0.0%
~ 40km/h or less	0	0.0%			

CRASHES	130	
Fatal crash	3	2.3%
Injury crash	66	50.8%
Non-casualty crash	61	46.9%

Time Group			% of Day
00:01 - 02:59	1	0.8%	12.5%
03:00 - 04:59	4	3.1%	8.3%
05:00 - 05:59	3	2.3%	4.2%
06:00 - 06:59	7	5.4%	4.2%
07:00 - 07:59	8	6.2%	4.2%
08:00 - 08:59	5	3.8%	4.2%
09:00 - 09:59	5	3.8%	4.2%
10:00 - 10:59	10	7.7%	4.2%
11:00 - 11:59	3	2.3%	4.2%
12:00 - 12:59	5	3.8%	4.2%
13:00 - 13:59	5	3.8%	4.2%
14:00 - 14:59	8	6.2%	4.2%
15:00 - 15:59	9	6.9%	4.2%
16:00 - 16:59	10	7.7%	4.2%
17:00 - 17:59	11	8.5%	4.2%
18:00 - 18:59	8	6.2%	4.2%
19:00 - 19:59	5	3.8%	4.2%
20:00 - 21:59	11	8.5%	8.3%
22:00 - 24:00	12	9.2%	8.3%

Street Lighting Off/Nil			% of Dark
15	of	40 in Dark	37.5%

CASUALTIES	110	
Killed	7	6.4%
Injured	103	93.6%
^ Unrestrained	6	5.5%

^ Belt fitted but not worn, No restraint fitted to position OR No helmet worn

Crashes		Casualties
28	2008	22
23	2007	17
18	2006	15
24	2005	26
37	2004	30

~ School Travel Time		
Involvement	27	20.8%

McLean Periods			% Week
A	20	15.4%	17.9%
B	7	5.4%	7.1%
C	24	18.5%	17.9%
D	6	4.6%	3.5%
E	6	4.6%	3.6%
F	27	20.8%	10.7%
G	15	11.5%	7.1%
H	7	5.4%	7.1%
I	5	3.8%	12.5%
J	13	10.0%	10.7%

Day of the Week						# Holiday Periods					
Monday	24	18.5%	Thursday	17	13.1%	Sunday	12	9.2%	New Year	0	0.0%	Queen's BD	2	1.5%	Easter SH	6	4.6%
Tuesday	20	15.4%	Friday	23	17.7%	WEEKDAY	98	75.4%	Aust. Day	0	0.0%	Labour Day	1	0.8%	June/July SH	6	4.6%
Wednesday	14	10.8%	Saturday	20	15.4%	WEEKEND	32	24.6%	Easter	2	1.5%	Christmas	1	0.8%	Sept./Oct. SH	1	0.8%
									Anzac Day	3	2.3%	January SH	7	5.4%	December SH	2	1.5%

Crashid dataset 3609 - All crashes selected for the entire length of Bringelly Rd from 10m east of The Northern Rd to Camden Valley Way. 2004 to 2008 data selected only.

Percentages are percentages of all crashes. Unknown values for each category are not shown on this report.

Appendix C

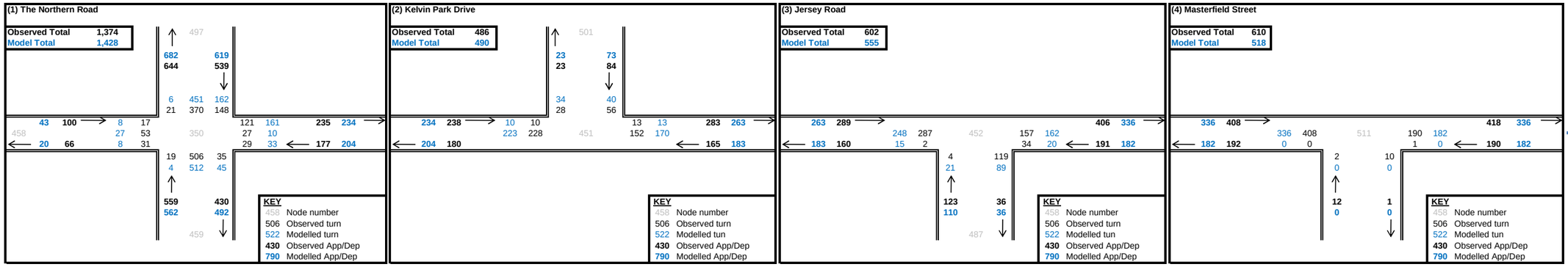
Base Year Calibration Results

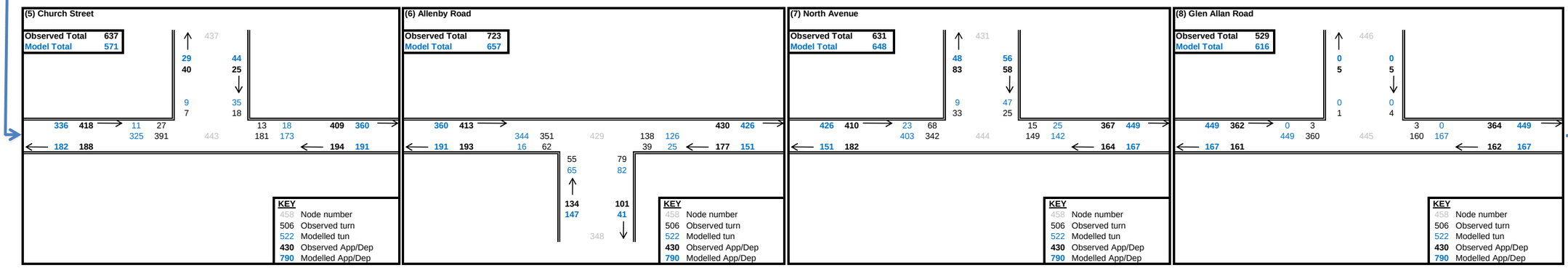
AECOM Sydney Strategic Model
Model Calibration Strategic Summary

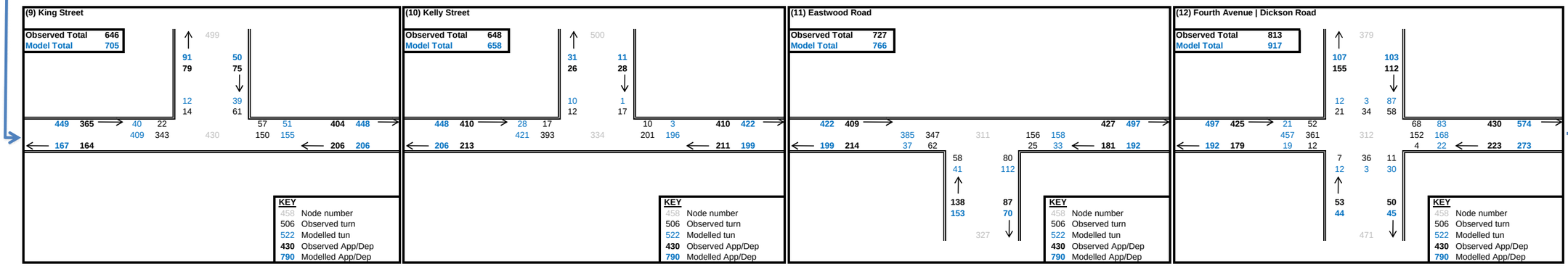
Base Year:	2008 AM Peak
Peak Period:	Average 1 Hour (07:00 - 09:00)
Veh Type:	All Vehicles
Filename:	MdlCal_toOct2007_Sc0926.xlsm
Scenario:	0926
Date:	Wednesday, February 2, 2011

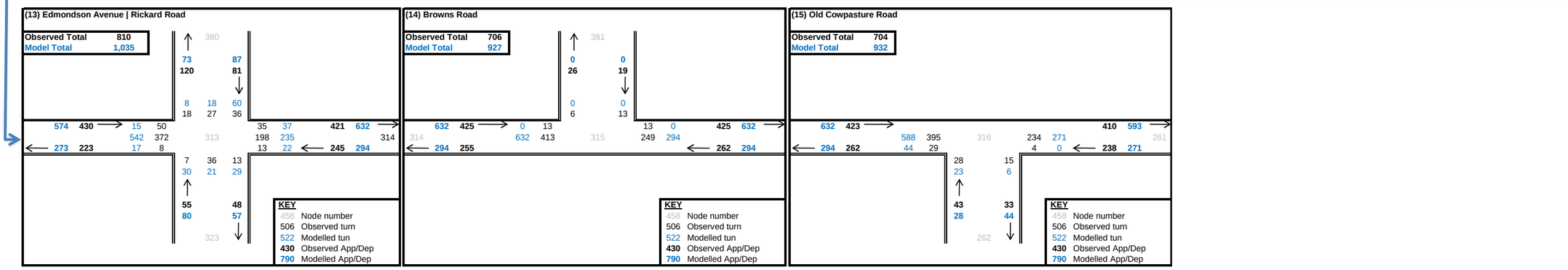
Screenline	INBOUND					OUTBOUND				
	08 Obs Dir 1	06 Mdl Dir 1	Difference	% Diff	GEH	08 Obs Dir 2	08 Mdl Dir 2	Difference	% Diff	GEH
1. Berowra to Sutherland	**41,289**	**41,198**	**-91**	**-0.2%**	0.4	**29,537**	**29,778**	**241**	**0.8%**	1.4
Sub Screenline 1a	4,095	4,302	207	5.1%	3.2	4,049	3,752	-297	-7.3%	4.8
Sub Screenline 1b	12,023	12,122	99	0.8%	0.9	6,516	6,589	74	1.1%	0.9
Sub Screenline 1c	8,997	8,770	-228	-2.5%	2.4	8,216	8,282	67	0.8%	0.7
Sub Screenline 1d	13,461	13,337	-124	-0.9%	1.1	8,679	8,947	268	3.1%	2.9
Sub Screenline 1e	2,713	2,667	-46	-1.7%	0.9	2,078	2,208	130	6.2%	2.8
2. Sydney Harbour to Penrith	**48,716**	**48,441**	**-275**	**-0.6%**	1.2	**40,707**	**40,397**	**-311**	**-0.8%**	1.5
Sub Screenline 2a	14,303	14,417	114	0.8%	1.0	12,946	12,916	-30	-0.2%	0.3
Sub Screenline 2b	26,936	26,661	-275	-1.0%	1.7	21,444	21,037	-407	-1.9%	2.8
Sub Screenline 2c	7,477	7,363	-115	-1.5%	1.3	6,317	6,443	126	2.0%	1.6
4. Taren Point to Bringelly	**20,357**	**20,269**	**-89**	**-0.4%**	0.6	**10,888**	**10,526**	**-363**	**-3.3%**	3.5
Sub Screenline 4a	7,909	7,814	-95	-1.2%	1.1	3,501	3,460	-41	-1.2%	0.7
Sub Screenline 4b	10,624	10,655	31	0.3%	0.3	6,140	6,074	-66	-1.1%	0.9
Sub Screenline 4c	1,825	1,800	-25	-1.4%	0.6	1,248	992	-255	-20.5%	7.6
5. Kogarah to Wallacia	**50,541**	**50,628**	**87**	**0.2%**	0.4	**30,471**	**29,861**	**-610**	**-2.0%**	3.5
Sub Screenline 5a	29,563	30,288	725	2.5%	4.2	15,031	15,016	-15	-0.1%	0.1
Sub Screenline 5b	15,423	15,168	-255	-1.7%	2.1	9,919	9,917	-2	0.0%	0.0
Sub Screenline 5c	5,555	5,172	-383	-6.9%	5.2	5,520	4,927	-593	-10.7%	8.2
6. Rushcutters Bay to Botany	**18,679**	**18,632**	**-47**	**-0.3%**	0.3	**15,482**	**15,589**	**107**	**0.7%**	0.9
Sub Screenline 6a	7,401	7,565	164	2.2%	1.9	4,081	4,222	141	3.4%	2.2
Sub Screenline 6b	11,279	11,067	-211	-1.9%	2.0	11,401	11,368	-34	-0.3%	0.3
7. Drummoyne to Marrickville Total	**14,136**	**14,342**	**206**	**1.5%**	1.7	**8,238**	**8,225**	**-13**	**-0.2%**	0.1
8. Pittwater to Manly	**9,538**	**9,600**	**62**	**0.6%**	0.6	**5,865**	**5,876**	**11**	**0.2%**	0.1
9. Castlereagh to St Ives	**29,407**	**29,414**	**8**	**0.0%**	0.0	**17,930**	**17,849**	**-81**	**-0.5%**	0.6
Sub Screenline 9a	2,532	2,492	-40	-1.6%	0.8	2,213	2,065	-148	-6.7%	3.2
Sub Screenline 9b	6,732	7,466	734	10.9%	8.7	5,147	5,082	-65	-1.3%	0.9
Sub Screenline 9c	12,063	11,688	-375	-3.1%	3.4	5,954	6,019	65	1.1%	0.8
Sub Screenline 9d	8,079	7,768	-312	-3.9%	3.5	4,616	4,682	66	1.4%	1.0
12. Campbelltown to Windsor	**20,087**	**19,354**	**-733**	**-3.6%**	5.2	**15,051**	**14,146**	**-905**	**-6.0%**	7.5
Sub Screenline 12a	1,653	1,567	-86	-5.2%	2.1	2,094	1,879	-214	-10.2%	4.8
Sub Screenline 12b	12,821	12,575	-246	-1.9%	2.2	8,693	8,366	-327	-3.8%	3.5
Sub Screenline 12c	5,613	5,212	-401	-7.2%	5.5	4,265	3,901	-364	-8.5%	5.7
15. Lane Cove to North Shore	**18,332**	**17,813**	**-520**	**-2.8%**	3.9	**12,216**	**11,895**	**-321**	**-2.6%**	2.9
Sub Screenline 15a	13,651	13,207	-444	-3.3%	3.8	9,222	8,905	-317	-3.4%	3.3
Sub Screenline 15b	4,681	4,605	-75	-1.6%	1.1	2,994	2,990	-4	-0.1%	0.1
16. West and South of the CBD	**19,497**	**19,828**	**330**	**1.7%**	2.4	**14,163**	**13,824**	**-340**	**-2.4%**	2.9
Sub Screenline 16a	9,882	9,996	114	1.2%	1.1	5,840	5,971	131	2.2%	1.7
Sub Screenline 16b	9,616	9,832	216	2.2%	2.2	8,323	7,853	-470	-5.7%	5.2
AECOM Screenline 1	**3,080**	**2,885**	**-195**	**-6.3%**	3.6	**1,417**	**1,267**	**-150**	**-10.6%**	4.1
AECOM Screenline 2	**2,125**	**2,025**	**-100**	**-4.7%**	2.2	**1,129**	**1,040**	**-89**	**-7.8%**	2.7
AECOM Screenline 3	**1,495**	**1,668**	**173**	**11.6%**	4.4	**728**	**811**	**83**	**11.4%**	3.0

Roads and Traffic Authority
Bringelly Road Traffic Assessment
AM Average Peak one hour Intersection Flow Comparison

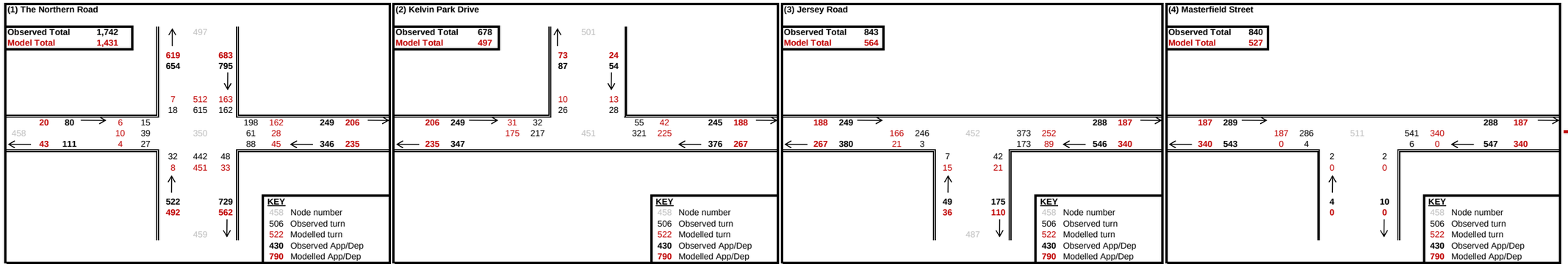


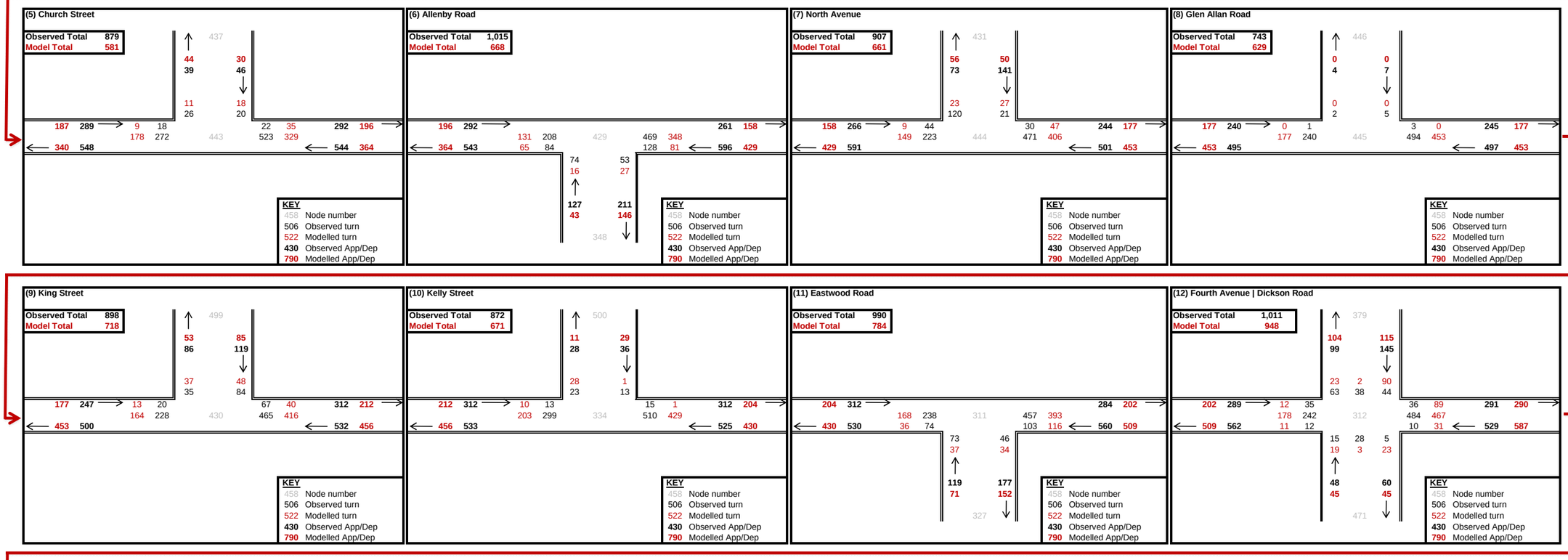


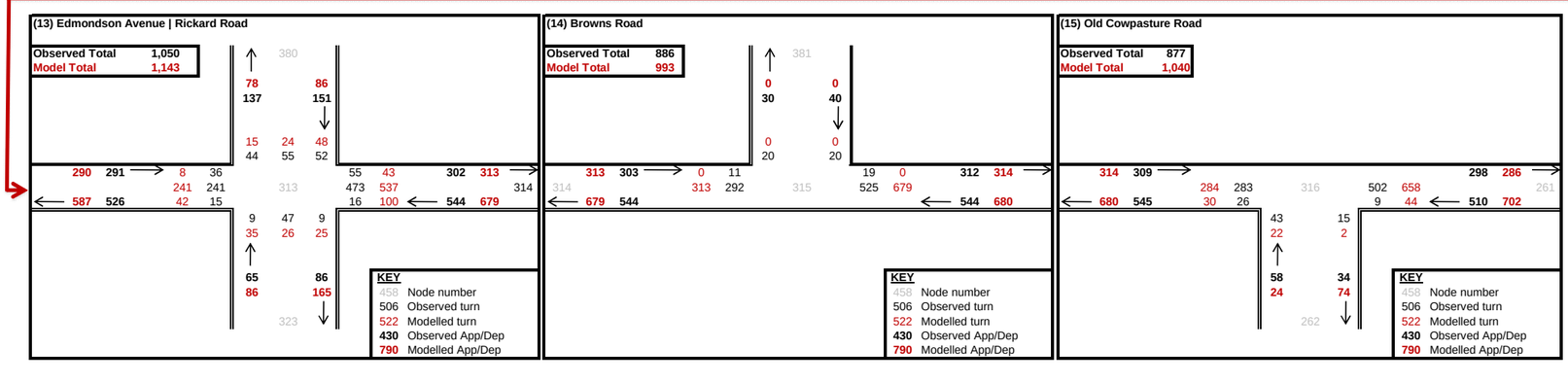




Roads and Traffic Authority
Bringelly Road Traffic Assessment
PM Average Peak one hour Intersection Flow Comparison







Appendix D

Forecast Model Trip Ends

AECOM Sydney Strategic Model

Model Trip Ends (PCUs) by year

	SLA Name	2008		2011		2016		2021		2026		2031		2036	
		Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest
	Liverpool - West	8,261	5,550	9,102	6,158	12,546	7,765	15,839	9,786	18,832	11,526	21,817	13,055	28,331	15,722
	Campbelltown - North	7,318	7,420	7,530	7,767	7,974	8,357	8,669	9,083	9,282	9,839	9,970	10,587	10,695	11,424
	Camden	6,911	5,835	9,005	7,442	13,267	10,086	17,058	12,425	22,627	16,137	27,588	19,794	31,142	22,140

Zone (TZ06)	SLA Name	2008		2011		2016		2021		2026		2031		2036	
		Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest
1140	Liverpool - West	381	177	390	186	404	197	409	204	410	212	410	220	411	230
1142	Liverpool - West	399	197	412	206	431	219	456	233	481	250	503	268	552	295
1143	Liverpool - West	69	72	72	77	81	83	87	90	96	97	103	104	117	114
1144	Liverpool - West	280	110	293	117	306	123	326	131	344	140	362	149	399	164
1146	Liverpool - West	376	136	390	143	406	150	431	159	453	169	474	180	519	198
1148	Liverpool - West	1	28	7	136	201	242	208	290	213	319	219	374	223	377
1149	Liverpool - West	390	143	405	150	421	158	447	167	470	178	492	188	540	207
1150	Liverpool - West	331	274	346	290	361	316	385	343	406	369	427	398	469	437
1151	Liverpool - West	4	3	39	18	183	85	190	87	196	91	202	95	206	97
1152	Liverpool - West	254	123	266	130	277	138	295	147	311	158	326	168	358	185
1154	Liverpool - West	308	134	321	141	334	148	355	158	374	168	392	179	430	196
1156	Liverpool - West	42	100	139	127	535	272	557	280	574	293	591	305	603	318
1157	Liverpool - West	178	91	193	98	224	111	250	123	282	137	309	151	357	171
1158	Liverpool - West	333	118	357	127	373	134	404	144	427	154	454	166	502	184
1159	Liverpool - West	432	189	480	207	568	237	591	247	615	261	634	274	647	288
1160	Liverpool - West	376	243	414	260	449	281	499	307	543	333	589	361	666	401
1161	Liverpool - West	26	20	27	22	32	24	35	26	39	28	43	30	49	33
1164	Liverpool - West	181	88	207	98	239	111	274	124	310	138	344	153	399	175
1165	Liverpool - West	23	411	24	431	25	450	26	475	27	496	28	518	29	547
1167	Liverpool - West	21	266	22	282	23	290	24	303	25	313	25	324	26	341
1169	Liverpool - West	484	239	532	260	616	292	635	305	651	322	668	338	682	357
1170	Liverpool - West	139	230	235	263	444	337	633	401	844	471	882	506	933	548
1171	Liverpool - West	352	144	386	157	446	178	501	196	565	219	621	241	717	275
1172	Liverpool - West	289	122	317	135	336	145	371	158	398	170	429	184	481	204
1173	Liverpool - West	265	103	293	113	315	122	350	133	380	145	412	158	464	177
1174	Liverpool - West	537	271	590	295	629	318	697	349	752	380	813	414	914	464
1175	Liverpool - West	336	167	398	189	446	209	505	231	554	254	612	279	653	302
1176	Liverpool - West	2	50	2	53	3	63	3	70	3	77	4	84	4	93
1179	Liverpool - West	57	38	58	40	61	43	65	46	68	49	71	52	78	56
1180	Liverpool - West	41	40	43	42	45	45	48	48	50	51	53	55	58	59
1181	Liverpool - West	65	63	67	66	71	70	75	74	79	78	82	82	90	88
1182	Liverpool - West	37	111	37	119	39	123	55	345	67	392	279	478	1,091	697
1183	Liverpool - West	16	31	16	33	16	34	23	159	27	184	57	215	212	282
1184	Liverpool - West	33	15	33	15	55	22	130	164	292	232	416	288	422	313
1185	Liverpool - West	27	21	27	22	45	28	99	43	226	79	323	107	328	110
1186	Liverpool - West	149	157	149	164	153	174	161	186	169	197	252	225	1,024	421
1187	Liverpool - West	60	52	60	54	62	57	65	61	67	64	59	65	240	138
1188	Liverpool - West	12	56	12	59	13	64	15	69	16	74	17	80	19	86
1189	Liverpool - West	22	20	22	21	23	22	26	24	28	25	56	45	234	136
1190	Liverpool - West	44	37	44	39	45	41	48	44	50	47	62	54	258	154
1191	Liverpool - West	43	37	43	38	44	41	48	44	51	47	62	52	255	150
1192	Liverpool - West	44	39	44	41	45	44	48	47	50	50	63	56	261	155
1193	Liverpool - West	9	9	9	9	10	9	11	10	13	11	70	27	294	157
1194	Liverpool - West	8	8	8	8	9	9	10	9	12	10	56	23	238	133
1195	Liverpool - West	13	6	13	6	14	6	15	7	16	7	25	10	105	56
1196	Liverpool - West	79	50	79	53	81	55	85	59	88	62	91	66	379	189
1197	Liverpool - West	56	43	56	45	57	47	60	50	63	54	74	59	307	139
1198	Liverpool - West	40	29	40	31	41	33	44	35	46	37	53	41	218	98
1199	Liverpool - West	19	13	19	13	159	52	299	107	439	172	579	236	719	284
1200	Liverpool - West	49	34	50	35	244	91	439	156	634	243	829	329	1,023	396
1201	Liverpool - West	66	28	66	31	214	71	361	133	509	200	657	267	804	318
1202	Liverpool - West	52	53	52	56	192	98	330	138	468	182	607	245	746	293
1203	Liverpool - West	95	101	95	107	377	174	657	248	941	404	1,223	516	1,502	583
1204	Liverpool - West	61	47	62	75	165	121	266	190	368	282	469	354	569	404
1205	Liverpool - West	42	53	43	81	135	124	225	178	317	269	408	339	498	384
1206	Liverpool - West	124	61	124	63	292	112	519	182	907	327	1,417	500	1,957	662
1207	Liverpool - West	29	19	36	21	52	27	125	53	150	68	150	69	150	71
1208	Liverpool - West	26	14	59	24	234	83	566	231	682	302	682	306	682	308

