Traffic Impact Assessment

Subdivision under approved Planning Proposal at 60-80 Southern Cross Avenue & 45-65 Hall Circuit Middleton Grange

Reference: 16.068r04v01 TRAFFIX TIA Report
Date: September 2017

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Document Verification

Job Number:	16.068
Project:	60-80 Southern Cross Avenue & 45-65 Hall Circuit, Middleton Grange
Client:	Manta Group Pty Ltd

Revision	Date	Prepared By	Approved By	Signature
v01	22/09/2017	MEHRDAD SHARIAT	MEHRDAD SHARIAT	

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Contents

Appendices

1. Introduction

A Planning Proposal has been approved for the Middleton Grange Town Centre, based on a concept plan as adopted in the Planning Proposal. Specifically, the APP Planning Proposal was completed in November 2015 along with a traffic report regarding the transport aspects of the planning proposal for the Middleton Grange Town Centre. This proposal was revised in April 2017 to address issues raised in relation to the study. The planning proposal relates to retail / commercial premises plus residential apartments and includes the realignment of the local road network and lot layout within the subject site.

Following this planning proposal approval, TRAFFIX has been commissioned by Manta Group Pty Ltd to undertake a Traffic Impact Assessment using Aimsun modelling in support of a subdivision at 60-80 Southern Cross Avenue & 45-65 Hall Circuit, Middleton Grange. The Planning Proposal has been submitted to Liverpool Council and is presently with the Department of Planning and Environment for Gateway Determination. The development is located within the Liverpool Council Local Government Area (LGA) and has been assessed under the Council's control. The site is zoned part B2 Local Centre, R1 General Residential, RE1 Public Recreation and SP2 Drainage and comprises an area of approximately 7.9 hectares.

This application relates to the subdivision of the site for a Town Centre comprising 912 residential units, 20,240m^2 GLA of retail area and 2,533m^2 GFA of commercial area. These are 'nominal' areas within the indicative concept plan that has been adopted for the purpose of assessing traffic impacts. This assessment has been undertaken to determine what infrastructure is required to support the planning proposal, in the knowledge that staged development would occur later; and subject to development applications. At that time, more detailed traffic investigations would be required, with this Planning proposal report providing the appropriate strategic traffic planning framework.

An Aimsun microsimulation model has been developed in response a request by both RMS and Liverpool City Council in a meeting dated 27 February 2017. This model provides the basis of the traffic assessment. The scope and requirement of this traffic modelling were outlined by RMS during an inception meeting held on 29 March 2017. In this regard, a 'base case model' has been developed by TRAFFIX and has been reviewed and approved by RMS for use. The model used in this study therefore incorporates all RMS comments and advice received during this extensive review process.

This report documents the findings of our investigations and should be read in the context of APP Corporation *'Planning Proposal – Amendments to Liverpool Local Environmental Plan 2008'* (November 2015), the revised planning proposal (April 2017) and the Colston Budd Hunt & Kafes report entitled *'Transport Aspects of Planning Proposal for Middleton Grange Town Centre'* (June 2015). The latter report established recommendations in relation to the consideration of the LEP and DCP in regard to road network and transport outcomes.

The development (subdivision) is a major development as it consists of more than 300 residential dwellings and 4,000m^2 shops and commercial premises. It will therefore require formal referral to the Roads & Maritime Services (RMS) under the provisions of SEPP (Infrastructure) 2007.

2. Background

2.1 Location and Site

The site is situated approximately 500 metres west of the M7 Motorway Interchange with Cowpasture Road, seven (7) kilometres west of the Liverpool CBD and 40 kilometres south-west of Sydney CBD. The site comprises eight (8) lots including:

Lots 1, 2, 3, 4, 5, and 6 in DP 1207518;

Lot 1 in DP 1078564; and

Lot 12 in DP 1108343

The site is also referred to as 60-80 Southern Cross Avenue and 45-65 Hall Circuit, Middleton Grange. It is irregular in configuration and has an approximate area of 79,000m^2 with a 200 metre frontage to Southern Cross Avenue, a 150 metre frontage to Bravo Avenue and a 320 metre frontage to Flynn Avenue.

The majority of the site is vacant, with the exception of five residential dwellings. Three of the five dwellings are located along Southern Cross Avenue on the northern portion of the site and the other two residential dwellings are located along Flynn Avenue within the southern boundary of the site.

A Location Plan is presented in **Figure 1**, with a Site Plan presented in **Figure 2**. Reference should also be made to the Photographic Record presented in **Appendix A**, which provides an appreciation of the general character of roads and other key attributes in proximity to the site.

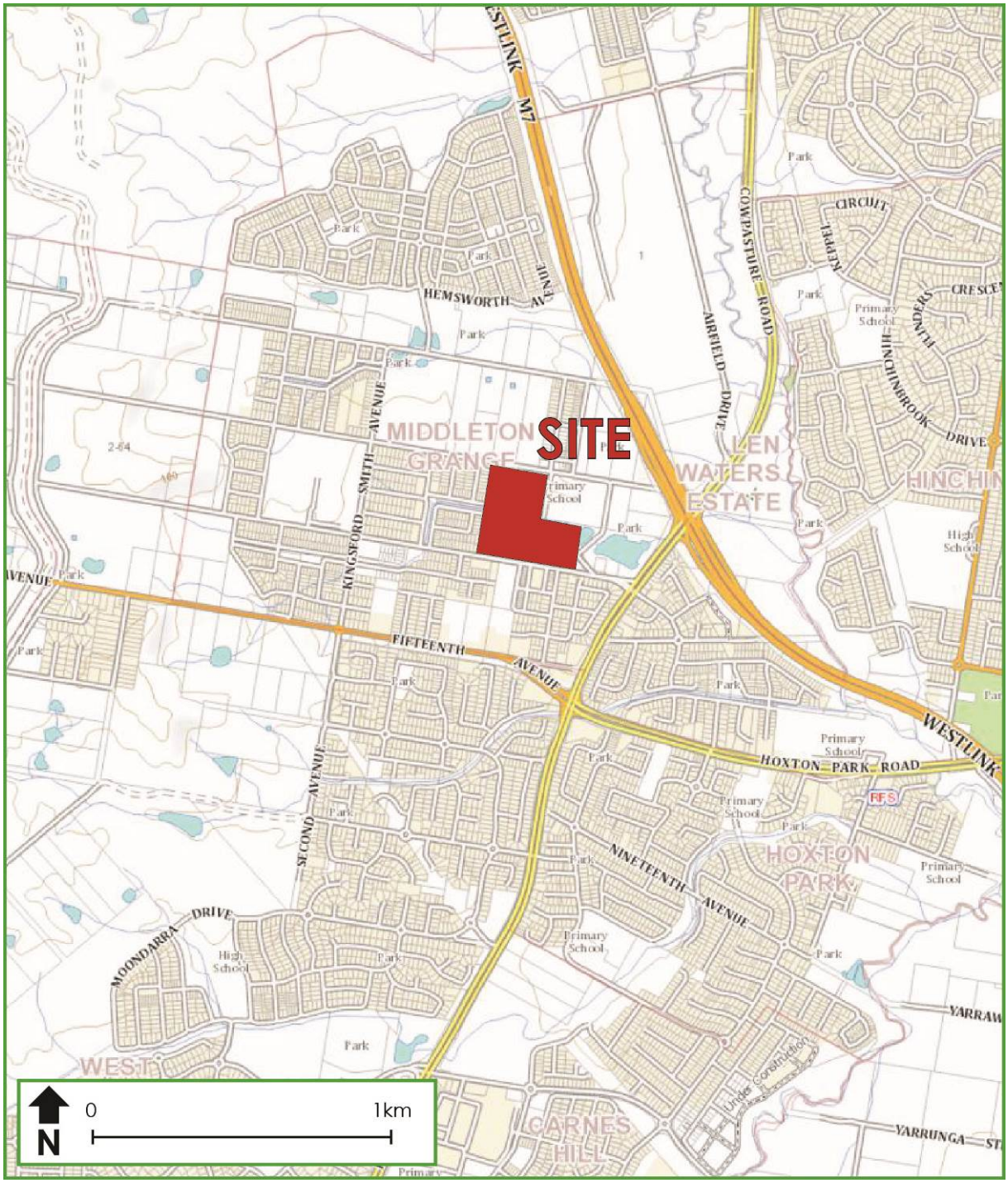


Figure 1: Location Plan

Figure 2: Site Plan

2.2 Overview Findings of the Planning Proposal

The APP Planning Proposal was completed in November 2015 along with a report regarding the transport aspects of the planning proposal for the Middleton Grange Town Centre. This proposal was revised in April 2017 to address issues raised in relation to the study.

Middleton Grange is to be rezoned to accommodate an urban town centre. The planning proposal relates to retail / commercial premises plus residential apartments and includes the realignment of the local road network and lot layout within the subject site.

Furthermore, two new roads traversing north-south are proposed, being Middleton Drive and Licata Avenue. These connect Southern Cross Avenue in the north with Flynn Avenue in south. An additional road (extension of Qantas Boulevard) will connect to Middleton Drive, traversing adjacent to the southern boundary of Middleton Grange Public School. This road will utilise the existing alignment of Hall Circuit and connect with Flynn Avenue. A detailed description of the proposed road network is provided in Section 4.

This subdivision is consistent with the Planning Proposal and is intended to deliver the concept plan as adopted in the planning proposal.

3. Existing Traffic Conditions

3.1 Road Network

The existing road hierarchy in the vicinity of the site is shown in **Figure 4,** with the following roads of particular interest:

- M7 Motorway (Westlink): a motorway that generally traverse north-south and provides 40 kilometres of uninterrupted stretch between Baulkham Hills in the north to Dean Park in the West and Prestons in the south. It carries 150,000 vehicles per day (vpd) on average. The road is subject to a 100 km/h speed zoning and connects to Motorway M2 and Motorway M5. M7 Motorway generally carries two lanes of traffic in either direction along a divided carriageway.

- Cowpasture Road: an RMS Main Road (MR 648) that runs in a north-south direction between The Horsley Drive in the north and Camden Valley Way in the south. Cowpasture Road carries approximately 27,000 vehicles per day within the vicinity of the site with 'No Stopping' restrictions applying along its length at all times. It is subject to a 70km/h speed zoning in the vicinity of the site and generally carries two lanes of traffic in either direction within a separated carriageway of width 30 metres.

- Fifteenth Avenue: a collector road that runs in an east-west direction between Cowpasture Road in the east and Ramsay Road in the west. It is subject to a 60km/h speed zoning. Fifteenth Avenue carries a single lane of traffic in each direction.

- Kingsford Smith Avenue: a local road that traverses north-south between Mclver Ave in north and Fifteenth Avenue in the south. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days. Kingsford Smith Avenue carries a single lane of traffic and kerb side parking in each direction with a carriageway of width 13 metres.

- Southern Cross Avenue: a local road that runs in an east-west direction between Hall Circuit in the east and De Garis Avenue in the west. It is subject to a 50km/h speed

zoning however, is also subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days. Southern Cross Avenue carries a single lane of traffic in each direction.

- Flynn Avenue: a local road that runs parallel to Southern Cross Avenue between Cowpasture Road in the east and De Garis Avenue in the west. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days (located near Kingsford Smith Avenue). This road is identified in the DCP as a neighbourhood centre street with a 26.7 metre reserve and 12.7 metre carriageway. Flynn Avenue carries a single lane of traffic and kerbside parking in either direction.

It can be seen from Figure 4 that the site is conveniently located with respect to the arterial and local road systems serving the region. It is therefore able to effectively access the arterial road network, minimising traffic impacts on local roads and residents / businesses in the vicinity of the site.

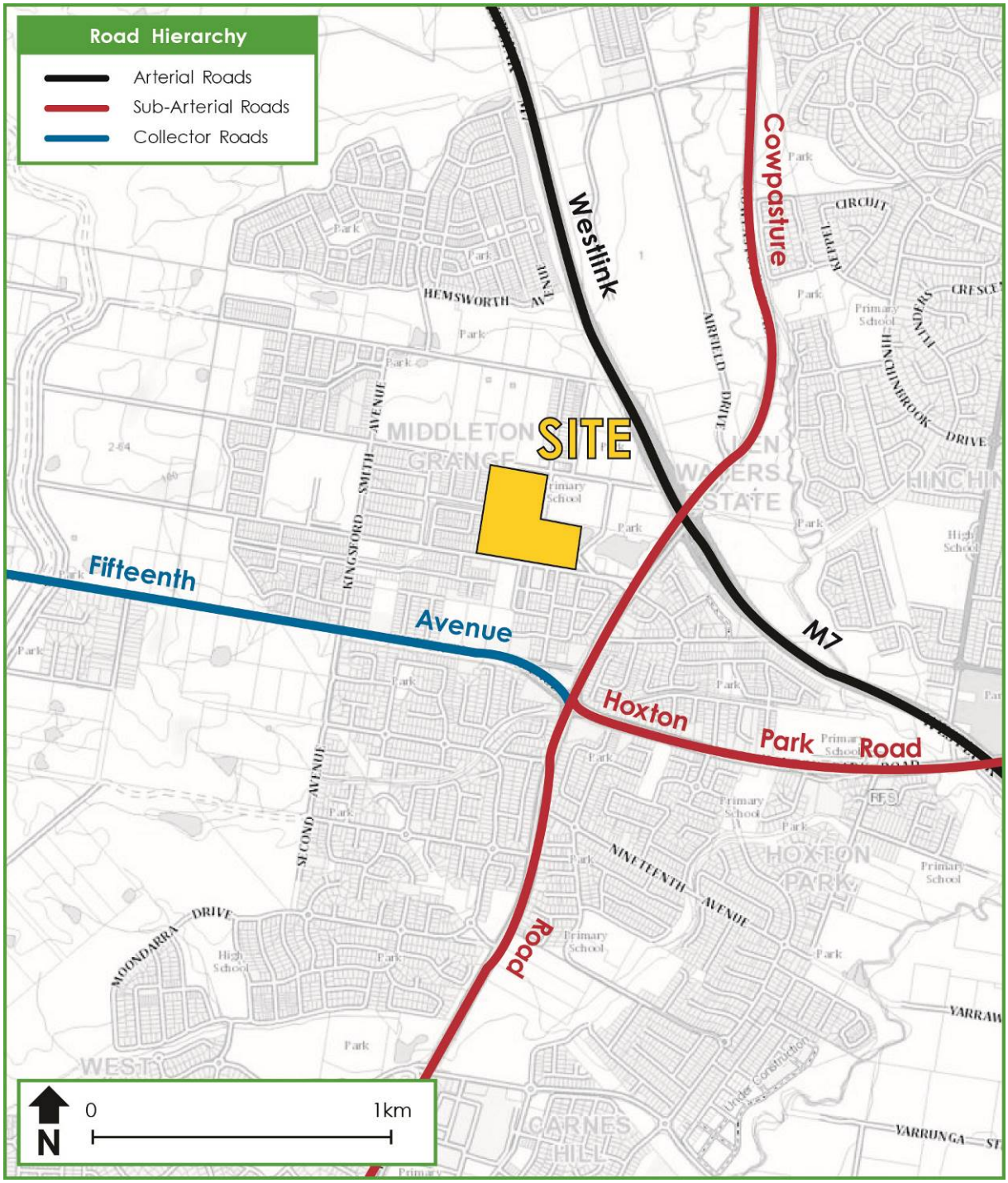


Figure 4: Existing Road Hierarchy

3.2 Public Transport

The existing bus service that operate in the locality is shown in **Figure 5**. It is evident that the development has limited public transport access with one bus service located within 400 metres of the site. Route 853 provides services between Carnes Hill Shopping Centre, Liverpool Westfield and Railway Station. Liverpool Train Station lies on the T2 Inner West & South Line, T3 Bankstown Line and T5 Cumberland Line. A description of the proposed Public Transport Network is provided in Section 4.

3.3 Existing Site Generation

The subject site accommodates five (5) dwelling houses. The RMS *Technical Direction TDT2013/04a* provides traffic generation rates for low density residential dwellings, and recommends an average Sydney based hourly trip generation rate of 0.99 vehicle trips per dwelling during the AM peak period and 0.95 vehicle trips per dwelling during the PM peak period. Application of these rates results in 5 vehicle trips during both the morning and evening peak periods.

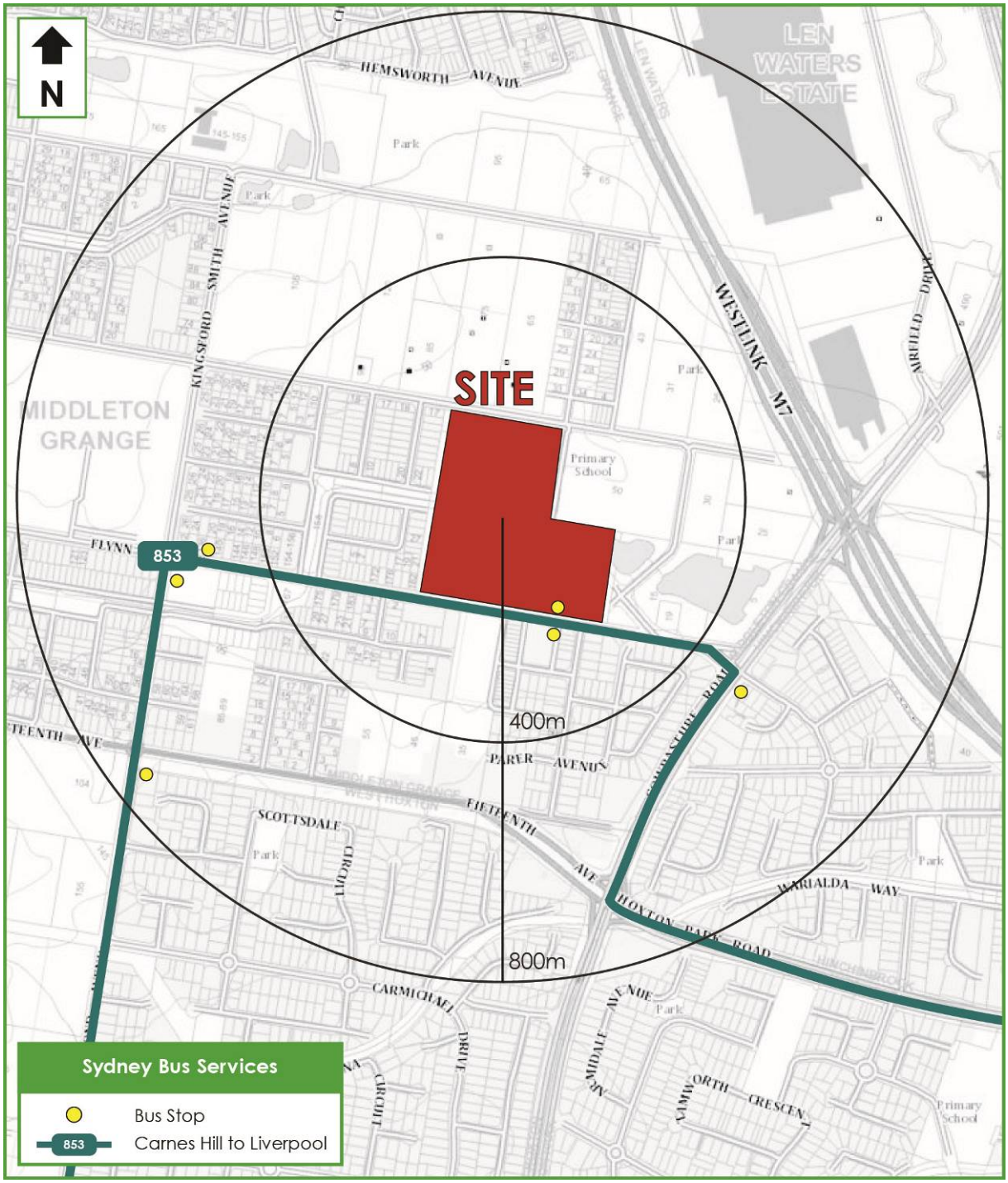


Figure 5: Existing Public Transport Services

4. Description of Proposed Development

4.1 Development Yield

A detailed description of the proposed development is provided in the Statement of Environmental Effects prepared separately. The overall development seeks to provide a wide range of land uses. For the purposes of this assessment, the following indicative yields have been adopted:

- Construction of a town centre which includes:
  - 20,240m^2 GLA of retail; and
  - 2,533m^2 GFA of commercial.
- A total of 912 high density residential units.

There is potentially scope for a range other land uses within the Precinct, including a community facility, childcare, public park area, passive open space and recreation facilities. However, for the purposes of this study, it is generally assumed that these uses will be ancillary to the overall development. For example, any public park area within the site would be expected to primarily cater for individuals in the immediate locality including the demands generated by the future residential and employee populations of the subject site. That is, these trips are to a very significant extent 'internalised' within the Town Centre.

The traffic impacts of the proposed development are discussed in Section 5. Reference should be made to the architectural plans submitted separately to Council, which are presented at reduced scale in **Appendix B**.

4.2 Access and Internal Road Arrangements

The locations and alignments of proposed Roads can be seen in **Figure 6**. The traffic facilities proposed with regards to these three roads and are generally consistent with the planning proposal approval and are discussed below.

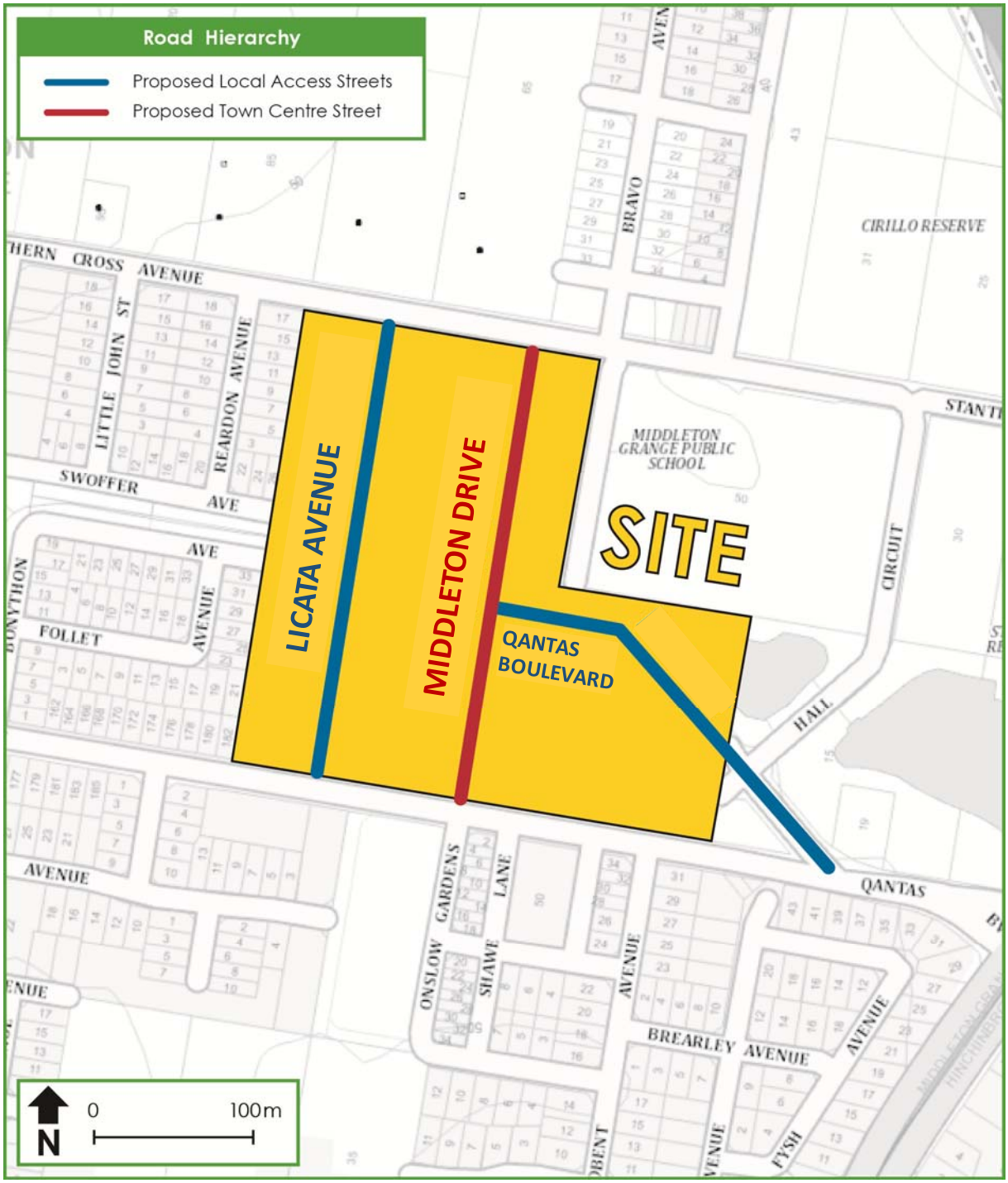


Figure 6: Proposed Road Hierarchy

Middleton Drive:

- Middleton Drive added to the existing intersection of Flynn Avenue and Onslow Gardens. Vehicles exiting Middleton Drive will be subject to Give Way control.
- A new intersection of Middleton Drive and Southern Cross Avenue with vehicles exiting Middleton Drive subject to Give Way control.
- Middleton Drive is proposed to be a 21.4 metre wide reserve which includes a single lane of traffic, a lane for kerbside parking and 4.0 to 4.5 metre verges on each side.

