Woorong Park Pty Ltd on behalf of the Department of Planning and Infrastructure
19 April 2013

Marsden Park Precinct

Traffic and Transport Assessment

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Prepared for

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Prepared by

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3	19-Apr-2013	Final report (with post-exhibition submission addressed)	Andy Yung Principal Transport Planner - Strategic Planning and Advisory	

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Executive Summary

Context

This report assesses the transport and access requirements of an Indicative Layout Plan for Marsden Park Precinct in the North West Growth Sector. This document will be part of a suite of documents forming the overall Marsden Park Precinct Plan. This report covers a range of transport modes and considers improvements to public transport and walking and cycling networks to ensure planned sustainable accessibility and transport opportunities for these communities in future. A detailed assessment of road network opportunities has been undertaken from both a strategic point of view and more local analysis to ensure appropriate highway connections and capacity to meet future forecast traffic volumes.

Road network

The strategic road network analysis has assisted in determining appropriate future highway corridor classifications and methods of control for intersections across the proposed road network for Marsden Park Precinct. The designated road network hierarchy focuses vehicular access on the most appropriate routes to arterial roads via higher order corridors. Vehicles are distributed through the precincts via the hierarchical network of Sub-Arterial, and Collector Roads then via local streets to individual land parcels.

The key strategic corridor serving the precinct is Richmond Road. Richmond Road is an arterial providing connectivity to the M7 motorway, Richmond, and also to the east via intersections with Schofields Road and Garfield Road. Schofields Road and Garfield Road are designated Transit Boulevards providing linkages to the Richmond Line and also across to Rouse Hill. All of these connections will have two to three lanes in each direction and also provide strategic public transport functionality. At ultimate development the Werrington Arterial as an extension of the South Street corridor will also provide a strategic link towards Penrith and the South West Growth Centre.

Through the precinct, the town centre will be a focal point for activity and will contain a north-south spine, with South Street and Marsden Park Industrial to the south, and linking through to the Vine Street and Garfield Road extensions to the north. This connection has also been identified as a potential corridor providing increased priority for public transport. The extension of Garfield Road to the Werrington Arterial will function as a sub-arterial corridor, providing an alternative route to Richmond Road, allowing regional through traffic to bypass the town centre.

An east-west road between Richmond Road and Stony Creek Road will provide a collector function for the majority of residential parcels within the precinct. A north-south collector running will also provide connectivity to a K-12 school and neighbourhood centre, located to the north of the precinct.

Intersections

All the intersections across the precincts have been designed so they will accommodate future year traffic volumes associated with the proposed full development of the precinct as well as wider regional development. The intersections will all operate at an acceptable level of service during the morning peak hour and evening peak hour, with appropriate forms of control.

In line with RMS guidance all intersections within the precinct which are proposed to be signalised have been assessed to perform at Level of Service (LoS) D or above, at full development in 2036, and therefore will provide adequate capacity and operational efficiency. Along Richmond Road heavy regional traffic demands associated with the surrounding network results in two intersections operating at LoS E, however within capacity DoS <1.

Sensitivity tests were undertaken to identify if additional capacity on Richmond Road through an additional northbound and southbound lane (three lanes in each direction) could improve operational performance, however was only found to attract additional traffic to the route and negatively impact operational performance. Localised widening or signal coordination with adjacent intersection will be required to improve operational performance at the intersection of Richmond Road | Garfield Road to LOS D. Improving the performance of the Richmond Road / South Street intersection to LoS D was not assessed since the intersection is the subject of the Marsden Park Industrial assessment.

Heavy Goods Vehicles

The proposed residential land uses within the Marsden Park Precinct are unlikely to generate a significant amount of heavy vehicles. Conversely, the adjacent industrial and commercial development within Marsden Park Industrial Precinct are likely to generate significant volumes of heavy vehicles.

A heavy goods vehicle (HGV) access strategy has been developed to prioritise HGV movements onto appropriate routes, to minimise conflict with residential land uses.

This envisages HGVs utilising roads of appropriate form and function, being those classified as an arterial. This would include Richmond Road and the Werrington Arterial. Delivery vehicles requiring access to retail premises within the town centre and neighbourhood centre, are likely to use available collector roads.

Public Transport Framework

The precinct will benefit from good public transport accessibility through a comprehensive proposed bus network and bus servicing strategy linking key centres, transport nodes, schools, employment opportunities and residential areas.

Key bus operating corridors, such as Schofield Road and Garfield Road, will provide efficient regional connections to connecting rail services such as the Richmond Line and future North West Rail link. Other notable regional destinations that will be available through public transport connections will include employment areas at Riverstone and Box Hill, and also the Rouse Hill Major Centre.

A draft bus strategy, Sydney's Bus Future, is currently being developed which is anticipated to provide regional plans for the NWGC and determine the bus network for Marsden Park Precinct.

Given the draft status of the bus strategy and the on-going development of how specific bus routes will be operating within Marsden park Precinct, it has been agreed with TfNSW that the proposed collector road and sub-arterial road network within the precinct are designed to accommodate bus routes to provide local, district and regional connectivity to public transport services within the North West Growth Centre. The bus capable road network provides connectivity to Richmond Road and the future transit boulevards of Schofields Road and Garfield Road, which can accommodate the bus routes identified for investigation in the NSW LTTMP. These bus routes include:

- Rouse Hill to Blacktown via Marsden Park;
- Penrith to Rouse Hill via Marsden Park;
- Marsden Park to Prairiewood; and
- Mount Druitt to Schofields via Marsden Park.

With the proposed bus capacble roads within the precinct, it is expected at least 90 per cent of the Precinct will be within 400m of a potential bus routes. Within the precinct, roads serving bus routes should have two lanes in each direction or one lane in each direction with a parking lane that could accommodate a bus stop. Lane widths need to be a minimum of 3.5 metres. Indented bus stops are not recommended and, where bus stops are located in proximity to education or activity centres, safe pedestrian crossing facilities have been proposed.

Proposed signalised intersection on Richmond Road will also provide bus priority through bus lanes commencing at the left turn diverge. These short bus lanes will allow opportunity for buses to bypass stop line queues, and direct access to bus stops on the intersection exit. This together with signal coordination in the peak direction will improve bus journey time reliability on the Richmond Road corridor. The central town centre north-south spine has also been identified as a key corridor for bus priority.

Pedestrian and Bicycle Networks

There are good opportunities for walking and cycling within the study area, but the limited existing provision of walking and cycling facilities within the precincts will not be appropriate to future demands.

Providing viable alternatives to the private car for journeys with destinations both within and outside the precincts is essential to encourage the sustainable development of the precincts. In particular it will be important to connect internal roads within the precinct with direct pedestrian and cycle connections to allow access to the future centres, schools, retail, employment, public transport nodes and other trip attractors in the area.

A comprehensive bicycle network is proposed for Marsden Park Precinct which will link the centres, schools, transport nodes and various residential neighbourhoods with key strategic routes and onward destinations. The proposed bicycle network will include a mixture of dedicated bicycle facilities which will take the form of off-road (shared path) and on-road (cycle lane) routes. Shared paths are provided adjacent to sub-arterial and collector corridors, resulting in a grid like network with approximately 800m between linkages.

Off-road shared paths are proposed along all arterial and sub-arterial roads providing a network of high order bicycle facilities for fast, efficient connections for travel between Marsden Park Precinct to regional destinations. These linkages are generally provided on the precinct boundary along Richmond Road and South Street extension, and also connecting transit boulevards such as Schofields Road and Garfield Road west.

Within the precinct, all collector roads will also have available shared path bicycle facilities to allow connections between key origins (residential) and destinations within the precinct and onto the external linkages. The proposed cycling connections are designed to create a continuous network of facilities removing obstacles and barriers to cycling, both physical and perceived.

All proposed roads throughout the Marsden Park Precinct will have pedestrian footpaths to create a comprehensive network following proposed road alignments. In order to ensure connectivity of the pedestrian network the provision of pedestrian crossing opportunities will be provided in areas likely to have increased pedestrian activity, such as within the town centre, or in proximity to schools or sporting fields.

The proposed road grid network and block sizes will also work to facilitate pedestrian permeability and be conducive to encouraging walking trips. As the network has been designed around a linear grid structure the regular cross streets with pedestrian footpaths, and block sizes will encourage pedestrian activity, and achieve a high level of permeability.

There is also opportunity to provide for recreational walking and cycling by creating links to open space, recreational areas and providing off-road paths within the conservation area towards the south west, under transmission line easements or within the riparian corridor.

Green Travel Plans should be established for schools within the Marsden Park Precinct. These should be integrated into the curriculum for the school and encourage parents and children to walk, cycle or catch public transport for journeys to school. Reducing the number of local car trips to schools is likely to result in better health, better social interaction at the community level, air quality improvements and road safety benefits. This is also important in establishing behaviours which continue later in life and an important part of the development of healthy, sustainable, active communities in Marsden Park Precinct.

1.0 Introduction

1.1 Background

The Metropolitan Plan for Sydney 2036 (December, 2010) reaffirmed the pressures being faced by the metropolitan area in terms of residential growth and associated demands for the economy and employment, housing, transport, environment and resources, parks and public places.

In response, the North West and South West Growth Centres were identified as the location for new communities to accommodate up to 500,000 people over the next 30 years. The growth centres will include land for 200,000 homes, 2,500 hectares for employment land, more than 70 schools and five bus / rail interchanges.

The overall direction of development in each Growth Centre is guided by the Structure Plan, with the timing, sequencing and planning undertaken at precinct wide level. Precinct planning is a coordinated process considering the precincts development potential with the aim of better coordination of infrastructure delivery and environmental outcomes.

The development of sustainable communities and best practice principles can provide residents within the growth centre increased choice in education, employment, leisure opportunities and travel decision. The technical studies that inform precinct planning, allows an integrated approach to achieving these sustainable outcomes.

The North West Growth Centre is approximately 10,000 hectares and will contain approximately 67,000 new residential lots within 16 Precincts. Eight of these precincts have been rezoned; these are North Kellyville, Alex Avenue, Riverstone, Riverstone West, Colebee, Area 20, Schofields and Marsden Park Industrial. Box Hill, Box Hill Industrial, and Riverstone East (part-released) precinct planning is still ongoing. Four precincts are still unzoned which includes; Shanes Park, Marsden Park North, West Schofields and Vineyard.

The Marsden Park Precinct (the Precinct) is a 1,800 hectare precinct which is expected to accommodate 10,000 residential dwellings, and supported by education and local activity centres. The Precinct is bounded by Marsden Park North and South Creek to the north, Marsden Park Industrial to the south, Shanes Park to the west and Schofields West to the east.

The Precinct together with the regional context of the North West Growth Centre is shown in **Figure 1-1**.

Figure 1-1 Regional context of the North West Growth Centre and Marsden Park Precinct

Source: Growth Centres Commission, 2011

1.2 Purpose and scope

AECOM has been appointed by Woorong Park Pty Ltd on behalf of the Department of Planning and Infrastructure (DP&I) to undertake a transport assessment of the Indicative Layout Plan (ILP) for the Marsden Park Precinct. The purpose of this study is to provide a transparent and robust assessment of the ILP by all modes of transport including walking, cycling, public transport and passenger vehicles. Integrated land use and transport planning provides residents increased travel choice and enables the development of sustainable communities.

The primary outcomes of the Transport and Access Strategy include:

- Consultation with NSW government agencies and local council;
- Confirmation of walking, cycling, public transport and road networks; and
- Identification of opportunities to improve these networks through changes to the ILP.

The Transport and Access Strategy identifies suitable facilities for people to walk, cycle, access to public transport or use private cars. This process enables people to make the most appropriate choice of transport mode for their journey, and ensures that the built environment supports travel choice; including walking for short trips to local shops, cycling to community centres or catching a bus to work. The communities are designed to increase travel choice, accessibility and reduce dependency on private cars and hence reduce the associated emissions generated by high levels of private car use.

1.3 Report framework

Each section of this report considers one mode of transport and has been structured into the following sections:

- Summary of approach/methodology to investigations;
- Description of existing conditions/situation;
- Description of impacts of the ILP/proposed development; and
- Recommended measures to manage the impacts.

2.0 Indicative Layout Plan

2.1 Introduction

Precinct Plans are the adopted approach to the delivery of greenfield residential developments, the intention being to achieve high quality design and planning outcomes, including easy access to jobs and major town centres, with streets and suburbs planned so that walking and cycling are practical transport modes for local trips, and frequent bus services link to the rail network for longer journeys.

Through an iterative process, a preliminary Indicative Layout Plan (ILP) for the Marsden Park Precinct has been developed by AECOM, commissioned by the(DP&I).

The transport network within the precinct plan broadly follows the North West Growth Centre road framework, with maximised opportunities for land use and transport integration.

2.2 Land use and built form

The NSW Government has clearly identified its vision for the growth centres as an opportunity to deliver new homes in a sustainable way. To achieve this outcome it is necessary to plan for a range of land uses that provide a balanced mix of housing, employment shops, services and activity centres. It is recognised that land use, built form and transport are intrinsically linked in planning terms, with good urban design helping to achieve good transport outcomes and vice versa.

A range of housing choices provides for different needs and different incomes, such as houses on their own block of land along with smaller medium density homes and terraces for older people and young singles or couples.

Residents from within the Precinct will have easy access to a town centre located to the south east of the Precinct along with a smaller village centre and neighbourhood shops for daily needs. These centres, together with centres such as Rouse Hill and Castle Hill will provide a full range of shops, recreational facilities and services.

Education facilities are available through a K-12 school located centrally within the precinct, and three primary schools located across the precinct to maximise catchment and accessibility.

2.3 Location

The Marsden Park Precinct is located within Blacktown City Council local government area (LGA) towards the western extent of the North West Growth Centre. It is bordered by new release precincts including Marsden Park North, Marsden Park Industrial, and Schofields West.

In the wider area, the Precinct is located approximately 50km from the Sydney CBD, 12km northwest of Blacktown and 10km west of Rouse Hill.

2.4 Draft Indicative Layout Plan

The Marsden Park Precinct Draft Indicative Layout Plan (ILP) has been developed by AECOM through an iterative process over a period of time. The process has involved multiple stakeholders across a range of technical disciplines, providing inputs and guidance relating to the Precinct's development opportunities and constraints.

The Draft ILP includes a variety of complementary land uses, which are described within this section and illustrated in **Figure 2-1**.

2.4.1 Residential land uses

The Precinct will accommodate approximately 10,600 dwellings; it will predominately consist of low residential housing with several medium and high density housing in key locations including along primary road corridors, and surrounding retail and commercial areas, and schools and sporting fields.

Population density will be a key factor determining the level of transport demand generated by the residences in various parts of the Precinct. Estimates of population density suggest an average of 2.9 persons per dwelling or 30,800 residents for the Marsden Park Precinct.

2.4.2 Town and local neighbourhood centres

The town centre is proposed to be located in the southeast of the Precinct and include 40,000 sqm GFA of retail, 10,000 sqm GFA of commercial and community uses. This town centre is adjacent to the boundary between the Marsden Park Precinct and Marsden Park Industrial Precinct, with direct links to the key road corridors including Richmond Road and South Street.

Two smaller retail / commercial centres are proposed towards the north and west of the Precinct.

It should be noted that the specific location of the Town Centre is still being explored in light of the recent Government announcement for a Public Transport Corridor to be located in the south east of the precinct. Refer to **Section 4.4.4**

2.4.3 Educational land uses

The Draft ILP proposes a number of school-zoned areas within the Precinct, the largest of which is located centrally and intended as a K-12 for 840 students. All school-zoned areas are located with good connectivity to the immediate and wider road network; it is important to provide connectivity to school areas via sustainable transport modes including walking, cycling, and public transport.

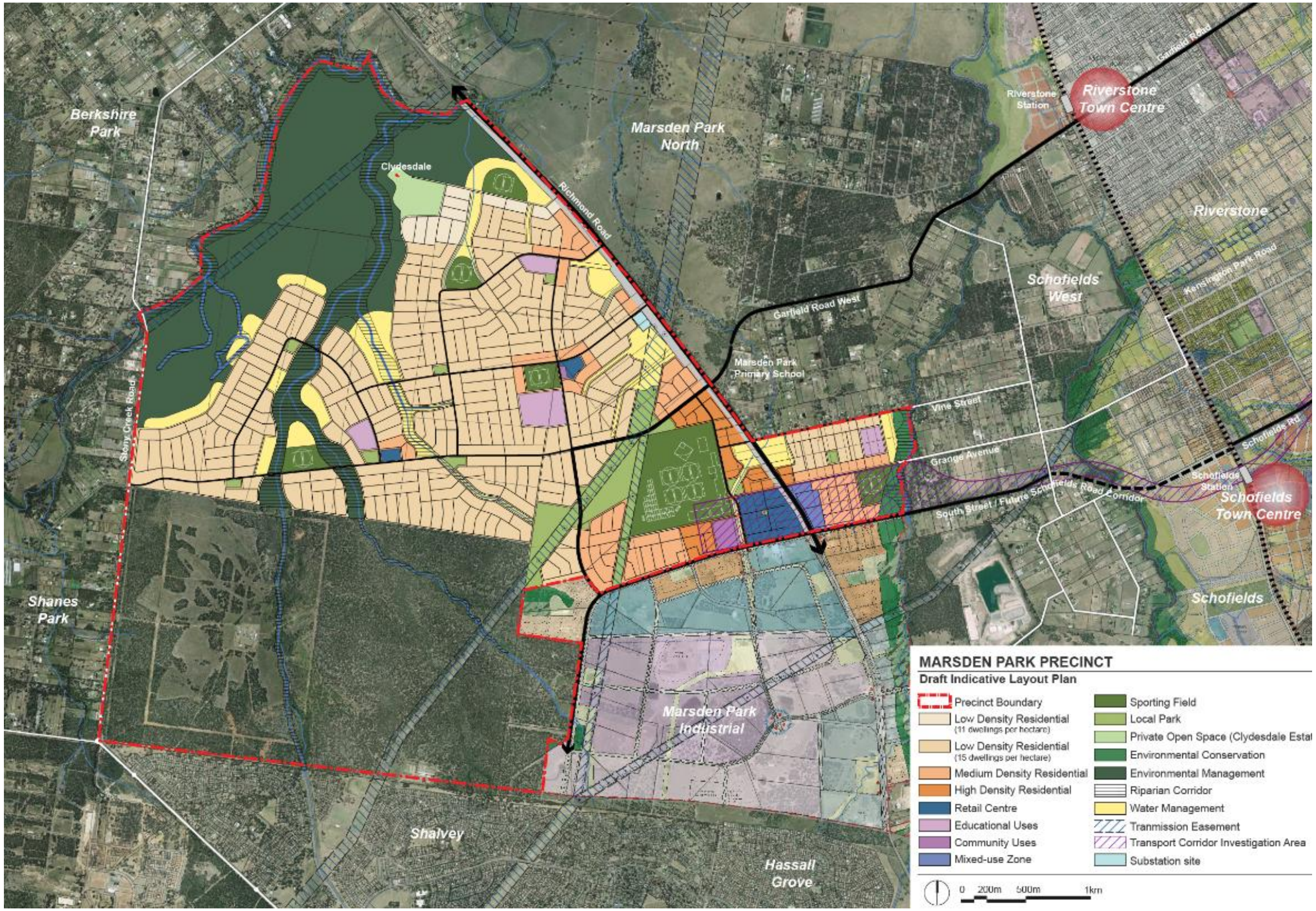
All of the school-zoned areas are also co-located with local centres and/or medium or high density residential areas.

2.4.4 Community uses and open space

Numerous local parks and sporting fields are proposed throughout the Precinct, in addition to the preservation of significant areas of the existing natural landscape. The largest developed community use space in the Precinct would be a large sports area located directly to the west of the primary retail and commercial centre. It is intended that open space and recreational areas would be easily accessible by public transport and/or walking and cycling routes.

The existing natural landscape includes a number of riparian corridors, the most significant of which are linked to South Creek and run between the northern and southern boundaries of the Precinct. These corridors would be preserved, and provide the opportunity for recreational walking and cycling routes, encouraging physical activity and providing health and wellbeing benefits to the community. It is noted that the provision of walking and cycling routes within riparian corridors may require the resolution of access and security at the rear of privately owned properties.

Figure 2-1 Marsden Park Precinct Draft Indicative Layout Plan



Source: AECOM, 2012

3.0 Road Network

3.1 Introduction

This section establishes principles for the design of road networks and then describes how the Precinct Plan has been tested against these guidelines.

3.2 Principles and guidelines

Guidelines for road network design can be allocated into three main categories:

- Road classification (road hierarchy) – how will traffic move through the precincts and are roads designed to accommodate particular function in mind?
- Road capacity – are adequate lanes provided on the streets to accommodate traffic without significant congestion?
- Intersection performance – are delays at intersections acceptable?

3.2.1 Road classification

Roads fall into a hierarchy of functional classes. The standards relating to each road are dependent upon this classification. Descriptions of each classification are shown in the tables below. **Table 3-1** shows the Austroads classifications and a description of the functionality of each.

Table 3-1: Urban road functional classification (Austroads)

Type of road	Function
Controlled access highways (motorways or freeways)	Motorways and freeways have an exclusive function to carry traffic within cities and to ensure the continuity of the national or regional primary road system. As they are designed to accommodate through traffic, they do not offer pedestrian or frontage access.
Urban arterial roads	Urban arterial roads have a predominant function to carry out but also serve other functions. They form the primary road network and link main districts of the urban area. Arterial roads that perform a secondary function are sometimes referred to as sub-arterial roads.
Urban collector/distributor roads	These are local streets that have a greater role than others in connecting contained urban areas (e.g. residential areas, activity areas) to the arterial road system. Generally, consideration of environment and local life predominate and improved amenity is encouraged over the use of vehicles on these roads.
Urban local roads	These are roads intended exclusively for access with no through traffic function.

Source: Austroads Guide to Road Design Part 2: Design Considerations 2006

NSW Roads and Maritime Services (RMS, formerly RTA) and Department of Planning (formerly Growth Centres Commission) have developed guidelines for classification of roads. **Table 3-2** summarises the RMS functional classification system.

Table 3-2: Functional classification of roads (NSW Roads and Maritime Services)

Road Type	Traffic Volume (AADT)	Through Traffic	Inter-Connections	Speed Limit (km/h)
Arterial/Freeway	No limit	Yes	Sub-arterial	70-110
Sub-Arterial	<20,000	Some	Arterial/Collector	60-80
Collector	<5,000	Little	Sub-arterial/Local	40-60
Local	<2,000	No	Collector	40

Source: Updated Guidelines for Functional Classification of Roads in Urban Areas, RMS, 1993

The Growth Centres Development Code (Growth Centres Commission, 2006) classifications, shown in **Table 3-3**, are broadly consistent with the RMS classifications, except with higher traffic volumes (AADT) limits for all road types, reflecting the amount of traffic that have been carried on elements of Sydney road network. These classifications have been designed for the growth centres and have therefore been adopted in this study.

Table 3-3: Functional classification of roads (Department of Planning and Infrastructure)

Road Type	AADT	Functions and Connections	Speed Limit
Arterial/Freeway	35,000+	Connects large urban areas	Up to 80km/h
Transit Boulevard	30,000 – 35,000	Located close to centres, Pedestrian friendly environment Allow for long term upgrades and dedicated busways	60 to 80km/h
Sub-Arterial	10,000 – 35,000	Arterial roads to town centres Carries major bus routes	Up to 70km/h
Collector	3,000 – 10,000	Connects neighbourhoods Can accommodate public transport	Up to 60km/h
Local	1,000 – 3,000	Priority to pedestrians and cyclists Designed to slow residential traffic	Up to 50km/h

Source: Growth Centres Development Code, GCC, October 2006

3.2.2 Road capacity

Mid-block capacity requirements for Richmond Road and the internal network have been ascertained based on Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis, Section 5.2.1, Table 5.1 and explanatory notes.

The Richmond Road corridor meets the conditions allowing a peak mid-block capacity of 1,200 to 1,400 vehicles per lane per hour. The conditions include: flaring at major upstream intersections, high volumes of traffic from upstream intersections during more than one phase of a signal cycle, absence of parking and good co-ordination of traffic signals along the route.

Mid-block capacity for internal links within the precinct are assumed to be in the order of 900 to 1,000 vehicles per lane per hour for median or kerbside lanes with no parking, at kerbside lanes with parking the mid-block capacity is 600 vehicles per lane per hour.

3.2.3 Intersection performance

The capacity of an urban road network is controlled by the capacity of the intersections within that network. Average delay is commonly used to assess the actual performance of intersections, with Level of Service used as an index. A summary of the Level of Service index is shown in **Table 3-4**.

Level of Service D is generally accepted by the RMS as a design constraint. The other important intersection measurement is Degree of Saturation (DoS), or the ratio of flow to capacity. It is generally accepted that intersections should have a degree of saturation of less than 0.9.

Table 3-4: Level of service criteria for intersections

Level of Service	Average Delay / Vehicle (sec/veh)	Traffic Signals, Roundabout	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	At capacity; requires other control mode
F	>70	Roundabouts require other control mode	At capacity; requires other control mode

Source: Guide to Traffic Generating Developments, RMS 2002

3.3 Existing road network

3.3.1 Existing road network – opportunities and constraints

Richmond Road, Garfield Road and the future Schofields Road (currently under construction) will provide the main strategic highway access by car to and from the study area. These routes connect to the wider road network including the Westlink M7 and Windsor Road.

Stony Creek Road provides connectivity to the west of the study area, however is unlikely to function as a dominant access route given project demands and destinations for employment and other attractions.

The South Street extension, which runs east-west along the southern boundary of the study area, is proposed as a sub-arterial. This linkage will form a key entry to the proposed Town Centre from Richmond Road; however will also be shared with the Marsden Park Industrial Precinct and in the future form part of the Werrington Arterial, providing direct connectivity to the M4.

One of the main challenges for the precinct is assuring efficient connectivity to the strategic network and to surrounding centres via corridors proposed in the North West Growth Centre Road Network Strategy. Richmond Road is identified as an arterial road, however, already experiences high demand and congestion at key locations such as at the Richmond Road / Garfield Road intersection.

The proximity of the precinct to Richmond Road provides opportunity to ensure sufficient access to the wider network, and a key focus of the of the study and in particular the traffic modelling component will be planning of the internal road network and how to achieve optimal access to strategic corridors such as Richmond Road and the Werrington Arterial.