AECOM Sydney Strategic Model

Model Trip Ends (PCUs) by year

	SLA Name	2008		2011		2016		2021		2026		2031		2036	
		Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest
	Liverpool - West	8,261	5,550	9,102	6,158	12,546	7,765	15,839	9,786	18,832	11,526	21,817	13,055	28,331	15,722
	Campbelltown - North	7,318	7,420	7,530	7,767	7,974	8,357	8,669	9,083	9,282	9,839	9,970	10,587	10,695	11,424
	Camden	6,911	5,835	9,005	7,442	13,267	10,086	17,058	12,425	22,627	16,137	27,588	19,794	31,142	22,140

Zone (TZ06)	SLA Name	2008		2011		2016		2021		2026		2031		2036	
		Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest
1209	Liverpool - West	27	13	47	19	145	56	350	147	422	190	422	192	422	194
1210	Liverpool - West	3	7	15	10	233	334	459	552	572	697	583	723	596	736
1211	Liverpool - West	4	1	13	4	69	25	167	70	201	91	201	92	201	93
1229	Campbelltown - North	54	81	100	92	249	121	268	133	288	146	310	160	319	175
1230	Campbelltown - North	138	68	139	70	141	72	148	75	153	79	160	84	165	89
1232	Campbelltown - North	82	17	99	19	118	22	142	25	164	29	190	32	214	36
1233	Campbelltown - North	283	149	288	157	292	165	308	176	319	187	337	201	349	215
1234	Campbelltown - North	151	130	156	139	160	151	172	166	184	181	200	198	214	218
1236	Campbelltown - North	270	252	274	263	277	279	292	300	300	321	315	345	324	372
1237	Campbelltown - North	362	157	368	163	375	172	396	183	409	194	431	208	445	222
1238	Campbelltown - North	29	14	29	14	29	14	31	15	32	16	33	17	34	18
1239	Campbelltown - North	8	451	8	464	9	497	10	539	10	574	11	608	11	651
1240	Campbelltown - North	52	1,016	53	1,041	56	1,125	61	1,215	64	1,292	67	1,369	70	1,464
1241	Campbelltown - North	162	278	166	299	171	326	182	354	189	381	200	410	208	444
1242	Campbelltown - North	307	196	310	206	315	217	319	229	324	243	328	257	366	285
1243	Campbelltown - North	14	30	15	32	15	34	16	38	17	42	18	46	19	51
1244	Campbelltown - North	368	198	376	207	384	219	406	232	421	246	444	263	460	280
1245	Campbelltown - North	235	105	238	109	242	113	246	116	250	120	254	124	327	149
1246	Campbelltown - North	7	641	7	670	8	717	8	770	9	814	9	858	10	915
1247	Campbelltown - North	262	117	267	122	272	127	287	134	296	141	312	150	323	159
1248	Campbelltown - North	201	100	205	105	209	110	220	116	228	123	240	132	249	141
1249	Campbelltown - North	233	144	236	150	240	158	253	169	261	181	274	194	283	209
1250	Campbelltown - North	286	120	291	125	297	130	303	134	309	141	314	147	383	173
1251	Campbelltown - North	252	110	256	114	260	119	264	122	269	127	273	132	333	155
1252	Campbelltown - North	272	115	276	119	282	123	297	130	307	137	323	146	334	154
1253	Campbelltown - North	214	112	217	118	222	124	235	133	243	141	256	151	266	160
1254	Campbelltown - North	301	133	306	138	312	144	330	152	341	161	359	171	371	181
1255	Campbelltown - North	278	333	291	353	306	374	331	398	343	418	358	439	377	467
1256	Campbelltown - North	157	125	159	135	161	145	169	156	174	167	183	180	189	193
1257	Campbelltown - North	376	198	382	207	390	217	412	230	426	244	449	261	464	277
1258	Campbelltown - North	207	250	210	270	215	293	227	318	235	342	247	368	256	399
1259	Campbelltown - North	210	98	214	102	218	106	230	112	238	119	251	128	260	136
1260	Campbelltown - North	206	161	210	170	215	185	227	201	236	215	249	232	259	250
1261	Campbelltown - North	277	665	287	697	301	734	323	778	333	812	345	848	361	895
1262	Campbelltown - North	35	24	36	25	36	26	36	27	37	28	37	29	56	37
1263	Campbelltown - North	333	164	339	170	346	178	366	190	379	202	400	217	414	232
1264	Campbelltown - North	11	356	11	366	12	403	14	445	15	483	16	523	17	570
1265	Campbelltown - North	340	164	345	173	351	179	369	189	380	199	399	212	412	225
1266	Campbelltown - North	34	25	35	27	36	29	38	32	41	34	44	38	48	42
1267	Campbelltown - North	289	118	293	123	298	128	315	136	325	144	342	154	354	164
1268	Campbelltown - North	14	4	15	5	15	5	17	5	18	5	19	6	21	6
1269	Campbelltown - North	0	0	0	0	0	0	68	44	312	197	569	332	727	392
1270	Campbelltown - North	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1271	Campbelltown - North	4	1	20	7	113	61	272	139	327	177	328	183	328	187
1272	Campbelltown - North	1	0	4	1	26	14	62	28	75	34	75	35	75	36
1345	Camden	18	9	20	10	21	10	22	11	22	11	22	12	22	13
1347	Camden	17	18	23	21	26	22	26	24	27	25	28	26	28	27
1354	Camden	8	15	8	16	145	55	150	56	154	59	159	61	164	64
1355	Camden	80	69	84	73	87	78	89	84	91	91	94	97	96	106
1356	Camden	8	5	76	29	269	103	281	106	292	112	305	117	317	123
1357	Camden	261	94	310	107	334	116	345	120	354	125	358	130	359	134
1358	Camden	281	108	530	202	928	356	934	354	939	361	941	366	943	371
1360	Camden	51	22	51	23	51	23	52	24	52	25	53	26	54	28
1361	Camden	40	53	43	57	120	77	124	82	127	88	131	94	135	101
1362	Camden	297	144	406	174	462	196	473	205	483	217	494	229	506	243
1363	Camden	114	376	120	395	172	427	176	451	179	472	182	493	186	521
1364	Camden	16	453	16	475	17	505	19	537	19	564	20	593	21	631
1365	Camden	268	73	400	105	470	122	482	124	495	129	508	134	521	139

AECOM Sydney Strategic Model

Model Trip Ends (PCUs) by year

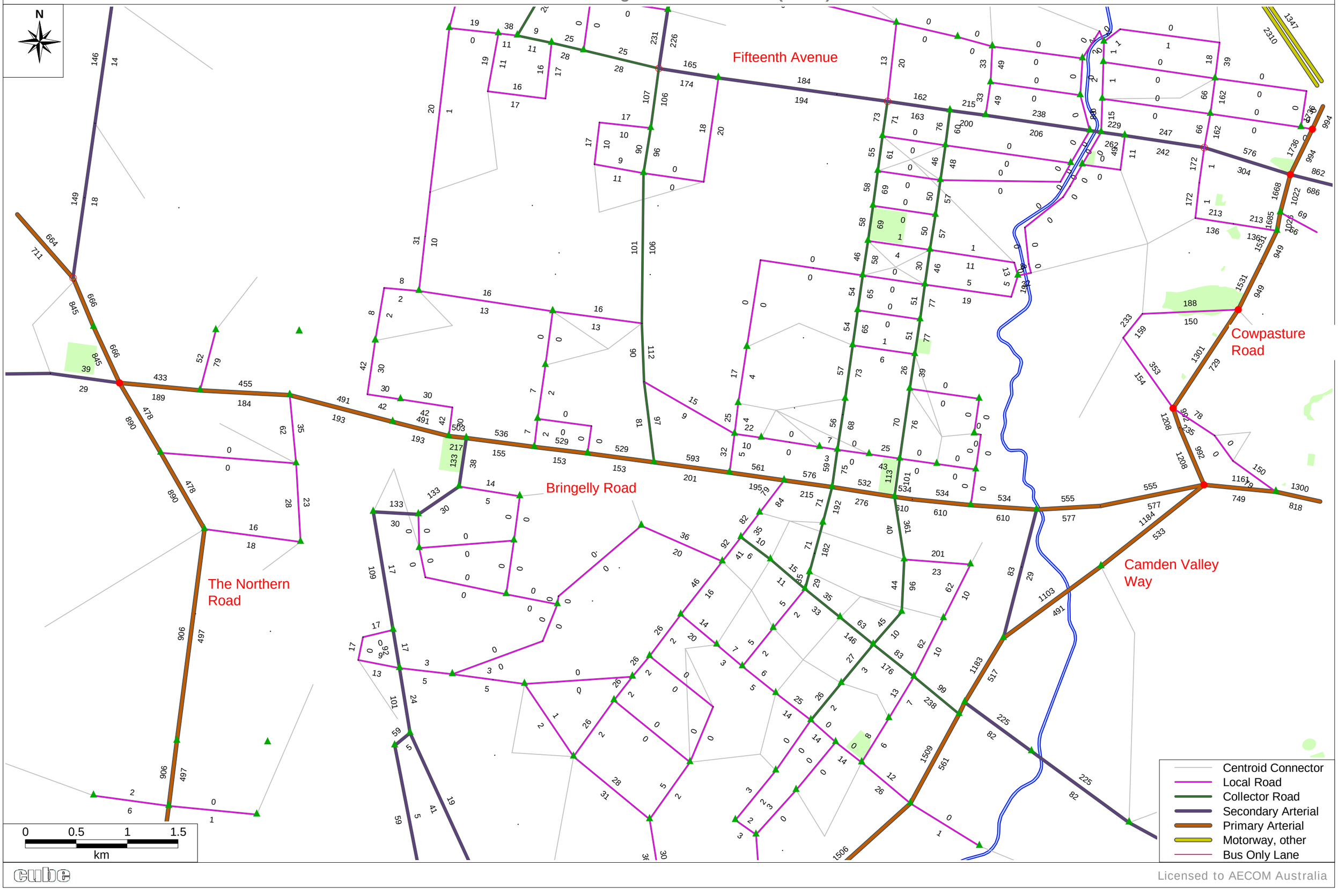
	SLA Name	2008		2011		2016		2021		2026		2031		2036	
		Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest
	Liverpool - West	8,261	5,550	9,102	6,158	12,546	7,765	15,839	9,786	18,832	11,526	21,817	13,055	28,331	15,722
	Campbelltown - North	7,318	7,420	7,530	7,767	7,974	8,357	8,669	9,083	9,282	9,839	9,970	10,587	10,695	11,424
	Camden	6,911	5,835	9,005	7,442	13,267	10,086	17,058	12,425	22,627	16,137	27,588	19,794	31,142	22,140

Zone (TZ06)	SLA Name	2008		2011		2016		2021		2026		2031		2036	
		Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest	Orig	Dest
1366	Camden	216	163	224	174	236	188	250	204	275	222	304	242	329	265
1367	Camden	209	481	216	513	370	599	378	650	386	698	395	748	404	809
1368	Camden	215	82	275	98	310	109	315	113	321	118	328	124	334	130
1369	Camden	560	270	561	282	562	298	563	312	564	329	566	346	568	367
1370	Camden	386	150	387	156	387	161	388	168	388	176	390	185	391	196
1371	Camden	80	954	85	1,008	92	1,107	96	1,204	100	1,294	103	1,388	108	1,505
1372	Camden	397	268	398	282	401	305	402	326	403	348	405	371	407	398
1373	Camden	59	42	490	187	742	284	786	297	830	317	888	343	976	381
1374	Camden	479	210	480	217	480	225	481	235	482	247	483	259	485	275
1375	Camden	345	171	396	189	426	204	431	214	437	226	443	238	449	254
1376	Camden	366	251	378	268	393	289	409	310	437	335	469	361	497	393
1377	Camden	22	10	72	27	224	86	233	88	242	92	251	97	260	101
1378	Camden	391	170	392	176	393	184	393	191	394	199	395	208	397	219
1379	Camden	10	13	93	36	343	132	359	136	375	144	397	154	433	170
1380	Camden	285	101	575	220	726	279	756	286	785	301	828	320	899	351
1381	Camden	98	47	104	50	168	67	175	71	186	76	198	82	209	89
1382	Camden	21	10	95	36	316	121	331	125	345	132	365	141	397	155
1383	Camden	574	269	582	282	588	295	589	306	591	321	594	336	597	354
1384	Camden	1	6	4	7	42	16	224	64	515	153	739	250	749	258
1385	Camden	0	1	2	2	36	10	205	65	470	162	676	279	685	284
1386	Camden	58	35	59	37	59	39	59	41	62	43	83	50	342	147
1387	Camden	21	12	21	13	31	16	54	29	124	65	179	115	181	117
1388	Camden	1	5	2	6	40	15	222	81	511	206	732	301	742	306
1389	Camden	0	0	1	0	24	6	133	57	307	148	440	217	445	221
1390	Camden	1	7	3	8	41	17	226	85	519	215	744	315	754	325
1391	Camden	0	0	2	1	28	7	157	68	362	176	519	258	526	262
1392	Camden	1	18	4	20	7	22	7	24	7	27	8	30	8	33
1393	Camden	6	12	51	22	280	132	539	234	763	327	787	343	787	347
1394	Camden	13	18	47	26	206	63	398	134	564	203	583	216	583	219
1395	Camden	5	3	53	18	296	127	572	236	810	336	836	353	836	356
1396	Camden	5	2	48	11	265	65	515	162	729	250	753	266	753	269
1397	Camden	39	27	39	28	40	29	40	30	42	32	59	37	244	96
1398	Camden	41	32	41	34	42	35	42	37	44	39	62	45	255	103
1399	Camden	25	13	25	13	25	14	26	15	107	41	234	90	408	159
1400	Camden	58	23	58	24	58	25	127	41	318	100	581	190	746	271
1401	Camden	44	32	44	34	45	36	117	54	332	105	607	196	779	281
1402	Camden	48	36	48	38	49	41	138	63	410	126	750	242	963	347
1403	Camden	26	31	27	33	29	35	114	57	394	122	721	227	926	326
1404	Camden	11	25	99	105	434	243	799	426	971	705	978	826	977	829
1405	Camden	20	25	88	100	332	205	613	383	747	652	753	768	753	766
1406	Camden	35	24	35	26	36	27	109	45	337	136	617	259	790	323
1407	Camden	28	21	29	22	29	24	88	38	268	109	491	208	628	261
1408	Camden	22	9	22	9	22	9	61	19	181	73	331	137	424	173
1409	Camden	34	23	34	24	34	25	97	40	287	118	524	223	671	279
1410	Camden	20	51	28	180	129	294	229	377	329	473	431	594	535	765
1411	Camden	21	68	33	263	89	402	145	541	202	722	259	894	313	1,015
1412	Camden	16	11	16	12	40	18	76	26	163	50	386	125	712	219
1413	Camden	52	96	68	366	131	991	189	1,429	329	2,131	442	2,917	612	3,198
1414	Camden	14	5	14	5	14	5	36	11	102	34	186	74	239	102
1415	Camden	15	9	15	9	15	10	47	17	148	51	271	110	348	151
1416	Camden	26	18	26	18	26	19	62	28	163	56	299	121	384	167
1417	Camden	13	15	13	16	13	17	49	26	165	56	303	125	389	174
1418	Camden	21	21	21	22	21	23	36	28	69	42	126	69	161	78

Appendix E

Future Year Traffic Forecasts

Bringelly Road Upgrade TA
2011 AM Average Peak Hour Flows (PCUs)



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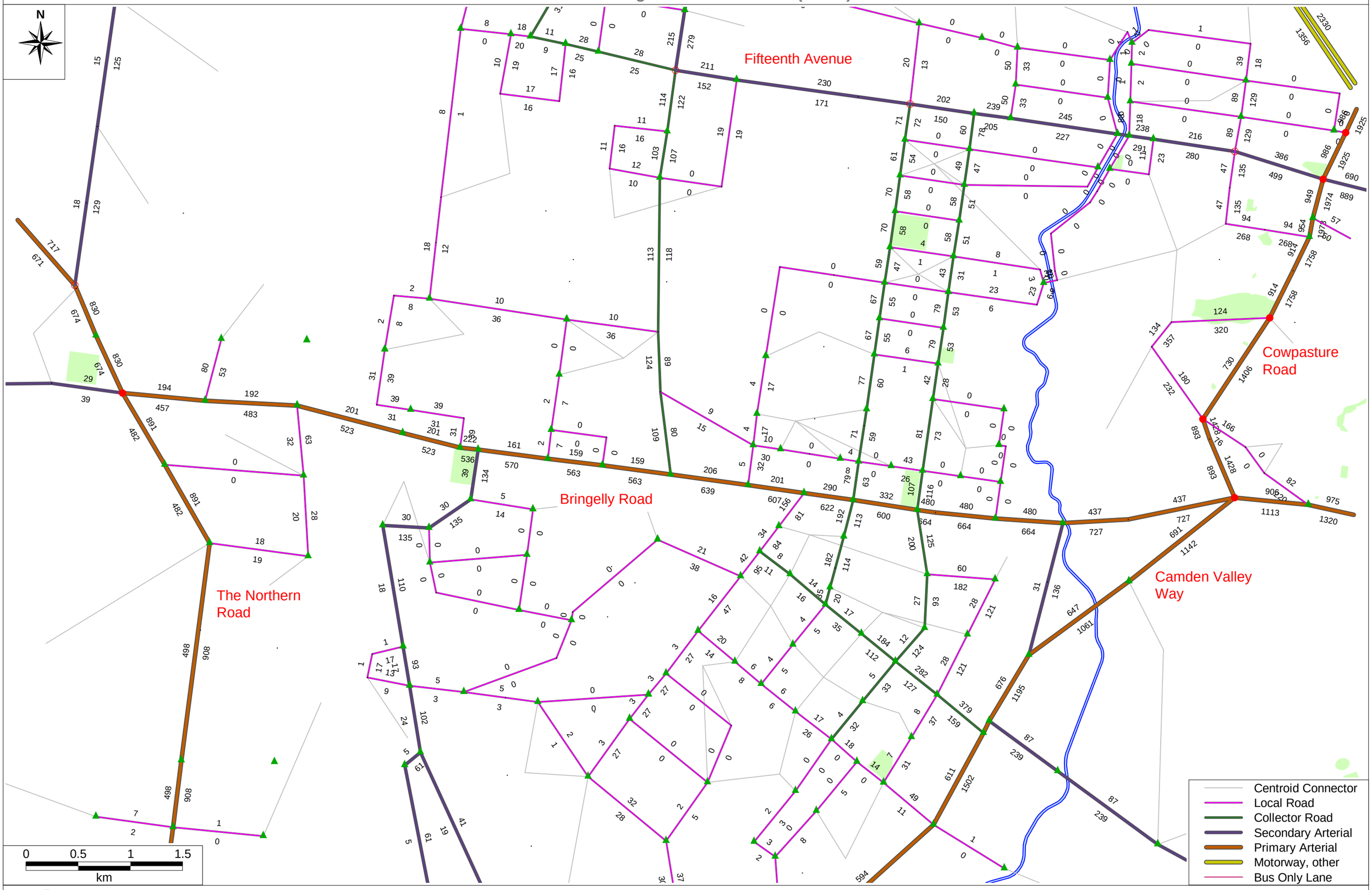
Bringelly Road Upgrade TA
2011 PM Average Peak Hour Flows (PCUs)



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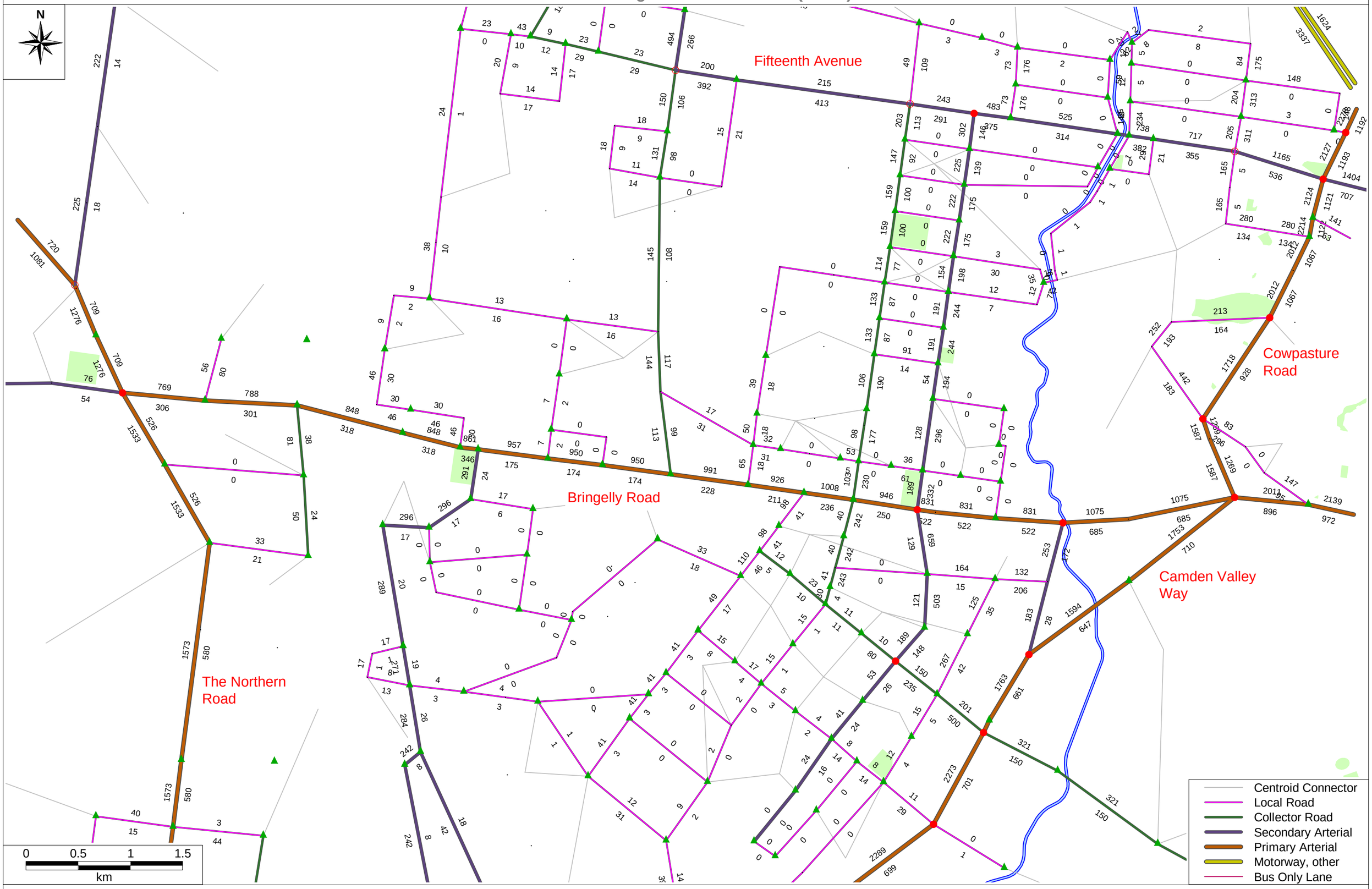
Bringelly Road Upgrade TA
2016 AM Average Peak Hour Flows (PCUs)