Licata Avenue:

- A new intersection of Road 4 and Flynn Avenue with vehicles exiting Road 4 subject to Give Way control.
- A new intersection of Road 4 and Southern Cross Avenue with vehicles exiting Road 4 subject to Give Way control.
- Road 4 is considered as a local access type 2 street with a 17.4 metre reserve which includes 9.4 metre carriageway with four metre verges.

Qantas Boulevard:

- Qantas Boulevard is proposed as a local access street type 1 with a 15.2 metre reserve which includes 7.2 metre carriageway and four metre verges.
- Bravo Avenue is located on the western side of the primary school (eastern side of the site) and would connect with Southern Cross Avenue / Hall Circuit and Qantas Boulevard. It provides a 13 metre reserve carrying a six metre carriageway and 3.5 metre verges.

4.3 Proposed Public Transport Routes

The Liverpool City Council DCP (2008) supplies proposed future bus routes for the land subdivision and development in Middleton Grange. It is noted that the routes were proposed prior to the Indicative Road Layout Plan provided in the Planning Proposal for 60-80 Southern Cross Avenue & 45-65 Hall Circuit, Middleton Grange. The indicative Road Layout Plan has been provided in Figure 6 and Appendix B. After matching routes within DCP and proposed road network the indicative public transport routes in **Figure 7** are included in traffic models and used in option assessment.

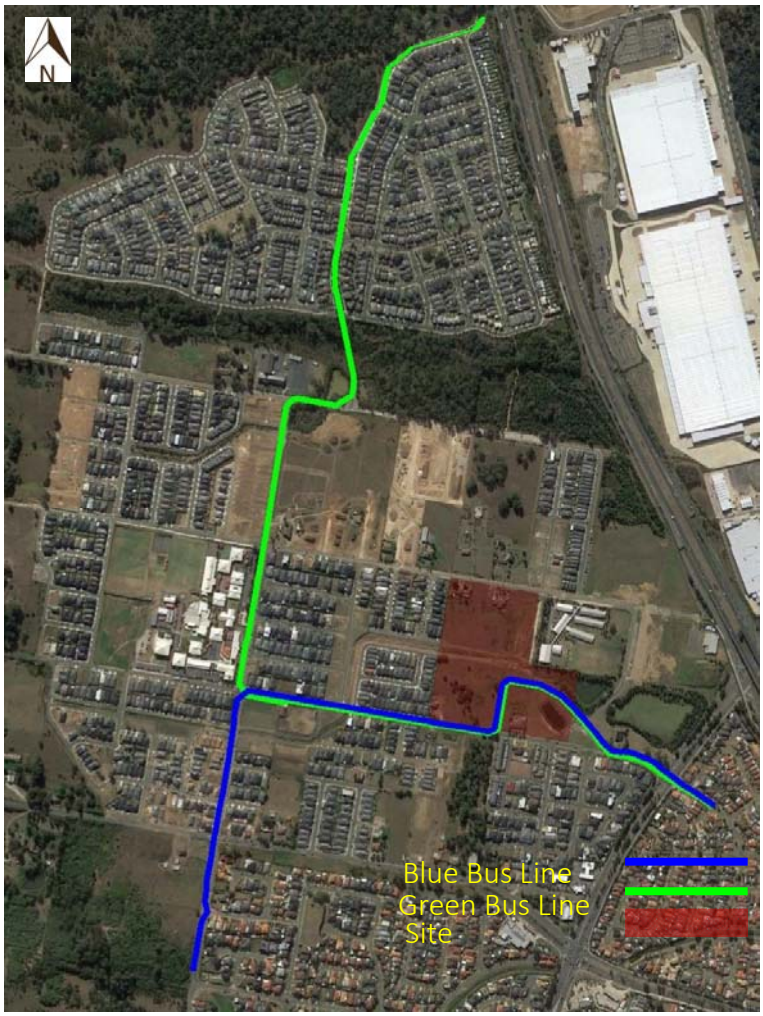


Figure 7: Proposed Public Transport Routes

5. Traffic Impacts

5.1 Methodology

Following development of the Base Case Model as now approved by RMS, the assessment has involved the following methodology:

- Determine indicative traffic generation and distribution based on land use assumptions;
- Growth rates to be adopted have been established from outputs of the Sydney strategic model and 2026 EMME2 data provided by the RMS;
- Identify potential access options, subject to spatial considerations and known design parameters;
- Undertake traffic modelling of key surrounding intersections and links within the study area; and
- Identify network improvements that are required in support of the subdivision, noting that these will be subject to further detailed analysis as part of the ongoing development assessment process, as well as the deliberations of a Working Group appointed by Liverpool City Council)

The impacts have been assessed using a microsimulation model, as required by RMS in the meeting dated February 2017. During the inception meeting dated 29 March 2017, the scope and requirements of the traffic modelling were identified. Subsequently, the Base Case model was developed by TRAFFIX (Appendix C) and has been reviewed and approved by RMS, following an extensive internal review process with RMS. The model therefore incorporates all RMS requirements and in particular, the Base Case Model (existing conditions) is appropriate as the basis for future development scenarios. The following scenarios are included within the scope of option assessment:

- Existing Base Case (model approved by RMS)
- Existing Base Case + Growth,
- Existing Base Case + Growth + Network Improvements,
- Existing Base Case + Growth + Development + Network Improvements,
- Existing Base Case + Development + Partial Network Improvements.

5.2 Study Area for Option Assessment

The study area for the option assessment using Aimsun model will generally be confined within Middleton Grange, with the following roads / streets included in the assessment:

- Cowpasture Road,
- Fifteenth Avenue,
- Kingsford Smith Avenue,
- Southern Cross Avenue,
- Sixteenth Avenue (Flynn Avenue), and
- Bird Walton Avenue.

A Study Area Plan and its relationship to the site is presented in **Figure 8**.

Figure 8: Study Area for option assessment based on developed microsimulation model

5.3 Modelling Assumptions

The Development of the Base Case Traffic Model used or this study (including data sources) includes model calibration and validation and this is explained in a separate report prepared by TRAFFIX (**Appendix C**). The application of changes to the base case model for the purpose of option assessment is premised on a range of assumptions related to trip generation, trip distribution and background traffic growth and these are discussed below.

5.3.1 Traffic Generation Rates

The trip rates adopted in this study were discussed during an inception meeting with RMS and Councils. These rates are generally higher than the typical rates provided in RMS *Guide to Traffic Generating Developments* and updated *Technical Direction 04a*, which reflects consideration of the presently limited operation of public transport within the subject site. This is therefore a worst case scenario, particularly in the long term when improved public transport services would be expected tom be delivered. A summary of the adopted traffic generations for the various land uses is provided in **Table 1** below.

Table 1: Adopted Traffic Generation Rates

Land Use	AM Peak			PM Peak		
	Traffic Generation Rate	IN	OUT	Traffic Generation Rate	IN	OUT
High Density Residential	0.4 / unit	20%	80%	0.4 / unit	80%	20%
Commercial	2 / 100m^2	80%	20%	1.6 / 100m^2	20%	80%
Retail	0.5 / 100m^2	80%	20%	6 / 100m^2	50%	50%

RMS Technical Direction 04a provides a traffic generation rate for high density residential developments of 0.19 veh/hr and 0.15 veh/hr during the AM and PM peaks respectively. The RMS rates were obtained from surveys conducted at eight separate locations within Sydney. It is noted that these locations surveyed were within close distance of ideal public transportation being near railway stations and a range of bus services. RMS Guide to Traffic Generating Developments for high density residential flat buildings in a metropolitan sub-regional centre also provides a traffic generation rate of 0.2 vehicle per hour. The trip rates adopted in this study, presented in table 2, ensure a worst case scenario, with a significant safety margin in relation to the road network performance.

5.3.2 Traffic Generation (Trips)

The future traffic generation associated with the site has also been assessed on the basis of the traffic generation rates outlined in the above, with the results summarised in **Table 2** below.

Table 2: Traffic Generation - Proposed Development

Land Use	No. / Area	Generation Rates		AM Peak			PM Peak		
		AM	PM	COMBINED	IN	OUT	COMBINED	IN	OUT
Residential	912	0.4 / unit	0.4 / unit	365	73	292	365	292	73
Commercial (GFA)	2,533	2 / 100m^2	1.6 / 100m^2	51	41	10	41	8	32
Retail (GLA)	20,240	0.5 / 100m^2	6 / 100m^2	101	81	20	1214	607	607
TOTAL				517	194	322	1620	907	713

Having regard for the above, the proposed development is expected to generate in the order of approximately 517 and 1,620 vehicles per hour during the weekday morning (AM) and evening (PM) peak periods, respectively.

5.3.3 Traffic Distribution

The relative distribution of 2011 Journey-to-Work (JTW) trips by car for areas in the vicinity of the site (for Travel Zones 3721 & 3722) has been used to determine the future distribution of traffic from the development onto the surrounding road network. This data is also combined with GIS maps to visualise the trip patterns according to 2011 surveys. Figure 9 and 10 shows desire line of trips after processing JTW data in GIS software. Figure 9 indicates where people who work in the area come from and Figure 10 shows where the employed residents of the area go to work. This trip pattern is combined with likely route choices of drivers to estimate percentage of trips associated with external traffic zones.

In this regard, the localised distribution of this traffic onto the surrounding road network is summarised in **Table 3** below. The distribution of trips associated with the retail component has been based on reasonable assumptions concerning the expected catchment area and this is a matter that will require closer assessment at development application stage.

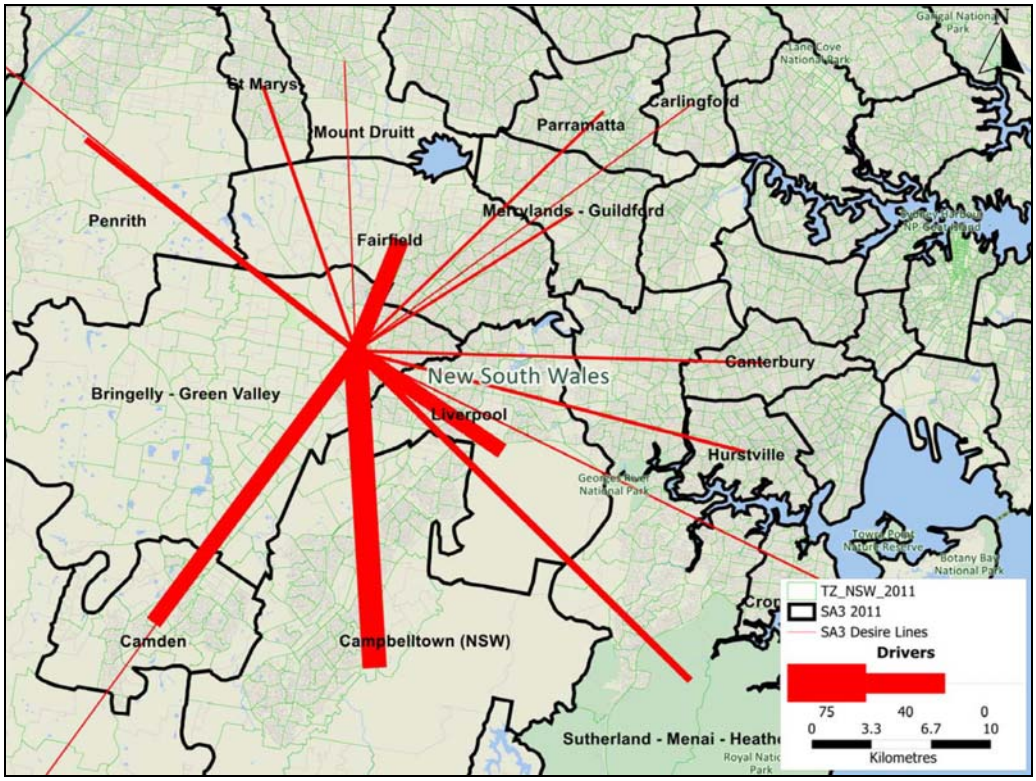


Figure 9: where people who work in of the area come from

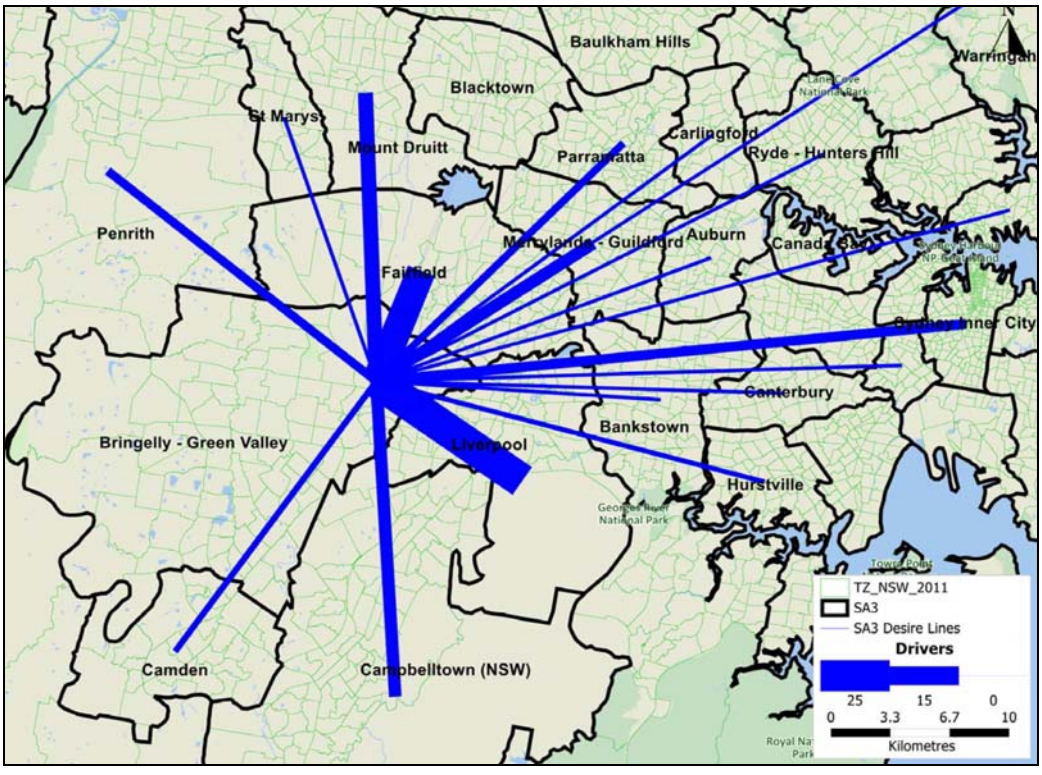


Figure 10: where the employed residents of the area go to work

Table 3: Traffic Distribution

Direction	Vehicles Percentage	
	Employed residents travelling to	Employed people coming from
M7 Ramp West	31%	7%
M7 Ramp East	14%	28%
Cowpasture Road South	21%	11%
Fifteenth Avenue West	20%	8%
Cowpasture Road North	14%	46%

It can be seen from Table 3 that much of the traffic generated by the development will be directed towards the east of the development site.

5.3.4 Background Traffic Growth

This study, in addition to assessing the impact of trips generated by the subject site, assesses the impact of potential background traffic growth for a 2026 scenario. To obtain future background traffic growth the outputs of future scenarios in the Sydney Strategic Transport Model were obtained.

It is noted that in the 2026 future scenario (based on EMME outputs from the Sydney strategic models provided for this study), Fifteenth Avenue is considered as a 6 lanes corridor (three-lanes in each direction) and Kingsford Smith Avenue is considered as a four-lane carriageway (two lanes in each direction) within the study area. In addition, in the 2036 scenarios, Cowpasture road is considered as a corridor with one additional through lane in each direction from M7 ramps to the south. While these currently uncommitted changes can significantly mitigate the traffic impacts of the subject site and accommodate traffic generated by the development, these corridor upgrades are not the subject of this study. However, the tested options in this report rely on committed projects as well as the potential network changes identified during the inception meeting. This report also examines partial improvements required to accommodate future traffic prior to full implementation of abovementioned corridor upgrades.

Using traffic volumes of 2016 and 2026 on Cowpasture Road and Sixteenth Avenue, the data shows 1.14% and 1.24% annual growth rate during AM peak and PM peak periods respectively. These

annual growth rates have been used for the future option assessments. Considering the fact that a number of key segments within existing road network are operating near or at capacity, this additional growth in itself will result in additional congestion and further delays, which require a strategic response from Government.

5.4 Measures of Effectiveness

To compare traffic scenarios, a range of traffic modelling outputs and microsimulation results are stored in the model output database and taken into consideration. In general, the outputs of microsimulation modelling have some differences with intersection analysis software and among the wide range of Measures of Effectiveness (MOEs), Total Travelled Time and Total Travelled Travel Distance are common measures which can summarise the overall traffic conditions on each microsimulation scenario. In this report the following measures are presented for each scenario:

Total Travelled Distance: total number of kilometres travelled by all the vehicles that have crossed the network.

Total Travelled Time: total travelled time experienced by all the vehicles that have crossed the network.

Speed: average speed for all vehicles that have left the system. This is calculated using the mean journey speed for each vehicle, produced by Aimsun, different from the ratio of the above measures.

Delay Time: average delay time per vehicle per kilometre. This is the difference between the expected travel time (the time it would take to traverse the system under ideal conditions) and the travel time.

Level of Service (LoS) based on Delay Time: this is a comparative measure which provides an indication of the operating performance of an intersection or each leg of an intersection. In this study the LoS at each leg of an intersection is calculated based on the delay occurring in the chain of connected sections to that approach. That is to avoid underestimation of delay when some sections are short and the congestion extend to next sections.

Table 4: LoS definition based on delay time

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals	Give Way and Stop Signs
A	less than 14	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 excessive delays. Roundabouts require other control mode	At capacity and requires other control mode
F	More than 70	Unsatisfactory and requires additional capacity.	Unsatisfactory and requires other control mode or major treatment.

The outputs in this study are provided based on the average statistics of runs for five standard random seeds, discussed in base case model development report (Appendix C).

5.5 Traffic Scenarios

The key components of each traffic scenario are the road network used in that scenario and the traffic demand assigned to the road network. The traffic demand assigned to the network can be any combination of the following items:

1. Existing Traffic Demand
2. Background Growth Traffic Demand
3. Development Traffic Demand

The assessed scenarios in Aimsun modelling are shown in **Table 5**. It outlines the network description and the traffic demand used for each of the modelled scenarios. **Table 6** also presents network changes and demand items used in each scenario in further details. Each of the above scenarios are assessed during each peak period.

Table 5: Scenarios modelled in Aimsun

Scenario No	Scenario Name	Network	Traffic Demand
1	Existing Base Case	Base network	Base Demand
2	Future Case, Do Nothing	Base network	Base Demand + Background Traffic Growth 2026
3	Future Case without Subject Development (Proposed Network in the absence of Development)	Future Network including the changes required to address traffic issues of Scenario 2	Base Demand + Background Traffic Growth 2026
4	Future Case with Subject Development (Proposed Option)	Preferred Future network: Changes in Scenario 3 +additional changes including access roads of development	Base Demand + Development Net Demand + Background Traffic Growth 2026
5	Partial Network Upgrade	A network with development access and partial upgrades required in the absence of background traffic growth	Future Network + Development Net Demand (No Background Traffic Growth)

Table 6: Road Network Changes

Model options			Scenario				
			1	2	3	4	5
Network Changes	1	Development Accesses				✓	✓
	2	Connection of Middleton Drive & Aviation Road under M7			✓	✓	✓
	3	Sixteenth Avenue with two-Lane signalised left turn to Cowpasture Road,			✓	✓	✓
	4	Conversion of Roundabout on Flynn Avenue to signalised intersection			✓	✓	
	5	Conversion of Roundabout on Fifteenth Avenue to signalised intersection			✓	✓	
	6	Two lane right turn from Fifteenth avenue to Cowpasture Road			✓	✓	
	7	No right turn from Flynn Avenue to Qantas Boulevard, except Buses			✓	✓	✓
	8	Three-Lane Cowpasture Northbound from Fifteenth Avenue to Airfield Drive			✓	✓	
	9	Three-Lane Cowpasture Southbound from M7 to Sixteenth Avenue			✓	✓	
	10	Two-Lane Eastbound at Sixteenth Avenue in the vicinity of the Site				✓	
Demand Items	1	Existing Demand	✓	✓	✓	✓	✓
	2	Future Background Growth (a 10 year growth)		✓	✓	✓	
	3	Development Demand				✓	✓

The location of changes on satellite images and modelled network maps are provided in section 5.5.6. The network-wide outputs for each scenario are presented as follows. In addition, a comparison of scenarios are provided at the level of intersections in section 5.5.7.

5.5.1 Scenario 1, Existing Base Case

The base network and observed traffic volumes form the existing base case scenario. This scenario is the one used in calibration and validation report. The congested areas of the existing network, identified during site inspections, are close to that simulated within this scenario. These areas are shown in **Figure 11**.

Figure 11: Existing Locations with Significant Traffic Congestion

The output database of the existing model as well as microsimulation animations show the following noteworthy items:

- The Road network segments along Cowpasture road northbound, between Fifteenth Avenue and Sixteenth Avenue, operates almost at capacity during the AM peak period. The model shows an average delay over 100 seconds per vehicle to pass this section during AM peak period. This is according to the model outputs at the level of road network sections which will be discussed in further details in section 5.5.7.

- The traffic queue along the abovementioned section extends to the south of Fifteenth Avenue. It also causes delay for right turn movements from Hoxton Park Road to Cowpasture Road northbound during AM peak period.

