Appendix J

Traffic

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MR154 THE NORTHERN ROAD UPGRADE

Between The Old Northern Rd & Mersey Rd

TRAFFIC AND TRANSPORT ASSESSMENT REPORT

- Rev 5
- August 2012
- NB11363-ETR-RP-0068

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SINCLAIR KNIGHT MERZ

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Executive Summary

Sinclair Knight Merz (SKM) has been appointed by the New South Wales Roads and Maritime Services (RMS) to undertake a Concept Design and a Review of Environmental Factors (REF) for MR154 The Northern Road upgrade. The project comprises 15km of The Northern Road, from The Old Northern Road to Mersey Road, upgrading it from an existing two lane rural undivided road to a four lane urban divided road. The upgrade will allow for an ultimate six lane configuration, with the future widening to occur in the median area. The upgrade will include intersection controls and facilities for buses, pedestrians and cyclists.

The majority of the study area is of semi-rural character with light densely populated residential facilities. These are mainly farms and single family detached houses which can be accessed via driveways and lanes off The Northern Road. Areas with more densely populated residential areas include Harrington Park in the south of the study area and Bringelly in the north.

The traffic and transport assessment forms part of the REF. The purpose of this assessment is to determine the operational and construction impacts of the proposed upgrade.

The following tasks were undertaken to perform the assessment:

- Review the existing traffic patterns and historic crash trend;
- Determine the operational performance of the key intersections under existing and future scenarios;
- Provide a consistent set of traffic demand forecasts for the entire project reflective of the RMS EMME model and adopted classified intersection counts and automatic traffic counts of surveyed traffic data;
- Project traffic in future years 2016, 2026 and 2036 by using the transportation-planning software package “SATURN”;
- Determine peak hour traffic demands on The Northern Road and turning movements at signalised intersections on the road network; and
- Furnish information for the impact assessment, concept design and preliminary construction traffic management plan.

Existing Traffic Network Analysis

A seven day automated classified count and major intersection counts on The Northern Road were undertaken between the 6th and the 12th June 2011 which is a non-holiday period. All midblock volume / capacity ratios were found to be below 65% capacity. The existing performance of the

intersections that are situated within the study area have been assessed as being generally acceptable (LoS C or better), with acceptable delays and spare capacity. This indicates that the existing traffic volumes in both the AM and PM peak periods are relatively low and have reserve capacity at the major intersections along The Northern Road.

Crash data along The Northern Road from the March quarter of 2005 to 2010 was analysed. A relatively significant number of crashes occurred at the twin Cobbitty Road intersections. The analysis shows that the majority of accidents in this section of The Northern Road are caused by opposed turning movements. This is likely a result of a large number of turning movements taking place within a high speed section (80km/hr) in a constraint area of The Northern Road.

Traffic Modelling

A traffic model of the area was developed using the SATURN modelling package. Models were developed for the existing road network (2011 base model), and for 2016 (initial opening), 2026 (4-lane configuration), and 2036 (6-lane configuration), to develop an integrated appreciation of future traffic patterns within the study area. In this modelling, only major road networks were coded. These included the existing The Northern Road, Jersey Road and road connections to the study area along it. All forecast flows were projected for the purpose of determining the midblock capacity and the optimum configuration of the intersections in the future. A sensitivity test was carried out to determine the requirement for a grade-separated interchange for The Northern Road / Bringelly Road intersection which showed that this was not required before 2036.

Midblock Capacity

To determine the midblock capacity of the road an assumption was made that The Northern Road will be upgraded to a dual carriageway with two lanes in each direction in 2026 with the provision to be upgraded to three lanes in each direction in 2036 to cater for the traffic growth on the surrounding network within the study area. Forecast traffic volumes from the SATURN model showed that the upgraded road would operate at LoS D or better during peak hours.

Intersection Performance

With substantial growth and development of Oran Park alongside The Northern Road, traffic from the surrounding developments will access the Northern Road at designated locations. The concept design proposes 14 signalised intersections within the study area. The signalised intersections are proposed to be provided at the following locations:

- Fairwater Drive/Porrende Street;
- Hillside Drive;
- Cobbitty Road;
- Oran Park Link Road 1 (Peter Brock Drive) ;
- Oran Park Link Road 2;
- Marylands Link Road 1;
- Mersey Road.
- Marylands Link Road 2;
- Marylands Link Road 3;
- Lowes Creek Link Road;
- Belmore Road;
- Bringelly Road/Greendale Road;
- Badgerys Creek Road;
- Derwent Road; and

Each of the above intersections was assessed under 2026 and 2036 forecast traffic flows and with the upgraded road based on a 4-lane and 6-lane configuration respectively. All intersections were found to operate at LoS D or better during peak hours and are expected to operate at or close to capacity.

Staging Requirements

In 2016, prior to full 4-lane widening, the sections of The Northern Road between the Bringelly Road and Mersey Road intersections are likely to remain in their existing lane configuration and intersection layouts. The remainder of the corridor is likely to be progressively upgraded to a four lane divided carriageway configuration.

In 2026, the sections of The Northern Road between the Badgerys Creek Road and Mersey Road intersections are likely to remain in their existing lane configuration and intersection layouts. The remainder of the corridor is to be progressively upgraded to a four lane divided carriageway configuration.

In 2036, the sections of The Northern Road between the Badgerys Creek Road and Mersey Road intersections are likely to be upgraded to a four lane divided carriageway configuration. The remainder of the corridor will be progressively upgraded to a six lane divided carriageway configuration.

Construction Traffic Management Plan

A preliminary Construction Traffic Management Plan (CTMP) addresses the potential impacts of works related to the upgrade of The Northern Road, and details the proposed traffic management measures for the maintenance of two-way traffic operations and access to adjoining roads during construction.

The Northern Road upgrade predominantly consists of the construction of a new carriageway adjacent to the existing alignment of The Northern Road, the installation of new intersections and

the upgrade of existing intersections. The new carriageway will be duplicated alternately between the eastern and western sides of the existing alignment. It is expected that construction will be undertaken in two main stages:

- First stage will involve construction of the new carriageway with traffic to be carried on the existing carriageway.
- Second stage will involve upgrading works on the existing carriageway with traffic to be carried on the new carriageway.

Areas within the construction site where heavy earthmoving vehicles and cranes are in operation will be separated and protected by temporary barriers. Appropriate detailed Traffic Management Plans and associated Traffic Control Plans will be utilised to advise road users of the changed traffic management arrangements.

All vehicles accessing the internal site roads for the purpose of material delivery and construction works will require safety flashing lights located on the top of the vehicle and functioning reverse beepers. All operators will be licensed for the particular item of equipment, and shall demonstrate competence in the use of the equipment as part of the site management and safety plan.

1. Introduction

1.1. Project Description

Sinclair Knight Merz (SKM) has been appointed by the New South Wales Roas and Maritime Services (RMS) to undertake a Concept Design and a Review of Environmental Factors (REF) for MR154 The Northern Road upgrade between The Old Northern Road, Narellan and Mersey Road, Bringelly (The Project).

The project comprises 15km of The Northern Road, from The Old Northern Road to Mersey Road, upgrading it from an existing two lane rural undivided road to a four lane urban divided road. The upgrade will allow for an ultimate six lane configuration, with the future widening to occur in the median area. The upgrade will include intersection controls and facilities for buses, pedestrians and cyclists.

The section of The Northern Road proposed for upgrade traverses close to the western boundary of the South West Growth Centre (SWGC). This area is intended to be mainly residential development, with some embedded employment. Immediately to the north, are the Western Sydney Employment Lands, the Western Sydney Employment Hub and Erskine Park. These are anticipated to become major employment areas for Western Sydney. A significant collector road network is planned for the SWGC and The Northern Road will need to be upgraded to accommodate significant traffic growth. Main features of The Project include:

- 15 km of median separated 80km/hr posted dual carriageway;
- 14 new signalised intersections plus left in left out intersections;
- 2 bridge structures: one over Narellan Creek on the southern section and one over;
- Thompson Creek north of Bringelly Road; and
- Multiple culvert structures.

1.2. Project Objectives

The main objectives of the road upgrade are to:

- Improve the accessibility of The Northern Road to accommodate for the future traffic growth generated from the SWGC;
- Reduce future traffic congestion;
- Minimise the impact on the environment along the route;
- Improve accessibility and efficiency for public transport;
- Improve safety for pedestrians, cyclists and motorists; and

- Minimise the project "whole of life cost".

1.3. Scope of the Report

This traffic and transport assessment forms part of the REF. The purpose of this assessment is to determine the operational and construction impacts of the proposed upgrade comprising the following key tasks:

- Analysis of existing traffic and transport conditions;
- Traffic and transport modelling development and assessment;
- Operational performance of the key intersections to determine the ultimate intersection configuration to cater for the projected traffic growth as a result of the development of SWGC;
- Operational impact on public transport, pedestrians and cyclists; and
- Preliminary construction traffic assessment.

1.4. Structure of this Report

The report has 8 chapters and is structured as follows:

- **Section 1** describes the background, objectives and scopes of this study.
- **Section 2** outlines the existing traffic and road network system.
- **Section 3** provides the details of the traffic modelling process and methodology to determine the future traffic volumes.
- **Section 4** summarises the outcomes of testing of the existing road network under forecast traffic conditions without the proposed upgrade.
- **Section 5** provides the future road network performance.
- **Section 6** outlines the preliminary construction traffic impacts.
- **Section 7** outlines the evaluaration of road user delays.
- **Section 8** outlines a construction traffic management plan covering the potential impacts and management measures
- **Section 9** provides a summary of the major findings of this project.

2. Existing Traffic and Road Network

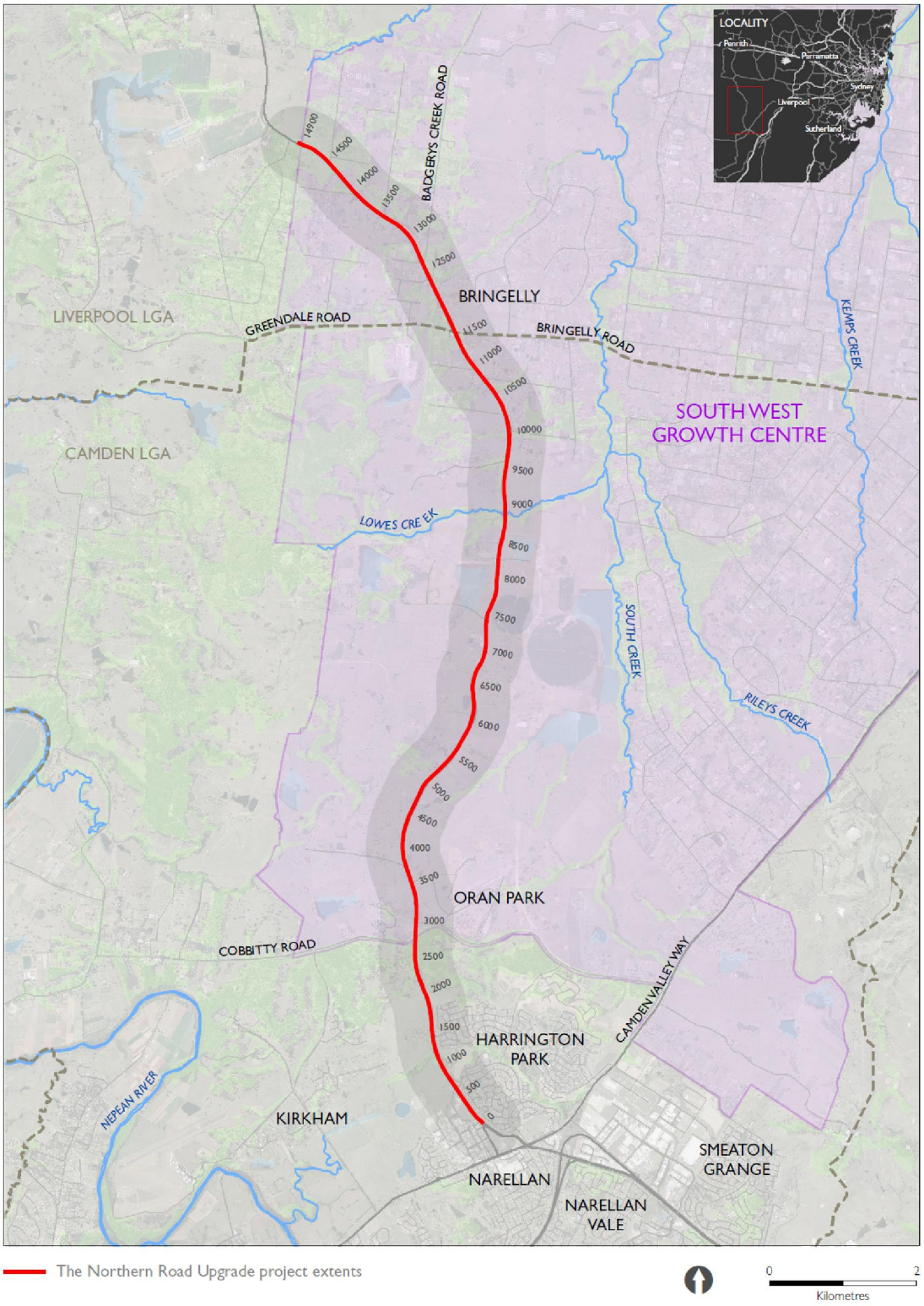
2.1. Existing Transport Environment

This section of the report describes the current transport environment in the study area to give an overview of the existing situation in the vicinity of The Northern Road. The review is based on observations from site visits, previous study reports, desktop analysis, review of third party data input and geographical sources.

2.1.1. Existing Traffic Network

The study area comprises The Northern Road from just north of its intersections with Old Northern Road (near Harrington Park) in the south and Mersey Road (north of Bringelly) in the north over a length of approximately 15km. For most of its length the Northern Road is a 2-lane road with paved shoulders through rural land. There are occasional overtaking lanes and 4-lane sections with turning lanes in Narellan and Bringelly. The Northern Road was repaved in 2002/03 and, consequently, the pavement has considerable residual life, not requiring any significant maintenance work in the near future. An overview of the study area can be found in **Figure 2-1**.

Figure 2-1: Study Area



2.1.2. Speed Environment

The Northern Road currently has speed limits of 60km/h and 80 km/h and the study area can be divided into the following four sections (from south to north):

- Old Northern Road ↔ Hillside Drive: 60km/h;
- Hillside Drive ↔ Belmore Road: 80km/h;
- Belmore Road ↔ Badgerys Creek Road: 60km/h; and
- Badgerys Creek Road ↔ Mersey Road: 80km/h.

In addition to the regular speed limits, a 40km/h school zone exists at the Bringelly Road intersection covering an area between 200m to 300m from the intersection in all directions.

2.1.3. Major Intersections

The Northern Road has a number of existing intersections with other roads over the length of the study area. The key intersections are (from south to north):

- Fairwater Drive – Roundabout;
- Hillside Drive – Roundabout;
- Cobbitty Road West – Priority intersection;
- Cobbitty Road East – Priority intersection;
- Belmore Road – Priority intersection;
- Bringelly Road – Signalised intersection; and
- Badgerys Creek Road – Roundabout.

There is one signalised intersection at Bringelly Road, three roundabouts at Fairwater Drive, Hillside Drive and Badgerys Creek Road, along the rest of the length are priority intersections with local streets and driveways.

2.1.4. Current Land Use

The majority of the study area is of semi-rural character with light densely populated residential properties. These are mainly farms and single family detached houses which can be accessed via driveways and lanes off The Northern Road. Areas with more densely populated residential areas include Harrington Park in the south of the study area and near Bringelly Road intersection in the north.

There are industrial light and heavy facilities in Bringelly and Narellan.

The only school along The Northern Road is Bringelly Public School near Bringelly Road intersection. In addition, there is Harrington Park Public School in Harrington Park which will have some traffic access from The Northern Road via Fairwater Drive and Hillside Drive.

2.1.5. Population and Employment

The study area incorporates areas of the following five Councils:

- Camden;
- Campbelltown;
- Fairfield;
- Liverpool; and
- Penrith.

Table 2-1 and **Table 2-2** show the expected growth in population and employment for locations within and adjacent to the study area. All data is based on the Census 2006 data and takes into account proposed residential and commercial development in the Council areas between 2011 and 2036.

- **Table 2-1: Current and Future Population around Study Area**

Council	2006	2011	2016	2026	2036
Camden	46,463	62,693	91,745	167,712	245,136
Campbelltown	32,970	36,582	41,687	55,944	68,222
Fairfield	725	778	854	990	1,184
Liverpool	10,070	10,395	11,070	34,528	74,690
Penrith	3,356	3,647	4,064	4,797	5,460

- **Table 2-2: Current and Future Employment around Study Area**

Council	2006	2011	2016	2026	2036
Camden	16,751	19,815	23,611	34,099	44,133
Campbelltown	19,315	21,898	24,222	29,607	34,883
Fairfield	321	341	350	385	413
Liverpool	2,914	3,106	3,295	6,554	9,682
Penrith	1,291	2,478	3,973	7,006	11,388

2.1.6. Public Transport

There are no existing regular bus routes along The Northern Road connecting the residential areas, however, some services operate through areas off The Northern Road including:

- Route 890 and Route 898 (operated by Busways) connect Harrington Park with Campbelltown Station;
- Route 856 (operated by Busabout) which connects Bringelly with Liverpool; and
- School bus services to local and regional primary and high schools.

2.1.7. Pedestrian and Cycle Facilities

The Northern Road has limited pedestrian and cycling facilities over the length of the study area. Cyclists can use the existing traffic lanes and no specific cyclist facilities have been incorporated in the existing intersections. The speed of traffic along The Northern Road combined with the rural nature of the area results in very minimal pedestrian and cycle activity. Over the majority of its length The Northern Road does not provide any sealed footpaths or other pedestrian facilities with the following exceptions:

- Harrington Park:
  - Sealed footpath adjacent to the northbound traffic lane extending between approximately 200m south and 150m north of the intersection of The Northern Road/ Old Northern Road; and
  - Signalised pedestrian crossing facilities are included in the southern and western arms of the intersection.
- Bringelly:
  - Sealed footpath adjacent to the southbound traffic lane extending for a distance of approximately 150m north of the intersection of The Northern Road/ Bringelly Road; and
  - Signalised pedestrian crossing facilities are included in the northern and western arms of the intersection.

2.1.8. Heavy Vehicles

To assess the heavy goods vehicle (HGV) volumes along The Northern Road, traffic counts were undertaken between the 6th and the 12th June 2011. The proportion of HGV is approximately 10% along the study corridor. **Table 2-2** below shows the average total number of heavy vehicles (all vehicles classified Class 3 or higher) on a weekday over 24 hours.

- **Table 2-2: ADT of Heavy Vehicles along The Northern Road**

Location	Northbound		Southbound	
	HV Vehicles	HV %	HV Vehicles	HV %
South of Fairwater Drive / Porrende Street	615	7%	604	8%
North of Bringelly Road / Greendale Road	822	11%	2,900	38%
North of Dwyer Rd	691	13%	549	10%

2.2. Traffic Volume

The seasonal variation along The Northern Road cannot be determined due to the limited availability of annual average daily traffic (AADT) data. However, based on the traffic survey data and the characteristics of the traffic that uses the road, it can be assumed that the seasonal variation will be low.

2.2.1. Midblock Traffic Counts

A 7-day automated classified count of traffic on The Northern Road was undertaken from 6th to 12th June 2011 which is a non-holiday period. The automated traffic count locations and 2-way traffic volumes are summarized in **Table 2-4**:

- The Northern Road: 100m south of Fairwater Drive / Porrende Street;
- The Northern Road: 100m north of Bringelly Road / Greendale Rd;
- The Northern Road: 50m north of Dwyer Rd; and
- Bringelly Rd: 100m east of The Northern Road.

It was noted that tube counts were not undertaken in between north of Cobbitty Road and south of Bringelly Road because there is no significant change in traffic numbers between these intersections hence no traffic tube counts were required in this area.

- **Table 2-4: Existing Midblock Traffic Volume**

Location	Average Daily Traffic (veh/day)	Average Weekday Traffic (veh/day)	AM Peak Hour (veh/hr)	PM Peak Hour (veh/hr)
The Northern Road South of Fairwater Drive / Porrende Street	15,702	16,460	1,205 (Start 0800)	1,483 (Start 1600)
The Northern Road North of Bringelly Road / Greendale Rd	13,558	14,781	1,260 (Start 0700)	1,383 (Start 1700)
The Northern Road North of Dwyer Rd	10,467	11,075	894 (Start 0700)	1,051 (Start 1600)
Bringelly Rd: East of The Northern Road	5,036	5,537	448 (Start 0700)	513 (Start 1600)

- The highest average daily traffic along The Northern Road during the week was 15,702, including 6% of heavy vehicles. The average weekday traffic volume was higher at 16,460, including 7% of heavy vehicles.
- The average daily traffic along the Bringelly Road during the week was 5,036, including 10% of heavy vehicles. The average weekday traffic volume was slightly higher at 5,537, including 11% of heavy vehicles.
- The morning peak hour for the traffic volume recorded in the study area took place between 0700 and 0800 and the evening peak was 1600 to 1700.

2.2.2. Directional Distribution

The directional distribution of traffic during peak hours is summarized in **Table 2-5**.

- **Table 2-5: Weekday and Weekend Directional Split**

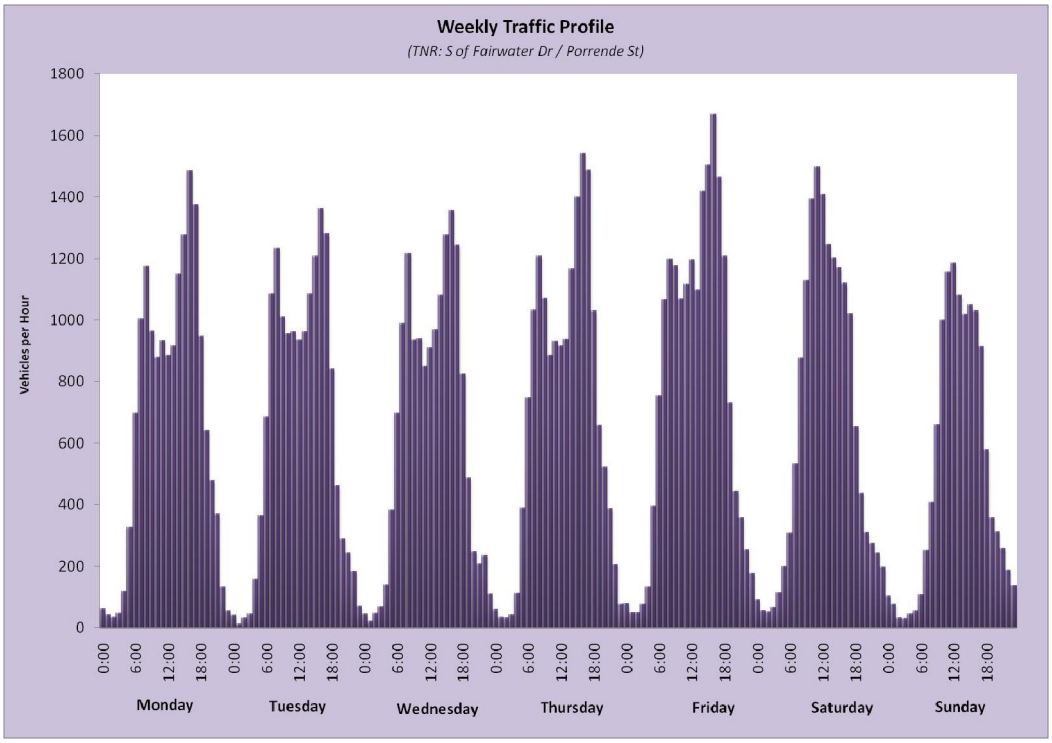
Location	Average Weekday Traffic			Average Weekend Traffic		
	Vehicles	NB / EB	SB / WB	Vehicles	NB / EB	SB / WB
The Northern Road: South of Fairwater Drive / Porrende Street	16,460	52%	48%	13,807	52%	48%
The Northern Road: North of Bringelly Road / Greendale Rd	14,781	49%	51%	10,500	50%	50%
The Northern Road: North of Dwyer Rd	11,075	50%	50%	8,947	50%	50%
Bringelly Rd: East of The Northern Road	5,537	50%	50%	3,784	49%	51%

The traffic survey sites had approximately 50/50 average daily traffic split on both weekdays and the weekend. The pattern of heavy vehicles is not notably different, which also had an approximately 50/50 directional split for all through traffic.

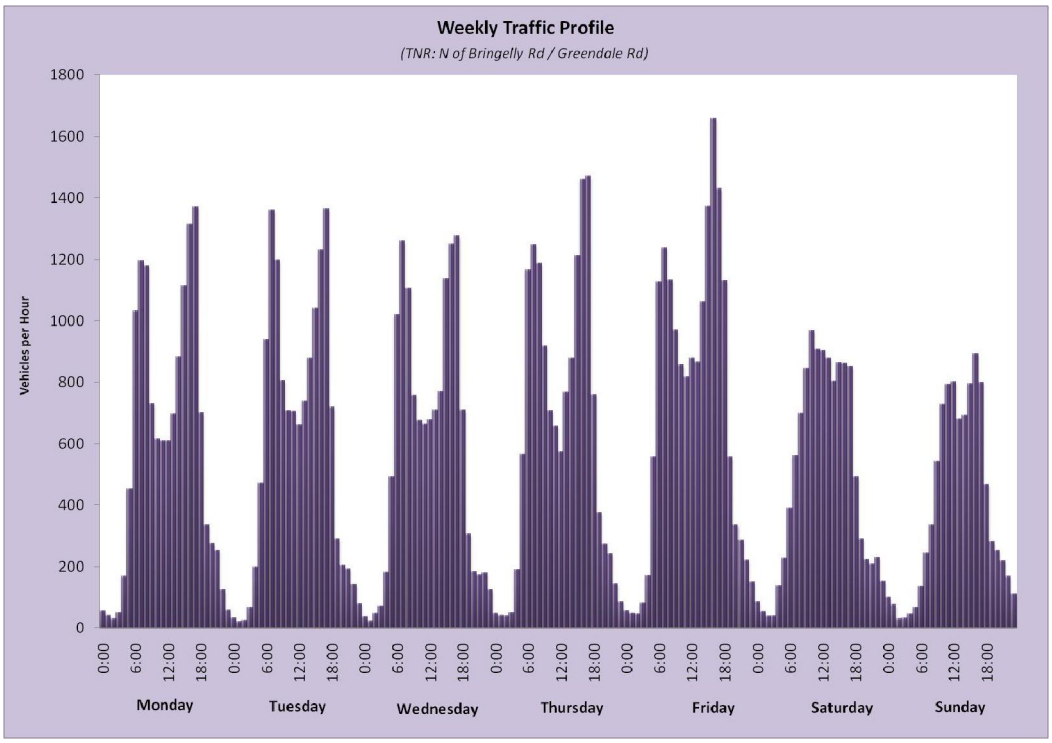
2.2.3. Daily Traffic Profile

Figure 2-2 to **Figure 2-5** shows the weekly 2-way traffic for all survey sites. All profiles indicate there are clearly defined morning and evening peak periods on all weekdays. Evening peaks volume is slightly higher than the morning peak periods. Traffic volume during the weekend is lower with no distinct peak periods.