A further particular focus of the study has been to plan the internal road network to maximise connectivity to the Town Centre, internal education facilities and to the wider road network. A strong traffic and transport need has been identified to and from the Richmond Road corridor through the precinct planning process. This has needed consideration of:

- Internal road alignment and linkages to intersections on Richmond Road that meet minimum intersection spacing requirements for the arterial;
- Identifying the optimal lane configuration along Richmond Road to optimise the operational performance of along the corridor and avoid attracting additional traffic from alternative strategic links such as Windsor Road; and
- Optimising the operational performance of the signalised intersections between the Precinct and Richmond Road, for both private vehicles and public transport, with a key driver being to enable efficient road access to new stations located at Schofields and Riverstone (Richmond Line) and Rouse Hill (North West Rail Link).

A concept design has been developed by AECOM in close consultation with RMS and DP&I to achieve a balanced approach of maintaining Richmond Road as an efficient through route while maximising accessibility to the future Marsden Precinct.

Provision of additional linkages to Richmond Road is in accordance with the RMS's North West Growth Centre Road Network Strategy and will provide a number of additional benefits for the road network in the vicinity of Marsden Park Precinct. These benefits include:

- Road Functionality –providing parallel routes servicing the residential area to the north of the Town Centre.
- Town Centre Accessibility – the South Street extension would provide direct accessibility to the south of the Town Centre from Richmond Road, with additional connections available from the north via Vine Street and Garfield Road, or direct connections from the south.
- Intersection Capacity - the need for additional intersections to relieve intersection capacity constraints at Richmond Road / South Street and Richmond Road / Garfield Road intersections.
- Traffic Management – Vine Street intersection and connections to the west to act as a traffic relief route during incidents / events within the Town Centre.

3.3.2 Existing road network flows

The Marsden Park Precinct is bounded by Stony Creek Road to the west and Richmond Road, Vine Street West and South Street to the east which forms the road network surrounding and providing access to the precinct, as illustrated in **Figure 3-1**.

3.3.2.1 Richmond Road

Richmond Road is a major arterial road linking major urban and rural areas carrying approximately 28,900 vehicles per day. In the vicinity of the Precinct it is a two lane road with a sealed shoulder for most of its length. Richmond Road provides connections to the M7 Motorway and Rooty Hill Road North to the south, and Blacktown Road and The Northern Road to the north.

Richmond Road has a sign posted speed limit ranging from 60 km/h to 80 km/h adjacent to the Precinct where the existing road experiences significant peak hour traffic congestion and delays. The existing rural/industrial activity in the area generates high volumes of heavy vehicles on the Richmond Road corridor, increasing safety concerns with accidents involving heavy vehicles and increasing the general risk of injury/fatality to persons in traffic accidents.

The RMS is currently planning to upgrade Richmond Road to two lanes in each direction between Bells Creek and Vine Street West, including intersection improvements at key locations. The planned upgrade of Richmond Road would be undertaken to service the expected traffic growth generated by the development within the North West Growth Centre; the improvements would improve road safety and efficiency for motorists, cyclists, pedestrians and bus users.

3.3.2.2 Stony Creek Road

Stony Creek Road is a sub-arterial road providing connections to Richmond Road (via St Marys Road) to the north and Palmyra Avenue to the south. The two lane road has a sign posted speed limit of 80 km/h which runs in a north-south direction.

3.3.2.3 South Street

South Street is a two lane undivided local road with a sign posted speed limit of 60 km/h. The street runs in an east-west direction providing access to residential areas and links to Richmond Road.

The RMS plans to upgrade South Street as part of the Schofields Road corridor project. Schofields Road is planned to be extended to Richmond Road and transformed into a transit boulevard, providing a major east-west connection between Richmond Road and Windsor Road. The transit boulevard will be a four lane divided road, with a wide central median to allow expansion to a six lane corridor to meet the future transport needs of the North West Growth Centre.

3.3.2.4 Vine Street West

Vine Street West is a two lane undivided local road with a sign posted speed limit of 60 km/h. The street runs in an east-west direction providing access to residential lots, and a connection to Richmond Road at its western end.

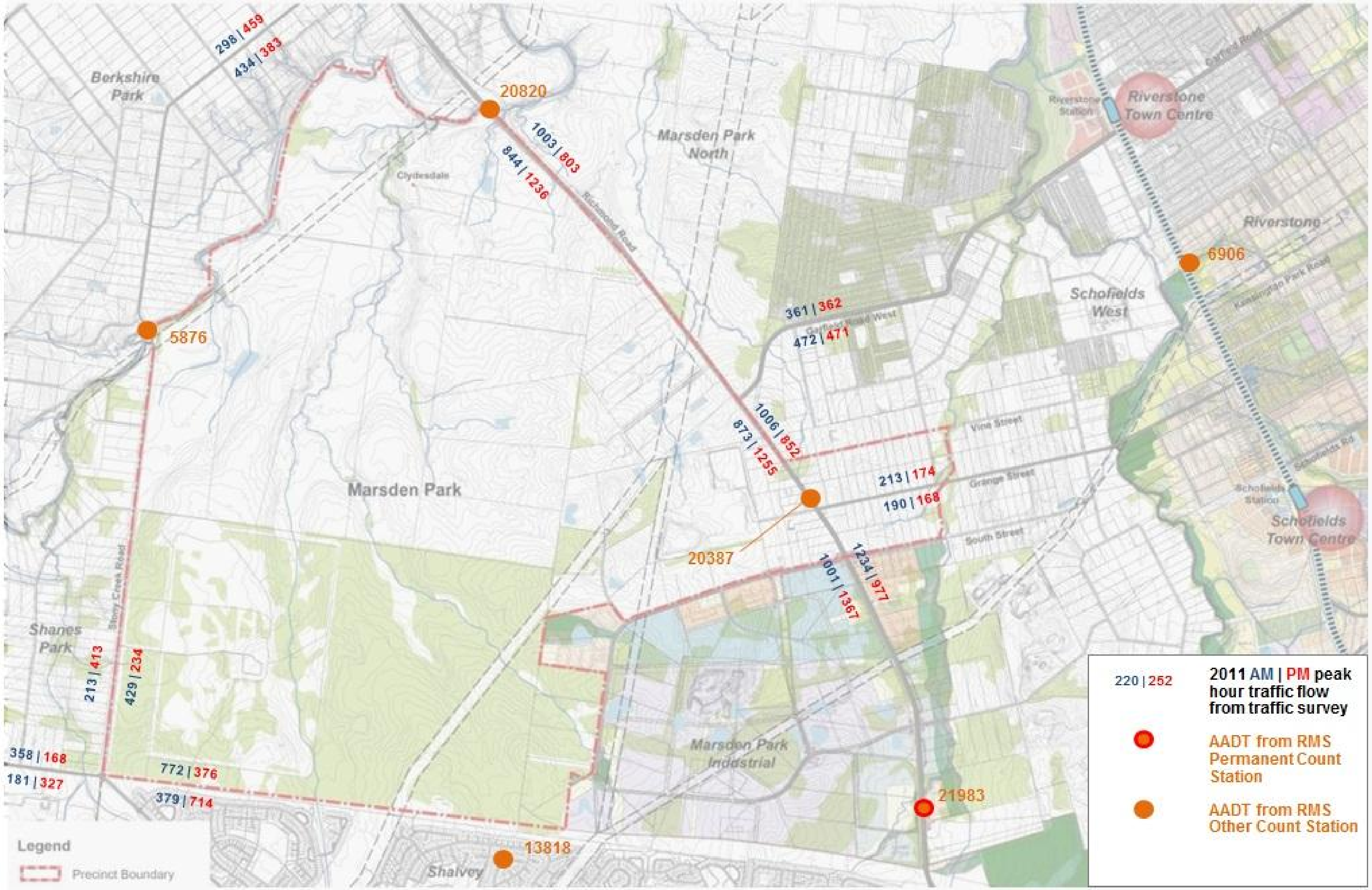
3.3.3 Existing intersections

Existing key intersections on the road network surrounding the Marsden Park Precinct are mainly constrained to Richmond Road.

Garfield Road West provides the primary east-west connection between Richmond Road and Windsor Road, via Riverstone Town Centre. Given the relatively high level of conflicting demand generated, the intersection between Richmond Road and Garfield Road West is signalised with provision for all possible turning movements. Under existing 2011 AM peak hour traffic demands, the intersection of Richmond Road / Garfield Road operates at LoS C, however with the southbound movement greater than 0.9 DOS and 95th percentile queue lengths in the order of 400m, indicating that the intersection is approaching capacity.

Grange Avenue provides an east-west link between Richmond Road and Schofields town centre, although demand is lower than on Garfield Road West. Due to the lower demand, the intersection between Richmond Road and Grange Avenue is priority controlled with all movements allowed.

Figure 3-1 Existing road network and peak hour traffic flows, 2011



Source: AECOM, 2011

Intersections between Richmond Road and Vine Street and Richmond Road and South Street currently provide access to and from local areas; these intersections are priority controlled due to the low levels of demand. Similarly there are a number of additional priority-controlled access points between local roads and properties and Richmond Road in the vicinity of the Precinct.

3.4 Traffic modelling overview

A traffic model has been developed as part of the project to forecast future year traffic volumes in the vicinity of the Marsden Park Precinct. The model takes into account assignment of locally generated car trips on the Precinct road network and provides a framework for network and travel demand scenario testing.

The intent of this model is to identify likely volumes on the strategic road network within the Precinct such that the form of the precinct plan can be confirmed as being appropriate. Information extracted from the model for this purpose includes link flows to confirm the number of lanes required and whether road hierarchy assumptions and network densities are appropriate.

This study has not considered road requirements beyond the boundary of the Precinct. Assessing the capacity of this infrastructure is part of the structure planning process that was undertaken to develop the Infrastructure Plan for the North West Growth Centre by the NSW Government.

3.4.1 CUBE model

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

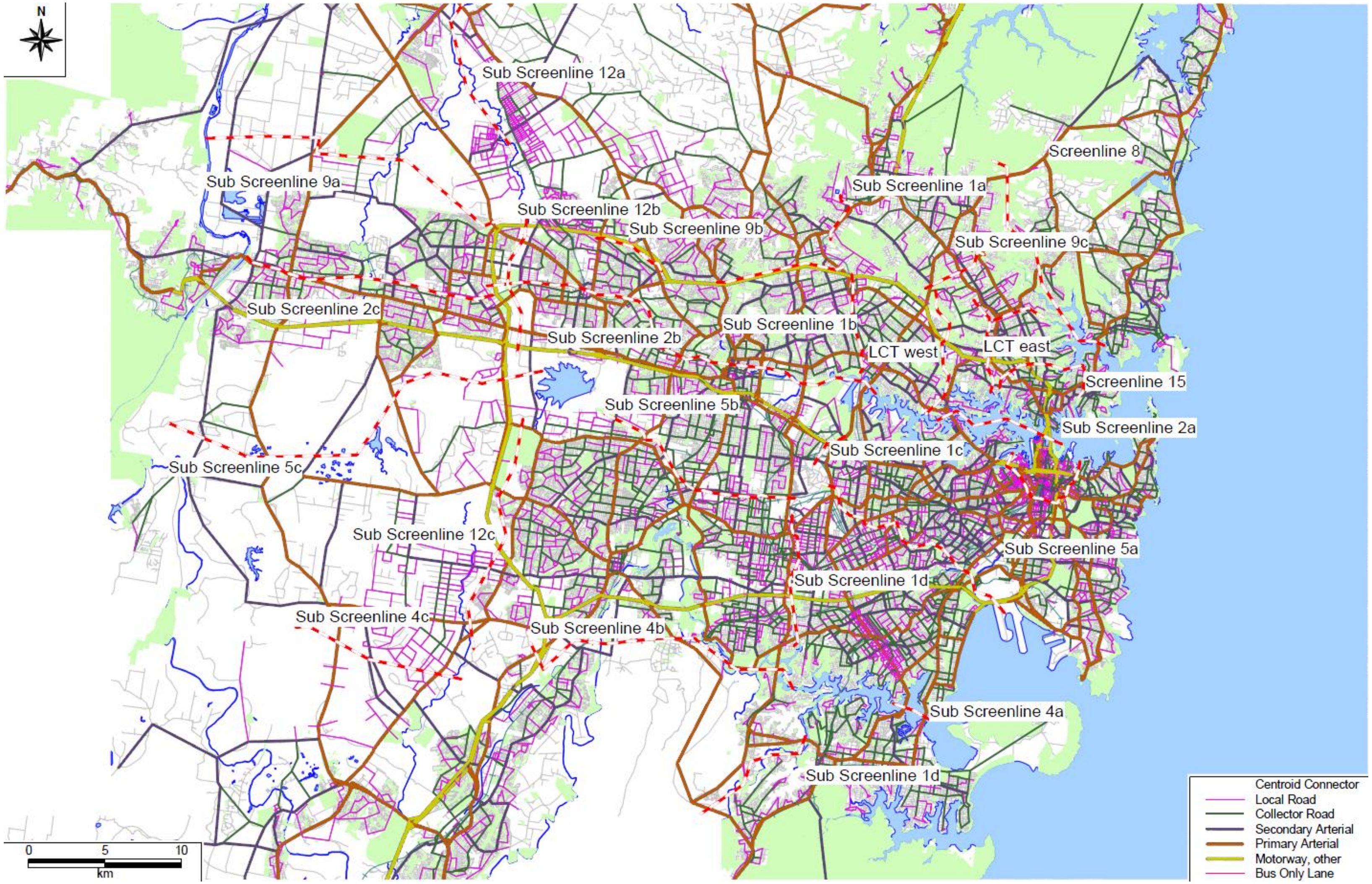
The model can provide traffic volumes on all major links in the Sydney Metropolitan Area road network. The model developed for the project is a strategic, link-based model reflecting all-vehicle demand for an average peak hour. **Figure 3-2** outlines the coverage of the model, as well as the screenlines to which the model is calibrated against. These screenline definitions broadly align with published RMS screenlines across the Sydney road network. Screenline counts are sourced from RTA permanent and sample sites for 2008, with supplementary counts sourced or estimated by AECOM to complete screenlines.

AECOM has used this model to provide traffic forecasts in both South West and North West Growth Centres, including Oran Park and Turner Road, Schofields Transport Assessment (TA) and Austral and Leppington North TA, as well as for the assessment of the Bringelly Road Upgrade. As such, considerable past effort has been invested in the model, ensuring the most contemporaneous data is used regarding network coding, and land use assumptions.

The key aspects of the CUBE model are listed below:

- The model covers the whole of the Sydney Metropolitan region.
- The model defines all the main road links in the Sydney road system in terms of length, capacity and a speed/flow relationship.
- The travel demand on the network is represented as an all-vehicle PCU matrix, with the matrix for the AM average peak including:
    - The peak period journey to work travel demands
    - Travel demands in the peak period for other purposes.
    - Commercial vehicle travel demands.
- The model uses a distributed value of time to incorporate all tolls into generalised cost.
- Model assignment and redistribution of traffic results from changes in utility (generalised cost) as a consequence of new road schemes. This utility takes into account changes in time, distance, speed/flow relationships and toll cost.
- The base year model is well calibrated against 2008 screenline counts.

Figure 3-2 AECOM Sydney strategic model coverage and location of screenlines



Source: AECOM, 2011

3.5 Base year model development

3.5.1 Base year model calibration

Model calibration is an essential stage in the modelling process to demonstrate that the modelled network reasonably reflects existing traffic conditions across the corresponding road network. To build confidence in the model and ensure robust and reliable future year traffic forecasts are produced, the base year model was calibrated to the AM peak hour traffic volumes at key screenline locations throughout the Sydney-wide network.

The screenline definitions broadly align with published RMS screenlines across the Sydney road network and are shown in **Figure 3-2**. For each screenline location, the model calibration process included a comparison of observed against modelled traffic flows and calculation of a Geoffrey E. Havers (GEH) value; this is a commonly used performance measure based on a chi-squared statistic as shown below:

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

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

An acceptable level of calibration is that all (or nearly all) screenline totals are within five per cent of observed flows and have a GEH < 5. **Table 3-5** provides details of the base year model calibration results for grouped screenlines by direction of travel. The table shows that the base year model is well calibrated, with nearly all of the screenline totals within five per cent of observed flows and having a GEH < 5. Only Screenline 12 falls short of the desired criteria for the two calibration measures.

The calibration results for each individual screenline by direction of travel is summarised in **Table 3-5**.

Table 3-5: Base year model screenline calibration summary

Screenline	Direction	Observed (veh/hr)	Modelled (veh/hr)	GEH	% Difference
1. Berowra to Sutherland	Inbound	41,115	40,962	0.8	-0.4%
	Outbound	29,447	29,427	0.1	-0.1%
2. Sydney Harbour to Penrith	Inbound	48,669	48,205	2.1	-1.0%
	Outbound	40,662	40,162	2.5	-1.2%
4. Taren Point to Bringelly	Inbound	20,667	20,524	1.0	-0.7%
	Outbound	10,768	10,517	2.4	-2.3%
5. Kogarah to Wallacia	Inbound	50,541	50,347	0.9	-0.4%
	Outbound	30,471	30,242	1.3	-0.8%
6. Rushcutters Bay to Botany	Inbound	18,679	18,569	0.8	-0.6%
	Outbound	15,482	15,300	1.5	-1.2%
7. Drummoyne to Marrickville	Inbound	14,136	13,998	1.2	-1.0%
	Outbound	8,238	8,100	1.5	-1.7%
8. Pittwater to Manly	Inbound	9,538	9,564	0.3	0.3%
	Outbound	5,865	5,866	0.0	0.0%
9. Castlereagh to St Ives	Inbound	29,407	29,528	0.7	0.4%
	Outbound	17,930	17,919	0.1	-0.1%
12. Campbelltown to Windsor	Inbound	20,113	19,329	5.6	-3.9%
	Outbound	15,130	14,303	6.8	-5.5%
15. Lane Cove to North Shore	Inbound	18,332	17,922	3.0	-2.2%
	Outbound	12,216	12,048	1.5	-1.4%
16. West and South of the CBD	Inbound	19,497	19,884	2.8	2.0%
	Outbound	14,163	13,803	3.0	-2.5%

Source: AECOM, 2011

3.6 Future year model development

Land use in the North West Growth Centre and Western Sydney is expected to change dramatically in the next 20 to 30 years, which will have a subsequent impact on the demands for travel.

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

3.6.1 Future Year Demand

Future year trip ends have been calculated using the AECOM Trip End Modification Model (TEMM), which has been developed to generate different future year trip ends based on:

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

3.6.2 Future year land use assumptions

The Metropolitan Plan for Sydney 2036 (NSW Government, 2010) identified a need to plan for 770,000 new homes in Sydney between 2006 and 2036.

The Sydney metropolitan region is divided into 10 Subregions for strategic planning purposes. The North West Subregion covers Baulkham Hills, Blacktown, Blue Mountains, Hawkesbury and Penrith local government areas (LGAs) and includes the North WestGrowth Centre. The relationship between the North West Subregion and the growth centre are shown in **Figure 3-3**.

The latest Department of Planning and Infrastructure forecasts for the North West Growth Centre comprises 16 precincts, which includes approximately 10,000 hectares of land and a planned capacity of approximately 67,000 new residential lots, or approximately 180,000 new residents. Approximately 40% of the future residential dwelling supply estimated in the North West Subregion will be provided in the growth centre. Other growth areas are provided within surrounding LGAs including Baulkham Hills, Blacktown and Penrith.

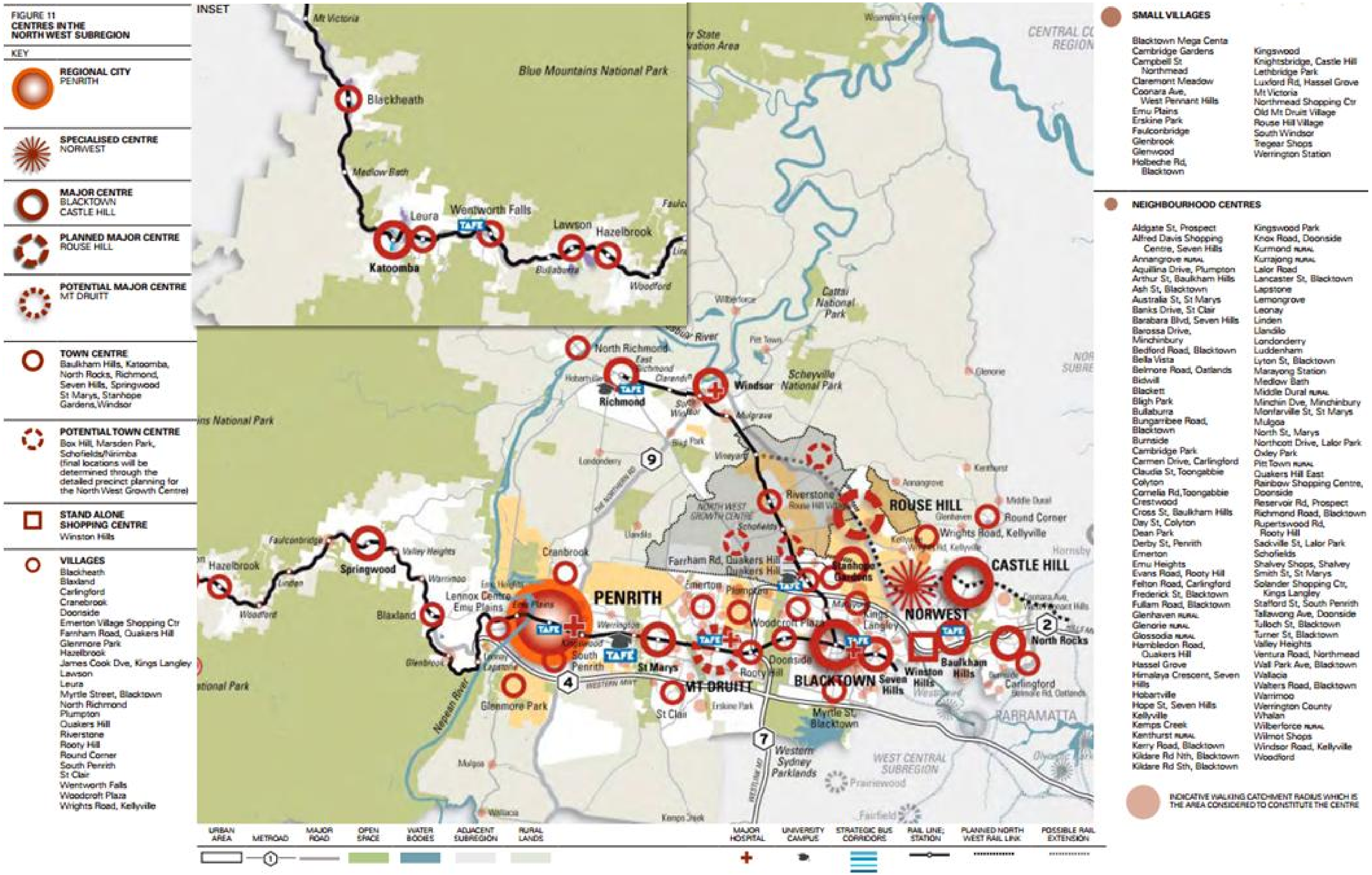
Eight of these precincts in the North West Growth Centre have been rezoned; these are North Kellyville, Alex Avenue, Riverstone, Riverstone West, Colebee, Area 20, Schofields and Marsden Park Industrial. Box Hill, Box Hill Industrial, and Riverstone East (part-released) precinct planning is still ongoing. Four precincts are still unzoned which includes; Shanes Park, Marsden Park North, West Schofields and Vineyard. The (DP&I)has supplied AECOM forecast dwelling numbers for every five years between 2016 and 2036 for each of the precincts for the purpose of model development.

A summary of population growth to ultimate development of the growth centre is summarised in **Table 3-6.** Modelling has assumed that at ultimate development the Marsden Park Precinct would accommodate a population of approximately 31,000 residents.

Table 3-6: Cumulative dwellings, population and employment projections in the North West Growth Centre to 2036

Year	Total lots	Population growth	Forecast population
2011	-	-	15,000
2016	5,949	16,000	31,000
2021	21,349	57,000	72,000
2026	40,454	109,000	124,000
2031	57,256	154,000	169,000
2036	64,453	173,000	188,000
Ultimate	66,791	179,000	194,000

Figure 3-3 Context of north west subregion and North West Growth Centre



Source: Department of Planning, North West Subregional Strategy, 2007

The North West Subregion has a relatively high level of employment self-containment, with a high proportion of people both living and working in the subregion. The North West Subregional strategy aims to at least maintain, or increase, the level of self-containment, reducing the number of additional trips outside the subregion; the delivery of proposed employment targets in major centres near the growth centre and within the subregion will assist in achieving this policy objective.

Following stakeholder engagement, no further self-containment assumptions than is already characteristic of the Blacktown LGA have been applied to the model.

Key employment sectors in the North West Subregion include manufacturing, retail, and wholesaling, as well as significant concentrations of agriculture and forestry related industries, construction, and trade services. The major employment centres and projected long term employment growth in the North West Subregion are shown in **Table 3-7**. Growth will be achieved through the development of new employment and industrial areas, as well as intensification of existing areas, to service the needs of Sydney's rapidly increasing population.

Table 3-7: Major centres and forecast employment in the North West Subregion

Centre	Centre Type	2036 Long Term Employment Capacity Target	2006-2036 Employment Growth
Penrith	Regional City	31,000	+11,000
Norwest	Specialised Centre	30,000	+17,000
Western Sydney Employment Hub	Specialised Centre	36,000[1]	+36,000
Riverstone West	Specialised Centre	11,000	+11,000
Marsden Park Industrial	Specialised Centre	10,000	+10,000
Box Hill Industrial	Specialised Centre	16,000	+16,000
Rouse Hill	Planned Major Centre	12,000	+12,000
Blacktown	Major Centre	16,000	+5,000
Castle Hill	Major Centre	13,000	+5,000
Total – North West Subregion		411,000	+145,000

Source: Metropolitan Plan for Sydney 2036, December 2010

Projected cumulative employment growth confined within the growth centre between 2016 and full ultimate development is shown in **Table 3-8**. These figures have been incorporated during the traffic forecasting process.

Table 3-8 Cumulative employment projections in the North West Growth Centre to 2036

Year	Employment growth	Forecast employment
2011	-	8,000
2016	9,000	17,000
2021	26,000	34,000
2026	39,000	47,000
2031	44,000	52,000
2036	45,000	53,000
Ultimate	37,000	53,000

[1] Northwest Subregional Strategy, 2010

Within the Marsden Park Precinct, the Draft ILP also proposes a mixed use development within the town centre including:

- Retail gross floor area (GFA) of 40,000sqm.
- Commercial GFA of 10,000sqm.