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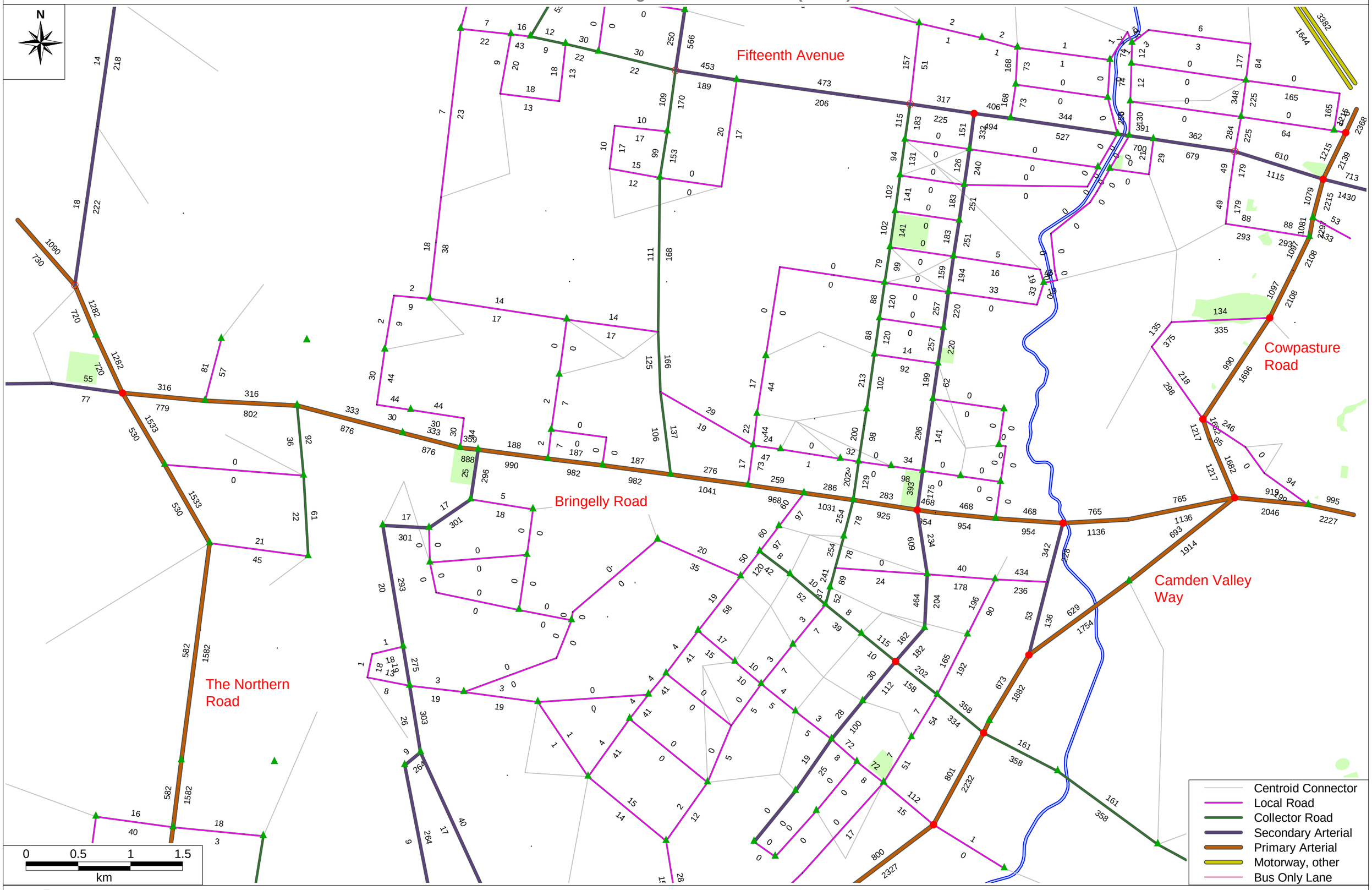
Bringelly Road Upgrade TA
2016 PM Average Peak Hour Flows (PCUs)



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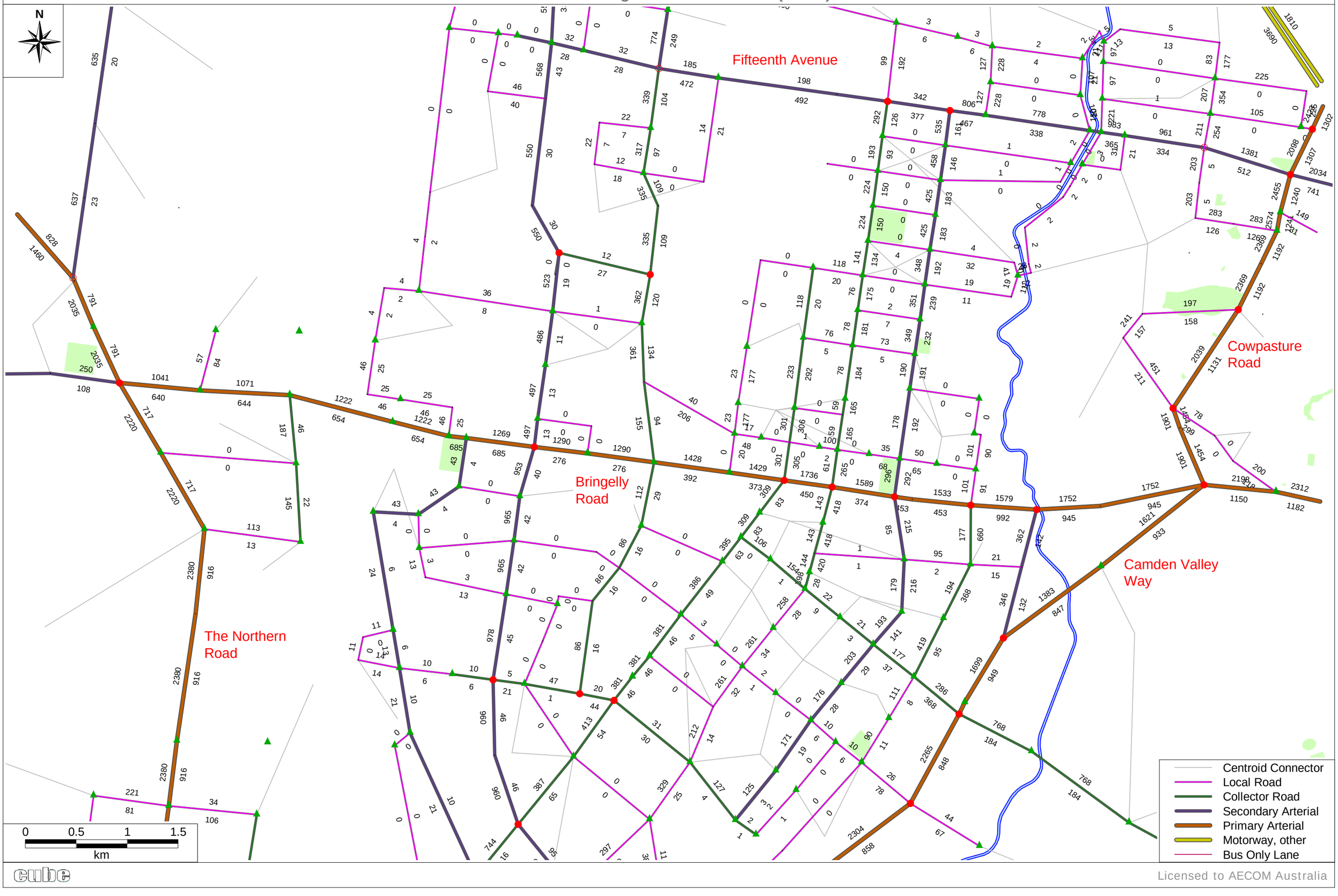
Bringelly Road Upgrade TA
2021 AM Average Peak Hour Flows (PCUs)



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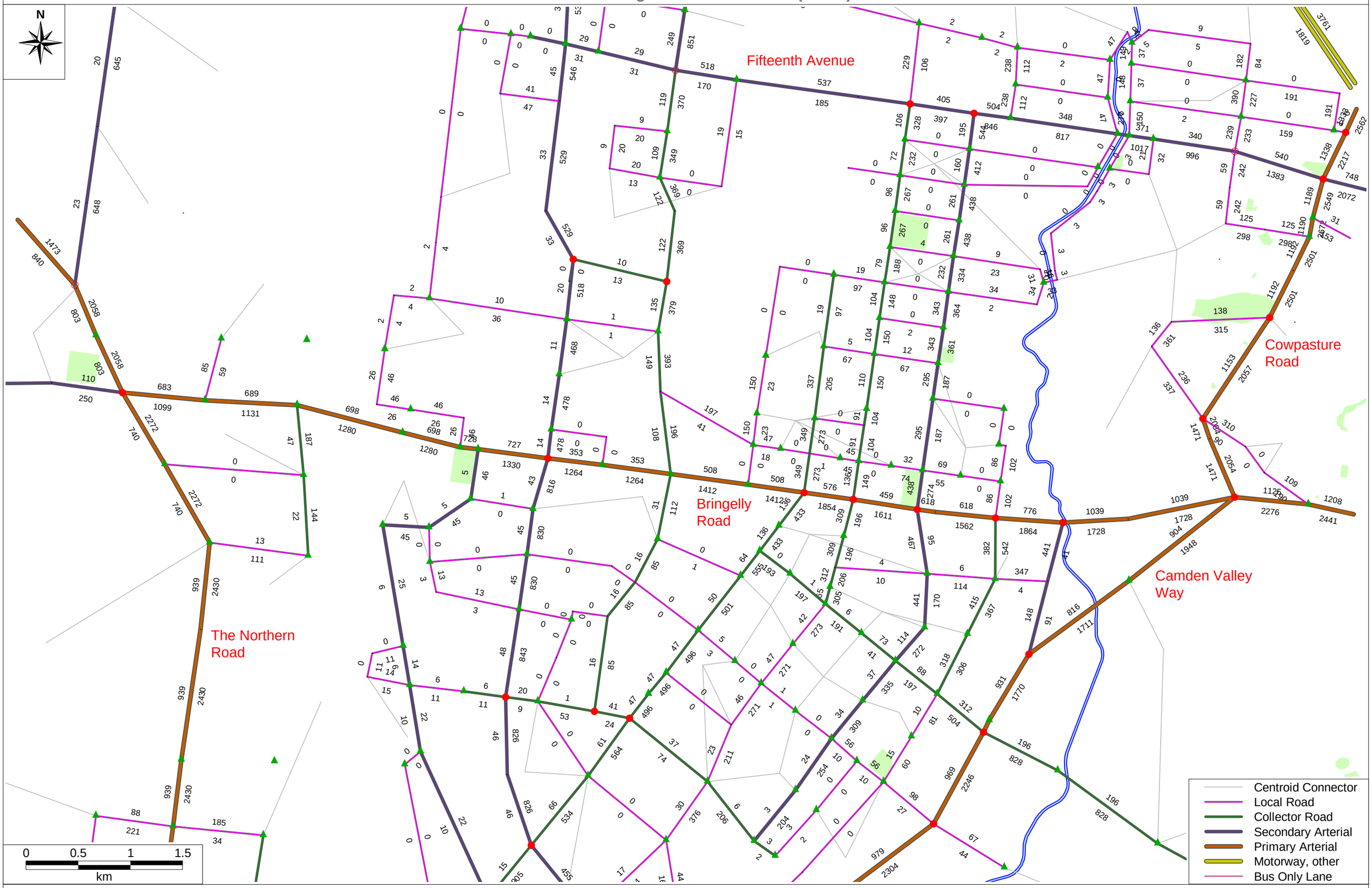
Bringelly Road Upgrade TA
2021 PM Average Peak Hour Flows (PCUs)



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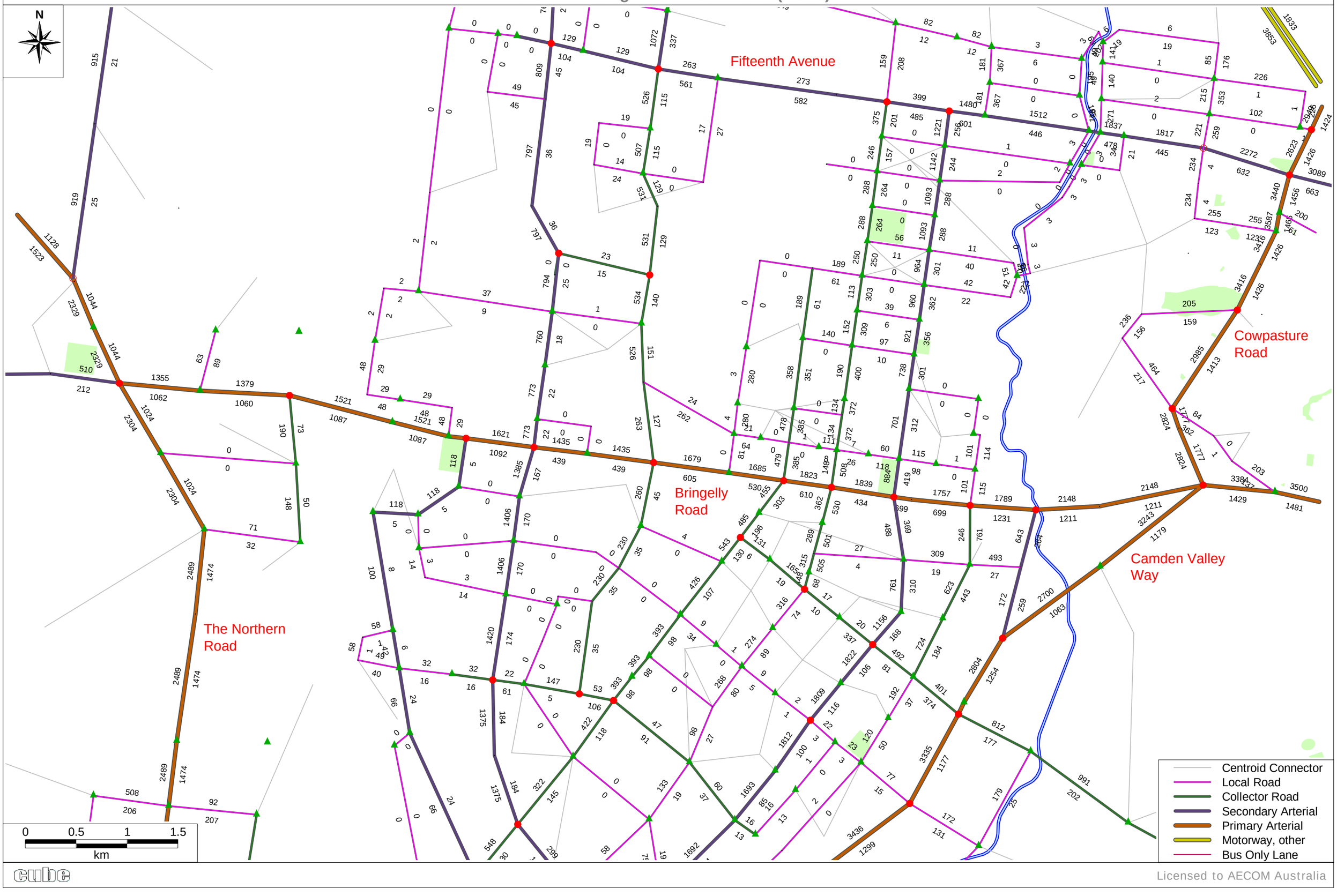
Bringelly Road Upgrade TA
2026 AM Average Peak Hour Flows (PCUs)



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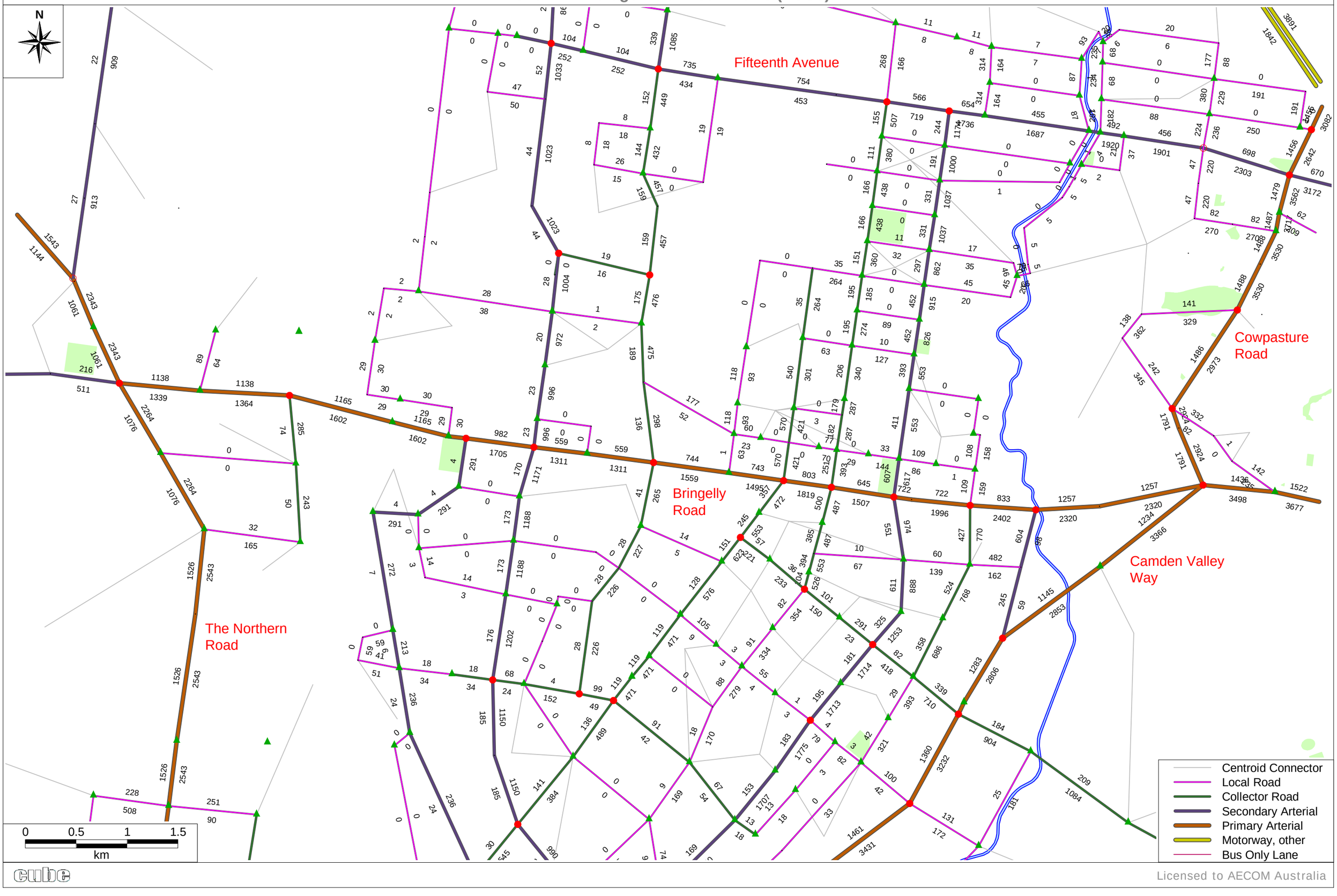
Bringelly Road Upgrade TA
2026 PM Average Peak Hour Flows (PCUs)



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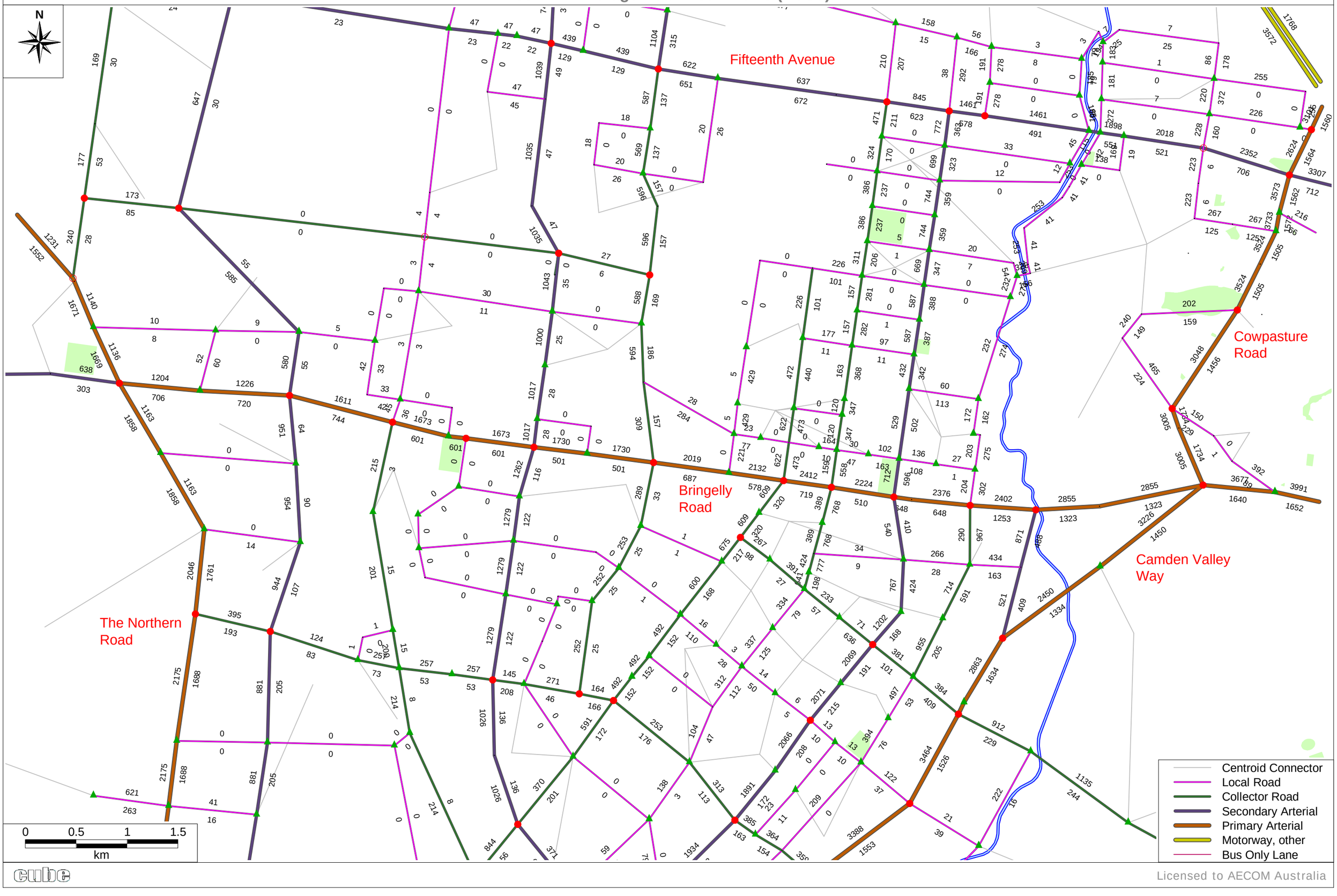
Bringelly Road Upgrade TA
2031 AM Average Peak Hour Flows (PCUs)



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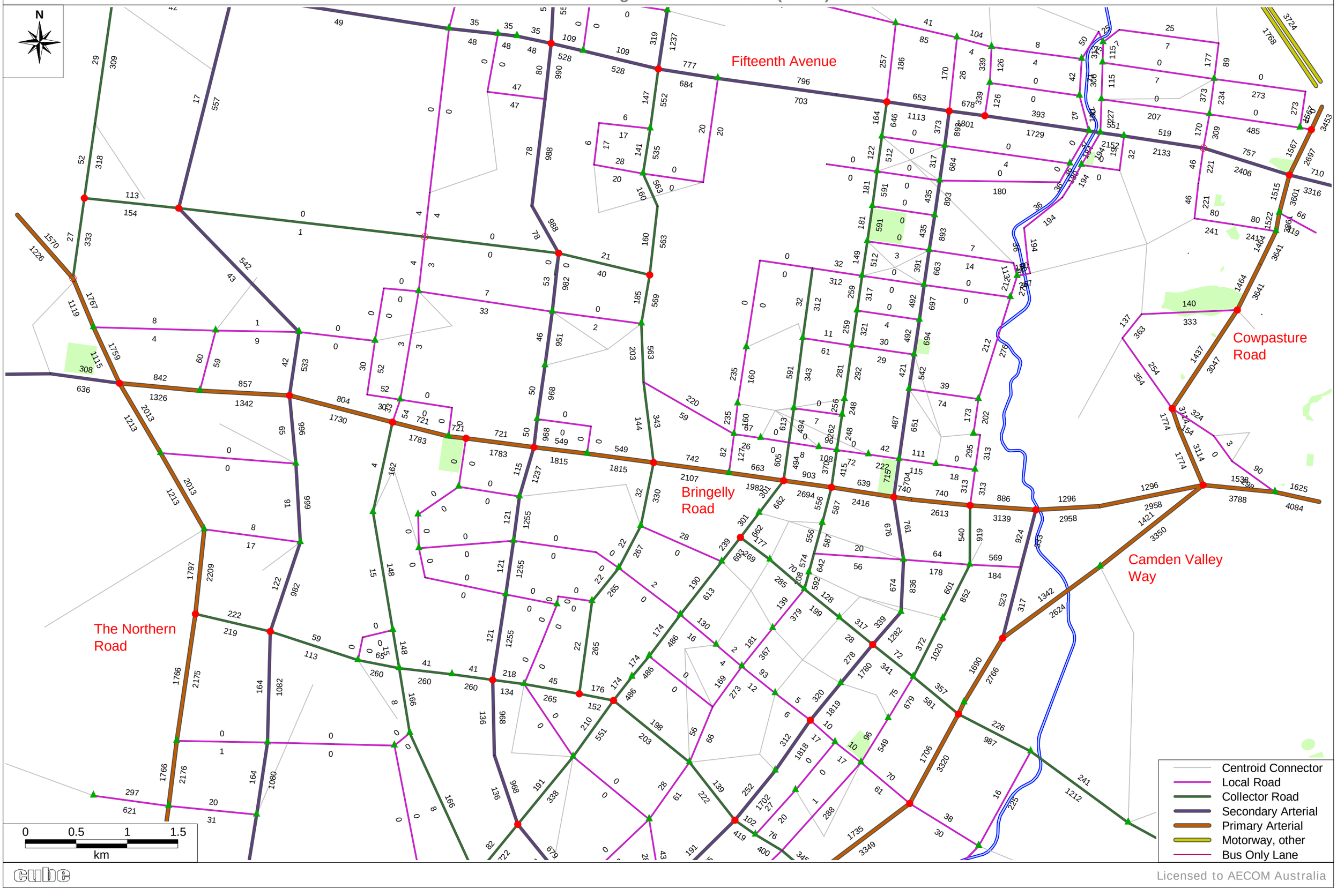
Bringelly Road Upgrade TA
2031 PM Average Peak Hour Flows (PCUs)