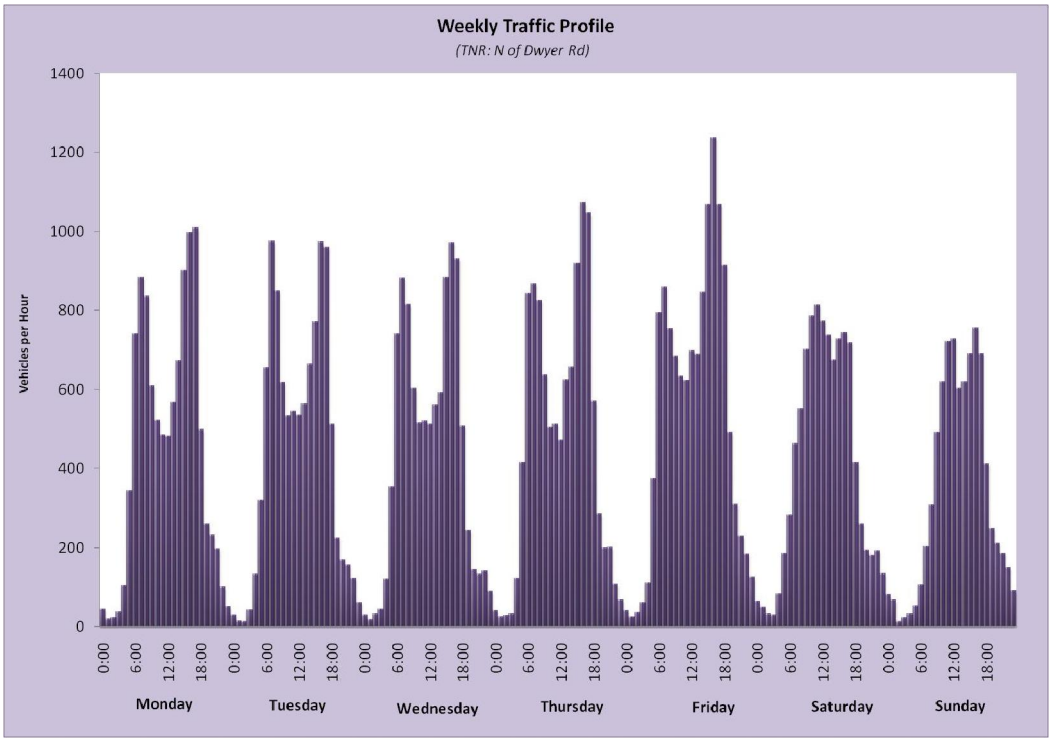
- **Figure 2-2: Daily Traffic Profile (The Northern Road: S of Fairwater Drive / Porrende Street)**



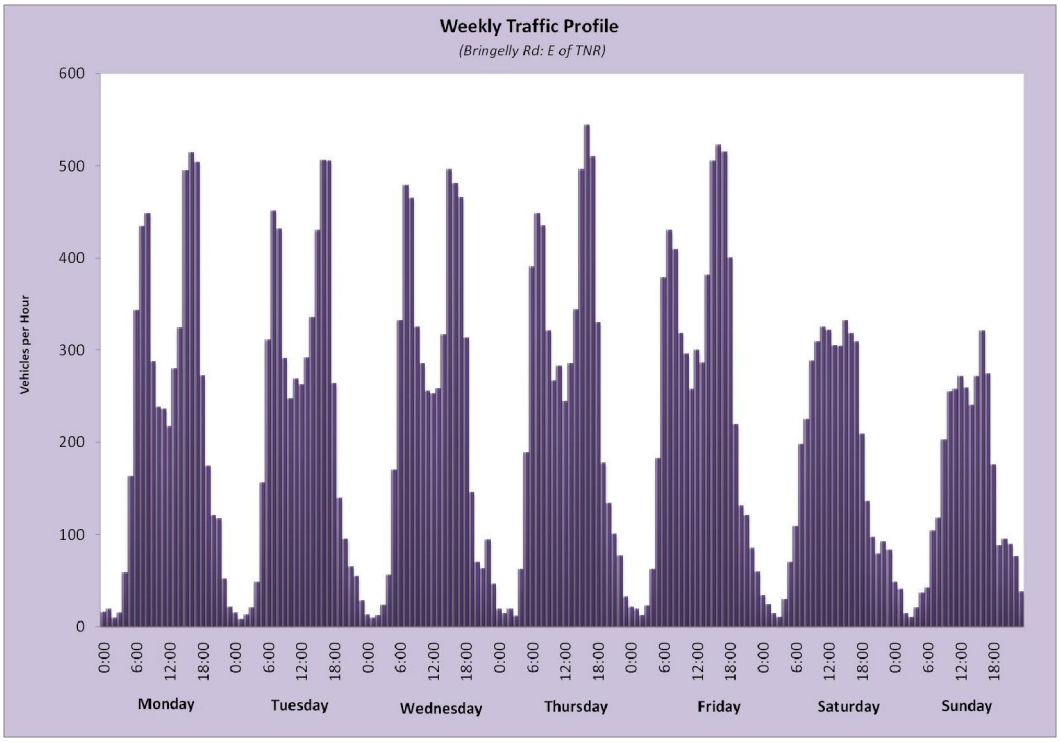
- **Figure 2-3: Daily Traffic Profile (The Northern Road: N of Bringelly Road / Greendale Rd)**



- **Figure 2-4: Daily Traffic Profile (The Northern Road: N of Dwyer Road)**



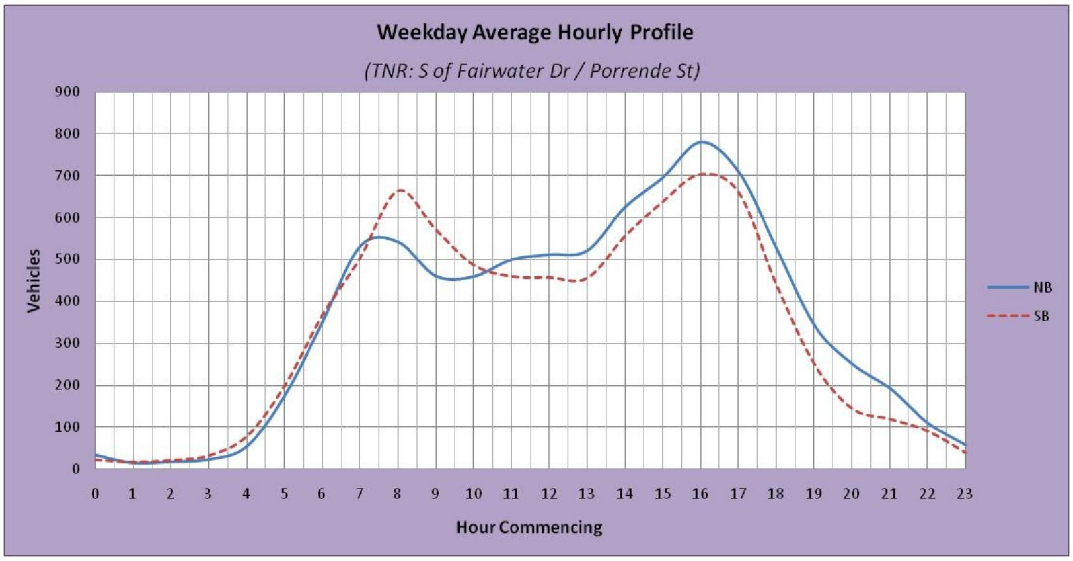
- **Figure 2-5: Daily Traffic Profile (Bringelly Road: E of The Northern Road)**



2.2.4. Hourly Traffic Profile

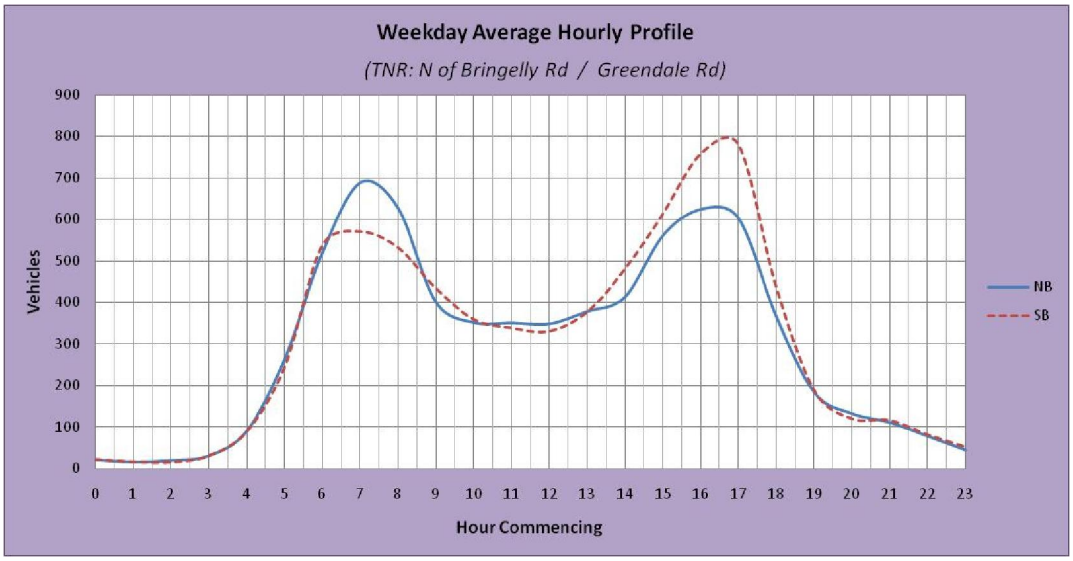
Figure 2-6 to **Figure 2-9** shows the average hourly traffic profile on weekdays at the four survey site locations.

- **Figure 2-6: Hourly Traffic Profile (The Northern Road: S of Fairwater Drive / Porrende Street)**



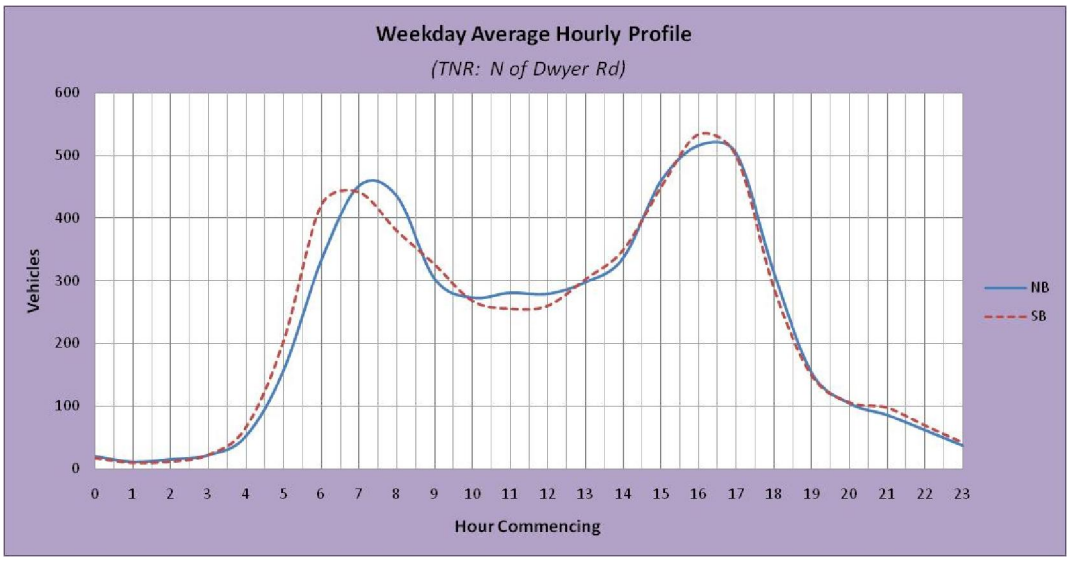
- The AM peak hour at this location is between 0800 and 0900, with an average weekday volume of 663 vehicles per hour, the majority of which are heading southbound.
- The PM peak is between 1600 and 1700, with an average of 780 vehicles per hour. The peak direction in the afternoon is northbound.

- **Figure 2-7: Hourly Traffic Profile (The Northern Road: N of Bringelly Road / Greendale Rd)**



- The AM peak hour at this location is between 0700 and 0800, with an average weekday volume of 689 vehicles per hour, the majority of which are heading northbound.
- The PM peak is between 1700 and 1800, with an average of 779 vehicles per hour. The peak direction in the afternoon is southbound.

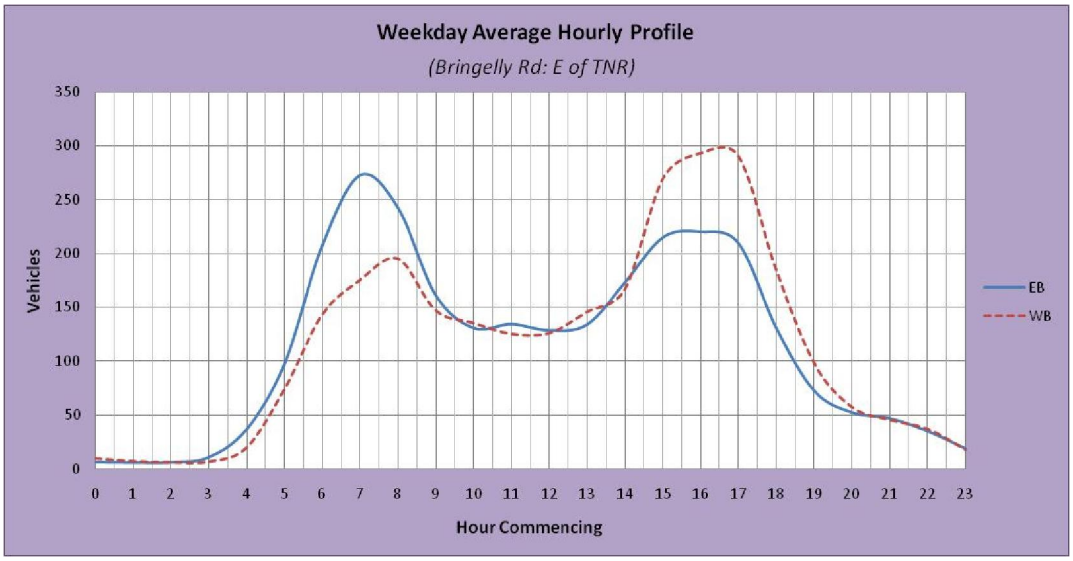
- **Figure 2-8: Hourly Traffic Profile (The Northern Road: N of Dwyer Road)**



- The AM peak hour at this location is between 0700 and 0800, with an average weekday volume of 452 vehicles per hour, the majority of which are heading northbound.

- The PM peak is between 1600 and 1700, with an average of 534 vehicles per hour. The peak direction in the afternoon is southbound.

- **Figure 2-9: Hourly Traffic Profile (Bringelly Road: E of The Northern Road)**



- The AM peak hour at this location is between 0700 and 0800, with an average weekday volume of 273 vehicles per hour, the majority of which are heading eastbound.
- The PM peak is between 1600 and 1700, with an average of 293 vehicles per hour. The peak direction in the afternoon is westbound.

2.2.5. Traffic Composition by Vehicle Type

According to the Austroads vehicle classification system, heavy vehicles (HV) include trucks with two or more axles, buses, semi trailers and B-Doubles (classification categories 3-12). Heavy vehicle demand was estimated based on the traffic counts carried out in June 2011. **Table 2-6** provides the average number of heavy vehicles as a percentage of the total.

- **Table 2-6: Heavy Vehicles on The Northern Road & Bringelly Road**

Location	Weekday			Weekend		
	2-way	NB / EB	SB / WB	2-way	NB / EB	SB / WB
The Northern Road: South of Fairwater Drive / Porrende Street						
HV as percent of daily	7%	7%	8%	4%	4%	4%
[1]Night HV as percent of total night vehicle	10%	9%	11%	7%	6%	8%
HV as percent of AM peak	8%	9%	6%	6%	7%	5%
HV as percent of PM peak	6%	6%	6%	3%	2%	4%
The Northern Road: North of Bringelly Road / Greendale Rd						
HV as percent of daily	25%	11%	38%	22%	7%	36%
[1]Night HV as percent of total night vehicle	30%	12%	48%	23%	7%	37%
HV as percent of AM peak	22%	9%	37%	26%	7%	44%
HV as percent of PM peak	23%	8%	34%	20%	6%	35%
The Northern Road: North of Dwyer Road						
HV as percent of daily	11%	13%	10%	6%	7%	5%
[1]Night HV as percent of total night vehicle	16%	17%	16%	8%	6%	10%
HV as percent of AM peak	9%	11%	8%	11%	14%	7%
HV as percent of PM peak	9%	12%	6%	5%	7%	3%
Bringelly Road: East of The Northern Road						
HV as percent of daily	11%	11%	11%	7%	7%	7%
[1]Night HV as percent of total night vehicle	14%	16%	12%	7%	11%	4%
HV as percent of AM peak	11%	10%	12%	10%	8%	11%
HV as percent of PM peak	9%	9%	9%	5%	5%	5%

1. Night vehicles from 2200 to 0600

Analysis of the heavy vehicle data in above survey locations shows the following pattern:

- The Northern Road, in the vicinity of Bringelly Road, has relatively high levels of heavy vehicles compared to other locations.
- On average heavy vehicles contribute approximately 14% of the weekday total traffic and 10% of the weekend traffic in the The Northern Road area.
- The Northern Road, in the vicinity of Bringelly Road, has a high proportion of southbound heavy vehicles, 48% traffic, recorded between 2200 to 0600.
- The proportion of heavy vehicles is generally uniform distributed directionally, except on The Northern Road, in the vicinity of Bringelly Road.

- The percentage of heavy vehicles on typical weekdays is approximately 60% higher than the weekend, except on The Northern Road, in the vicinity of Bringelly Road.

2.3. Operational Performance Assessment

To ascertain the existing operational performance of The Northern Road, the link capacity of the road was determined and detailed intersection analysis of the significant intersections was undertaken.

2.3.1. Midblock Capacity

A midblock link capacity analysis of the existing road network was undertaken using the Austroads Guide to Traffic Management Part 3 – Traffic Studies and Analysis, Section 5.2.1 and explanatory notes. Volume to capacity ratio (v/c) for the peak direction traffic volumes at each of the four survey locations was calculated by adopting a capacity of 900 vehicles per lane per hour (with kerb lane). The peak hour directional traffic flows and associated volume/capacity ratios are summarised in **Table 2-7** and **Table 2-8**.

- **Table 2-7: Midblock Peak Hour Capacity – AM**

Location	AM Peak (1-hr)			
	NB / EB (vehicles)	v/c	SB / WB (vehicles)	v/c
The Northern Road: South of Fairwater Drive / Porrende Street	542	0.60	663	0.74
The Northern Road: North of Bringelly Road / Greendale Rd	689	0.77	571	0.63
The Northern Road: North of Dwyer Rd	452	0.50	442	0.49
Bringelly Rd: East of The Northern Road	273	0.30	176	0.20

- **Table 2-8: Midblock Peak Hour Capacity – PM**

Location	PM Peak (1-hr)			
	NB / EB (vehicles)	v/c	SB / WB (vehicles)	v/c
The Northern Road: South of Fairwater Drive / Porrende Street	780	0.87	703	0.78
The Northern Road: North of Bringelly Road / Greendale Rd	604	0.67	779	0.87
The Northern Road: North of Dwyer Rd	516	0.57	534	0.59
Bringelly Rd: East of The Northern Road	220	0.24	293	0.33

- All volume capacity ratios are below 90% capacity.
- This indicates that the current traffic volume in both AM and PM peak periods are not saturated and The Northern Road has a small amount of reserve capacity.

2.3.2. Existing Intersections Analysis

Traffic volumes at key intersections were surveyed on the Thursday 9th June 2011 (non-school holiday) for 2 hours during the morning peak (0700 to 0900) and afternoon peak (1600 to 1800) at the following intersections along The Northern Road:

- Porrende Street / Fairwater Drive;
- Hillside Drive;
- Cobbitty Road West;
- Belmore Road;
- Greendale Road / Bringelly Road;
- Badgerys Creek Road;
- Derwent Road; and
- Mersey Road.

Analysis of the intersections was undertaken using the SIDRA Intersection analysis software (Version 5.1) to determine their operational performance. Operating conditions can be compared to the performance criteria set out in **Table 2-9**.

Table 2-9: Level of Service Criteria

Level of Service	Average Delay per Vehicle (sec/veh)	Traffic Signals and Roundabouts	Give Way and Stop Signs
A	Less than 15	Good Operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause delays Roundabouts require other control mode	At capacity, requires other control mode
F	Over 70	Extra capacity required	Extreme delay, traffic signal or other major treatment required.

Source: *Guide to Traffic Generating Developments*, (RTA, 2002, Version 2.2)

A summary of 2011 AM and PM SIDRA results are provided in **Appendix A1**. The results of the analysis along The Northern Road are summarised in **Table 2-10** and **Table 2-11**.

Table 2-10: Existing Intersection Performance – 2011 AM Peak Hour

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	1,766	0.53	15.7	B	31.6 <The Northern Rd - South>
Hillside Drive	*Roundabout	1,531	0.51	15.7	B	34.2 <The Northern Rd - South>
Cobbitty Road West	*Priority	1,943	0.48	24.3	B	27.6 <Cobbitty Rd West>
Belmore Road	*Priority	1,093	0.34	17.5	B	23.6 <The Northern Rd - North>
Bringelly Road	Signalised	1,489	0.58	15.6	B	71.7 <The Northern Rd - South>
Badgerys Creek Road	*Roundabout	1,317	0.43	14.8	B	26.9 <The Northern Rd - South>
Derwent Road	*Priority	1,004	0.26	22.1	B	minimum queue length
Mersey Road	*Priority	984	0.28	23.2	B	26.8 <The Northern Rd - South>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- **Table 2-11: Existing Intersection Performance – 2011 PM Peak Hour**

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	2,172	0.80	18.4	B	93.4 <The Northern Rd - North>
Hillside Drive	*Roundabout	1,661	0.63	16.8	B	42.8 <The Northern Rd - North>
Cobbitty Road West	*Priority	1,925	0.54	34.7	C	17.6 <Cobbitty Rd West>
Belmore Road	*Priority	1,361	0.42	19.9	B	56.8 <The Northern Rd - North>
Bringelly Road	Signalised	1,745	0.68	17.1	B	103.8 <The Northern Rd - North>
Badgerys Creek Road	*Roundabout	1,557	0.44	15.3	B	28.1 <The Northern Rd - South>
Derwent Road	*Priority	1,191	0.29	22.7	B	minimal queuing
Mersey Road	*Priority	2,172	0.34	19.9	B	93.4 <The Northern Rd - North>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

From **Table 2-7** and **Table 2-8**, it can be seen that the existing performance of the intersections that are situated within the study area operate satisfactory with LoS C or better and minimal delays.

2.3.3. Travel Time and Travel Speed

A site inspection was conducted on Thursday, 9th June 2011 by SKM and travel time was measured in both the AM and PM peak periods from The Old Northern Road to Mersey Road. The travel time was recorded for each direction on three occasions to determine the average travel time. **Table 2-12** shows the travel time and travel speed information in both peak hours.

- **Table 2-12: Existing Travel Time / Travel Speed – 2011 Peak Hour**

Sections	AM Observed (mm:ss) <km/hr>		PM Observed (mm:ss) <km/hr>		Free flow (mm:ss) <km/hr>
	NB	SB	NB	SB	NB/SB
Between: Old Northern Road and Hillside Drive	02:09 <42>	02:05 <43>	02:22 <38>	02:29 <36>	01:30 <60>
Between: Hillside Drive and Belmore Road	07:14 <74>	07:05 <75>	07:00 <76>	07:15 <74>	06:42 <80>
Between: Belmore Road and Badgerys Creek Road	02:56 <51>	02:51 <53>	02:58 <51>	03:12 <47>	02:30 <60>
Between: Badgerys Creek Road and Mersey Road	01:37 <67>	01:32 <70>	01:33 <70>	01:39 <65>	01:24 <80>
Total Travel Time	**13:56**	**13:33**	**13:53**	**14:35**	**12:06**

2.4. Review of Existing Crash Data

2.4.1. Overview

Analysis was performed on crash data along The Northern Road between the March quarter of 2005 to 2010. A map showing the location and type of crashes can be seen in **Figure 2-10** and **Figure 2-11**.

During the analysis period one fatality and 51 injuries occurred from a total of 76 crashes. It has to be noted that a single accident can produce more than one injury. The majority of crashes were during daylight hours in dry conditions and 56% of all crashes occurred at an intersection.

Fatigue was involved in ten crashes and speed was involved in eleven. Two thirds of all crashes included multiple vehicles.

Figure 2-10. Northern Section of The Northern Road

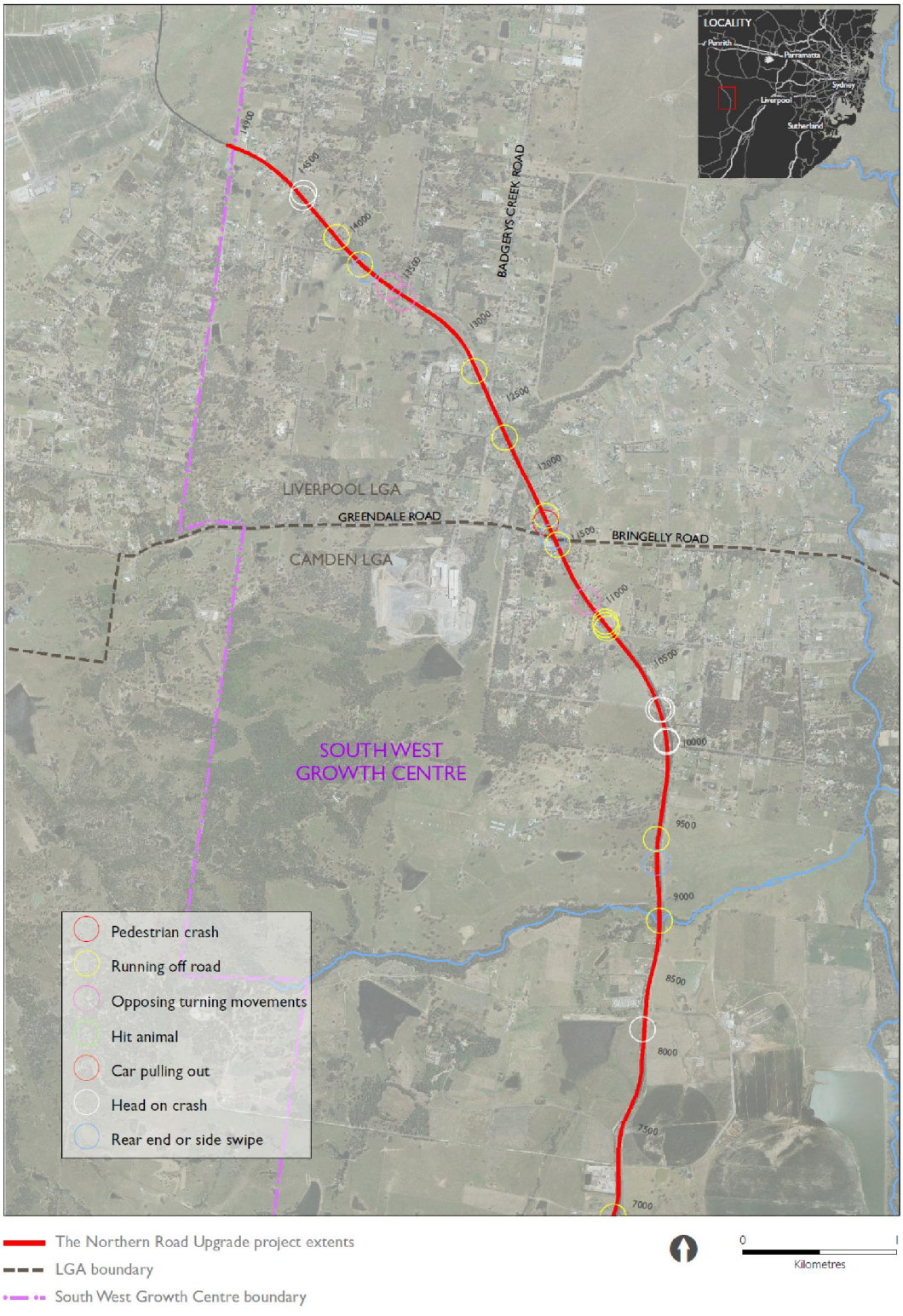
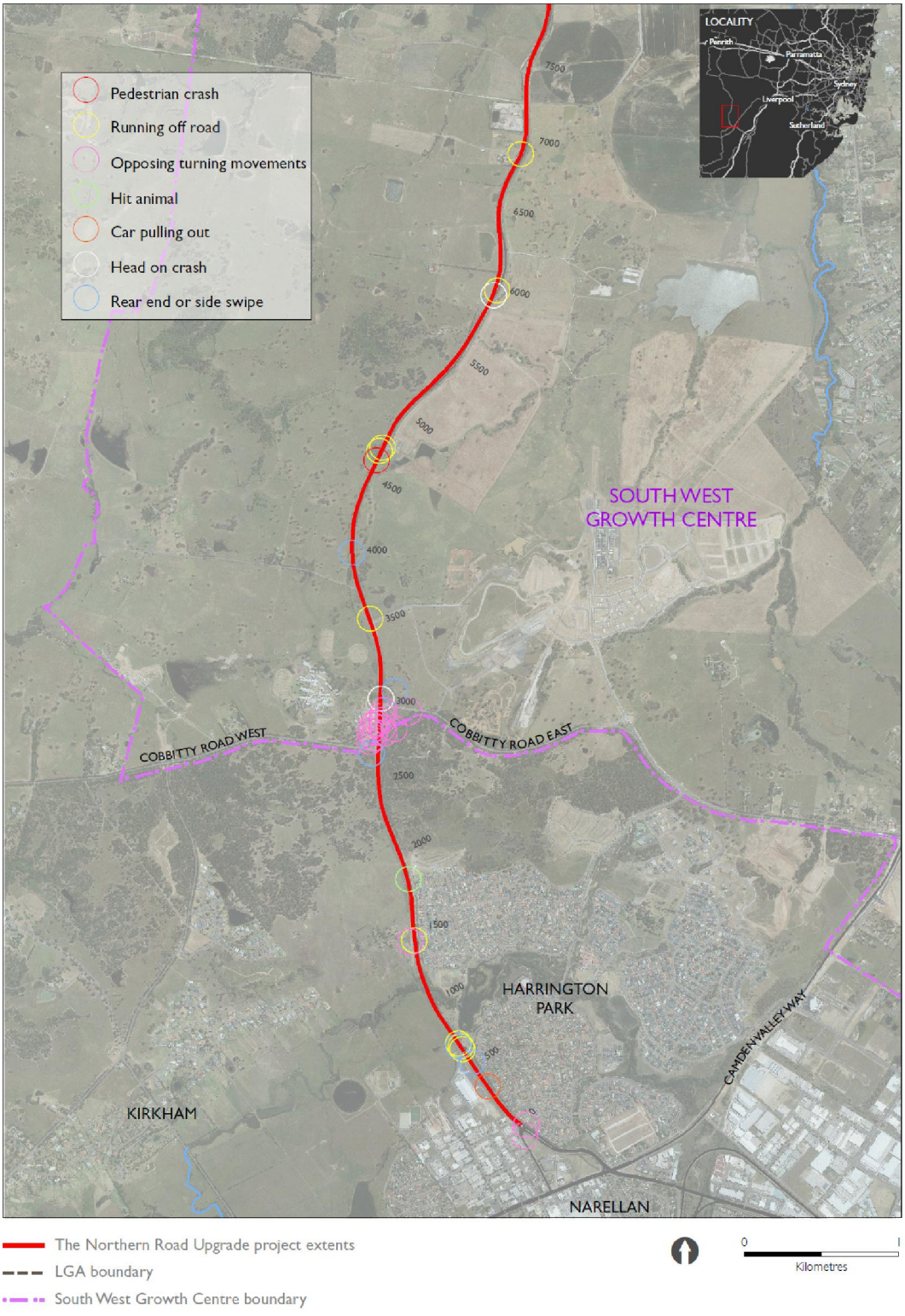