Trips associated with the retail component were added to the PM peak hour strategic model in order to capture the impacts associated with retail activity. Trip generation rates for retail activity were obtained from the RMS *Guide to Traffic Generating Developments.* These trips are additional to those associated with the employment projections for the North West Growth Centre.

Allowance has also been made for trips associated with the proposed combined K-12 school located within the precinct. Assumptions in relation to staging and trip generation were as follows:

- 500 students enrolled by 2021, 1,000 students enrolled by 2036;
- 45% of trips to the school are made by car, with this trip rate derived from traffic surveys of an existing K-12 school; and
- 60% of car trips to the school come from within the Marsden Park Precinct. The remaining 40% come from within the North West Growth Centre.

Richmond Road will provide the primary arterial route to and from the Marsden Park Precinct, providing a link south to the M7 Westlink, and extending north to the Northern Road and beyond. Other primary arterial routes would be provided by South Street, which borders both the Marsden Park and Marsden Park Industrial Precincts, as well as the planned Werrington Arterial. The significant increase in population and employment throughout the North West Growth Centre will generate a substantial increase in travel demand, placing pressure on these key routes and throughout the existing transport network.

Due to the increase in travel demand, the development of additional capacity across the transport network, including the construction of new roads, upgrade of existing roads, and development of an efficient, integrated public transport network will be required to facilitate trips into, out of, and within the Precinct.

Traffic forecasting scenarios have been created using the population and employment projections within the Marsden Park Precinct and across the North West Growth Centre, summarised in **Table 3-6** and **Table 3-7** respectively. Travel demand for the Precinct and throughout the growth centre will increase in line with staged land development. As an example, Richmond Road will provide a key connection between the growth centre and the M7 Westlink, with demand increasing in line with the development of the Marsden Park Precinct, as well as Marsden Park Industrial Precinct, Colebee, Schofields West, Riverstone West, and Marden Park North. Consequently the rate of release of all of these Precincts will have a significant influence on the required timing of improvements to the existing transport network.

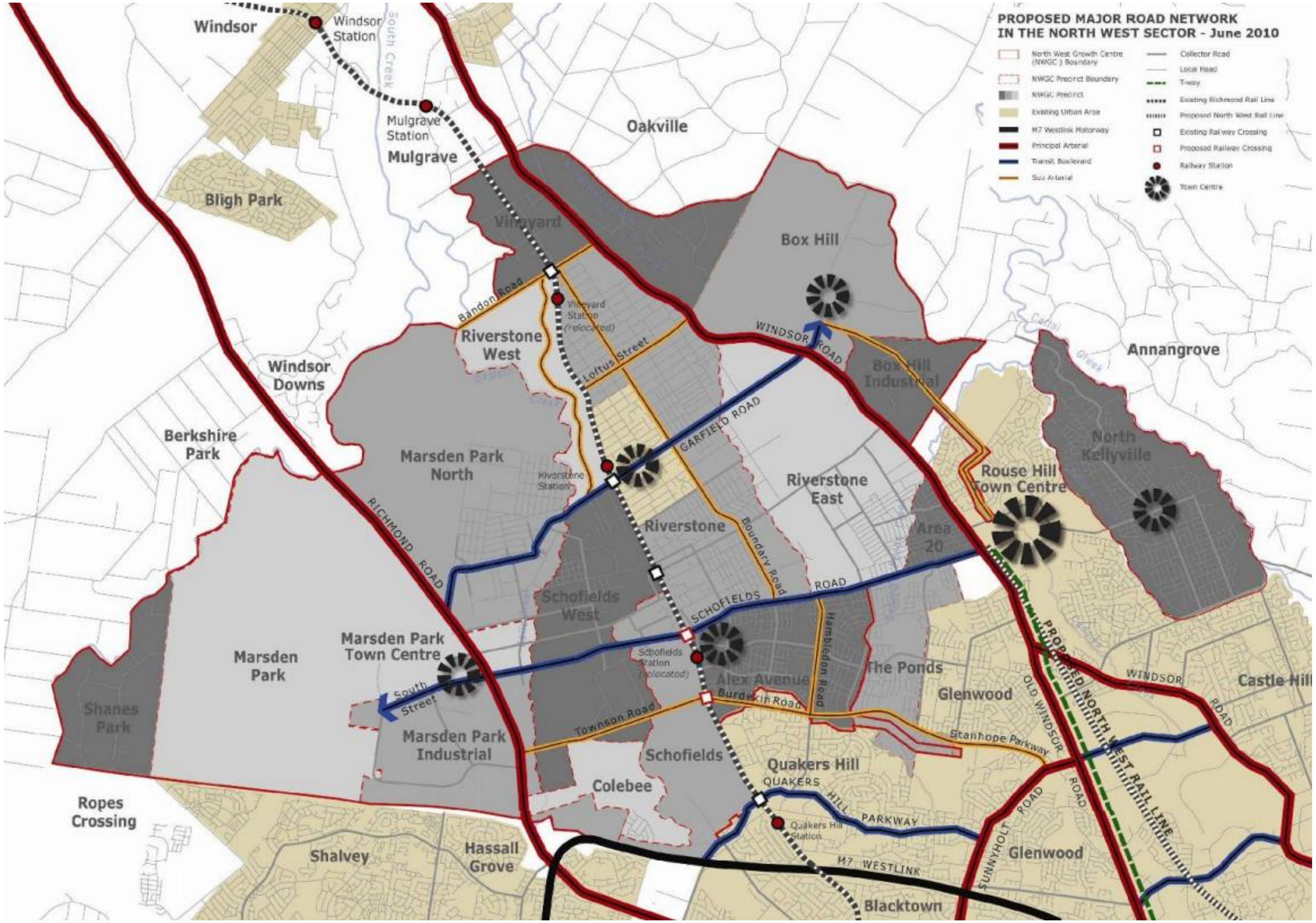
3.6.3 Future road network assumptions

The RMS has prepared a draft Road Network Strategy for the North West Growth Centre in order to enable greater certainty in planning, design and construction of the future regional road network in the growth centre and to cater for the future expected increase in population and employment growth in the region. The Draft Road Network Strategy is illustrated in **Figure 3-4**.

The purpose of the strategy is to establish a strategic level of integrated land use and road planning, ensuring that the development of road networks for individual Precincts is aligned with the strategic road network proposed for the North West Growth Centre. The North West Road Network Strategy also focuses on aligning the proposed road network with the State Road Network beyond its boundaries, including Richmond Road, Windsor Road, and the Werrington Arterial.

Following an approach of integrated and co-ordinated road network planning is intended to maintain the efficient performance of the arterial routes, while at the same time enabling the development of local road networks serving centres and communities appropriate to proposed land uses.

Figure 3-4 North West Growth Centre existing and proposed road network (draft)



Source: The North West Growth Centre Road Framework (NSW Roads and Maritime Services, 2010)

The proposed road upgrades in the North West Growth Centre and other proposed major road upgrades in Sydney are reflected in the strategic model based on information published by RMS and other motoring bodies. In the AECOM model, future year network schemes are coded based on assumptions regarding:

- Upgrade timing.
- Connectivity and alignment.
- Speed/flow relationships.
- Toll costs, where applicable.

The Long Term Transport Master Plan (LTTMP) released by the NSW Government in December 2012 provided several actions focused on improving NSW's transport system, one of which is relevant to this precinct is focused on preserving future transport corridors in Greater Sydney and across regional NSW. The Outer Sydney Orbital (M9), a potential multi-modal corridor connecting the existing road and rail networks to the North West and South West Growth Centres, has been proposed under the medium and long term actions of the LTTMP. AECOM acknowledges no further details including timing and alignment of the corridor is available and therefore has not included this potential road corridor as part of the CUBE model.

3.6.4 Public transport assumptions

Maximising public transport use (and walking and cycling) for commuting and other trips in the North West Growth Centre is a central objective of both land use and transport planning activities in order to achieve sustainable growth of the area.

Section 4.4 highlights the key public transport infrastructure and services proposed in the growth centre including the North West Sector Bus Servicing Plan, the North West Rail Link and the Rail Clearways Program, which have been factored into the future year model development. For the purpose of assessment, existing travel characteristics and mode split within the Blacktown LGA was assumed.

3.6.5 Traffic forecasting methodology

To represent future demand for travel associated with the projected population and employment growth, calibrated base year demand tables for the AM average peak hour were taken and rebalanced to create future year trip ends. Future year trip ends have been calculated using the AECOM Trip End Modification Model (TEMM). The TEMM has been developed by AECOM to generate different future year trip ends based on:

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

The model has accounted for major road improvements, such as the upgrade of the M5 Motorway, at a strategic level. To enable the model to accurately assess the impact of the Marsden Park Precinct redevelopment, a cordon is created around the study area, and a local area model extracted and enhanced.

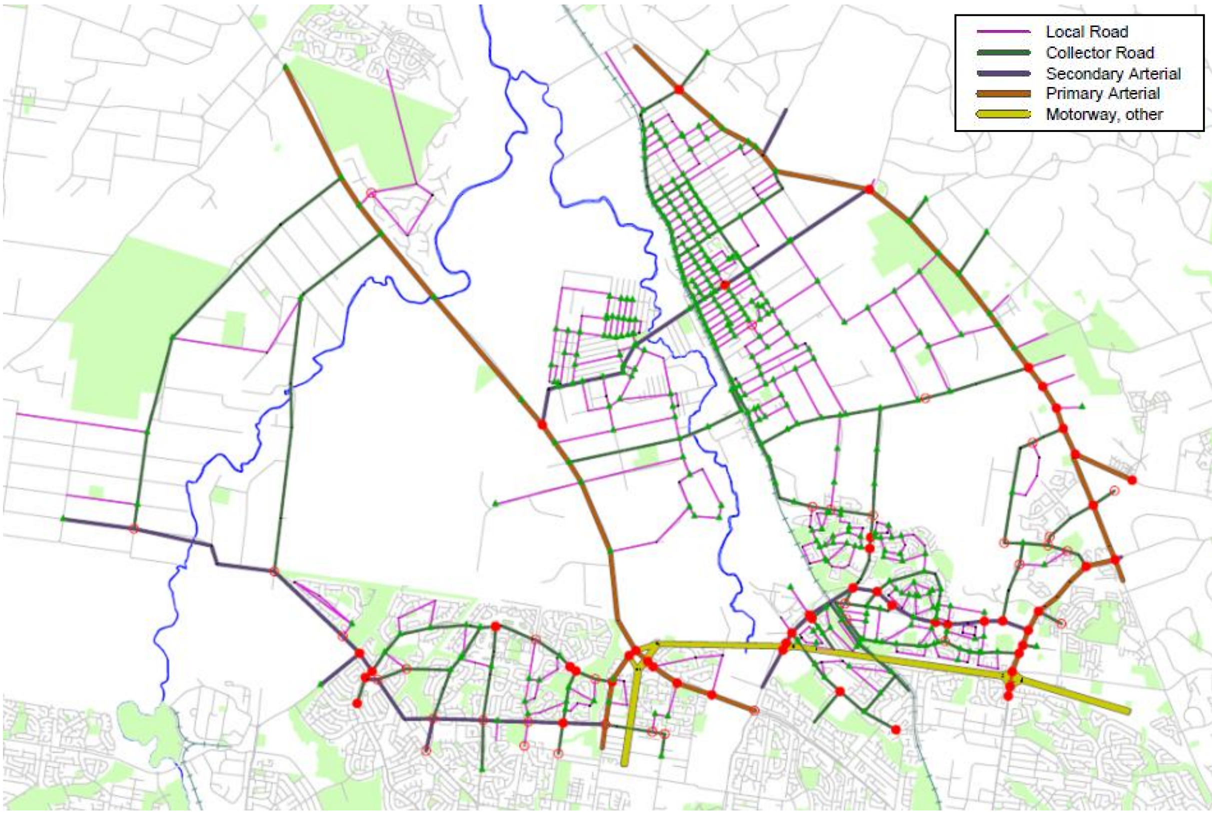
The local area model has been refined to better reflect changes on a smaller, localised level. These changes include:

- Coding of lower order local roads and adjustment to centroid connector loading points to better distribute traffic to and from zones and the modelled road network.
- Coding of intersection delay algorithms to better approximate delay for individual turning movements.
- Adjustment of future year trip rates to reflect expected higher public transport use and lower car use for areas in the vicinity of the North West Rail Link.
- Adjustment of trip distribution to reflect the park and ride facilities at new stations along the North West Rail Link.

The coverage of the local area model is shown in **Figure 3-5**; it also clearly identifies the current intersection locations in the model. **Figure 3-6** indicates the location of zone boundaries in relation to the road network.

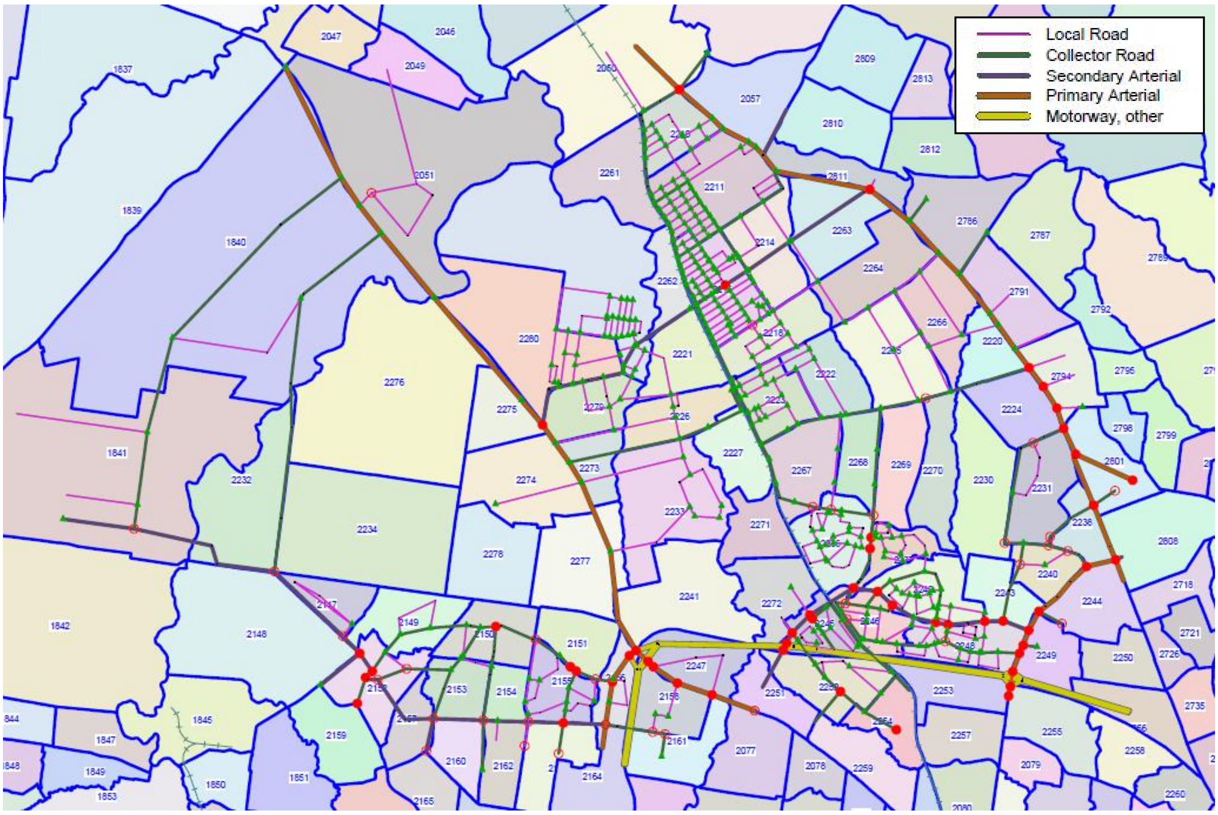
The figures show that the local area model covers a wider area surrounding the Marsden Park Precinct to allow for the strategic impact of nearby road upgrades and land use developments to be incorporated.

Figure 3-5 Local area model coverage and intersection locations



Source: AECOM, 2011.

Figure 3-6 Local area model zone boundaries



Source: AECOM, 2011

3.7 Road network analysis and classification (road hierarchy)

The CUBE model was used to forecast traffic volumes within the Marsden Park Precinct based on the proposed future land use and infrastructure developments in the Precinct and the wider North West Growth Centre, as set out in **Section 3.6**. The outputs of the modelled forecast traffic flows at full development are provided in **Appendix A** for both the 2036 morning and evening peak hours.

Guidelines for the future road network hierarchy are discussed in detail **i**n **Section 3.2.1**and **Section 3.2.2**. In summary, the DP&I and RMS have identified criteria which classify road hierarchy, comprising **Arterial Roads**, for example Richmond Road, **Sub-Arterial Roads**, **Transit Boulevards** which provide a traffic function and a public transport corridor function, **Collector Roads** and **Local Streets**.

The road hierarchy for the precinct has been determined based on forecast daily traffic flows, estimated using modelled 2036 peak hour flows. The classification also considers the location, proposed function and capacity of links within the proposed road network. The proposed road network hierarchy for the precincts is illustrated in **Figure 3-7**; the future forecast volumes and the implications of these volumes for the upgrade of highway links are in line with the north west network classification system (See **Section 3.2**).

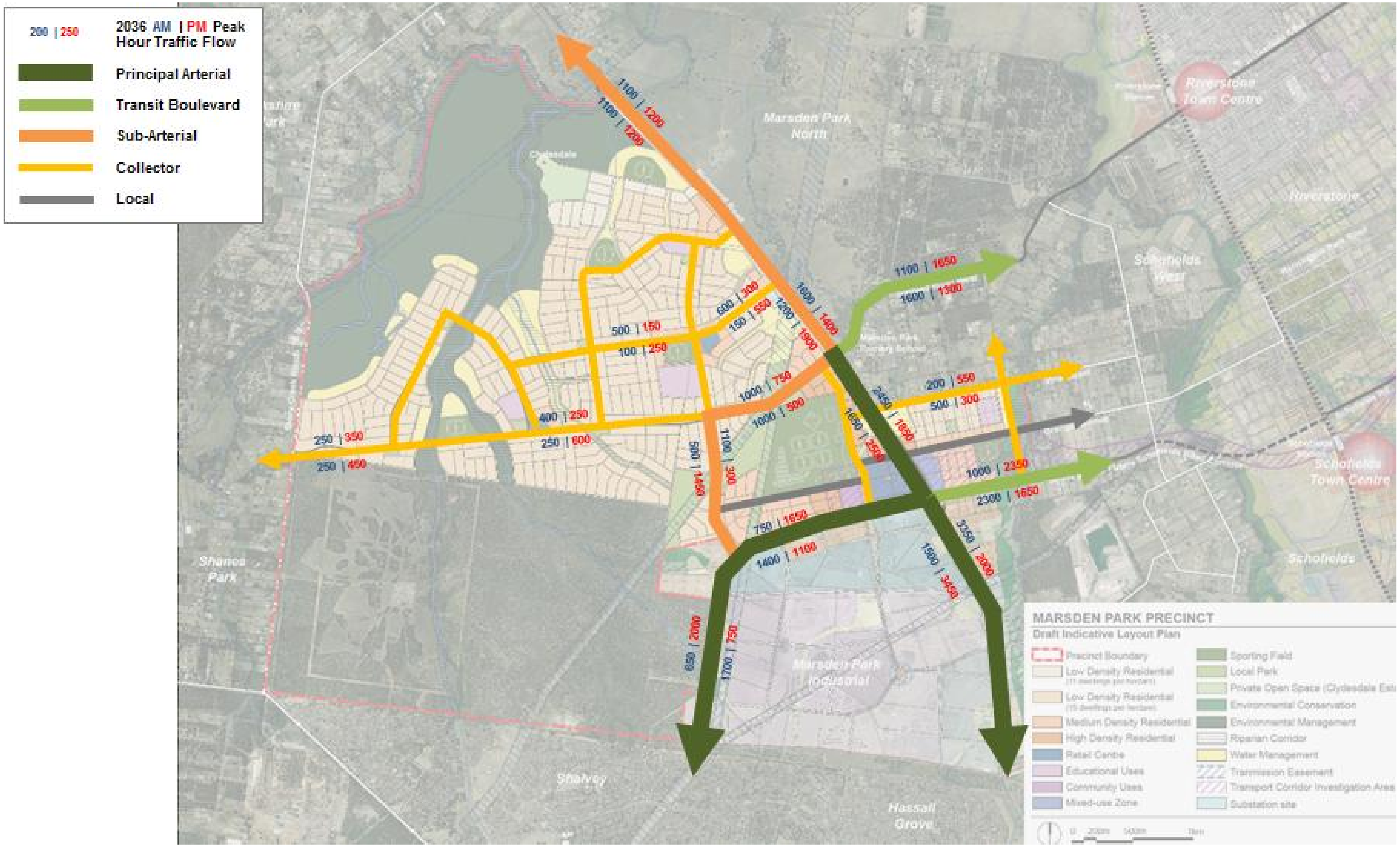
Arterial routes allowing traffic to travel to and from the Precinct would be provided by Richmond Road and South Street. These links would provide connectivity to key town and regional centres to the south of the Precinct, as well as major road links including the Westlink M7 and proposed Werrington Arterial.

Garfield Road West and South Street (including the Schofields Road extension) to the east of Richmond Road would provide Transit Boulevards, accommodating significant traffic volumes as well as providing key public transport routes with connectivity to the Riverstone and Schofields train stations.

Within the Precinct the development would include a predominantly new road network to accommodate internal traffic, bicycle and pedestrian movements. Sub-arterial routes would also be provided on Richmond Road north of Garfield Road West, as well as a connection between Garfield Road West and South Street. A proposed east-west collector road would provide a key internal road link between the eastern (Richmond Road) and western (Stony Creek Road) boundaries of the Precinct. Collector and local roads would be provided as appropriate to feed traffic onto higher-order routes.

Street lighting within public roads will be designed in accordance with AS/NZS 1158.

Figure 3-7 Proposed road hierarchy



Source: AECOM, 2012

3.7.1 Road network analysis

In November 2011, RMS released the proposed concept design and review of environmental factors for the Richmond Road Upgrade between Bells Creek, Colebee and Vine Street West, Marsden Park. An analysis has been undertaken to determine the optimal configuration of the Richmond Road corridor north of this segment, under forecast 2036 AM and PM peak traffic volumes, with the ultimate development of the North West Growth Centre.

Three lane configuration scenarios were considered as part of the assessment in order to identify the optimal arrangement. The results of the analysis identified the preferred lane configuration to be consistent with currently committed upgrades for the Richmond Road corridor, including the following:

- 6 through lanes between the M7 and South Street.
- 4 through lanes between South Street and the Richmond Road / Marsden Park Precinct Access Road (north of Garfield Road West).
- 2 through lanes between the Richmond Road / Marsden Park Precinct Access Road (north of Garfield Road West) and The Northern Road.

The volume to capacity (V/C) ratio is a method of assessing congested conditions on road links between intersections. Essentially if V/C ratios approach 1.0 the mid-block flow is approaching capacity and is therefore a key indicator of congested conditions.

AM peak and PM peak hour midblock volumes along Richmond Road for the proposed lane configuration are summarised in **Table 3-9**. As outlined in **Section 3.2.2**, a total capacity of 1,400 vehicles per lane per hour was set as the upper limit for mid-block locations between intersections on Richmond Road.

For uninterrupted linkages, such as north of the Richmond Road / Access Road signalised intersection, the *Austroads Guide to Traffic Management, Part 3 (2009)* identifies midblock capacity. The following mid-block capacities and categories were assumed north of Access 2, where the north and southbound movement is effectively "uninterrupted" until St Marys Road, located 3.7km away:

- Class 1, two lane two way arterial – 1,700 veh/h for each direction;
- Multi-lane highway, 70km/h, LoS D – 1,530 veh/h/lane for each direction

The analysis indicates that Richmond Road would have sufficient capacity to cater for forecast 2021 and 2036 AM and PM peak hour traffic demand. The corridor needs to provide in the order of two lanes in each direction between South Street and the signalised intersection of Richmond Road with Access Road (adjacent to the transmission line), with only one lane required in each direction north this point.

Table 3-9 Richmond Road 2036 forecast peak traffic volumes and volume / capacity analysis

Richmond Road (between)	Peak direction of traffic flow				% of Capacity	
	AM Peak		PM Peak		AM Peak	PM Peak
South creek and Access Road	1,150	NB	1,450	NB	75%	95%
Access Road and Garfield Road	1,600	SB	1,900	NB	55%	66%
Garfield Road and Vine Street	2,250	SB	2,300	NB	78%	79%
Vine Street and Grange Avenue	2,450	SB	2,500	NB	84%	86%

Within the precinct, mid-block capacity is in the order of 900 to 1,000 vehicles per lane per hour for median or kerbside lanes with no parking. From **Figure 3-7**, it can be seen that all internal links have sufficient capacity to meet forecast demands. This is based on the assumption that those links identified as collector roads would have available at least one travel lane and one parking lane, and those links identified as sub-arterial would have at least two travel lanes free of parking available.

Further detail relating to the recommended cross-section for each road classification is provided in **Chapter 6.0**.

3.8 Intersection analysis

Access points connecting the Precinct to the wider road network will be provided by intersections along Richmond Road, South Street and Stony Creek Road. The results of the traffic modelling indicate that at key intersections around the precinct, traffic signals would be required to manage heavy conflicting movements, and provide increased priority to buses. Signalised intersections also provide increased safety for pedestrians and cyclists on key desire lines between local centres and surrounding residential areas, as well as within centres.

Bus priority facilities may be required at signalised intersections on bus routes. In future, as delays increase for general vehicles, these facilities will enable buses to maintain journey times and improve the attractiveness of public transport.

3.8.1 Intersection operational assessment

Turning movements used in the assessment of intersection operations along Richmond Road have been extracted from the CUBE model for the forecast future year with full development (2036). Details of the traffic forecasting process are discussed in **Section 3.4** to **Section 3.6**.