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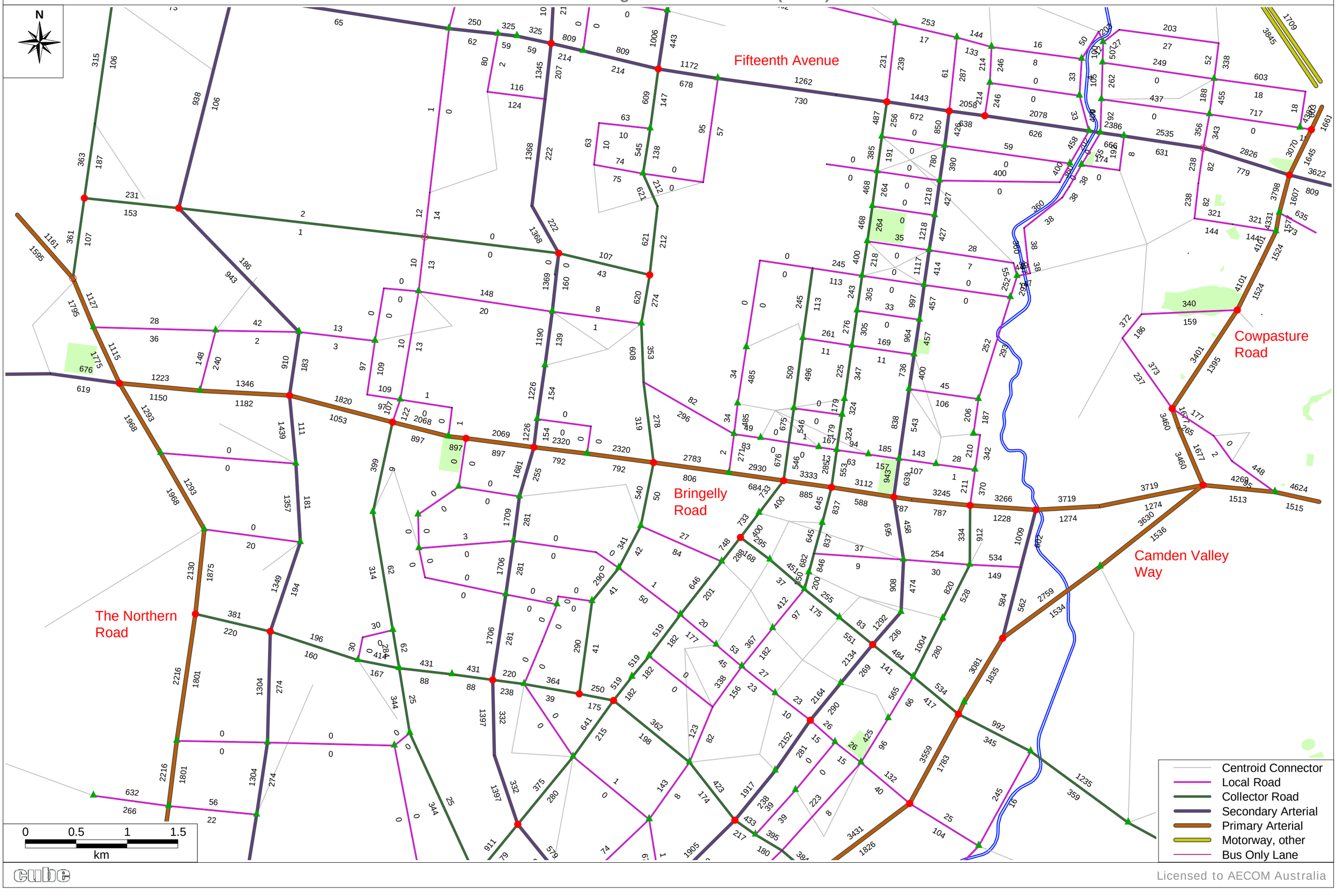
Bringelly Road Upgrade TA
2036 AM Average Peak Hour Flows (PCUs)



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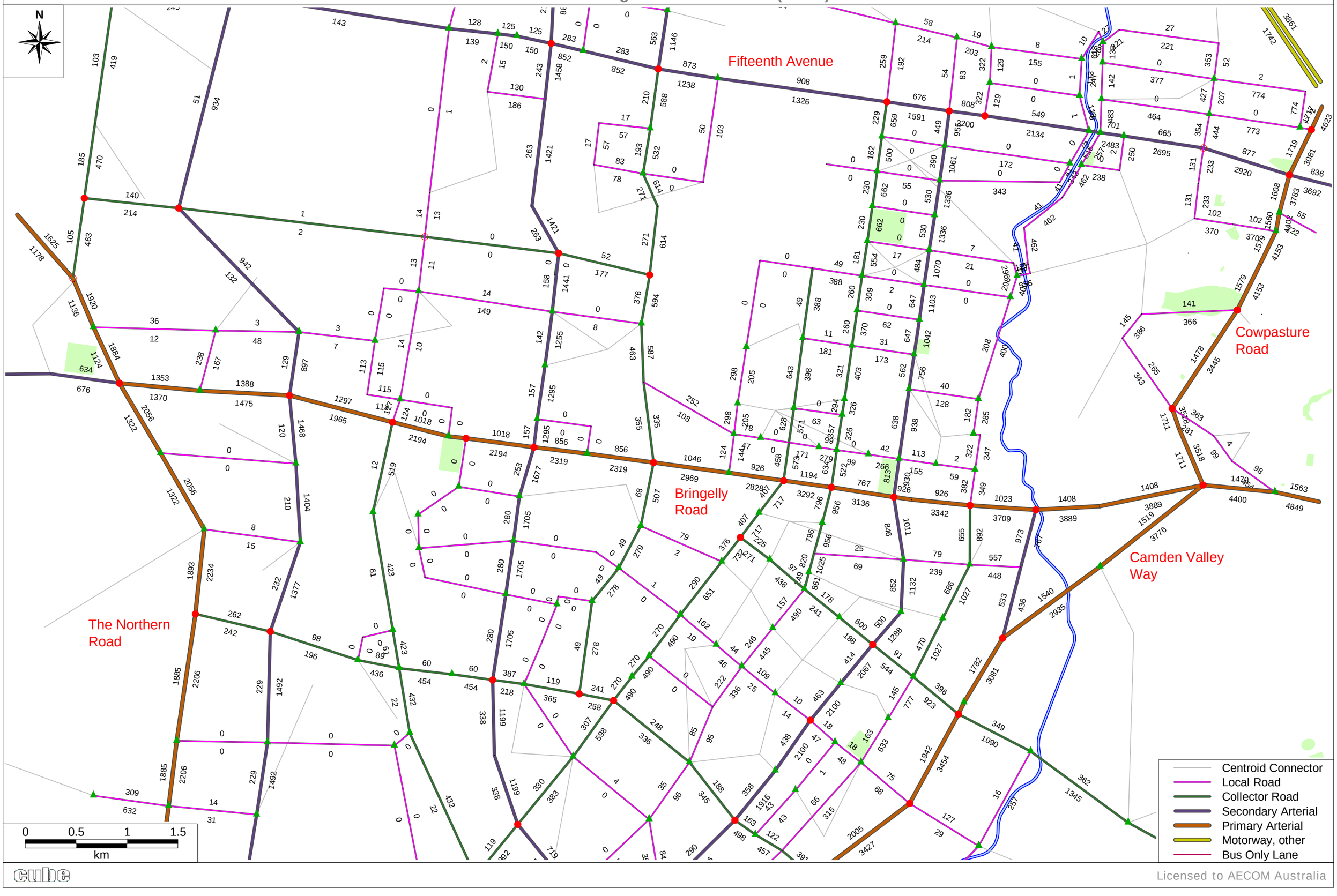
Bringelly Road Upgrade TA
2036 PM Average Peak Hour Flows (PCUs)



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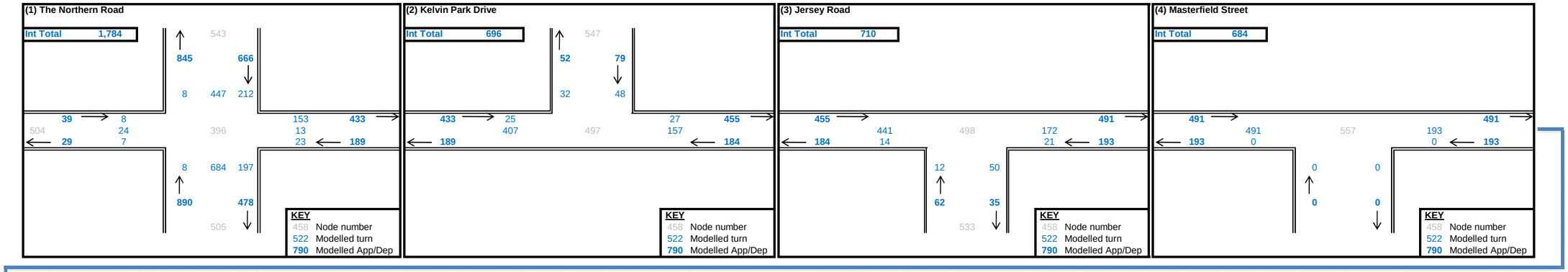
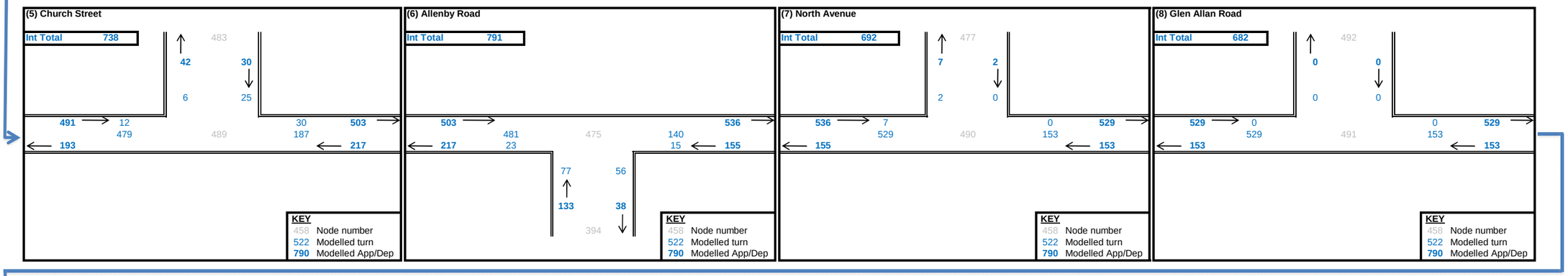
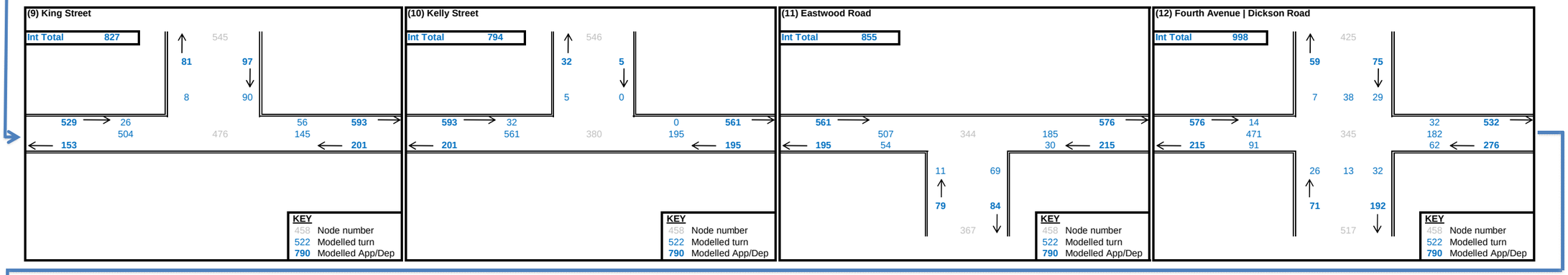
Appendix F

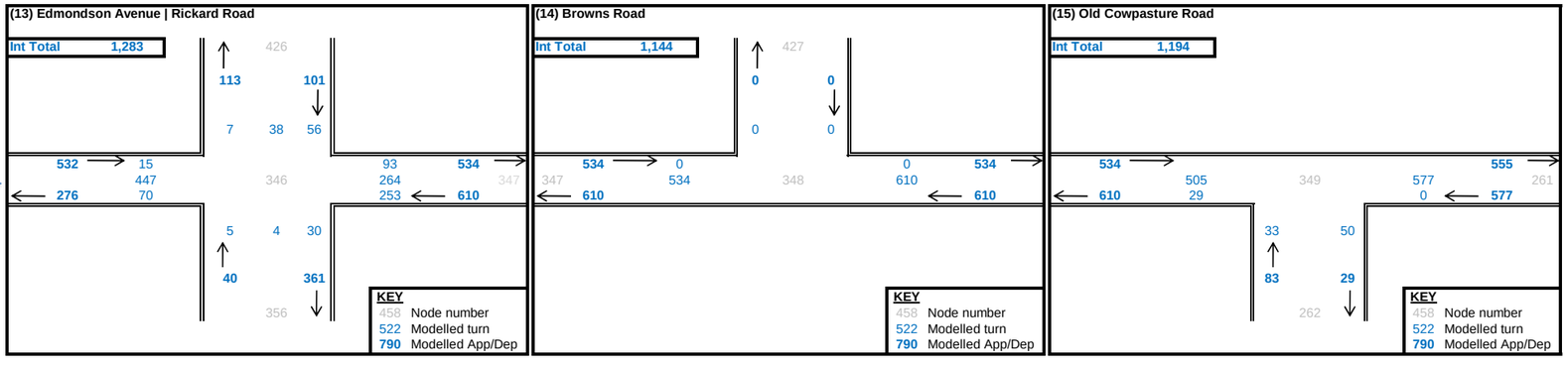
Future Year Turning Movements and Intersection Performance

Roads and Traffic Authority
Bringelly Road Traffic Assessment
2011 AM Average Peak one hour Intersection Flow

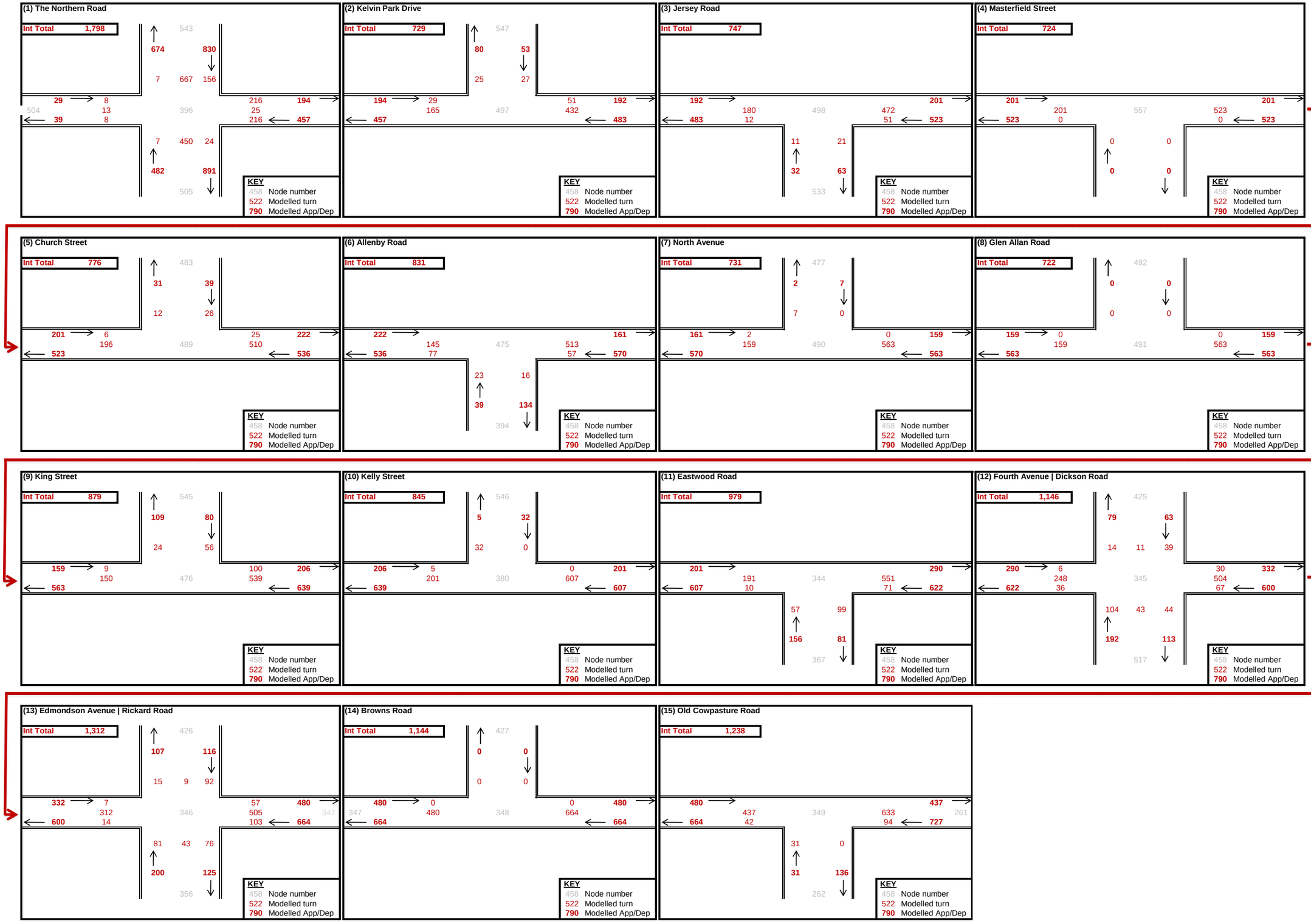




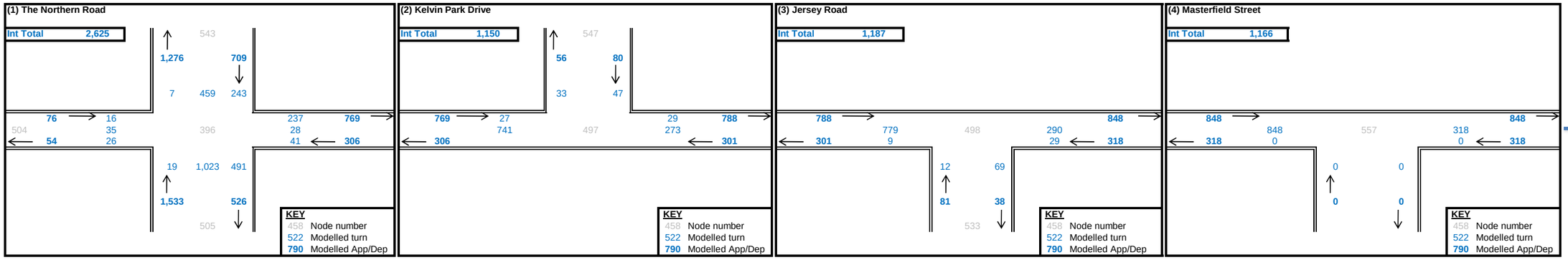


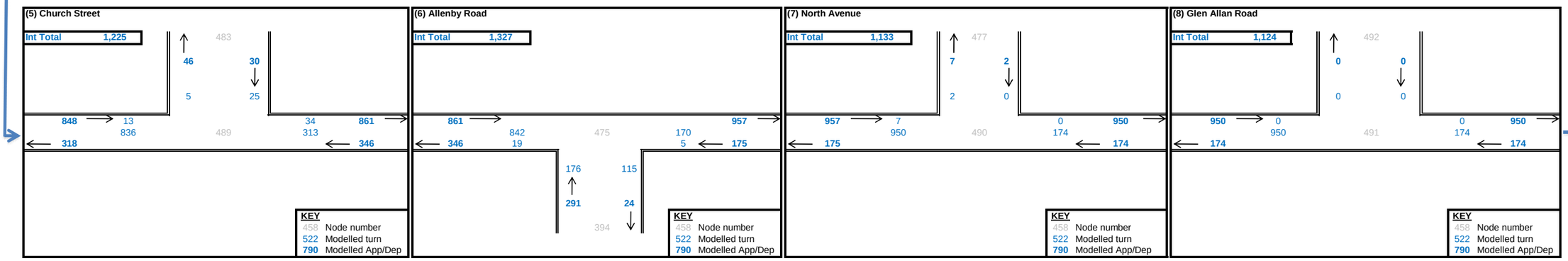


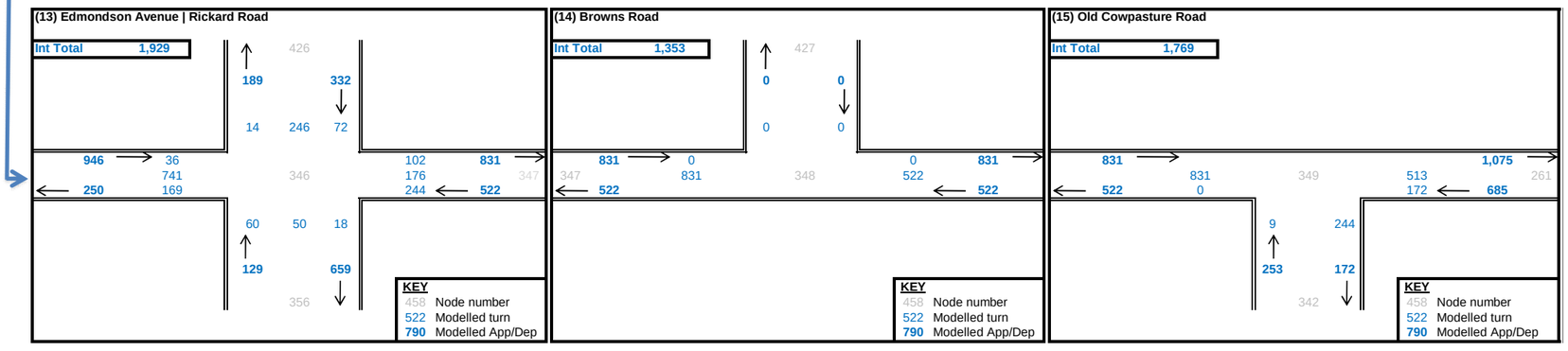
Roads and Traffic Authority
Bringelly Road Traffic Assessment
2011 PM Average Peak one hour Intersection Flow



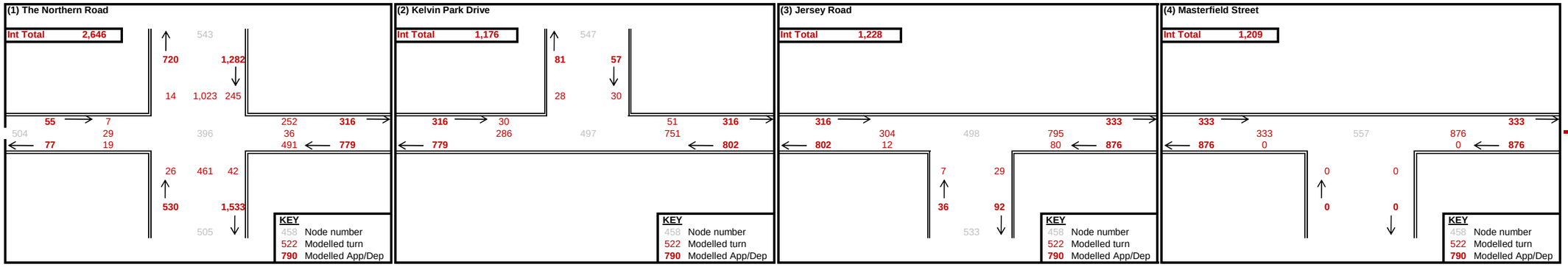
Roads and Traffic Authority
Bringelly Road Traffic Assessment
2016 AM Average Peak one hour Intersection Flow

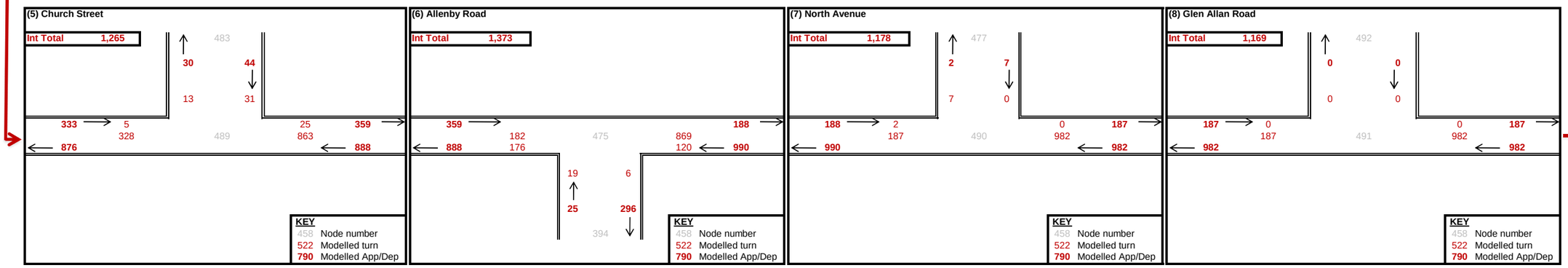


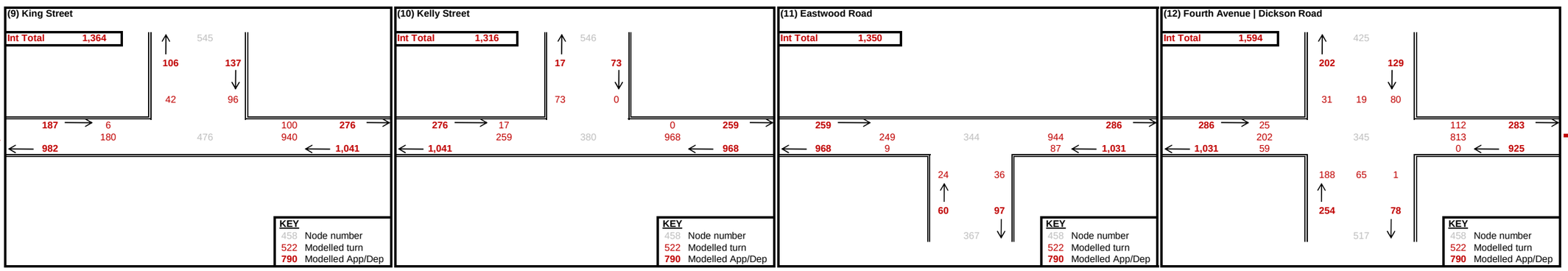


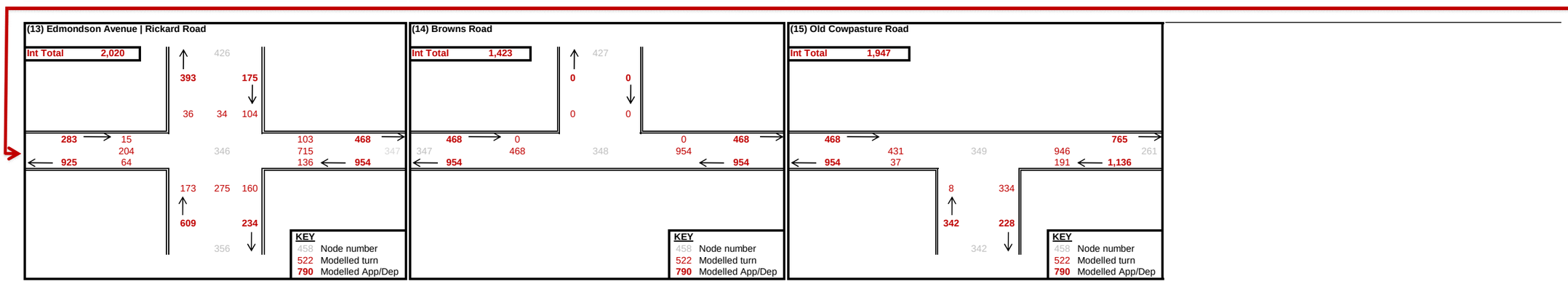


Roads and Traffic Authority
Bringelly Road Traffic Assessment
2016 PM Average Peak one hour Intersection Flow