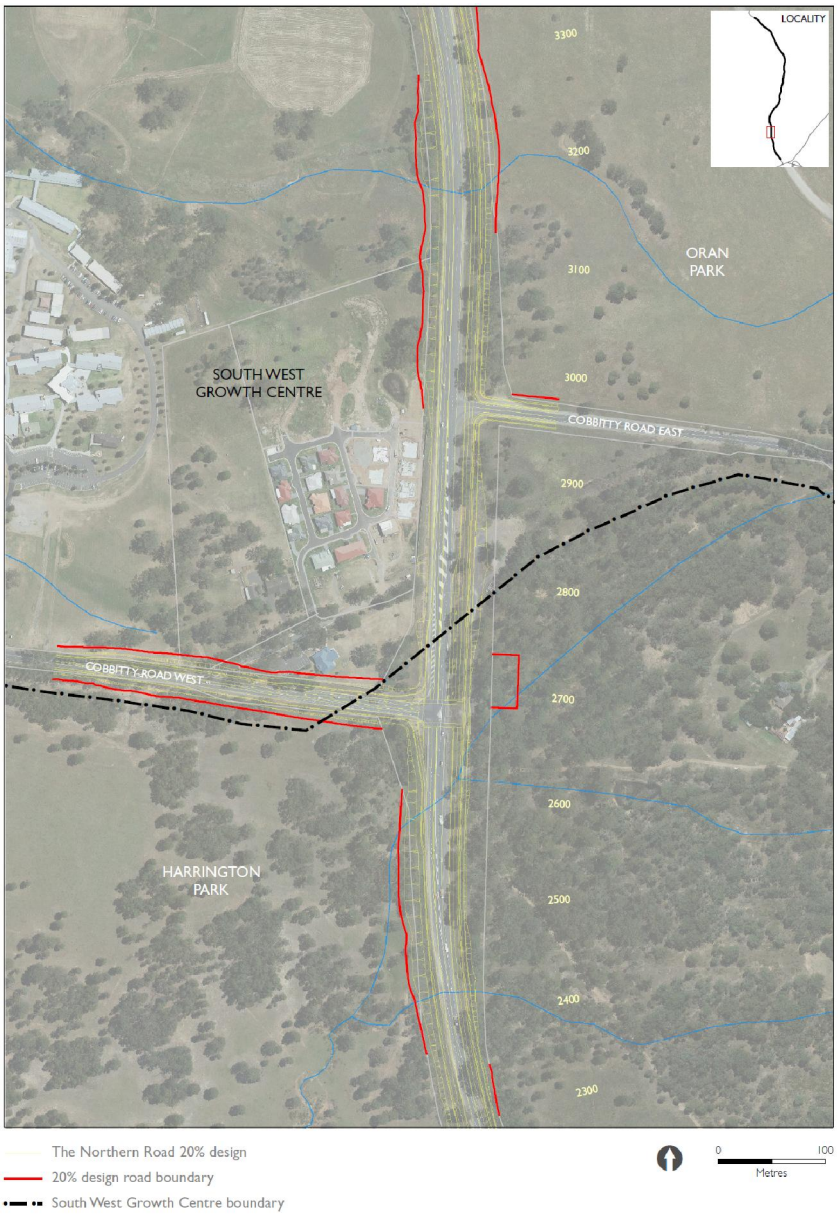
Figure 2-11: Southern Section of The Northern Road



2.4.2. Cobbitty Road Intersections

A relatively large number of crashes occurred at the twin Cobbitty Road intersections, shown in **Figure 2-12**, just west of Oran Park. Cobbitty Road East and West intersect with The Northern Road approximately 300m apart. As a consequence, a large number of turning movements occur within this short section of The Northern Road which operates with a relatively high speed limit of 80km/h. Currently both intersections are priority controlled intersections. The analysis shows that the majority of accidents are caused by opposed turning movements.

- **Figure 2-12: Cobbitty Road Intersections**



2.4.3. Pedestrians and Cyclists

There was a single pedestrian crash and a single cyclist crash within the study area and within the period of analysis.

2.4.4. Roundabouts

At the roundabouts on town fringes most crashes are single vehicles losing control. This would indicate that, while the roundabouts are not very busy, vehicles may be entering the roundabouts with a speed too high to navigate them safely. In its present configuration the roundabouts are the first change in road configuration that would cause a driver to slow down after an extended period of high speed driving in a rural setting. This is especially the case where The Northern Road traffic dominates movements at the roundabout and drivers can approach with little regard to having to give way.

3. Model Development

3.1. Study Objectives

One of the main objectives of this study is to develop the future models for the periods 2016, 2026 and 2036 to forecast the peak hour traffic volumes within the study area. This forecast includes the following steps:

- Obtain 2011 peak hour base models comprising the current study network;
- Calibrate the base models to ensure their robustness in terms of replicating the current traffic conditions;
- Include modifications to the base model network to represent proposed 2016, 2026 and 2036 future networks;
- Apply growth factors to the base model trips to develop 2016, 2026 and 2036 future year origin-destination (OD) trip matrices; and
- With the future year networks and the corresponding OD matrices, execute the models to obtain the forecast traffic volumes.

The model methodology was to draw heavily on the RMS EMME model for traffic demands and to use SATURN to refine the local traffic patterns and provide a tool to calculate turning flows for detailed analysis. The SATURN model was not used as a primary network performance model but rather used as a convenient and indicative traffic assignment tool only. As such, the calibration task was a minor adjustment of the demand matrices so the major features of the demands from the RMS model were retained.

3.2. 2011 Peak Hour Base Models Development

SKM obtained the RMS's EMME model, from which the following data was extracted for the modelling task:

- Cordon network comprising the links, nodes, zones and link speed information; and
- Cordon 2011 peak hour origin-destination (OD) matrices.

The SATURN base model development included the following tasks:

- Code the 2011 road network in SATURN;
- Undertake the matrix estimation procedures to estimate 2011 base model OD trip matrices for AM and PM peak periods; and
- Calibrate the base models to ensure that the model reflects recently collected turning movement counts in the study area.

3.2.1. 2011 Model Network

The model network was coded using MapInfo to provide a mechanism for calculating accurate link lengths. The modelled network and internal zoning system used for the model are illustrated in **Figure 3-1**. There are 39 internal zones to represent the major trip production/ attraction regions within the study area. In addition, there are 22 external zones connected to the study area. The zoning system was kept consistent between base and future models to simplify the demand manipulation. In the base year demand matrix, some undeveloped zones had zero trips.

The internal zones were created by refining the RMS EMME model's zoning system. **Table 3-1** summarises the equivalence of two zoning systems.

The SATURN network used simulation coding format to provide access to the assigned turn flows although all intersections were coded with no simulation delays (i.e. coded as "dummy nodes"). Route choice was influenced using indicative average link speeds and altered to give sensible route choice. This approach was used to provide explicit control over the intended traffic routes such that the flows from the model used subsequent traffic design were consistent with intended future road hierarchy function.

- **Table 3-1: Equivalence of RMS and SKM Zoning Systems**

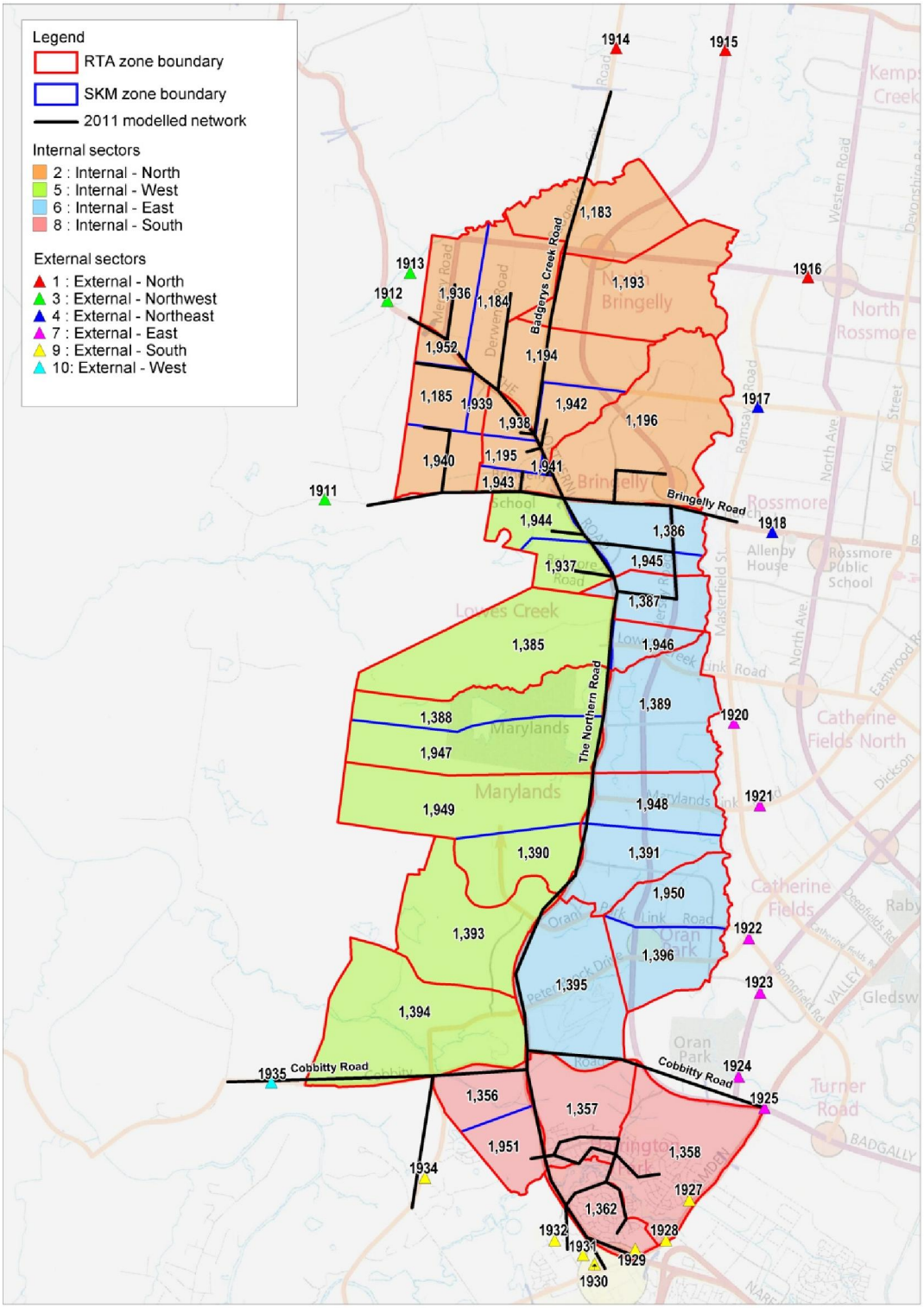
RMS EMME Zone	SKM SATURN Zone	Split proportion (of RMS EMME zone)	Sector number	Sector Description
1183	1183	100%	2	Internal – North
1184	1184	50%	2	Internal – North
1184	1936	50%	2	Internal – North
1185	1185	25%	2	Internal – North
1185	1939	0%*	2	Internal – North
1185	1940	50%	2	Internal – North
1185	1952	25%	2	Internal – North
1193	1193	100%	2	Internal – North
1194	1194	50%	2	Internal - North
1194	1942	50%	2	Internal - North
1195	1195	10%	2	Internal - North
1195	1938	10%	2	Internal - North
1195	1941	10%	2	Internal - North
1195	1943	70%	2	Internal - North
1196	1196	100%	2	Internal - North
1356	1356	50%	8	Internal - South
1356	1951	50%	8	Internal - South

RMS EMME Zone	SKM SATURN Zone	Split proportion (of RMS EMME zone)	Sector number	Sector Description
1357	1357	100%	8	Internal - South
1358	1358	100%	8	Internal - South
1362	1362	100%	8	Internal - South
1385	1385	100%	5	Internal - West
1385	1946	0%*	6	Internal - East
1386	1386	25%	6	Internal - East
1386	1937	25%	5	Internal - West
1386	1944	25%	5	Internal - West
1386	1945	25%	6	Internal - East
1387	1387	100%	6	Internal - East
1388	1388	10%	5	Internal - West
1388	1947	90%	5	Internal - West
1389	1389	100%	6	Internal - East
1390	1390	50%	5	Internal - West
1390	1949	50%	5	Internal - West
1391	1391	50%	6	Internal - East
1391	1948	50%	6	Internal - East
1393	1393	100%	5	Internal - West
1394	1394	100%	5	Internal - West
1395	1395	100%	6	Internal - East
1396	1396	50%	6	Internal - East
1396	1950	50%	6	Internal - East
1911	1911	100%	3	External - Northwest
1912	1912	100%	3	External - Northwest
1913	1913	100%	3	External - Northwest
1914	1914	100%	1	External - North
1915	1915	100%	1	External - North
1916	1916	100%	1	External - North
1917	1917	100%	4	External - Northeast
1918	1918	100%	4	External - Northeast
1920	1920	100%	7	External - East
1921	1921	100%	7	External - East
1922	1922	100%	7	External - East
1923	1923	100%	7	External - East
1924	1924	100%	7	External - East
1925	1925	100%	7	External - East
1927	1927	100%	9	External - South
1928	1928	100%	9	External - South

RMS EMME Zone	SKM SATURN Zone	Split proportion (of RMS EMME zone)	Sector number	Sector Description
1929	1929	100%	9	External - South
1930	1930	100%	9	External - South
1931	1931	100%	9	External - South
1932	1932	100%	9	External - South
1934	1934	100%	9	External - South
1935	1935	100%	10	External - West

* 0% because it is created for coding in U-turn facility in the network.

- **Figure 3-1: Zone and Sector Systems (with 2036 proposed network map as background)**



3.2.2. 2011 Base models OD Matrix Estimation

SATURN Matrix Estimator (SATME) was used to generate 2011 base OD trip matrices. This estimation process requires two data sets:

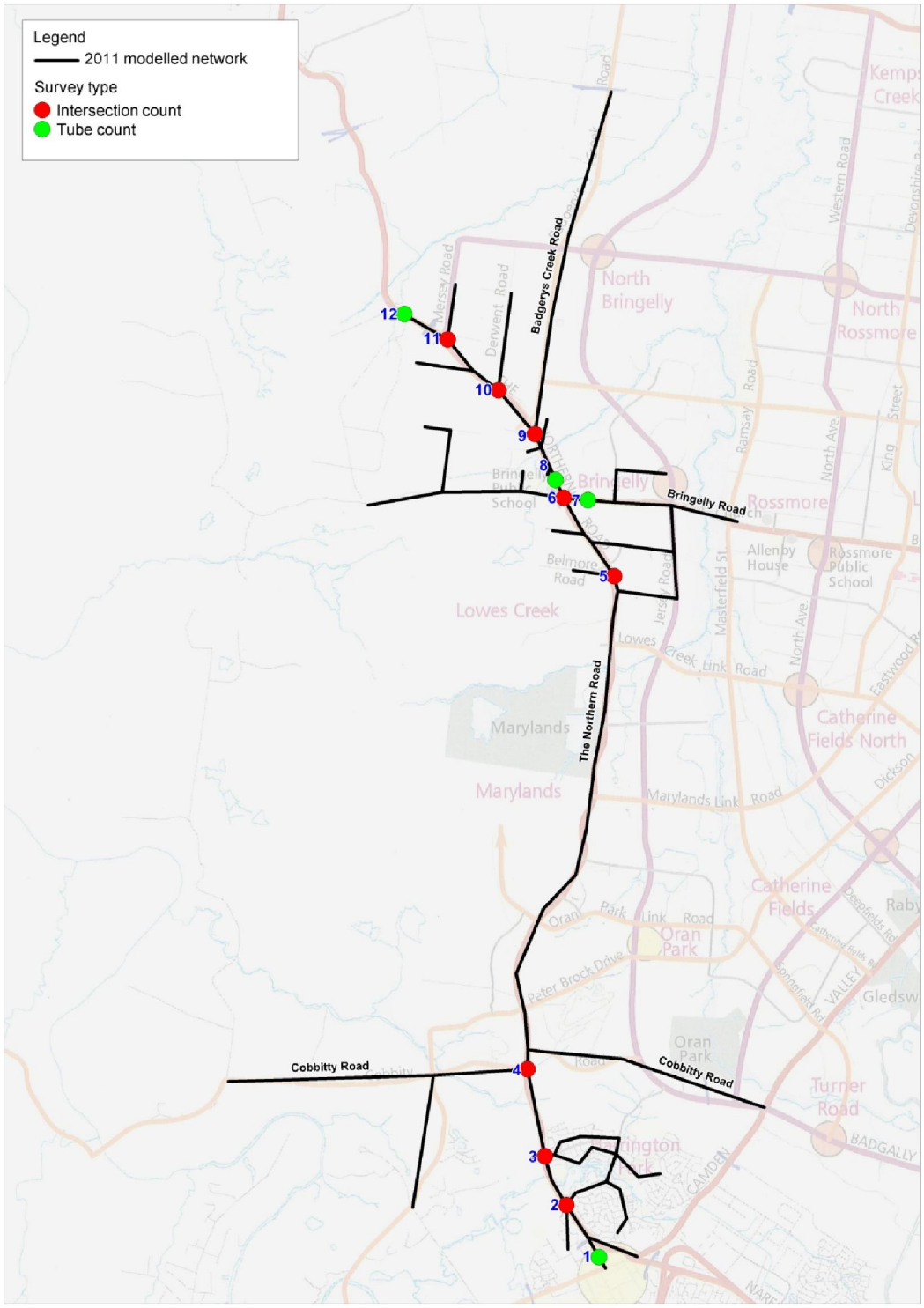
- Prior OD trip matrices; and
- Observed intersection turning counts –2011 intersection traffic surveys counts commissioned by SKM for this study.

As mentioned in ***Section 3.2,*** the 2011 cordon peak OD trip matrices from the RMS EMME models were extracted. SKM engaged Skyhigh Pty Ltd to undertake intersection tube counts (one week) and tube counts, on 9th June 2011 (Thursday) at 0700 – 0900 and 1600 – 1800 periods. These survey locations are summarised in **Table 3-2** and illustrated in **Figure 3-2**. Both trip matrices and intersection counts data was provided to the SATME process and the 2011 base OD trip matrices from the RMS model calibrated to observed traffic flows.

- **Table 3-2: Traffic Counts Survey Locations**

Location ID	Location	Survey Type
1	The Northern Road (west of Camden Valley Way)	Tube count
2	The Northern Road/ Porrende Street/ Fairwater Drive	Intersection count
3	The Northern Road/ Hillside Drive/ Service Road	Intersection count
4	The Northern Road/ Cobbitty Road West	Intersection count
5	The Northern Road/ Belmore Road	Intersection count
6	The Northern Road/ Bringelly Road/ Greendale Road	Intersection count
7	Bringelly Road (east of The Northern Road)	Tube count
8	The Northern Road (north of Bringelly Road)	Tube count
9	The Northern Road/ Badgerys Creek Road	Intersection count
10	The Northern Road/ Derwent Road	Intersection count
11	The Northern Road/ Mersey Road	Intersection count
12	The Northern Road (north of Dwyer Road)	Tube count

- **Figure 3-2: Survey Locations (with 2036 proposed network map as background)**



3.2.3. 2011 Base Models Calibration

The 'calibration' terms in the transport modelling fields are the processes of respectively fitting then verifying the model in terms of reflecting the real-world's current traffic conditions. In general, this is done by comparing known observed traffic datasets (such as turning counts, queue lengths, travel times and link flows) against the corresponding modelled output results.

For the current modelling purpose, the traffic turning volume outputs from the base modes were calibrated against the observed peak hour intersection turning counts and assessed in terms of the GEH statistic[1] criteria below:

- At least 85 percent of turning flows should have GEH less than 5.0; and
- 100 percent of turning flows should have GEH less than 10.0.

The summary of the calibration results are listed in **Table 3-3**.

[1] GEH Statistic is a modified Chi-Square empirical formula named after Geoffrey E. Harves, who invented it in 1970s to compare two sets of traffic volumes. The use of GEH as an acceptance criterion is widely recognised in the traffic forecasting and traffic/ transport modelling practice areas. The formula is:

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

where:
M is the traffic flow output from model; and
C is the observed real-world traffic flow.

A GEH less than 5.0 is considered to be a good match between modelled and observed traffic volumes. According to the UK Highways Agency's Design Manual for Road and Bridges (DMRB), a more than 85% of model links should comprise 'GEH less than 5.0'. And GEH between 5.0 to 10.0 may warrant further investigation and GEH greater than 10.0 is not accepted and definitely requires further investigation.

Table 3-3: Calibration Statistics Summary

Description	Value
Total number of individual turning flows	60
AM Base Model	
Percentage of individual turning movements with GEH less than 5.0	98%
Percentage of individual turning movements with GEH less than 10.0	100%
PM Base Model	
Percentage of individual turning movements with GEH less than 5.0	100%
Percentage of individual turning movements with GEH less than 10.0	100%

For the current analysis purposes, the base models were further checked against the tube count traffic volumes. Please note that the tube counts results were available at hourly aggregated flow basis, therefore the observed data for the periods 0700 to 0800 and 1600 to 1700 were considered for the peak hour modelled data. These results were summarised in **Table 3-4**.

Table 3-4: Base Model Calibration Statistics

Location	AM Base Model			PM Base Model		
	Modelled Flow	Observed Flow	GEH	Modelled Flow	Observed Flow	GEH
The Northern Road (west of Camden Valley Way) - Northbound	683	553	5.2	575	716	5.5
The Northern Road (west of Camden Valley Way) - Southbound	591	653	2.5	676	772	3.6
The Northern Rd (north of Bringelly Rd) - Northbound	642	652	0.4	635	647	0.5
The Northern Rd (north of Bringelly Rd) - Southbound	540	536	0.2	822	825	0.1
Bringelly Rd (east of The Northern Rd) - Eastbound	291	227	4.0	230	212	1.2
Bringelly Rd (east of The Northern Rd) - Westbound	177	208	2.2	310	298	0.7
The Northern Rd (north of Dwyer Rd) - Northbound	490	452	1.8	565	529	1.5
The Northern Rd (north of Dwyer Rd) - Southbound	441	374	3.3	517	517	0.0

Based on the above summary, apart from Northern Road northbound (at the west of Camden Valley), the peak hour base models considered to be calibrated within the 'good fit' acceptable criteria (i.e. GEH less than 5.0).

It is worth noting that the overall fit of the RMS model demands was good. The modifications made to the prior matrices (i.e. the RMS demands used as a starting point) were relatively minor. The total demand changes for the AM and PM peak matrices were only 297 (7%) and 512 (11%) vehicle trips respectively. The supplied RMS matrices were therefore considered a suitable basis for the base and future traffic demands with minor adjustments. On this basis, the RMS model is assumed to be sufficiently proven as fit for purpose and thus no further validation exercise was warranted.

3.2.4. 2011 Peak Hour Base Model Volumes

A summary of 2011 AM and PM link flow plots are provided in **Appendix B1**.

3.3. Future Year Models Development

As discussed in ***Section 3.1***, the network upgrades to the base models were included to develop 2016, 2026 and 2036 future year models.

3.3.1. Future year Origin-Destination estimation

To estimate the future year OD matrices (i.e. for 2016, 2026 and 2036), the trips difference between the RMS's 2011 base OD trips and corresponding trips in the future years were calculated. These additional trips were applied to the SKM's 2011 base model OD trips, in order to generate the corresponding future year OD trips. Please note that any estimated growth trips resulted in negative future trips, these were disregarded and the OD cell value reduced to zero.

3.3.2. 2016 AM and PM Peak Model

The 2016 road network and the indicative coded road link speeds were shown in **Figure 3-3**.

A summary of 2016 AM and PM link flow plots are provided in **Appendix B2**.

3.3.3. 2026 AM and PM Peak Model

The 2026 road network and the road link speeds were shown in **Figure 3-4**.

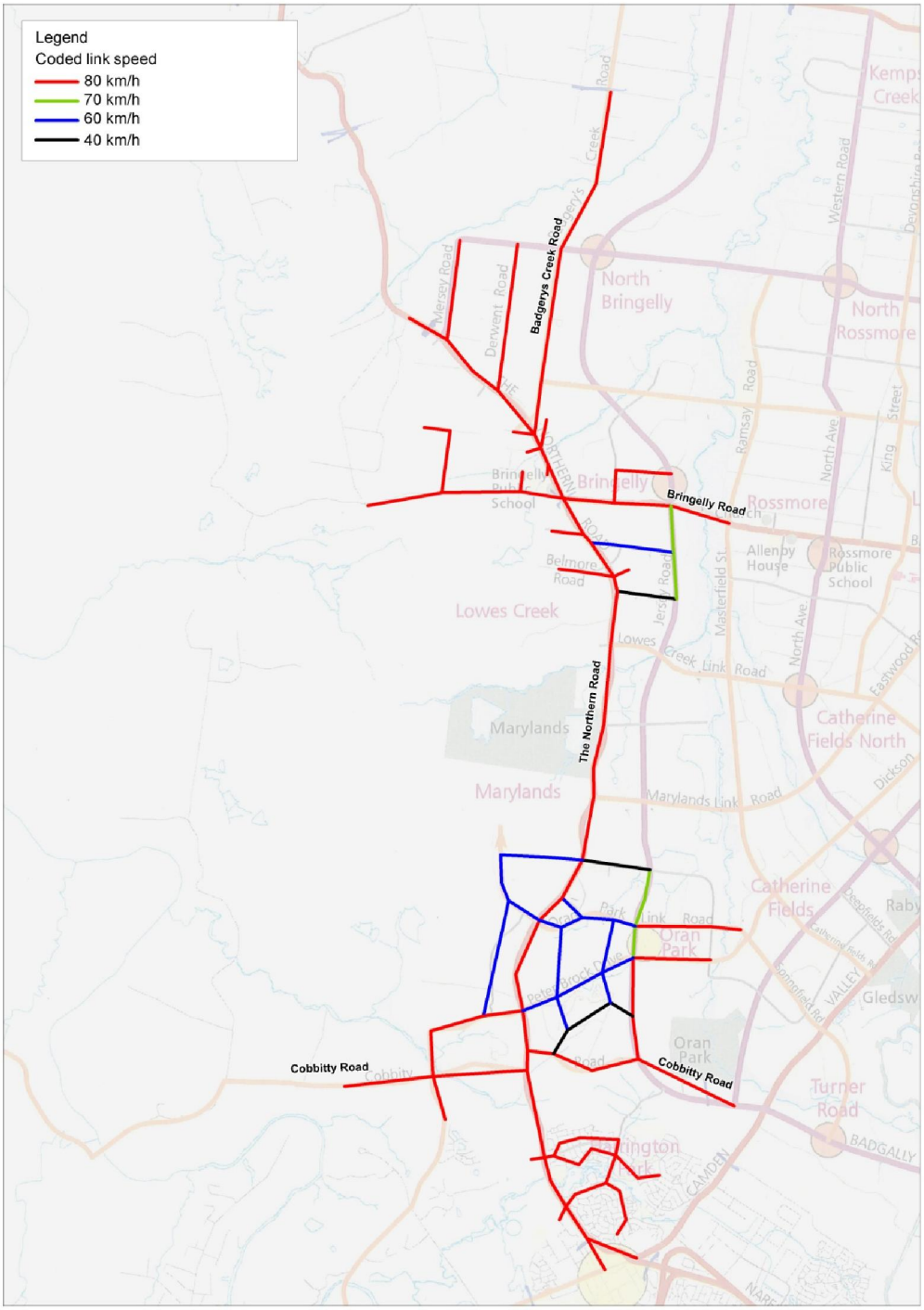
A summary of 2026 AM and PM link flow plots are provided in **Appendix B3**

3.3.4. 2036 AM and PM Peak Model

The 2036 road network and the road link speeds were shown in **Figure 3-5**.