Intersection analysis, including the determination of proposed layouts and anticipated performance, has been undertaken for key intersections within and providing access to the precinct with the aid of SIDRA Intersection 5.0. The main performance indicators identified through the analysis include:

- Degree of Saturation (DoS) – a measure of the ratio between traffic volumes and capacity of the intersection is used to measure the performance of isolated intersections. As DoS approaches 1.0, both queue length and delays increase rapidly. Satisfactory operations usually occur with a DoS range between 0.7-0.8 or below;
- Average Delay – duration, in seconds, of the average vehicle waiting at an intersection; and
- Level of Service (LoS) – a measure of the performance of the intersection (as described in **Section 3.2.3**).

The assessment has been undertaken under 2036 AM and PM peak hour forecast as determined through the strategic model.

Options assessed considered the impacts of various turning movement options and layouts, as well as the type and form of control of pedestrian crossing movements, intersection and network performance, to optimise network performance for all road users.

The intersection analysis is presented in two parts, with the analysis of those intersections on Richmond Road discussed in **Section 3.8.1.1** and the analysis of other key intersections within the precinct in **Section 3.8.1.2**.

3.8.1.1 Richmond Road intersections

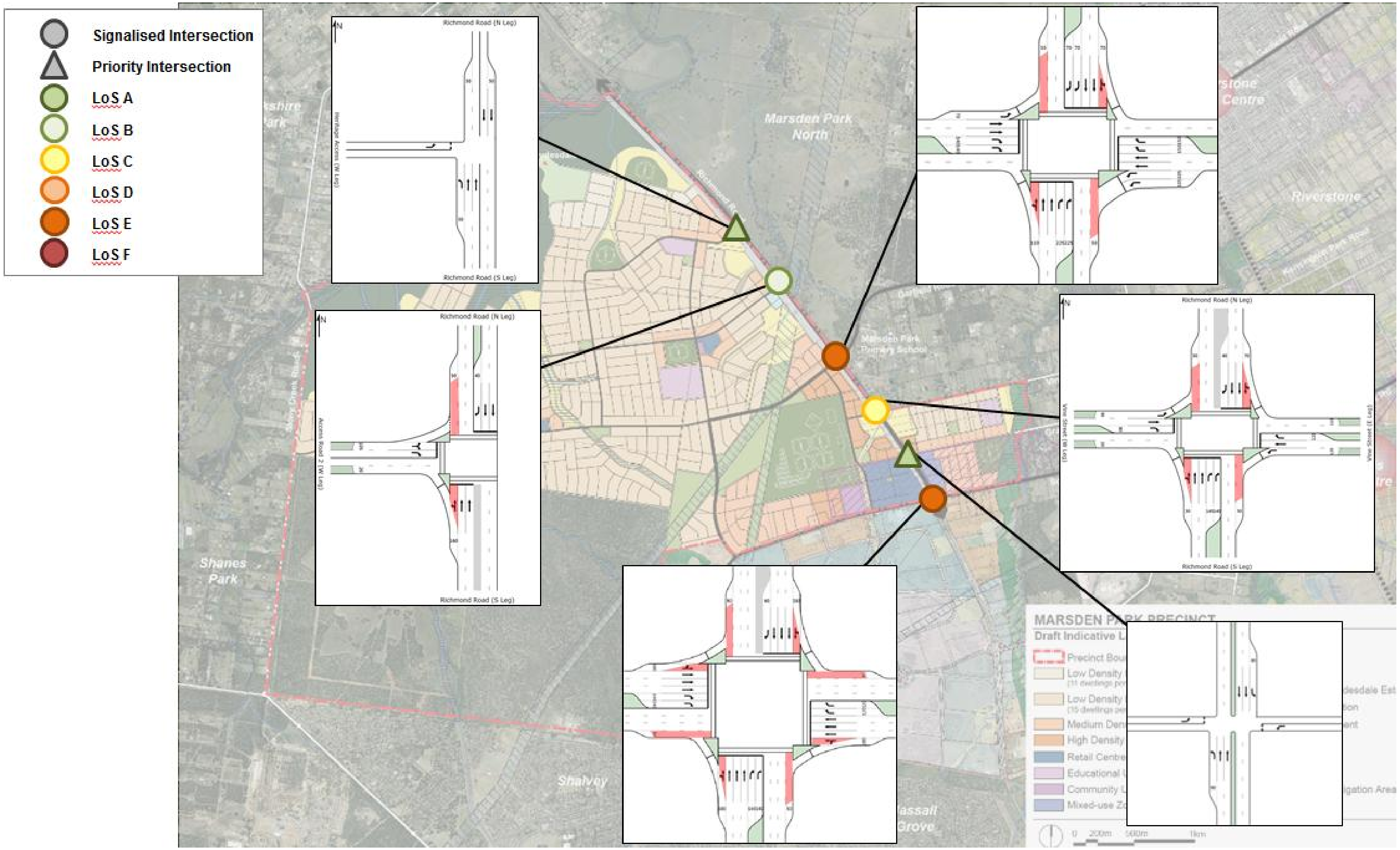
There are six available access points from Richmond Road to the Marsden Park Precinct. The determination of the most appropriate form of control for each of these intersections was determined based on a number of factors. These factors include:

- Forecast traffic demands and access requirements for the Marsden Park Precinct;
- Forecast turning flows at each intersection determined from the AECOM Cube model;
- Need to consider RMS planning and the North West Road Structure Plan;
- Minimum intersection spacing requirements for an arterial road;
- Need to consider the requirement for future upgrade of the Richmond Road / South Street intersection to a grade-separated interchange.

This last factor precludes the opportunity for a signalised intersection at the intersection of Richmond Road / Grange Avenue due to insufficient intersection spacing (400m) from the potential grade separated interchange.

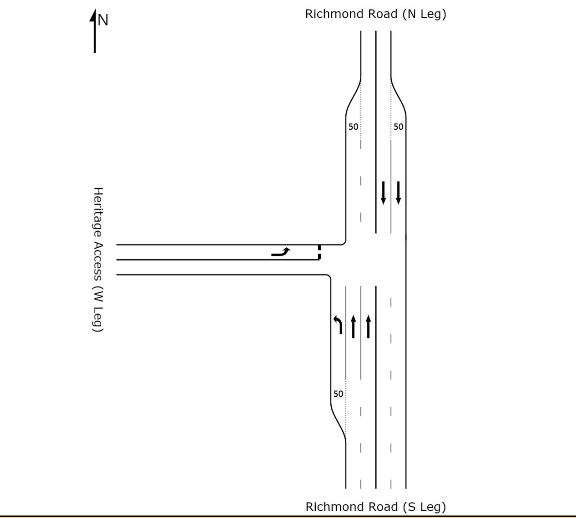
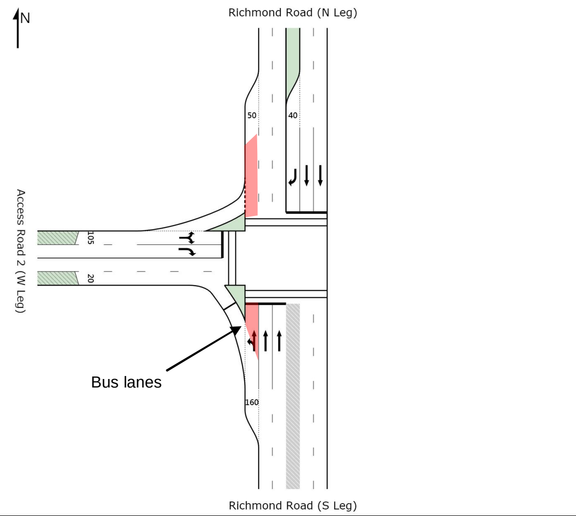
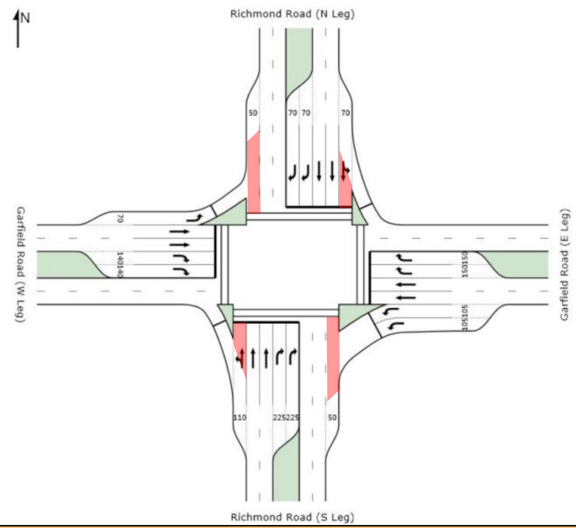
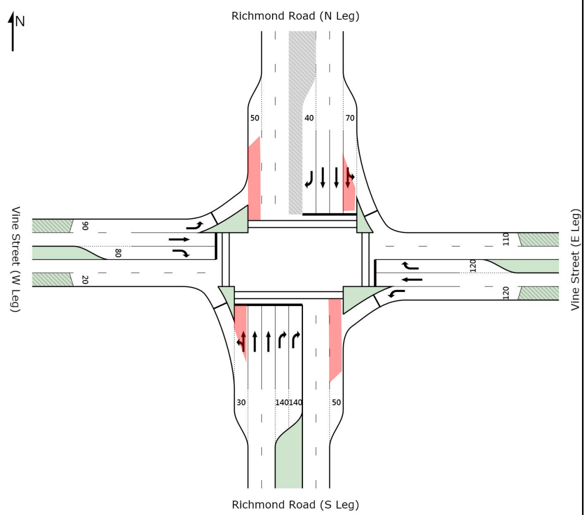
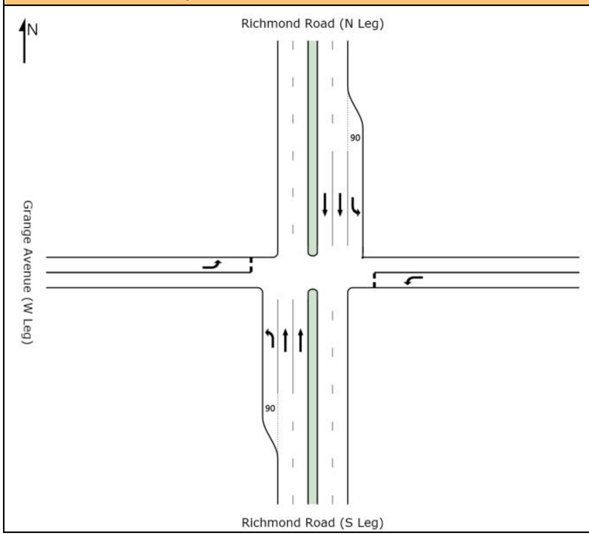
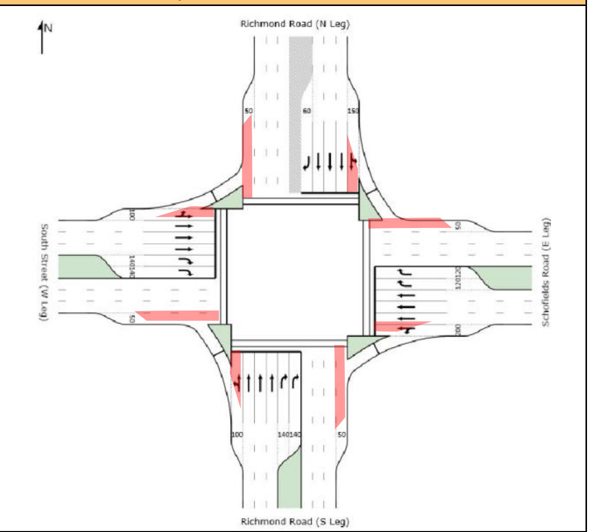
A summary of the proposed intersection location and layouts for each of the Richmond Road intersections providing access to the Marsden Park Precinct is provided in **Figure 3-8** and **Table 3-10**.

Figure 3-8 Key intersection performance summary



Source: AECOM, 2012

Table 3-10 Proposed intersection layouts

Richmond Road | Marsden Park Precinct Access Road (North) (Access #1)	Richmond Road | Marsden Park Precinct Access Road (North of Garfield Road West) (Access #2)
	
Richmond Road | Garfield Road West	Richmond Road | Vine Street
	
Richmond Road | Grange Avenue	Richmond Road | South Street
	

Source: AECOM, 2012

As illustrated, the proposed access strategy involves the signalisation of:

- Richmond Road / Marsden Park Precinct Access Road (north of Garfield Road West)
- Richmond Road / Garfield Road West (existing signalised intersection)
- Richmond Road / Vine Street
- Richmond Road / South Street

These signalised intersections will provide the main access points to and from the Precinct. At-grade intersection layouts were determined through the analysis in order to accommodate forecast flows, as far as practicable. A maximum of two lanes for right turning movements was deemed appropriate for the corridor, considering spatial requirements for swept paths.

Priority intersections will also be provided along Richmond Road adjacent to the Precinct. These priority intersections would only allow left-in / left out turning movement and be located at:

- Richmond Road / Marsden Park Precinct Access Road (north)
- Richmond Road / Grange Avenue

A summary of the performance assessment for each of the proposed intersection layouts under 2036 AM and PM peak hour demand is summarised in **Table 3-11**.

Table 3-11 Proposed intersection performance

Approach	Demand Flow (veh/h)	Level of Service (LoS)	Deg of Satn. (DoS)	Ave Delay (sec)	95% back of queue (m)	Approach with longest queue
2036 AM Peak						
Richmond Rd | Access 1 Rd	2,486	LOS A	0.469	0.7	4	Heritage Access (EB)
Richmond Rd | Access 2 Rd	3,136	LOS B	0.832	26.1	157	Richmond Rd (NB)
Richmond Rd | Garfield Rd	6,273	LOS E	0.961	65.0	388	Richmond Rd (SB)
Richmond Rd / Garfield Rd[2]	6,273	LOS D	0.929	45.4	196	Garfield Road (WB)
Richmond Rd | Vine St	4,569	LOS C	0.942	34.1	481	Richmond Rd (SB)
Richmond Rd | Grange Ave	4,373	LOS A[1]	0.962	5.8	86	Grange Ave (WB)
Richmond Rd | South St	7,367	LOS E	0.976	60.6	512	Richmond Rd (SB)
2036 PM Peak						
Richmond Rd | Access 1 Rd	3,058	LOS A[1]	0.699	4.4	47	Richmond Rd (NB)
Richmond Rd | Access 2 Rd	3,649	LOS B	0.864	21.1	202	Richmond Rd (NB)
Richmond Rd | Garfield Rd	6,425	LOS E	0.994	69.1	392	Richmond Rd (SB)
Richmond Rd / Garfield Rd[2]	6,425	LOS D	0.918	46.7	202	Garfield Road (EB)
Richmond Rd | Vine St	4,906	LOS C	0.914	37.3	448	Richmond Rd (SB)
Richmond Rd | Grange Ave	4,647	LOS A	0.742	2.4	21	Grange Ave (EB)
Richmond Rd | South St	8,741	LOS D	0.946	53.5	321	Richmond Rd (NB)

Source: AECOM, 2012

***Note**:*

[1]Intersection operations at Grange Avenue and Access 1 Road have assumed that gaps in the traffic flow would occur as a result of platooning effects created by upstream signalised intersections. Modelling of these intersections has assumed that for a minimum of 8 seconds per minute, there would be no conflicting traffic flow on Richmond Road due to these effects; during this time, traffic from Grange Avenue and Access 1 Road would be able to access Richmond Road unopposed.

[2]Intersection performance at Richmond Road / Garfield Road with localised widening (three northbound and southbound lanes for 200m) at intersection approach.

Under the 2036 ultimate development flows, the upgraded intersections on the Richmond Road Corridor would operate within capacity. The intersections located at Garfield Road and South Street are both anticipated to operate at LoS E; the performance of these intersections would therefore be most critical to the performance of the overall Richmond Road corridor. Signal coordination along the Richmond Road corridor is strongly recommended for the peak direction to improve performance; further performance improvements could be achieved if pedestrian crossing phases were not included in every signal cycle.

Sensitivity testing indicated that increased capacity in the corridor through the provision of an additional lane north of South Street was found to not provide surplus capacity or improve overall performance; increasing capacity was found to attract additional through traffic to the route, negatively impacting the operational performance of intersections, particularly to the south of the corridor (eg. Richmond Road | South Street). However, localised widening at the intersection of Richmond Road / Garfield Road to three lanes in each direction, for 200m on either side of the intersection would improve operational performance. Under this layout the intersection performance returns to LoS D. Improving the performance of the Richmond Road / South Street intersection to LoS D was not assessed since the intersection is the subject of the Marsden Park Industrial assessment.

The results of the intersection and midblock analysis indicate that the modelled (and currently committed) road network will enable acceptable operational performance when accommodating 2036 forecast traffic projections, for both the North West Growth Centre and wider strategic network. It is recommended that Richmond Road provides a four lane north-south corridor between South Street and the Precinct Access Road north of Garfield Road West (Access 2), with no further upgrades to Richmond Road north of the Marsden Park Precinct.

The results of this operational assessment indicate that adequate performance could be achieved through the provision of at-grade intersections along the Richmond Road corridor. It is noted however that in the review of environmental factors for the Richmond Road Upgrade between Bells Creek, Colebee and Vine Street West, Marsden Park, it is indicated that in the future the Richmond Road | South Street intersection would require grade separation to maintain an adequate Level of Service.

If the intersection of Richmond Road | South Street intersection is upgraded to a grade separated interchange, the operational performance of the Richmond Road | Garfield Road intersection could be improved through localised widening of Richmond Road to three lanes in each direction at the intersection. Under 2036 forecasts, provision of an additional southbound lane on Richmond Road for 200m on the approach and exit of the intersection would return a LoS D.

3.8.1.2 Intersections within the Precinct

At key intersections within the precinct, the determination of the most appropriate form of control, for example as a signalised intersection, roundabout, or priority control, has been determined based on the following factors:

- Forecast link flows on approaches to intersections (extracted from the AECOM Cube model for the purposes of this analysis).
- Forecast turning flows at key intersections (extracted from the AECOM Cube model).
- RMS warrants for traffic signal design.
- Need to control major/ minor road interactions, traffic throughput and turning flows.
- The presence of proximate land uses which would generate high volumes of pedestrian movements, such as town centres and schools.

An extracted summary of the NSW RMS Warrants for Traffic Signal Design is provided in **Table 3-12**.

Table 3-12 RMS Warrants for Traffic Signal Design

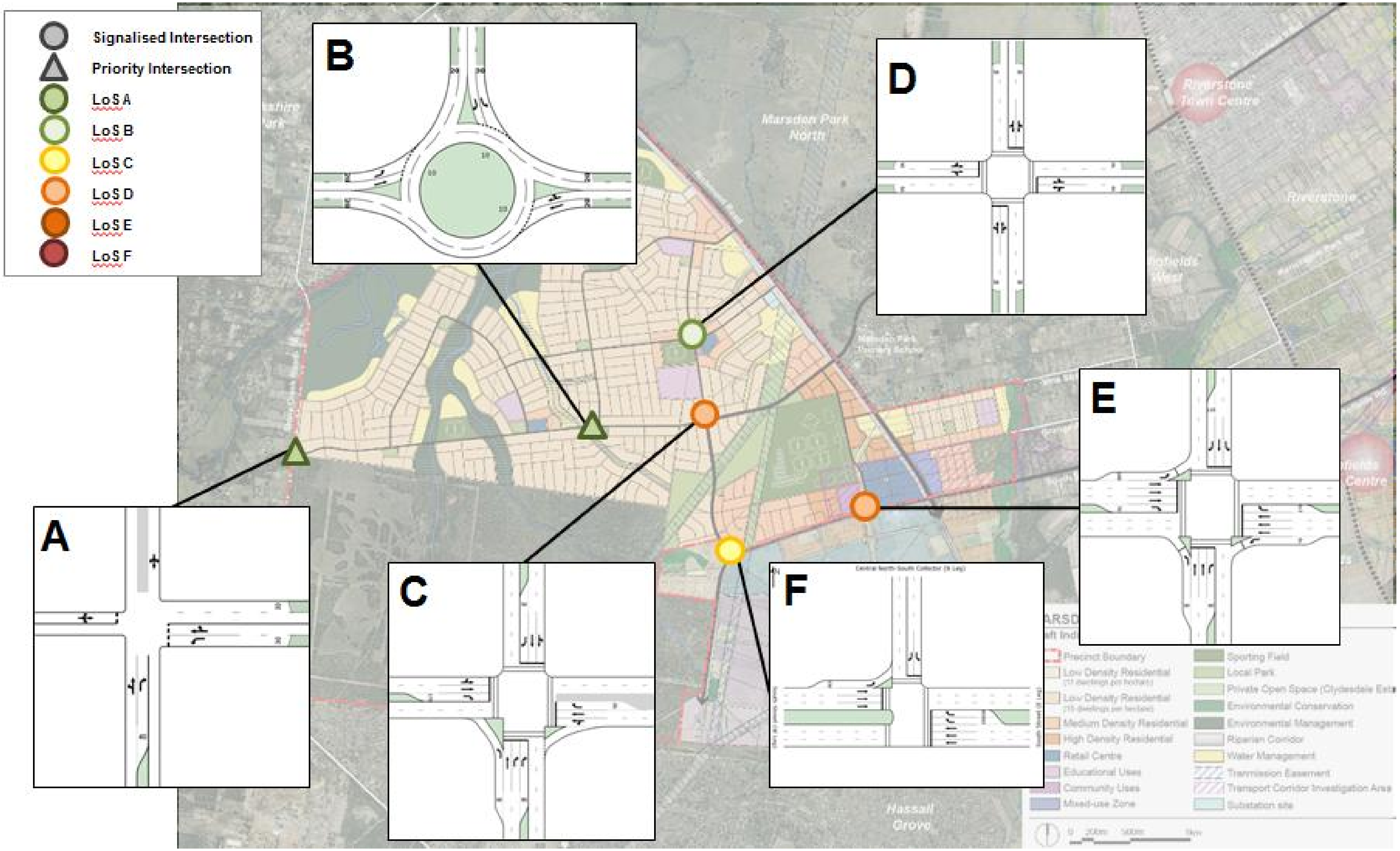
Key Criteria	Sub-Criteria 1	Sub-Criteria 2	Sub-Criteria 3	Sub-Criteria 4
(A) Traffic Demand	Major road flow exceeds 600 veh/ hr (each direction)	Minor road flow exceeds 200 veh/ hr (one direction)		
(B) Continuous Traffic	Major road flow exceeds 900 veh/ hr (each direction)	Minor road flow exceeds 100 veh/ hr (one direction)	Traffic speed (major rd) or sight distance (minor rd) causes a hazard	No alternative nearby traffic signals for use by minor road traffic
(C) Pedestrian Safety	Pedestrian flow crossing major road >150 persons/ hr	Major road flow exceeds 600 veh/ hr (each direction)		

Source: RMA Traffic Signal Design Guidelines, 2008

The RMS warrants for assisting in the determination of locations for traffic signal controlled intersections is due to the strategic nature of the traffic model and also related to the potential development of land uses in the Town Centre, with uncertainty over the precise location of access roads. This analysis has been used to determine the indicative quantum of each type of major intersection within the precincts.

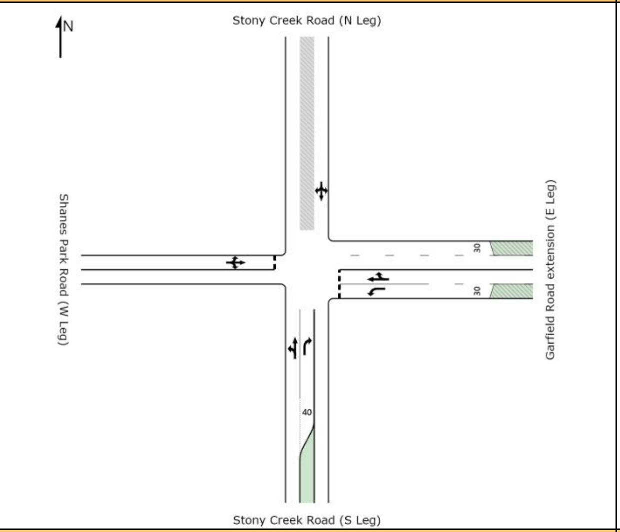
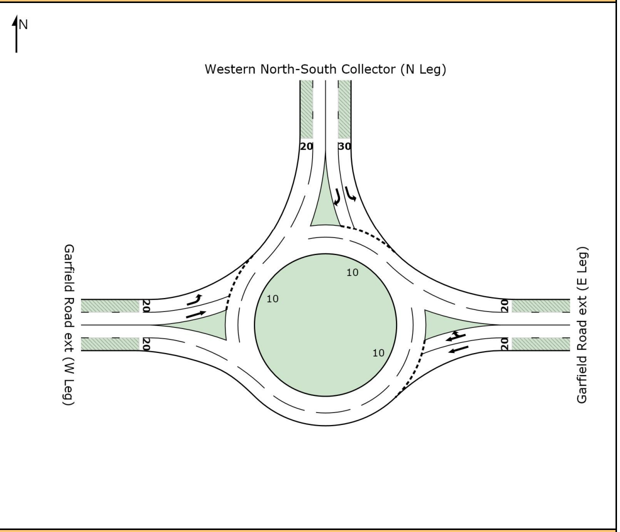
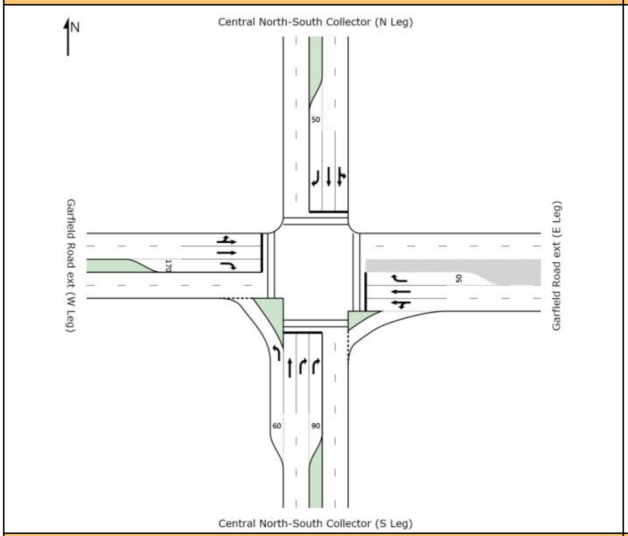
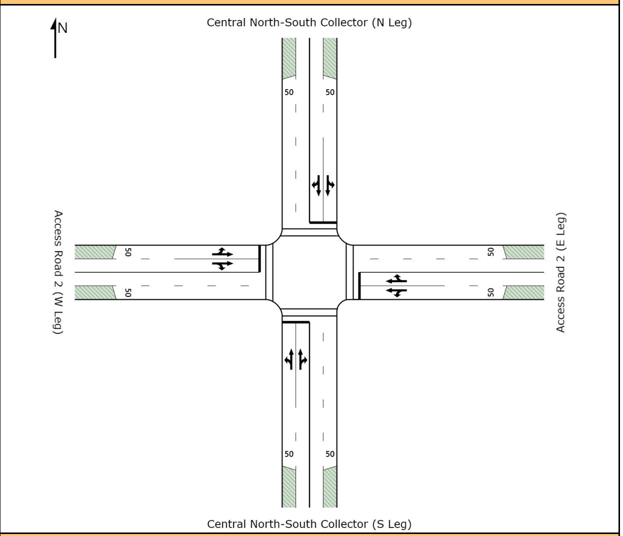
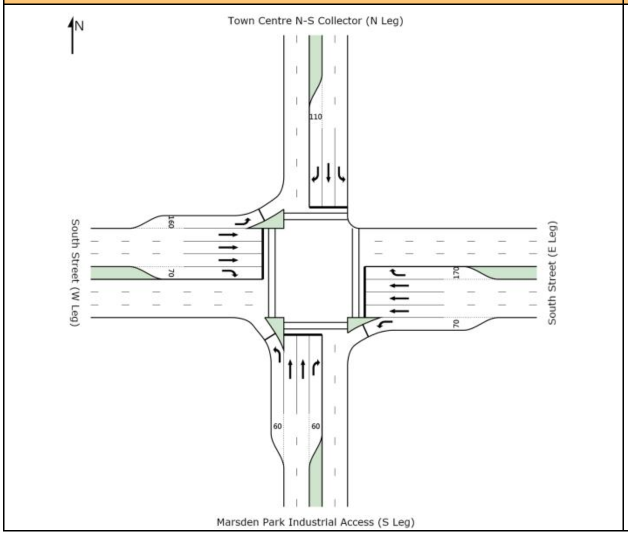
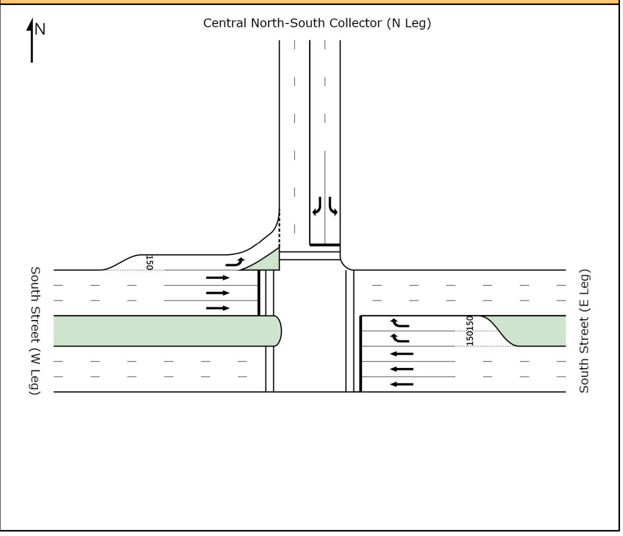
Proposed layouts for key internal intersections within the Precinct are illustrated in **Figure 3-9** and **Table 3-13**.