- Road network segment along Cowpasture Road southbound between Airfield Drive and M7 ramps provides limited capacity during PM peak period.

- Long queues on Sixteenth Avenue eastbound extends beyond its intersection with Hall Circuit during AM peak period.

- Roundabouts at Kingsford Smith Avenue experience congestion at some periods within the peak hours, resulting in traffic delays along Fifteenth and Sixteenth Avenue.

The road network performance statistics which are based on the existing demand are summarised in **Table 7** during AM (7:30 to 8:30) and PM peak (16:45 to 17:45). These outputs are the average statistics of runs for five standards random seeds, discussed in base case model development stage.

Table 7: Road Network statistics of Scenario 1

Network Statistics	AM	PM
Total travelled distance (km)	16832	14890
Total travelled time (hours)	532	416
Average Delay (sec/km)	54	35
Average Travel time (sec/km)	118	105
Average Speed (Km/hr)	35	37

As can be seen from Table 7, the existing network during the AM peak period experiences more delay than that of during PM peak period. The average speed also during the morning peak is less than that experienced during evening peak period.

5.5.2 Scenario 2, Do Nothing

On the condition that the future growth demand is assigned to the base network, it would form a Do-nothing scenario with no additional transport supply. In this scenario, the future growth explained in modelling assumptions has been added to traffic demand. This is a ten-year growth excluding trips generated by the subject development.

The road network performance statistics of this scenario is shown in **Table 8.**

Table 8: Road Network statistics of Scenario 2

Network Statistics	AM	PM
Total travelled distance (km)	16146	17485
Total travelled time (hours)	691	539
Average Delay (sec/km)	100	46
Average Travel time (sec/km)	163	116
Average Speed (Km/hr)	29	34

EX Net +BG Only, NDev

As can be seen from Table 8, the addition of background traffic growth results in more delays and lower speed within road network.

5.5.3 Scenario 3, Future Case without Subject Development

This Scenario includes network improvements to accommodate future background growth within the road network, prior to the addition of development demand. In other words, this scenario attempts to address the issues identified in existing and do nothing scenarios. This scenario includes the following changes on road network, shown in further details and separate figures in section 5.5.6:

- Connection of Middleton Drive & Aviation Road under M7,
- Sixteenth Avenue with two-lane signalised left turn to Cowpasture Road,
- Conversion of Roundabout at Kingsford Smith/ Fifteenth Avenue to a signalised intersection,
- Conversion of Roundabout at Kingsford Smith/ Flynn Avenue to a signalised intersection,
- Fifteenth Avenue with two lane right turn to Cowpasture Road,
- No right turn from Sixteenth Avenue (Flynn Avenue) to Qantas Boulevard, except Buses,
- Three-Lane Cowpasture Northbound from Fifteenth Avenue to above Airfield Drive, and
- Three-Lane Cowpasture Southbound from M7 to Sixteenth Avenue.

Signal phases, cycle time and offset times have been kept with no changes. However, there has been minor adjustment of signal timing according to the changes in traffic demand. The road network performance statistics of this scenario is shown in **Table 9.**

Table 9: Road Network statistics of Scenario 3

Network Statistics	AM	PM
Total travelled distance (km)	20294	17933
Total travelled time (hours)	612	552
Average Delay (sec/km)	55	48
Average Travel time (sec/km)	118	117
Average Speed (Km/hr)	34	34

Future Net +BG Only, NDev

As can be seen from Table 9, the network improvements introduced in this scenario results in better traffic conditions in comparison with Do-nothing scenario.

5.5.4 Scenario 4, Future Case with Subject Development (Preferred Option)

This scenario comprises changes on road network to address existing and future traffic issues when both traffic growth and development demand are added to the existing traffic demand. Much of these changes are related to Scenario 3 associated with background traffic growth. The road network within this scenario includes:

- All network improvements in Scenario 3;
- Addition of development access roads; and
- Two-Lane East Bound at Sixteenth Avenue (Flynn Avenue) in the vicinity of the Site

The changes on road network are shown in further details and in separate figures in Section 5.5.6. These figures compare the changes on the future network with the existing road network. The traffic demand assigned to the road network in this scenario includes all existing, future growth and development demand.

Table 10: Road Network statistics of Scenario 4

Network Statistics	AM	PM
Total travelled distance (km)	20996	20333
Total travelled time (hours)	656	712
Average Delay (sec/km)	59	64
Average Travel time (sec/km)	122	134
Average Speed (Km/hr)	33	31

Future Net + Dev + BG

As can be seen from Table 10, the network improvements introduced in this scenario results in better traffic conditions in comparison with Do-nothing scenario. The reduction of average network speed in this scenario in comparison with the previous scenario is to some degree the result of additional trips in new local roads. In other words, a significant part of the additional total travelled distance is occurring in local streets, giving lower average speed. This scenario has also addressed issues found in the Scenario 3 road network which is presented in Section 5.5.7.

5.5.5 Scenario 5, Partial Network Upgrade

This scenario assesses the impact of the existing demand together with development demand without future background growth. This separate scenario tests a road network with changes less significant than Scenario 3 and 4. The road network improvements in this scenario address some of existing traffic issues as well as potential impacts of the development. The changes of existing road network which are made in this scenario are as follows:

- Addition of development access roads
- Connection of Middleton Drive and Aviation Road under M7
- Sixteenth Avenue with two-Lane signalised left turn to Cowpasture Road,
- No right turn from Flynn Avenue to Qantas Boulevard, except Buses

The road network performance statistics of this scenario are shown in **Table 11.**

Table 11: Road Network statistics of Scenario 5

Network Statistics	AM	PM
Total travelled distance (km)	18235	17373
Total travelled time (hours)	602	554
Average Delay (sec/km)	59	48
Average Travel time (sec/km)	124	120
Average Speed (Km/hr)	33	33

Future_Min + Dev Only, NBG

Scenario 5 includes new local roads associated with the development and its traffic demand, resulting in the increase of total travelled distance and total travelled time, as shown in Table 11.

5.5.6 Comparison of future preferred scenario with existing base case scenario

The scenarios provided in this report identify potential network improvements to accommodate the additional demand derived from future growth as well as the traffic demand generated by the development. The network improvements provided in this study have been tested using the Aimsun Microsimulation model, to identify which changes are required to improve the traffic condition of the study area, with the objective of achieving lower delays for all the users on the road network.

In previous sections, the changes associated with each scenario as well as statistics showing road network performance were provided. However, **Figures 12** to **18 below** show further details related to the proposed road network in comparison with the existing road network. These figures also show the location of proposed network improvements on satellite images as well as existing and proposed road network within the Aimsun model.