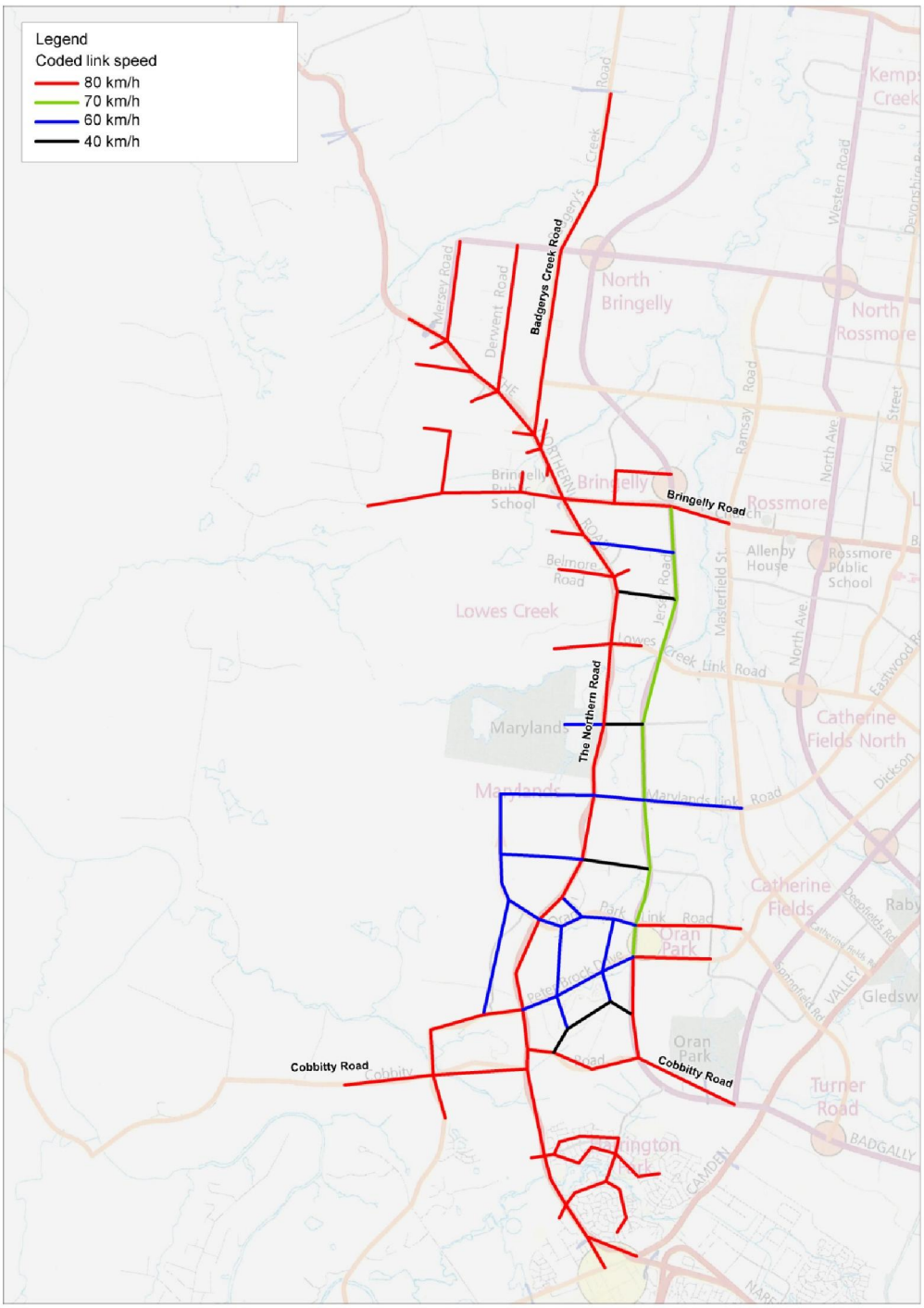
A summary of 2026 AM and PM link flow plots are provided in **Appendix B4**

- **Figure 3-3: 2016 Network and Link Speeds (with 2036 proposed network map as background)**



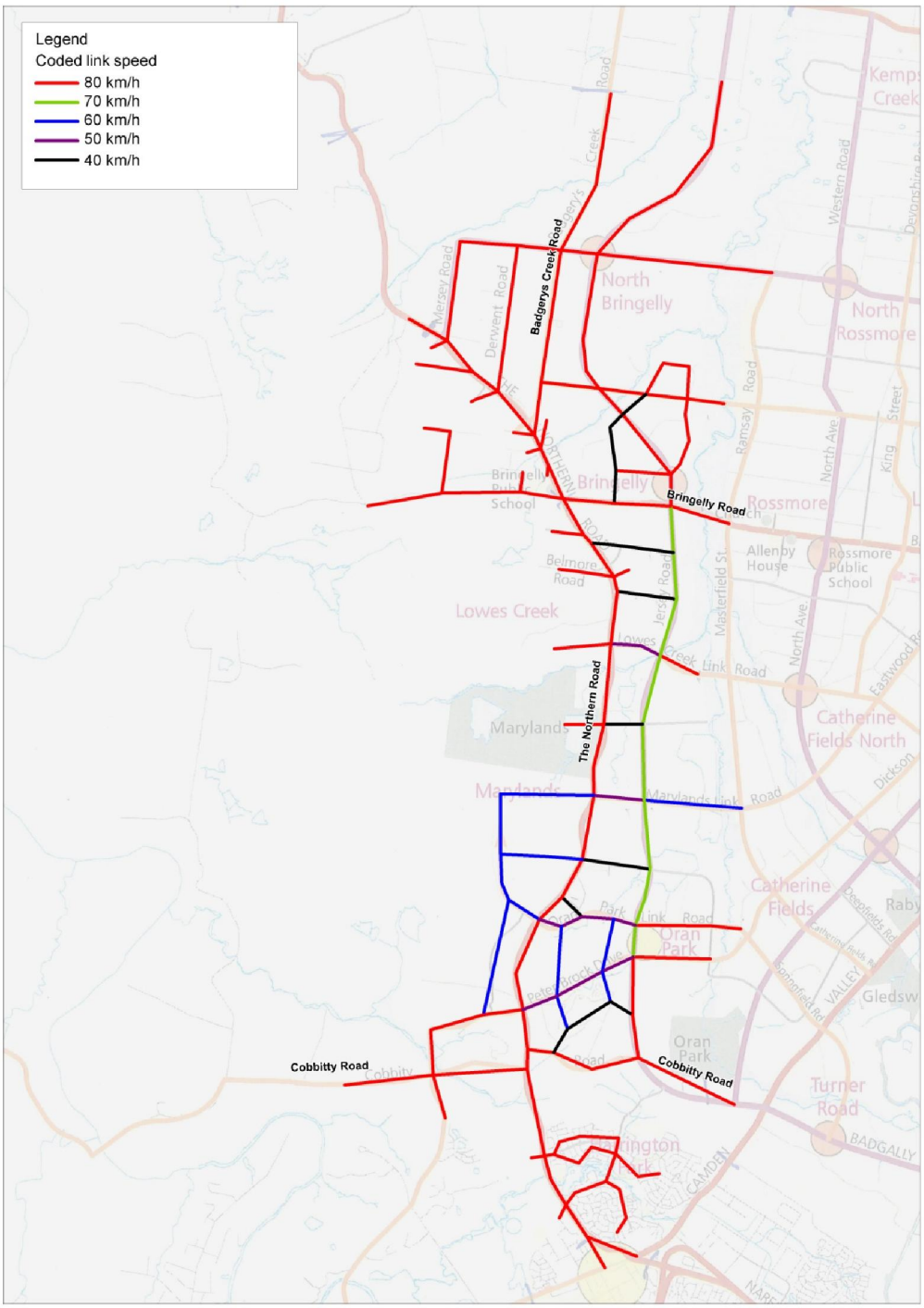
*Note: The road link speeds are only indicative; it uses to promote a sensible route choice for the traffic using The Northern Road and Jersey Road.

- **Figure 3-4: 2026 Network and Link Speeds (with 2036 proposed network map as background)**



*Note: The road link speeds are only indicative; it uses to promote a sensible route choice for the traffic using The Northern Road and Jersey Road.

- **Figure 3-5: 2036 Network and Link Speeds (with 2036 proposed network map as background)**



*Note: The road link speeds are only indicative; it uses to promote a sensible route choice for the traffic using The Northern Road and Jersey Road.

3.3.5. Sensitivity Test

During the Strategic Concept Design there was a concern that The Northern Road / Bringelly Road intersection might require grade separation. Sensitivity testing was undertaken to identify the scenario where this would be required. The sensitivity testing identified that the need for grade separation largely depended on the right turn traffic volume from The Northern Road south into Bringelly Road and also the left turn volume in the reverse direction.

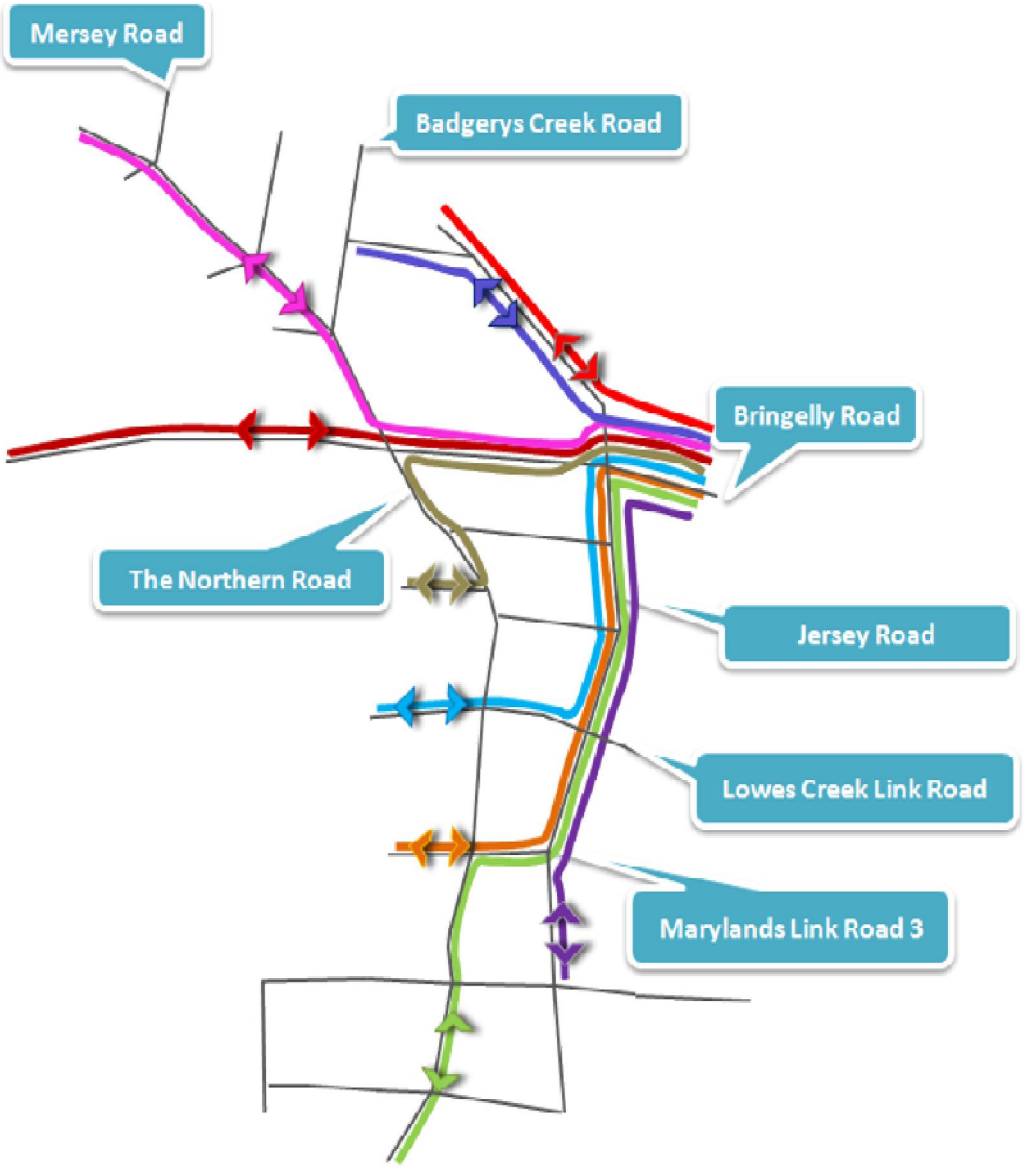
The two scenarios were conducted as described below:

- Scenario 1 - "**Base**" (share trips using The Northern Road/ Jersey Road) and
- Scenario 2 - "**Alternate**" (enforce all trips making turning movements at The Northern Road / Bringelly intersection)

Scenario1 - share trips using The Northern Road/ Jersey Road*:*

In the 2036 SATURN model Jersey Road is assumed to be the main route for traffic accessing Bringelly Road (east of Jersey Road) for traffic approaching from the south of Carrington Road. **Figure 3-6** shows the route choice between various locations and east of Bringelly Road.

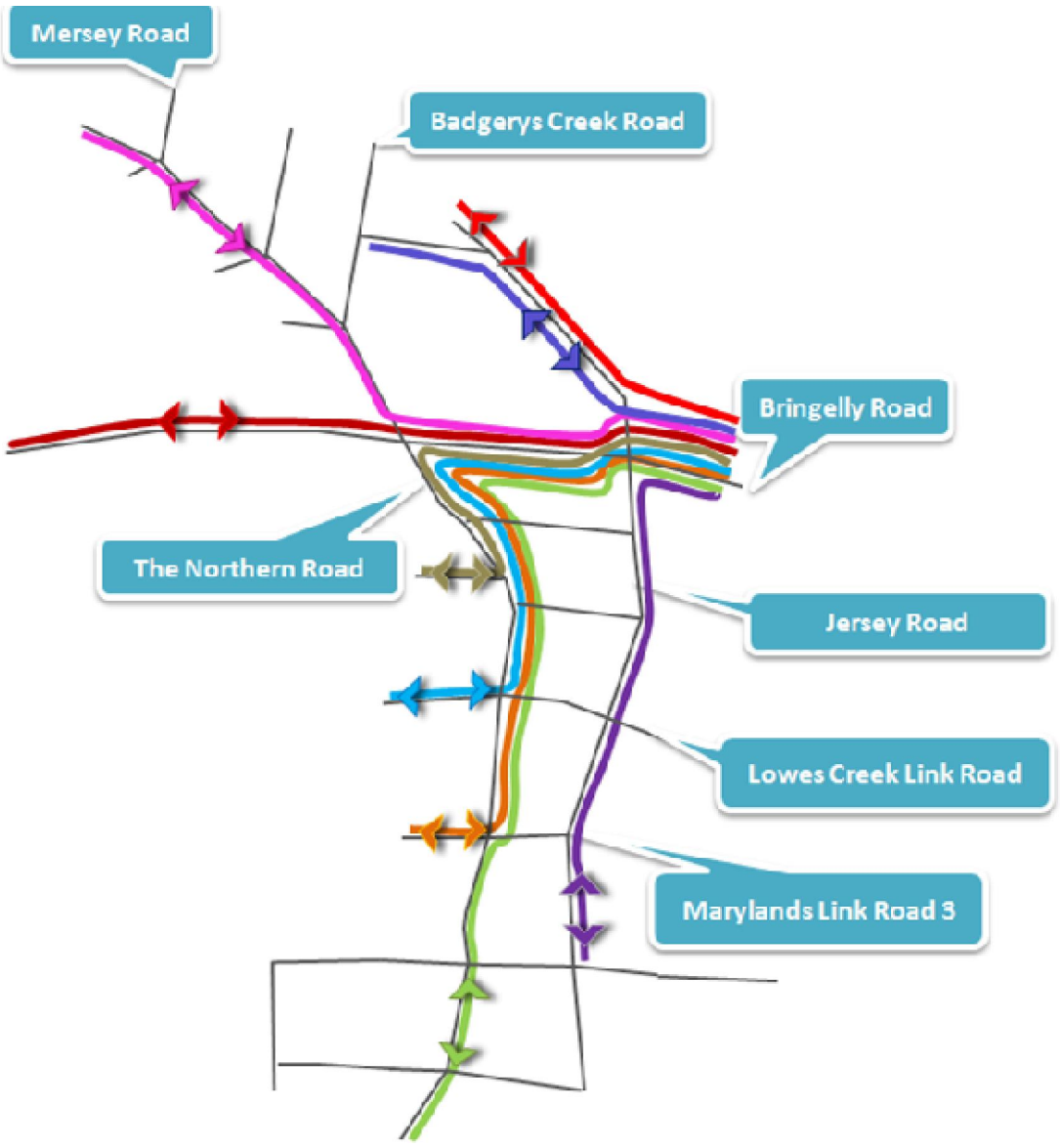
- **Figure 3-6: Scenario 1 - Route Choice on Bringelly Road, east of Jersey Road**



Scenario 2 - enforce all trips making turning movements at The Northern Road / Bringelly intersection:

An alternative case was investigated wherein vehicle movements from Lowes Creek Link Road and Marylands Link Road 3 to Bringelly Road, east of Jersey Road were re-assigned to make the turning movement at The Northern Road /Bringelly Road intersection instead of using Jersey Road (between The Northern Road and Jersey Road). Should this occur, the diverted flows would impose significant pressure on all midblock and intersection performance. **Figure 3-7** shows the route choice between various locations and east of Bringelly Road under this altered route choice scenario.

- **Figure 3-7: Scenario 2 - Route Choice on Bringelly Road, east of Jersey Road**

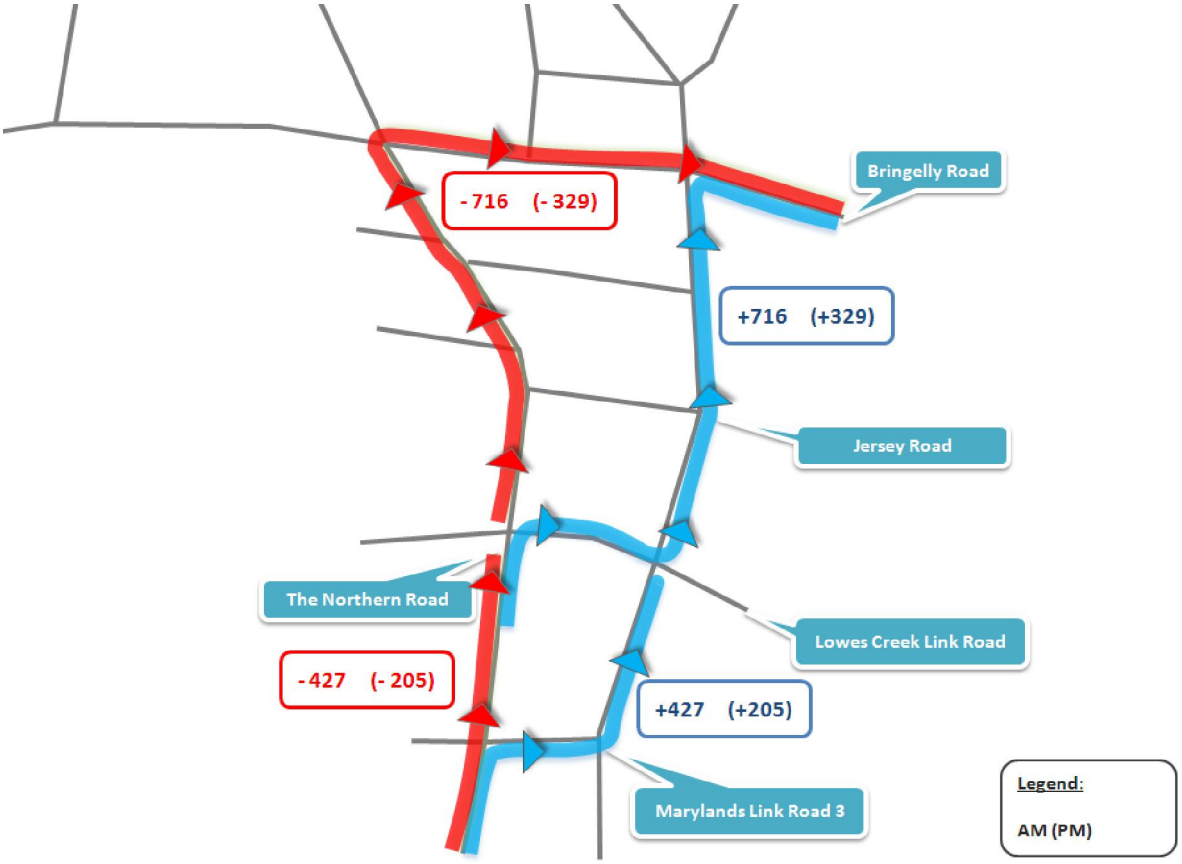


Results:

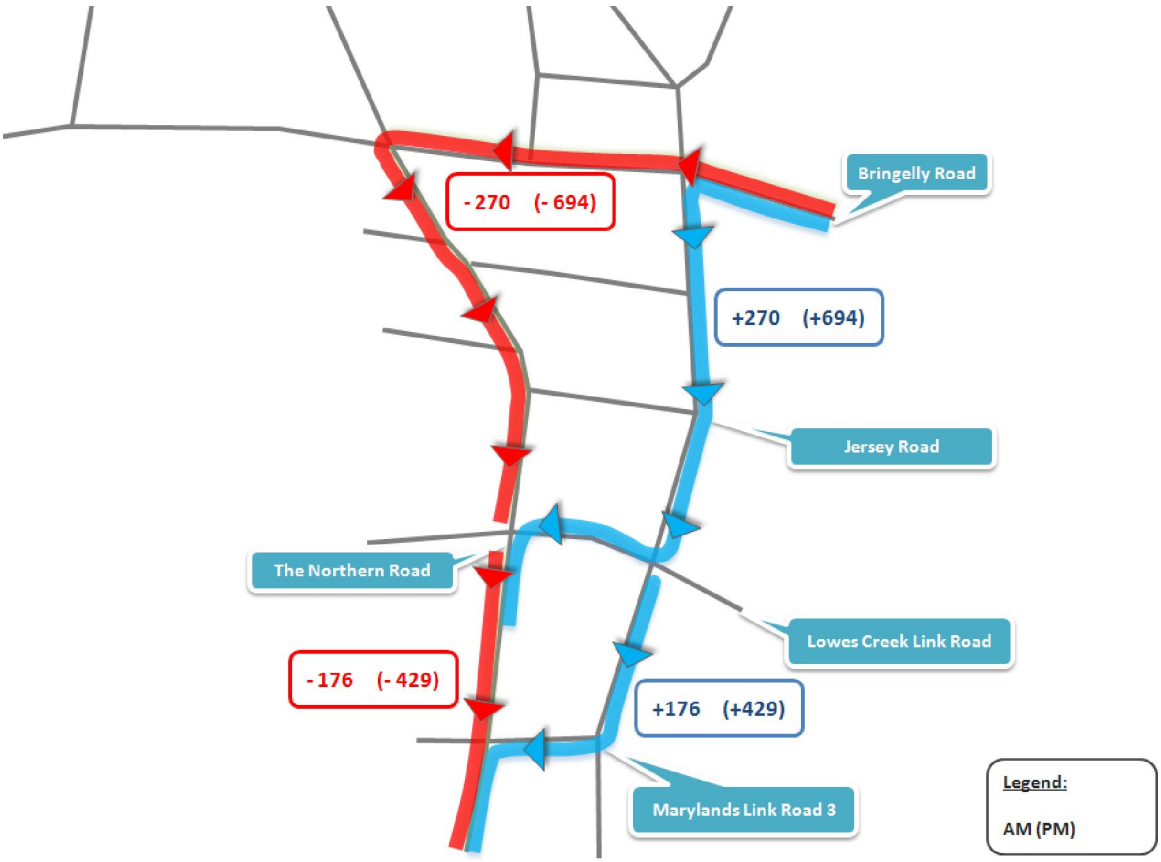
Link Flow:

Figure 3-8 and **Figure 3-9** provides the potential shift of the northbound and southbound traffic under ***Scenario1*** and ***Scenario 2***.

- **Figure 3-8: 2036 Northbound Traffic shifted on The Northern Road and Jersey Road**



- **Figure 3-9: 2036 Southbound Traffic shifted on The Northern Road and Jersey Road**



Intersections:

The flows and calculated performance at key intersections for "**Scenario 1"** (share trips using The Northern Road / Jersey Road) and "**Scenario 2"** (enforce all trips making turning movements at The Northern Road / Bringelly intersection) are summarized in **Table 3-5** and **Table 3-6.**

- **Table 3-5: Sensitivity Test – 2036 – Intersection Performance (Scenario 1)**

Intersection	Type of Control	Period	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Marylands Link Rd 3	Signalised	AM	6,309	0.86	55.9	D	>200
		PM	6,563	0.88	52.9	D	>200
Lowes Creek Rd	Signalised	AM	4,842	0.75	44.2	D	>200
		PM	4,948	0.80	43.0	D	>200
Bringelly Road	Signalised	AM	5,168	0.72	45.0	C	>200
		PM	5,129	0.84	43.6	D	>200

- **Table 3-6: Sensitivity Test– 2036 – Intersection Performance (Scenario 2)**

Intersection	Type of Control	Period	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Marylands Link Rd 3	Signalised	AM	6,943	0.91	60.6	E	>200
		PM	7,232	0.98	69.3	E	>200
Lowes Creek Rd	Signalised	AM	5,880	1.02	>70	F	>200
		PM	6,082	1.07	>70	F	>200
Bringelly Road	Signalised	AM	6,206	1.08	>70	F	>200
		PM	6,206	1.01	>70	F	>200

Discussion:

Under **Scenario 1**, key intersections performed at LoS D or better under both peak periods. A focal point strategy will be applied at the key intersections (i.e. Marylands Link Road 3 and Lowes Creek Road) to direct drivers towards Jersey Road (north of Bringelly Road) or Bringelly Road (east of Jersey Road) as their destinations. From the intersection analysis we can conclude that the performance is reasonable without the need for the grade separation at The Northern Road/ Bringelly Road by shifting traffic onto Jersey Road. Therefore, the use of Jersey Road (Marylands Link Road 3 to Bringelly Road) is expected to be critical in the overall operation of the network as an alternative route to The Northern Road in future years.

Flows that could potentially occur in **Scenario 2**, result in failures of some key intersections (LoS E or worse), due to the heavy turning movement to / from Bringelly Road. Under **Scenario 2**, the capacity of The Northern Road/ Bringelly Road intersection would need to be increased to accomodate this and grade separation may have to be considered by 2036.

4. Future Conditions (Base Case of No Upgrade)

To illustrate the benefit of the proposed upgrade, a Do Nothing scenario (the existing base road network) under 2016, 2026 and 2036 year traffic flow has been analysed to gain an appreciation of purpose of this project. Midblock volume and turning movements of the key intersections along The Northern Road between Fairwater Drive and Mersey Road have been extracted from the SATURN models of 2016, 2026 and 2036.

4.1. Midblock Capacity

A midblock link capacity analysis of the existing road network was undertaken using the Austroads Guide to Traffic Management Part 3 – Traffic Studies and Analysis, Section 5.2.1 and explanatory notes. Adopting capacity of 900 vehicles per lane per hour, the volume to capacity (v/c) ratio for the road network without the proposed upgrade has been examined for the year 2016, 2026 and 2036 for both AM and PM peak periods based on the existing network. The results are presented in **Table 4-1** to **Table 4-6**.