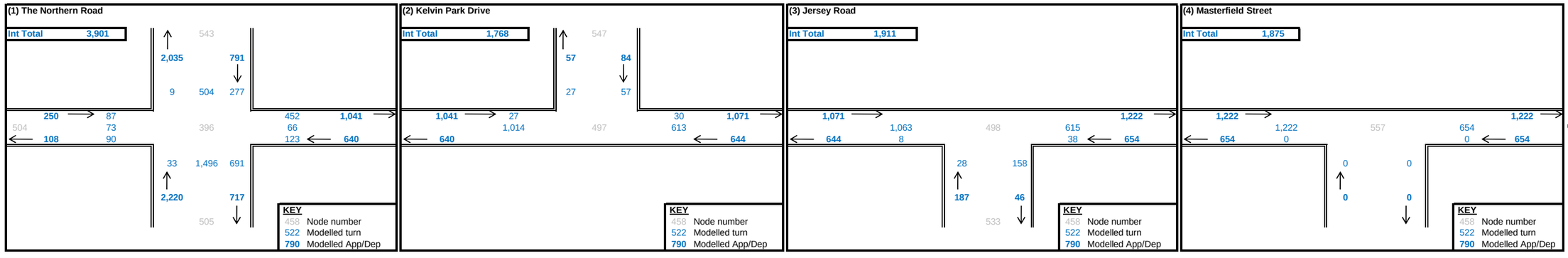


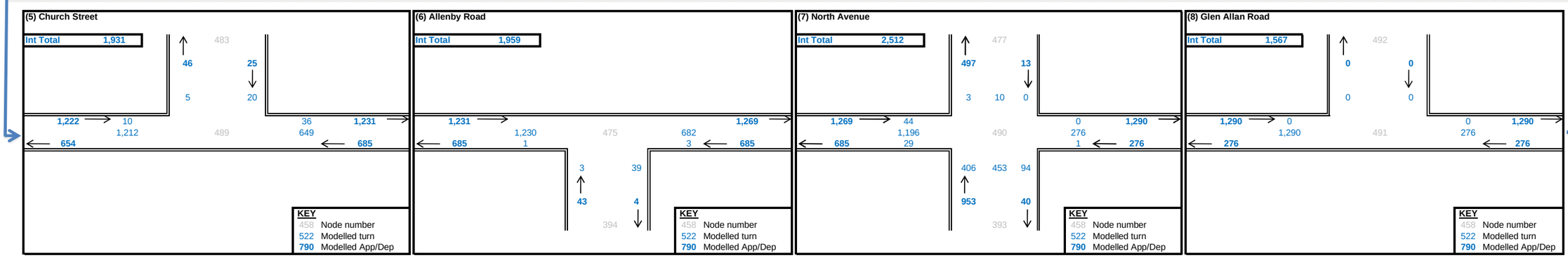


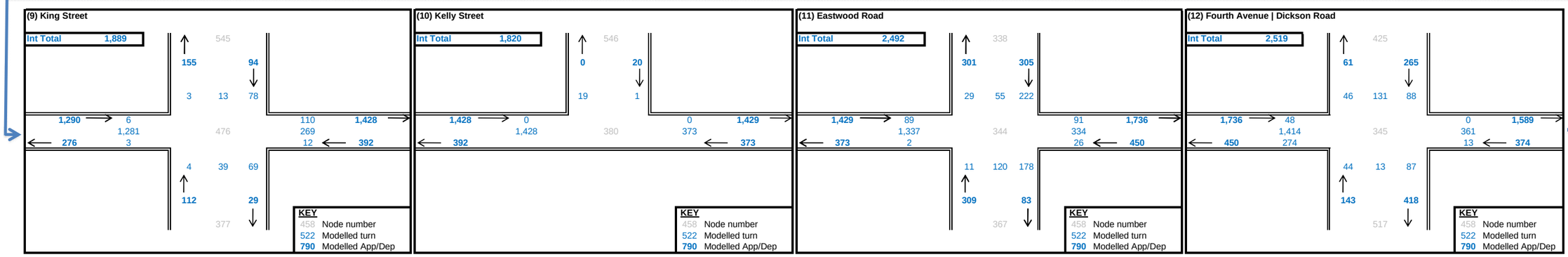


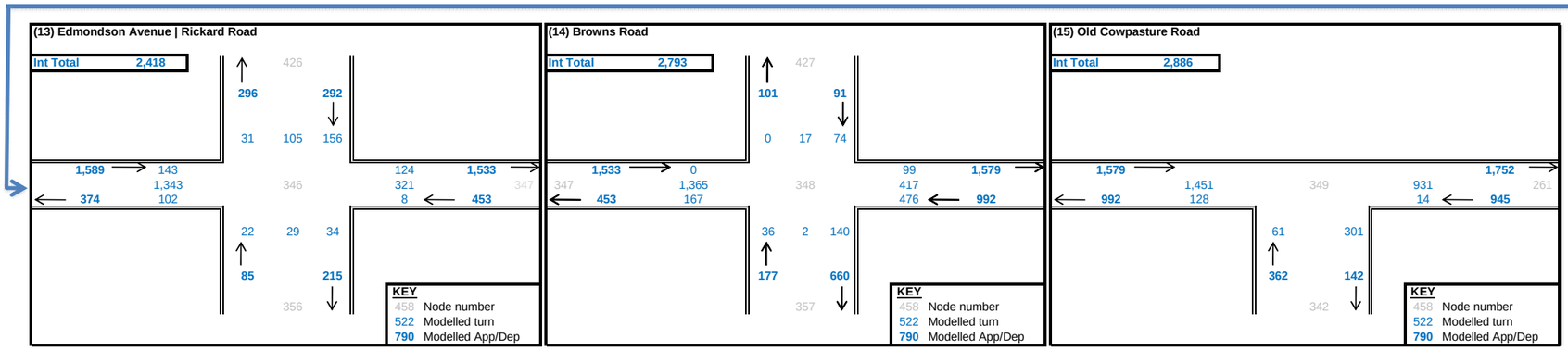


Roads and Traffic Authority
Bringelly Road Traffic Assessment
2021 AM Average Peak one hour Intersection Flow

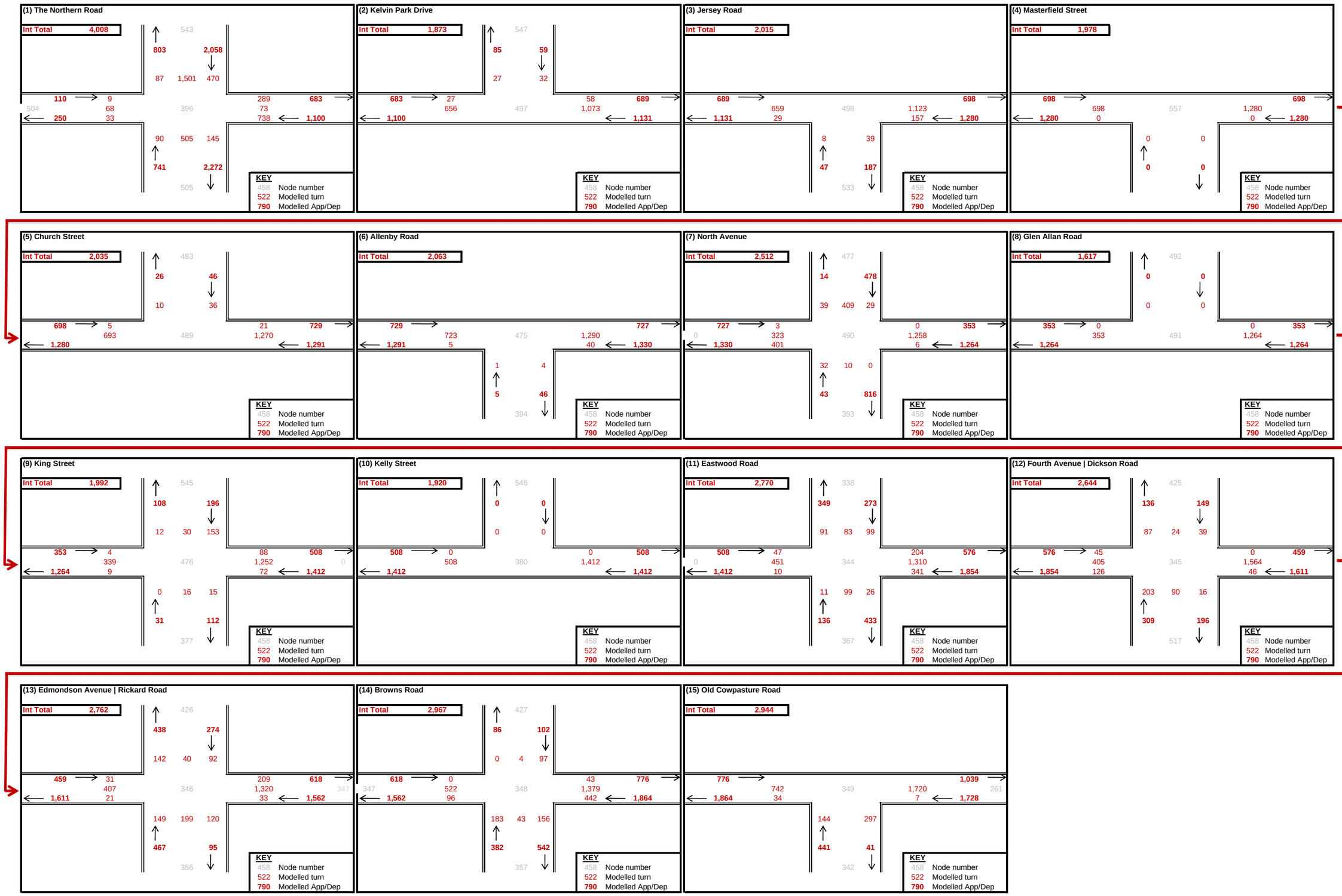




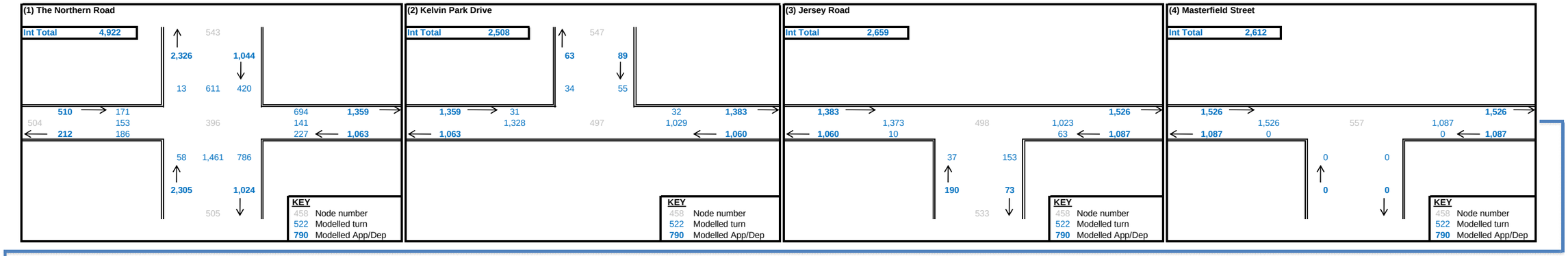


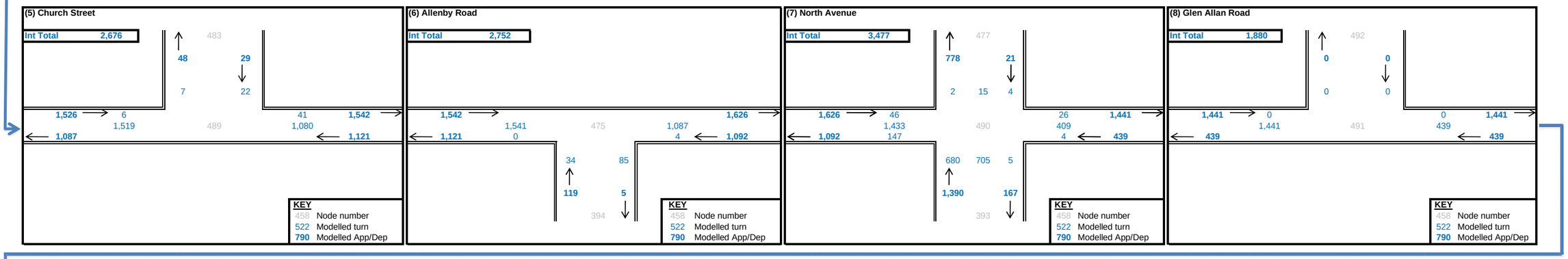


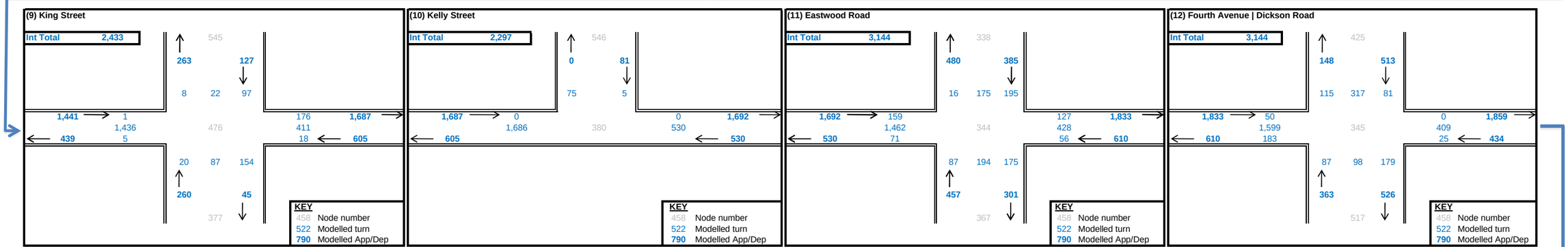
Roads and Traffic Authority
Bringelly Road Traffic Assessment
2021 PM Average Peak one hour Intersection Flow

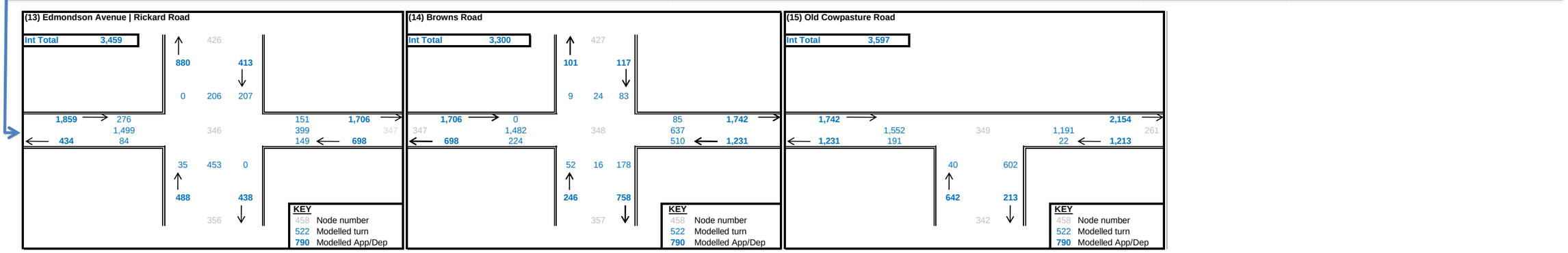


Roads and Traffic Authority
Bringelly Road Traffic Assessment
2026 AM Average Peak one hour Intersection Flow

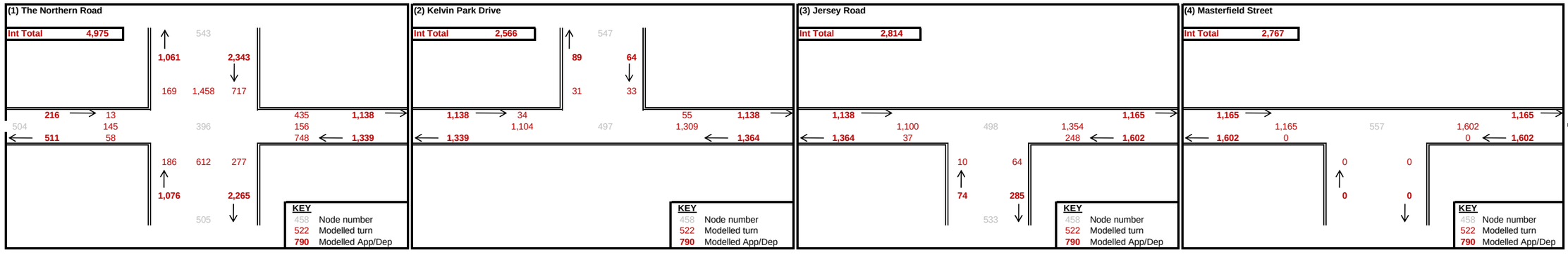


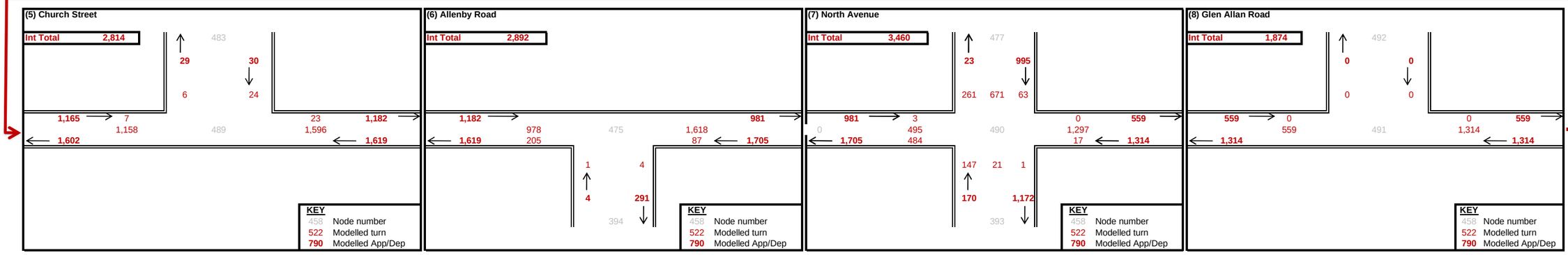


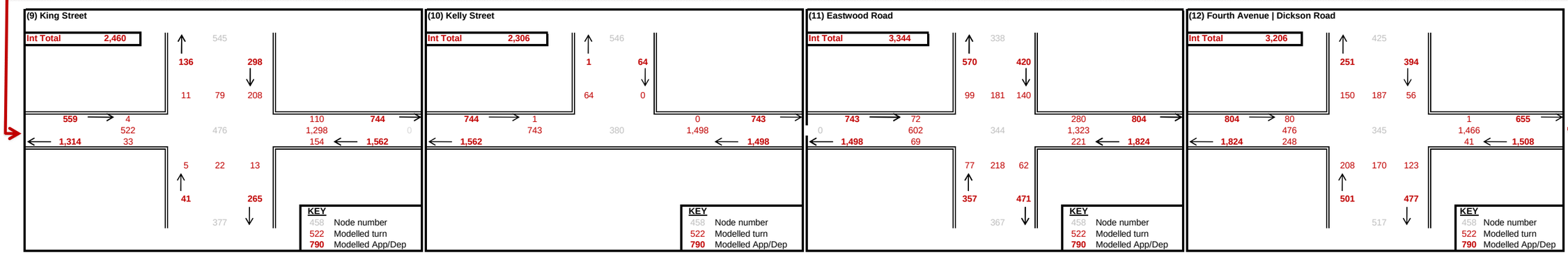


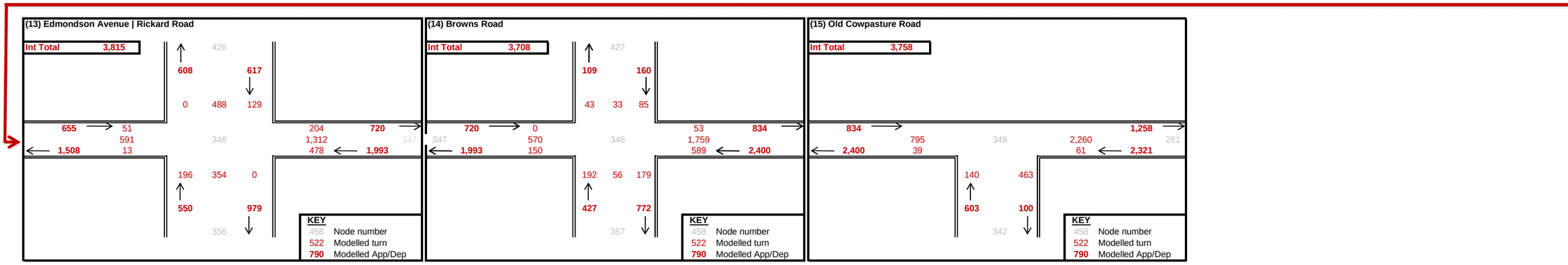


Roads and Traffic Authority
Bringelly Road Traffic Assessment
2026 PM Average Peak one hour Intersection Flow