Figure 12: Proposed Changes on Sixteenth Avenue / Cowpasture Road

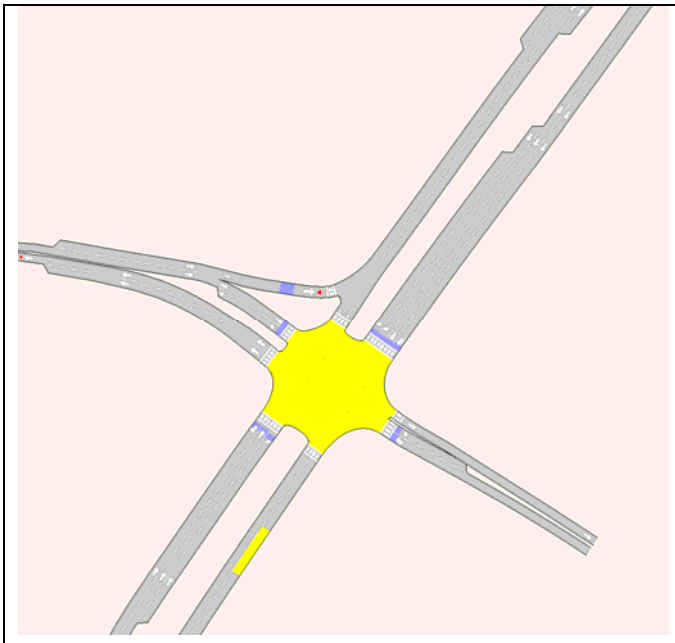


Figure 12a: Existing Road Network

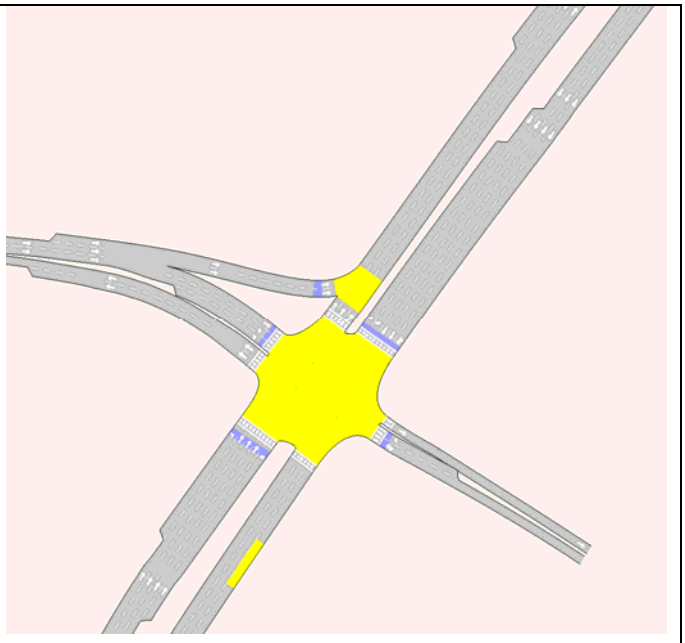


Figure 12b: Future Road Network

Figure 13: Proposed Changes on Fifteenth Avenue

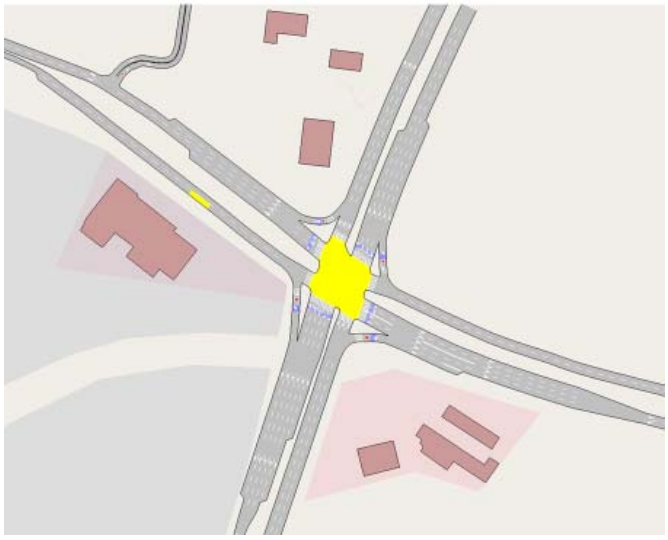


Figure 13a: Existing Road Network

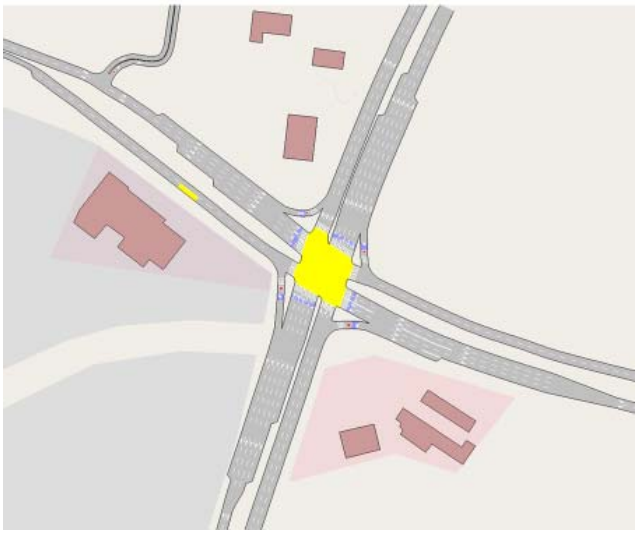


Figure 13b: Future Road Network

Figure 14: Proposed New Access Roads

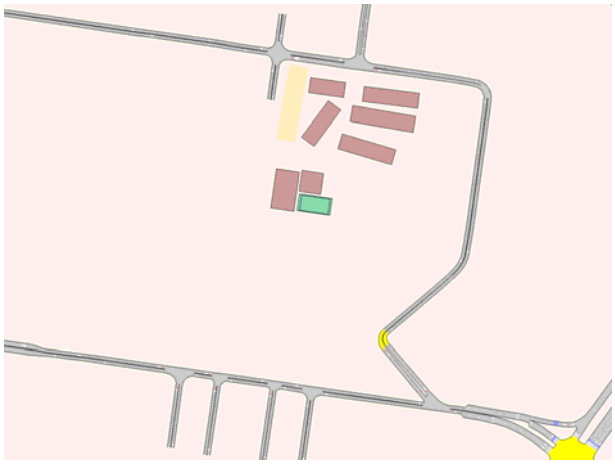


Figure 14a: Existing Road Network

Figure 14b: Future Road Network

Figure 15: Proposed Partial Widening of Flynn Avenue Eastbound

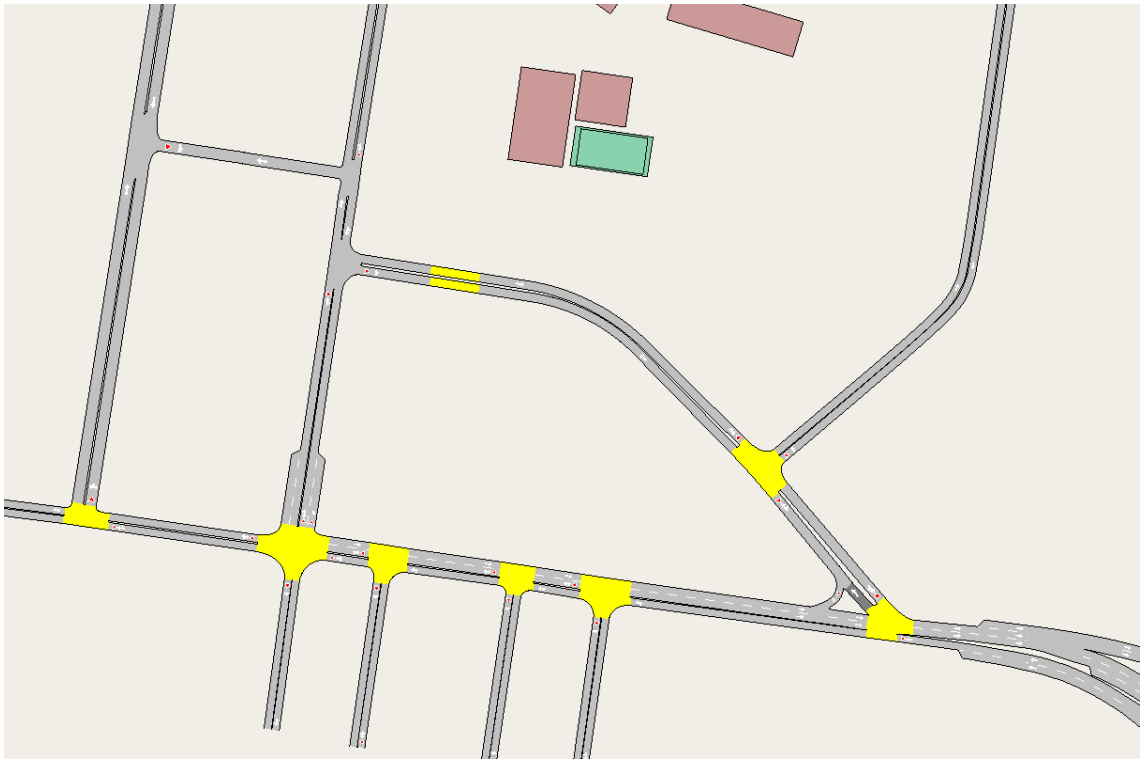


Figure 15a. Future Road Network with Partial Widening of Flynn Avenue Eastbound

Figure 16: Proposed Connection of Middleton Drive and Aviation Road Under M7

Figure 16a: Existing Road Network

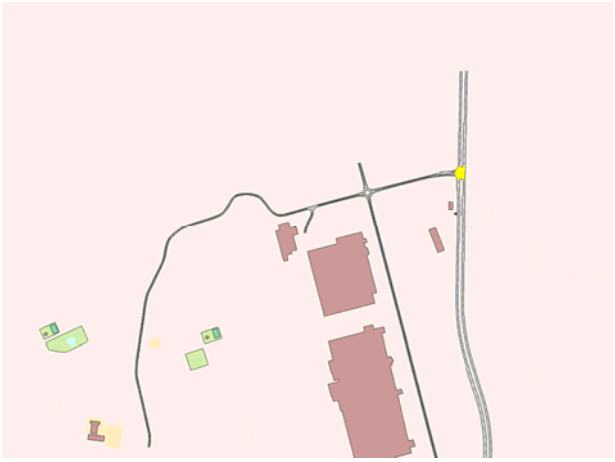


Figure 16b: Future Road Network

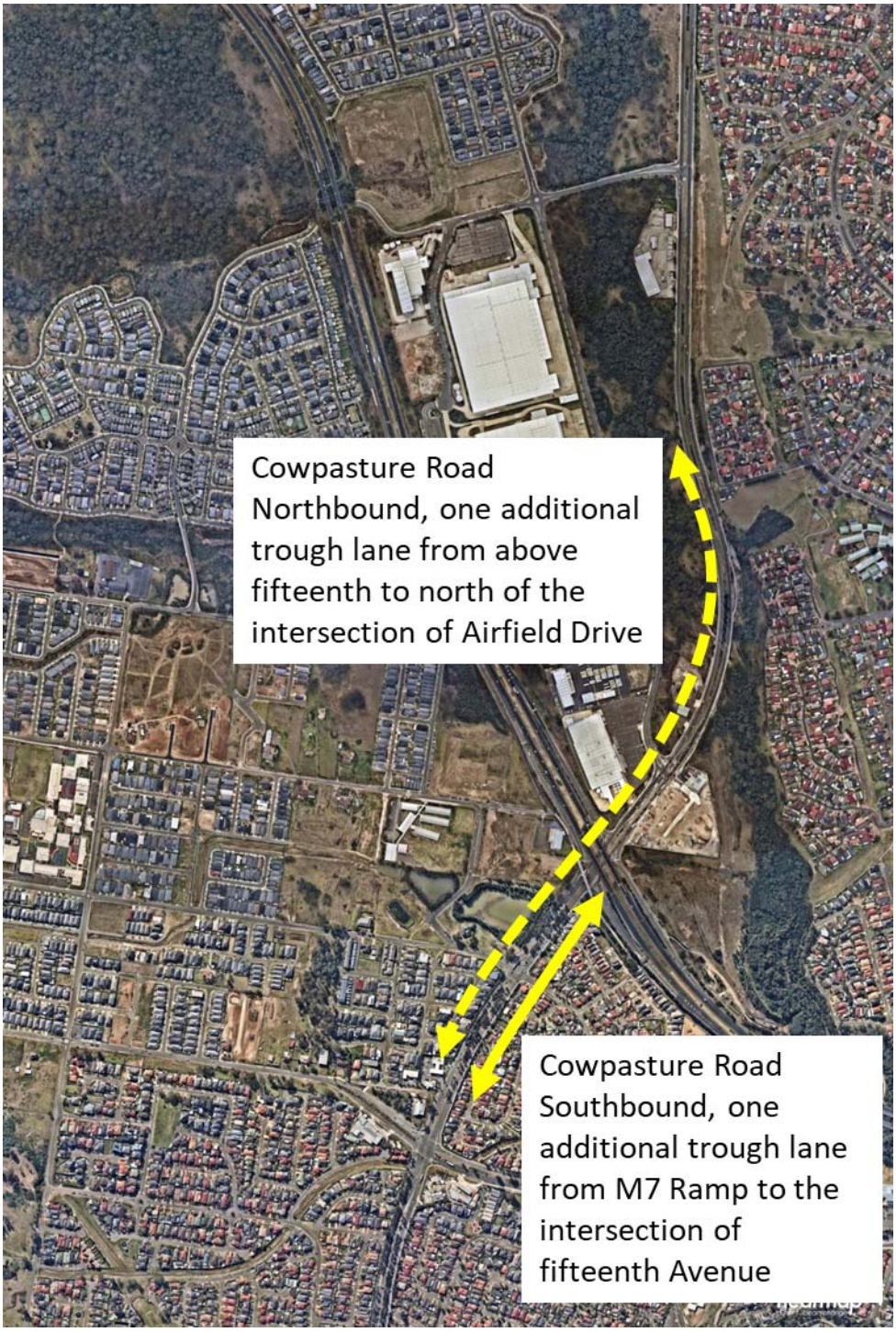


Figure 17: Proposed Changes on Cowpasture Road

Figure 17: Proposed Changes on Kingsford Smith/ Fifteenth Avenue

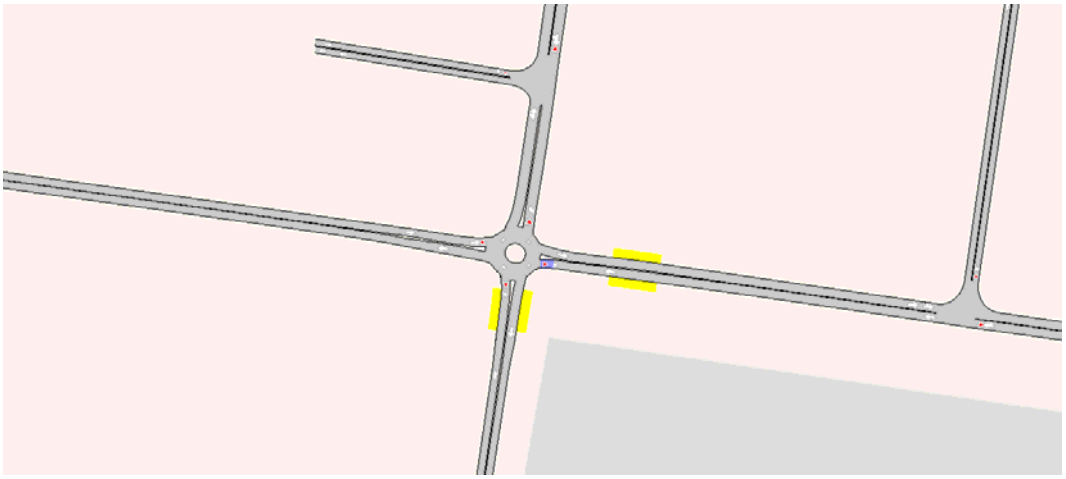


Figure 17a: Existing Road Network

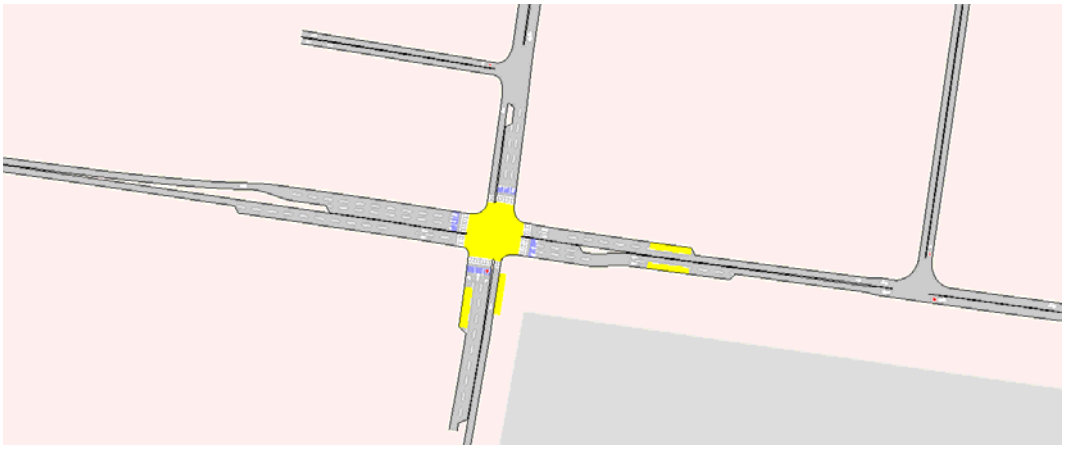


Figure 17b: Future Road Network

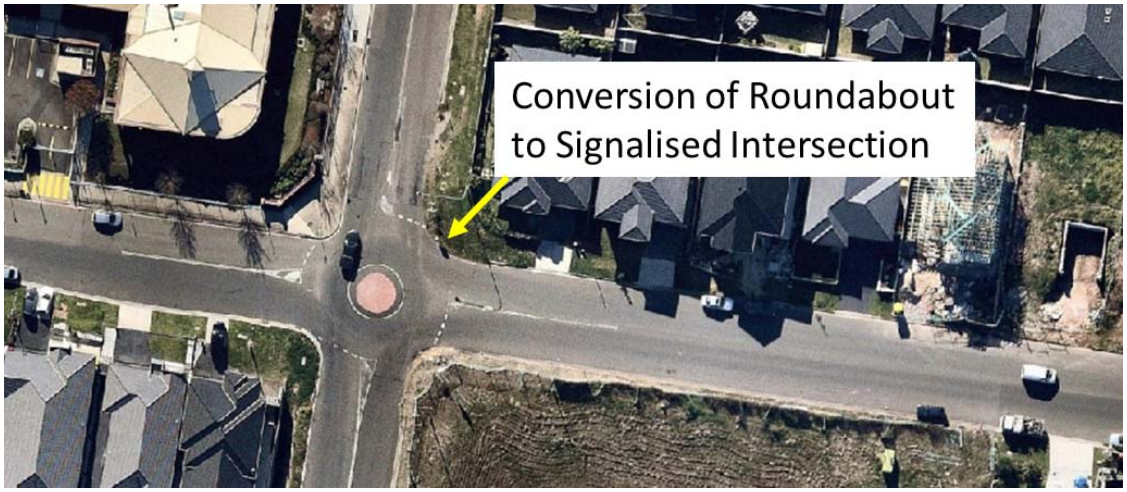


Figure 18: Proposed Changes on Kingsford Smith/ Flynn Avenue

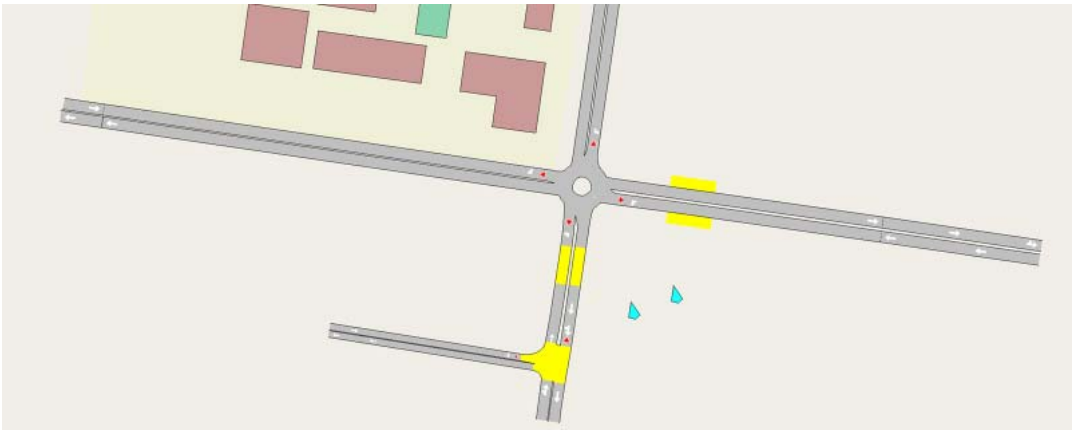


Figure 18a: Existing Road Network

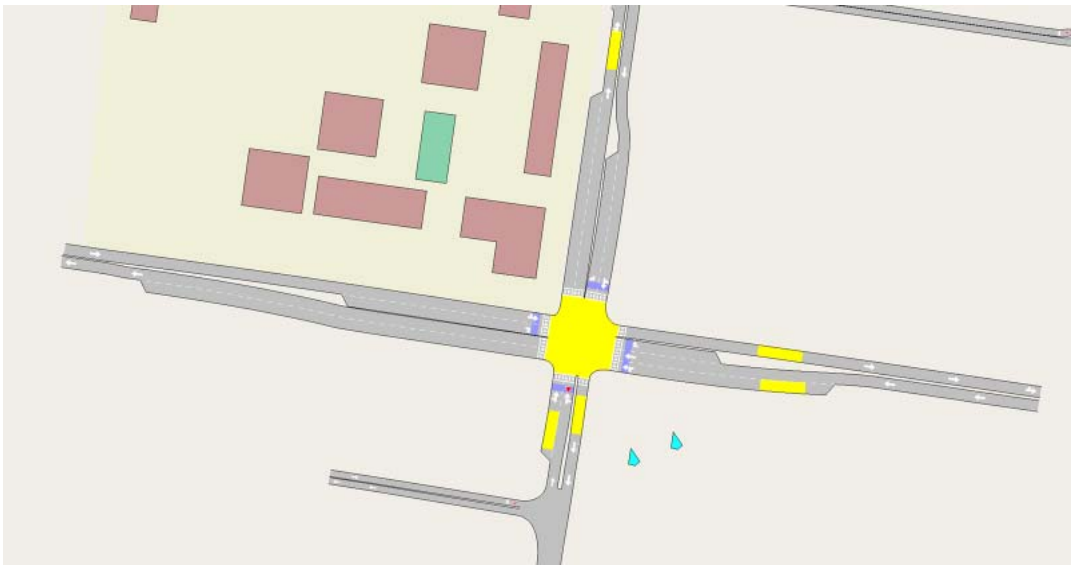


Figure 18b: Future Road Network

5.5.7 Comparison of Level of Services

Using the Aimsun model, the Level of Service (LoS) at different intersections has been calculated for different scenarios. In general, intersection performance has improved under Scenario 4. It has also been identified that the Do nothing condition (the existing road network) would lead to failure of the network during both AM and PM peak periods. The results of the intersection LoS during the AM and PM peaks are summarised in **Table 12** and **Table 13** respectively.

It should be noted that the average delay is calculated based on connected road sections when the sections immediate to the intersection is short or the travel time of connected sections are affected by the downstream intersection.

Table 12: AM Peak Hour- Intersection performance comparison

Intersection	Leg	Approach	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
			Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS
1. Cowpasture Road/ Flynn Avenue	Collarenebri Road	East	59.1	E	65.5	E	65.1	E	70.3	F	63.3	E
	Flynn Avenue	West	72.4	F	74.0	F	54.9	D	56.6	E	57.0	E
	Cowpasture Road	South	113.0	F	167.2	F	17.8	B	27.2	B	124.8	F
	Cowpasture Road	North	24.7	B	30.7	C	26.0	B	29.4	C	26.6	B
2. Cowpasture Road/ Fifteenth Avenue	Hoxton Park Road	East	122.3	F	514.9	F	43.2	D	42.5	D	151.4	F
	Fifteenth Avenue	West	42.1	D	44.0	D	41.8	C	40.6	C	41.3	C
	Cowpasture Road	South	49.3	D	148.6	F	90.2	F	92.4	F	48.3	D
	Cowpasture Road	North	27.7	B	31.4	C	29.5	C	33.4	C	29.4	C
3. Fifteenth Ave/ Kingsford Smith Avenue	Fifteenth Avenue	East	28.8	C	71.4	F	32.8	C	35.6	C	40.4	C
	Fifteenth Avenue	West	9.0	A	58.0	E	39.9	C	42.2	D	13.0	A
	Second Avenue	South	22.4	B	35.5	C	41.0	C	41.7	C	39.8	C
	Kingsford Smith Avenue	North	21.9	B	38.0	C	44.6	D	43.2	D	32.2	C
4. Flynn Ave/ Kingsford Smith Avenue	Flynn Avenue	East	17.4	B	146.7	F	30.3	C	33.4	C	34.5	C
	Flynn Avenue	West	6.4	A	11.1	A	33.0	C	35.6	C	5.6	A
	Kingsford Smith Avenue	South	15.9	B	3.5	A	25.6	B	26.3	B	5.0	A
	Kingsford Smith Avenue	North	5.1	A	25.6	B	32.6	C	33.8	C	8.2	A
5. Flynn Avenue/ Onslow Gardens	Flynn Avenue	East	0.5	A	4.4	A	0.5	A	6.0	A	3.5	A
	Flynn Avenue	West	0.9	A	2.6	A	0.8	A	1.0	A	1.7	A
	Onslow Gardens	South	5.9	A	34.7	C	8.0	A	10.9	A	3.8	A
6. Southern Cross Avenue/ Bravo Avenue	Southern Cross Avenue	East	0.1	A	0.5	A	0.1	A	0.0	A	0.0	A
	Southern Cross Avenue	West	0.2	A	0.2	A	0.2	A	0.3	A	0.5	A
	Bravo Avenue	South	-1.0	A	-1.0	A	-1.0	A	0.7	A	0.8	A
	Bravo Avenue	North	0.6	A	0.9	A	0.6	A	0.8	A	0.8	A

Intersection	Leg	Approach	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
			Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS
7. Southern Cross Avenue/ Kingsford Smith Avenue.	Southern Cross Avenue	East	5.4	A	4.5	A	7.6	A	6.0	A	6.6	A
	Southern Cross Avenue	West	2.1	A	2.1	A	2.7	A	3.3	A	3.8	A
	Kingsford Smith Avenue	South	3.6	A	3.9	A	4.0	A	3.6	A	4.0	A
	Kingsford Smith Avenue	North	1.3	A	1.3	A	1.6	A	1.7	A	1.7	A
8. Middleton Drive/ Bird Walton Avenue/ Mclver Avenue	Bird Walton Avenue	East	0.8	A	0.6	A	0.8	A	1.3	A	1.3	A
	Mclver Avenue	West	0.3	A	0.4	A	0.4	A	0.4	A	0.4	A
	Middleton Drive	North	0.7	A	0.6	A	0.8	A	0.9	A	1.0	A
9. Cowpasture Road/ M7 Ramps	M7 Ramps	East	63.8	E	57.6	E	57.7	E	57.5	E	60.1	E
	M7 Ramps	West	63.7	E	60.0	E	56.1	E	56.1	E	58.3	E
	Cowpasture Road	South	9.5	A	11.6	A	8.3	A	9.2	A	11.7	A
	Cowpasture Road	North	22.8	B	24.8	B	24.5	B	24.7	B	24.3	B
	Cowpasture Road	North	22.8	B	24.8	B	24.5	B	24.7	B	24.3	B
10. Cowpasture Roads/ Airfield Drive	Airfield Drive	West	55.8	D	57.9	E	56.2	E	56.1	E	56.1	E
	Cowpasture Road	South	1.9	A	2.2	A	1.4	A	1.4	A	2.0	A
	Cowpasture Road	North	7.9	A	9.5	A	8.5	A	8.6	A	7.4	A
11. Cowpasture Rd/ Aviation Road	Aviation Road	West	58.5	E	75.2	F	73.0	F	61.8	E	71.6	F
	Cowpasture Road	South	5.6	A	5.1	A	6.6	A	6.5	A	5.1	A
	Cowpasture Road	North	2.5	A	2.4	A	4.0	A	4.0	A	5.2	A

Table 13: PM Peak Hour- Intersection Performance Comparison

Intersection	Intersection Leg	Approach	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
			Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS
1. Cowpasture Road/ Flynn Avenue	Collarenebri Road	East	57.4	E	64.1	E	63.3	E	66.4	E	58.1	E
	Flynn Avenue	West	59.8	E	62.5	E	58.5	E	62.5	E	61.2	E
	Cowpasture Road	South	26.8	B	48.1	D	32.3	C	43.7	D	71.0	F
	Cowpasture Road	North	16.7	B	26.2	B	16.8	B	27.7	B	30.2	C
2. Cowpasture Road/ Fifteenth Avenue	Hoxton Park Road	East	41.1	C	41.8	C	39.9	C	39.9	C	41.3	C
	Fifteenth Avenue	West	44.3	D	54.3	D	45.1	D	43.3	D	44.0	D
	Cowpasture Road	South	32.5	C	51.5	D	39.6	C	42.1	D	48.1	D
	Cowpasture Road	North	27.6	B	25.6	B	34.4	C	53.7	D	36.0	C
3. Fifteenth Ave/ Kingsford Smith Avenue	Fifteenth Avenue	East	5.7	A	9.0	A	25.1	B	44.2	D	15.7	B
	Fifteenth Avenue	West	4.2	A	9.0	A	29.7	C	39.8	C	15.0	B
	Second Avenue	South	7.7	A	13.0	A	32.7	C	47.0	D	17.1	B
	Kingsford Smith Avenue	North	12.9	A	22.9	B	37.0	C	47.1	D	26.7	B
4. Flynn Ave/ Kingsford Smith Avenue	Flynn Avenue	East	5.9	A	8.5	A	30.0	C	39.2	C	12.9	A
	Flynn Avenue	West	2.9	A	2.9	A	24.7	B	40.5	C	4.6	A
	Kingsford Smith Avenue	South	6.7	A	4.0	A	24.4	B	26.9	B	4.4	A
	Kingsford Smith Avenue	North	2.8	A	1.9	A	25.2	B	41.9	C	4.0	A
5. Flynn Avenue/ Onslow Gardens	Flynn Avenue	East	0.5	A	0.5	A	0.5	A	7.0	A	3.2	A
	Flynn Avenue	West	0.4	A	0.4	A	0.4	A	1.1	A	1.3	A
	Onslow Gardens	South	7.3	A	9.4	A	13.9	A	4.9	A	5.8	A
6. Southern Cross Avenue/ Bravo Avenue	Southern Cross Avenue	East	0.0	A	0.1	A	0.0	A	0.3	A	0.0	A
	Southern Cross Avenue	West	0.4	A	0.3	A	0.2	A	0.9	A	0.8	A
	Bravo Avenue	South	-1.0	A	-1.0	A	-1.0	A	1.9	A	1.2	A
	Bravo Avenue	North	0.7	A	0.9	A	0.7	A	1.5	A	0.9	A

Intersection	Intersection Leg	Approach	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
			Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS	Average Delay	LoS
7. Southern Cross Avenue/ Kingsford Smith Avenue.	Southern Cross Avenue	East	1.4	A	2.5	A	6.8	A	8.2	A	5.9	A
	Southern Cross Avenue	West	1.2	A	1.2	A	2.2	A	5.9	A	4.1	A
	Kingsford Smith Avenue	South	3.0	A	3.1	A	3.5	A	4.7	A	3.2	A
	Kingsford Smith Avenue	North	0.7	A	0.8	A	1.2	A	1.5	A	1.2	A
8. Middleton Drive/ Bird Walton Avenue/ Mclver Avenue	Bird Walton Avenue	East	1.7	A	1.8	A	2.3	A	2.7	A	2.7	A
	Mclver Avenue	West	0.4	A	0.4	A	0.5	A	0.5	A	0.4	A
	Middleton Drive	North	1.0	A	1.1	A	1.1	A	6.6	A	2.7	A
9. Cowpasture Road/ M7 Ramps	M7 Ramps	East	51.6	D	53.0	D	52.6	D	52.6	D	51.9	D
	M7 Ramps	West	55.6	D	72.5	F	49.0	D	50.0	D	48.1	D
	Cowpasture Road	South	16.1	B	19.4	B	16.4	B	22.0	B	24.3	B
	Cowpasture Road	North	15.0	B	22.4	B	20.9	B	24.1	B	24.6	B
	Cowpasture Road	North	15.0	B	22.4	B	20.9	B	24.1	B	24.6	B
10. Cowpasture Roads/ Airfield Drive	Airfield Drive	West	51.1	D	49.1	D	49.7	D	48.8	D	48.3	D
	Cowpasture Road	South	11.3	A	12.6	A	14.1	B	10.6	A	10.6	A
	Cowpasture Road	North	12.2	A	25.7	B	18.8	B	20.4	B	16.4	B
11. Cowpasture Rd/ Aviation Road	Aviation Road	West	63.9	E	70.7	F	87.5	F	51.6	D	100.0	F
	Cowpasture Road	South	8.1	A	8.9	A	10.1	A	14.2	B	8.9	A
	Cowpasture Road	North	2.6	A	2.8	A	3.5	A	7.2	A	3.0	A

As presented in **Table 12** and **Table 13**, under Scenario 4 (preferred scenario), the implementation of the changes as proposed would generally improve LoS during both AM and PM peak periods when compared to the road network in either Base case or Do nothing scenarios.

6. Access & Internal Design Aspects

6.1 Access

Access to the site is proposed via four new intersections as shown in **Figure 19** and are discussed further below.

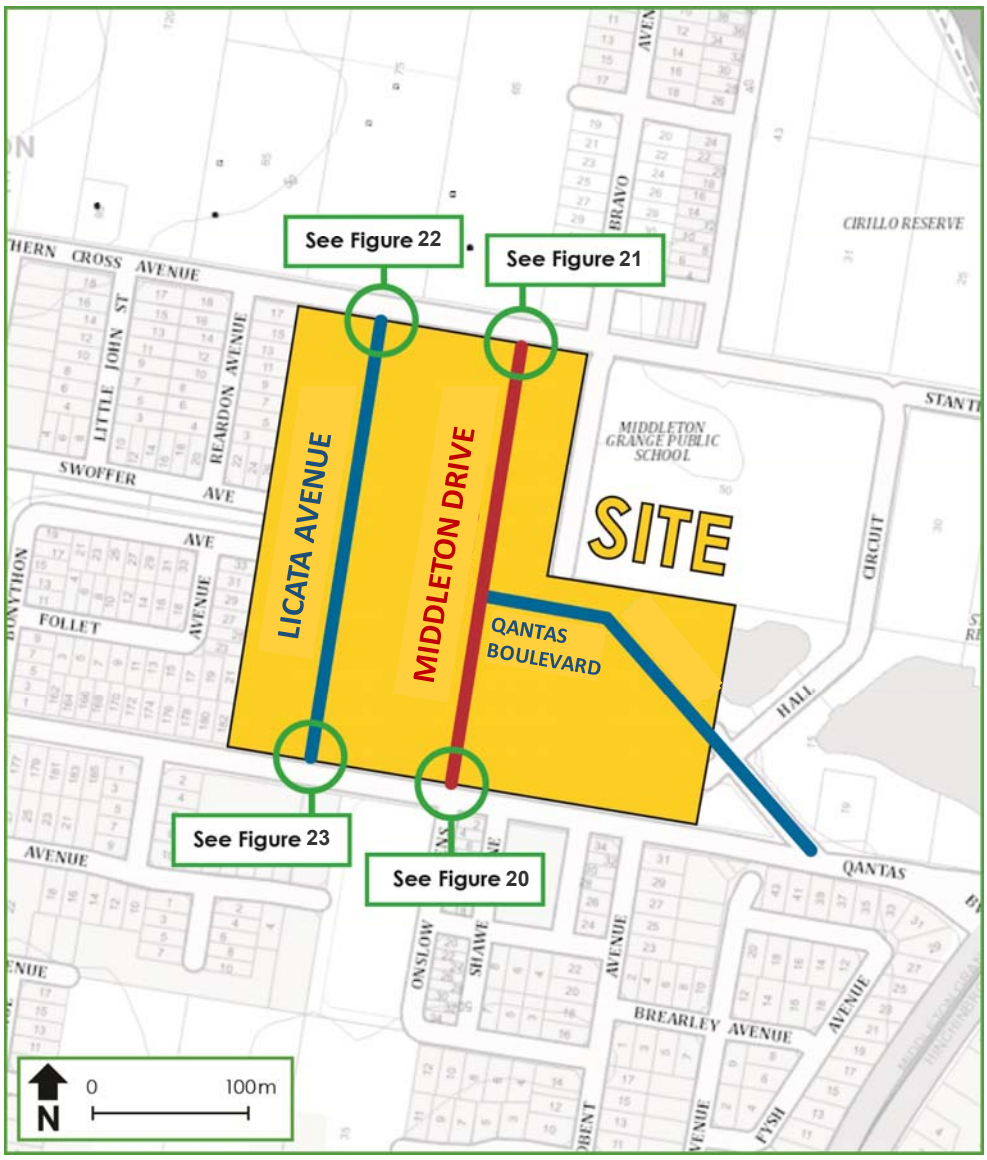


Figure 19: Proposed Intersections providing access to the Site

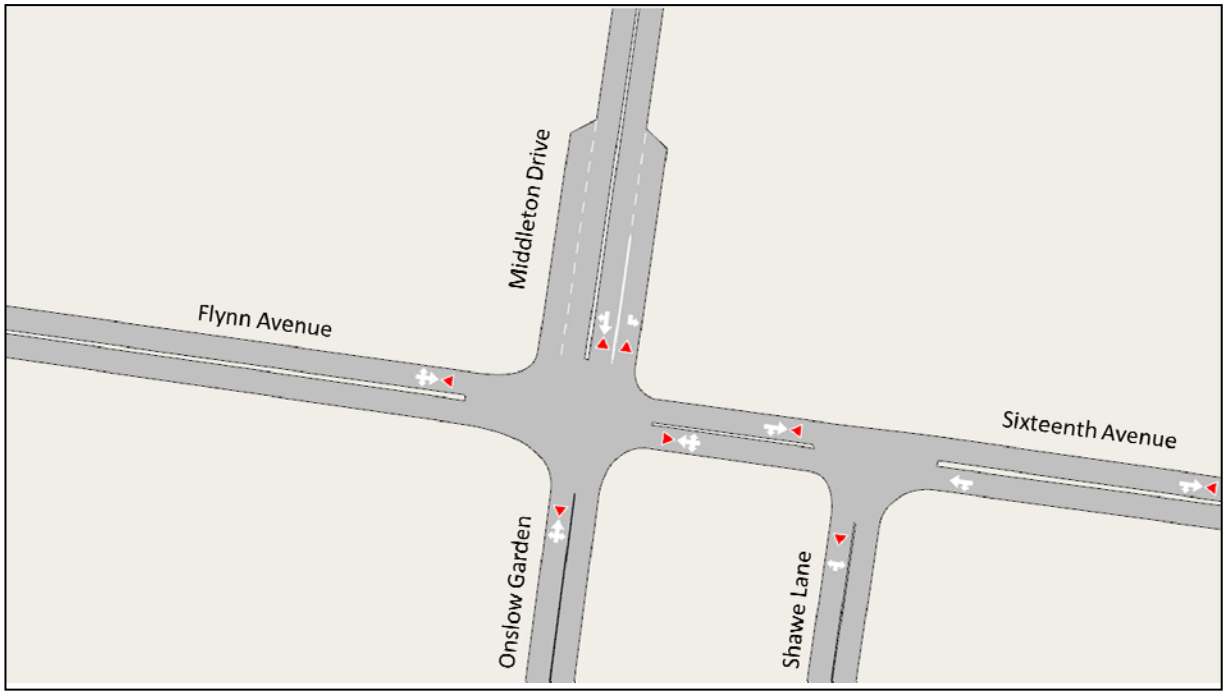


Figure 20: Indicative Intersection Arrangement – Flynn Avenue x Middleton Drive x Onslow Gardens

It can be seen from **Figure 20** that the intersection of Flynn Avenue, Middleton Drive and Onslow Gardens will form a four-way intersection with 'Give Way' priority controls at Middleton Drive and Onslow Gardens. At this intersection, all turns are permitted. The north approach of Middleton Drive provides a single left-turn lane with parking permitted 30 metres from the intersection and one traffic lane for through and right-turn movements. It is noted that Middleton Drive provides a single lane of traffic and kerbside parking on each side.