- **Table 4-1: Midblock Peak Hour Capacity – 2016 AM (Base Case)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	910	1.01	1,137	1.26
Hillside Drive	1,072	1.19	1,028	1.14
Cobbitty Road West	882	0.98	876	0.97
Belmore Road	1,341	1.49	547	0.61
Bringelly Road	985	1.09	631	0.70
Badgerys Creek Road	664	0.74	527	0.59
Derwent Road	663	0.74	506	0.56
Mersey Road	661	0.73	491	0.55

- **Table 4-2: Midblock Peak Hour Capacity – 2016 PM (Base Case)**

Location on The Northern Road (north of the following intersections)	PM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,043	1.16	1,286	1.43
Hillside Drive	993	1.10	1,382	1.54
Cobbitty Road West	812	0.90	1,350	1.50
Belmore Road	672	0.75	1,384	1.54
Bringelly Road	697	0.77	1,083	1.20
Badgerys Creek Road	616	0.68	656	0.73
Derwent Road	599	0.67	644	0.72
Mersey Road	587	0.65	632	0.70

- **Table 4-3: Midblock Peak Hour Capacity – 2026 AM (Base Case)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,176	1.31	2,149	2.39
Hillside Drive	1,390	1.54	2,112	2.35
Cobbitty Road West	1,178	1.31	1,976	2.20
Belmore Road	1,769	1.97	1,976	2.20
Bringelly Road	1,575	1.75	656	0.73
Badgerys Creek Road	997	1.11	520	0.58
Derwent Road	943	1.05	501	0.56
Mersey Road	893	0.99	480	0.53

- **Table 4-4: Midblock Peak Hour Capacity – 2026 PM (Base Case)**

Location on The Northern Road (north of the following intersections)	PM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,911	2.12	1,690	1.88
Hillside Drive	1,978	2.20	1,867	2.07
Cobbitty Road West	1,846	2.05	1,855	2.06
Belmore Road	784	0.87	1,657	1.84
Bringelly Road	760	0.84	1,532	1.70
Badgerys Creek Road	645	0.72	879	0.98
Derwent Road	617	0.69	819	0.91
Mersey Road	601	0.67	757	0.84

- **Table 4-5: Midblock Peak Hour Capacity – 2036 AM (Base Case)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,285	1.43	2,313	2.57
Hillside Drive	1,555	1.73	2,361	2.62
Cobbitty Road West	1,334	1.48	2,308	2.56
Belmore Road	2,403	2.67	1,093	1.21
Bringelly Road	2,176	2.42	1,059	1.18
Badgerys Creek Road	1,223	1.36	556	0.62
Derwent Road	1,124	1.25	505	0.56
Mersey Road	1,073	1.19	602	0.67

- **Table 4-6: Midblock Peak Hour Capacity – 2036 PM (Base Case)**

Location on The Northern Road (north of the following intersections)	PM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	2,180	2.42	1,666	1.85
Hillside Drive	2,288	2.54	1,875	2.08
Cobbitty Road West	2,104	2.34	1,977	2.20
Belmore Road	1,280	1.42	2,292	2.55
Bringelly Road	1,063	1.18	2,135	2.37
Badgerys Creek Road	7,23	0.80	1,085	1.21
Derwent Road	652	0.72	971	1.08
Mersey Road	736	0.82	921	1.02

As expected, the figures show that there is an increase in the number of road links operating at or above capacity in the period from 2011 to 2036. Most importantly, during both the AM and PM peak periods, almost all the midblocks from Fairwater Drive to Derwent Road are forecast to operate at inadequate v/c ratios > 0.9 by 2026, indicating capacity deficiency (according to SIDRA models Degree of Saturation methods , Table 11.6). Such operation will cause extensive delays at critical intersections. This indicates an upgrade of the road network is required to cater for the forecast future traffic.

4.2. Intersection Analysis

The performance of the intersections in addition to the link congestion contributes to the overall poor performance of The Northern Road. It would be expected that traffic in the roads intersecting with The Northern Road, in particular Fairwater Drive, Hillside Drive, Cobbitty Road West and

Bringelly Road, would be similarly affected as it would be difficult for these movements to find suitable gaps in the congested The Northern Road traffic stream. Link mid-block congestion was an indicator of overall performance that the more detailed intersection analyses confirmed.

Using the existing intersection layouts as a starting point, an analysis of the future performance of the key intersections have been undertaken using the SIDRA Intersection analysis software by extracting turning volume from SATURN models. A summary of 2016, 2026 and 2036 AM and PM turning movements, results and intersection layout are provided in **Appendices A2, A3 and A4**.

The results of the analysis along The Northern Road are summarized in **Table 4-7** and **Table 4-12**.

- **Table 4-7: Intersection Performance – 2016 AM (Base Case)**

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	2,751	>1.0	>100	F	>200 <The Northern Rd - North>
Hillside Drive	*Roundabout	2,542	0.77	37.0	C	75.9 <The Northern Rd - South>
Cobbitty Road West	*Priority	2,418	>1.0	>100	F	>200 <Cobbitty Rd West>
Belmore Road	*Priority	1,988	1.0	>100	F	161.2 <The Northern Rd - North>
Bringelly Road	Signalised	2,492	>1.0	27.9	B	>200 <The Northern Rd - South>
Badgerys Creek Road	*Roundabout	1,715	0.61	14.8	B	51.4 <The Northern Rd - South>
Derwent Road	*Priority	1,259	0.28	19.8	B	minimal queuing
Mersey Road	*Priority	1,242	0.38	28.6	C	45.0 <The Northern Rd - South>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

Table 4-8: Intersection Performance – 2016 PM (Base Case)

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	3,264	>1.0	>100	F	>200 <The Northern Rd - North>
Hillside Drive	*Roundabout	2,893	>1.0	>100	F	>200 <The Northern Rd - North>
Cobbitty Road West	*Priority	2,719	>1.0	>100	F	>200 <Cobbitty Rd West>
Belmore Road	*Priority	2,157	1.0	>100	F	199.6 <The Northern Rd - North>
Bringelly Road	Signalised	2,744	>1.0	>100	F	>200 <The Northern Rd - North>
Badgerys Creek Road	*Roundabout	1,881	0.60	19.7	B	42.4 <Badgerys Ck Rd>
Derwent Road	*Priority	1,348	0.36	26.3	B	minimal queuing
Mersey Road	*Priority	1,324	0.35	24.3	B	44.9 <The Northern Rd - South>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

Table 4-9: Intersection Performance – 2026 AM (Base Case)

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	4,104	>1.0	>100	F	>200 <The Northern Rd - North>
Hillside Drive	*Roundabout	4,032	>1.0	>100	F	>200 <The Northern Rd - North>
Cobbitty Road West	*Priority	3,916	>1.0	>100	F	>200 <Cobbitty Rd West>
Belmore Road	*Priority	2,563	1.0	>100	F	>200 <The Northern Rd - North>
Bringelly Road	Signalised	3,388	>1.0	>100	F	>200 <The Northern Rd - South>

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Badgerys Creek Road	*Roundabout	2,374	0.99	21.8	B	>200 <The Northern Rd - South>
Derwent Road	*Priority	1,602	0.34	26.6	B	minimal queuing
Mersey Road	*Priority	1,519	0.56	50.7	D	93.4 <The Northern Rd - South>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- **Table 4-10: Intersection Performance – 2026 PM (Base Case)**

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	4,526	>1.0	>100	F	>200 <The Northern Rd - South>
Hillside Drive	*Roundabout	4,447	>1.0	>100	F	>200 <The Northern Rd - South>
Cobbitty Road West	*Priority	4,144	>1.0	>100	F	>200 <Cobbitty Rd West>
Belmore Road	*Priority	2,571	1.0	>100	F	>200 <The Northern Rd - North>
Bringelly Road	Signalised	3,420	>1.0	>100	F	>200 <The Northern Rd - South>
Badgerys Creek Road	*Roundabout	2,441	>1.0	>100	F	>200 <Badgerys Ck Rd - East>
Derwent Road	*Priority	1,600	0.55	51.9	D	15.0 <Derwent Rd>
Mersey Road	*Priority	1,509	0.55	50.1	D	54.8 <The Northern Rd - South>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

Table 4-11: Intersection Performance – 2036 AM (Base Case)

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	4,395	>1.0	>100	F	>200 <The Northern Rd - South>
Hillside Drive	*Roundabout	4,449	>1.0	>100	F	>200 <The Northern Rd - South>
Cobbitty Road West	*Priority	4,445	>1.0	>100	F	>200 <The Northern Rd>
Belmore Road	*Priority	3,623	>1.0	>100	F	>200 <Belmore Rd - West>
Bringelly Road	Signalised	5,168	>1.0	>100	F	>200 <The Northern Rd - South>
Badgerys Creek Road	*Roundabout	3,245	>1.0	>100	F	>200 <The Northern Rd - South>
Derwent Road	*Priority	1,797	0.4	36.9	C	minimal queuing
Mersey Road	*Priority	1,838	1.0	>100	F	127.3 <The Northern Rd - South>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

Table 4-12: Intersection Performance – 2036 PM (Base Case)

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Fairwater Drive	*Roundabout	4,829	>1.0	>100	F	>200 <The Northern Rd - South>
Hillside Drive	*Roundabout	4,729	>1.0	>100	F	>200 <The Northern Rd - North>
Cobbitty Road West	*Priority	4,780	>1.0	>100	F	>200 <The Northern Rd>
Belmore Road	*Priority	3,695	>1.0	>100	F	>200 <The Northern Rd - North>

Intersections	Type of Control	Intersection Volume (veh/hr)	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
Bringelly Road	Signalised	5,129	>1.0	>100	F	>200 <The Northern Rd - North>
Badgerys Creek Road	*Roundabout	3,226	>1.0	>100	F	>200 <Badgerys Rd - East>
Derwent Road	*Priority	1,793	0.79	>100	F	24.9 <Derwent Rd>
Mersey Road	*Priority	1,825	1.0	>100	F	132.5 <Mersey Rd - West>

* The worst movement average delay and LoS are reported for roundabouts and priority intersections.

By considering both AM and PM peak periods, the performance of all of the intersections are forecast to be unacceptable (LoS D or worse) under the Base Case in 2016, 2026 and 2036. The performance of the intersections, north of Badgerys Creek Road, are satisfactory or good with a LoS B or better in the opening year 2016 for this project.

The results of the intersection analysis are consistent with the midblock analysis. From both analyses, it is evident that the performance of the existing intersections between Fairwater Drive and Badgerys Creek Road in the Base Case in 2016, 2026 and 2036 would deteriorate over time to a level where insufficient gaps would be available for traffic to enter safely into the main traffic stream along The Northern Road. This would occur in particular during the peak hour periods (on which the analysis is based), but may also occur during holiday periods.

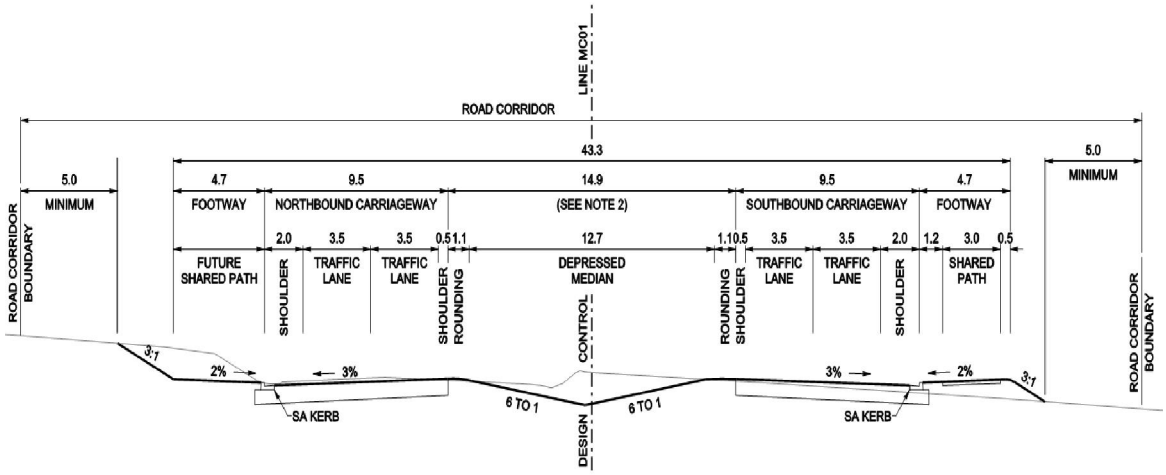
5. Future Road Network Conditions

5.1. Concept Design

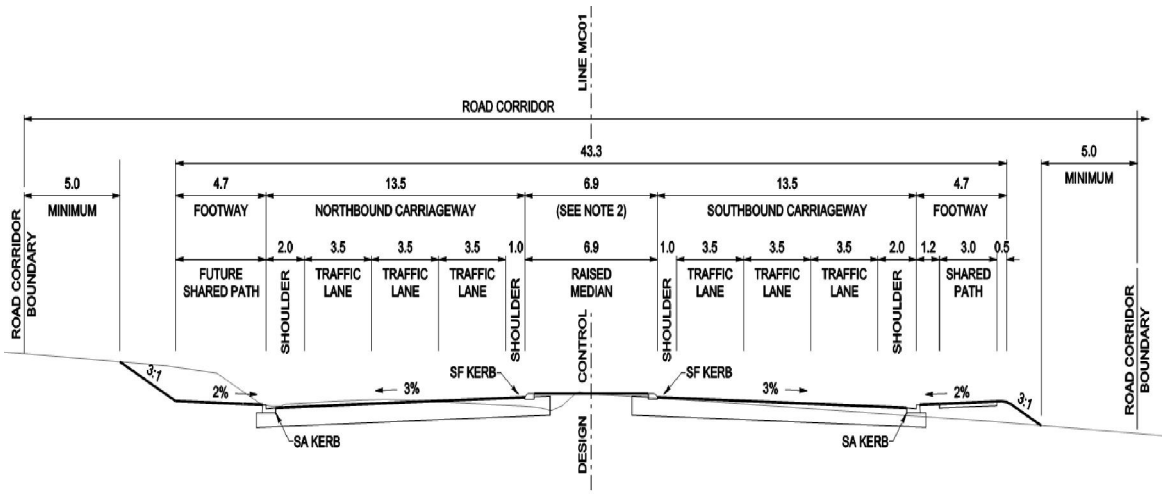
In order to cater for the increasing traffic flows and to improve the safety of the corridor, the concept design involves upgrading the 15 km section of The Northern Road between Old Northern Road and Mersey Road from a two-lane two way road to four lane divided road. The concept design scope encompasses the following key elements:

- Upgrade to a 4-lane divided road with a wide central median in 2016 and 2026 and ultimately as a 6-lane divided road in 2036. The typical cross-sections are shown in **Figure 5-1** and **Figure 5-2**.
- A posted speed limit of 80 km/h;
- Mid-block cross-section width: 43.3m;
- Provision for landscaping in the median consistent with the Camden Valley Way up-grade;
- A three metre wide off-road shared pedestrian/cyclist path;
- Two metre wide kerbside shoulders used as on cycleway;
- Adjustments to public utilities such as gas, electricity, water, sewer and telephone services along the route;
- Designated turning lanes, and bicycle and pedestrian crossing provisions;
- Traffic Control signals; and
- Bus priority at traffic signals and indented departure side bus bays.

- **Figure 5-1: Cross Section Between Intersection – 4-lane divided road**



- **Figure 5-2: Cross Section Between Intersection – 6-lane divided road**

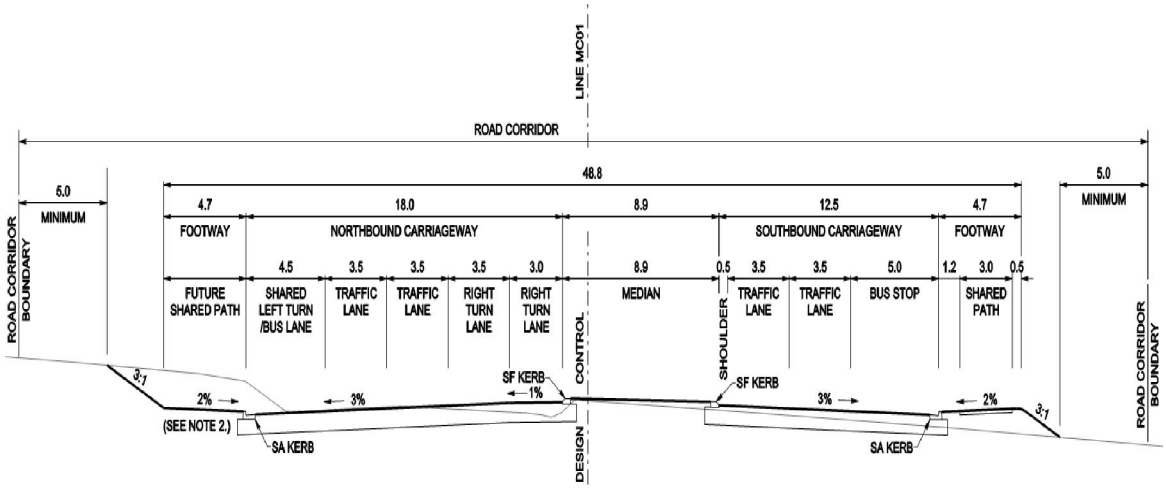


With substantial growth and development of Oran Park and Marylands alongside the Northern Road, traffic from the surrounding developments will access The Northern Road at designated locations. The concept design proposes 14 signalised intersections within the study area. The signalised intersections are proposed to be provided at the following locations:

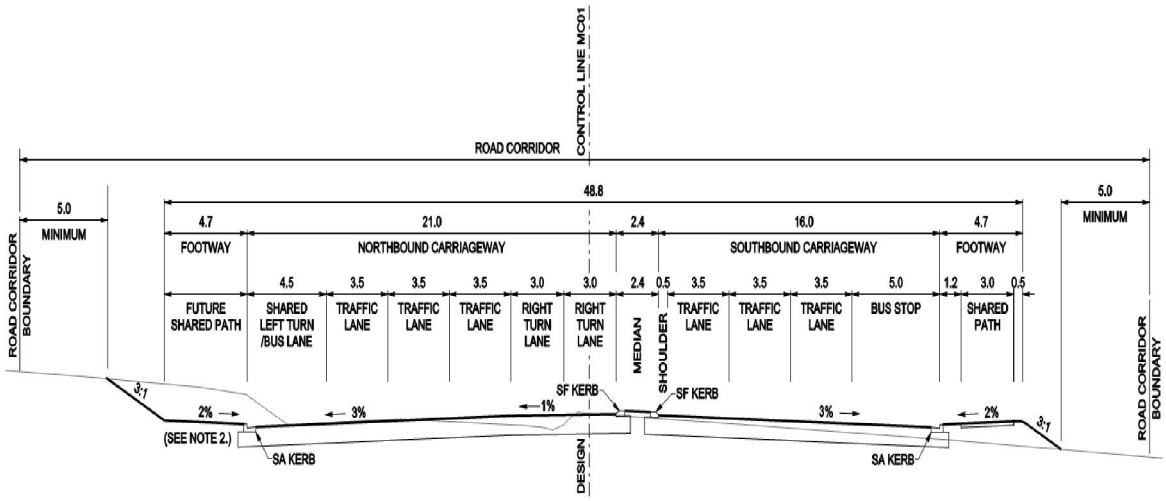
- Fairwater Drive/Porrende Street;
- Hillside Drive;
- Cobbitty Road West;
- Oran Park Link Road 1 (Peter Brock Drive) ;
- Oran Park Link Road 2;
- Marylands Link Road 1;
- Marylands Link Road 2;
- Marylands Link Road 3;
- Lowes Creek Link Road;
- Belmore Road;
- Bringelly Road/Greendale Road;
- Badgerys Creek Road;
- Derwent Road; and
- Mersey Road.

The proposed cross sections at intersections are shown in **Figure 6-3** and **Figure 6-4**.

- **Figure 5-3: Cross Section At Intersection – 4-lane divided road**



- **Figure 5-4: Cross Section At Intersection – 6-lane divided road**



Intersection locations are based on existing road intersections supplemented additional intersections at approximately one kilometre intervals. The locations of several intersections have been adjusted to suit the topography and avoid undesirable vertical geometry on the side roads.

Left in and left out access would generally be provided at minor roads where there are no other alternatives. Several 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 at Maryland Link Road 1, Lowes Creek Road, Greendale Road and Derwent Road.

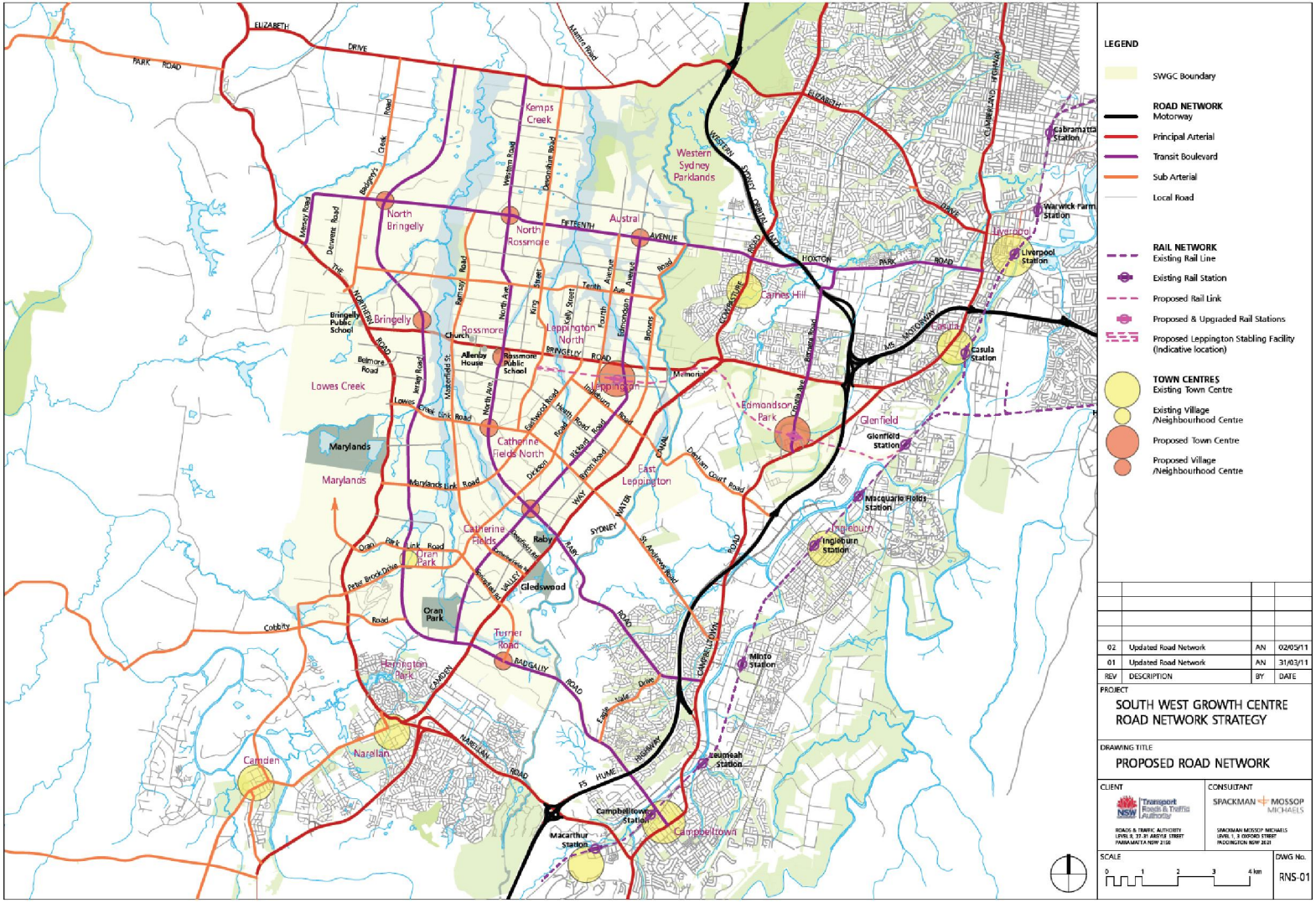
5.2. Future Road Network

The study area is made up of the Oran Park and Marylands industrial area development precincts. Oran Park was identified as first release area in the Government's announcement in December 2004. The future staging and sequencing of the other precincts will be coordinated by the Department of Planning and Infrastructure. The study area consists mainly of large rural properties.

The RMS 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 **Figure 5-5** shows the draft road network strategy.

Within the proposed network, The Northern Road will be classified as a principal arterial road and Jersey Road will be categorized as a Transit Boulevard. The remainder of the major roads in vicinity of The Northern Road will be classified as sub-arterial roads.

Figure 5-5: Proposed Road Network



5.3. Future Growth

The study area population and employment are expected to grow by 7% - 8% per annum compounded from 2011 to 2036. This growth factor is based on Bureau of Transport Statistics (BTS) population and employment forecasts, which were released in October 2009. They are summarised in **Table 5-1**.

In addition, the total modelled trip ends are compared to the population and employment forecasts in **Table 5-1.** Their growth rates are 7%, consistent with the population and employment growth rates. The modelled trip ends are the sum of hourly trip productions and trip attractions. One trip has essentially two trip ends. Therefore, the number of hourly trips modelled is half of the trip ends. The morning peak hour for the traffic volume is 0700 and 0800 and the evening peak is 1600 to 1700.

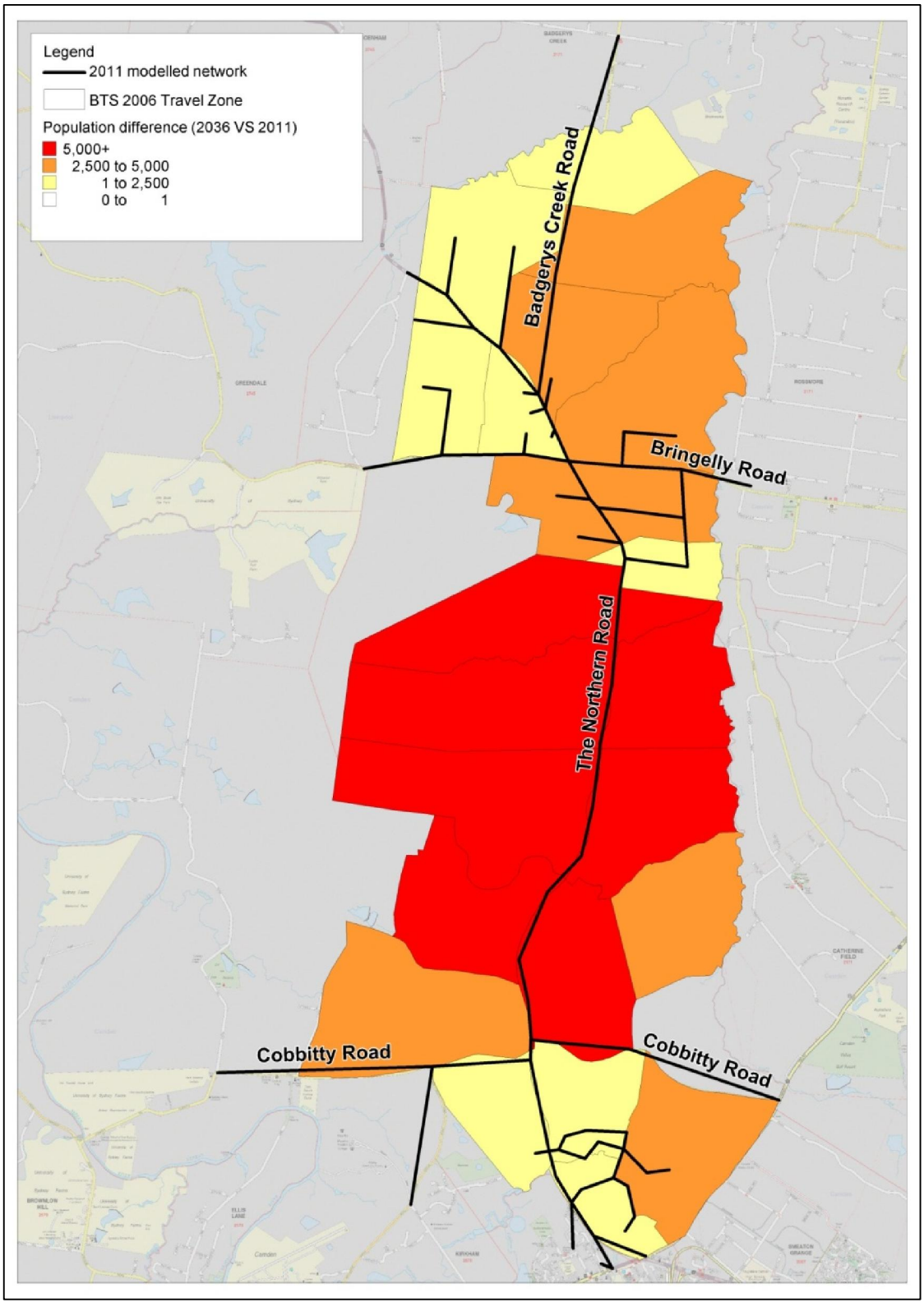
The trip ends modelled in the RMS EMME model and this study's SATURN model are compared to demonstrate the consistency between the two models albeit the minimal adjustment to the 2011 demands due to the calibration process. The trip ends are compared in terms of internal and external. Trips that end in internal zones are considered internal while those that end outside the study area are considered external. **Table 5-1** shows that the internal trip ends have higher growth rate than the external trip ends. This can be explained by the high internal population and employment growth.