Figure 3-9 Key intersection performance summary



Source: AECOM, 2012

Table 3-13 Proposed Intersection Layouts

Intersection A	Intersection B
	
Intersection C	**Intersection D**
	
Intersection E	**Intersection F**
	

Source: AECOM, 2012

A summary of the performance assessment for each of the proposed intersection layouts under 2036 AM and PM peak hour demand is summarised in **Table 3-14**.

Table 3-14 Proposed Intersection Performance

Approach	Demand Flow (veh/h)	Level of Service (LoS)	Deg of Satn. (DoS)	Ave Delay (sec)	95% back of queue (m)	Approach with longest queue
2036 AM Peak						
Stony Creek Rd | Garfield Rd	1,816	A	0.601	9.1	53	Stony Crk Rd (N Leg)
Intersection B	741	A	0.261	6.9	13	Garfield Rd (W Leg)
Intersection C	2,813	D	0.844	43.6	183	Garfield Rd (E Leg)
Intersection D	1,179	B	0.633	24.8	77	Access Rd 2 (W Leg)
Intersection E	2,929	C	0.779	38.3	138	Town Centre (N Leg)
Intersection F	3,078	B	0.870	24.2	160	Central N-S (N Leg)
2036 PM Peak						
Stony Creek Rd | Garfield Rd	1,943	A	0.553	8.3	34	Stony Crk Rd (N leg)
Intersection B	830	A	0.329	6.9	19	Garfield Rd (E Leg)
Intersection C	2,262	B	0.652	25.4	90	Central N-S (S Leg)
Intersection D	1,177	B	0.716	20.5	66	Access Rd 2 (E Leg)
Intersection E	3,710	D	0.825	43.1	231	South St (W Leg)
Intersection F	3,771	C	0.839	34.4	163	South Street (E Leg)

Source: AECOM, 2012

In line with RMS guidance all intersections within the precinct which are proposed to be signalised have been assessed to perform at Level of Service (LoS) D or above, at full development in 2036, and therefore will provide adequate capacity and operational efficiency. A signal warrant review is required to be undertaken at a later stage to ensure proposed signalised intersections meet RMS warrants. .

The intersection locations and the proposed form of control for those intersections shown in **Figure 3-9** are based on the criteria described in **Section 3.8.1.2**. The justification for the proposed methods of intersection control, the RMS warrants applied (Refer **Table 3-12**), and other considerations applied are set out below in **Table 3-15**.

Table 3-15 Intersection control and justification

ID	Major road	Minor road	Method of control	RMS Warrant	Additional considerations
A	Stony Creek Road	Garfield Road extension	priority	-	
B	Garfield Road extension	Western north-south collector	roundabout	-	
C	Garfield Road extension	Central north-south collector	signalised	A	
D	Access Road 2	Central north-south collector	signalised	C	Pedestrian activity
E	South Street extension	Central north-south collector	signalised	A, C	Pedestrian activity
F	South Street extension	Town centre north-south collector	signalised	A	

3.9 Staging of road network upgrades

Road network upgrades would be required to provide adequate infrastructure to facilitate the increased movement of people and goods associated with the land use change and forecast growth in the Marsden Park Precinct, as well as development in adjacent precincts and across the wider North West Growth Centre.

An indicative scope of required road network upgrades, including intersection treatments, is outlined in **Section 3.7** and **Section 3.8**. The timing of upgrades would have a significant dependency on the development of the North West Growth Centre in its entirety, as well as localised development within the Marsden Park Precinct. A defined staging plan for development is in the process of being developed. Through this process, specific upgrades required to provide suitable access as development progresses will be identified.

Upgrades for the precinct will also need to consider the timescales for major road upgrade projects for the strategic highway network serving the precinct, such as the Richmond Road Upgrade between Bells Creek, Colebee and Vine Street West, Marsden Park, the extension of the Schofields Road (South Street) corridor between Schofields and Marsden Park, and the development of the proposed Werrington Arterial Route.

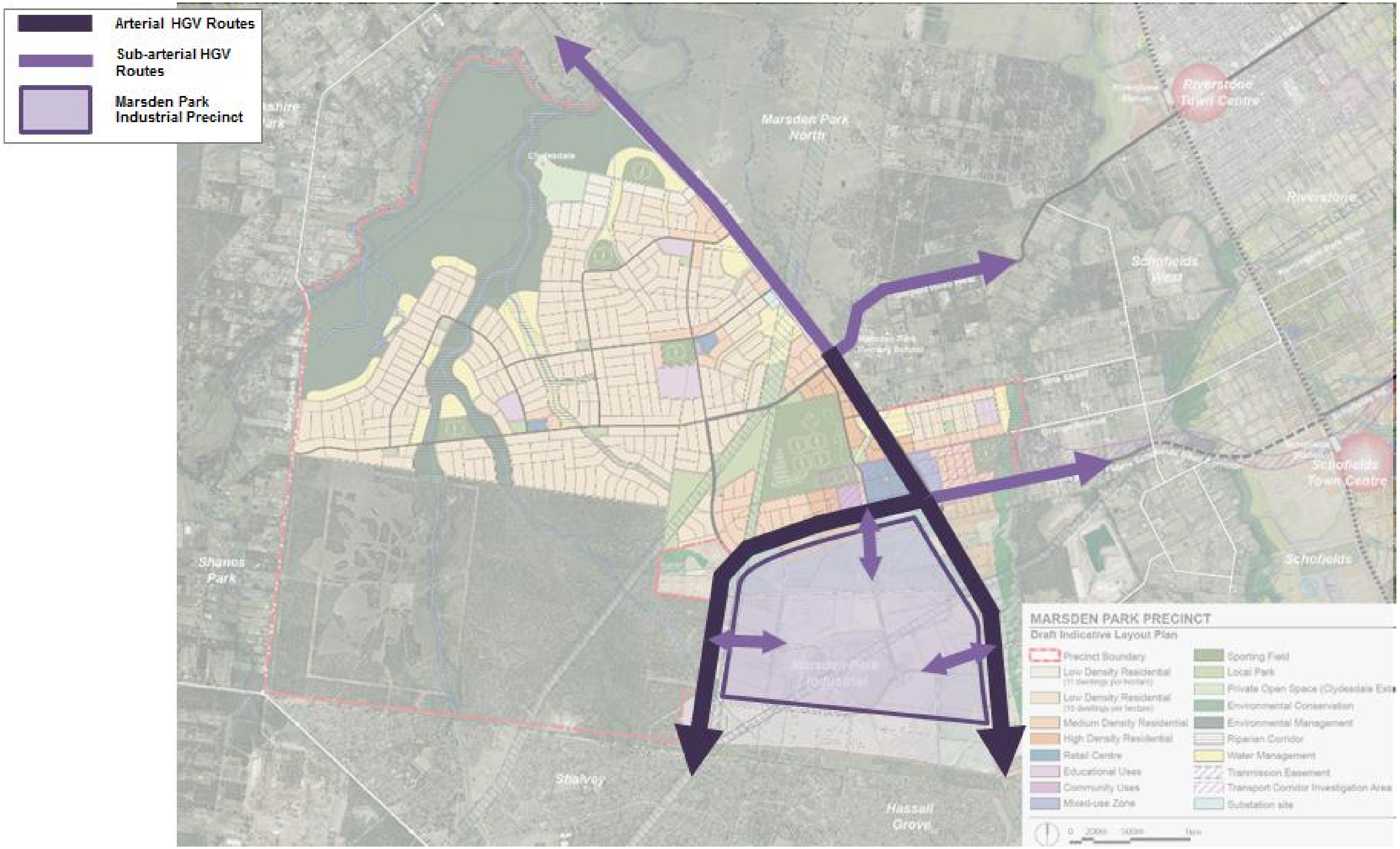
In addition to the alignment with the development of arterial and other strategic routes, the development of the road network within the Precinct will need to be structured around and in line with staged land development; this includes a further dependency on the timing of the release of sub-divisions within the Precinct.

3.10 Heavy goods vehicles

The proposed residential land uses within the Marsden Park Precinct are not expected to generate a significant amount of heavy goods vehicles (HGVs), as the majority of the proposed development within the Precinct is residential. Conversely the adjacent industrial and commercial development in Marsden Park Industrial Precinct, and surrounding areas including Riverstone and Box Hill are likely to generate significant volumes of HGV traffic on arterial and sub-arterial routes in the area.

Figure 3-10 illustrates the routes proposed to accommodate HGV demand on the road network surrounding the Marsden Park Precinct, particularly demand generated by the Marsden Park Industrial Precinct; delivery vehicles requiring access to retail premises within the town centre are expected to use Richmond Road as well as the South Street extension.

Figure 3-10 Proposed heavy goods vehicle routes



Source: AECOM, 2012

The proposed routes would enable HGV access between industrial and commercial areas and the principal highway network using Richmond Road and South Street, as well as Garfield Road West to a lesser degree. These routes are proposed as arterial, sub-arterial, or transit boulevards; they would therefore be constructed to a standard appropriate to accommodate HGVs.

The HGV access and routing strategy is designed to minimise conflicts between traffic generated by residential areas with industrial, commercial, and other non-complimentary land-uses. To achieve this, heavy vehicle restrictions would also likely be required to minimise HGV traffic movements within residential areas, including on Garfield Road West (west of Richmond Road) and the proposed road connection between Garfield Road West and South Street.

3.11 Findings and recommendations

3.11.1 Road network classification | hierarchy

The road network classification and hierarchy has been developed for the Precinct using established principles and guidelines. The strategic road network analysis has assisted in determining appropriate future highway corridor classifications and methods of control for intersections across the proposed road network for Marsden Park Precinct. The designated road network hierarchy focuses vehicular access on the most appropriate routes to arterial roads via higher order corridors. Vehicles are distributed through the precincts via the hierarchical network of Sub-Arterial, Transit Boulevard and Collector Roads then via local streets to individual land parcels.

The key strategic corridor serving the precinct is Richmond Road. Richmond Road is an arterial providing connectivity to the M7 motorway, Richmond, and also to the east via intersections with Schofields Road and Garfield Road. Schofields Road and Garfield Road are designated Transit Boulevards providing linkages to the Richmond Line and also across to Rouse Hill. All of these connections will have two to three lanes in each direction and also provide strategic public transport functionality. At ultimate development the Werrington Arterial will also provide a strategic link towards the south west.

Through the precinct, the town centre will be a focal point for activity and will contain a north-south spine, with South Street and Marsden Park Industrial to the south, and linking through to the Vine Street and Garfield Road extensions to the north. This connection has also been identified as a potential corridor providing increased priority for public transport. The extension of Garfield Road to the Werrington Arterial will function as a sub-arterial corridor, providing an alternative route to Richmond Road, allowing regional through traffic to bypass the town centre.

An east-west road between Richmond Road and Stony Creek Road will provide a collector function for the majority of residential parcels within the precinct. A north-south collector running will also provide connectivity to a K-12 school and neighbourhood centre, located to the north of the precinct.

3.11.2 Intersections

All the intersections across the precincts have been designed so they will accommodate future year traffic volumes associated with the proposed full development of the precinct as well as wider regional development. The intersections will all operate at an acceptable level of service during the morning peak hour and evening peak hour, with appropriate forms of control.

In line with RMS guidance all intersections within the precinct which are proposed to be signalised have been assessed to perform at Level of Service (LoS) D or above, at full development in 2036, and therefore will provide adequate capacity and operational efficiency. Along Richmond Road heavy regional traffic demands associated with the surrounding network results in two intersections operating at LoS E, however within capacity DoS <1. Sensitivity tests were undertaken to identify if additional capacity on Richmond Road through an additional northbound and southbound lane (three lanes in each direction) could improve operational performance, however was only found to attract additional traffic to the route and negatively impact operational performance. Localised widening or signal coordination with the proposed adjacent intersection will be required to improve operational performance at the intersection of Richmond Road | Garfield Road to LOS D.

3.11.3 Heavy goods vehicles

The proposed residential land uses within the Marsden Park Precinct are unlikely to generate a significant amount of heavy vehicles. Conversely, the adjacent industrial and commercial development, within Marsden Park Industrial Precinct, is likely to generate significant volumes of heavy vehicles.

A heavy goods vehicle (HGV) access strategy has been developed to prioritise HGV movements onto appropriate routes, to minimise conflict with residential land uses.

This envisages HGVs utilising roads of appropriate form and function, being those classified as arterial. This would include Richmond Road and the Werrington Arterial. Delivery vehicles requiring access to retail premises within the town centre and neighbourhood centre, are likely to use available collector roads.

4.0 Public Transport Network

4.1 Urban design principles

Efficient public transport networks are influenced by four primary factors (TCRP Report 116: Guidebook for Evaluating, Selecting and Implementing Suburban Transit Services, TRB, 2006):

- **Density** – the number of people within a given area. Density directly affects patronage potential. The more people within the service catchment, the more opportunity for a successful service.
- **Diversity** – the mix of land uses present. A mix of origins and destinations within a service area presents the opportunity for public transport services to collect passengers at different points in the network and at different times of the day.
- **Design** – the quality of the urban form. The urban form can be considered through the availability of footpaths to enable passengers to easily walk to bus stops and the connectivity of the street network (grid coverage, cul-de-sacs and/or curvilinear road forms). Footpaths should be provided on all roads to enable pedestrians to access public transport services.
- **Driving Deterrents** – reasons why people would choose public transport over driving. The major factors in travel choice are travel time and cost of parking. Networks should be designed to provide public transport priority wherever required and possible.

Other factors that influence the use of public transport systems include:

- Building orientation, pedestrian access and provision of free parking.
- Location of bus stops and availability of pedestrian crossing points.
- Quality of the urban infrastructure, including bus stop facilities (shelters, seating, timetables, etc).
- Streetscapes that discourage walking or limit access to facilities (rear fences, noise walls, etc).

These factors have been considered in defining public transport options for the Marsden Park Precinct Plan.

4.2 Existing conditions

There is very limited public transport serving Marsden Park Precinct at present, with no direct rail service within its boundaries; 2 bus services provide direct connections via Richmond Road and Stony Creek Road.

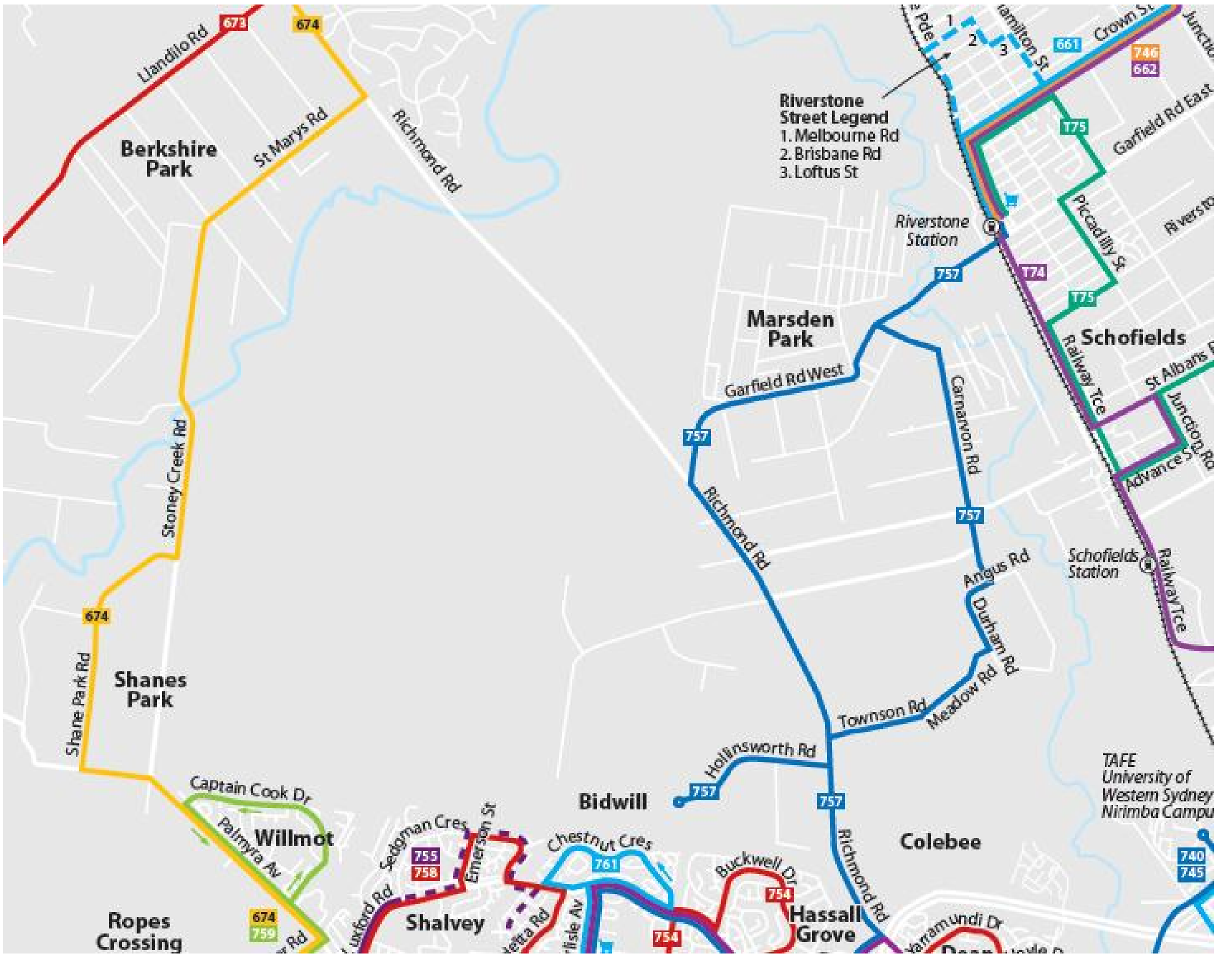
4.2.1 Bus services

Due to the current low level of development, there are currently limited bus services within the vicinity of the proposed Marsden Park Precinct. Two bus services are currently provided in the vicinity of the Precinct:

- Service 757 provided by Busways uses Richmond Road to travel between Riverstone and Mount Druitt via Rooty Hill and Plumpton, and through the existing developed area of Marsden Park to the east of Richmond Road. This service includes a stop on Richmond Road just north of South Street.
- Service 674 provided by Westbus travels along Stony Creek Road on the western boundary of the Precinct between Windsor and Mount Druitt via Shanes Park and South Windsor.

Existing bus service routes in the vicinity of the Precinct are shown in **Figure 4-1**, with the number and frequency of services shown in **Table 4-1**. Existing timetables indicate that service 757 is scheduled to connect with inbound and outbound train services at Riverstone Station.

Figure 4-1 Existing bus services routes



Source: Busways, 2012

Table 4-1 Number and frequency of existing bus services

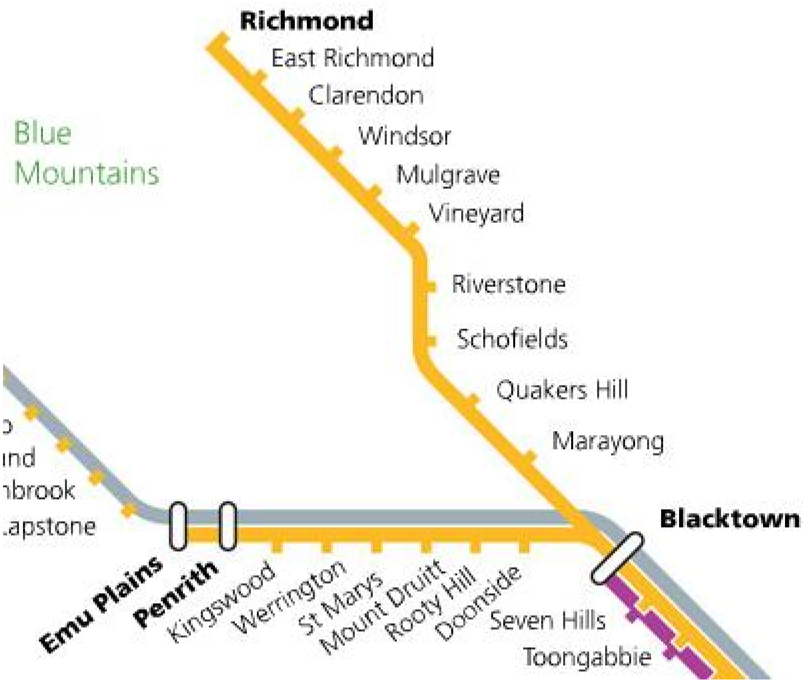
Route	Description	Weekday AM Peak (7am – 9am)		Weekday PM Peak (4pm – 6pm)		Weekday Off Peak (10am – 3pm)	
		Services	Frequency (Average)	Services	Frequency (Average)	Services	Frequency (Average)
757	Mt Druitt to Riverstone via Rooty Hill & Plumpton	3	30 minutes	2	60 minutes	4	2 hours
	Riverstone to Mt Druitt via Plumpton & Rooty Hill	3	40 minutes	3	30 minutes	3	2 hours
674	Mt Druitt to Windsor via Shanes Park & South Windsor	1	2.5 hours	2	60 minutes	2	2.5 hours
	Windsor to Mt Druitt via South Windsor & Shanes Park	3	45 minutes	2	60 minutes	1	3 hours

Source: Busways, 2012 and Westbus, 2012

4.2.2 Rail services

Marsden Park Precinct is situated approximately 4km west of Schofields and Riverstone Stations, which are both served by the Richmond Line (a section of the Western Line) of the existing suburban rail network. The extent of the rail network serving this area of north-western Sydney is shown in **Figure 4-2**. Existing services to these stations run between approximately 4:30am and 12:30 am seven days a week; the number and frequency of train services to and from Schofields and Riverstone Stations are provided in **Table 4-2**.

Figure 4-2 Existing rail network



Source: CityRail, 2012

Table 4-2 Number and frequency of existing rail services

Description	Weekday AM Peak (7am – 9am)		Weekday PM Peak (4pm – 6pm)		Weekday Off Peak (10am – 3pm)	
	Services	Frequency (Average)	Services	Frequency (Average)	Services	Frequency (Average)
Riverstone - Northbound Services	4	30 minutes	4	30 minutes	10	30 minutes
Riverstone - Southbound Services	4	30 minutes	4	30 minutes	10	30 minutes
Schofields - Northbound Services	4	30 minutes	5	30 minutes	10	30 minutes
Schofields -Southbound Services	8	15 minutes	5	30 minutes	10	30 minutes

Source: CityRail, 2012

Stage 1 of the Rail Clearways program was completed in October 2011; this has enabled the provision of additional southbound services from Schofields Station, as indicated in **Table 4-2**. Further details of the Rail Clearways program are included in **Section 4.4.3.1**.