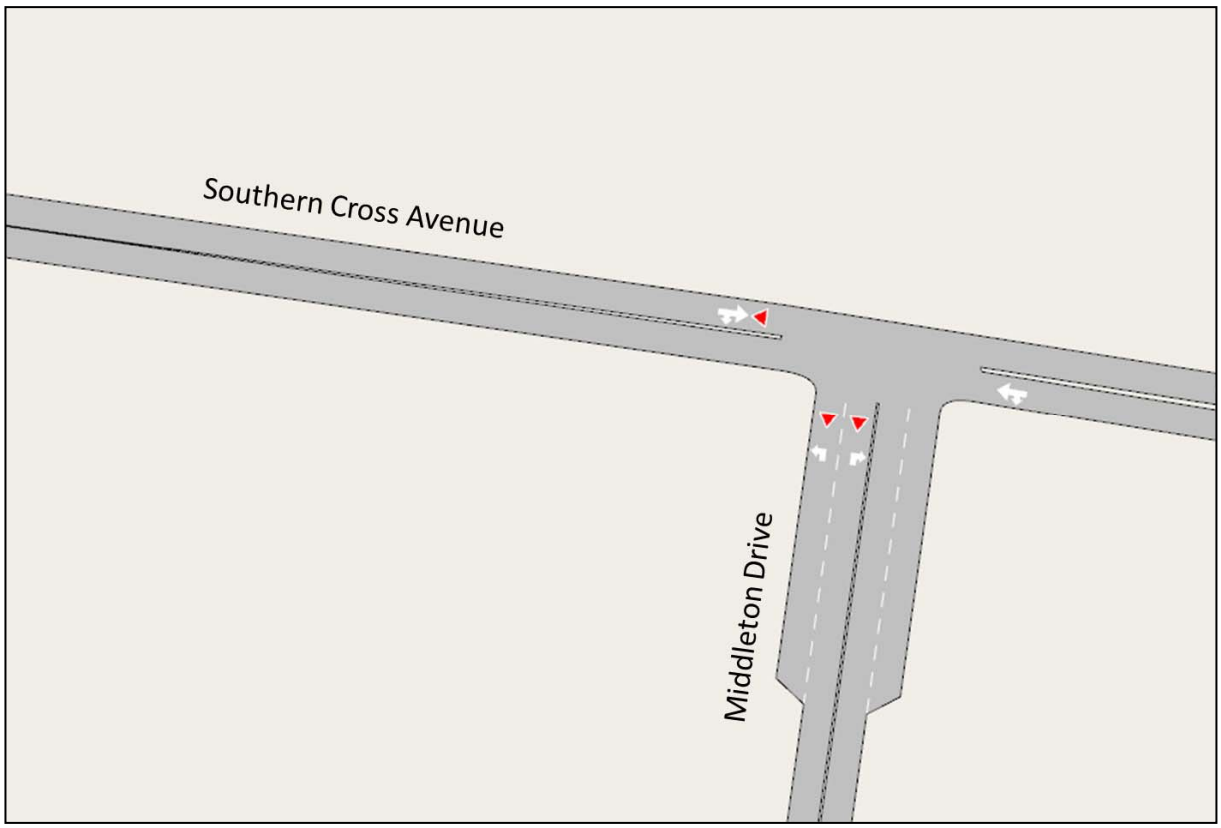


Figure 21: Indicative Intersection Arrangement – Southern Cross Avenue x Middleton Drive

It can be seen from **Figure 21** that the intersection of Southern Cross Avenue with Middleton Drive will form a T-junction that has a 'Give Way' priority control. Both east and west legs on Southern Cross Avenue accommodate a single lane of traffic in each direction. The south leg of Middleton Drive generally provides a single lane of traffic and an additional lane for kerb side parking however, it forms two lanes at the intersection with Southern Cross Avenue.

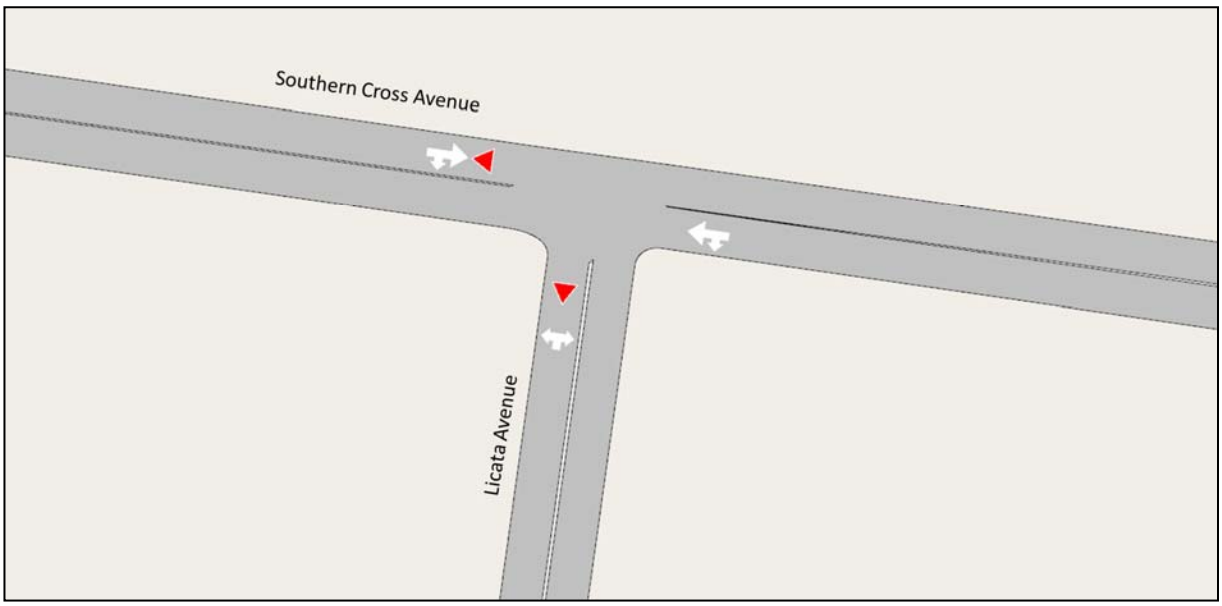


Figure 22: Indicative Intersection Arrangement – Southern Cross Avenue x Licata Avenue

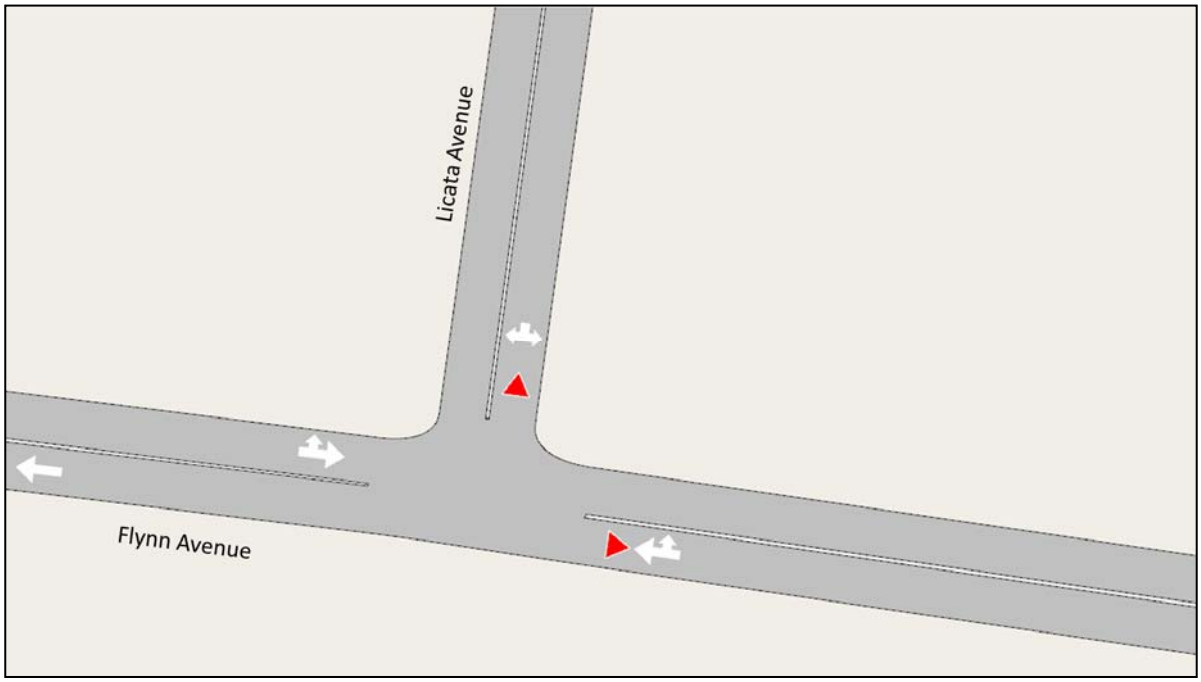


Figure 23: Indicative Intersection Arrangement – Flynn Avenue x Licata Avenue

It can be seen from **Figure 22** and **Figure 23** that the intersections of Southern Cross Avenue with Licata Avenue and Flynn Ave with Licata Avenue will both form a T-junction that have 'Give Way' priority control at the intersection. Furthermore, all legs on Southern Cross Avenue, Flynn Avenue and Licata Avenue accommodate a single lane of traffic in each direction.

6.2 Internal Design

The internal road network is shown on the plans provided in Appendix B. The internal road network has varying carriageway widths which are dependent on their function in the road hierarchy. As outlined in **Table 14** below:

Table 14: Proposed Road Geometry

Classification (Road)	Road Reserve Width	Approximate Carriageway Width
Northern Connector Street (Middleton Drive)	21.4	13.6
Local Access Street Type 2 (Licata Avenue)	17.4	9.4
Local Access Street Type 1 (Qantas Boulevard)	15.2	7.2

The above widths are consistent with those nominally required within the Middleton Grange DCP. These carriageway widths are generous and will operate effectively. In addition, the proposed road geometry satisfies the recommended width outlined within the Australian Model Code for Residential Development (AMCORD) which recommends a minimum width of 5.5 metres (or 7.0 metres) for a local access street within a 13.5 metre road reserve.

In summary, the internal design is considered appropriate and will provide an appropriate amenity for future residents and other road users.

7. Conclusions

The following conclusions are noteworthy:

- TRAFFIX has been commissioned by Manta Group Pty Ltd to undertake a Traffic Impact Assessment using Aimsun modelling in support of a subdivision for the proposed Town Centre at 60-80 Southern Cross Avenue & 45-65 Hall Circuit, Middleton Grange. This follows upon the approved Planning Proposal and the development concept assessed in this traffic report is generally consistent with that principles and development yields adopted in the Planning Proposal. i

- This application relates to the subdivision of the site for a Town Centre comprising of 912 residential units, 20,240m^2 GLA of retail and 2,533m^2 GFA of commercial. This is however a concept yield adopted for assessment purposes only and will be subject to further assessment at development application stage/stages.

- It is emphasised that this assessment reflects a worst case scenario, with conservatively high trip rates and high-range development yields. This provides a safety margin and the results of this modelling are unlikely, for example, to be significantly affected by changes in yields, particularly associated with the residential component which is a low-order traffic generating land use.

- Three new roads are proposed within the site. Two roads traverse north-south, Middleton Drive and Licata Avenue between Southern Cross Avenue in the north and Flynn Avenue in south. An additional road which is extension of Qantas Boulevard will connect to Middleton Drive traversing adjacent to the southern boundary of Middleton Grange Public School. This road will utilise the existing alignment of Hall Circuit and connect to Flynn Avenue

- The impacts of the development which the subdivision supports have been assessed based on the RMS trip rates. The proposed development is expected to generate in the order of 517 and 1620 vehicles per hour during the weekday morning and evening peak periods respectively.

- The internal road cross sections are compliant with the Middleton Grange DCP and provide three different road typologies based on their role in the hierarchy. These will provide a legible hierarchy that is functional and efficient for vehicular traffic, while also providing footpaths on both sides and opportunities for on-street parking.

- Direct access to properties will be available from all internal roads.

- Five (5) scenarios are assessed using the Aimsun model, as follows:

1. Existing Base Case (model as approved by RMS)
2. Existing Base Case + Growth,
3. Existing Base Case + Growth + Network Improvements,
4. Existing Base Case + Growth + Development + Network Improvements,
5. Existing Base Case + Development + Partial Network Improvements.

- Scenario 2 (the addition of future traffic growth to the existing road network, with no development) results in long delays in roundabouts along Kingsford Smith Avenue. Conversion of these roundabouts to signalised intersections is proposed to improve the road network performance.

- To alleviate existing traffic delays along Cowpasture north-bound during AM peak, and Cowpasture Road south-bound during PM peak, as well as providing road capacity to accommodate future growth, a set of changes are introduced in all future scenarios. These include partial widening of Cowpasture Road as well as additional right turn lanes at the intersection of Cowpasture Road with Fifteenth Avenue and Sixteenth Avenue.

- The connection of Middleton Drive and Aviation Road under the M7 and the conversion of the one lane left turn to a two lane signalised left turn from Sixteenth Avenue to Cowpasture Road are effective changes under all scenarios, resulting in a reduction of traffic delays.

- The preferred scenario (Scenario 4), provides capacity for both future growth and trips generated by the subject development. It is therefore concluded that the planning proposal is supportable on traffic planning grounds and will operate satisfactorily, subject to improvements being implemented under Scenario 4. These improvements include:

  - Connection of Middleton Drive & Aviation Road under the M7,
  - Sixteenth Avenue with two-lane signalised left turn to Cowpasture Road,
  - Conversion of Roundabout at Kingsford Smith/ Fifteenth Avenue to a signalised intersection,
  - Conversion of Roundabout at Kingsford Smith/ Flynn Avenue to a signalised intersection,
  - Fifteenth Avenue with two lane right turn to Cowpasture Road,
  - No right turn from Sixteenth avenue (Flynn Avenue) to Qantas Boulevard, except Buses,
  - Three-Lane Cowpasture Northbound from Fifteenth Avenue to above Airfield Drive, and
  - Three-Lane Cowpasture Southbound from M7 to Sixteenth Avenue.
  - Addition of development access roads; and

- Two-Lane East Bound at Sixteenth Avenue (Flynn Avenue) in the vicinity of the Site

The above improvements will need to be staged and this will be the subject of development applications that identify the progressive cumulative impact associated with each development. However, this report identifies the appropriate strategic road planning framework against which all developments may be assessed.

Appendix A

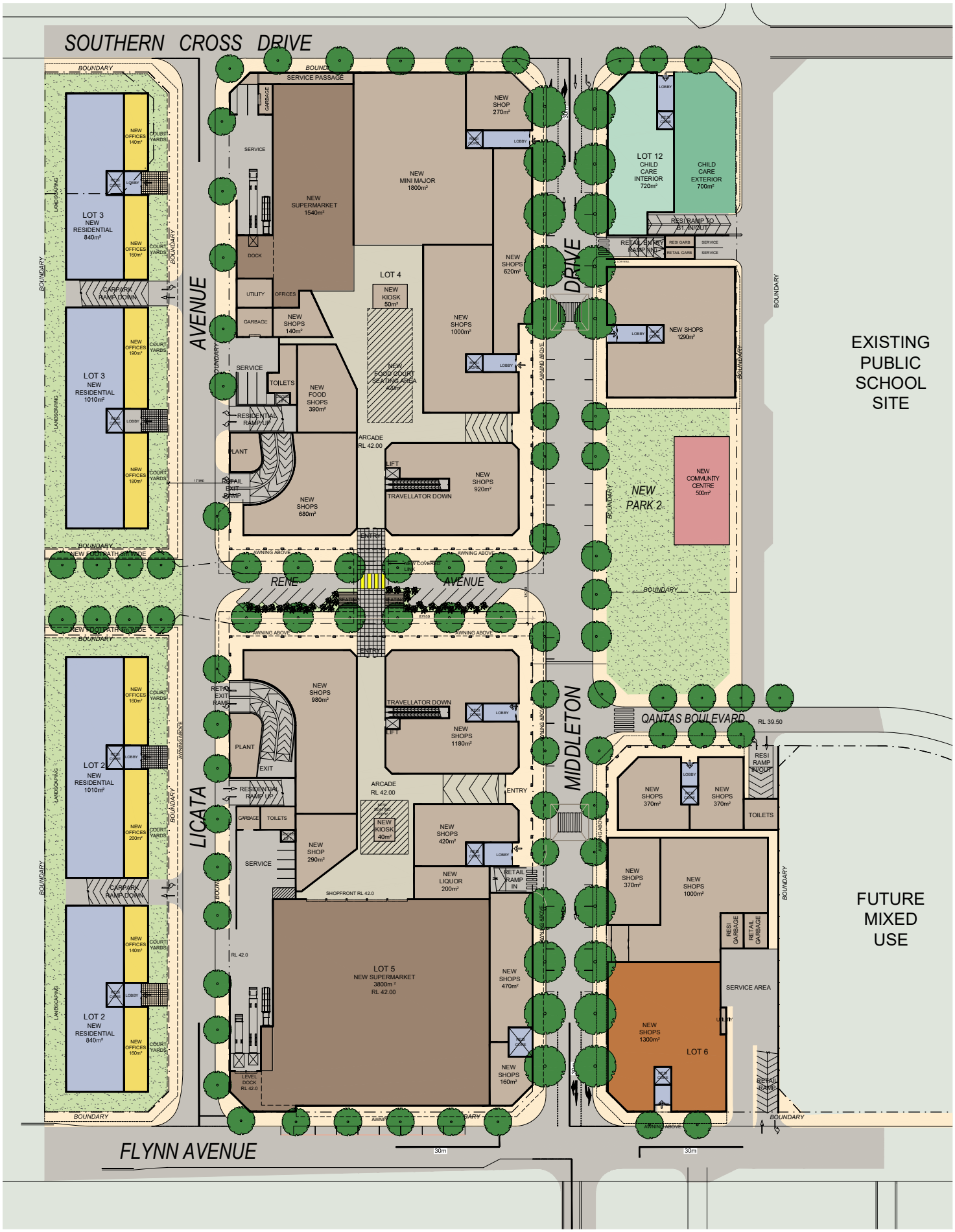
Photographic Record

View looking west on Flynn Avenue with subject site on right hand side of photograph.

View looking west on Flynn Avenue with subject site on left hand side of photograph.

Appendix B

Reduced Plans



PLANNING PROPOSAL ENVELOPE

GROUND LEVEL PLAN 1:500 RL 42.00

SCALE 1:500

ISSUE	DATE	AMENDMENT
P1	06-11-15	PRELIMINARY
P3	21-11-16	PRELIMINARY
P6	23-01-17	PRELIMINARY
P7	31-01-17	PRELIMINARY
P8	08-03-17	PRELIMINARY
P9	31-03-17	PRELIMINARY
P10	19-04-17	PRELIMINARY

architect
christiansenobrienarchitects

manta group pty. ltd.

PROPOSED CONCEPT PLANS
NEW MIXED USED DEVELOPMENT
Cnr Flynn & Seventeenth Avenue, Middleton Grange, NSW.

OPTION 9 REV **P10**

SCALE 1:500 @A1
DATE 19/04/17
DRWN MR, PA, JG

DRG **SK03**

SOUTHERN CROSS AVENUE

REARDON AVENUE

SWOFFER AVENUE

DRAINAGE RESERVE

DRAINAGE RESERVE

BONYTHON AVE

FOLLET AVE

FLYNN AVENUE

RENE AVENUE

LICATA AVENUE

MIDDLETON DRIVE

BRAVO AVENUE

QANTAS BOULEVARDE

HALL CIRCUIT

MIDDLETON GRANGE PUBLIC SCHOOL

LOT 102 D P 1 1 2 8 1 1 1 PUBLIC RESERVE

Lot 1 D P 1 2 0 7 5 1 8

1 D.P.1078564 1029m²

Lot 2 4960m²

Lot 3 3935m²

Lot 4 1.244ha

Lot 5 1.244ha

Lot 6 5316m²

Lot 7 3617m²

Lot 8 2000m²

Note: Dimensions and areas are subject to final survey

No.	AMENDMENT	DATE

vince morgan SURVEYORS

Vince Morgan (Surveyors) Pty Ltd
77 UNION ROAD PENRITH
PO BOX 4156 PENRITH PLAZA 2750
Ph 47215293 Fax 47312821
email mail@vmsurvey.com.au
www.vincemorgansurveyors.com.au

DATUM:	DATE: 21.04.17
ORIGIN:	SCALE 1:1000 @A2
DRAWN: IVM	CHECKED:

MANTA GROUP

MIDDLETON GRANGE TOWN CENTRE

LOT CALCULATION PLAN
MIDDLETON GRANGE TOWN CENTRE

PLAN No. 19133-P20

SHEET 1 OF 1 SHEETS

FILE:

Appendix C

Model Calibration & Validation

Base Model Development Report

60-80 Southern Cross Avenue & 45-65 Hall Circuit – Middleton Grange

Reference: 16.068r03v02 TRAFFIX Report,
Date: September 2017

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traffic & transport planners
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Surry Hills NSW 2011
t: +61 2 8324 8700
w: www.traffix.com.au

Document Verification

Job Number:	16.068			
Project:	60-80 Southern Cross Avenue & 45-65 Hall Circuit – Middleton Grange			
Client:	Manta Group Pty Ltd			
Revision	Date	Prepared By	Checked By	Signed
v01	05/06/17	MEHRDAD SHARIAT	MEHRDAD SHARIAT	
v02	15/09/17	MEHRDAD SHARIAT	MEHRDAD SHARIAT	

Contents

Appendices

1. Introduction

1.1 Background

TRAFFIX has been commissioned by Manta Group Pty Ltd to undertake an Aimsun micro-simulation assessment in response to both RMS and Liverpool City Council's Requirements dated 27 February 2017. The application relates to the subdivision of the site for a Town Centre comprising of 912 residential units, 20,240m^2 GLA of retail and 2,533m^2 GFA of commercial.

The requirements of the modelling were set out in an inception meeting held between the Roads and Maritime Services (RMS), Liverpool City Council and TRAFFIX on 29 March 2017.

The purpose of this report is to provide the calibration and validation data for the purpose of obtaining approval for the base case models prior to the commencement of the future option assessment.

In this regard the base case model has been assessed taking due account of the RMS Modelling Guidelines to Microsimulation Modelling and other relevant documentation.

1.2 Site and Study Area

Site:

The site is situated approximately 500 metres west of the M7 Motorway Interchange with Cowpasture Road, seven (7) kilometres west of the Liverpool CBD and 40 kilometres south-west of Sydney CBD. The site comprises eight (8) lots.