Table 5-1: Future Trip Ends, Population and Employment

Description	2011	2016	2026	2036	Annual Growth Rate
Internal - AM trip ends (RMS)	2,735	6,229	17,195	25,504	9%
External - AM trip ends (RMS)	6,368	9,969	17,337	24,814	6%
Total AM trip ends (RMS)	**9,104**	**16,198**	**34,532**	**50,318**	**7%**
AM hourly trips (RMS)	*4,552*	*8,099*	*17,266*	*25,159*	
Internal - PM trip ends (RMS)	2,744	6,456	18,006	26,879	10%
External - PM trip ends (RMS)	6,554	10,305	17,564	25,113	6%
Total PM trip ends (RMS)	**9,297**	**16,761**	**35,569**	**51,992**	**7%**
PM hourly trips (RMS)	*4,649*	*8,381*	*17,785*	*25,996*	

Description	2011	2016	2026	2036	Annual Growth Rate
Internal - AM trip ends (SKM)	2,779	6,295	17,291	25,618	9%
External - AM trip ends (SKM)	6,917	10,547	18,049	25,542	5%
Total AM trip ends (SKM)	**9,697**	**16,842**	**35,340**	**51,159**	**7%**
AM hourly trips (SKM)	*4,849*	*8,421*	*17,670*	*25,580*	
Internal - PM trip ends (SKM)	3,140	6,853	18,417	27,287	9%
External - PM trip ends (SKM)	7,182	10,948	18,353	25,864	5%
Total PM trip ends (SKM)	**10,322**	**17,801**	**36,771**	**53,152**	**7%**
PM hourly trips (SKM)	*5,161*	*8,901*	*18,386*	*26,576*	
Internal - Total population (BTS)	13,570	25,420	63,827	92,540	8%
Internal - Total employment (BTS)	1,537	2,448	6,694	9,267	7%

- **Figure 5-6: Population Difference (2036 versus 2011) by BTS Travel Zones**



- **Figure 5-7: Employment Difference (2036 versus 2011) by BTS Travel Zones**

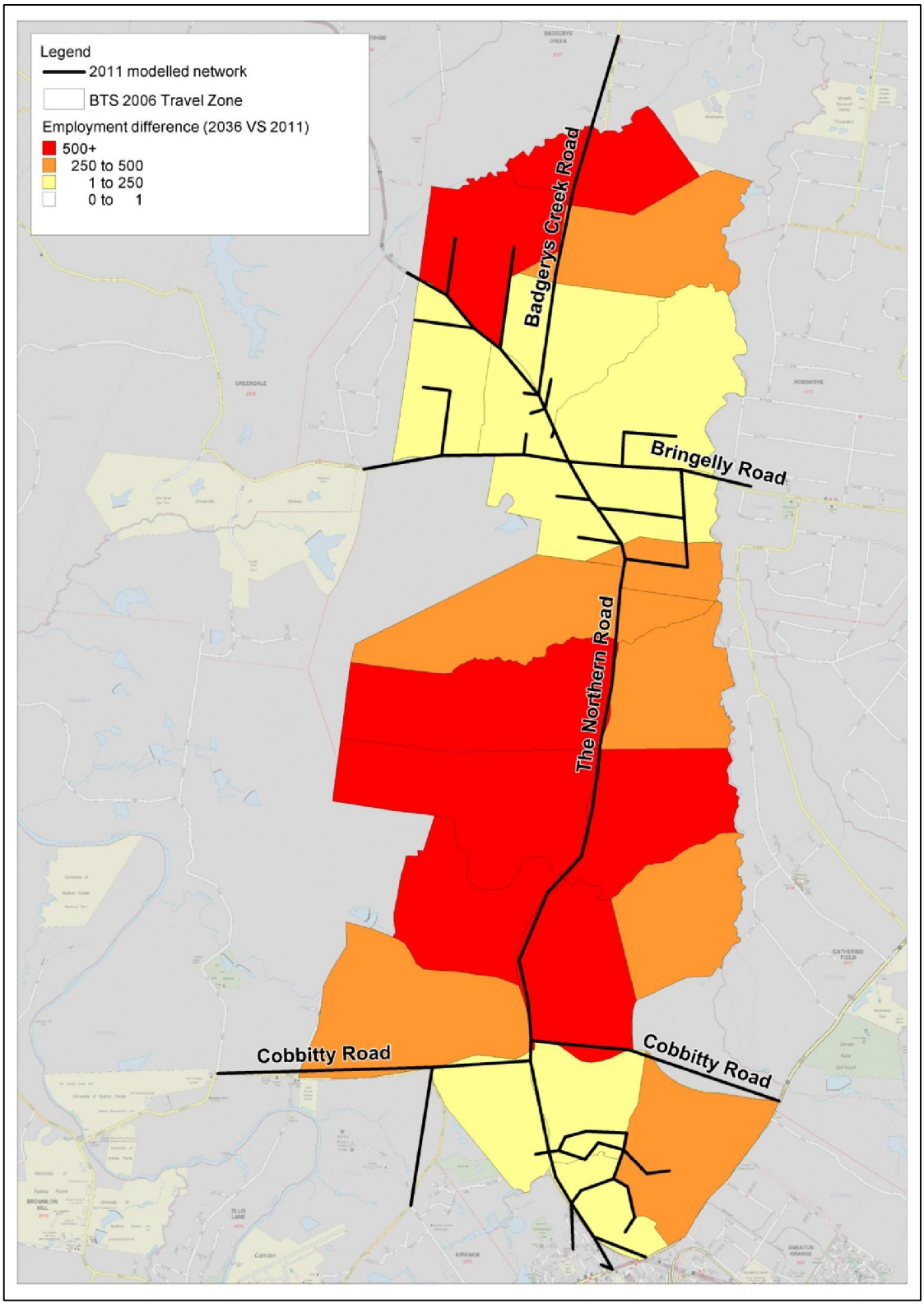


Figure 5-6 and **Figure 5-7** highlight the major population and employment growth areas respectively. As shown in **Figure 5-6**, the BTS Travel Zones between Bringelly Road and Cobbitty Road have significant population growth of greater than 5,000 people over the next 25 years (i.e. from 2011 to 2036). On the other hand, **Figure 5-7** shows that the BTS Travel Zones between Bringelly Road and Cobbitty Road, as well as those between The Northern Road and Badgerys Creek Road, have significant employment growth of greater than 500 jobs over the next 25 years.

5.4. Trip Patterns

The model zones have been grouped into 10 sectors for this discussion: 4 internal sectors and 6 external sectors. This sector system and trip end growth is shown in **Figure 5-8**, and will be used to explain the change in future trip patterns.

The trip origins and destinations, before and after matrix estimation, are summarised by sector in **Table 5-2** and **Table 5-3**. There are little differences between the sector growth rates except for Sector 1 (External – North). The growth rate for this sector falls from 12% (before matrix estimation) to 8% (after matrix estimation) due to the increased traffic observed in base year.

Figure 5-8: Sector System and 2036 Modelled Network

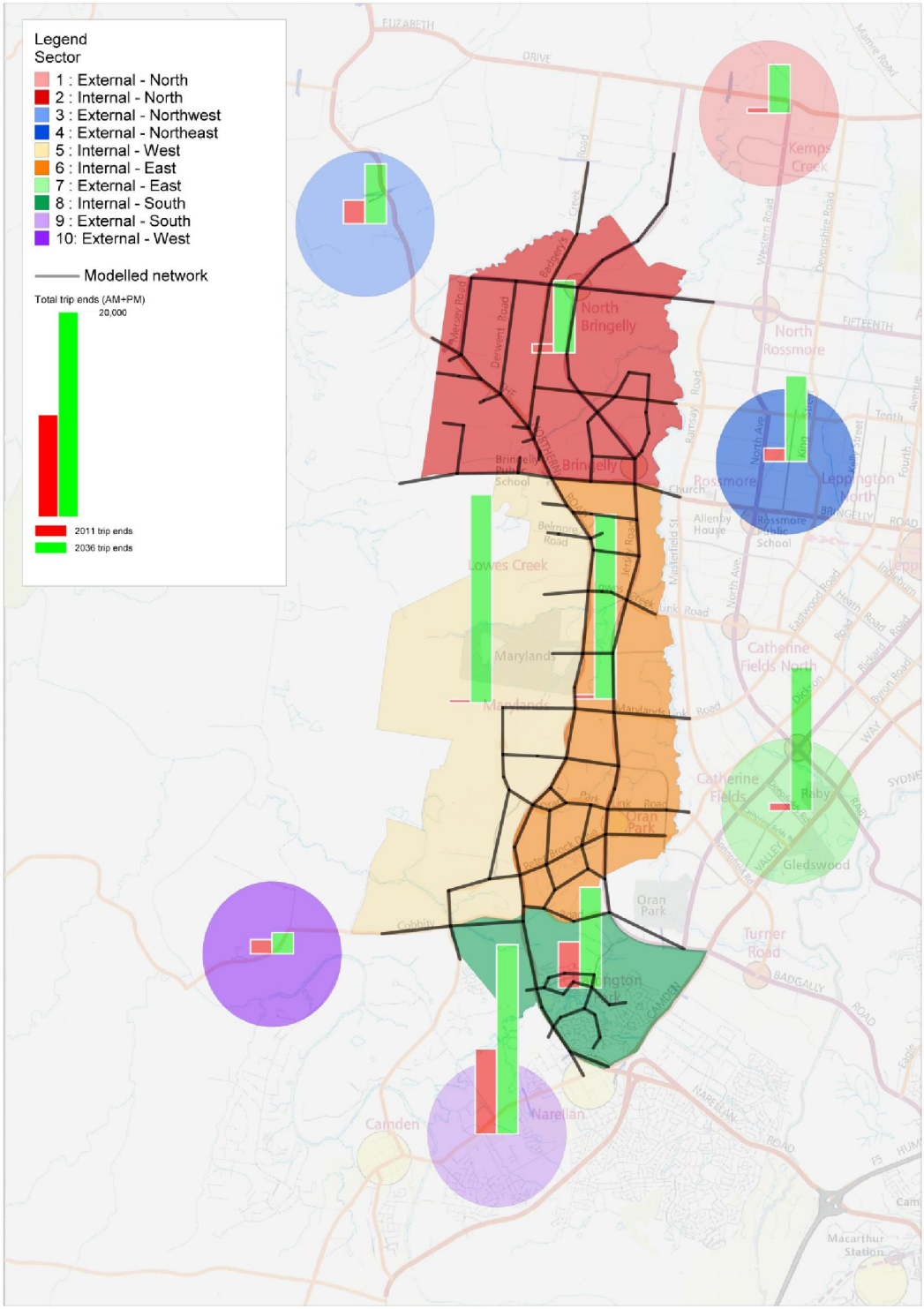


Table 5-2: Trip Summary (on sector level) "BEFORE" Matrix Estimation

Sector Description	Sector ID	2011 AM Origin	2011 AM Destination	2011 AM total	2036 AM Origin	2036 AM Destination	2036 AM total	Growth rate p.a.	2011 PM Origin	2011 PM Destination	2011 PM total	2036 PM Origin	2036 PM Destination	2036 PM total	Growth rate p.a.
Trip Ends															
Internal - North	2	199	132	332	1,897	1,324	3,221	10%	168	198	366	1,493	1,858	3,351	9%
Internal - East	6	130	83	213	5,504	3,233	8,737	16%	98	137	235	3,911	5,465	9,375	16%
Internal - South	8	1,541	536	2,077	2,947	1,509	4,456	3%	760	1,263	2,022	1,915	2,724	4,639	3%
Internal - West	5	43	71	114	6,044	3,046	9,091	19%	67	54	121	3,744	5,769	9,513	19%
External - Northwest	3	580	547	1,127	1,269	1,681	2,950	4%	649	577	1,226	1,584	1,245	2,829	3%
External - North	1	33	108	141	457	1,731	2,187	12%	99	35	134	1,491	553	2,044	12%
External - Northeast	4	263	547	810	1,477	2,583	4,060	7%	517	330	846	2,477	1,718	4,194	7%
External - East	7	114	225	340	2,374	4,116	6,489	13%	189	167	355	4,055	2,840	6,895	13%
External - South	9	1,311	2,151	3,461	2,757	5,564	8,321	4%	1,924	1,564	3,488	4,953	3,395	8,348	4%
External - West	10	338	152	490	434	372	806	2%	180	325	505	373	430	804	2%
Total		**4,552**	**4,552**	**9,104**	**25,159**	**25,159**	**50,318**	**7%**	**4,649**	**4,649**	**9,297**	**25,996**	**25,996**	**51,992**	**7%**
Trips Ends (on sector level)															
Internal-to-internal				128			4,064	15%			148			4,575	15%
Internal-to-external				1,784			12,328	8%			944			6,488	8%
External-to-internal				694			5,048	8%			1,504			11,240	8%
External-to-external				1,945			3,719	3%			2,053			3,693	2%
Total				**4,552**			**25,159**	**7%**			**4,649**			**25,996**	**7%**

Table 5-3: Trip Summary (on sector level) "AFTER" Matrix Estimation

Sector Description	Sector ID	2011 AM Origin	2011 AM Destination	2011 AM total	2036 AM Origin	2036 AM Destination	2036 AM total	Growth rate p.a.	2011 PM Origin	2011 PM Destination	2011 PM total	2036 PM Origin	2036 PM Destination	2036 PM total	Growth rate p.a.
Trip Ends															
Internal - North	2	251	136	387	1,951	1,330	3,280	9%	239	226	465	1,565	1,887	3,452	8%
Internal - East	6	96	75	171	5,254	3,073	8,327	17%	105	106	210	3,734	5,202	8,935	16%
Internal - South	8	1,431	610	2,042	2,902	1,584	4,486	3%	805	1,474	2,279	1,962	2,944	4,906	3%
Internal - West	5	70	109	180	6,288	3,236	9,524	17%	113	73	186	3,973	6,021	9,994	17%
External - Northwest	3	510	520	1,029	1,201	1,659	2,859	4%	550	623	1,172	1,487	1,291	2,778	4%
External - North	1	77	175	252	501	1,804	2,305	9%	253	65	318	1,645	583	2,227	8%
External - Northeast	4	194	393	587	1,408	2,508	3,916	8%	403	264	667	2,422	1,653	4,075	8%
External - East	7	151	264	415	2,410	4,170	6,580	12%	253	103	356	4,120	2,781	6,901	13%
External - South	9	1,616	2,236	3,853	3,077	5,666	8,743	3%	2,232	1,849	4,081	5,268	3,691	8,959	3%
External - West	10	452	330	782	588	551	1,138	2%	208	379	587	401	523	924	2%
Total		**4,848**	**4,848**	**9,697**	**25,580**	**25,580**	**51,159**	**7%**	**5,161**	**5,161**	**10,322**	**26,576**	**26,576**	**53,152**	**7%**
Trips Ends (on sector level)															
Internal-to-internal				145			4,081	14%			174			4,602	14%
Internal-to-external				1,704			12,314	8%			1,088			6,632	7%
External-to-internal				785			5,142	8%			1,704			11,452	8%
External-to-external				2,214			4,043	2%			2,195			3,891	2%
Total				**4,848**			**25,580**	**7%**			**5,161**			**26,576**	**7%**

The compound annual growth rates for AM and PM peak trip ends from 2011 to 2036 are 7%, which is consistent to the growth of population and employment summarised in ***Table 5-1***. Sectors with significant trip end growth rates greater than 10% per annum are:

- Sector 5 (Internal – West);
- Sector 6 (Internal – East); and
- Sector 7 (External – East).

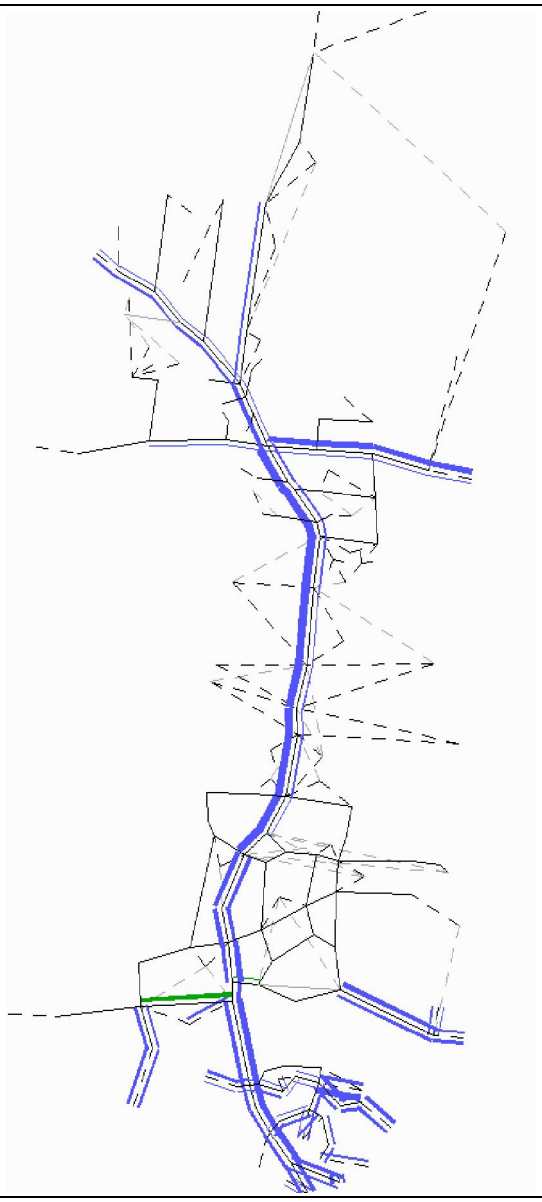
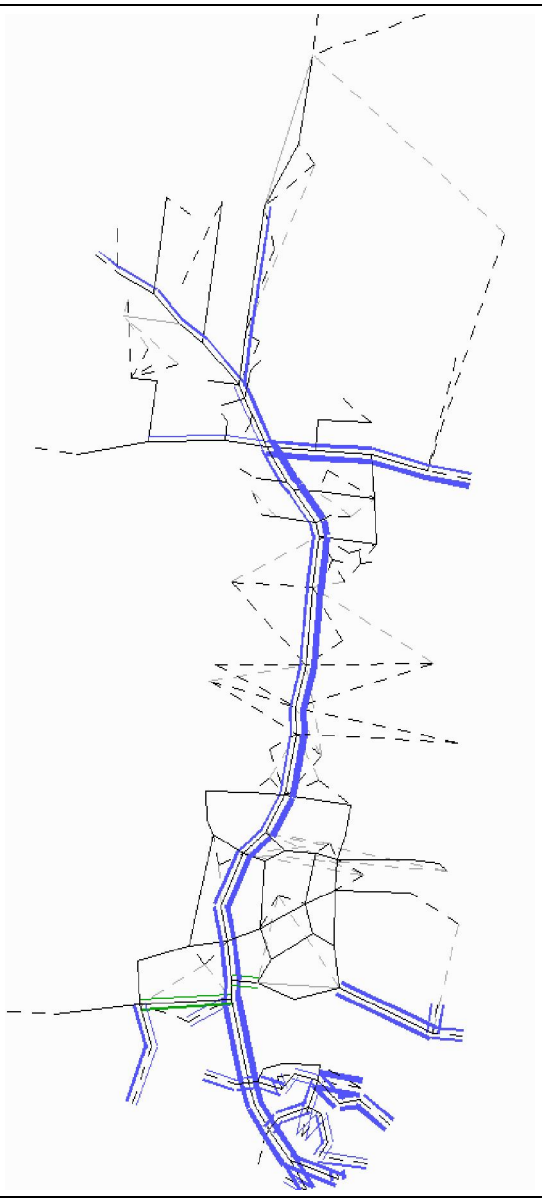
The large growths in Sectors 5, 6 and 7's trip ends are caused by their large population and employment growth. As a result, the trips between internal sectors will grow at 14% per annum. The growths also encourage the trips between internal and external sectors to grow at 7%-8% per annum. However, the trips between external sectors grow at a lower (or conservative) rate of 2% per annum.

5.5. Flow Difference

Flow difference plots are generated from SATURN and shown in **Figure 5-9** to **Figure 5-11**. Flows are only compared on common network links. Therefore, there is no flow difference shown on future network links.

The flow difference plots show sensible growth in traffic volumes. The traffic flow increases (shown in blue) as the forecast year increases and negative flow differences (shown in green) only occur at Cobbitty Road East and West. These are caused by the change in route choice as alternative routes become available.

- **Figure 5-9: Flow Difference Plots - 2016 versus 2011**

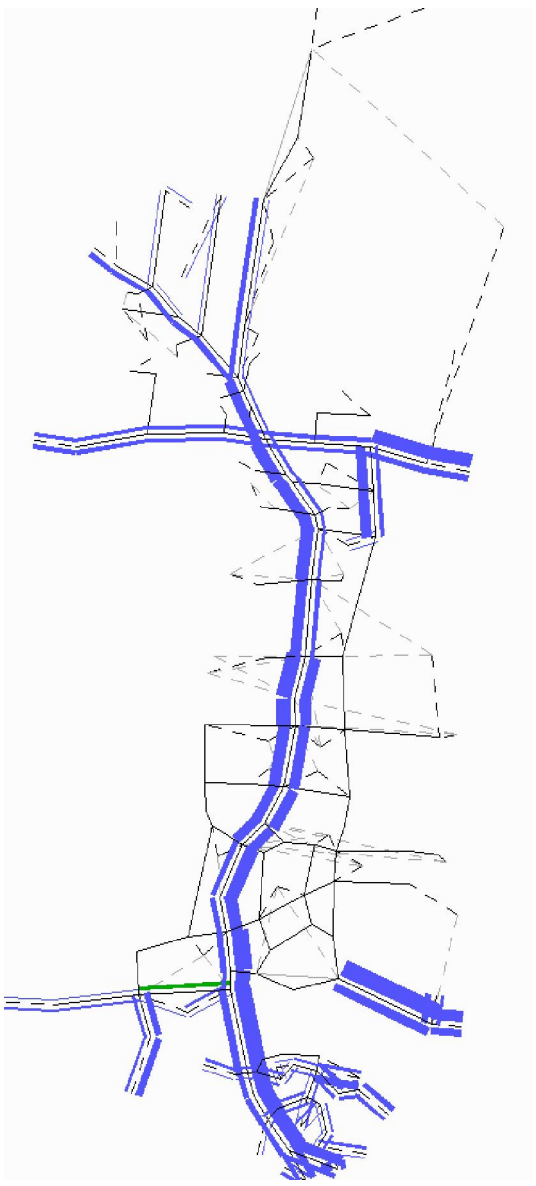
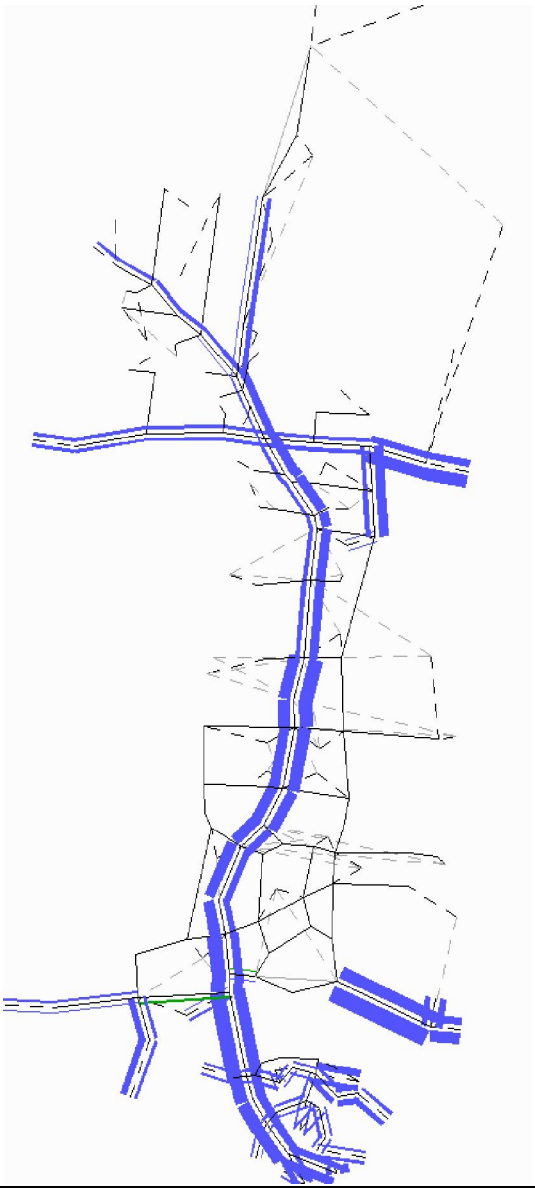
2016 AM versus 2011 AM	2016 PM versus 2011 PM
	

* +ve Trips (Bandwidth)

* -ve Trips (Bandwidth)

- Not in Scale ; Please note the flow difference in between the future and existing year will not show on the uncommon links(roads).

Figure 5-10: Flow Difference Plots - 2026 versus 2011

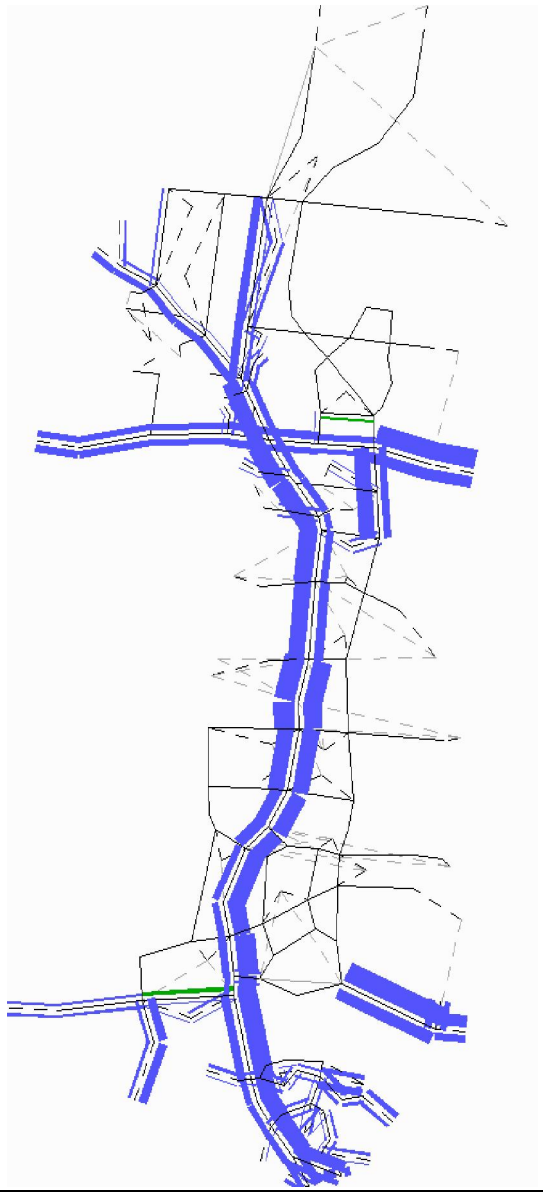
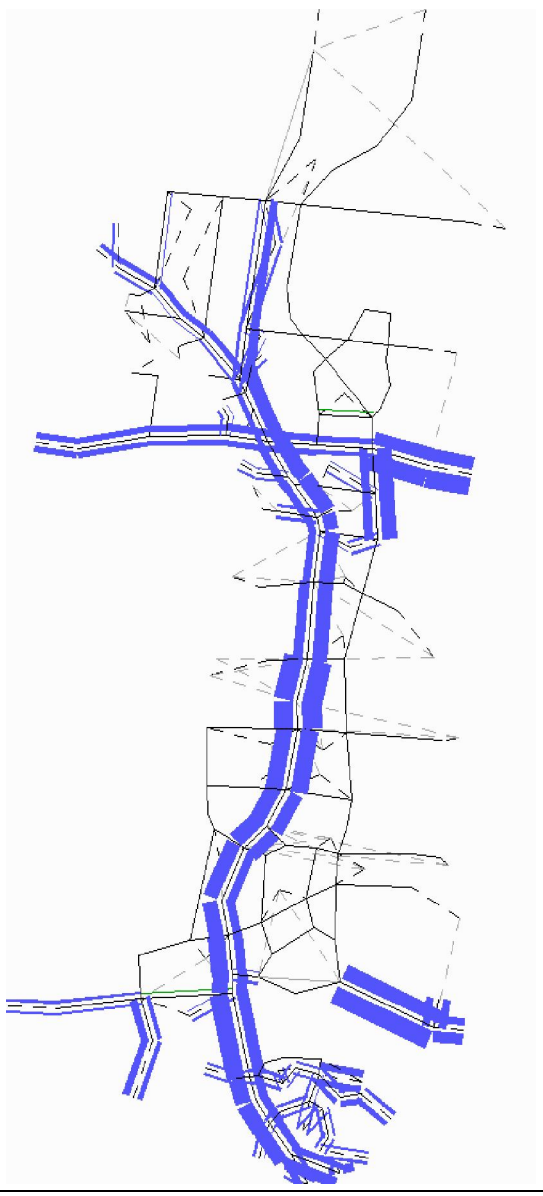
2026 AM versus 2011 AM	2026 PM versus 2011 PM
	

* +ve Trips (Bandwidth)

* -ve Trips (Bandwidth)

- Not in Scale; Please note the flow difference in between the future and existing year will not show on the uncommon links(roads).

Figure 5-11: Flow Difference Plots - 2036 versus 2011

2036 AM versus 2011 AM	2036 PM versus 2011 PM
	

* +ve Trips (Bandwidth)

* -ve Trips (Bandwidth)

- Not in Scale; Please note the flow difference in between the future and existing year will not show on the uncommon links(roads).

5.6. Forecast Traffic Volume

The SATURN model was used to forecast traffic volumes along The Northern Road based on the proposed land use changes in SWGC and proposed network changes using demands from the RMS EMME model as discussed in previous sections.