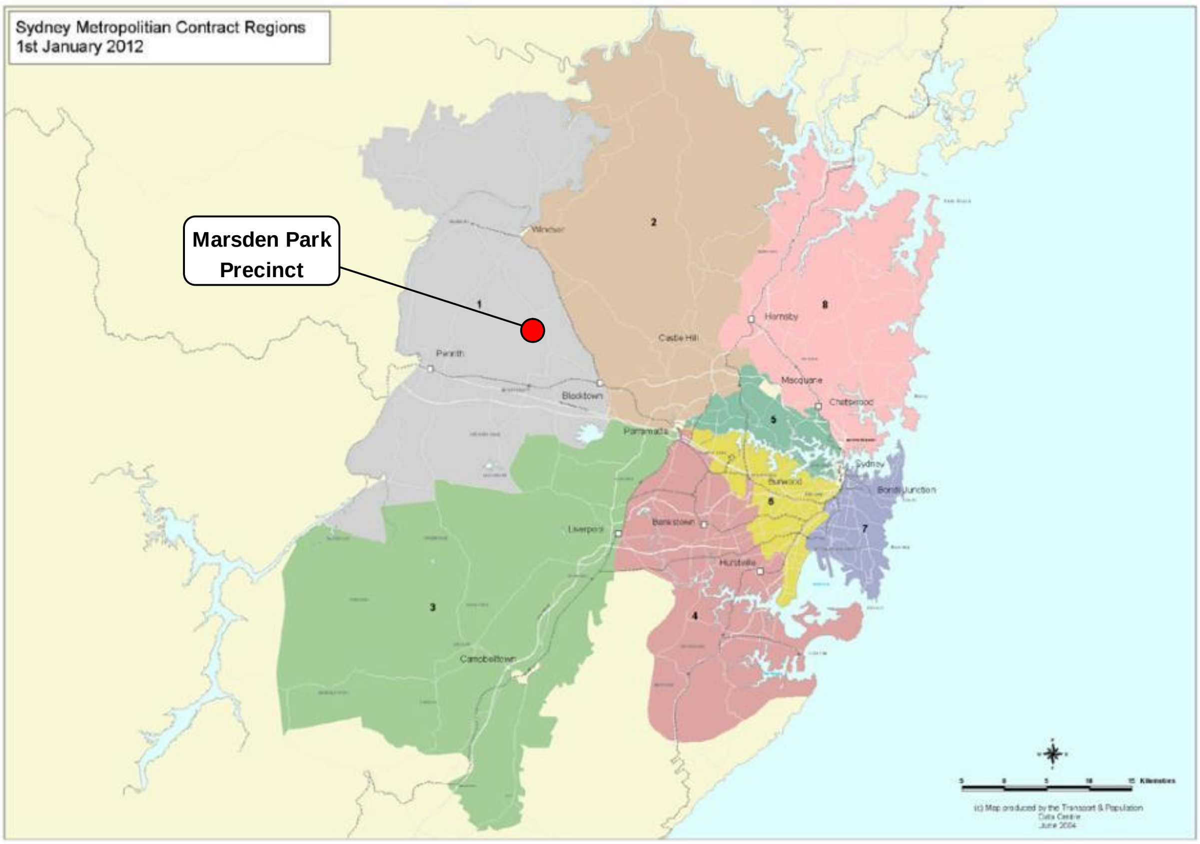
4.3 Principles and guidelines

4.3.1 NSW Bus Service Planning Guidelines

In NSW, bus network planning is directed by the NSW Service Planning Guidelines (NSW Ministry of Transport, 2006). The NSW Government's bus reform program included the consolidation of 87 small contract areas into larger contract regions to support the implementation of new, integrated service networks. These include 43 strategic bus corridors linking key regional centres.

In January 2005, 15 new contract regions were created by consolidating the 87 original contract areas within the Sydney Metropolitan Area. In January 2012 these were consolidated further into 8 contract regions, with bus services within these areas undertaken on a contract basis by operators on behalf of DoT. The boundaries of the contract regions are shown in **Figure 4-3**; Marsden Park Precinct is located in Contract Region 1.

Figure 4-3 Sydney Metropolitan Contract Regions, 2012



Source: Transport for NSW, 2012

The NSW Government, in consultation with bus operators, has developed an Integrated Network Plan for Contract Region 1 *"to establish Strategic Transport Corridors and a hierarchy of bus route types that:*

- *link to regional centre(s)*
- *pass through patronage generators such as district centres, TAFE colleges, hospitals and universities*
- *connect with other transport modes (trains, ferries and other buses)*
- *are multifunctional (serving journeys to work, education, shopping and recreation)*
- *are direct and frequent; and*
- *meet the network planning principles."*

A detailed summary of the Service Planning Guidelines planning principles is provided in **Table 4-3**. These principles have been used to confirm the suitability of the proposed bus strategy, specifically for the Marsden Park Precinct, and to identify whether any adjustments would be required.

The NSW Service Planning Guidelines also include frequency requirements for bus services; a summary of these requirements is shown in **Table 4-4**.

Table 4-3 Service Planning Guidelines summary

Bus Planning Characteristics	Benchmark/Criteria
Network (Area) Coverage	- 90% of households to be within 400 metres of a rail line and/or a Regional or District bus route during commuter peaks, inter peak and weekend day time. - 90% of households to be within 800m of a rail line and/or a Regional or District bus route at other times.
Network Legibility	- Peak and off-peak services should use the same route wherever possible.
Route Design	- Regional Routes to be between 10 and 25 kilometres in length. - Routes to be between 30 and 60 minutes in duration. - Maximum diversion from the fastest or shortest route (between termini) to be no more than 20%.
Accessible Buses	- Low floor, wheelchair accessible buses to be allocated to Strategic Transport Corridor routes. - Accessible buses to be evenly timetabled on the corridors and advertised as "accessible" trips in the public timetable.
Dedicated School Services	- Dedicated school services should be kept to a minimum in order to maximise the frequency and availability of normal route services. - Average 5 boardings per revenue kilometre. - Students to be delivered to their school within half an hour of school commencement time and picked up within half an hour of school finishing.
Section Points	- The range of section point lengths to be between 1.3 km and 1.9 km. - The average length of section points within each route to be 1.6 km.
Patronage	- Average 1.5 to 2.5 boardings per revenue kilometre (based on an average operating speed of 24 kph). - Peak period patronage to be in the range of 50% (25% at other times) seated capacity and 85% of the legal bus capacity (averaged by the number of trips operated during any 20 minute period) at maximum load point. - Passengers not to stand for more than 30" of a timetabled service.

Source: NSW Service Planning Guidelines, NSW Ministry of Transport, 2006

Table 4-4 Service frequency requirements by route type

Route Type	Time Period	Frequency (Minimum)
Regional Routes	Pre AM Peak	30 mins
	Peaks	20 mins
	Weekday Daytime	30 mins
	Post PM peak	60 mins
	Weekend daytime	30 mins
District Routes	Peaks	60 mins
	Weekday Daytime	
	Weekend Daytime	
Local Fixed Routes	Weekday / Weekend Daytime	120 mins
Local Flexible Transport Services	All	As required (Negotiated with the Ministry)

Source: NSW Service Planning Guidelines, NSW Ministry of Transport, 2006

4.4 Future public transport service provision

4.4.1 Overview

Public transport for the Marsden Park Precinct would be provided by improved bus services within the precinct, which would connect to key centres and transport interchanges outside of its boundaries. Integration between bus and rail would be a significant factor in the successful uptake of public transport; the connections between the Precinct and public transport interchanges at Riverstone (via Garfield Road West) and Schofields (via South Street / Schofields Road) would be key links. These routes have been identified as future transit boulevards, as indicated in **Section 3.7**.

The staged rollout of bus services would also need to be considered, ensuring the provision of services is coordinated to align with the staged development of the Precinct; the timely provision of bus services would be important in maximising uptake of public transport from an early stage.

4.4.2 Future bus service provision

Forward planning of a comprehensive future bus network is required to provide equitable access to local and regional areas for employment, retail and recreational purposes. Future services would need to provide sufficient mobility within the Marsden Park Precinct in both east-west and north-south directions, and onward connections outside of the Precinct's boundaries to and from other major centres, transport interchanges, and other key areas.

In addition to the provision of services, it is also important to ensure that good public transport access and interchange facilities are provided at major trip generators, including the primary retail and commercial centre in the east of the Precinct, as well as at key transport interchanges at Riverstone and Schofields train stations.

Further to this, the east-west connections between the Precinct's centre and these transport interchanges (i.e. Garfield Road West and South Street / Schofields Road – see **Section 3.7**) have been designated as transit boulevards, providing public transport priority opportunities between and within these key areas. Given their significance as bus corridors, priority measures should be considered during their development to cater for increasing bus demand while maintaining or improving travel times.

4.4.2.1 North West Sector Bus Servicing Plan

The North West Sector Bus Servicing Plan was produced in 2009, by McCormick Rankin Cagney for NSW Transport and Infrastructure. The details of this plan form the basis of the proposed network for the Marsden Park Precinct, which has been adjusted to maximise potential patronage and coverage.

The plan proposes a strategic bus corridor between Rouse Hill and Mount Druitt via Schofields, Marsden Park, and Carlisle Avenue and the proposed bus network for the North West Sector. However, this plan has been superseded by a draft Bus Strategy, known as Sydney's Bus Future, currently being developed as art of the NSW Long Term Transport Master Plan.

4.4.2.2 NSW Long Term Transport Master Plan

The NSW LTTMP has indicated a draft Bus Strategy, known as Sydney's Bus Future, is currently being developed which will define the strategic bus network for the Sydney Metropolitan Area. The strategy will show the city's primary centre-to-centre bus system, as well as the next tier of cross-metropolitan bus routes.

The NSW LTTMP has identified several strategic bus corridors/routes to be investigated relevant to the Marsden Park Precinct which includes:

- Rouse Hill to Blacktown via Marsden Park bus corridor for bus priority investment;
- Penrith to Rouse Hill via Marsden Park and Marsden Park to Prairiewood as a cross-metropolitan route; andMount Druitt to Schofields via Marsden Park as part of The Bus Head Start Program to support the NWGC.

4.4.3 Future rail service provision

4.4.3.1 Rail Clearways Program

The scope of works for the Rail Clearways program includes the construction of an additional track on the Richmond Line between Quakers Hill and Vineyard Stations, in conjunction with an upgrade of Riverstone Station and new stations at Schofields and Vineyard. The duplication of the track will enable the line to accommodate additional peak hour services, to meet increased future demand resulting from the anticipated population and employment growth in the North West Growth Centre, reduce passenger crowding, and improve service reliability.

The upgrades are being delivered in 2 stages. Stage 1 included construction of the new Schofields Station and track between Quakers Hill and Schofields; this work was completed in October 2011, and has enabled the provision of additional southbound services from Schofields Station. Stage 2 includes the upgrade of Riverstone Station, a new station at Vineyard and additional track between Schofields and Vineyard.

4.4.3.2 North West Rail Link

Planning is currently being undertaken by the NSW Government for the North West Rail Link, which would terminate at Cudgegong Road in the Area 20 Precinct of the North West Growth Centre, approximately 8km east of the Marsden Park Precinct. The proposed alignment and station locations are shown in **Figure 4-4**.

The proposed expansion of the rail network is a key component in providing an integrated and affordable public transport system for the people of north west Sydney. The proposed rail link would link existing communities and new growth areas with jobs and services in the wider area; it would directly connect north west Sydney to employment hubs at Epping, Macquarie Park, and Chatswood, with onward connections to Sydney's CBD.

The proposal would be expected to improve transport network efficiency by facilitating a shift from road to rail for trips to and from north west Sydney. The proposed Cudgegong Road station would be located approximately 8km east of the Marsden Park Precinct; within the Precinct the effects would include a significant increase in bus demand linking to this and train stations on the extended rail network, with travellers opting to use a combination of bus and rail services which would offer travel time savings and improved reliability when compared to equivalent car journeys.

Figure 4-4 Proposed North West Rail Link Alignment and Station Locations

Source: Transport for NSW, 2012

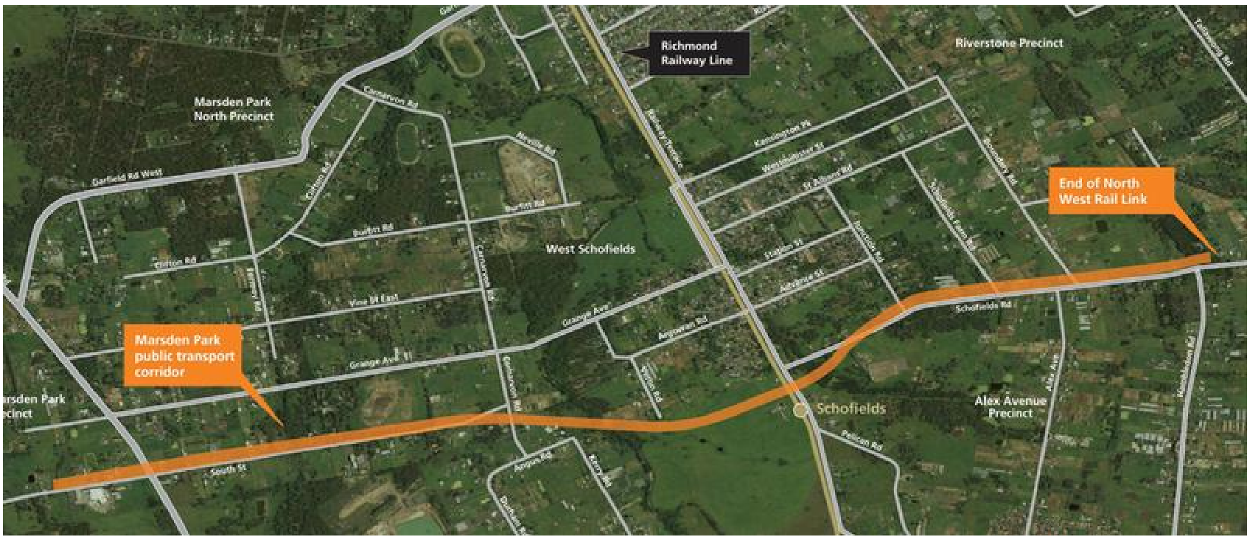
4.4.4 North West Transport Options

Planning for North West Sydney's future public transport needs has led to the discussion of securing a dedicated public transport corridor through the North West Growth Centre. The North West Transport Options Discussion Paper has identified two transport corridor options that would run from the end of the proposed North West Rail Link at Cudgegong Road, these include:

- Option A: Cudgegong Road to Schofields and Marsden Park
- Option B: Cudgegong Road to Riverstone

In regards to Marsden Park, Option A will improve connections to Rouse Hill, Cudgegong and Schofields. The Option A transport corridor is shown in **Figure 4-5**.

Figure 4-5 Option A transport corridor



Source: Transport for NSW, 2012

Transport for NSW has announced that Option A, the transport corridor into Marsden Park will be secured for future generations and included in the NSW LTTMP. Following this, the Government will now progress further detailed studies into the Marsden Park corridor.

In assessing the preferred corridor, a number of factors will be impacted, such as:

- Impact on major roads such as Richmond Road;
- Impacts on pedestrian activity and safety;
- Impact on the proposed Town Centre;
- Access to the proposed transport corridor and amenities for residents within the Marsden Park Precinct and surrounding users; and
- Impact on existing properties.

4.5 Public transport framework analysis

4.5.1 Bus network

The bus network for the Marsden Park Precinct is expected to comprise of a mixture of regional and district routes to maximise speed and efficiency of high frequency peak hour services as well as to ensure maximum coverage throughout the precincts, facilitating public transport access and travel choice for all.

4.5.1.1 Proposed network routes

A draft bus strategy, Sydney's Bus Future, is currently being developed which is anticipated to provide regional plans for the NWGC and determine the bus network for Marsden Park Precinct.

Given the draft status of the bus strategy and the on-going development of how specific bus routes will be operating within Marsden park Precinct, it has been agreed with TfNSW that the proposed collector road and sub-arterial road network within the precinct are designed to accommodate bus routes to provide local, district and regional connectivity to public transport services within the North West Growth Centre. The bus capable road network is shown in **Figure 4-6**, which is expected to accommodate the proposed bus routes in Sydney's Bus Future.

The bus capable road network provides connectivity to Richmond Road and the future transit boulevards of Schofields Road and Garfield Road, which can accommodate the bus routes identified for investigation in the NSW LTTMP. These bus routes include:

- Rouse Hill to Blacktown via Marsden Park;
- Penrith to Rouse Hill via Marsden Park;
- Marsden Park to Prairiewood; and
- Mount Druitt to Schofields via Marsden Park.

The main east-west collector road provides bus access to and from Stony Creek Road and Richmond Road, allowing bus movements throughout the Precinct. The north-south collector road (adjacent to the southern Town Centre), allows bus routes access to the proposed bus interchange within the Town Centre and connectivity to the South Street transit boulevard and Marsden Park Industrial Precinct.

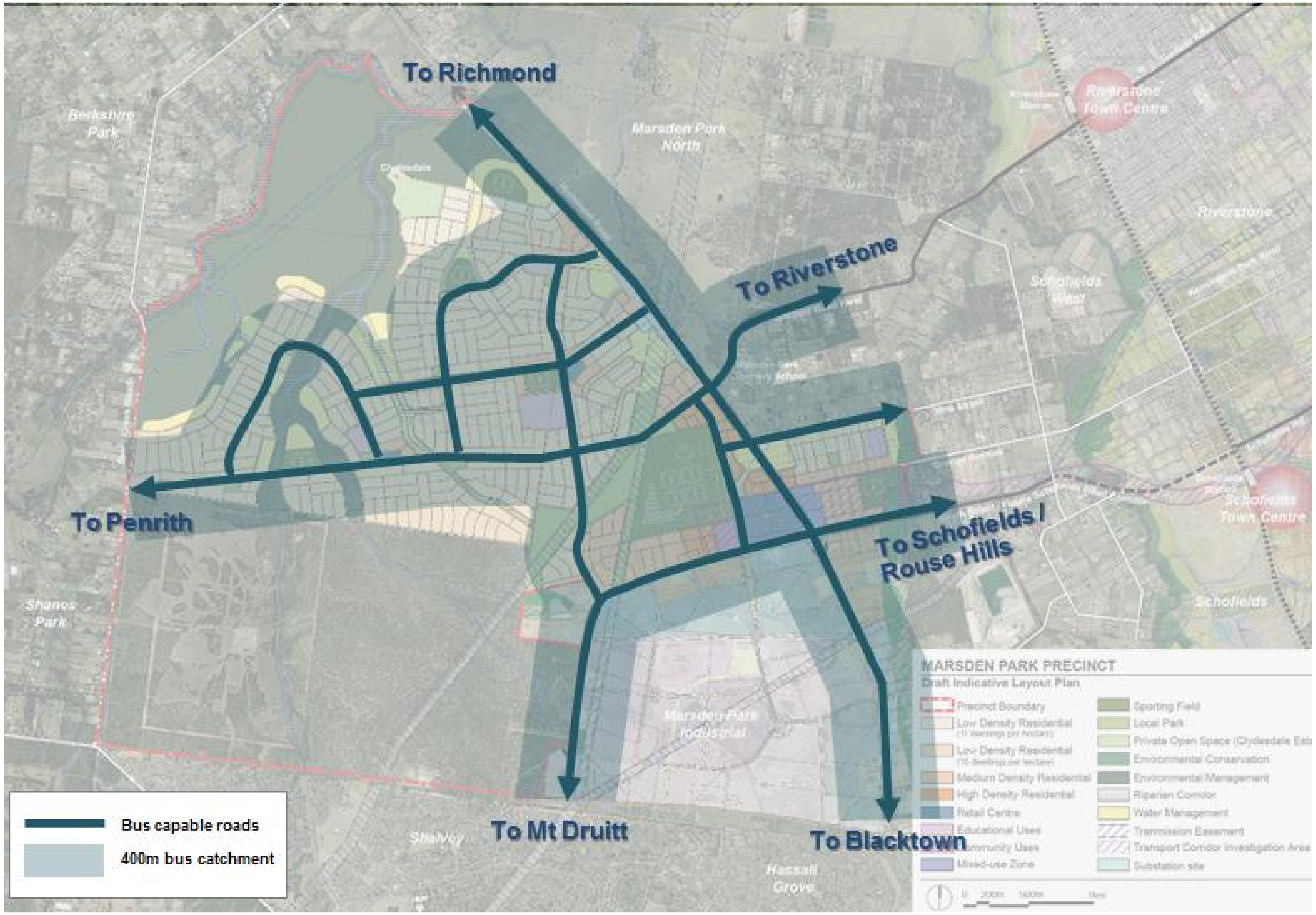
The bus network is also expected to meet the bus planning criteria defined in the NSW Service Planning Guidelines as shown in **Table 4-5** and provide a high level of service to the major commercial and retail centre proposed within the Precinct.

Table 4-5 Bus network evaluation criteria

Bus Planning Characteristics	Benchmark/Criteria	Satisfied[2]
Network (Area) Coverage	- 90% of households to be within 400 metres of a rail line and/or a Regional or District bus route during commuter peaks, inter peak and weekend day time. - 90% of households to be within 800m of a rail line and/or a Regional or District bus route at other times.	Yes
Network Legibility	- Peak and off-peak services use the same routes.	Yes
Route Design	- Regional Routes to be between 10 and 25 kilometres. - Routes to be between 30 and 60 minutes in duration. - Maximum diversion from the fastest or shortest route (between termini) to be no more than 20%.	Yes*
Section Points	- The range of section point lengths to be between 1.3km and 1.9km. - The average length of section points within each route to be 1.6 km.	Yes*

[2] Subject to the development and finalisation of the ILP as well as the release of Sydney's Bus Future.

Figure 4-6 Bus capable roads



Source: AECOM, 2013

4.5.1.2 School bus services

Dedicated school bus services would be introduced as appropriate to transport students to and from new schools within the Precinct where warranted by demand. In general however students would be encouraged to use scheduled public transport services where possible, given that all school zoned areas in the Precinct would be located close to one or more proposed routes on the bus network.

The justification for dedicated school bus services would be based on combined commuter and student travel demand exceeding the carrying capacity of public bus services.

4.5.1.3 Bus stops

Bus stop locations would be defined during detailed planning as proposed land uses within the Precinct become more accurately refined and bus routes have been identified in Sydney's Bus Future. All routes identified as bus corridors would be required to provide a road reserve of sufficient width to accommodate bus stops, including shelters where appropriate. Lane widths for bus routes in the Precinct would need to be a minimum of 3.5m; adequate seating and shelter is recommended at bus stops located on key regional routes, including Richmond Road, Schofields Road, and South Street.

The final bus network should provide stops with a minimum spacing of 400m to maintain route speeds and provide sufficient access for passengers, while minimising the impact of stopping buses on general traffic flows. This would require routes to have two lanes in each direction or one lane in each direction plus a parking lane that could accommodate a bus stop.

Indented bus stops are a possible solution where a route provides only one lane per direction; however, they do not allow the flexibility of other solutions to modify stop locations as land uses and patronage demands change, and are therefore avoided where possible.

Bus stops in the proximity of traffic signals on arterial roads such as Richmond Road and South Street would be located on the departure side of signalised intersections.

Bus stops provided will require good pedestrian access and will need to meet the requirements of the Disability Standards for Accessible Public Transport (DSAPT) and the Disability Discrimination Act (DDA).The final location of bus stops should be determined by bus operators and Transport NSW in consultation with Blacktown City Council's Local Traffic Committee.

4.5.2 Rail network

The Precinct would have strong connectivity to the city rail network via Riverstone and Schofields stations on the existing Richmond Line, as well as via the proposed Cudgegong Road station on the North West Rail Link.

4.5.2.1 Richmond Line (Western Line)

The Richmond Line currently provides access to key centres located throughout Sydney via both direct links and onward connections. Under construction as part of the Rail Clearways Program, the Richmond Line Rail Duplication will improve the performance of rail services, increasing the frequency and reliability of train services for all passengers, including those travelling to and from the Marsden Park Precinct.

In addition as part of this program, the newly relocated Schofields Station will allow the residents of Marsden Park Precinct to access the station by several transport modes, with the provision of car parking and kiss and ride facilities, as well as bicycle racks and a bus interchange. The bus interchange has been designed to cater for future bus demand at the station, including both regional and local services, while the new station has been designed to maximise accessibility, incorporating features including easy access pedestrian footbridges.

Existing services time periods and frequencies on the Richmond Line are detailed in **Section 4.2.2**; from Schofields station to the south peak service frequency is 15 minutes following the recent duplication of the line. Stations north of Schofields, including Riverstone would be able to accommodate the same peak service frequency following completion of the Richmond Line Duplication.

4.5.2.2 North West Rail Link

The North West Rail Link will provide an enhanced, direct rail link between north west Sydney and employment hubs at Epping, Macquarie Park, and Chatswood, as well as onward connections to Sydney's CBD. Details including the location and design of stations, transport interchanges, park and ride facilities, and cycling and pedestrian facilities are all to be finalised.

A key objective of the project is "facilitating a shift from road to rail for trips to and from the North West"; it is therefore expected that the planning and delivery of this major infrastructure will be aligned with widespread upgrades to and integration with the existing transport network, in particular sustainable transport modes, to encourage this shift.

Services on the line are expected to be provided at a minimum frequency of 15 minutes throughout the day, seven days per week (North West rail link Community Newsletter, NSW Transport, July-August 2011).

As discussed in **Section 4.4.4**, a public transport corridor has also been identified that will be extended from the proposed North West Rail Link at Cudgegong Road into Marsden Park, improving public transport connectivity to Schofields, Rouse Hill and major centres in the wider Sydney Metropolitan area.

4.5.3 Public transport interchanges

The provision of effective public transport interchanges will be a key factor contributing to the success of the public transport system provided within the Marsden Park Precinct and throughout the North West Growth Centre. These facilities are required to provide the necessary accessibility to, and interconnection between bus and train services that would support widespread public transport patronage.