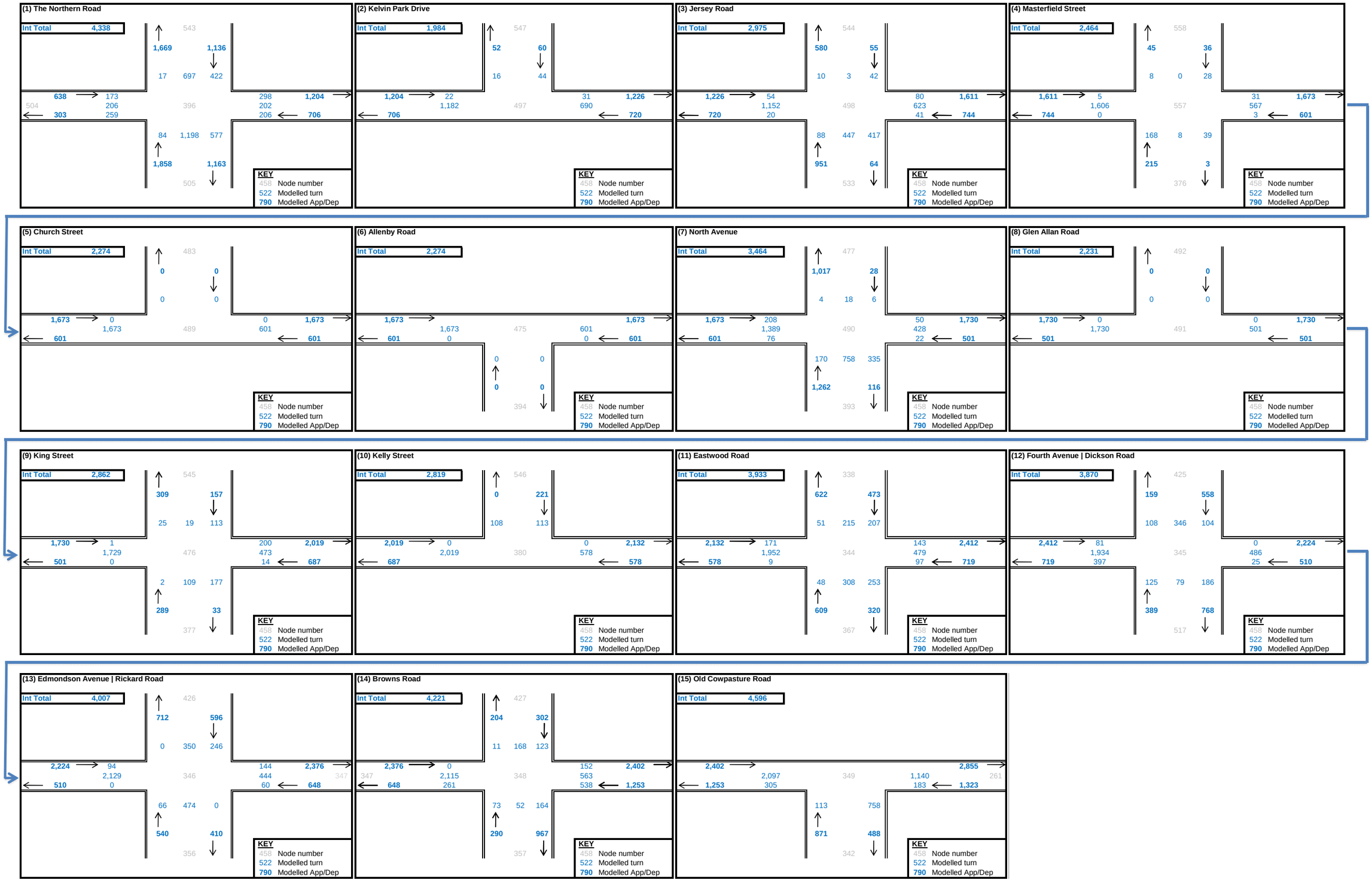




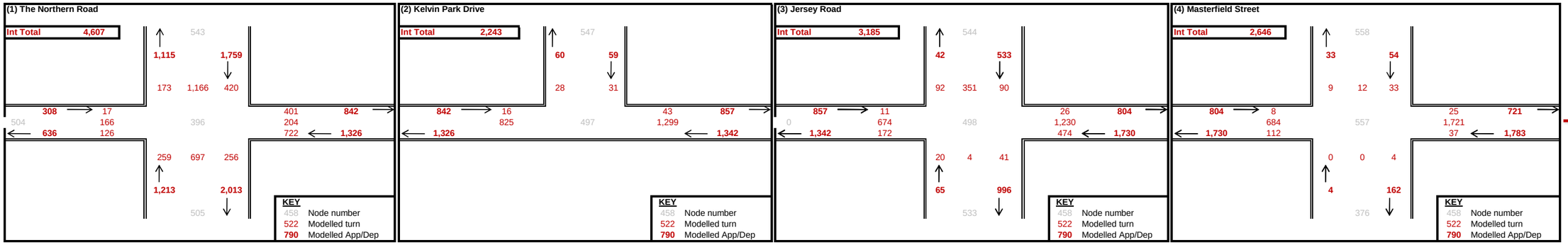


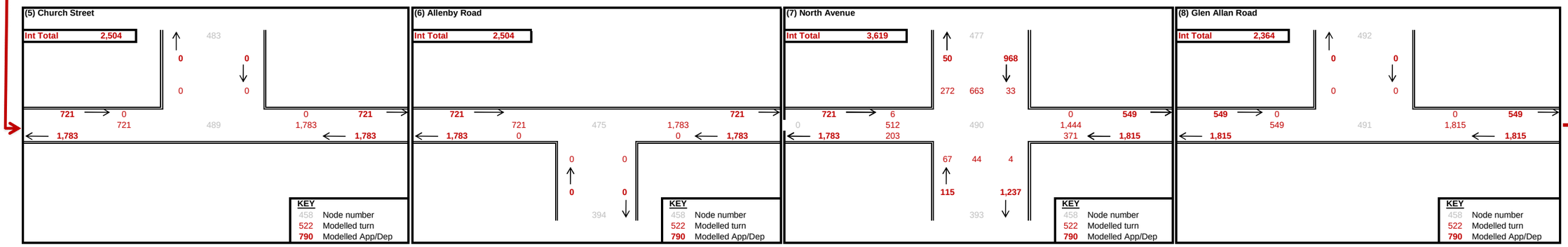


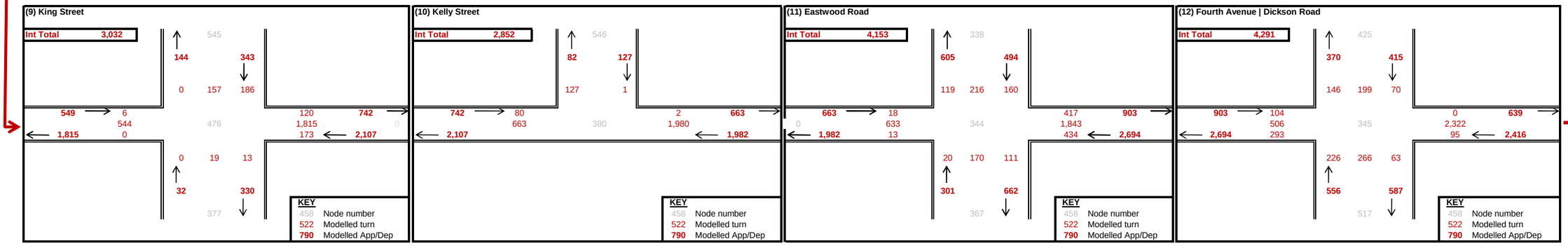
Roads and Traffic Authority
Bringelly Road Traffic Assessment
2031 AM Average Peak one hour Intersection Flow

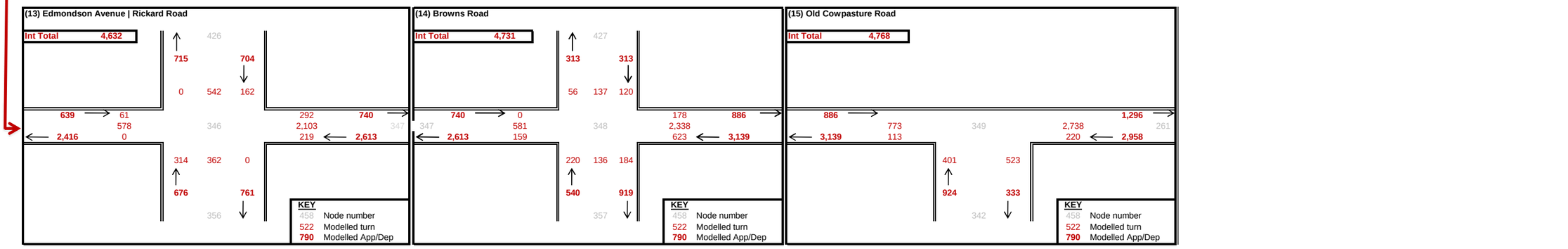


Roads and Traffic Authority
Bringelly Road Traffic Assessment
2031 PM Average Peak one hour Intersection Flow

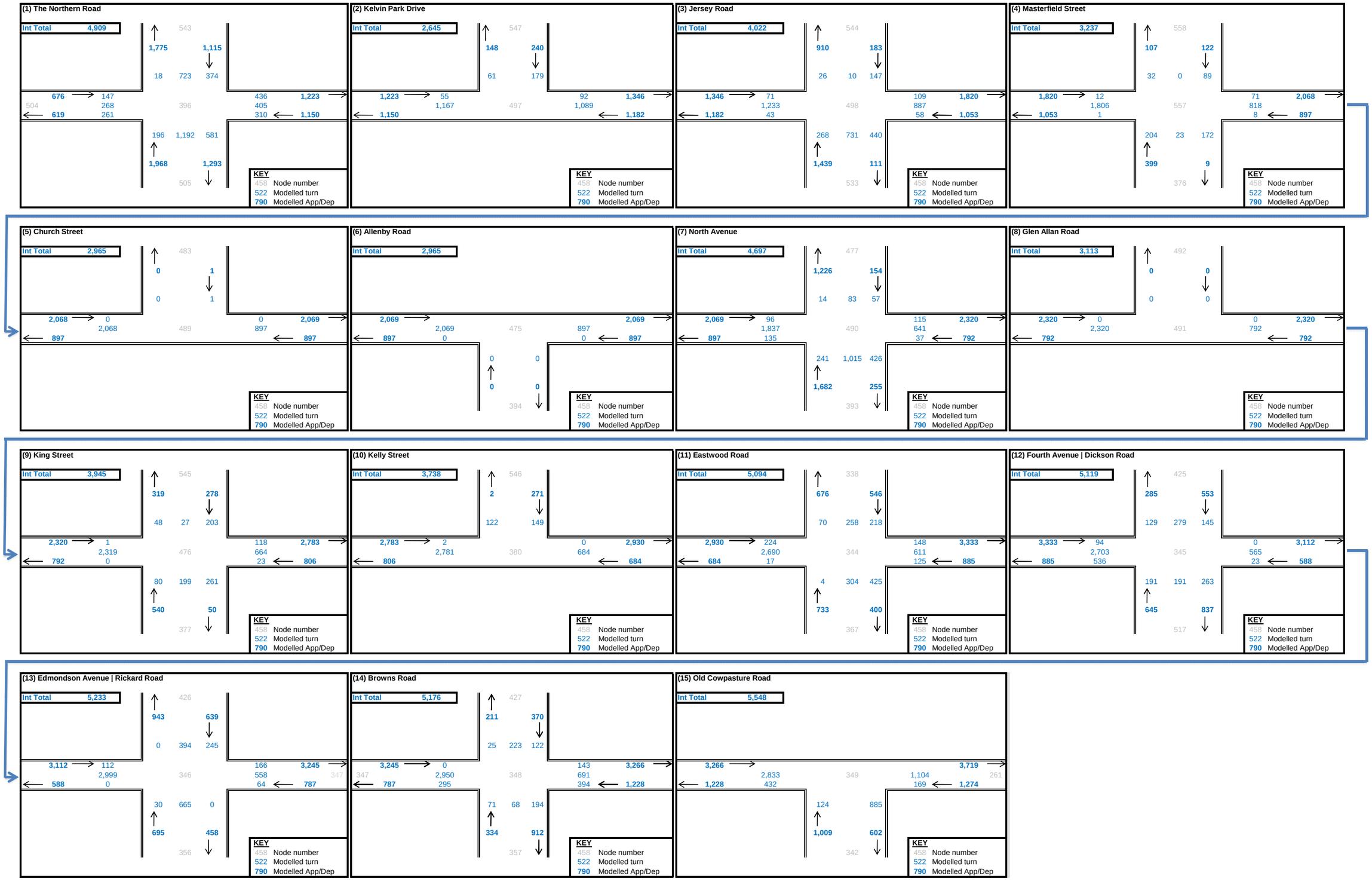




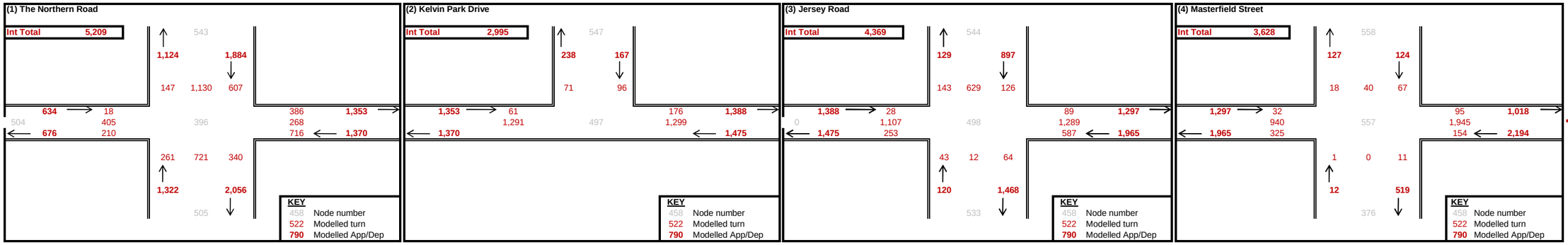


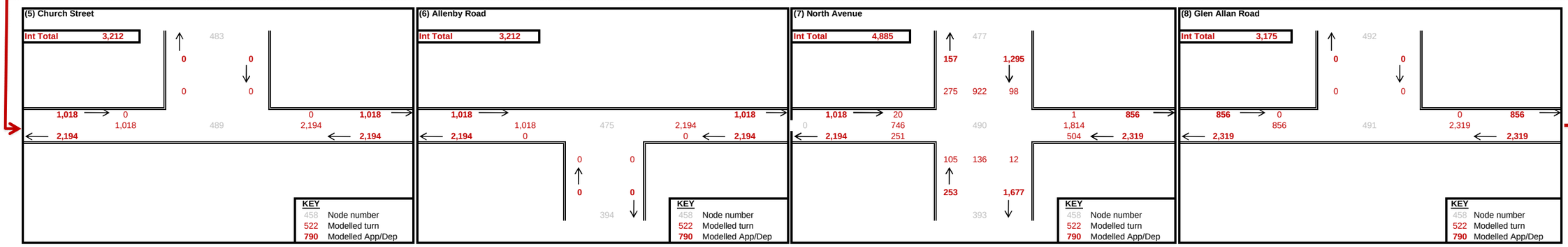


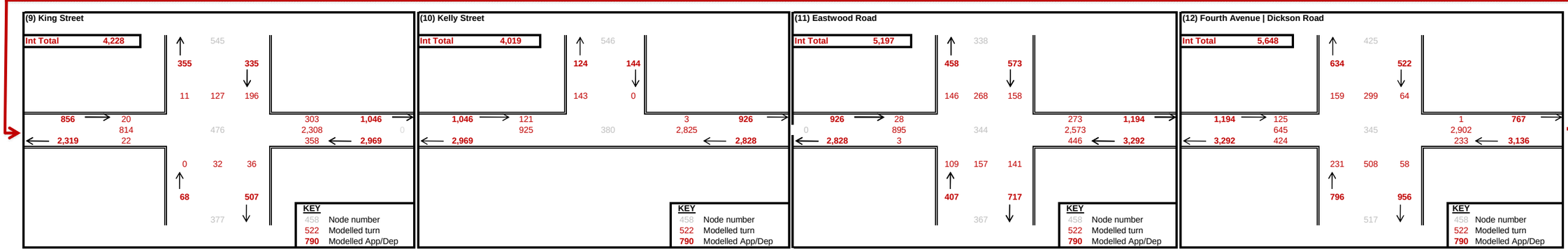
Roads and Traffic Authority
Bringelly Road Traffic Assessment
2036 AM Average Peak one hour Intersection Flow

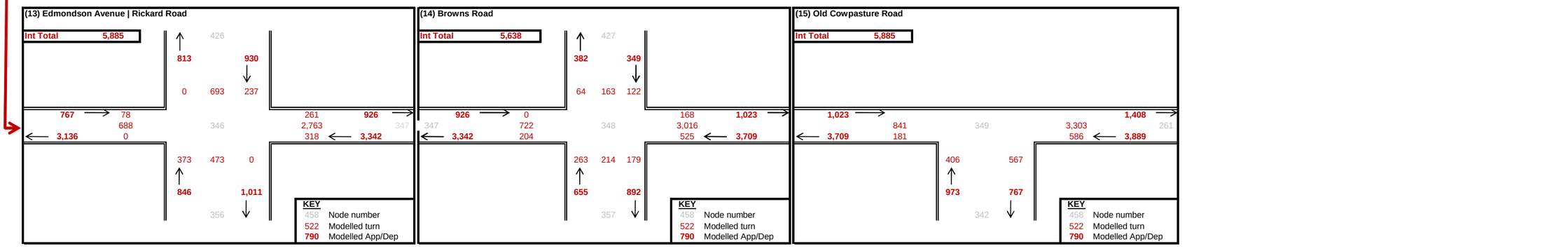


Roads and Traffic Authority
Bringelly Road Traffic Assessment
2036 PM Average Peak one hour Intersection Flow

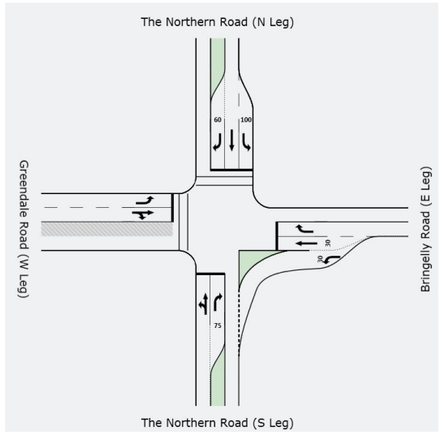




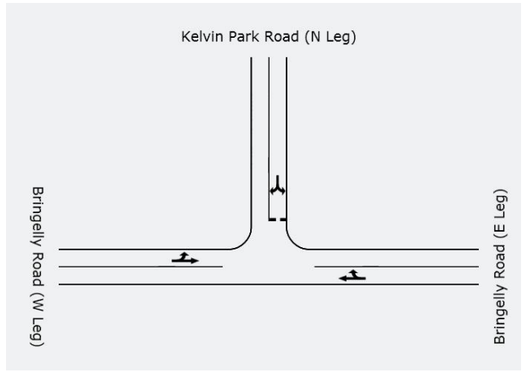




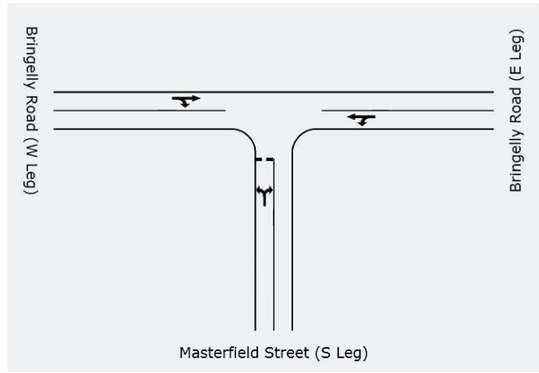
2011: Bringelly Road – The Northern Road to King Street



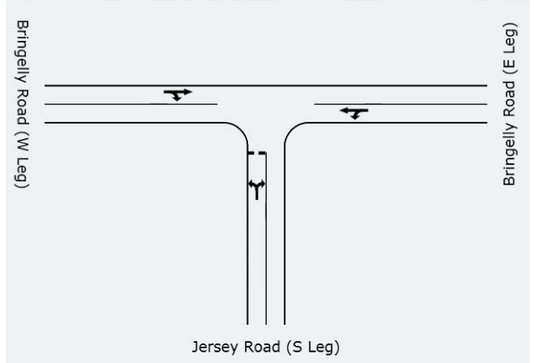
	Int. LoS	DoS	Worst Q	App
AM	B	0.792	180.5	NB TL
PM	B	0.684	136.9	SB T



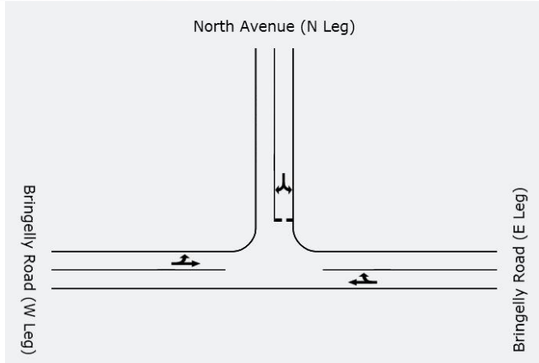
	Int. LoS	DoS	Worst Q	App
AM	A	0.222	6.2	WB
PM	A	0.255	15.3	WB



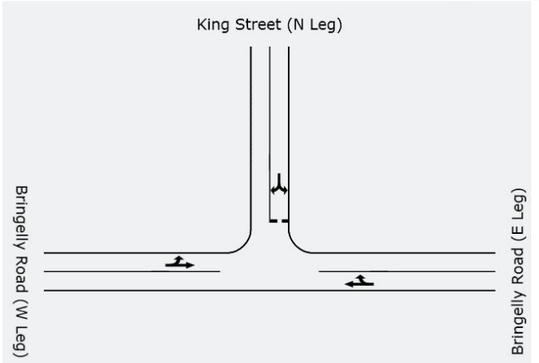
	Int. LoS	DoS	Worst Q	App
AM	A	0.252	15.5	EB
PM	A	0.269	7.4	EB



	Int. LoS	DoS	Worst Q	App
AM	A	0.235	14.1	EB
PM	A	0.270	7.0	EB



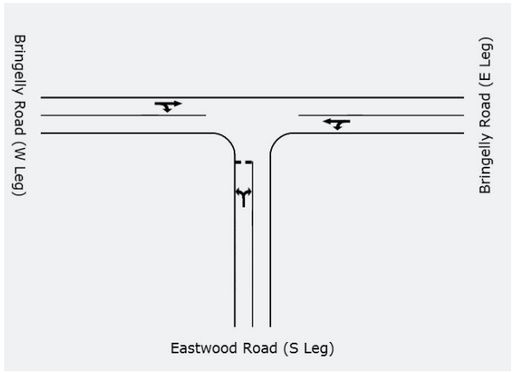
	Int. LoS	DoS	Worst Q	App
AM	A	0.275	5.6	WB
PM	A	0.289	18.0	WB



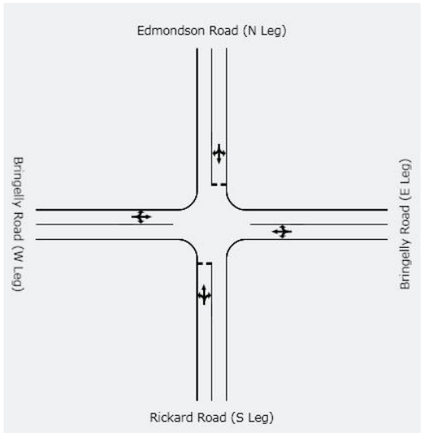
	Int. LoS	DoS	Worst Q	App
AM	A	0.272	7.6	WB
PM	A	0.340	21.7	WB

AECOM

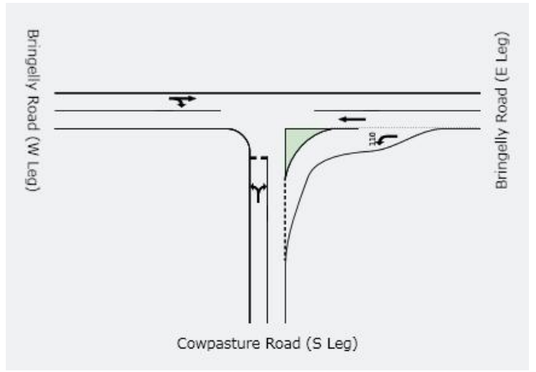
2011: Bringelly Road – Eastwood Road to Camden Valley Way



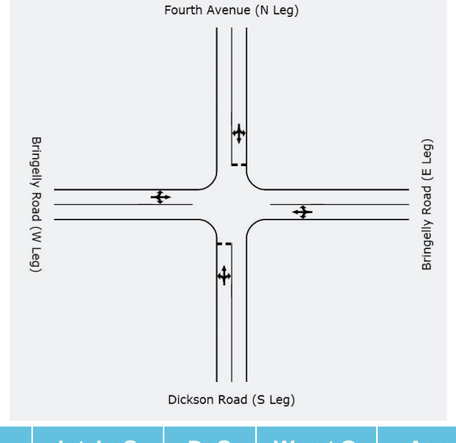
	Int. LoS	DoS	Worst Q	App
AM	A	0.296	18.8	EB
PM	A	0.321	11.5	NB



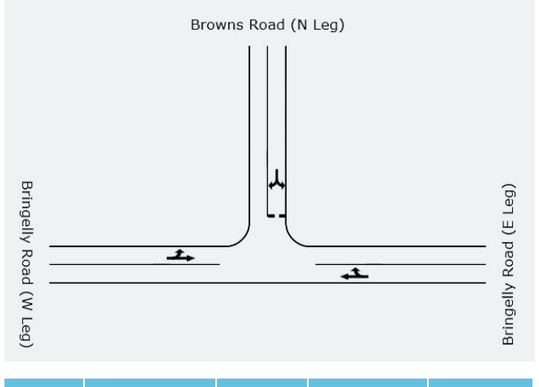
	Int. LoS	DoS	Worst Q	App
AM	A	0.354	27.0	WB
PM	A	0.486	26.0	WB



	Int. LoS	DoS	Worst Q	App
AM	A	0.296	26.3	EB TR
PM	A	0.325	24.6	EB TR



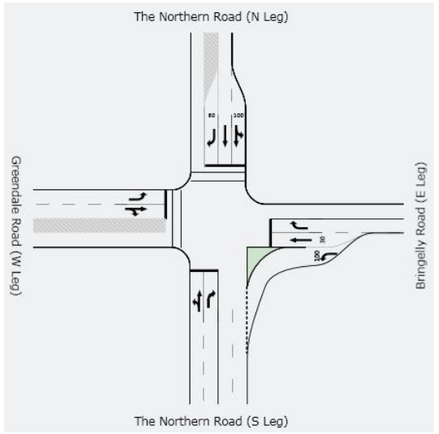
	Int. LoS	DoS	Worst Q	App
AM	A	0.312	20.2	EB
PM	A	0.377	21.2	WB



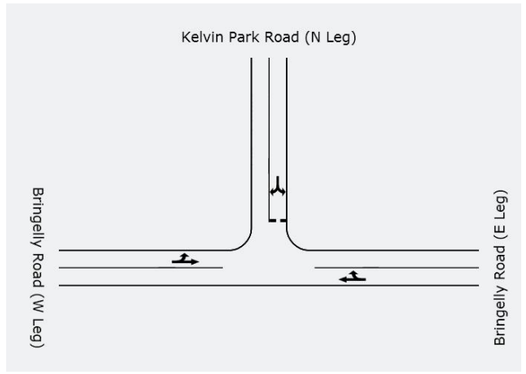
	Int. LoS	DoS	Worst Q	App
AM	A	0.314	29.9	WB
PM	A	0.341	32.6	WB

AECOM

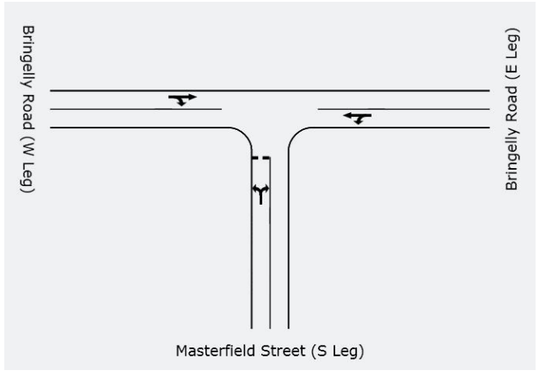
2016: Bringelly Road – The Northern Road to King Street