Peak hour traffic forecasts for each mid-block sections between major intersections along The Northern Road for 2016 to 2036 at four-year intervals are provided in **Appendix B**. It should be noted that the 2036 traffic forecast represents the ultimate SWGC development scenario. However, if the rate of development is slower than expected, it might not occur. The timing of development is set by the current assumptions in the RMS EMME model.

5.6.1. Midblock Capacity

A midblock link capacity analysis of the existing road network was undertaken using the Austroads Guide to Traffic Management Part 3 – Traffic Studies and Analysis, Section 5.2.1 and explanatory notes. Adopting capacity of [2]1,200 vehicles per lane per hour, the volume to capacity (v/c) ratio for the road network with the proposed upgrade has been examined for the year 2016, 2026 and 2036 for both AM and PM peak periods. The results are presented in **Table 5-4** to **Table 5-9**.

[2] Austroads Guide to Traffic Management Part 3: Peak period mid-block traffic volumes may increase to 1200 to 1400 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

- **Table 5-4: Midblock Peak Hour Capacity – 2016 AM (4-lane divided road)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	910	0.38	1,137	0.47
Hillside Drive	1,072	0.45	1,028	0.43
Cobbitty Road West	882	0.37	876	0.37
Oran Park Link Road 1	1,031	0.43	729	0.30
Oran Park Link Road 2	1,303	0.54	458	0.19
Marylands Link Road 1	1,307	0.54	529	0.22
Marylands Link Road 2	assume intersections not built in 2016			
Marylands Link Road 3	assume intersections not built in 2016			
Lowes Creek Link Road	assume intersections not built in 2016			
Belmore Road	1,341	0.56	547	0.23
Bringelly Road	985	0.41	631	0.26
Badgerys Creek Road	664	0.28	527	0.22
Derwent Road	663	0.28	506	0.21
Mersey Road	661	0.28	491	0.20

- **Table 5-5: Midblock Peak Hour Capacity – 2016 PM (4-lane divided road)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,043	0.43	1,286	0.54
Hillside Drive	993	0.41	1,382	0.58
Cobbitty Road West	812	0.34	1,350	0.56
Oran Park Link Road 1	771	0.32	1,208	0.50
Oran Park Link Road 2	624	0.26	1,190	0.50
Marylands Link Road 1	657	0.27	1,358	0.57
Marylands Link Road 2	assume intersections not built in 2016			
Marylands Link Road 3	assume intersections not built in 2016			
Lowes Creek Link Road	assume intersections not built in 2016			
Belmore Road	672	0.28	1,384	0.58
Bringelly Road	697	0.29	1,083	0.45
Badgerys Creek Road	616	0.26	656	0.27
Derwent Road	599	0.25	644	0.27
Mersey Road	587	0.24	632	0.26

Table 5-6: Midblock Peak Hour Capacity – 2026 AM (4-lane divided road)

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,176	0.49	2,149	0.90
Hillside Drive	1,390	0.58	2,112	0.88
Cobbitty Road West	1,178	0.49	1,976	0.82
Oran Park Link Road 1	1,064	0.44	1,631	0.68
Oran Park Link Road 2	1,532	0.64	1,265	0.53
Marylands Link Road 1	1,741	0.73	1,367	0.57
Marylands Link Road 2	2,031	0.85	1,458	0.61
Marylands Link Road 3	1,580	0.66	821	0.34
Lowes Creek Link Road	1,750	0.73	687	0.29
Belmore Road	1,769	0.74	669	0.28
Bringelly Road	1,575	0.66	656	0.27
Badgerys Creek Road	997	0.42	520	0.22
Derwent Road	943	0.39	501	0.21
Mersey Road	893	0.37	480	0.20

Table 5-7: Midblock Peak Hour Capacity – 2026 PM (4-lane divided road)

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,911	0.80	1,690	0.70
Hillside Drive	1,978	0.82	1,867	0.78
Cobbitty Road West	1,846	0.77	1,855	0.77
Oran Park Link Road 1	1,548	0.65	1,373	0.57
Oran Park Link Road 2	1,488	0.62	1,473	0.61
Marylands Link Road 1	1,467	0.61	1,892	0.79
Marylands Link Road 2	1,581	0.66	2,110	0.88
Marylands Link Road 3	884	0.37	1,583	0.66
Lowes Creek Link Road	787	0.33	1,688	0.70
Belmore Road	784	0.33	1,657	0.69
Bringelly Road	760	0.32	1,532	0.64
Badgerys Creek Road	645	0.27	879	0.37
Derwent Road	617	0.26	819	0.34
Mersey Road	601	0.25	757	0.32

- **Table 5-8: Midblock Peak Hour Capacity – 2036 AM (6-lane divided road)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	1,285	0.36	2,313	0.64
Hillside Drive	1,555	0.43	2,361	0.66
Cobbitty Road West	1,334	0.37	2,308	0.64
Oran Park Link Road 1	1,243	0.35	2,071	0.58
Oran Park Link Road 2	1,722	0.48	1,892	0.53
Marylands Link Road 1	2,175	0.60	1,995	0.55
Marylands Link Road 2	2,583	0.72	2,232	0.62
Marylands Link Road 3	2,168	0.60	1,357	0.38
Lowes Creek Link Road	2,262	0.63	1,079	0.30
Belmore Road	2,403	0.67	1,093	0.30
Bringelly Road	2,176	0.60	1,059	0.29
Badgerys Creek Road	1,223	0.34	556	0.15
Derwent Road	1,124	0.31	505	0.14
Mersey Road	1,073	0.30	602	0.17

- **Table 5-9: Midblock Peak Hour Capacity – 2036 PM (6-lane divided road)**

Location on The Northern Road (north of the following intersections)	AM Peak (1-hr)			
	NB (vehicles)	v/c	SB (vehicles)	v/c
Fairwater Drive	2,180	0.61	1,666	0.46
Hillside Drive	2,288	0.64	1,875	0.52
Cobbitty Road West	2,104	0.58	1,977	0.55
Oran Park Link Road 1	1,923	0.53	1,589	0.44
Oran Park Link Road 2	1,986	0.55	1,945	0.54
Marylands Link Road 1	2,105	0.58	2,384	0.66
Marylands Link Road 2	2,371	0.66	2,750	0.76
Marylands Link Road 3	1,431	0.40	2,193	0.61
Lowes Creek Link Road	1,180	0.33	2,202	0.61
Belmore Road	1,280	0.36	2,292	0.64
Bringelly Road	1,063	0.30	2,135	0.59
Badgerys Creek Road	723	0.20	1,085	0.30
Derwent Road	652	0.18	971	0.27
Mersey Road	736	0.20	921	0.26

In general, the upgrade of The Northern Road in 4-lane divided road under 2016 and 2026 and 6-lane divided road under 2036 will provide sufficient capacity under the development of SWGC with forecast years' traffic flow. Almost all sections operate with v/c ratio less than 0.85. It indicates drivers have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. Overall, the results indicate the upgrade of The Northern Road will operate acceptable performance through 2036 and provide a substantial improvement in performance relative to the Base Case.

5.6.2. Proposed Staging Upgrade

Based on v/c ratio from the forecast traffic flow in AM and PM peak periods, the suggested progressive upgrading for each section are shown in **Table 5-10**.

- **Table 5-10: The Northern Road Proposed Staged Midblock Upgrade Requirements**

Road Sections	2011	2016	2026	2036
Derwent Road TO Mersey Road	2-LANE UNDIVIDED CARRIAGEWAY	2-LANE UNDIVIDED CARRIAGEWAY	2-LANE UNDIVIDED CARRIAGE WAY	4-LANE DIVIDED CARRIAGE WAY
Badgerys Creek Road TO Derwent Road				
Bringelly Road TO Badgerys Creek Road			4-LANE DIVIDED CARRIAGEWAY	6-LANE DIVIDED CARRIAGEWAY
Belmore Road TO Bringelly Road		4-LANE DIVIDED CARRIAGEWAY		
Lowes Creek Link Road TO Belmore Road				
Marylands Link Road 3 TO Lowes Creek Link Road				
Marylands Link Road 2 TO Marylands Link Road 3				
Marylands Link Road 1 TO Marylands Link Road 2				
Oran Park Link Road 2 TO Marylands Link Road 1				
Oran Park Link Road 1 TO Oran Park Link Road 2				
Cobbitty Road West TO Oran Park Link Road 1				
Hillside Drive TO Cobbitty Road West				
Fairwater Drive TO Hillside Drive				

In 2016, prior to full 4-lane widening, the sections of The Northern Road between the Bringelly Road and Mersey Road intersections are likely to be adequate in their existing lane configuration and intersection layouts. The remainder of the corridor is likely to require progressive upgrade to a four lane divided carriageway configuration.

In 2026, the sections of The Northern Road between the Badgerys Creek Road and Mersey Road intersections are likely to be adequate in their existing lane configuration and intersection layouts. The remainder of the corridor is likely to require progressive upgrade to a four lane divided carriageway configuration.

In 2036, the sections of The Northern Road between the Badgerys Creek Road and Mersey Road intersections are likely to require a four lane divided carriageway configuration. The remainder of the corridor will be progressively required upgrade to a six lane divided carriageway configuration.

It should be noted that the proposed staged midblock upgrade requirements are estimated according to the midblock capacity analysis. The final staging details will depend on the rate of development.

5.6.3. Intersection Analysis

A traffic assessment of the proposed significant intersections along the project was undertaken using SIDRA v5.1. The assessment considered AM and PM peak hour volumes for the proposed upgrade (extracted from the SATURN network model) in 2016, 2026 and 2036. According to the below intersection results at Bringelly Road intersection, grade separating The Northern Road / Bringelly Road intersection can be avoided by 2036.

All forecast traffic turning volumes were extracted from the SATURN models. Some of the intersection turning volume are less than 5 vehicles. These turning movements have been manually increased by adopting a figure equivalent to 10% of the though movement traffic in order to present a more realistic representation of adjacent land uses and improved balance in the turning movements.

Table 5-11 to **Table 5-16** summarise the predicated performance of the signalised and priority intersections matching the proposed midblock lane configurations stated in **Table 5-10**. All proposed signalised intersections provide signalised pedestrian crossing across all arms.

A summary of 2016 AM and PM turning movements, results and intersection layout are provided in **Table 5-11** and **Table 5-12** with full details provided in **Appendix A5**.

Table 5-11: Intersection Performance – 2016 AM

*Intersections	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
(S) Fairwater Drive	0.69	38.1	C	189.0 <The Northern Rd - North>
(S) Hillside Drive	0.53	30.0	C	132.0 <The Northern Rd - North>
(S) Cobbitty Road West	0.39	21.3	B	83.5 <The Northern Rd - South>
(P)** Cobbitty Road East	0.27	14.8	B	minimal queuing
(S) Oran Park Link Road 1	0.46	39.8	C	123.9 <Oran park Link Rd - West>
(S) Oran Park Link Road 2	0.54	47.3	D	140.8 <The Northern Rd - South>
(P)** Oran Park Link Road 3	0.36	11.2	A	minimum queue length
(S) Marylands Link Road 1	0.56	22.6	B	132.6 <The Northern Rd - South>
(S) Marylands Link Road 2	assume intersections not build in 2016			
(S) Marylands Link Road 3	assume intersections not build in 2016			
(S) Lowes Creek Link Road	assume intersections not build in 2016			
(P)** Carrington Road	0.37	11.3	A	minimal queuing
(S) Belmore Road	0.61	14.3	A	138.8 <The Northern Rd - South>
(P)** Robinson Road	0.37	11.3	A	minimal queuing
(P)** Loftus Road	0.37	23.2	B	minimal queuing
(S) Bringelly Road	0.43	38.0	C	92.6 <The Northern Rd - South>
(P)** Thames Road	very low traffic, no impact			
(P)** Solway Road	very low traffic, no impact			
(P)** Lea Road	very low traffic, no impact			
(R)** Badgerys Creek Road (2 lane undivided carriageway)	0.62	14.8	B	63.4 <The Northern Rd - South>
(P)** Derwent Road (2 lane undivided carriageway)	0.28	19.8	B	minimal queuing
(P)** Avon Road	very low traffic, no impact			
(P) ** Mersey Road (2 lane undivided carriageway)	0.38	28.6	C	53.9 <The Northern Rd - South>

* (P = Priority Junction; S = Signalised Junction; R= Roundabout)

** The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- **Table 5-12: Intersection Performance – 2016 PM**

*Intersections	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
(S) Fairwater Drive	0.70	41.9	C	>200 <The Northern Rd - North>
(S) Hillside Drive	0.70	35.1	C	>200 <The Northern Rd - North>
(S) Cobbitty Road West	0.45	18.6	B	95.7 < The Northern Rd - South>
(P)** Cobbitty Road East	0.33	19.0	B	15.3 <Cobbitty Rd East>
(S) Oran Park Link Road 1	0.51	36.8	C	130.2 <The Northern Rd - North>
(S) Oran Park Link Road 2	0.54	38.8	C	144.0 <The Northern Rd - North>
(P)** Oran Park Link Road 3	0.33	18.0	B	minimal queuing
(S) Marylands Link Road 1	0.61	18.6	B	160.6 <The Northern Rd - North>
(S) Marylands Link Road 2	assume intersections not build in 2016			
(S) Marylands Link Road 3	assume intersections not build in 2016			
(S) Lowes Creek Link Road	assume intersections not build in 2016			
(P)** Carrington Road	0.38	23.5	B	minimal queuing
(S) Belmore Road	0.62	13.9	A	146.8 <The Northern Rd - North>
(P)** Robinson Road	0.38	23.5	B	minimal queuing
(P)** Loftus Road	0.38	12.2	A	minimal queuing
(S) Bringelly Road	0.65	39.0	C	182.8 <The Northern Rd - North>
(P)** Thames Road	very low traffic, no impact			
(P)** Solway Road	very low traffic, no impact			
(P)** Lea Road	very low traffic, no impact			
(R)** Badgerys Creek Road (2 lane undivided carriageway)	0.60	19.7	B	50.8 <Badgerys Ck Rd>
(P)** Derwent Road (2 lane undivided carriageway)	0.36	26.3	B	minimal queuing
(P)** Avon Road	very low traffic, no impact			
(P) ** Mersey Road (2 lane undivided carriageway)	0.35	24.3	B	53.8 <The Northern Rd - South>

* (P = Priority Junction; S = Signalised Junction; R= Roundabout)

** The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- Under 2016 AM and PM peak periods, all intersections are expected to operate below capacity, at worst, a LoS of D on any one leg.
- Junctions north of Bringelly Road intersection will not cause any adverse impact under existing configuration with 2016 forecast traffic flows. All junctions will operate LoS C or better.

A summary of 2026 AM and PM turning movements, results and intersection layout are provided in **Table 5-13** and **Table 5-14** with full details provided in **Appendix A6**.

- **Table 5-13: Intersection Performance – 2026 AM**

*Intersections	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
(S) Fairwater Drive	0.84	33.4	C	>200 <The Northern Rd - North>
(S) Hillside Drive	0.84	31.1	C	>200 <The Northern Rd - North>
(S) Cobbitty Road West	0.71	16.0	B	120.7 <The Northern Rd - South>
(P)** Cobbitty Road East	0.59	37.7	C	25.3 <Cobbitty Road East>
(S) Oran Park Link Road 1	0.78	49.9	D	>200 <The Northern Rd - North>
(S) Oran Park Link Road 2	0.78	52.5	D	>200 <The Northern Rd - North>
(P)** Oran Park Link Road 3	0.43	20.1	B	minimal queuing
(S) Marylands Link Road 1	0.88	42.7	D	>200 <The Northern Rd - South>
(S) Marylands Link Road 2	0.82	33.6	C	>200 <The Northern Rd - South>
(S) Marylands Link Road 3	0.73	47.3	D	>200 <The Northern Rd - South>
(S) Lowes Creek Link Road	0.88	40.9	C	>200 <The Northern Rd - South>
(P)** Carrington Road	0.49	12.0	A	minimal queuing
(S) Belmore Road	0.80	15.3	B	>200 <The Northern Rd - South>
(P)** Robinson Road	0.49	11.7	A	minimal queuing
(P)** Loftus Road	0.49	41.2	C	minimal queuing
(S) Bringelly Road	0.70	40.3	C	>200 <The Northern Rd - South>
(P)** Thames Road	0.44	29.1	C	minimal queuing
(P)** Solway Road	0.44	29.2	C	minimal queuing
(P)** Lea Road	0.44	11.9	A	minimal queuing
(S) Badgerys Creek Road	0.50	32.0	C	115.7 <The Northern Rd - South>
(P)** Derwent Road (2 lane undivided carriageway)	0.34	24.1	B	minimal queuing
(P)** Avon Road (2 lane undivided carriageway)	0.53	47.5	D	59.1 <The Northern Rd - North>
(P)** Mersey Road (2 lane undivided carriageway)	0.56	47.9	D	107.1 <The Northern Rd - South>

* (P = Priority Junction; S = Signalised Junction; R= Roundabout)

** The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- **Table 5-14: Intersection Performance – 2026 PM**

*Intersections	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
(S) Fairwater Drive	0.79	40.7	C	>200 <The Northern Rd - South>
(S) Hillside Drive	0.86	37.1	C	>200 <The Northern Rd - South>
(S) Cobbitty Road West	0.77	18.8	B	>200 <The Northern Rd - South>
(P)** Cobbitty Road East	0.68	39.2	C	67.2 < Cobbitty Road East>
(S) Oran Park Link Road 1	0.71	44.4	D	>200 <The Northern Rd - South>
(S) Oran Park Link Road 2	0.76	47.1	D	>200 <The Northern Rd - South>
(P)** Oran Park Link Road 3	0.42	25.9	B	minimum queue length
(S) Marylands Link Road 1	0.86	41.1	C	>200 <The Northern Rd - North>
(S) Marylands Link Road 2	0.81	36.6	C	>200 <The Northern Rd - North>
(S) Marylands Link Road 3	0.83	46.7	D	>200 <The Northern Rd - North>
(S) Lowes Creek Link Road	0.83	31.8	C	196.9 <The Northern Rd - North>
(P)** Carrington Road	0.47	42.8	D	15.5 <Carrington Rd - East>
(S) Belmore Road	0.74	16.9	B	>200 <The Northern Rd - North>
(P)** Robinson Road	0.46	36.3	C	minimal queuing
(P)** Loftus Road	0.46	12.8	A	minimal queuing
(S) Bringelly Road	0.74	38.3	C	>200 <The Northern Rd - North>
(P)** Thames Road	0.43	12.5	A	minimal queuing
(P)** Solway Road	0.42	12.5	A	minimal queuing
(P)** Lea Road	0.46	36.3	C	minimal queuing
(S) Badgerys Creek Road	0.70	28.0	B	194.2 <The Northern Rd - North>
(P)** Derwent Road (2 lane undivided carriageway)	0.53	47.3	D	17.9 <Derwent Rd - East>
(P)** Avon Road (2 lane undivided carriageway)	0.46	50.3	D	93.1 <The Northern Rd - North>
(P)** Mersey Road (2 lane undivided carriageway)	0.55	47.2	D	65.5 <The Northern Rd - South>

* (P = Priority Junction; S = Signalised Junction; R= Roundabout)

** The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- Under 2026 AM and PM peak periods, all intersections will operate at LoS D or better.
- A few intersections have DoS approximate close to 0.9, which is almost the same as the recommended maximum degree of saturation of 90%. This means these intersections will operate at capacity and any additional traffic demand will result in oversaturated operation with associated delays and queuing.

- Junctions north of Badgerys Creek Road intersection will not cause any adverse impact under the existing configuration with 2026 forecast traffic flows. All junctions will operate at LoS D or better.

A summary of 2036 AM and PM turning movements, results and intersection layout are provided in **Table 5-15** and **Table 5-16** with full details provided in **Appendix A7**.

- **Table 5-15: Intersection Performance – 2036 AM**

*Intersections	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
(S) Fairwater Drive	0.73	37.3	C	>200 <The Northern Rd - North>
(S) Hillside Drive	0.74	36.7	C	>200 <The Northern Rd - North>
(S) Cobbitty Road West	0.57	19.9	B	121.7 <The Northern Rd - South>
(P)** Cobbitty Road East	0.82	55.4	D	101.4 <Cobbitty Road East>
(S) Oran Park Link Road 1	0.86	50.6	D	>200 <The Northern Rd - North>
(S) Oran Park Link Road 2	0.85	55.1	D	>200 <The Northern Rd - North>
(P)** Oran Park Link Road 3	0.35	30.8	C	minimal queuing
(S) Marylands Link Road 1	0.77	42.7	D	>200 <The Northern Rd - North>
(S) Marylands Link Road 2	0.82	43.2	D	>200 <The Northern Rd - South>
(S) Marylands Link Road 3	0.86	55.9	D	>200 <The Northern Rd - South>
(S) Lowes Creek Link Road	0.75	44.2	D	>200 <The Northern Rd - South>
(P)** Carrington Road	0.42	12.8	A	minimal queuing
(S) Belmore Road	0.86	31.3	C	>200 <The Northern Rd - South>
(P)** Robinson Road	0.45	12.8	A	minimal queuing
(P)** Loftus Road	0.60	39.4	C	26.7 <Loftus Rd - West>
(S) Bringelly Road	0.72	45.0	C	>200 <The Northern Rd - South>
(P)** Thames Road	0.40	48.3	D	minimal queuing
(P)** Solway Road	0.41	48.9	D	minimal queuing
(P)** Lea Road	0.40	14.3	A	21.8 <Lea Rd - East>
(S) Badgerys Creek Road	0.69	32.9	C	178.6 <The Northern Rd - South>
(S) Derwent Road (4 lane divided carriageway)	0.65	28.7	C	191.6 <The Northern Rd - South>
(P)** Avon Road (4 lane divided carriageway)	0.31	17.2	B	minimal queuing
(S) Mersey Road (4 lane divided carriageway)	0.52	23.2	B	123.0 <The Northern Rd - South>

* (P = Priority Junction; S = Signalised Junction; R= Roundabout)

** The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- **Table 5-16: Intersection Performance – 2036 PM**

*Intersections	Degree of Saturation (DoS)	Average Delay (sec)	Level of Service (LoS)	Queue Length (m) <Worst Approach>
(S) Fairwater Drive	0.83	44.9	D	>200 <The Northern Rd - South>
(S) Hillside Drive	0.77	39.0	C	>200 <The Northern Rd - South>
(S) Cobbitty Road West	0.75	23.1	B	>200 <The Northern Rd - South>
(P)** Cobbitty Road East	0.76	36.0	C	109.5 <Cobbitty Road East>
(S) Oran Park Link Road 1	0.85	55.1	D	>200 <The Northern Rd - South>
(S) Oran Park Link Road 2	0.83	52.8	D	>200 <The Northern Rd - South>
(P)** Oran Park Link Road 3	0.37	32.6	C	minimal queuing
(S) Marylands Link Road 1	0.83	43.6	D	>200 <The Northern Rd - North>
(S) Marylands Link Road 2	0.88	48.6	D	>200 <The Northern Rd - North>
(S) Marylands Link Road 3	0.88	52.9	D	>200 <The Northern Rd - North>
(S) Lowes Creek Link Road	0.80	43.0	D	>200 <The Northern Rd - North>
(P)** Carrington Road	0.46	29.7	C	19.6 <Carrington Rd - East>
(S) Belmore Road	0.67	28.0	C	>200 <The Northern Rd - North>
(P)** Robinson Road	0.43	25.3	B	minimal queuing
(P)** Loftus Road	0.42	13.8	A	minimal queuing
(S) Bringelly Road	0.84	43.6	D	199.1 <The Northern Rd - North>
(P)** Thames Road	0.40	15.1	B	minimal queuing
(P)** Solway Road	0.37	15.1	B	minimal queuing
(P)** Lea Road	0.43	25.3	B	minimal queuing
(S) Badgerys Creek Road	0.59	34.5	C	145.2 <Badgerys Creek Rd - East>
(S) Derwent Road (4 lane divided carriageway)	0.56	25.8	B	148.9 <The Northern Rd - North>
(P)** Avon Road (4 lane divided carriageway)	0.27	11.7	A	minimal queuing
(S) Mersey Road (4 lane divided carriageway)	0.57	35.5	C	134.3 <The Northern Rd - North>

* (P = Priority Junction; S = Signalised Junction; R= Roundabout)

** The worst movement average delay and LoS are reported for roundabouts and priority intersections.

- Under 2036 AM and PM peak periods, all intersections will operate at LoS D or better.
- A few intersections have a DoS close to 0.9, which is almost the same as the recommended maximum degree of saturation of 90%. This means these intersections will operate at capacity and if additional traffic volume comes across intersection these intersections may experience cycle failures.

- Junctions north of Badgerys Creek Road intersection will not cause any adverse impact under 4-lane dividend carriageway with 2036 forecast traffic flows. All junctions will operate LoS C or better.

According to the above analyses all the intersections would operate at LoS D or better for the years analysed. The analyses show the importance of proposed upgrade in the road network under different stages. At grade intersections would have sufficient capacity to cater for future forecast traffic under 2036.

6. Preliminary Construction Traffic Impacts

6.1. Traffic Delays

Delays for traffic using The Northern Road are anticipated during the construction phase in those periods when reduced speed limits are in place and when manual traffic control is in operation to facilitate the movement of construction vehicles into and out of work sites. There would also be delays to local traffic during periods when other minor roads are being tied in with the upgrade works. Short local detours may be required to facilitate these tie-in works. Local roads that would experience some delays during construction include Cobbitty Road West, Bringelly Road and Badgerys Creek Road. The contractor would be required to develop detailed Construction Traffic Management Plans and associated Traffic Control Plans to ensure the safe and efficient movement of traffic on The Northern Road and adjacent local road network.

6.2. Public Transport

There will be minimal operational impacts to existing bus routes. The work may require the relocation of existing bus stops as opportunities for bus stops will be provided on the departure side of each signalised intersection. The Northern Road serves areas of the South West Growth Centre including Oran Park as well as residential upgrades in and around Bringelly and Harrington Park. To date, no detailed plans for bus services have been specified, however, it is expected that regular bus services and school bus services will connect and serve the new development areas using The Northern Road.

6.3. Pedestrian and Cycle Networks

The upgrade of The Northern Road includes the introduction of a series of signalised intersections which incorporate pedestrian crossing facilities. As part of the upgrade a 3m wide shared path is to be provided along the eastern side of the upgrade.

To improve facilities for cyclists the upgrade of The Northern Road will incorporate 2m shoulders which will act as unofficial cycle lanes as well as the off road shared path.

6.4. Construction Traffic

Construction traffic will generally operate away from existing roads. Bridges and cuttings would be completed early in the construction phase so that haulage routes could be contained within the construction site. Haulage of additional material to the site, plus general construction workforce traffic, visitors and material deliveries would add to the traffic on the existing highway and some local roads used to provide access. Cuttings would be completed early in the construction phase so that haulage routes could be contained within the construction zone.

It is expect there will be minor increase in travel time due to the reduced speed limit around the construction site. Some local streets would be used for access to the project and traffic during construction will require appropriate management. The construction contractor will be required to provide traffic management on all roads impacted by the works. A maximum of 100 trucks per day would be importing materials for pavement construction for approximately 12 months towards the end of the overall construction period. Traffic management measures would be established to ensure safe passage of vehicle movements into and out of the construction site.

7. Evaluation of Road User Delays

The RTA Guidelines on the evaluation of road user delays detail several key elements that should be addressed when undertaking any study. However as mentioned previously, some information is yet to be determined and as such, will be included as the project progresses.

No specific estimates or calculations in regards to travel delay and delay cost have been undertaken in this study. These will be carried when the final staging of the project has been determined and the construction methodology finalised.

7.1. Co-ordination with other Agencies

Preliminary consultation with other agencies likely to be undertaking infrastructure works within the vicinity of the construction footprint as part of the development of the Concept Design. Under the RTA Guidelines, local Councils along with relevant service providers (water, gas, sewerage, electricity and telecommunications) will need to be contacted as the design is progressed and prior to any construction activity taking place on site.

7.2. Concept Design Considerations

Within the concept design of The Northern Road Upgrade Project each section of the work has been developed in such a way that construction can be carried out in two main stages:

- In first stage, a new 2-lane carriageway will be constructed alongside the existing carriageway. During this stage of work, the traffic will continue to be carried along the existing carriageway; and
- In second stage, the traffic will be switched onto the new carriageway (operating bidirectionally) and the existing carriageway will be upgraded.

In order to maximise the use of existing road length during construction and to optimise traffic performance, the following aspects were considered during the design process:

- Ensuring that the alignment of the new carriageway avoids, as much as possible, encroaching on the existing trafficked carriageway;
- Minimising the number of points where the new carriageway crosses the existing road; and
- providing sufficient width to permit the maximum feasible isolation of construction activity from the existing road.

7.3. Haulage of Road Building Materials

While the grading of many road projects is selected so as to balance the volume of earthworks as far as is practicable, it is often the case that there is a surplus or deficit of material, which must be transported either away from or onto the work site. Where earthworks are balanced, haulage routes may intersect with or utilise The Northern Road or other local roads thereby impacting motorists.