It is irregular in shape and is bounded by Southern Cross Avenue to the north, Flynn Avenue to the south, Middleton Grange Public School (and vacant land) to the east and residential developments to the west. It is noted that Kingsford Smith Avenue and Flynn Avenue provide access to the site with respect to the wider road network.

A Location and Site Plan for the development are presented in **Figure 1** and **Figure 2**, respectively. The road hierarchy in the vicinity of the precinct is also shown in **Figure 3.**

Study Area:

The study area for the Aimsun model will generally be confined within Middleton Grange with the following roads / streets to be included the assessment:

- Cowpasture Road: an RMS Main Road (MR 648) that runs in a north-south direction between The Horsley Drive in the north and Camden Valley Way in the south. Cowpasture Road carries approximately 27,000 vehicles per day within the vicinity of the site with 'No Stopping' restrictions applying along its length at all times. It is subject to a 70km/h speed zoning in the vicinity of the site and generally carries two lanes of traffic in either direction within a separated carriageway of width 30 metres.

- Fifteenth Avenue: a collector road that runs in an east-west direction between Cowpasture Road in the east and Ramsay Road in the west. It is subject to a 60km/h speed zoning. Fifteenth Avenue carries a single lane of traffic in each direction.

- Kingsford Smith Avenue: a local road that traverses north-south between McIver Ave in north and Fifteenth Avenue in the south. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days. Kingsford Smith Avenue carries a single lane of traffic and kerb side parking in each direction with a carriageway of width 13 metres.

- Southern Cross Avenue: a local road that runs in an east-west direction between Hall Circuit in the east and De Garis Avenue in the west. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days. Southern Cross Avenue carries a single lane of traffic in each direction.

- Flynn Avenue: a local road that runs parallel to Southern Cross Avenue between Cowpasture Road in the east and De Garis Avenue in the west. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days (located near Kingsford Smith Avenue). This road is identified in the DCP as a neighbourhood centre street with a 26.7 metre reserve and 12.7 metre carriageway. Flynn Avenue carries a single lane of traffic and kerbside parking in either direction.

- Bird Walton Avenue: a local road that runs parallel to Southern Cross Avenue between Bravo Avenue in the east and Kingsford Smith Avenue in the west. It carries a single lane of traffic and kerbside parking in either direction.

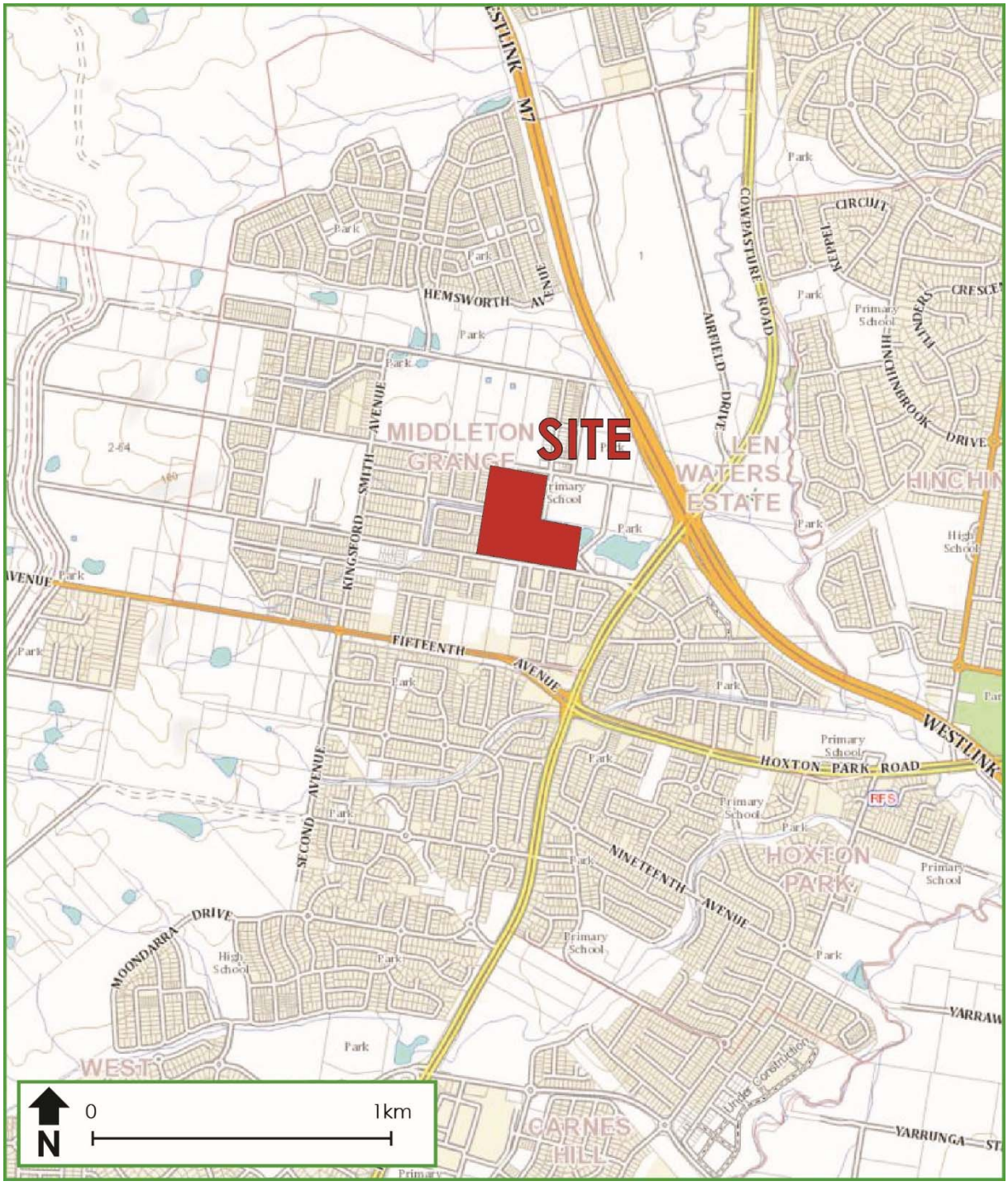

Figure 1: Location Plan

Figure 2: Precinct Plan

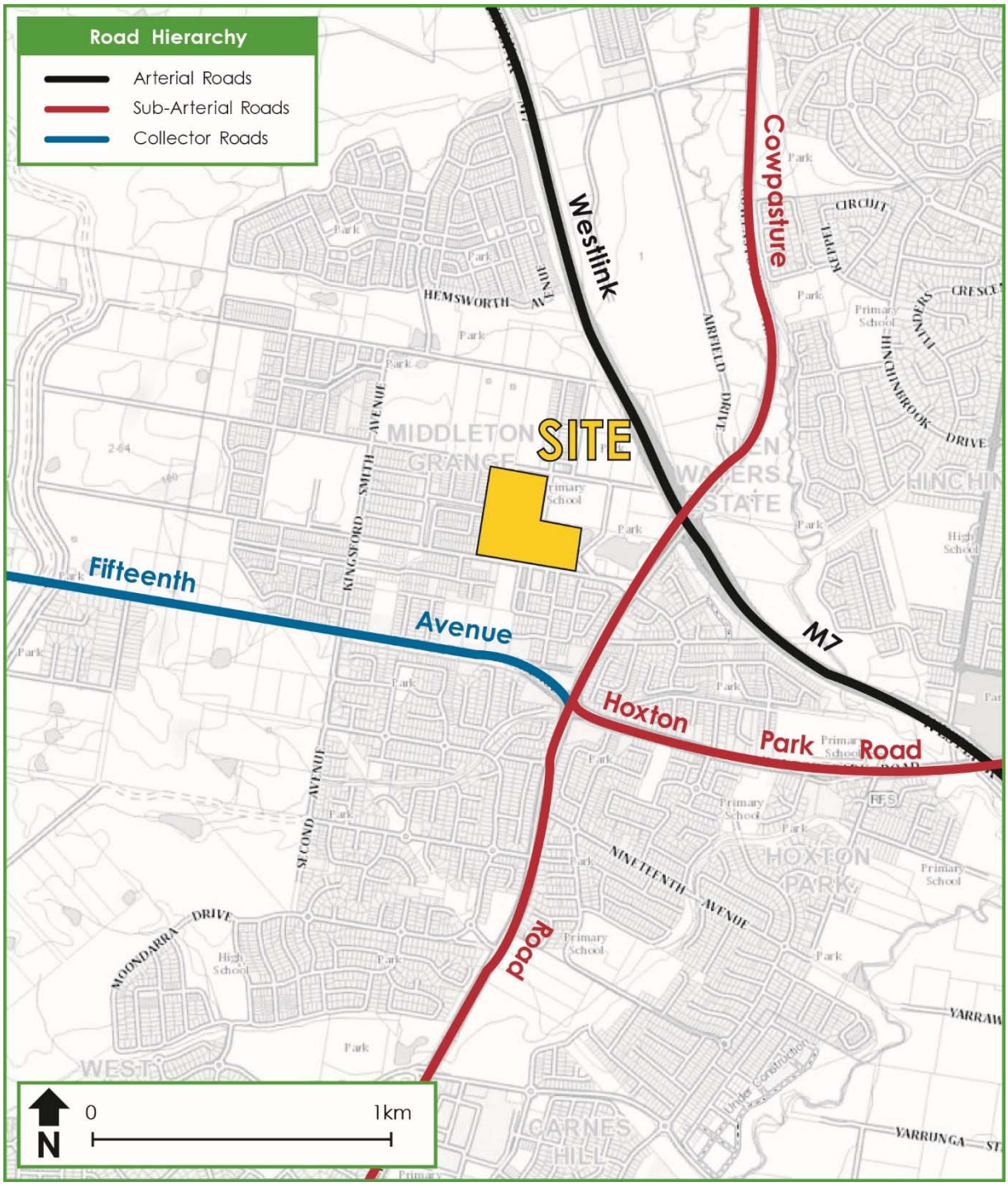

Figure 3: Existing Road Hierarchy

A Study Area Plan and its relationship to the site is presented in **Figure 4** below.

Figure 4: Study area

The dashed line is related to future cases which include Middleton Grange road connection under the M7, with Aviation Road.

1.3 Purpose and Scope of the Model

The purpose of developing a microsimulation model for this study is to assess future impacts associated with development and testing future options, including background growth and network upgrades. This Base Case Development Model provides the foundation for this subsequent stage

The modelled area to the west and south of this area are surrounded by Kingsford Smith Avenue and Fifteenth Avenue respectively while to the east it is bounded by the Cowpasture road. This study area also covers Middleton Drive and Aviation Road to the north.

For this microsimulation modelling, AIMSUN version 8.2.0 microsimulation software package has been adopted; in addition Excel VBA 2016, Python 2.7 and DB Browser for SQLite 3.8 are the other tools used to boost the calibration and validation process

2. Data Collection

Data required for modelling, and the extent of data to be collected were identified in an inception meeting on 29th of March. The collected data included the following:

- Intersection Counts
- Signal layout and signal control plans
- IDM data including signal timing and phasing
- Signal Coordination and Signal offset times
- SCATS detector counts
- Queue length data
- Travel time data
- Data of previous studies

Furthermore, the modelling team also inspected the site and visited the study area both on foot and by car to assess existing conditions during the survey date and obtain additional characteristics of the road network

The intersections included for calibration and validation process are shown in Figure 5.

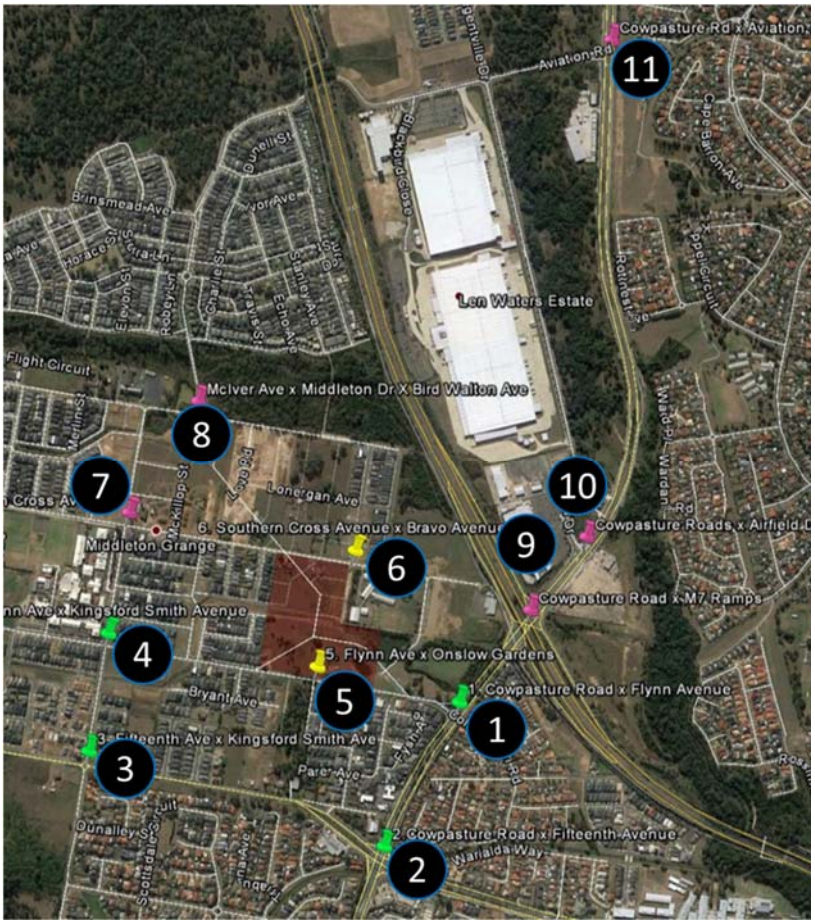

Figure 5: Intersections included in turning movement counts

1. Cowpasture Road / Flynn Avenue
2. Cowpasture Road / Fifteenth Avenue
3. Fifteenth Ave / Kingsford Smith Avenue
4. Flynn Ave / Kingsford Smith Avenue
5. Flynn Avenue / Onslow Gardens
6. Southern Cross Avenue / Bravo Avenue
7. Southern Cross Avenue / Kingsford Smith Avenue.
8. Middleton Drive / Bird Walton Avenue / McIver Avenue
9. Cowpasture Road / M7 Ramps
10. Cowpasture Roads / Airfield Drive
11. Cowpasture Rd / Aviation Road

Intersection turning movement counts for intersections 1 to 6 are based on 2016 surveys, and the rest (intersection 7 to 11) are collected on Thursday 6 April 2017. These survey were in 15 minute intervals between 7:00am and 9:00am and 4:00pm and 6:00pm with distinguishing between heavy and light vehicles.

The application of the collected data is explained with further details in each relevant section of the report including network coding, demand development as well as model calibration and validation.

3. Network Development

3.1 Base Model

All of the road segments have been coded based on the latest aerial photographs provided by Nearmap. AIMSUN open street map data has also been extracted and then corrected based on these latest aerial maps, as well as from the photographic records from the site inspections. The base model (existing) network is shown in **Figure 6**.

Figure 6: The Base Model Network

3.2 Network Coding

Charactrestics of existing transport supply within the area are introduced to the model and all sections were verified and calibrated to represent real conditions through the site visits, photographic records and aerial photography. These sections have been categorised into appropriate types in accordance with their characteristics. Nodes were coded as objects indicating intersecting points of the network, with turning movements and properties subsequently defined.

Road segment properties such as lane widths, lane lengths, number of lanes, direction of travel, road positioning, speed limits, location of bus stops and intersection configurations are set at this stage. Modelling software also allows the user to classify the roads within the model to replicate driver behaviour within each group. The relevant road hierarchy for the study area is shown in figure 7.

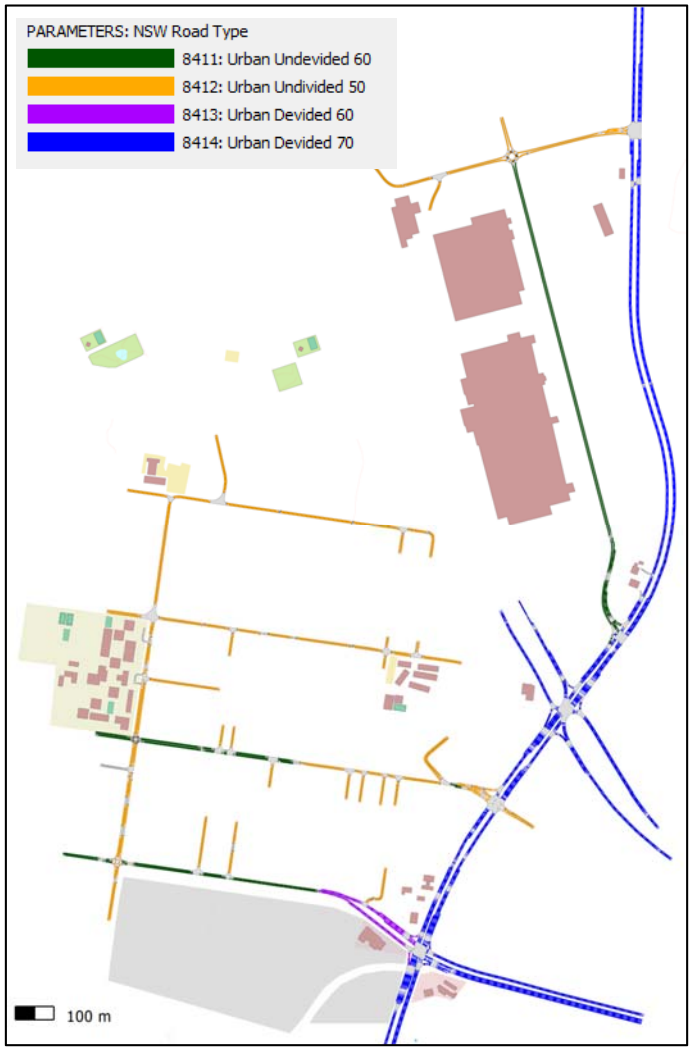

Figure 7: Road Hierarchy

3.3 Signalised Intersections

There are five (5) signalised intersections included in the Aimsun Base model. The intersections are:

- Cowpasture Road / Flynn Avenue
- Cowpasture Road / Fifteenth Avenue
- Cowpasture Road / M7
- Cowpasture Road / Airfield Drive
- Cowpasture Road / Aviation Road

For each of these, the following traffic signal data was obtained from Roads and Maritime Service:

- Intersection Diagnostic Monitor (IDM) data.
- Signal Layout Plans (TCS drawings).
- LX File of the region.

TRAFFIX was provided with a complete set of raw IDMs for Thursday 6th of April, which is in accordance with the onsite survey, data collection and site inspection for the site.

IDM data contains all traffic signal operation statistics at each site on a cycle by cycle basis. These IDM records include traffic signal phases, minimum, maximum and average green time, interphase and cycle time operated during each interval. Overall, the IDM provides a comprehensive snapshot of how the traffic signals operate at each intersection.

Each of the signalised intersections has been coded as 'actuated' in the model. All of the signalised intersections along Cowpasture Road (five (5) in total) are configured based on active phases on survey and data collection date. These signals are modelled as coordinated, using average offset times during each peak period on the survey date. The cycle times, minimum, maximum and average green time have been derived from the IDM data and were used as inputs in the model. Moreover, pedestrian signals are included to model their effect on intersections.

3.3.1 Cowpasture Road / Flynn Avenue (Sixteen Avenue)

This is a seven-potential-phase intersection that operates with a phase sequence A-B-C-D-E-F-G and phase sequence D1-D2-F2-G1 and G2 as alternatives for the main phases. A summary of the phasing sequences is provided in **Figure 8**. Phase G1 is the repeat of B and Phase G2 is the repeat of C.

Figure 8: Cowpasture Road / Flynn Avenue phase sequences

3.3.2 Cowpasture Road / Fifteenth Avenue

This is a seven-potential-phase intersection that operates with a phase sequence A-B-C-D-E-F1-G and phase sequence D1-D2-F2-G1 and G2 are alternatives for the main phases. A summary of the phasing sequences is provided in **Figure 9**. Phase G1 is the repeat of C and Phase F1 is the repeat of D1.

Figure 9: Cowpasture Road / Fifteenth Avenue phase sequences

3.3.3 Cowpasture Road / M7

This is a five-phase intersection that operates with a phase sequence A-B-C-D and E. A summary of the phasing sequences is provided in **Figure 10**. Phase E2, is the repeat of phase C, and Phase E1, is the repeat of B.

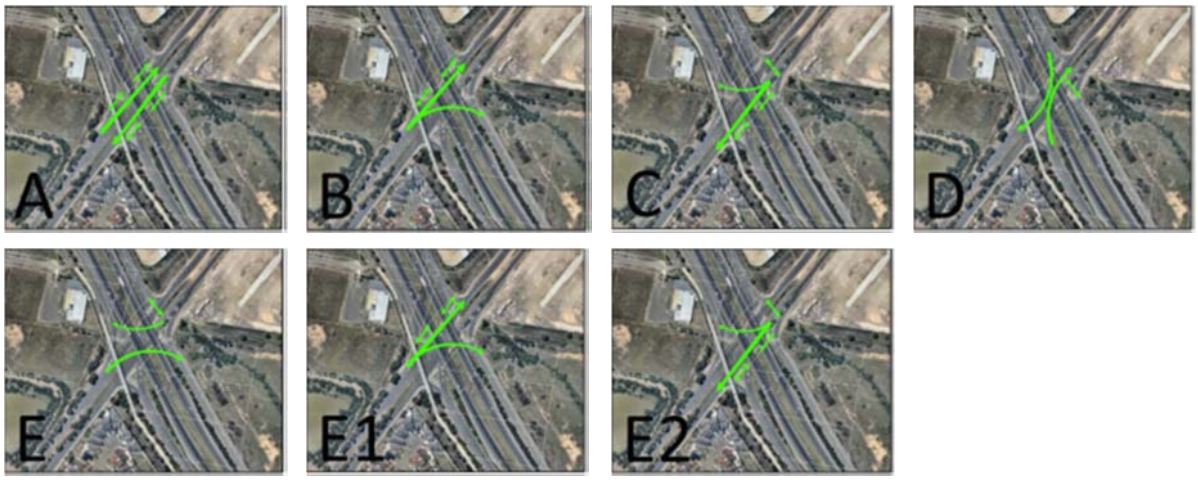

Figure 10: Cowpasture Road / M7

3.3.4 Cowpasture Road / Airfield Drive

This is a four-phase intersection that operates with a phase sequence A-B-C and D. A summary of the phasing sequences is provided in **Figure 11**. Phase D is the repeat of phase B.

Figure 11: Cowpasture Road / Airfield Drive

3.3.5 Cowpasture Road / Aviation Road

This is a four-phase intersection that operates with a phase sequence A-B-C and D. A summary of the phasing sequences is provided in **Figure 12**. Phase D is the repeat of phase B, and Phase C is less frequent than other phases.

Figure 12: Cowpasture Road / Aviation Road

3.3.6 Signal Coordination and offset times

Signalised intersections within the study area are coordinated for their main phase along Cowpasture Road. This coordination is identified in the site inspections during both AM and PM peak periods and calculated based on raw IDM data. Appropriate scripts is also developed to extract the offset times of consecutive intersections. The results are summarised in **Table 1**.