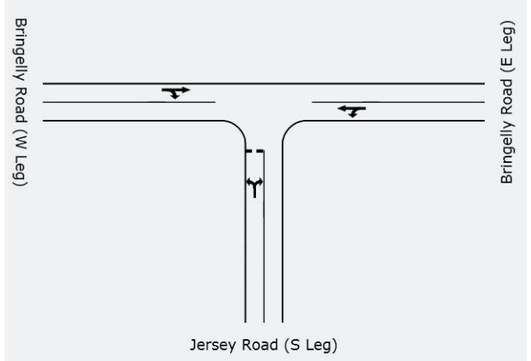
	Int. LoS	DoS	Worst Q	App
AM	C	0.901	244.0	NB TL
PM	C	0.918	327.5	SB T



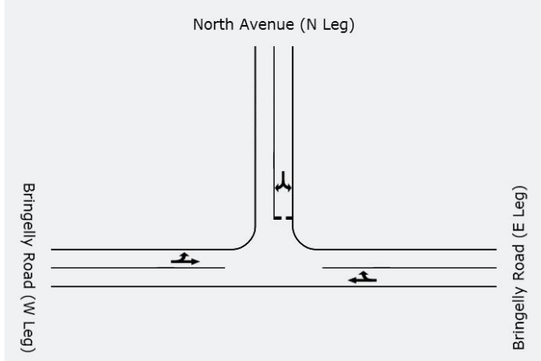
	Int. LoS	DoS	Worst Q	App
AM	A	0.395	15.8	WB
PM	A	0.432	38.9	WB



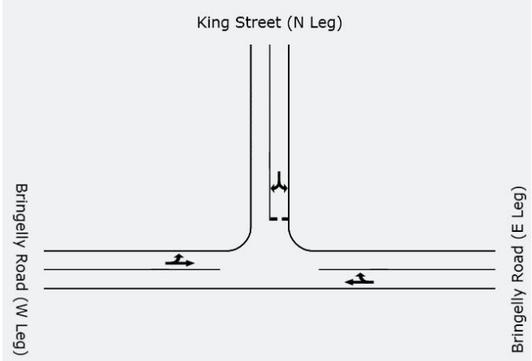
	Int. LoS	DoS	Worst Q	App
AM	A	0.436	42.5	EB
PM	A	0.450	20.1	EB



	Int. LoS	DoS	Worst Q	App
AM	A	0.406	35.8	EB
PM	A	0.451	19.1	EB



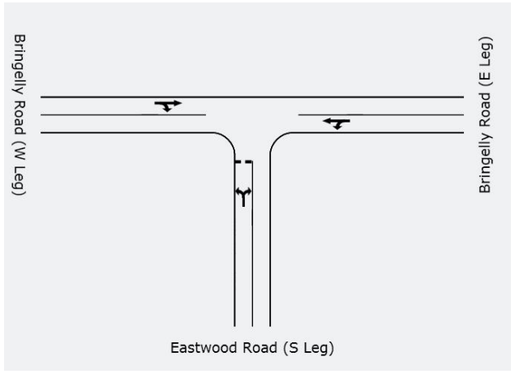
	Int. LoS	DoS	Worst Q	App
AM	A	0.491	11.2	WB
PM	A	0.504	42.2	WB



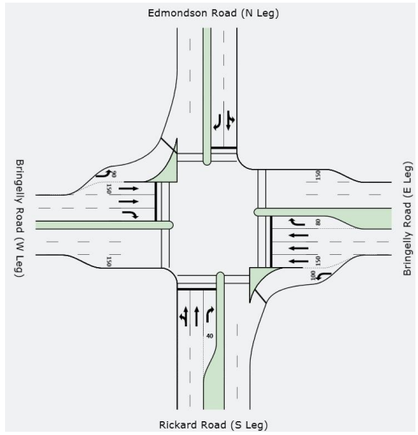
	Int. LoS	DoS	Worst Q	App
AM	A	0.488	16.6	WB
PM	A	0.548	55.4	WB

AECOM

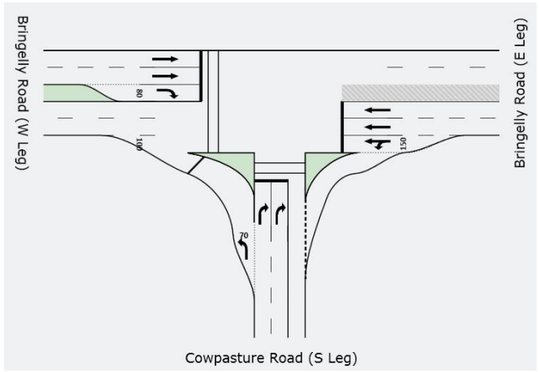
2016: Bringelly Road – Eastwood Road to Camden Valley Way



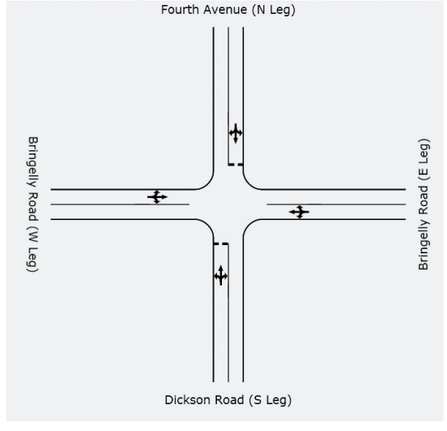
	Int. LoS	DoS	Worst Q	App
AM	A	0.476	43.6	EB
PM	A	0.531	19.7	EB



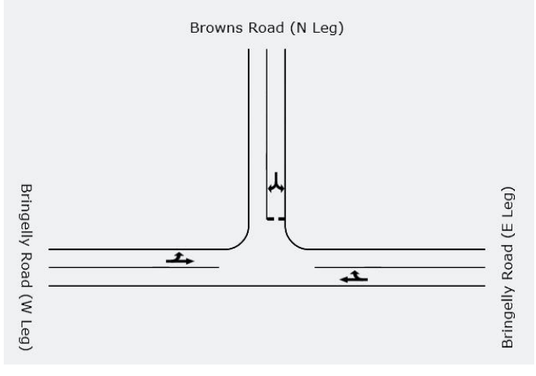
	Int. LoS	DoS	Worst Q	App
AM	C	0.867	269.1	EB T
PM	C	0.769	110.5	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.554	74.0	EB T
PM	B	0.707	111.2	WB T



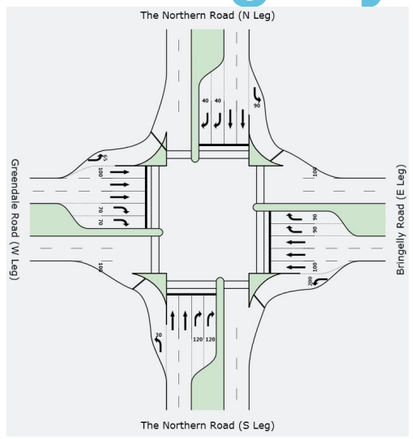
	Int. LoS	DoS	Worst Q	App
AM	A	0.808	54.3	EB
PM	A	0.806	46.8	NB



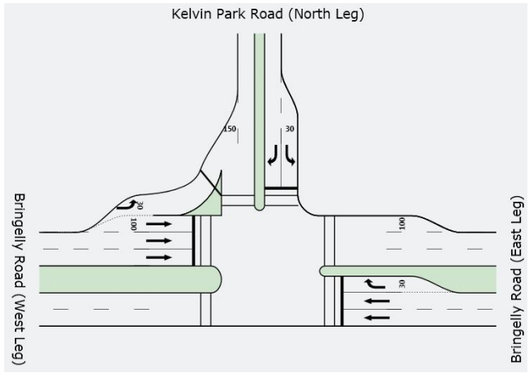
	Int. LoS	DoS	Worst Q	App
AM	A	0.427	35.2	WB
PM	A	0.490	67.1	WB

AECOM

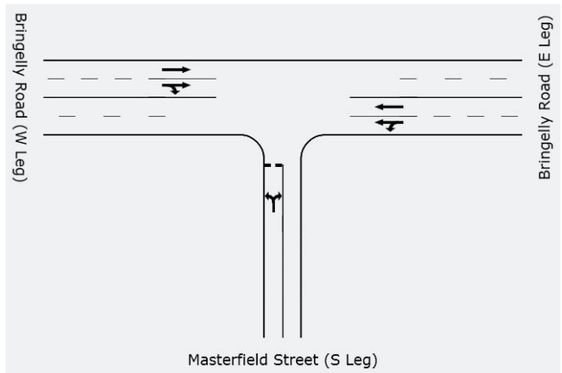
2021: Bringelly Road – The Northern Road to King Street



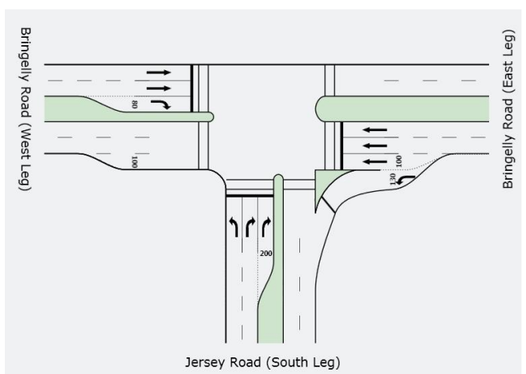
	Int. LoS	DoS	Worst Q	App
AM	C	0.813	192.0	NB T
PM	D	0.998	519.2	SB T



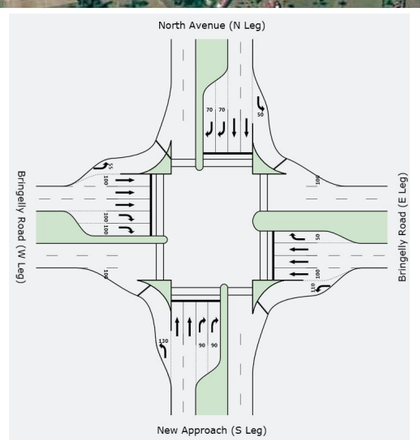
	Int. LoS	DoS	Worst Q	App
AM	B	0.462	107.3	EB T
PM	B	0.405	121.8	EB T



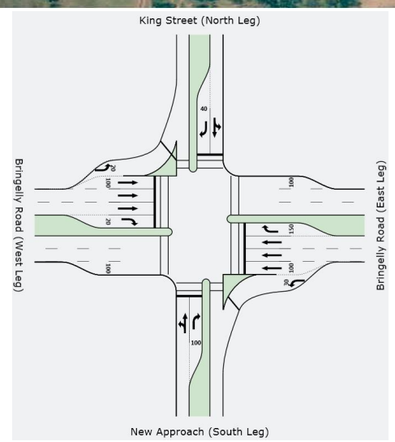
	Int. LoS	DoS	Worst Q	App
AM	A	0.314	33.7	EB TR
PM	A	0.328	30.4	EB TR



	Int. LoS	DoS	Worst Q	App
AM	B	0.458	90.6	WB T
PM	B	0.494	115.5	WB T



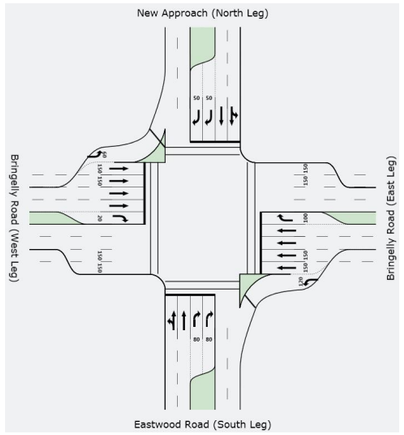
	Int. LoS	DoS	Worst Q	App
AM	C	0.846	193.4	EB T
PM	C	0.834	227.5	WB T



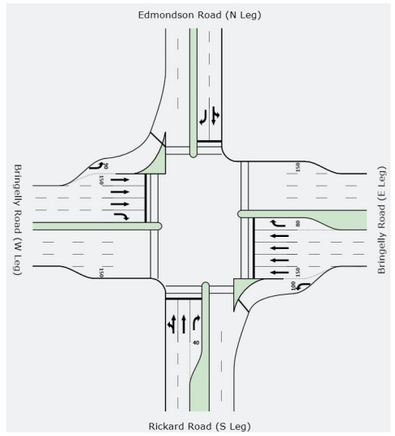
	Int. LoS	DoS	Worst Q	App
AM	C	0.635	181.3	EB T
PM	B	0.607	159.3	WB T

AECOM

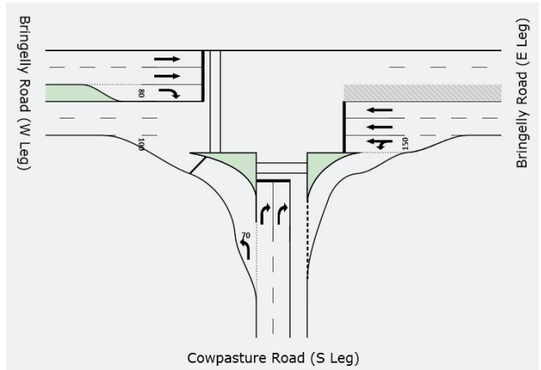
2021: Bringelly Road – Eastwood Road to Camden Valley Way



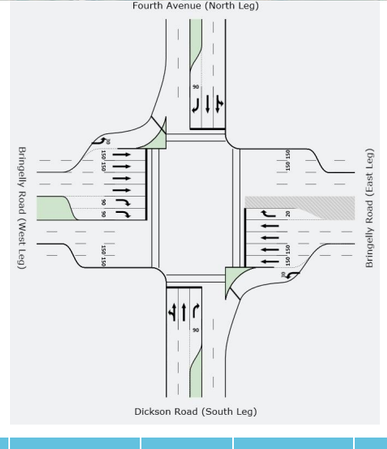
	Int. LoS	DoS	Worst Q	App
AM	C	0.879	165.9	EB T
PM	C	0.675	138.4	WB T



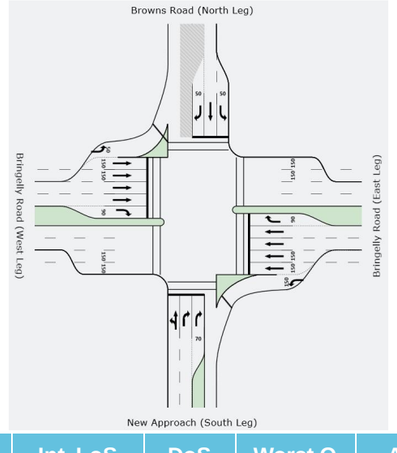
	Int. LoS	DoS	Worst Q	App
AM	C	0.870	257.0	EB T
PM	C	0.835	235.1	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.859	171.9	EB T
PM	B	0.866	262.6	WB T



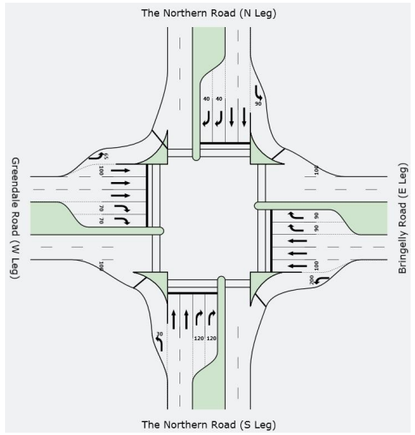
	Int. LoS	DoS	Worst Q	App
AM	C	0.740	135.3	EB T
PM	B	0.726	148.4	WB T



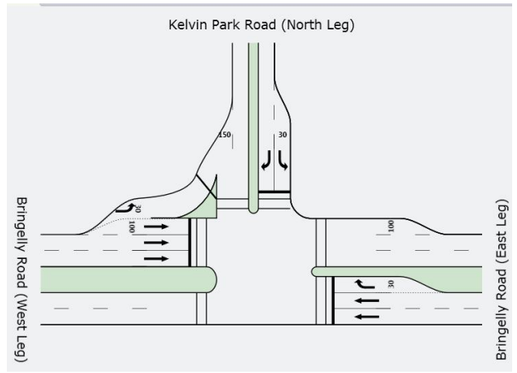
	Int. LoS	DoS	Worst Q	App
AM	C	0.736	157.9	WB L
PM	C	0.780	159.5	WB T

AECOM

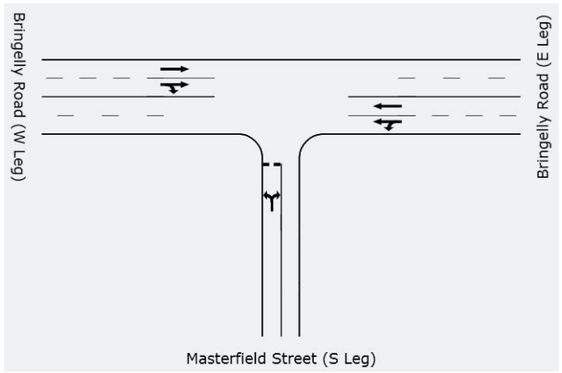
2026: Bringelly Road – The Northern Road to King Street



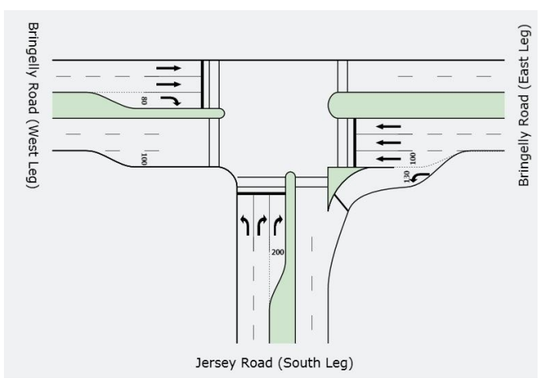
	Int. LoS	DoS	Worst Q	App
AM	C	1.000	217.5	NB T
PM	D	1.000	473.0	SB T



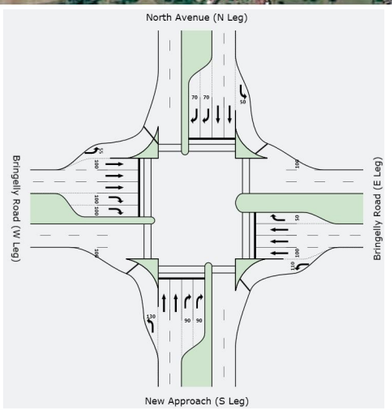
	Int. LoS	DoS	Worst Q	App
AM	A	0.509	104.9	WB T
PM	A	0.502	172.1	EB T



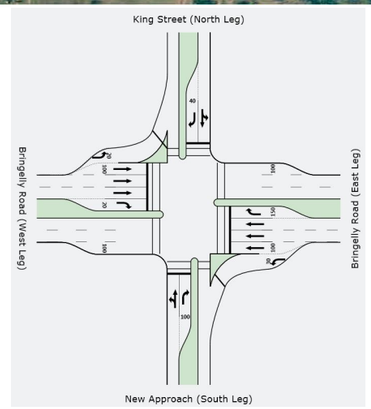
	Int. LoS	DoS	Worst Q	App
AM	A	1.000	71.3	EB TR
PM	A	1.000	84.0	EB TR



	Int. LoS	DoS	Worst Q	App
AM	B	0.562	152.2	WB T
PM	B	0.582	142.3	WB T



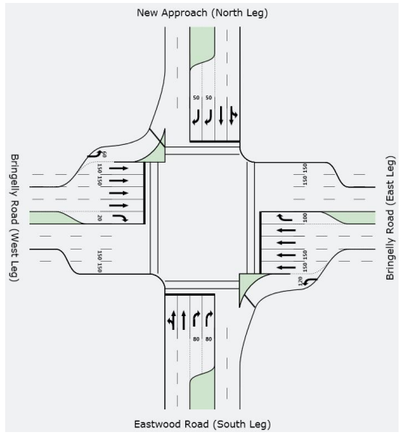
	Int. LoS	DoS	Worst Q	App
AM	C	0.875	251.0	EB T
PM	D	0.893	285.4	WB T



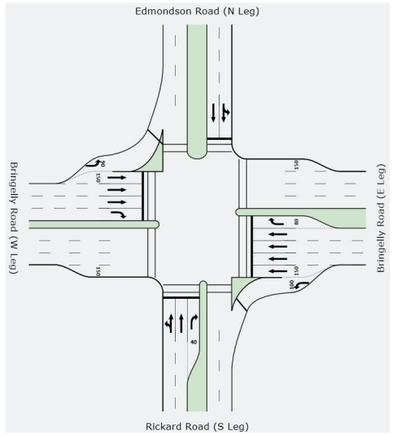
	Int. LoS	DoS	Worst Q	App
AM	C	0.828	289.9	EB T
PM	C	0.666	179.5	WB T

AECOM

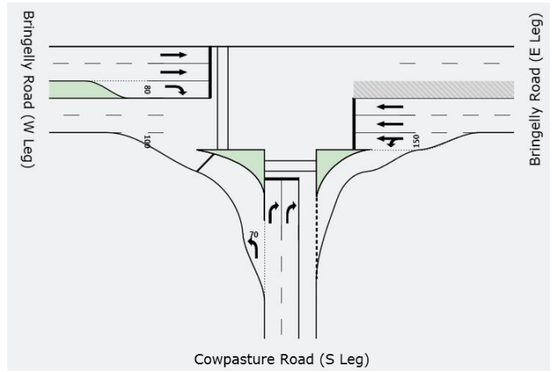
2026: Bringelly Road – Eastwood Road to Camden Valley Way



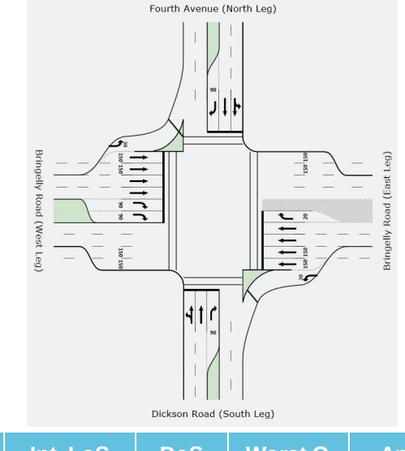
	Int. LoS	DoS	Worst Q	App
AM	C	0.827	177.9	EB T
PM	C	0.770	161.3	WB T



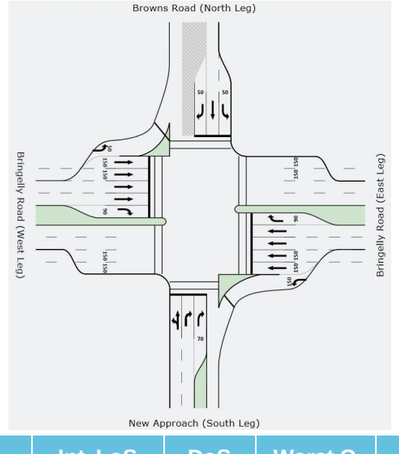
	Int. LoS	DoS	Worst Q	App
AM	D	0.893	320.9	EB T
PM	C	0.905	225.2	EB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.811	163.4	EB T
PM	B	0.886	429.7	WB T



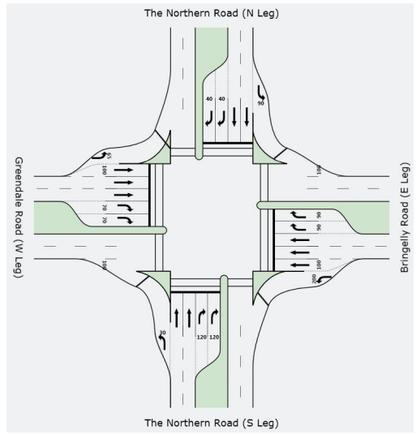
	Int. LoS	DoS	Worst Q	App
AM	C	0.801	183.0	EB T
PM	C	0.856	172.3	WB T



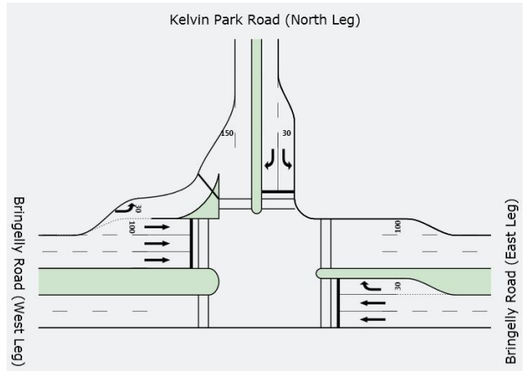
	Int. LoS	DoS	Worst Q	App
AM	C	0.809	195.9	EB T
PM	D	0.870	261.7	WB T

AECOM

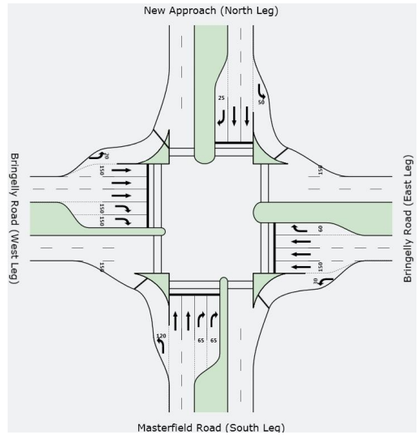
2031: Bringelly Road – The Northern Road to King Street



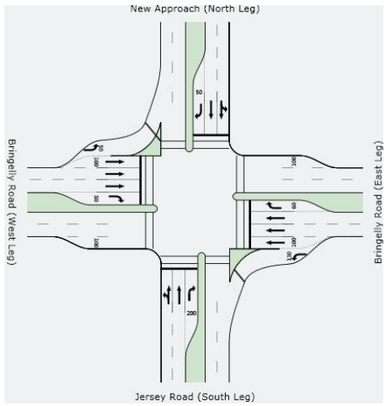
	Int. LoS	DoS	Worst Q	App
AM	C	0.842	110.8	NB R
PM	C	0.879	256.0	WB L



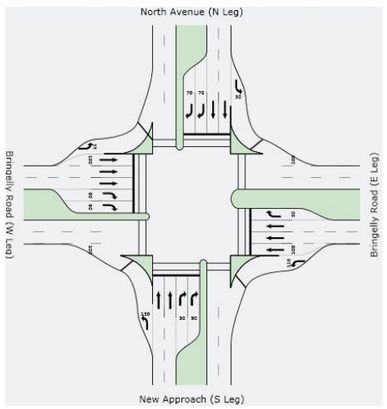
	Int. LoS	DoS	Worst Q	App
AM	A	0.444	68.1	EB T
PM	A	0.450	125.5	EB T