Where the grading and location of a section of The Northern Road indicates that such a situation is likely to occur, the potential haulage route(s) and their intersections with existing roads will need to be identified. This would allow for subsequent consideration of the possible delays likely to be experienced by road users.

7.4. Road User Delay

Preliminary construction staging has been developed for the upgrade, resulting in six separate sections as shown in **Figure 7-1**. A detail discussion of the methodology that will be adopted to construct these sections is presented in **Section 8.1.**

In **Section 8**, the conceptual Construction Traffic Management Plan (CTMP) discusses the potential impacts and the proposed traffic management measures for the two-way traffic operations. Based on this information, the key issues likely to contribute to delays or traffic disruptions are identified below:

- Reduction in existing speed limits through the implementation of a roadwork speed limit of 60kph on a full-time basis on the approach to, through and departure from the work site. This is a reduction from the current posted speed limit of 80kph;
- At the tie-in locations where traffic is switched between existing and new carriageways is likely to cause further delays due to constraints in the temporary alignment at the cross over points;
- The reduction in shoulder width to 1m to allocate sufficient space for temporary safety barriers is likely to cause traffic disruption and delays in the event of a vehicle break down within the construction zone;
- The arrival and departure of construction traffic to/ from the construction access points; and
- The arrival and departure of workers at shift rotations will result increased traffic demand along the construction zone and turning manoeuvres to/ from the site access points, however, the start and finish of work shifts will most likely occur outside of peak traffic periods (i.e. 0630 – 0700 in AM and 1500 – 1600 in PM).

With the upgrade works being undertaken in relatively short sections, the overall delay resulting from the reduction in speed zoning is expected to be relatively minor. Similarly, the staged upgrade, and consequential reduced construction footprint, will require a smaller workforce and reduced quantities of materials during each stage. These mitigating factors will contribute to a minimisation of road user delays.

7.4.1. Property Access

Full access to all properties will be maintained throughout the course of the construction of each section of work.

7.4.2. Bus Operations

There are no existing public transport routes servicing The Northern Road. Therefore, at the time of writing, the proposed changes are not expected to impact on existing public transport routes or timetabling.

7.4.3. Cyclists

The construction activity will require the narrowing of the road shoulder which may impact on cyclists passing through the work site. Cyclists will need to move into the traffic lane as they travel through the work site. Given the rural nature of the road, it is expected that cyclist volumes will be low and the overall delay is anticipated to be relatively minor. No remedial measures are required.

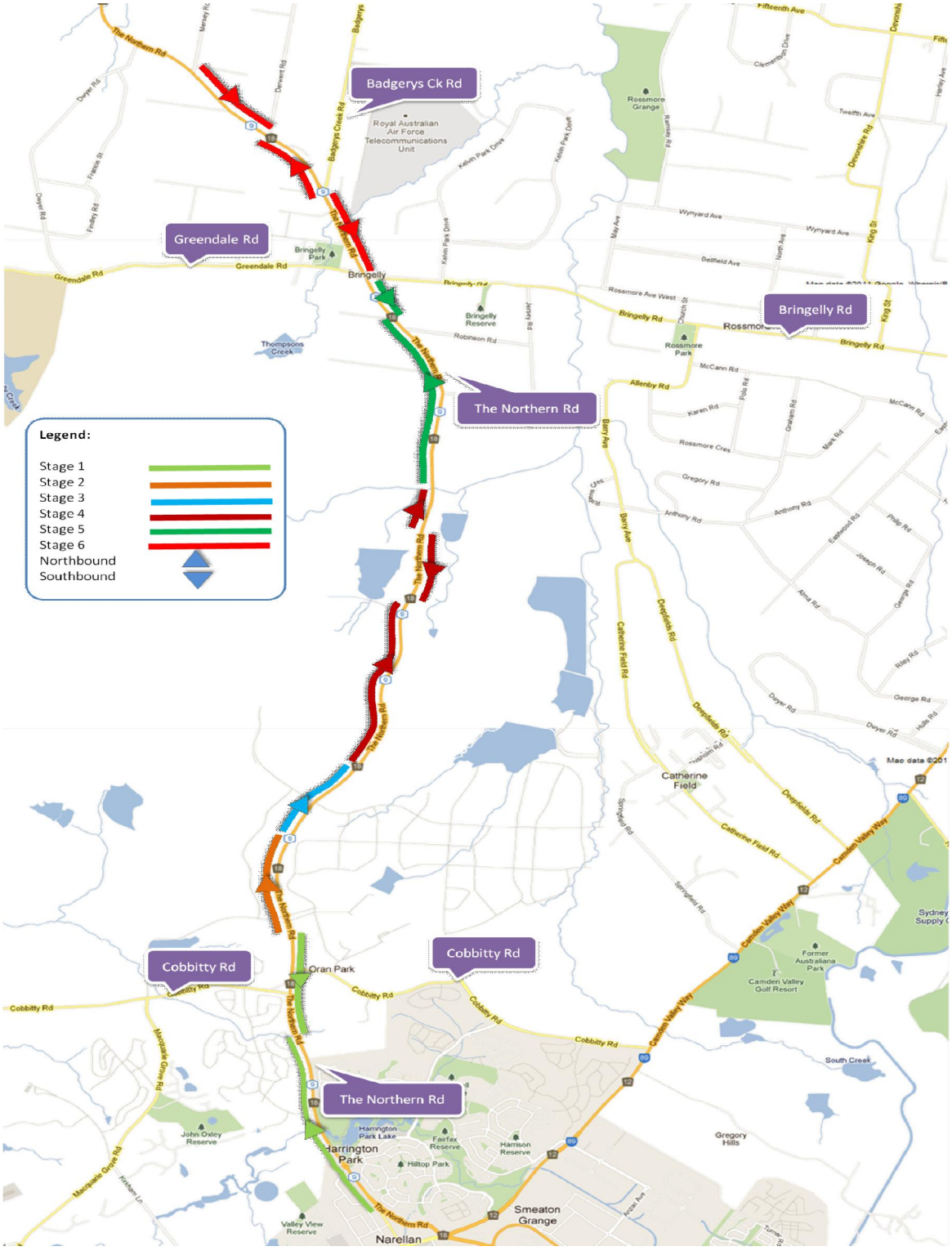
7.4.4. Pedestrians

Pedestrians travelling through the worksite will be guided to cross the road at designated locations. This may cause minor delays but given the very low pedestrian volumes using The Northern Road, this is not considered to be a significant issue.

7.4.5. Impact on Emergency Vehicles

The construction activity will not have any impact on emergency vehicles, as vehicular access along the Hume Highway will be maintained. No remedial measures are required.

- **Figure 7-1: The Northern Road Upgrade – Preliminary Construction Staging of New Carriageway**



8. Construction Traffic Impact and Management

This preliminary Construction Traffic Management Plan (CTMP) addresses the potential impacts of works related to the upgrade of The Northern Road, and details the proposed traffic management measures for the maintenance of two-way traffic operations and access to adjoining roads during construction.

8.1. Staging and Construction Activity

The Northern Road upgrade predominantly consists of the construction of a new carriageway adjacent to the existing alignment of The Northern Road, the installation of new intersections and the upgrade of existing intersections. The new carriageway will be duplicated alternately between the eastern and western sides of the existing alignment. It is expected that construction will be undertaken in two main stages:

- First stage will involve construction of the new carriageway with traffic to be carried on the existing carriageway; and
- Second stage will involve upgrading works on the existing carriageway with traffic to be carried on the new carriageway.

Proposed concept design staging drawings are provided in **Appendix C**.

Preliminary construction staging has been developed for the upgrade, resulting in six sub-sections as described below:

- **Section 1**, the southernmost section, involves the construction of a new northbound carriageway to the west of the existing alignment from The Old Northern Road (CH 0.00) to approximately 300m south of Cobbitty Road West (CH 2400.00), and the construction of a new southbound carriageway to the east of the existing alignment from CH 2400.00 to approximately 350m north of Cobbitty Road East (CH 3350.00). This sub-section contains the construction of a new bridge over Narellan Creek and the addition of shared path to the outside of the existing bridge; the removal of the roundabouts at Porrende Street / Fairwater Drive and Hillside Drive, and their replacement with traffic signals; installation of traffic signals at Cobbitty Road West; and works at Cobbitty Road East to integrate it with the new dual carriageway.
- **Section 2** is between CH 3350.00 (approximately 350m north of Cobbitty Road East) and CH 3370.00 (approximately 370m north of Cobbitty Road East and approximately 230m south of the future Peter Brock Drive intersection). This section has been designed by Brown Consulting for greenfield development and is expected to be constructed by the developer.

Temporary tie-in works extends to CH 3089.00 at the southern limit of works and CH 3980.00 at the northern limit of works.

- **Section 3** involves the construction of a new northbound carriageway to the west of the existing alignment from CH 3750.00 to approximately 500m south of the proposed Oran Park Link Road 2 (CH 4500.00). This sub-section contains the construction of a new signalised intersection at the proposed Oran Park Link Road 1.
- **Section 4** involves the construction of a new northbound carriageway to the west of the existing alignment from CH 4500.00 to approximately 400m south of the proposed Marylands Link Road 1 (CH 5700.00). This sub-section contains the construction of a new signalised intersection at the proposed Oran Park Link Road 2 and a give-way controlled intersection at the proposed Oran Park Link Road 3.
- **Section 5** involves the construction of a new northbound carriageway to the west of the existing alignment from CH 5700.00 to the proposed Marylands Link Road 3 (CH 8200.00), and also from CH 8700.00 to the proposed Lowes Creek Link Road (CH 9300.00); and the construction of a new southbound carriageway to the east of the existing alignment from Marylands Links Road 1 (CH 6050.00) to CH 6300.00 and also from CH 8200.00 to CH 8700.00. This sub-section contains the construction of new signalised intersections at the proposed Marylands Link Road 1, Marylands Link Road 2, Marylands Link Road 3 and Lowes Creek Link Road.
- **Section 6** involves the construction of a new northbound carriageway to the west of the existing alignment from CH 9300.00 to approximately 400m north of Belmore Road (CH 10800.00), and the construction of a new southbound carriageway to the east of the existing alignment from CH 9950.00 to CH 10200.00 and also from CH 10800.00 to approximately 200m south of Bringelly Road / Greendale Road (CH 11400.00). This sub-section contains the installation of traffic signals at Belmore Road, and works at Carrington Road, Robinson Road and Loftus Road to integrate them with the new dual carriageway.
- **Section 7** involves the construction of a new southbound carriageway to the east of the existing alignment from CH 11400.00 to Thames Road (CH 12100.00) including the intersection at Greendale Road/Bringelly Road, and also from CH 12600.00 to approximately 400m north of Mersey Road (CH 15000.00); and the construction of a new northbound carriageway to the west of the existing alignment from CH 12100.00 to CH 12600.00 and also from CH 13650.00 to CH 13900.00. This sub-section contains the upgrade of the signalised intersection at Greendale Road / Bringelly Road, the installation of traffic signals at Derwent Road and Mersey Road; the removal of the roundabout at Badgerys Creek Road, and its replacement with traffic signals; and works at Solway Road, Lea Road and Avon Road to integrate them with the new dual carriageway.

These sub-sections are shown in overleaf **Figure 8-1**.

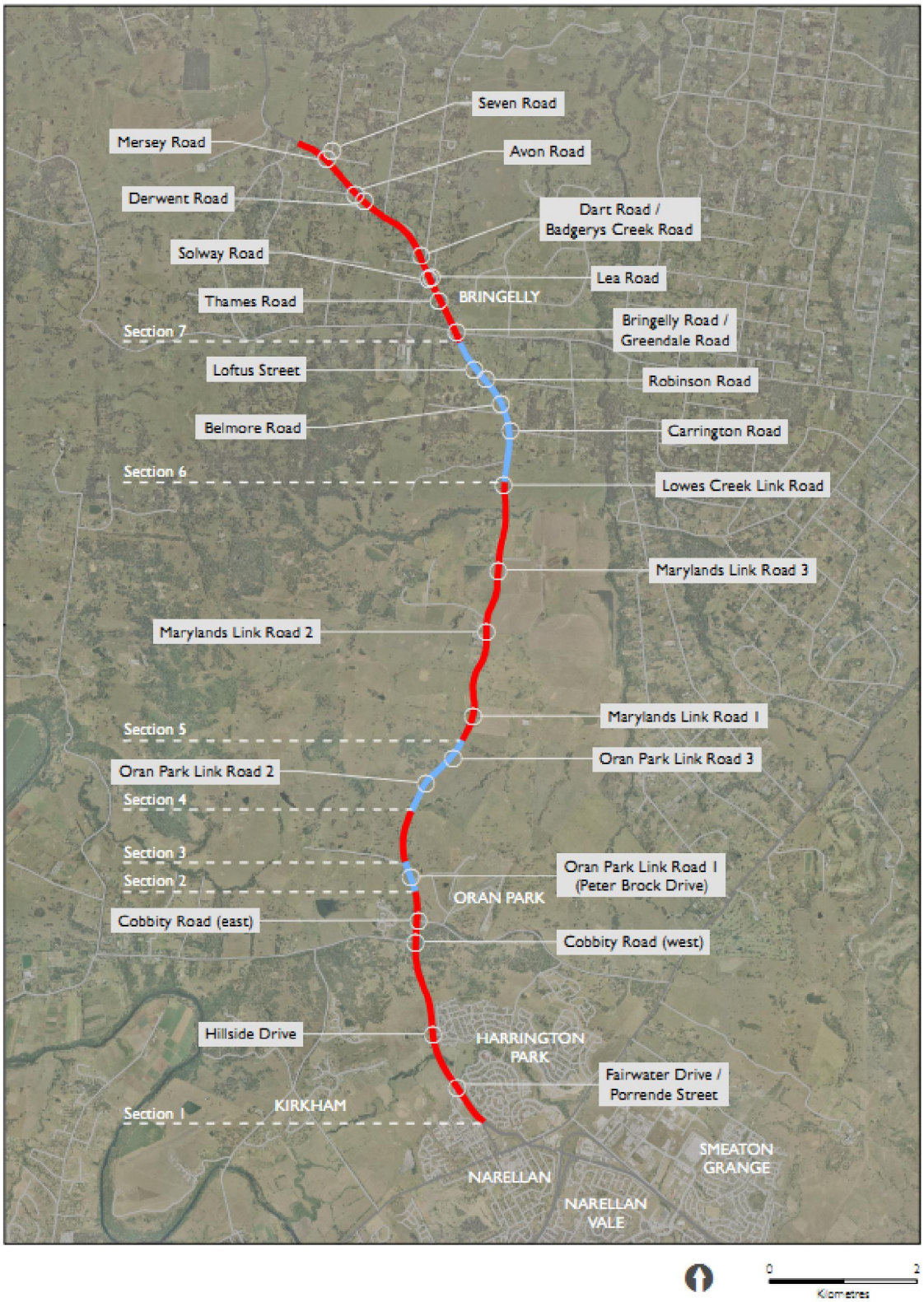
It is envisaged that Section 2 will be built first, followed by Sections 3, 1, 5, 4, 6 and 7.

The general scope of activities and arrangements expected for The Northern Road upgrade, whilst maintaining two-way traffic adjacent to or through construction zones, includes the following:

- The implementation of a roadwork speed limit of 60kph on a full-time basis on the approach to, through and departure from the work site. This is a reduction from the current posted speed limit of 80kph. The speed limit reduction will remain in place for the duration of each of the stages of roadworks. A further reduction of the speed limit to 40kph may also be required on a periodic basis when works under traffic control are required, although it would be desirable that this occurred outside of the AM and PM peaks and also on a short term (shift by shift) basis.
- Concrete barriers or other crash protection will be installed on either side of the road shoulder (depending on which side of the existing road the duplication is being constructed) to provide protection for through traffic from any works being undertaken within the work site and to provide for worker safety. Existing line marking may need to be removed or altered, with new temporary line marking installed to delineate the centre and edge lines in both directions.
- Traffic switches at tie-ins to the existing carriageway will be required at various stages throughout the upgrade, where traffic will be redirected from the existing carriageway to the newly constructed road. This will enable works to be undertaken on the existing carriageway. Delineation to separate northbound and southbound traffic will be provided using temporary materials. Concrete barriers or other crash protection previously used along the existing carriageway will be moved to the appropriate side on the new carriageway.
- At intersections where roundabouts will be replaced with traffic signals, or where traffic signals will be installed in place of current priority arrangements, roundabout removal and / or traffic signal installation works will be undertaken concurrently with the construction of the new carriageway, to enable completion of the traffic signals prior to traffic switches. These works will require the realignment of some roads on approach to and departure from The Northern Road. Access for general traffic will be maintained during all stages of construction. Concrete barriers or other crash protection will be installed, as well as the implementation of a roadwork speed limit on the approach to and departure from the work sites, and delineation of centre and edge lines will be provided using temporary materials.
- At intersections that are to be upgraded and integrated into the new dual carriageway without the installation of traffic signals, some realignment on the approaches to and departure from The Northern Road may be required. Arrangements described in the point above will be in place to ensure access is maintained for general traffic.

- At the end of the upgrade, finishing works will include the installation of permanent pavement markings and road furniture, construction of tie-ins to the existing carriageway / new carriageway, landscaping works, removal of temporary crash barriers and the opening of both carriageways to traffic.

Figure 8-1: Location Map – Work Sub-sections



8.2. Site Access

Wherever possible, site access will be provided at points located off The Northern Road via adjoining roads. Where this is not possible or practical, a break in the crash barrier on The Northern Road (with suitable end treatments) will be provided to allow access into and out of the site. Left-in / left-out only movements are preferable to minimise delays.

The number and locations of site compounds are shown in the 20% engineering design drawings, however, these will be finalised during detailed design, upon which this CTMP will be updated if necessary.

8.3. Access to Adjoining Properties

It will be ensured that safe and convenient passage for vehicles, pedestrians, cyclists and stock to and from side roads and property accesses connecting to The Northern Road will be maintained at all times. Alternative access provisions and the removal of temporary roads will only be undertaken in consultation with, and to the satisfaction of, the relevant local government authority.

Alternative provisions will always be made available before side roads and accesses are affected by works in progress.

8.4. Construction Vehicles and Volumes

Standard construction work hours are expected to be between 0700 to 1800 Monday to Friday and 0700 to 1300 on Saturday. Construction work will generally not be undertaken on Sundays or public holidays, however in some circumstances works outside these hours may be required for operational and / or construction related reasons.

Vehicles that will likely be required for construction activity include:

- Piling drill rigs;
- Excavators;
- Mobile crane;
- Concrete pumps;
- Front end loaders;
- Tippers;
- Bob cats;
- Flat bed trucks;
- Concrete delivery trucks;
- Concrete pavers; and
- Vibratory rollers.

Whenever practical, all removal and delivery of materials and plant will be timed to occur outside of peak traffic periods to minimise delays.

8.5. Haulage Routes during Construction Work

Designated access routes for construction and spoil vehicles will be along the arterial road network where practicable. Details of all routes used for access and haulage during construction will be developed in consultation with the relevant local government authority upon confirmation of quarry locations. Roads in the area that are likely to be used for access and haulage include:

- Narellan Road.
- Camden Valley Way.
- Hume Highway.
- Bringelly Road.
- Elizabeth Drive.
- Western Motorway.
- Great Western Highway.
- Badgerys Creek Road.

Spoil haulage routes will be developed in a format such that a suite of individual instructions and maps are provided to contract operators for all points of origin to respective destinations and return. In addition, layover areas will be nominated should vehicles need to 'store' prior to arriving at the spoil removal sites. Approximate travel times in AM, off and PM peaks will be developed for each route as a guide to operators and also assist in more consistent and uniform arrival rates at each site.

Dilapidation surveys of regional and local roads used by construction traffic will be undertaken prior to their use for construction as well as after construction is complete. Monitoring will be carried out to the satisfaction of, and a dilapidation report submitted to, relevant local government authorities. The proponent (RMS) will be responsible for any necessary repair of deterioration attributable to the impacts of construction traffic.

8.6. Site Construction and Internal Vehicle Management

Areas within the construction site where heavy earthmoving vehicles and cranes are in operation will be separated and protected by temporary fencing, additional signs and / or security persons at times the site is shared with other contractors.

All vehicles accessing the internal site roads for the purpose of material delivery and construction works will require safety flashing lights located on the top of the vehicle and functioning reverse beepers. All operators will be licensed for the particular item of equipment, and shall demonstrate competence in the use of the equipment as part of the site management and safety plan.

Generally, small utility vehicles will have limited access to the construction site. Vehicles fitted with safety flashing lights may be used for the delivery of tools, small plant and equipment, and immediately returned to the nearest temporary construction car park once the delivery task is completed.

8.7. Potential Impacts Arising

The following impacts are anticipated to result from the construction works:

- Increase in through travel times due to the reduction in speed limit over the length of the construction zone, and potential short-term traffic control.
- There will be new construction access points established to allow construction vehicles to access the work sites. The slowing down, entering and turning movements of construction traffic into and out of the work sites has the potential to impact the safety of other road users. This will be mitigated by ensuring that adequate roadwork, truck turning signage and the roadwork speed limit are designed and installed in accordance with a Traffic Control Plan (TCP) prepared by an appropriately qualified person and submitted for the approval of the road authority.
- There may be safety risks associated with the construction activity and through traffic. These will be mitigated by providing a concrete or other approved traffic crash barrier to separate the construction activities from the general public.
- There will be a reduction in road shoulder width, which will require any pedestrians walking along the side of the road to cross to the other side of the road. Given the very low pedestrian volumes using The Northern Road, this is not considered to be a significant issue. There will be a roadwork speed limit in place which will assist pedestrians to cross the road by increasing the time available before a vehicle arrives at the chosen crossing point. Similarly, the narrowing of road shoulder width may impact on any cyclists who are using The Northern Road. Cyclists will need to move into the traffic lane to pass through the road works. Given the rural nature of the road, it is expected that cyclist volumes will be low, and any cyclists who do use the road will be experienced enough to understand the requirement to occupy the lane. This requirement to occupy the through lane occurs for various reasons on any cycle trip made on rural roads with variable shoulder widths and conditions. The provision of a roadwork speed limit and roadwork signage will further assist cyclists moving through the worksite.
- There will be the need for staff parking at the work site. If staff do not require their vehicles to be able to undertake their jobs, they will be directed to park in a temporary worker car parking area (size and location is yet to be determined). No worker parking will be permitted within The Northern Road corridor, and only plant and vehicles required to undertake construction activities will be permitted to park behind the crash barriers.
- There will be an increase in construction vehicles using the adjacent road network, the scale of which will be determined upon detailed construction staging. The volume of construction traffic will be related to the arrival and departure of workers, the delivery of plant and equipment, and the arrival and departure of trucks carrying materials such as select fill, asphalt, etc. The predominant traffic movement will be the arrival and departure of workers at

the start and end of shifts, which will most likely occur between 0630-0700 and 1500-1600PM. Therefore, the peak periods for worker traffic movements will occur in the shoulders of the main traffic peak hours for general traffic and as such, is not expected to result in a significant reduction in the Level of Service on the adjacent road network.

8.8. Consultation and Ongoing Impact Management

Prior to the commencement of construction, affected property and business owners along the upgrade corridor, and students and parents at Bringelly Public School and Macarthur Anglican School, will be notified in writing about the works. Notices will also be placed in the following local newspapers:

- Campbelltown-Macarthur Advertiser;
- Macarthur Chronicle;
- Camden Advertiser;
- Wollondilly Advertiser;
- South Western Rural Advertiser;
- The Sun-Guardian;
- Penrith City Star;
- Penrith Press;
- Liverpool Leader; and
- Liverpool City Champion.

During initial consultation affected parties will be supplied an information leaflet providing project contact details, emergency services numbers, general project information and details of the traffic implications due to the construction works.

8.9. Safeguards and Overall Mitigation Measures

8.9.1. Managing Risks and Approvals

Risks associated with traffic management are typically managed by ensuring that no activity commences on site that has an effect on traffic without an approved Road Occupancy Licence (ROL). In addition, it should be ensured that all work on site occurs in accordance with the relevant CTMP, Traffic Control Plan (TCP) and associated ROL. Safeguards in place at work sites typically include barriers, signage, beacons and traffic controllers.

8.9.2. Traffic Control Plans (TCPs)

8.9.2.1. Preparation and Implementation of TCPs

All TCPs to be used during the construction activity will be developed in accordance with Australian Standard 1742.3 and the RTA's *Guide to Traffic Control at Work Sites* by a suitably qualified person.

A TCP can only be prepared by a person who has undertaken and successfully passed the RTA's *Traffic Control at Work Sites Manual* training course and holds a current certification.

Relevant reference documents include:

- Australian Standard AS1742.3 – 2009, *Manual of uniform traffic control devices – Traffic control for works on roads.*
- Roads and Traffic Authority NSW, *Guide to Traffic Control at Work Sites*, Version 4 (2010).
- Roads and Traffic Authority NSW, *QA Specification G10 Control of Traffic,* Edition 4 / Revision 2 (2005).
- Austroads, *Guide to Traffic Management Part 3: Traffic Studies and Analysis* (2009).

All work sites and TCPs will be implemented as per the authorised TCP for the appropriate stage of works by suitably qualified personnel.

8.9.2.2. Inspection of Roadwork Traffic Schemes

The requirement to inspect traffic control schemes is stipulated in Section 6 of the RTA's *Guide to Traffic Control at Work Sites* and Appendix A of Australian Standard 1742.3. There are three main types of inspection:

- Pre-start and pre-closedown inspections of short-term traffic control.
- Weekly inspections of long-term traffic control.
- Night inspections of long-term traffic control.

The checklist provided in the RTA's *Guide to Traffic Control at Work Sites* is generic and can be used for all three types of inspection.

The responsibility and frequency of inspections is clearly stipulated in Section 6.1 of the RTA's *Guide to Traffic Control at Work Sites* and is summarised in **Table 7-1**.

- **Table 7-1: TCP inspections**

Inspection type	Responsibility	Frequency
Pre-start and pre-finish	Works supervisor	Daily
Weekly audit	Site supervisor	Twice a week
Night audit	Site supervisor	Once a week
Pre-opening	Traffic engineer	Prior to opening any new temporary roadwork site or major adjustment

8.9.3. Road Occupancy Licence (ROL)

A ROL authorises the occupation of a portion of the road that would normally be available to traffic. Except in the case of an unplanned incident, or when directed by the police or other emergency services, a ROL must be obtained for any work which:

- Slows, stops or otherwise delays or affects the otherwise normal flow of traffic;
- Diverts traffic from its normal course along the road, including lane closures and detours; and
- Occupies any portion of the road related area, including the footpath that is normally available for motorised, pedestrian or bicycle movement.

Applicants are required to prepare submissions for ROLs and complete the RMS's application form.

Applications for ROLs should be submitted to the RMS and either Camden Council or Liverpool City Council at least ten working days prior to the proposed occupancy. The RMS and / or Council will grant or reject the application within this period.

Traffic control arrangements must provide sufficient capacity to accommodate the expected traffic volumes during the period of occupancy. The RMS and / or Council will not grant approval for those activities that will not satisfy this requirement.

9. Summary

This traffic and transport assessment forms part of the REF. The purpose of this assessment is to determine the operational and construction impacts of the proposed upgrade. From the existing traffic patterns and characteristics determined for this study, it was found that The Northern Road was operating with a satisfactory level of service during both the AM and PM peak periods.

The study area population and employment are expected to grow by 7% - 8% per annum compounded from 2011 to 2036. The substantial growth and development of Oran Park alongside The Northern Road will result in reduced accessibility especially during peak periods. From the analysis undertaken of the existing traffic and transport network, and adopting the forecast 2016 traffic demand, it is evident that there is a critical deficiency in road network capacity.

In 2016, prior to full 4-lane widening, the sections of The Northern Road between the Bringelly Road and Mersey Road intersections are likely to remain in their existing lane configuration and intersection layouts. The remainder of the corridor is likely to be progressively upgraded to a four lane divided carriageway configuration.

In 2026, the sections of The Northern Road between the Badgerys Creek Road and Mersey Road intersections are likely to remain in their existing lane configuration and intersection layouts. The remainder of the corridor is to be progressively upgraded to a four lane divided carriageway configuration.

In 2036, the sections of The Northern Road between the Badgerys Creek Road and Mersey Road intersections are likely to be upgraded to a four lane divided carriageway configuration. The remainder of the corridor will be progressively upgraded to a six lane divided carriageway configuration.

The proposed upgrade of The Northern Road will provide extra capacity and will improve traffic conditions across the corridor. Traffic from east of Bringelly Road will also distribute to Jersey Road taking advantage of this Transit Boulevard. In the analysis, forecast flows from the SATURN model showed that The Northern Road will operate at level of service D or better during peak periods in 2016, 2026 and 2036 when calculated at both midblock locations and its intersection with the adjacent road network.

A preliminary Construction Traffic Management Plan (CTMP) addresses the potential impacts of works related to the upgrade of The Northern Road, and details the proposed traffic management measures for the maintenance of two-way traffic operations and access to adjoining roads during construction.