Table 1: Signal offset times along Cowpasture Road

Reference	Time Period	1. Fifteenth Avenue	2. Sixteenth Avenue	3. M7 Ramps	4. Airfield Drive	5. Aviation Road
Offset against Preceding signal	AM Peak	0	27	14	10	-47
	PM Peak	0	-15	-22	-5	20
Offset against benchmark (Reference Signal 1)	AM Peak	0	27	41	51	4
	PM Peak	0	-15	-37	-42	-22

These offset times are modelled using vehicle actuated control plans with coordinated phases along Cowpasture road.

3.3.7 Queue Lengths at Signalised Intersections

Queue length data for the signalised intersections has been collected to be used for calibration and validation of the model. These queue lengths has been based on recorded videos. The results are the maximum number of vehicles in queue for each approach of the intersection; all lanes combined. The locations of the collected queues on 6th April 2017 are as follows:

- Cowpasture Road / M7 Ramps
- Cowpasture Roads / Airfield Drive
- Cowpasture Rd / Aviation Road

It should be noted that journey route time data sets cover main road segments within the study area and this supplementary queue length data is collected to enable additional checks. Queue length results in each approach is shown in **Table 2**.

Table 2: Queue Length survey results

Time		Cowpasture Road/ M7 Ramps				Cowpasture Roads/ Airfield Drive			Cowpasture Rd/ Aviation Road		
Start	End	NA	EA	SA	WA	NA	SA	WA	NA	SA	WA
7:00	7:15	9	8	24	10	10	8	5	5	10	3
7:15	7:30	16	6	18	8	11	9	6	7	15	2
7:30	7:45	20	7	25	10	18	11	5	12	15	3
7:45	8:00	15	8	25	9	20	15	4	11	16	4
8:00	8:15	14	6	18	7	17	16	7	15	17	2
8:15	8:30	14	5	16	6	11	9	6	10	18	2
8:30	8:45	12	3	16	5	15	7	5	10	14	2
8:45	9:00	11	4	15	5	9	7	6	9	12	2
16:00	16:15	27	6	20	10	18	28	4	10	10	2
16:15	16:30	24	8	15	8	15	22	5	15	10	2
16:30	16:45	28	4	18	10	16	25	5	12	14	2
16:45	17:00	20	4	18	8	8	28	4	12	12	2
17:00	17:15	22	8	16	9	16	25	6	15	10	2
17:15	17:30	16	5	12	8	14	22	6	16	8	2
17:30	17:45	16	4	11	10	17	26	5	17	10	3
17:45	18:00	15	5	11	8	15	20	4	12	7	2
18:00	18:15	19	5	10	10	12	19	4	10	8	2
18:15	18:30	16	5	11	7	15	17	4	9	8	2

Note: SA: South Approach EA: East Approach WA: West Approach NA: North Approach

3.4 Priority Intersections

There are several priority intersections in the study area and six (6) of them are included in turning movement count surveys and further calibration and validation process. The priority intersections were coded based on existing give way priority road rules, noting that U-Turn movements are prohibited at these intersections:

- Fifteenth Ave / Kingsford Smith Avenue
- Flynn Ave / Kingsford Smith Avenue
- Flynn Avenue / Onslow Gardens
- Southern Cross Avenue / Bravo Avenue

- Southern Cross Avenue / Kingsford Smith Avenue.
- Middleton Drive / Bird Walton Avenue / Mclver Avenue

3.5 Vehicle Speeds

The maximum speed of vehicles in sections of road network are defined based on posted speeds and observed traffic signs. A summary of these speeds is the following:

- Cowpasture Road 70 Km/h;
- Fifteenth Avenue 60 Km/h;
- Kingsford Smith Avenue 50 Km/h in south of Southern Cross Avenue and 60 Km/h in north of Southern Cross Avenue;

  in south of Southern Cross Avenue, this street is subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days;
- Southern Cross Avenue 50 Km/h, and subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days;
- Flynn Avenue 50 Km/h, and subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days;
- Onslow Gardens 50 Km/h;
- Bravo Avenue 50 Km/h;
- Middleton Drive 50 Km/h;
- Bird Walton Avenue 50 Km/h;
- Mclver Avenue 50 Km/h

To model school zone conditions a python script automatically changes the section speeds when the time is within school zone hours.

3.6 Public Transport

The existing bus routes and their characteristics has been modelled in the AIMSUN. There are four bus routes that traverse roads within the study area:

- Route 852 – Carnes hill to Liverpool via Greenway Dr & Cowpasture Road
- Route 853 – Carnes hill to Liverpool via Hoxton Park Road.
- Route 854 – Carnes hill to Liverpool via Greenway Dr & Hoxton Park Road.
- Route 855 – Rutleigh Park to Liverpool via Austral & Leppington Station.

The AM and PM peak timetables have been reviewed for each route and the timetables with the corresponding headways have been coded in the model. Each bus therefore arrives according to its timetable. Bus stops has been coded based on their real locations.

4. Demand Development

All available data was used to define the traffic demand in Aimsun for the existing demand. The existing traffic volumes are determined from the following sources:

- Traffic counts, and
- Turning movement counts.

The counts were carried out for two (2) hours during AM period from 7:00 to 9:00 and for two and half (2.5) hours during PM period from 14:00 to 16:30 and recorded in 15 minutes increments. The vehicles are classified as light and heavy vehicles. The number of heavy vehicles has been taken directly from the classified traffic surveys.

4.1 Traffic Zones

In order to set up traffic demand matrices, the centroid replicating the origin and destination of trips are added to the model. Each centroid can represent a zone where travel demand originates and terminates. **Figure 13** shows centroid configuration used for this modelling, including 40 traffic zones.

4.2 Peak Periods and Profiles

The traffic count data demonstrated the following AM and PM peak periods and accordingly, these time periods were adopted for the model:

- AM: 7:30am to 8:30am,
- PM: 4:45pm to 5:45pm.

Sufficient traffic count data was collected to allow traffic profiles to be established at 15 minute intervals over the AM and PM peak periods. Traffic profiles of each vehicle type are calculated according to the variable observed profile of each origin resulting in 15 minutes OD demand matrices. **Table 3** shows the demand matrices included in the model as well as total sum of each matrix.

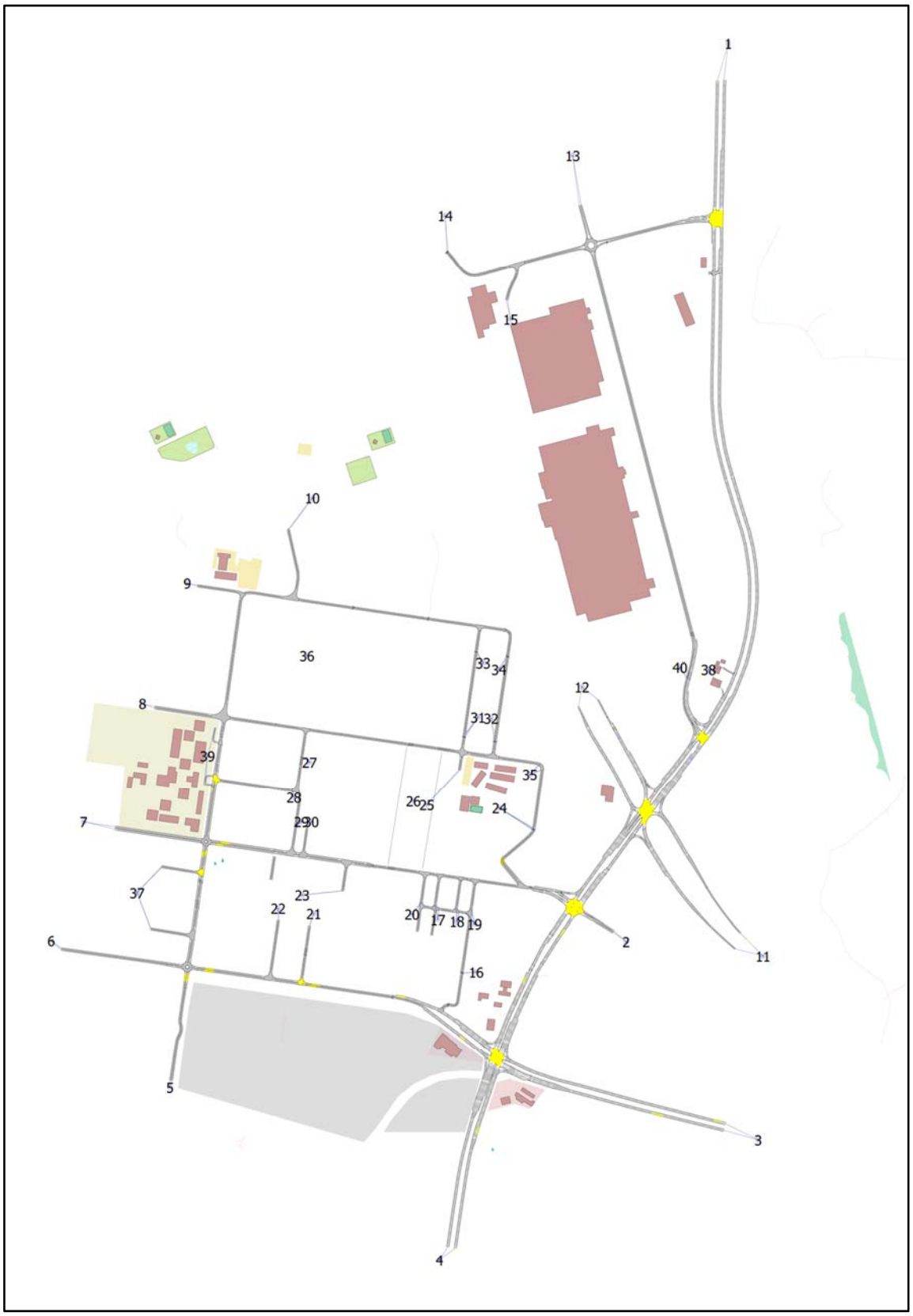

Figure 13. Traffic Zones

Table 3: Demand Matrices

AM Period	Light Vehicle	Heavy Vehicle	PM Period	Light Vehicle	Heavy Vehicle
07:00 - 07:15	1423	71	16:15 - 16:30	1760	71
07:15 - 07:30	1948	92	16:30 - 16:45	1844	77
07:30 - 07:45	1988	119	16:45 - 17:00	1768	92
07:45 - 08:00	2124	118	17:00 - 17:15	1685	57
08:00 - 08:15	2159	91	17:15 - 17:30	1830	64
08:15 - 08:30	2015	97	17:30 - 17:45	1897	76

Separate traffic demands for adequate warm-up period of 30 minutes during each peak (which is also not less than the longest trip) has also been included in the model to ensure the network is populated prior to the data collection period.

In addition to existing demand, at next stage of modelling which is related to future scenarios, the future traffic demand will also be included in the model. This demand will reflect background traffic growth and the additional demand generated by development during AM and PM peak periods.

4.3 Saturday Traffic

To identify the extent of additional impacts a separate Saturday model could assess, and if demand development for Saturday may change the outcome of study, a separate data analysis is undertaken. To do so, at first step SCATS detectors counts of intersections experiencing most delay and highest volumes, for both Weekday and Saturday condition is obtained. Afterwards, maximum hourly traffic volumes entering these intersections are extracted and summarised in Table 4. The results indicate lower levels of traffic on Saturday peaks in comparison with weekday conditions.

Table 4: Throughput of major intersections near the site

Intersection	Weekday peak (Hourly)	Saturday Peak (Hourly)	Ratio (WD/Sat)
Cowpasture Road / Fifteenth Avenue	4938	4030	23%
Cowpasture Road / Flynn (Sixteenth) Avenue	4144	3504	18%

Data suggests that existing throughput of major intersections in vicinity of the site during weekday peak hours are about 18 to 23 percent greater than that of Saturday.

Accordingly, models for AM and PM peak periods during the modelled weekday are reflective of more critical conditions.

5. Model Stability

The model has been run under different seed numbers. A model is considered 'stable' when it produces similar and comparable results between runs. The AM and PM models have been run using the standard seed numbers (28, 2894, 560, 86524 and 7771) as defined in the RMS Modelling Guide.

The total travel time in the network can be used as an indication of model stability. The travel times for each seed run is provided in **Table 5 and Table 6** during AM and PM peak period of 7:30-8:30am and 16:45-17:45pm respectively. It is noted that each run included a 30 minutes warm-up period prior to the start of data collection period.

Table 5. Total Travel time in Network during AM Peak

Seed Value	AM Total Travel Time (h)
560	547
28	537
7771	529
86524	499
2849	548
Average	532

Table 6. Total Travel time in Network during PM Peak

Seed Value	PM Total Travel Time (h)
560	438
28	407
7771	414
86524	395
2849	424
Average	416

Some sections of the existing network experience significant queues and delays; however, no blockage occurs in the network and the number of vehicles waiting to enter is zero. Tables 5 and 6 demonstrate that the total travel time in the network are comparable between the various runs over the period 7:30-8:30am and 16:45-17:45pm. Both the AM and PM models are therefore considered stable.

6. Model Calibration and Validation

To show if the model represents real traffic conditions within the area, the modelling outputs are examined in comparison with observed values. This includes a comparison of observed and modelled traffic volumes, journey time, queue lengths, and signal timing and phasing.

The criteria used to calibrate and validate the models have been adopted from the microsimulation modelling section of the RMS Traffic Modelling Guidelines.

After checking the model stability, the model has been validated with the use of network statistics stored in model database and outputs generated by the model with statistics based on observed on-site data sets.

6.1 Traffic Volumes

According to Table 11.2 of the Microsimulation Modelling – RMS Modelling Guidelines, the following criteria is used to test the validity of traffic flows.

- Flows<99- to be within 10 vehicles of observed value
- Flows 100 to 999- to be within 10 percent of observed vehicles
- Flows 1000 to 1999- to be within 100 vehicles of observed values
- Flows >2000 - to be within 5 percent of observed value
- 100 percent of observations to be within tolerance limits
- R^2 value to be included with plots and to be >0.95

The full set of modelled and observed data, and their relative differences is provided in **Appendix B**. **Figure 14** and **Figure 15** show plots of observed and modelled traffic flows during the AM peak hour. **Figure 16** and **Figure 17** also show plots of observed and modelled traffic flows during the PM peak hour.

It should be noted that many studies use GEH as the criterion of model calibration and target to have volumes with GEH less than five (5) for about over 85 percent of individual turns. Since this study has

used a more rigorous criteria, the latter criteria is fully met and all GEH at the level of turning movement are below 2.5.

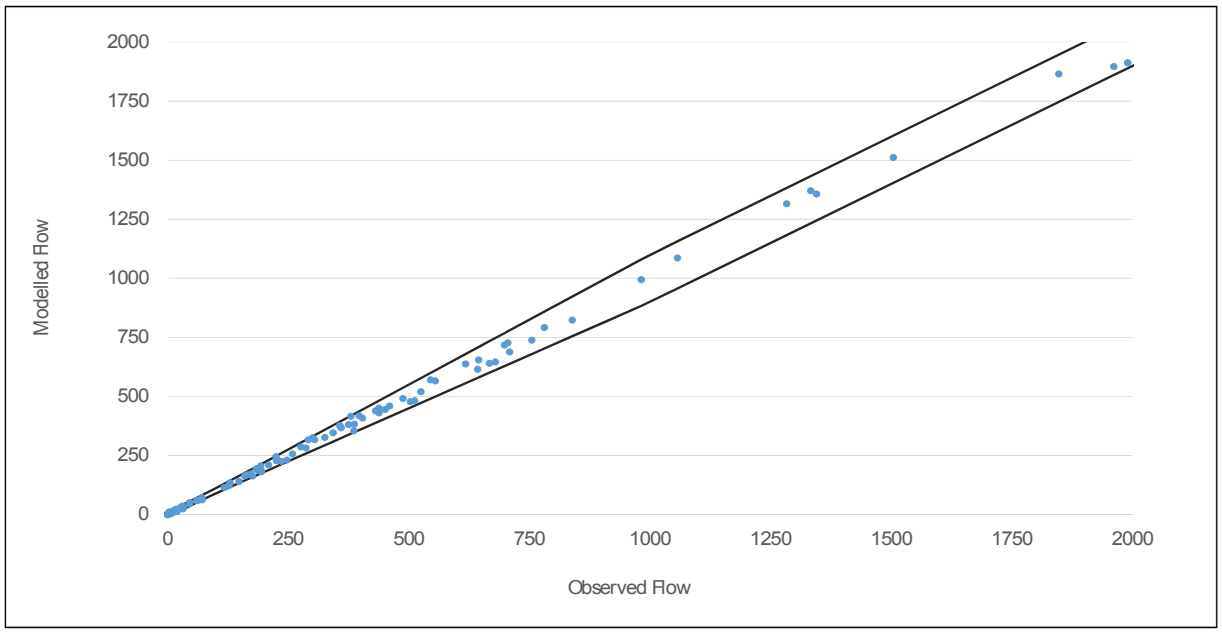

Figure 14. AM peak observed and modelled traffic flows

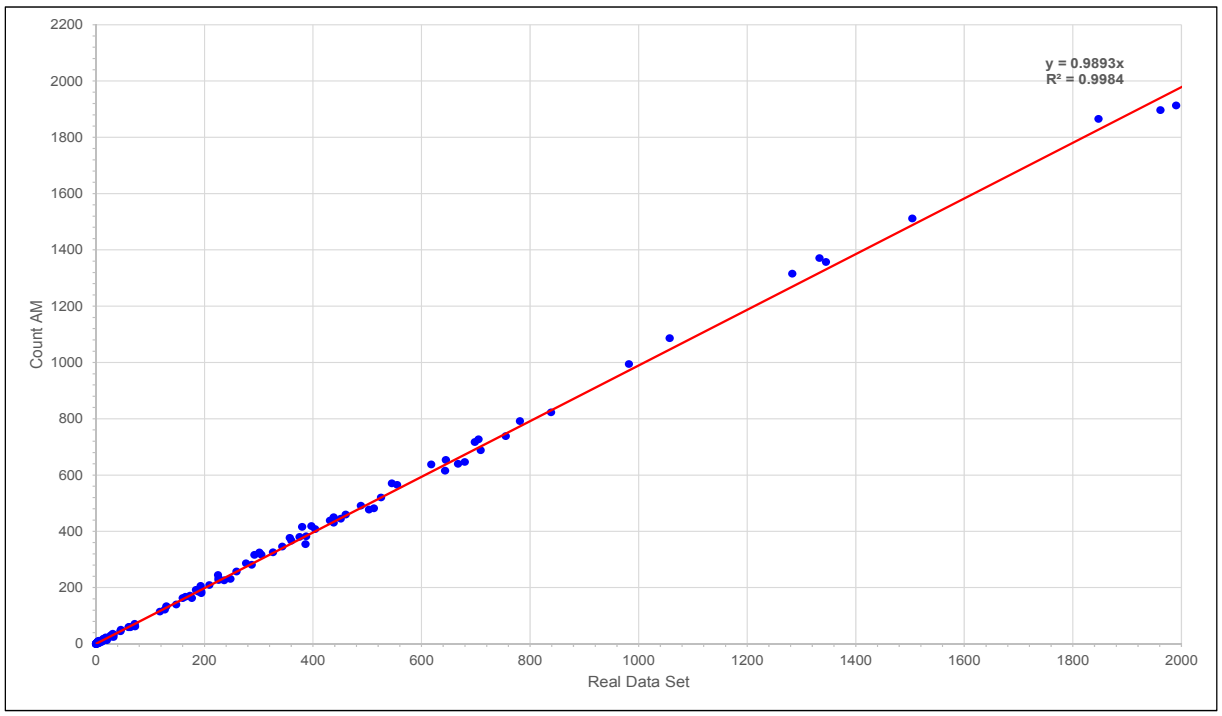

Figure 15. AM peak observed and modelled traffic flows

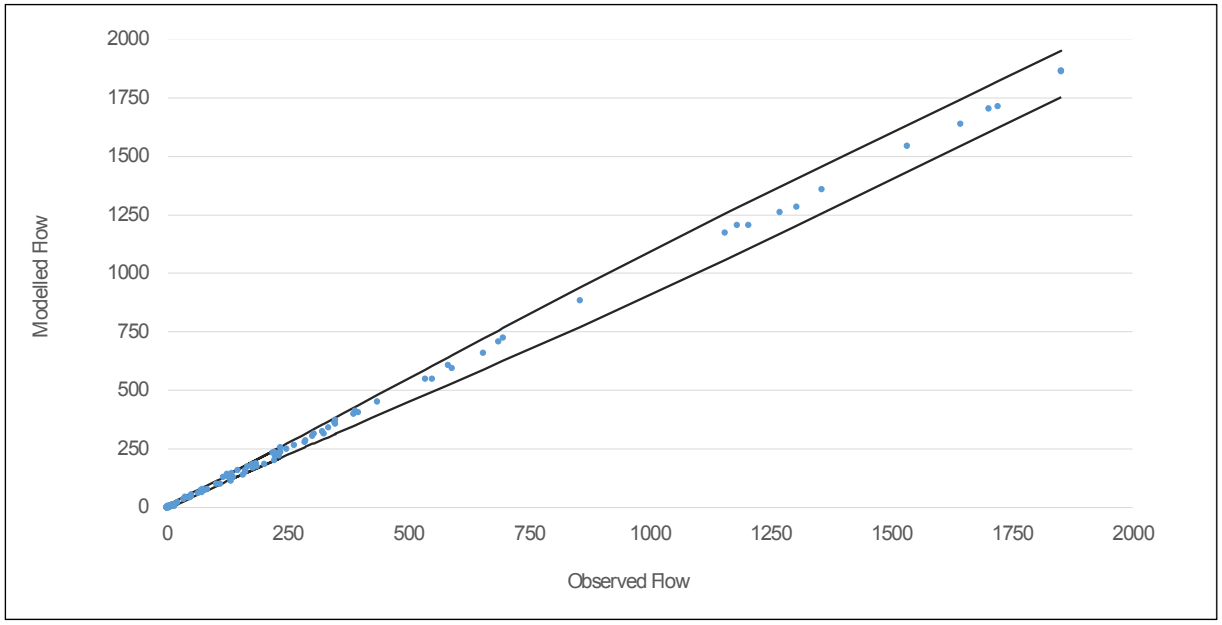

Figure 16. PM peak observed and modelled traffic flows

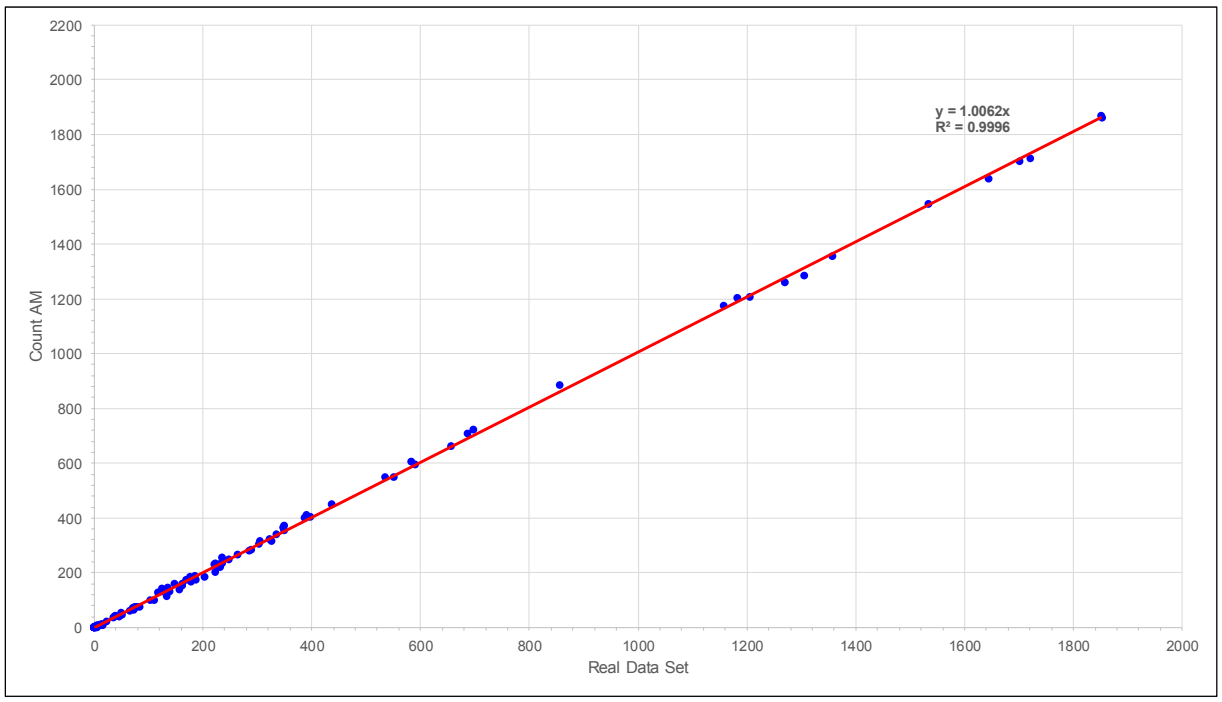

Figure 17. PM peak observed and modelled traffic flows

6.2 Journey Time Routes

The observed and modelled journey times along the routes shown in **Figure 18** are compared to control whether the model generates outputs similar to real conditions. **Table 7** below presents that the difference of average observed and modelled journey times during the AM and PM peak periods are within 15 percent tolerance limit or less than one minute.