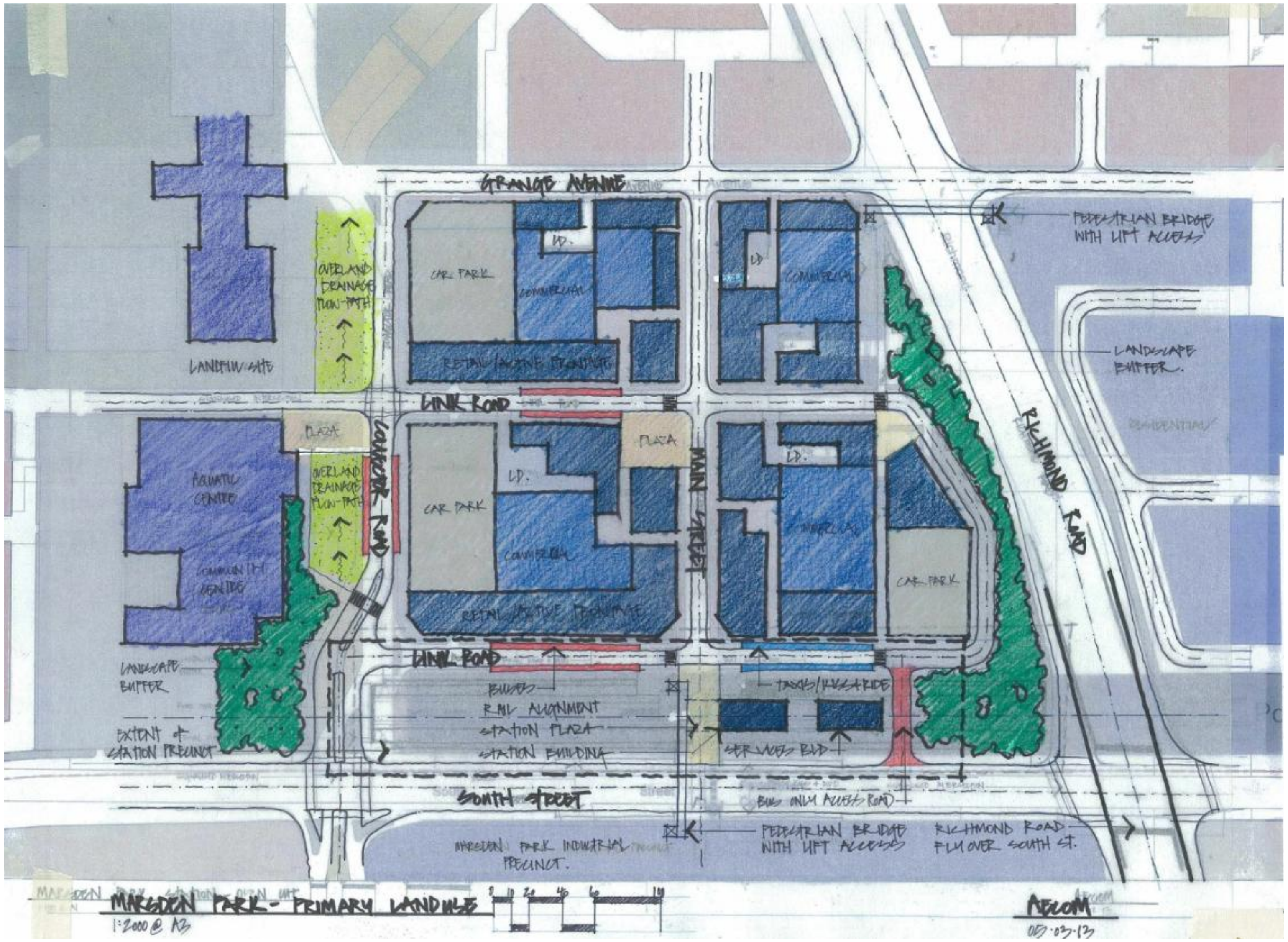
Indicative features of the proposed interchange within the Precinct include:

- On-street bus interchange, located on an east-west aligned street located between the Precinct's centre and South Street, and on the path of key bus services.
- Supplementary bus stops surrounding the Precinct's centre to cater for north-south aligned bus routes.
- Provision of bus bays, including short-term bus layover and driver break facilities.
- Provision of pedestrian friendly connections to the bus interchange including multiple stops in both directions, zebra and signal controlled pedestrian crossings, and median safety barriers.
- Additional design considerations include low posted speeds limits, the promotion of retail storefronts, and the avoidance car-park entrances along the proposed route.

The number of bus bays required at the Marsden Park Town Centre will be established during the detailed planning stage and once the number of bus routes traversing through the Precinct has been confirmed. An indicative layout showing the bus interchange at the Marsden Park Precinct Town Centre is presented in **Figure 4-7** and **Figure 4-8**. It is recommended further scoping studies are undertaken at a later stage, once Sydney's Bus Future has been completed, to confirm interchange layout and requirements.

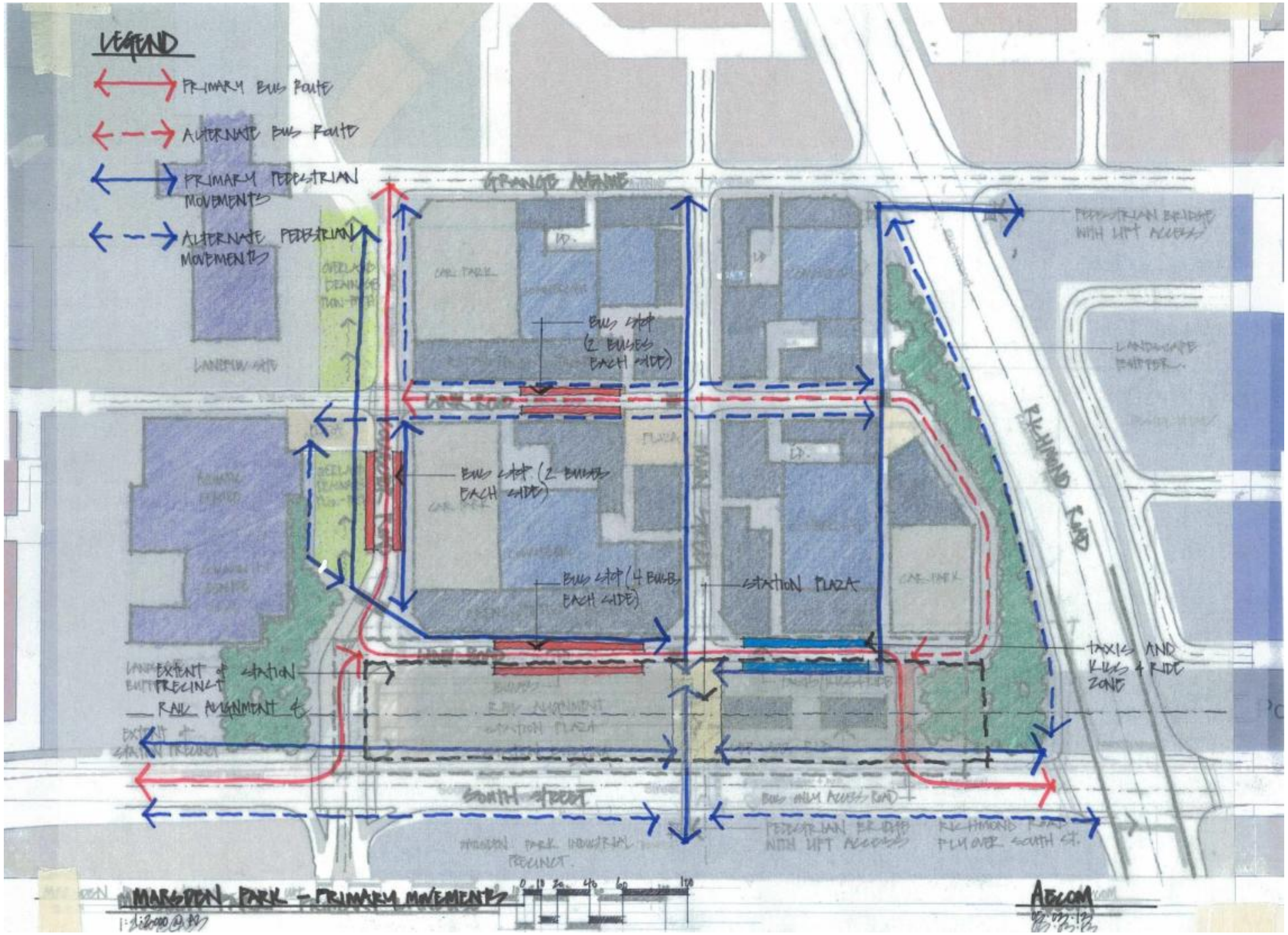
It is also recognised that the provision of effective transport interchanges outside the boundaries of the Precinct will also have a key role in encouraging the use of public transport within Marsden Park. Well-designed transport interchanges at Riverstone and Schofields train stations on the Richmond Line, as well as the proposed Cudgegong Road train station on the North West Rail Link, would be required to provide efficient public transport connections between the Marsden Park Precinct and the wider Sydney Metropolitan Area for trips integrating bus and rail services.

Figure 4-7 Marsden Park Town Centre indicative layout



Source: AECOM, 2013

Figure 4-8 Indicative bus interchange



Source: AECOM, 2013

4.5.4 Sustainable Travel Measures

To encourage sustainable travel and reduce car dependence within the Precinct, it is recommended each household is to be provided with a household information packs (HIPs) which would include a sustainable travel component. The HIPs will set out the sustainable travel options available to residents and the specific local initiatives available to encourage sustainable travel.

This would incorporate public transport leaflets, route maps and timetables (including direction to the 131500 travel information line and website and bus, train and fare information), pedestrian and cycle network maps including leisure maps, and information on any sustainable community initiatives.

4.6 Findings and recommendations

The precincts will benefit from good public transport accessibility through a comprehensive bus capable road network which links key centres, transport nodes, schools, employment opportunities and residential areas.

Key bus operating corridors, such as Schofield Road and Garfield Road, will provide efficient regional connections to connecting rail services such as the Richmond Line and future North West Rail link. Other notable regional destinations that will be available through public transport connections will include employment areas at Riverstone and Box Hill, and also the Rouse Hill Major Centre.

The bus capable road network provides connectivity to Richmond Road and the future transit boulevards of Schofields Road and Garfield Road, which can accommodate the bus routes identified for investigation in the NSW LTTMP. These bus routes include:

- Rouse Hill to Blacktown via Marsden Park;
- Penrith to Rouse Hill via Marsden Park;
- Marsden Park to Prairiewood; and
- Mount Druitt to Schofields via Marsden Park.

Within the precinct, roads serving bus routes should have two lanes in each direction or one lane in each direction with a parking lane that could accommodate a bus stop. Lane widths need to be a minimum of 3.5 metres. Indented bus stops are not recommended and, where bus stops are located in proximity to education or activity centres, safe pedestrian crossing facilities have been proposed.

Proposed signalised intersections on Richmond Road will also provide bus priority through bus lanes commencing at the left turn diverge. These short bus lanes will allow opportunity for buses to bypass stop line queues, and direct access to bus stops on the intersection exit. This together with signal coordination in the peak direction will improve bus journey time reliability on the Richmond Road corridor. The central town centre north-south spine has also been identified as a key corridor for bus priority.

5.0 Walking and Cycling Network

5.1 Introduction

Walking and cycling has a major role to play in the future transport system and land use planning initiatives for Metropolitan Sydney. The NSW State Plan aims to increase the share of short trips by bike in Greater Sydney for all travel purposes to five per cent by 2016; this objective is supported by the Blacktown City Bike Plan, providing a network of off-road cycling track and safer on-road routes. Walking is also a smart travel choice and a viable option for a significant number of shorter transport trips.

Mixed use developments and proximity to local centres are key factors in promoting active, sustainable transport modes, together with high quality walking and cycling routes with streetscapes that encourage these modes.

The objective of this section is to present opportunities to provide high quality walking and cycling networks within the Marsden Park Precinct, while aligning and integrating these networks with adjacent precincts (e.g. Shanes Park, Marsden Park Industrial, Schofields West) and regional routes and infrastructure, such as the Westlink M7 cycleway.

5.2 Opportunities and constraints

Overall the precinct is generally flat with gentle slopes in proximity to the heritage house, providing opportunity to encourage walking and cycling in the area. In developing the precinct, providing viable alternatives to the private car for journeys with destinations both within and outside the precincts is essential to encourage sustainable travel patterns. In particular it will be important to connect internal roads within the precinct with direct pedestrian and cycle connections to allow access to the town centre, proposed schools, public transport nodes and smaller neighbourhood centres.

The future widening of Richmond Road and extension of South Street could create a potential barrier to east-west and north-south pedestrian and cycle movements. These corridors would need to be planned to provide sufficient pedestrian and cycle crossing facilities to minimise adverse impacts. Another consideration would be to minimise the potential for heavy vehicle intrusion into the precinct from Marsden Park Industrial, as heavy vehicles traversing the precinct would reduce amenity and potentially increase safety risks for pedestrians, particularly within the town centre.

There are good opportunities to provide for recreational walking and cycling by creating links to the open space, recreational areas and providing off-road paths within the conservation area towards the south west, under transmission line easements or within the riparian corridor.

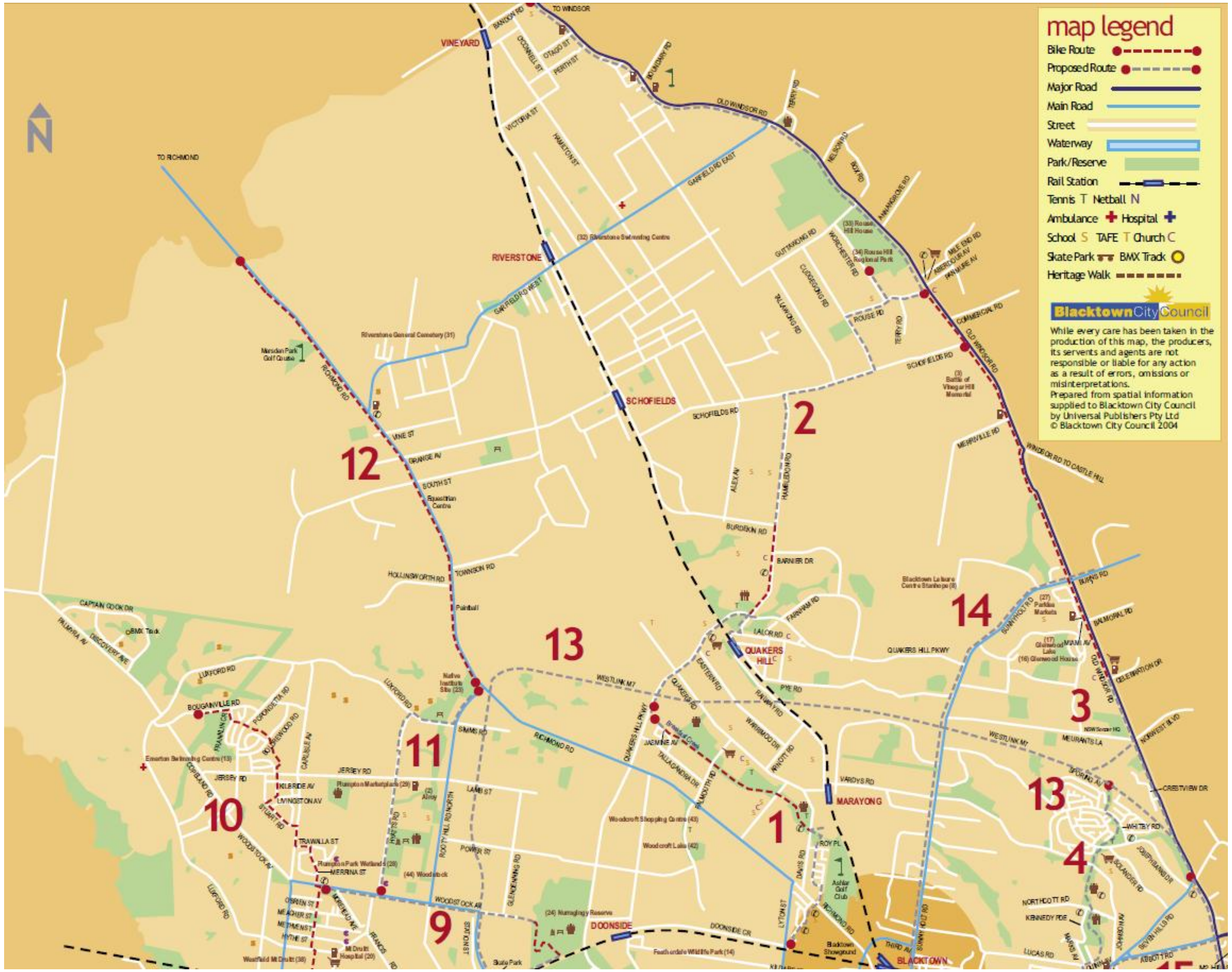
The increase in available public transport services and provision of dedicated walking and cycling infrastructure in the surrounding network as precincts are developed will further enhance pedestrian and cycling links, increasing accessibility and connectivity to surrounding centres and destinations.

5.3 Existing conditions

Due to the current undeveloped, primarily rural nature of Marsden Park, existing pedestrian and cycling routes and facilities within and surrounding the Precinct are limited. Pedestrian crossing facilities are provided at the signalised intersection of Richmond Road and Garfield Road West, and a dedicated cycleway in the form of a continuous sealed shoulder is provided along Richmond Road to the north, south, and through the Precinct.

Regional cycling links are provided on the surrounding network, including cycle lanes on the M7 Motorway and on-road cycle lanes on Quakers Hill Parkway. These routes are now operational, although they are shown as proposed routes in the Blacktown City Council Bike Routes in **Figure 5-1**.

Figure 5-1 Blacktown City Council Bike Routes



Source: Blacktown City Council, 2004

5.4 Principles and guidelines

Two documents guide the provision of pedestrian and cycling networks and facilities in this area.

- The Growth Centres Development Code; this code includes guidelines for all aspects of urban design from street layout to open space and water use.
- NSW Bicycle Guidelines (NSW Roads and Traffic Authority, 2003).

5.4.1 Growth Centres Development Code

Key objectives of the Growth Centres Development Code that relate to pedestrian and cycle planning include the improvement of:

- Facilities at a local level (i.e. walking/cycling distance from residences).
- Access to public transport.
- Encouraging reduction of the reliance on private vehicles.
- Walking and cycling connections, especially between residential areas, shops and schools.
- Buildings and landscapes to define thoroughfares as civic places.
- Developments to accommodate pedestrians while also adequately accommodating vehicles.

The objectives can be achieved by adhering to the elements of the Code that follow. The elements highlighted in **bold** can be achieved at this stage of planning. The remaining elements would be carried forward for consideration during later planning stages through planning instruments including development control plans, although it is important to ensure that deferred elements are not precluded by initial design decisions:

- **Pedestrian and cycle routes will be direct, continuous** and well lit.
- **Cycle routes will be linked to those outside the site**.
- **Grid like street network pattern to facilitate cycling**.
- **Limit use of cul-de-sacs** (they should be used only where other more permeable options are not available).
- **Clearly delineated routes for pedestrian, bicycles and vehicles**.
- **Public open space should be a design feature, with recreational uses along drainage lines**.
- **"Recreational trails" will connect public open space using on or off road routes**.
- **Smaller lots and higher densities should be provided close to centres and public transport**.
- Pedestrian movement should not be inhibited by parking areas in town centres.
- Lots will front open space and major streets to provide casual surveillance.
- High level of pedestrian amenity, with active streets and links between parks and plazas.
- Streets and lanes will be shared spaces accommodating all users.

5.4.2 NSW Bicycle Guidelines

The NSW Bicycle Guidelines (NSW Roads and Traffic Authority, 2003) assist in the design of bicycle facilities; the principles of network design are also relevant when designing pedestrian facilities. The document provides a step by step process that the design should move through and details factors that should be considered. It is a best practice guide and professional judgement should be used when applying the guidelines.

The NSW Bicycle Guidelines identify five key principles to adopt when designing a cycle network. These are:

- **Coherence**: The cycle network should link popular destinations in a continuous form, with consistent quality across the network. The correct path, especially at intersections, should be clear. There should be adequate density of routes to offer a choice to cyclists.
- **Directness**: Long detours should be avoided, but minor detours to avoid the steepest section of a hill are advisable so that the cyclist can maintain a constant speed throughout the journey. Barriers, such as a crossing at critical points can disrupt the momentum of the ride.
- **Safety**: Intersections should be designed with bicycles in mind and should include a path for cyclists. Roadway crossings should be safe and easy to negotiate.
- **Attractiveness**: Bicycle infrastructure should fit with the surrounding environment. Routes should be clearly signed, line marked and well lit to offer a sense of security.
- **Comfort**: A smooth surface ensures a safe and comfortable ride. Space should be allocated to cyclists within the road reserve (in either a cycle lane or separated path) on all roads unless speed and traffic volumes are very low.

5.4.3 Further considerations

Other principles considered during the development of active transport facilities that are not included in the guidelines reviewed include the following:

- **Capacity**: There must be adequate space for waiting pedestrians, particularly at bus stops.
- **Integration**: Walking and cycling should be integrated with other modes (particularly bus and train services) through the provision of obvious, safe and convenient pedestrian and cycle access paths to interchange areas, as well as secure cycle storage facilities.
- **Storage facilities**: Appropriate storage facilities should be provided at all key destinations including train stations, major bus stops, and key centres. Storage facilities should provide for both long and short term storage of cycles and related equipment. Facilities should be designed to provide both security and weather protection, and convey a sense of high priority for bicycle users.

It is acknowledged that commuter cyclists prefer to use direct routes and are not as deterred by gradients and travel within the vehicle carriageway as recreational cyclists. Recreational cyclists are more likely to prefer a longer but flatter route; travel time is less of a consideration than the riding environment.

5.5 Proposed bicycle and pedestrian networks

Due to the rural, undeveloped nature of the Marsden Park Precinct at present, walking and cycling facilities are currently limited. However, opportunities to develop these facilities will increase in line with urban development in the area.

Blacktown City Council is committed to providing off-road cycling tracks, in addition to working to improve the safety of on-road cycling. Current planning by Blacktown City Council includes the provision of cycle links along all major roads (defined as roads carrying traffic volumes over 10,000 vehicles per hour) such as Richmond Road, and the future transit boulevards Schofields Road and Garfield Road.

5.5.1 Bicycle network

A comprehensive bicycle network is proposed for the Marsden Park Precinct has been developed with a focus on connectivity between education precincts, public transport stops and interchanges, and commercial and employment activity areas. The proposed bicycle network as shown in **Figure 5-2** would include a mixture of on-road and off-road dedicated and shared bicycle facilities as follows:

- On-Road:
    - Linemarked Bicycle Lanes.
    - Signposted Routes.
- Off-Road:
    - Dedicated Bicycle Paths.
    - Shared Pedestrian / Bicycle Paths.
    - Shared Pedestrian / Bicycle Paths – Green Corridors.

Off-road dedicated bicycle paths are proposed along arterial roads; namely Richmond Road and South Street. As part of the planned upgrade of Richmond Road it is proposed that the existing on-road shared shoulder / bicycle lane is upgraded to an off-road dedicated bicycle path, improving cycling connectivity to the Westlink M7 Cycleway and reducing safety concerns for cyclists.

In addition off-road shared pedestrian / bicycle paths would be provided along the transit boulevards proposed on Garfield Road West and South Street | Schofields Road, linking the Precinct with Riverstone and Schofields Town Centres. Similar facilities along sub-arterial roads and collector roads would improve connectivity between and through the Precinct's centre and residential areas. Local roads would not be provided with bicycle-specific facilities; the low volumes and speed of traffic allow bicycles and motor vehicles to safely share these roads. Sub-arterial roads within the precinct will also be provided with off-road shared pedestrian/bicycle paths. On-road line-marked bicycle lanes will be provided on roads within the Town Centre providing connectivity between key origins and destinations within the Precinct. .

The proposed cycling connections are designed to create a continuous network of facilities removing obstacles and barriers to cycling, both physical and perceived. Crossing points of the creek lines and other physical barriers are mainly shared with road infrastructure; they have been included in the proposed plan to ensure route connectivity and network permeability.

There are also further opportunities to create shared pedestrian / bicycle paths along the riparian corridors created by the tributary arms of South Creek, which traverse the Precinct aligning roughly north-south. A proposed route is included in **Figure 5-2**, although its provision would require access behind private property boundaries, and is in a zone liable to flooding. These routes could be considered in future if opportunities arise for further development and consolidation to create additional bicycle paths.

The width of the proposed bicycle network will need to meet the RMS Bicycle Guidelines and Austroad Guidelines, as shown in **Table 5-1**.

Table 5-1 Austroads and RMS Bicycle guidelines

Type	Minimum width	
	Austroads Guideline	RMS Bicycle Guideline
On road bicycle lane	-	1.4m – 2.5m
Off road shared path	2.5m – 3.0m	2.0m – 4.0m
Off road shared path (recreational)	3.0m – 4.0m	-

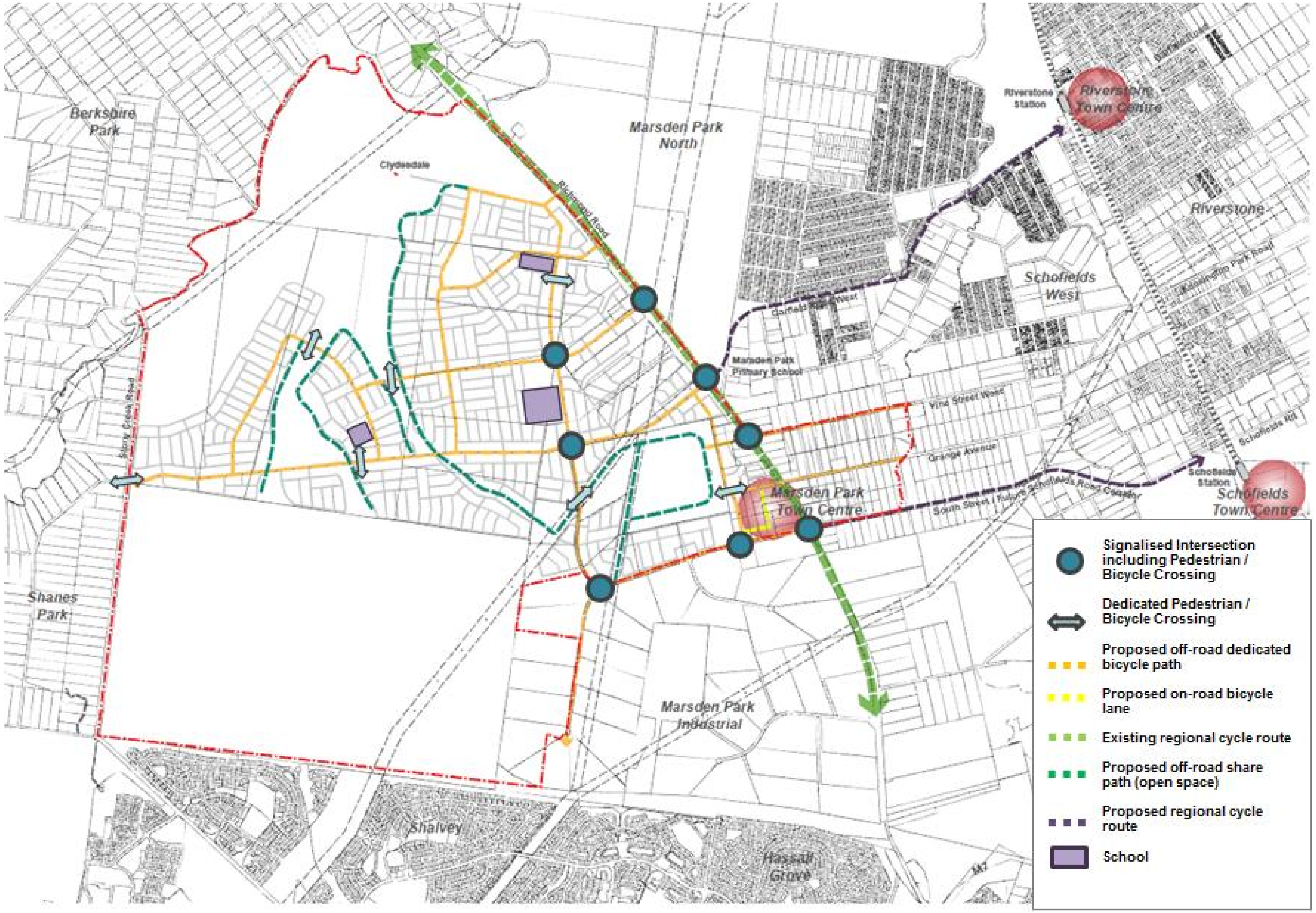
Source: Austroads, 2009 and RMS, 2005

The road cross section within the Precinct indicate these guidelines are met by providing a 2.5m off road shared path along collector and sub-arterial roads and a 1.7m on road bicycle lane.