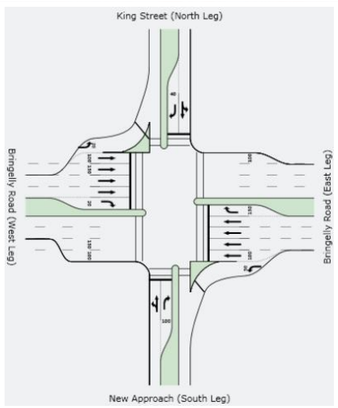
	Int. LoS	DoS	Worst Q	App
AM	B	0.662	169.6	EB T
PM	B	0.717	203.9	WB T



	Int. LoS	DoS	Worst Q	App
AM	D	0.866	249.5	EB T
PM	C	0.800	194.4	WB T



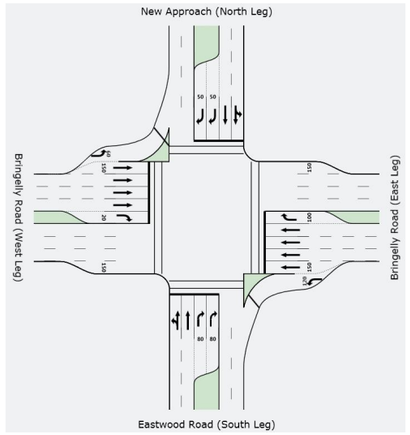
	Int. LoS	DoS	Worst Q	App
AM	C	0.902	254.1	EB T
PM	C	0.880	278.6	WB T



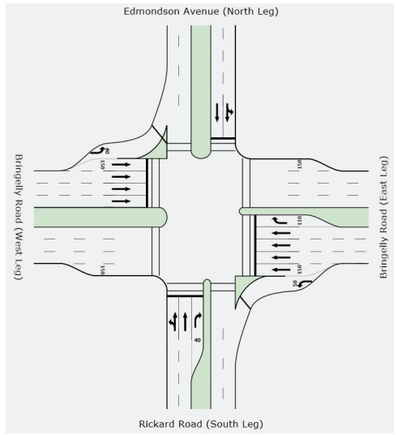
	Int. LoS	DoS	Worst Q	App
AM	C	0.788	249.6	EB T
PM	C	0.743	176.7	WB T

AECOM

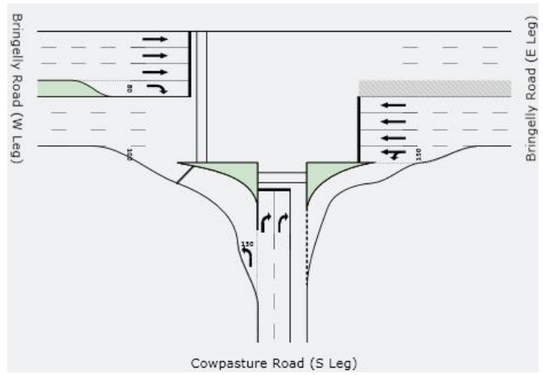
2031: Bringelly Road – Eastwood Road to Camden Valley Way



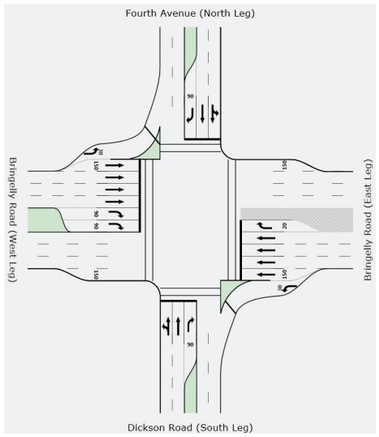
	Int. LoS	DoS	Worst Q	App
AM	D	0.859	294.5	EB T
PM	D	0.977	210.6	WB T



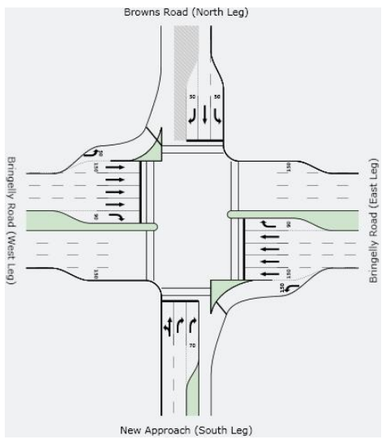
	Int. LoS	DoS	Worst Q	App
AM	C	0.727	229.3	EB T
PM	C	0.635	173.8	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.773	124.0	EB T
PM	C	0.903	329.8	WB T



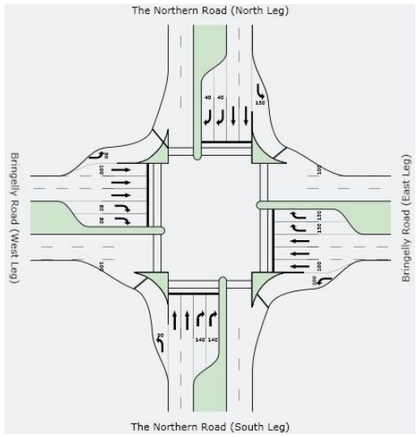
	Int. LoS	DoS	Worst Q	App
AM	C	0.849	249.8	EB T
PM	D	0.900	361.4	WB T



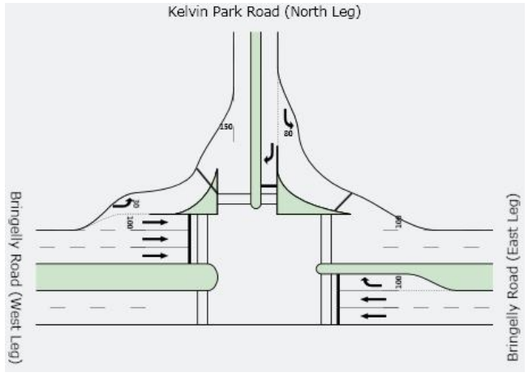
	Int. LoS	DoS	Worst Q	App
AM	D	0.881	330.7	EB T
PM	D	0.936	418.3	WB T

AECOM

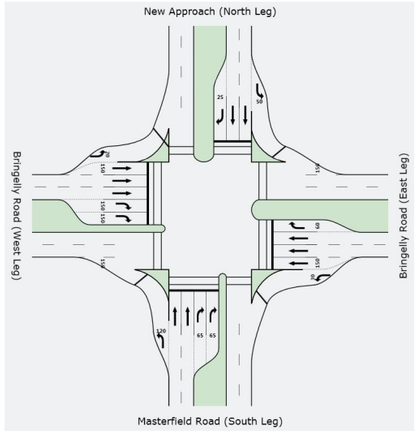
2036: Bringelly Road – The Northern Road to King Street



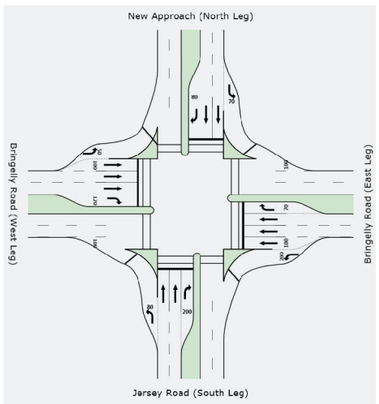
	Int. LoS	DoS	Worst Q	App
AM	D	0.670	167.6	NB T
PM	D	0.923	326.8	WB L



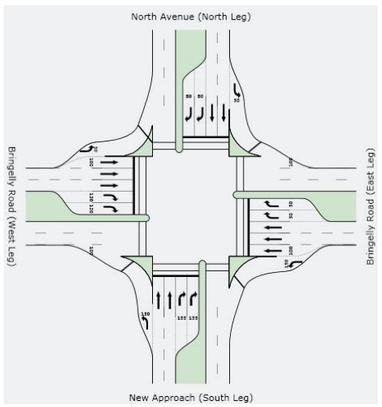
	Int. LoS	DoS	Worst Q	App
AM	B	0.532	133.4	EB T
PM	B	0.601	218.6	EB T



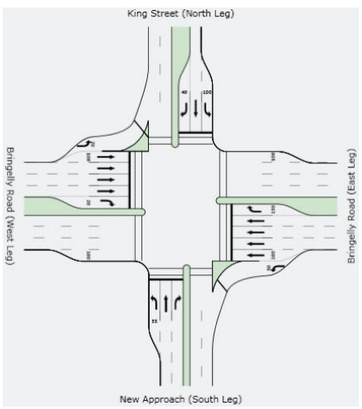
	Int. LoS	DoS	Worst Q	App
AM	B	0.789	266.1	EB T
PM	C	0.892	394.8	WB T



	Int. LoS	DoS	Worst Q	App
AM	D	0.880	228.2	EB T
PM	C	0.840	212.4	WB T



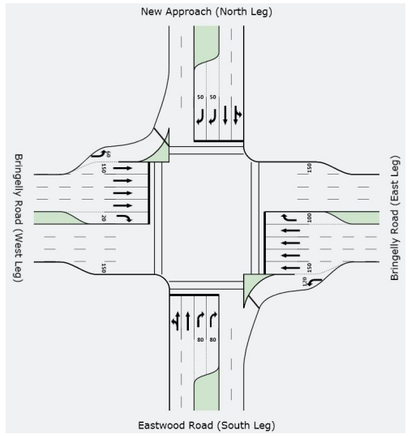
	Int. LoS	DoS	Worst Q	App
AM	D	0.929	438.7	EB T
PM	D	0.860	329.1	WB T



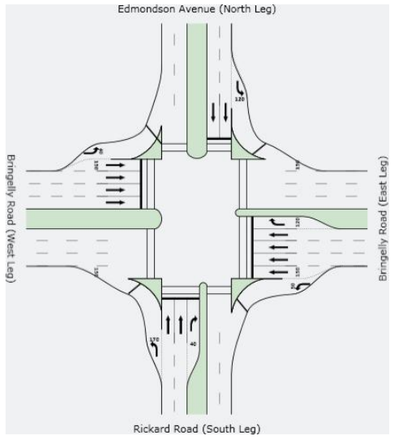
	Int. LoS	DoS	Worst Q	App
AM	D	0.913	391.0	EB T
PM	C	0.890	315.5	WB T

AECOM

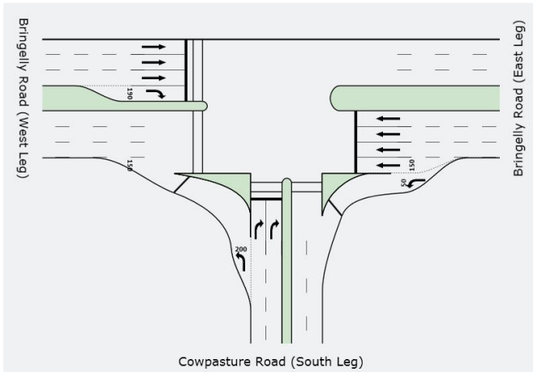
2036: Bringelly Road – Eastwood Road to Camden Valley Way



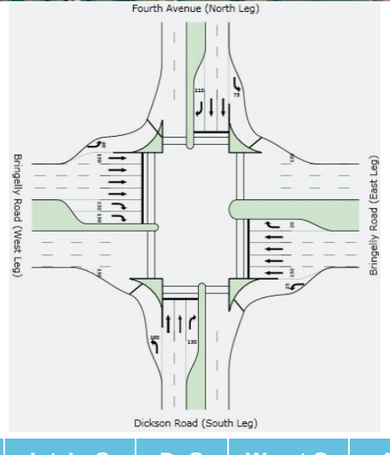
	Int. LoS	DoS	Worst Q	App
AM	C	0.908	337.2	EB T
PM	B	0.756	126.2	EB T



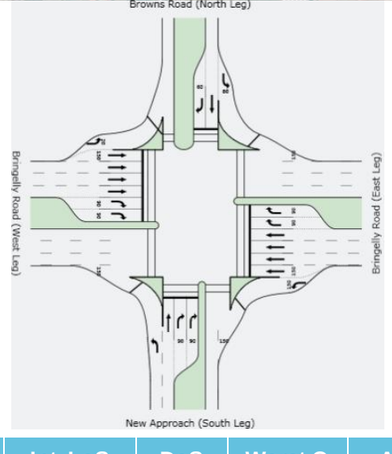
	Int. LoS	DoS	Worst Q	App
AM	C	0.928	479.0	EB T
PM	C	0.762	225.4	WB T



	Int. LoS	DoS	Worst Q	App
AM	C	0.790	245.1	EB T
PM	C	0.916	420.3	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.844	199.0	EB T
PM	C	0.821	230.6	WB T



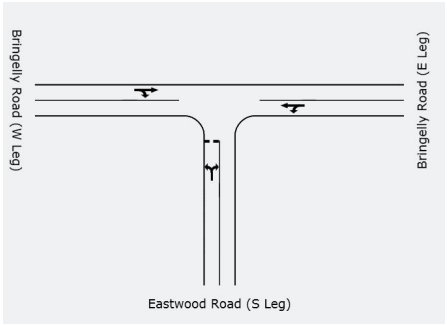
	Int. LoS	DoS	Worst Q	App
AM	D	0.936	497.8	EB T
PM	D	0.933	494.5	WB T

AECOM

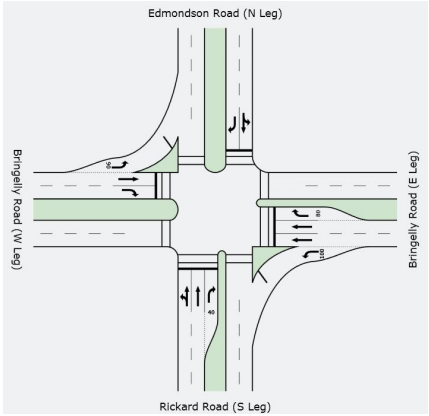
Appendix G

Intersection Analysis Sensitivity Test (2-lane Analysis)

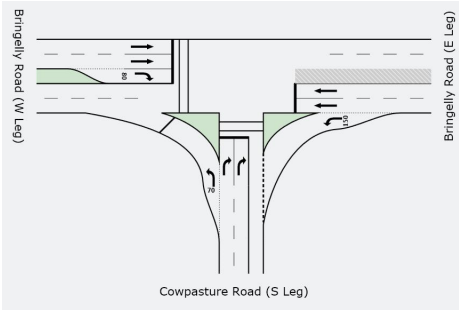
2016: Bringelly Road – Eastwood Road to Browns Road



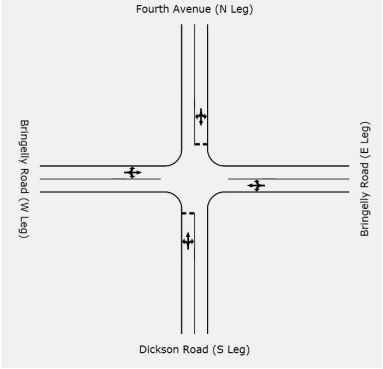
	Int. LoS	DoS	Worst Q	App
AM	A	0.476	43.6	EB
PM	A	0.531	19.7	EB



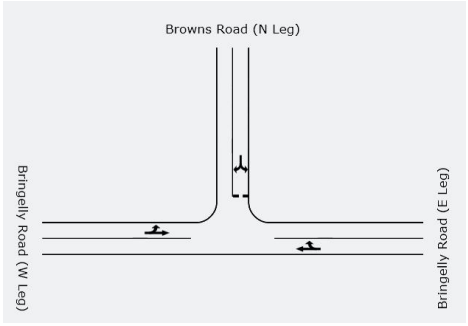
	Int. LoS	DoS	Worst Q	App
AM	C	0.842	269.1	EB T
PM	C	0.724	113.2	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.464	68.0	EB T
PM	B	0.710	99.4	WB T



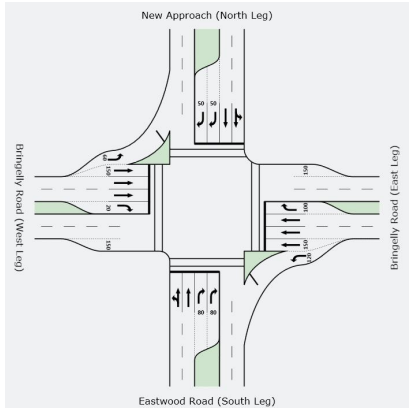
	Int. LoS	DoS	Worst Q	App
AM	A	0.808	54.3	EB
PM	A	0.806	46.8	NB



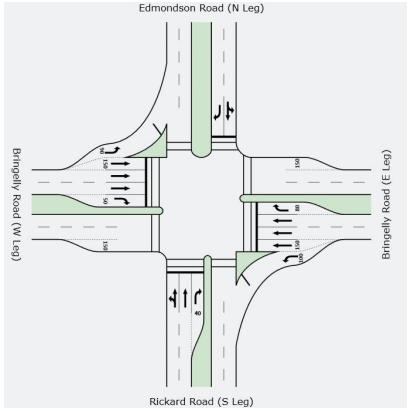
	Int. LoS	DoS	Worst Q	App
AM	A	0.427	35.2	WB
PM	A	0.490	67.1	WB

AECOM

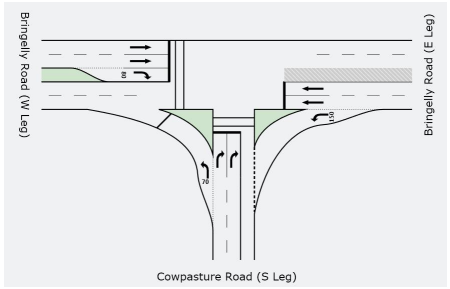
2021: Bringelly Road – Eastwood Road to Browns Road



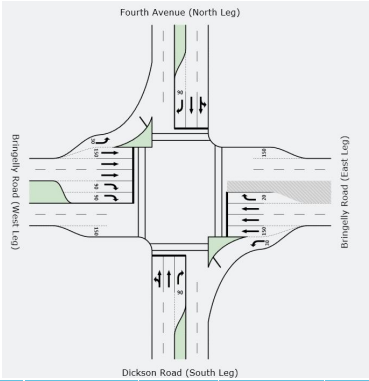
	Int. LoS	DoS	Worst Q	App
AM	C	0.869	247.0	EB T
PM	C	0.851	233.0	WB T



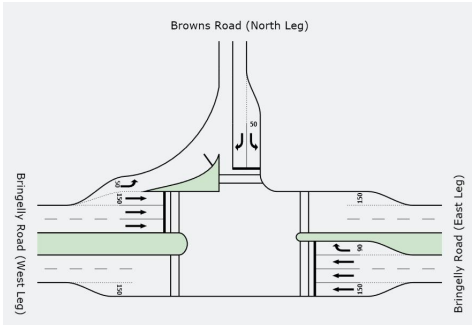
	Int. LoS	DoS	Worst Q	App
AM	E	1.000	335.6	EB T
PM	E	1.000	361.9	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.843	140.0	EB T
PM	B	0.845	252.3	WB T



	Int. LoS	DoS	Worst Q	App
AM	C	0.876	263.5	EB T
PM	C	0.833	271.6	WB T



	Int. LoS	DoS	Worst Q	App
AM	B	0.659	240.7	EB T
PM	B	0.713	229.0	WB T

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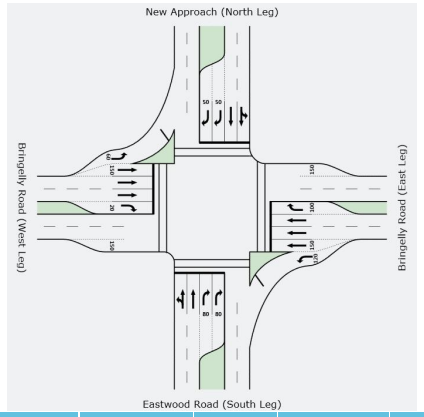
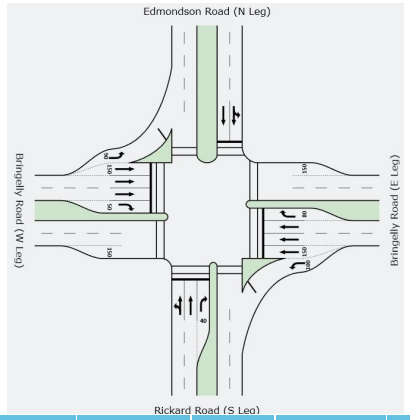
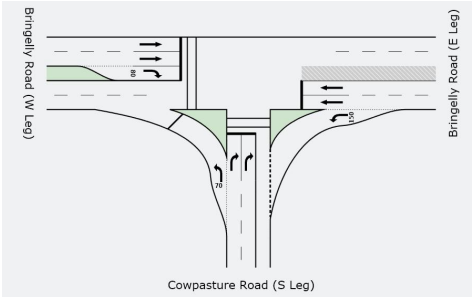
2026: Bringelly Road – Eastwood Road to Browns Road



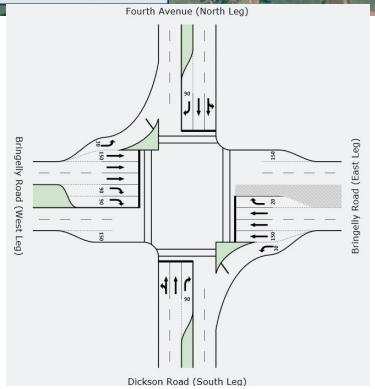
	Int. LoS	DoS	Av delay	Worst delay	Worst Q	Worst Q App
AM	C	0.909	42.2	NB RT	306.2	EB T
PM	C	0.880	41.0	EB RT	252.0	WB T



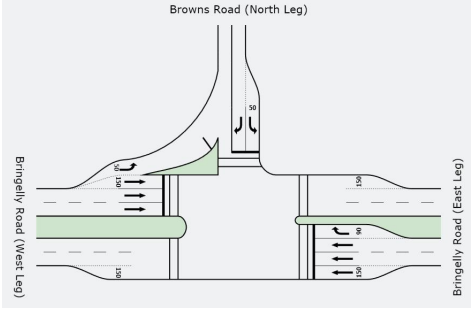
	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	D	1.000	53.7	WB RT	415.6	EB T
PM	F	1.068	141.7	NB LT	911.3	WB T



	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	B	0.891	25.7	EB RT	177.8	EB T
PM	B	0.866	24.3	EB RT	388.4	WB T



	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	D	0.879	45.5	NB RT	342.9	EB T
PM	D	0.868	42.6	EB RT	305.9	WB T



	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	B	0.699	17.6	WB R	273.5	EB T
PM	B	0.858	17.9	WB R	398.1	WB T

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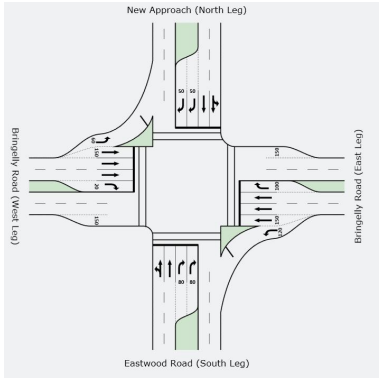
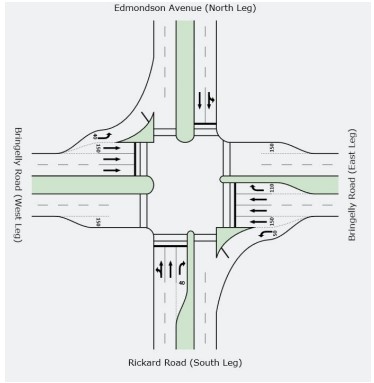
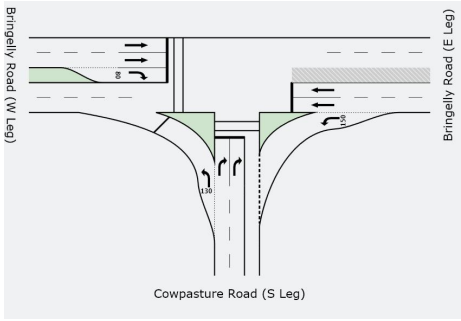
2031: Bringelly Road – Eastwood Road to Browns Road



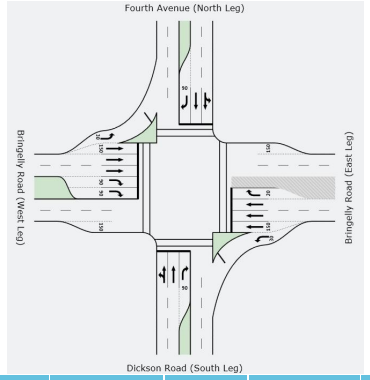
	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	F	0.987	74.4	NB RT	738.5	EB T
PM	D	0.959	48.0	SB RT	368.3	WB T



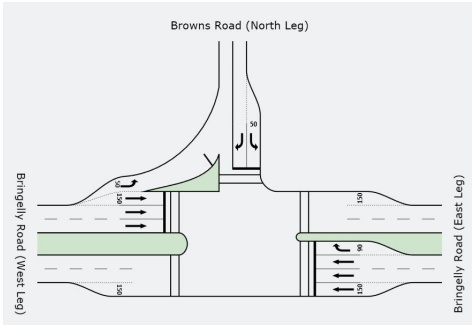
	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	C	1.000	35.7	WB RT	433.3	EB T
PM	C	0.920	38.4	SB LT	294.7	WB T



	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	B	0.878	27.8	EB RT	227.7	EB T
PM	F	1.188	81.3	EB RT	761.1	WB T



	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	F	1.030	102.9	EB T	900.6	EB T
PM	F	1.145	215.4	WB T	1650.1	WB T



	Int. LoS	DoS	Av delay	Worst delay	Worst Q	App
AM	D	0.978	52.7	WB RT	799.4	EB T
PM	F	1.042	110.0	WB T	1433.7	WB T

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