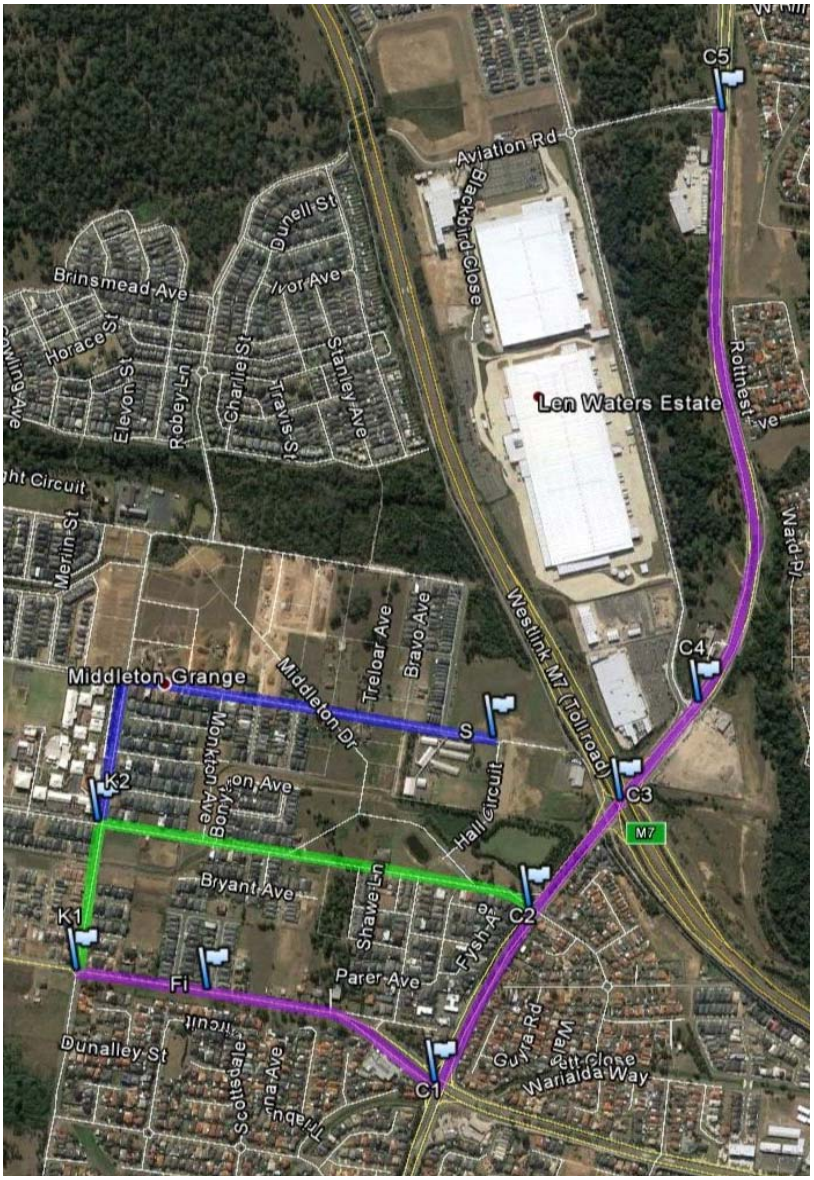

Figure 18. Journey Time Routes

Table 7: Journey Travel time calibration

Route	AM Peak			PM Peak			Control
	Average Observed (Sec)	Average Modelled (Sec)	Absolute difference (Sec)	Average Observed (Sec)	Average Modelled (Sec)	Absolute difference (Sec)	Difference <60 Sec or <15%
Route 1 from West to East and then to the North	377	400	23	317	314	4	✓
Route 1 from North to South and then to the West	366	341	26	377	327	50	✓
Route 2 from East to West and then to the South	162	143	19	177	156	21	✓
Route 2 to North and East	164	190	27	187	149	38	✓
Route 3 from East to West and then to the South	142	124	17	158	119	39	✓
Route 3 from West to North and East	143	122	21	153	118	35	✓

The AM and PM models therefore meet the validation criteria related to journey travel times.

6.3 Queue Length

The queue length survey encompassed all approaches for signalised intersections surveyed in 6 April 2017.

In this study, the queue lengths at the surveyed intersections are compared to model outputs during both AM and PM peak periods. **Table 8** provides a comparison between maximum observed queue lengths and maximum modelled queue lengths for each of the intersections. This shows that the model queues are comparable to real observed values.

It should be noted that the maximum queue length generated by model at some intersection legs may not be the same as that observed values. The random driving behaviour, differences between arrival rates as well as limitations in ordinary surveys to cover long queues would be some reasons causing these queue length differences.

Table 8: AM and PM comparison of queue length

Intersection	Approach	AM		PM	
		Observed max queue	Model max queue	Observed max queue	Model max queue
Cowpasture Road/ M7 Ramps	North	20	22	near capacity	near capacity
	East	8	13	8	14
	South	25	26	18	21
	West	10	10	10	19
Cowpasture Roads/ Airfield Drive	North	20	19	17	22
	South	16	9	28	27
	West	7	13	6	8
Cowpasture Rd/ Aviation Road	North	15	13	17	16
	South	18	18	12	19
	West	4	4	3	5

It can be seen from **Table 8** that the maximum modelled queue lengths are comparable with the maximum observed queues and therefore the modelled queues are considered representative of existing conditions.

6.4 Signal Timing

To measure the similarity of traffic signals in the model and the reality, the modelling outputs are compared with the observed datasets, provided by RMS in the form of relevant SCATS output. In section 3.3 the inclusion of coordinated traffic signals in the model as multi-ring actuated traffic signal controls has been explained.

Table 9 compares the average percentage of each signal phase generated by the model with the percentages of corresponding active phases in real datasets during AM peak period. These values are the ratio of total phase time assigned to each active phase to total data collection period. **Table 10** shows the same contents during PM peak period.

To obtain these tables, Aimsun is set to record traffic control events into the model database and using SQL queries, data required for this comparison is extracted. A separate datasheet and script is also prepared to extract data sets of observed phase percentages from raw IDM data.

According to the outputs of the model, the operation of the signal cycles and timings are considered similar to the recorded on-street operation.

Table 9: AM peak observed and model simulated phase time

Intersection	Active Phases	Average Phase Time Observed	Average Phase Time Simulated	Difference
Cowpasture Road/ Fifteenth Avenue	A	39.2%	35.9%	-3.3%
	D	16.5%	20.4%	3.8%
	E	25.6%	22.9%	-2.7%
	G	18.7%	20.9%	2.2%
Cowpasture Road/ Flynn Avenue (Sixteenth Ave)	A	61.7%	53.9%	-7.8%
	D	13.4%	15.6%	2.2%
	E	11.0%	11.4%	0.4%
	G	13.9%	19.0%	5.2%
Cowpasture Road/ M7 Ramps	A	66.2%	65.4%	-0.7%
	D	17.0%	14.8%	-2.2%
	E	16.9%	19.8%	2.9%
Cowpasture Roads/ Airfield Drive	A	79.2%	81.9%	2.7%
	B	4.4%	1.1%	-3.2%
	C	16.4%	17.0%	0.6%
Cowpasture Rd/ Aviation Road	A	90.5%	84.1%	-6.4%
	B	8.2%	14.0%	5.8%
	C	1.3%	1.9%	0.6%

Table 10: PM peak observed and model simulated phase time

Intersection	Active Phases	Average Phase Time Observed	Average Phase Time Simulated	Difference
Cowpasture Road/ Fifteenth Avenue	A	47.4%	45.0%	-2.4%
	D	16.5%	18.5%	2.0%
	E	20.3%	19.1%	-1.2%
	G	15.7%	17.4%	1.7%
Cowpasture Road/ Flynn Avenue (Sixteenth Ave)	A	62.5%	63.4%	0.9%
	D	11.5%	11.0%	-0.5%
	E	9.7%	4.6%	-5.1%
	G	16.3%	21.0%	4.6%
Cowpasture Road/ M7 Ramps	A	65.1%	64.2%	-0.9%
	D	18.1%	19.7%	1.6%
	E	16.8%	16.0%	-0.7%
Cowpasture Roads/ Airfield Drive	A	75.0%	69.9%	-5.1%
	B	4.3%	12.0%	7.7%
	C	20.7%	18.1%	-2.6%
Cowpasture Rd/ Aviation Road	A	84.2%	83.5%	-0.8%
	B	13.3%	14.8%	1.6%
	C	2.5%	1.7%	-0.8%

Each Phase includes its active alternatives.

7. Summary

The purpose of modelling at this stage is to prepare the Base Case Model which will subsequently be used to assess the impact of development and future scenarios.

The model stability is checked and the reliability of Base Model has been assessed by comparisons of traffic volumes, queue lengths, travel times, and signal timing and phasing as following:

Model stability	Total travel times generated by using five different seeds are compared in order to show the stability of the model; additional controls also show that no blockage occurs within the network and vehicles do not queue outside of study area
Modeled traffic volumes versus observed volumes	All turning movement volumes generated by the models are near to the observed values in 11 surveyed intersections. All GEH values are less than 2.5 and the volumes are within the limits required by RMS modelling guidelines.
Modelled journey route times versus observed values	The travel times generated by the model are compared with observed values. All the differences between observed average route travel time and outputs of the model are less than one (1) minute.
Modelled signal phasing timing versus real signal phasing and timing	Signal phasing and timing assigned by vehicle actuated control plans with signal coordination are near to that extracted from IDM data of survey date.
Modelled queue lengths versus observed queues	Traffic queue lengths are comparable to observed surveyed values indicating the same overall traffic behaviours within the study area.

The calibration and validation of the AM and PM base models demonstrates that the models are stable and representative of the observed traffic conditions. In this regard, both the AM and PM models are considered adequate for future year scenario testing and traffic impact assessment.

Appendix A

Photographic records

View looking West along Flynn Avenue at Flynn Avenue / Kingsford Smith Avenue

View looking north along Kingsford Smith Avenue

View looking south along Kingsford Smith Avenue
at Kingsford Smith Avenue / Southern Cross Avenue

View looking north along Onslow Gardens

View looking west along Flynn Avenue at Flynn Avenue / Onslow Gardens

View looking north along Cowpasture Road
at Cowpasture Road / Flynn (Sixteenth) Avenue

View looking at Cowpasture Road / Airfield Drive

View looking south along Cowpasture Road at Cowpasture Road / Fifteenth Avenue

View looking south at Cowpasture Road / Sixteenth Avenue, PM Peak

View looking south along Cowpasture Road at Cowpasture Road / M7 Ramps, PM Peak

Appendix B

Traffic Volume Calibration

AM Peak Turning Movement Statistics

Object	Count - Real Data Set AM - All	Count - AM Model- All	Absolute Difference	Relative Difference (%)	GEH
9867	160	164	3.88	2.43	0.31
9866	1847	1866	18.93	1.02	0.44
9650	15	13	-1.60	-10.67	0.42
9649	3	2	-1.20	-40.00	0.77
9648	46	51	4.60	10.00	0.66
9647	9	11	1.60	17.78	0.51
9646	6	5	-0.80	-13.33	0.34
9645	18	15	-3.20	-17.78	0.79
9644	17	15	-2.40	-14.12	0.60
9643	5	3	-2.20	-44.00	1.11
9642	236	226	-9.80	-4.15	0.64
9641	194	180	-13.60	-7.01	0.99
9640	148	140	-7.80	-5.27	0.65
9639	61	61	-0.20	-0.33	0.03
9543	11	8	-3.20	-29.09	1.04
9542	1	4	3.40	340.00	2.07
9540	2	5	2.60	130.00	1.43
9539	14	18	4.00	28.57	1.00
9537	2	2	0.20	10.00	0.14
9536	4	9	4.80	120.00	1.90
9510	173	172	-1.20	-0.69	0.09
9509	645	654	9.60	1.49	0.38
9405	9	10	1.20	13.33	0.39
9404	193	206	13.00	6.74	0.92
9403	5	12	6.60	132.00	2.29
9402	32	25	-7.20	-22.50	1.35
9401	188	186	-1.80	-0.96	0.13
9400	60	59	-0.60	-1.00	0.08
9290	386	355	-31.20	-8.08	1.62
9289	3	6	3.00	100.00	1.41
9288	555	565	10.40	1.87	0.44
9287	10	9	-1.00	-10.00	0.32
9286	0	2	2.20	inf	2.10
9285	5	9	4.20	84.00	1.58
9077	488	492	3.60	0.74	0.16
9076	357	377	20.20	5.66	1.05
9075	460	460	-0.40	-0.09	0.02
9074	438	431	-7.40	-1.69	0.36
9073	380	416	36.20	9.53	1.81

Object	Count - Real Data Set AM - All	Count - AM Model- All	Absolute Difference	Relative Difference (%)	GEH
9072	512	482	-29.80	-5.82	1.34
9071	525	520	-4.60	-0.88	0.20
9070	545	571	25.80	4.73	1.09
9069	360	367	7.20	2.00	0.38
9068	194	186	-7.60	-3.92	0.55
9067	301	325	24.40	8.11	1.38
9064	404	408	4.20	1.04	0.21
9036	705	727	22.20	3.15	0.83
9035	451	445	-5.80	-1.29	0.27
9034	431	439	7.80	1.81	0.37
9033	438	450	12.40	2.83	0.59
9032	698	717	19.40	2.78	0.73
9031	643	615	-27.60	-4.29	1.10
9030	755	738	-16.80	-2.23	0.61
9029	326	326	0.00	0.00	0.00
9028	287	282	-5.40	-1.88	0.32
9027	375	381	5.60	1.49	0.29
9025	781	792	11.00	1.41	0.39
9024	667	640	-26.60	-3.99	1.04
8594	9	7	-1.60	-17.78	0.56
8593	118	115	-2.52	-2.14	0.23
8592	305	317	12.64	4.15	0.72
8591	27	26	-1.06	-3.97	0.21
8590	982	995	12.82	1.31	0.41
8589	27	30	3.00	11.11	0.56
8588	71	71	0.06	0.09	0.01
8587	32	33	0.17	0.51	0.03
8586	63	60	-3.52	-5.58	0.45
8585	1961	1897	-63.99	-3.26	1.46
8584	18	23	5.28	29.46	1.16
8582	127	123	-4.12	-3.25	0.37
8581	618	638	20.13	3.26	0.80
8501	343	346	3.12	0.91	0.17
8500	1504	1512	7.81	0.52	0.20
8499	397	419	22.00	5.54	1.09
8497	248	231	-16.60	-6.70	1.07
8496	130	134	4.80	3.70	0.42
8495	709	688	-20.46	-2.89	0.77
8493	176	163	-13.29	-7.53	1.02
8492	503	478	-25.20	-5.01	1.14

Object	Count - Real Data Set AM - All	Count - AM Model- All	Absolute Difference	Relative Difference (%)	GEH
8449	679	647	-32.89	-4.84	1.28
8448	276	287	10.11	3.66	0.60
8443	292	316	24.37	8.34	1.40
8442	838	823	-15.27	-1.82	0.53
10693	1283	1316	33.00	2.57	0.92
10450	3	9	6.00	200.00	2.45
10449	45	45	0.00	0.00	0.00
10443	31	36	5.20	16.77	0.90
10442	1345	1357	12.20	0.91	0.33
10441	20	13	-6.60	-33.00	1.62
10440	2062	1963	-99.20	-4.81	2.21
10382	1333	1371	38.40	2.88	1.04
10381	4	3	-1.40	-35.00	0.77
10372	8	8	0.00	0.00	0.00
10354	184	192	8.00	4.35	0.58
10353	13	17	4.40	33.85	1.13
10338	226	228	1.60	0.71	0.11
10336	1057	1087	29.80	2.82	0.91
10324	165	168	3.00	1.82	0.23
10323	72	62	-9.80	-13.61	1.20
10295	259	257	-1.60	-0.62	0.10
10281	225	245	20.40	9.07	1.33
10280	2038	1970	-67.60	-3.32	1.51
10279	387	383	-4.40	-1.14	0.22
10261	209	210	0.80	0.38	0.06
10257	226	234	7.60	3.36	0.50
10255	1990	1913	-76.80	-3.86	1.74

PM Peak Turning Movement Statistics

Object	Count - Real Data Set PM - All	Count - PM Model - All	Absolute Difference	Relative Difference (%)	GEH
9867	157	141	-16.48	-10.49	1.35
9866	1181	1206	24.30	2.06	0.70
9650	4	3	-0.60	-15.00	0.31
9649	1	0	-0.80	-80.00	1.03
9648	35	36	1.20	3.43	0.20
9647	5	2	-2.60	-52.00	1.35
9646	2	1	-1.40	-70.00	1.23
9645	7	7	0.40	5.71	0.15
9644	1	2	1.20	120.00	0.95
9643	0	1	1.20	inf	1.55
9642	83	77	-6.20	-7.47	0.69
9641	15	7	-7.60	-50.67	2.27
9640	65	61	-4.40	-6.77	0.56
9639	162	154	-8.40	-5.19	0.67
9543	5	2	-3.20	-64.00	1.74
9542	0	2	2.20	inf	2.10
9540	1	2	1.00	100.00	0.82
9539	3	4	0.60	20.00	0.33
9537	12	9	-3.40	-28.33	1.06
9536	15	11	-3.80	-25.33	1.05
9510	397	406	9.43	2.38	0.47
9509	697	724	27.56	3.96	1.03
9405	3	4	1.40	46.67	0.73
9404	74	77	3.20	4.32	0.37
9403	2	6	4.00	200.00	2.00
9402	162	161	-1.00	-0.62	0.08
9401	72	66	-6.20	-8.61	0.75
9400	138	131	-6.60	-4.78	0.57
9290	322	325	2.60	0.81	0.14
9289	4	6	1.80	45.00	0.81
9288	168	175	7.40	4.40	0.56
9287	0	1	1.20	inf	1.55
9286	1	2	0.80	80.00	0.68
9285	1	2	0.80	80.00	0.68
9077	184	189	4.60	2.50	0.34
9076	334	343	8.60	2.57	0.47
9075	285	280	-5.00	-1.75	0.30
9074	223	236	13.40	6.01	0.88
9073	147	160	13.40	9.12	1.08

Object	Count - Real Data Set PM - All	Count - PM Model - All	Absolute Difference	Relative Difference (%)	GEH
9072	223	202	-20.60	-9.24	1.41
9071	304	315	10.80	3.55	0.61
9070	348	373	25.40	7.30	1.34
9069	103	100	-2.60	-2.52	0.26
9068	110	101	-9.00	-8.18	0.88
9067	235	238	3.20	1.36	0.21
9064	186	176	-10.00	-5.38	0.74
9036	535	548	13.40	2.50	0.58
9035	288	285	-2.60	-0.90	0.15
9034	235	236	1.40	0.60	0.09
9033	220	233	13.00	5.91	0.86
9032	550	550	0.40	0.07	0.02
9031	583	608	25.00	4.29	1.02
9030	686	710	24.20	3.53	0.92
9029	117	129	12.00	10.26	1.08
9028	202	186	-15.60	-7.72	1.12
9027	233	235	1.80	0.77	0.12
9025	590	597	6.60	1.12	0.27
9024	655	661	6.20	0.95	0.24
8594	5	6	0.60	12.00	0.26
8593	46	42	-3.79	-8.25	0.57
8592	387	400	13.13	3.40	0.66
8591	71	73	2.39	3.36	0.28
8590	1701	1702	1.08	0.06	0.03
8589	10	9	-1.40	-14.00	0.46
8588	36	41	4.63	12.87	0.75
8587	22	24	1.83	8.42	0.38
8586	130	136	5.94	4.57	0.52
8585	1205	1207	2.24	0.19	0.06
8584	38	44	6.49	17.13	1.01
8582	51	47	-3.59	-7.04	0.51
8581	235	256	20.53	8.73	1.31
8501	326	316	-9.87	-3.03	0.55
8500	855	886	30.17	3.53	1.02
8499	349	357	7.80	2.23	0.42
8497	348	366	17.96	5.17	0.95
8496	177	185	8.45	4.79	0.63
8495	1356	1357	1.37	0.10	0.04
8493	134	145	10.83	8.06	0.92
8492	302	305	2.60	0.86	0.15

Object	Count - Real Data Set PM - All	Count - PM Model - All	Absolute Difference	Relative Difference (%)	GEH
8449	436	452	15.43	3.54	0.73
8448	178	170	-8.05	-4.53	0.61
8443	232	222	-9.97	-4.30	0.66
8442	1533	1545	12.82	0.84	0.33
10693	1721	1713	-7.80	-0.45	0.19
10450	5	7	1.80	36.00	0.74
10449	50	55	5.00	10.00	0.69
10443	49	47	-2.00	-4.08	0.29
10442	1851	1867	16.40	0.89	0.38
10441	11	13	2.20	20.00	0.63
10440	1304	1286	-18.40	-1.41	0.51
10382	1852	1863	11.00	0.59	0.26
10381	1	0	-1.00	-100.00	1.41
10372	4	8	3.60	90.00	1.49
10354	390	412	22.40	5.74	1.12
10353	14	12	-2.00	-14.29	0.55
10338	77	74	-2.80	-3.64	0.32
10336	1644	1639	-5.40	-0.33	0.13
10324	224	221	-3.40	-1.52	0.23
10323	125	134	9.20	7.36	0.81
10295	264	266	1.80	0.68	0.11
10281	72	73	0.60	0.83	0.07
10280	1156	1175	19.00	1.64	0.56
10279	248	251	2.80	1.13	0.18
10261	133	114	-18.80	-14.14	1.69
10257	125	142	16.80	13.44	1.45
10255	1269	1260	-9.00	-0.71	0.25