To permit safe operation of the proposed bicycle lane and off road shared path appropriate path linemarkings and regulatory signage are to be installed as stated in the RMS Bicycle Guidelines and Austroad Guidelines (ie. R8-2 signs for shared paths). Special lighting may need to be installed in locations remote from the road network, for example along the off-road share path provided along the riparian corridors.

In addition directional signage is to be included to improve connectivity and help users to find their way around the bicycle network. Directional signage should be positioned so that cyclists can safely follow their chosen route.

Figure 5-2 Proposed bicycle network and location of pedestrian crossing facilities



Source: AECOM, 2013

5.5.2 Pedestrian network

The proposed pedestrian footpath network is not explicitly illustrated; it is proposed that all roads throughout the Marsden Park Precinct included in the Draft ILP in **Figure 2-1** (**Section 2.0**) would provide dedicated pedestrian footpaths, creating a comprehensive pedestrian network. Proposed pedestrian facilities are illustrated in detail in **Section 6.0**; these facilities would meet or exceed relevant guidelines on footpath provision.

Within the Precinct the road network has been designed with a predominantly linear structure, including regular cross streets. In addition, block sizes have been designed to weave pedestrian activity into the urban fabric. As a result, a high level of permeability would be achieved based on the network proposed by the ILP.

In addition to the provision of adequate footpaths, the provision of suitable crossing facilities to ensure connectivity would be the other key element of the pedestrian network. All signalised intersections would include pedestrian crossing facilities; dedicated pedestrian crossing facilities including signalised and zebra-controlled crossings would also be provided to facilitate safe pedestrian movements, and to maintain network connectivity throughout the Precinct.

Pedestrian and bicycle facilities are proposed at or near the Precinct's activity centres, schools and the proposed bus interchange; it is recommended that the road network adjacent to these areas would warrant sign posted speeds of no more than 60km/h in order to improve safety for pedestrians and cyclists.

The locations of pedestrian crossing facilities are shown in **Figure 5-2**. The figure also indicates proposed bus routes within the Precinct, demonstrating that effective, safe and efficient connections would be created between the pedestrian and public transport networks.

5.5.3 Green Travel Plans and sustainable travel measures

The proposed bicycle network will provide high quality infrastructure designed to make bicycle travel attractive, convenient, safe and efficient. This can result in bicycle travel being a realistic alternative, especially for local travel. i.e trips under 5kms. The provision of accurate and useful directional way finding signage is recommended to compliment the bicycle and pedestrian network to promote cycle routes and pedestrian links between community facilities such as the local town centres, schools and open spaces.

It is recommended that Green Travel Plans should be established for schools within the Precinct; these plans would be integrated into school curricula, encouraging parents and children to walk, cycle or catch public transport for journeys to school when practical.

Reducing the number of local car trips to schools is likely to result in health benefits, better social interaction within communities, air quality improvements and road safety benefits. This is also important in establishing behaviours which continue later in life and are important part of the development of healthy, sustainable, and active communities within the Precinct.

In addition to maximise cycle usage throughout the Precinct, the provision of sufficient end of trip facilities, such as bicycle parking, at key locations is essential. Bicycle parking is therefore proposed to be provided in proximity to the local town centres, parks and sports facilities. Other areas of key open space are expected to also have bicycle parking for leisure and recreational use.

5.6 Proposed walking and cycling network analysis

The pedestrian and bicycle network proposed for the Precinct has been assessed against the planning principles and guidelines included **in Section 5.4**; a summary of this evaluation is shown in **Table 5- 1**.

The results indicate that the proposed network fulfils the required and suggested criteria defined by Growth Centres Development Code and NSW Bicycle Guidelines.

Table 5- 1– Pedestrian and bicycle network evaluation criteria

Benchmark/Criteria	Satisfied[3]
Growth Centres Development Code	
Pedestrian and cycle routes will be direct and continuous.	Yes
Cycle routes will be linked to those outside the site.	Yes
Grid like street network pattern to facilitate cycling.	Yes
Limit use of cul-de-sacs.	Yes
Clearly delineated routes for pedestrian, bicycles and vehicles.	Yes
Public open space should be a design feature, with recreational uses along drainage lines.	Yes
"Recreational trails" will connect public open space using on or off road routes.	Yes
Smaller lots and higher densities should be provided close to centres and public transport.	Yes
NSW Bicycle Guidelines	
Coherence: The cycle network should link popular destinations in a continuous form, with consistent quality across the network. The correct path, especially at intersections, should be clear. There should be adequate density of routes to offer a choice to cyclists.	Yes
Directness: Long detours should be avoided, but minor detours to avoid the steepest section of a hill are advisable so that the cyclist can maintain a constant speed throughout the journey. Barriers, such as a crossing at critical points can disrupt the momentum of the ride.	Yes
Safety: Intersections should be designed with bicycles in mind and should include a path for cyclists. Roadway crossings should be safe and easy to negotiate.	Yes
Attractiveness: Bicycle infrastructure should fit with the surrounding environment. Routes should be clearly signed, line marked and well lit to offer a sense of security.	Yes
Comfort: A smooth surface ensures a safe and comfortable ride. Space should be allocated to cyclists within the road reserve (in either a cycle lane or separated path) on all roads unless speed and traffic volumes are very low.	Yes
Further Considerations	
Capacity: There will be adequate space for waiting pedestrians, particularly at bus stops.	Yes
Integration: Walking and cycling should be integrated with other modes (particularly bus and train services) through the provision of obvious, safe and convenient pedestrian and cycle access paths to interchange areas, as well as secure cycle storage facilities.	Yes
Storage facilities: Appropriate storage facilities should be provided at all key destinations including train stations, major bus stops, and key centres. Storage facilities should provide for both long and short term storage of cycles and related equipment. Facilities should be designed to provide both security and weather protection, and convey a sense of high priority for bicycle users.	Yes

Source: Growth Centres Development Code, Growth Centres Commission, 2006 and NSW Bicycle Guidelines, NSW Roads and Traffic Authority, 2003

[3] Subject to the development and finalisation of the ILP.

5.7 Findings and recommendations

There are good opportunities for walking and cycling within the study area, but the limited existing provision of walking and cycling facilities within the precincts will not be appropriate to future demands.

Providing viable alternatives to cars for journeys within and outside the Precinct is essential for the achievement of sustainable outcomes. Overall the Marsden Park Precinct is generally flat with gentle slopes. The relatively flat area provides good opportunities for pedestrian and cycling routes to, from and within the study area.

Natural and built constraints within the precinct include:

- South Creek which runs along the north western part of the site restricting some east-west movements; and
- Richmond Road arterial corridor, limiting crossing opportunities at signalised intersections and constraining pedestrian and cycleway linkages to the east.

A comprehensive bicycle network is proposed for Marsden Park Precinct which will link the residential areas to the town centre, neighbourhood centres and schools and provide regional connectivity. The proposed bicycle network will include a mixture of dedicated bicycle facilities which will take the form of off-road (shared path) and on-road (cycle lane) routes.

On-road cycle lanes are proposed along roads within the the Town Centre which aims to minimise conflict between pedestrians and cyclists.

Within the precinct, all sub-arterial and collector roads will also have available a shared path bicycle facilities to allow connections between key origins (residential) and destinations within the precinct and onto the external linkages. The proposed cycling connections are designed to create a continuous network of facilities removing obstacles and barriers to cycling, both physical and perceived.

There is also opportunity to provide recreational paths along the riparian corridor along South Creek and under electrical transmission easements; however these paths may be subject to permitting access behind property boundaries in private ownership. Providing a recreational trail together with linkages to parks and open space would encourage cycling and provide facilities for recreational cyclists.

All proposed roads throughout the Marsden Park Precinct will have dedicated pedestrian footpaths to create a comprehensive network following proposed road alignments. In order to ensure connectivity of the pedestrian network the provision of pedestrian crossing opportunities will be provided in areas likely to have increased pedestrian activity, such as within the town centre, or in proximity to schools or sporting fields.

The proposed road grid network and block sizes will also work to facilitate pedestrian permeability and be conducive to encouraging walking trips. As the network has been designed around a linear grid structure the regular cross streets with pedestrian footpaths, and block sizes will encourage pedestrian activity, and achieve a high level of permeability.

Green Travel Plans should be established for schools within the Marsden Park Precinct. These should be integrated into the curriculum for the school and encourage parents and children to walk, cycle or catch public transport for journeys to school. Reducing the number of local car trips to schools is likely to result in better health, better social interaction at the community level, air quality improvements and road safety benefits. This is also important in establishing behaviours which continue later in life and an important part of the development of healthy, sustainable, active communities in Marsden Park Precinct. Wayfinding signage is also recommended to compliment the pedestrian and cycling network.

6.0 Road Cross-sections

6.1 Introduction

The development of road cross-sections and composition within the Marsden Park Precinct is guided by the Growth Centres Development Code. The development of appropriate road designs considers the following elements of the Precinct Planning process:

- Density and urban form.
- Pedestrian and cycle network connectivity.
- Parking provision.
- Landscape strategy.
- Public transport.
- Environmental engineering.

As discussed in **Section 3.2.1**, RMS and the DP&I provide guidelines for the classification of roads.

The Growth Centres Development Code classifications developed by the DP&I are broadly consistent with the RMS classifications, and have been tailored specifically for application to growth centre networks. These guidelines have been adopted for this study and used to develop the proposed road hierarchy detailed in **Section 3.7** and illustrated in **Figure 3-7**.

This chapter includes indicative details of the proposed cross sectional width, composition of vehicle travel lanes, parking, landscaping and verge treatments, footpaths and bicycle facilities, for each road classification.

6.2 Arterial roads

Arterial roads are high-capacity routes that carry large volumes (>35,000 vehicles per day) of traffic between urban areas, generally designed for vehicle speeds up to 80km/h. Richmond Road (south of Garfield Road West) and South Street (west of Richmond Road) have been classified as arterial roads.

Arterial roads are designed and managed by RMS; lane cross-section and composition requirements vary and are defined on a case-by-case basis. In general the road corridor would include wide off-street cycleways and footpaths, with parking limited to service roads. Land uses along arterial roads include employment and service uses, including business parks, petrol stations and restaurants.

6.3 Transit boulevards

Transit Boulevards are intended to provide public transport facilities and pedestrian-friendly environments on arterial corridors. These corridors offer a balance between inter-centre transport and local access functions, generally limited to speeds of 60km/h, located within walking distances of centres, and characterised by formal tree planting.

South Street | Schofields Road and Garfield Road West to the east of Richmond Road are both classified as Transit Boulevards. These routes typically include two vehicle travel lanes in each direction, with additional widening at intersections to accommodate turn lanes and / or bus priority where necessary. Other features often include shared pedestrian / bicycle paths, and median strips and verges including landscaping treatments.

Typical lane cross-section and composition requirements for Transit Boulevards are included in **Table 6-1**; a typical cross-section is illustrated in **Figure 6-1**.

Table 6-1 – Transit Boulevard Lane Cross-section and Composition Requirements

Road Type	Service Road	Verge (Shared Path)	Vehicle Lanes	Median	Vehicle Lanes	Verge (Shared Path)	Total Width
Transit Boulevard	5.5m	4.25m (2.5m)	7.0m	13m	7.0m	4.25m (2.5m)	*41m*

Source: Growth Centres Development Code, GCC, October 2006

While no transit boulevards are currently proposed within the precinct, the provision of a bus priority corridor adjacent to the town centre (north-south) was requested for consideration during the government agency workshops. This north-south corridor, extending from the Marsden Park Industrial signalised intersection, and located between the town centre and the proposed open space could take the form of a transit boulevard connecting to Garfield Road.

6.4 Sub-arterial roads

Sub-arterial roads will have two vehicle travel lanes in each direction, on-road bicycle paths and pedestrian facilities on both sides of the road, and provision for on-street parking. Richmond Road north of Garfield Road West, and Garfield Road West to the west of Richmond Road connecting to the Werrington Arterial will function as sub-arterial corridors, linking between the collector road and arterial road networks.

Typical lane cross-section and composition requirements for sub-arterial roads are included in **Table 6-2**; a typical cross-section is illustrated in **Figure 6-2**.

Table 6-2 – Sub-arterial road lane cross-section and composition requirements

Source	Verge/ Foot Path	Parking Lane	Cycle Path	Travel Lanes	Median	Travel Lanes	Cycle Path	Parking Lane	Verge /Foot Path	Total Width
GC Development Code	5.0m	-	1.8m	7.0m	7.2m	7.0m	1.8m	-	5.0m	*34.8m*
Blacktown Growth Centre Precincts DCP	4.25m			6.25m	4m	6.25m			5.25	*26m*

Source: Growth Centres Development Code, GCC, October 2006

It is proposed that both Richmond Road and Garfield Road West will form part of the cycle network within the Precinct. It is recommended that cyclists are accommodated via dedicated off-road paths, comprising either shared or dedicated cycle paths. Off-road cycle paths provide increased safety by separating vehicles and cyclists on these higher order roads with increased traffic volumes and vehicle speeds.

The Growth Centre Development Code stipulates that 3.5m travel lanes are provided, whereas the Blacktown Growth Centre Precincts DCP suggests a narrower corridor with a total of 6.25m for two travel lanes. A minimum of 6.5m is recommended, which would allow for a 3.5m public transport lane and 3m kerbside travel lane.

During off-peak period the kerbside lane could be converted to parking lanes.

The proposed road cross section for sub-arterial roads in the precinct is shown in **Table 6-3**, with the proposed cross section illustrated in **Figure 6-3**.

Table 6-3 Proposed sub-arterial road cross section

Road	Verge	Share path	Street trees	Carriageway	Median	Carriageway	Street trees	Footpath	Verge	Total
Sub-arterial	0.9m	2.5m	1.7m	6.5m	4.2m	6.5m	1.7m	1.5m	0.9m	26.4m

6.5 Collector roads

Collector roads balance through traffic and urban functions, linking local roads to the wider road network; these roads are also often required to accommodate bus routes.

Suggested road composition would typically include a single vehicle travel lane in each direction, with a shared bicycle / pedestrian path on at least one side, a dedicated footpath on the other side, as well as intermittent parking and landscaping features on both sides of the road. Amenity and safety on collector roads is maintained by restricting vehicle speeds through traffic-calming measures and intersection design.

The western-most section of Garfield Road West, Vine Street, and the north-south road connection located to the west of the Precinct's centre, as well as a number of additional roads, will all provide collector road functions.

Typical lane cross-section and composition requirements for collector roads are included in **Table 6-4**; a typical cross-section is illustrated in **Figure 6-4**.

Table 6-4 – Collector road lane cross-section and composition requirements

Road Type	Planting	Foot Path	Parking/ Landscape	Vehicle Lane	Vehicle Lane	Parking/ Landscape	Planting	Shared Path	Total Width
GC Development Code	5.0m			3.5m	3.5m	6.0m			18.0m
Blacktown Growth Centre Precincts DCP	4.5m		5.5m		5.5m		4.5m		20.0m

Source: Growth Centres Development Code, GCC, October 2006

The proposed road cross section for collector roads in the precinct is shown in **Table 6-5** and illustrated in **Figure 6-5**.

Table 6-5 Proposed collector road cross section

Road	Verge	Footpath	Street trees	Parking	Carriageway	Parking	Street trees	Sharepath	Verge	Total
Collector	0.9m	1.5m	1.5m	2.5m	7.0m	2.5m	1.5m	2.5m	0.9m	20.8m

6.6 Local roads

Local roads provide an urban function; they are intended to carry low volumes of traffic and be suitable for cycling without a requirement for dedicated cycling facilities. They also provide local residential access and therefore have a high level of amenity.

These roads typically provide a single vehicle travel lane in each direction, parking lanes and footpaths on both sides of the road and planting areas on a discretionary basis. Typical lane cross-section and composition requirements for local roads are included in **Table 6-6**; a typical cross-section is illustrated in **Figure 6-6**.

Table 6-6 – Local road lane cross-section and composition requirements

Road Type	Planting	Foot Path	Parking/ Landscape	Vehicle Lane	Vehicle Lane	Parking/ Landscape	Planting	Shared Path	Total Width
GC Development Code	5.0m			3.0m	3.0m	5.0m			16.0m
Blacktown Growth Centre Precincts DCP	.9m	1.6	1.0	4.5m	4.5m		3.5m		16.0m

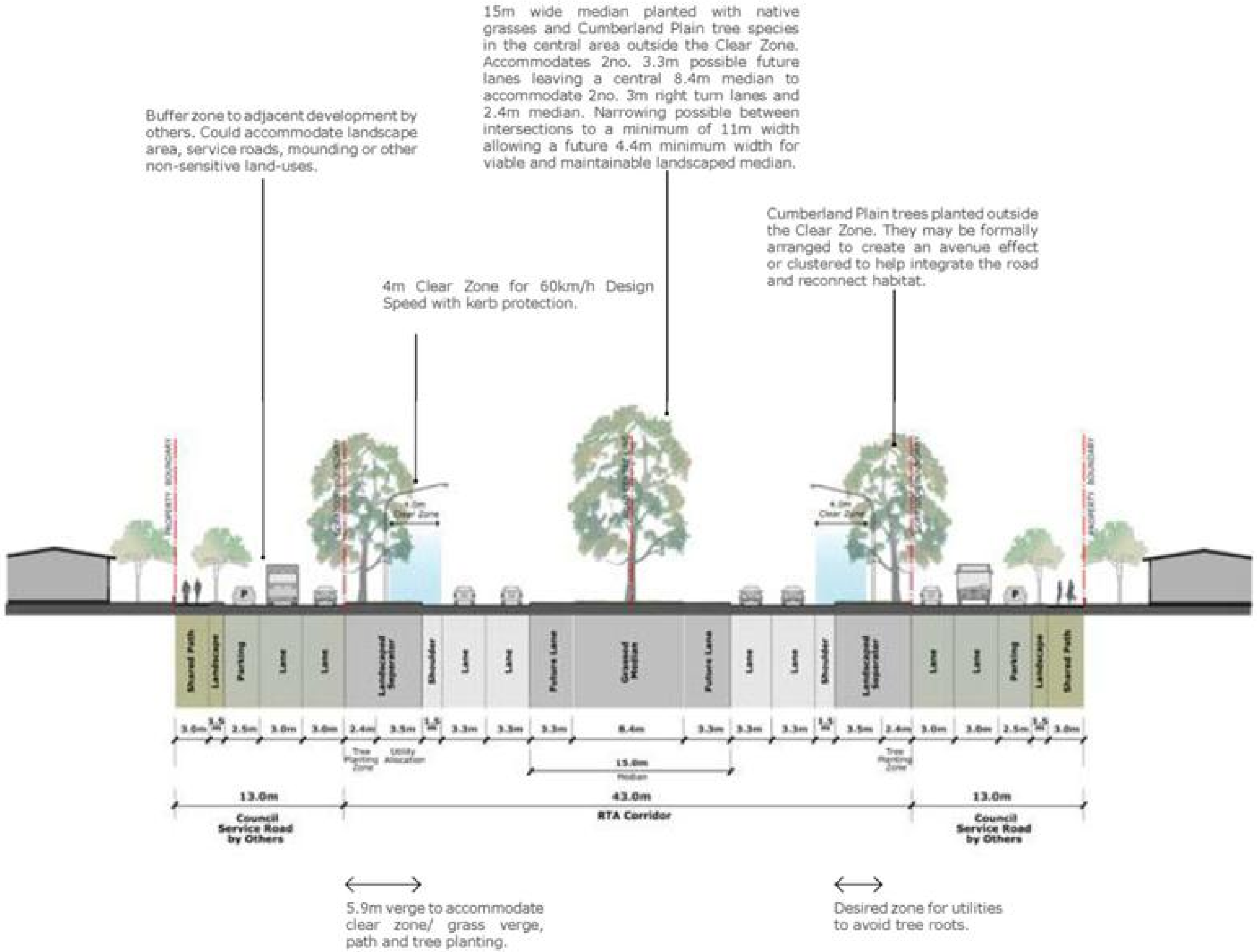
Source: Growth Centres Development Code, GCC, October 2006

The proposed cross section for local streets in the precinct is shown in **Table 6-7** and a cross section is provided in **Figure 6-7**.

Table 6-7 Proposed collector road cross section

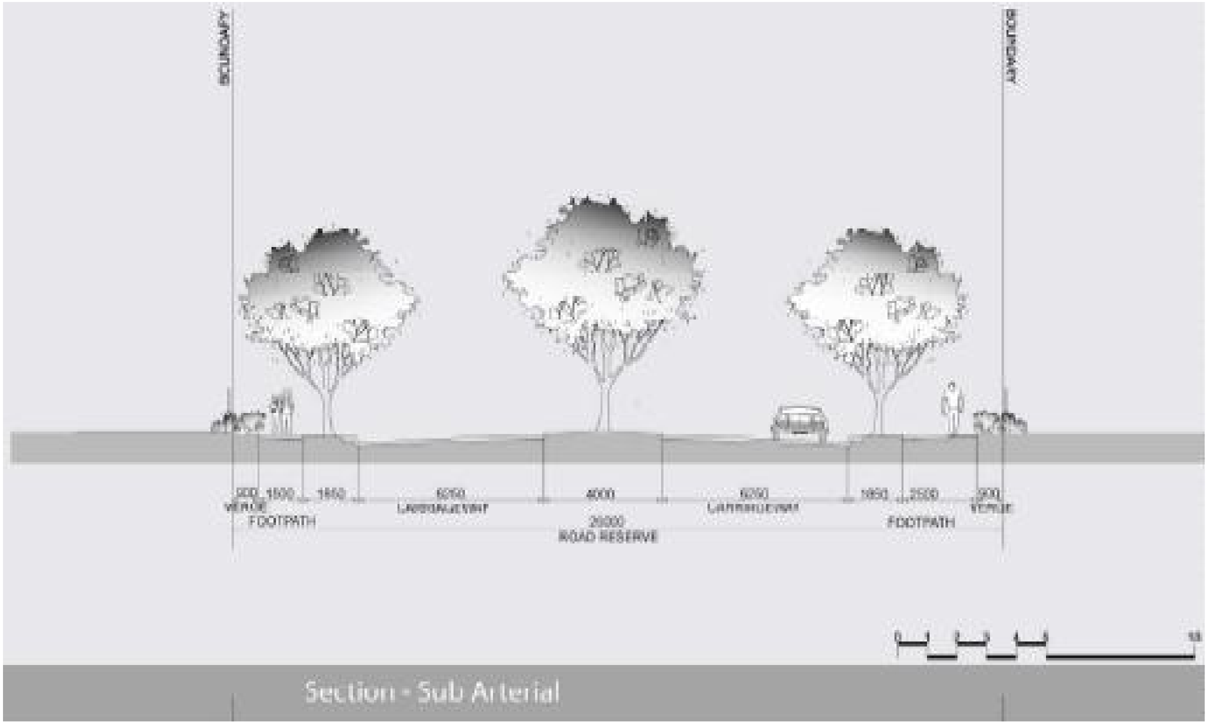
Road	Verge	Footpath	Street trees	Carriageway	Street trees	Footpath	Verge	Total
Local	0.9m	1.5m	1.4m	9.0m	1.4m	1.5m	0.9m	16.6m

Figure 6-1 Transit boulevard – typical cross-section



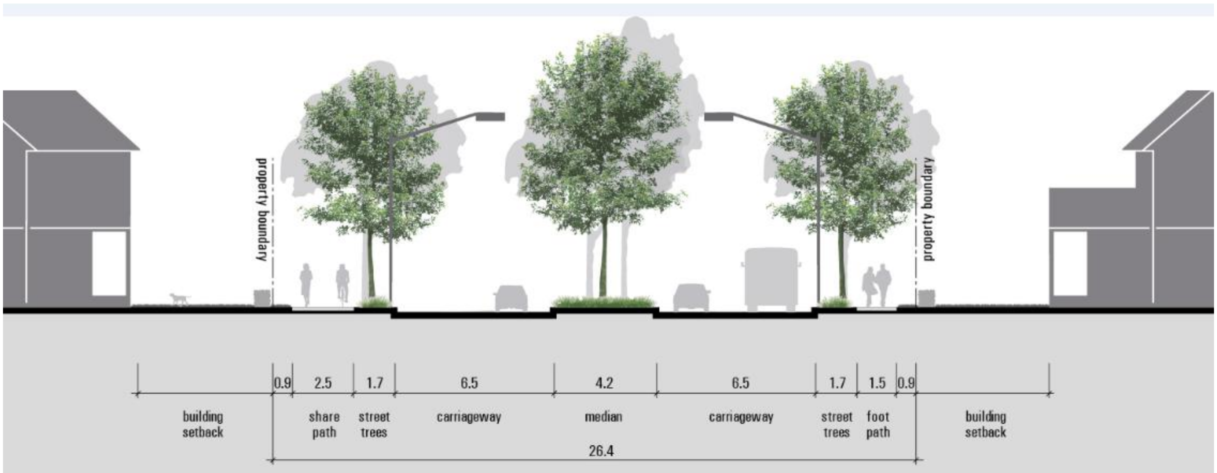
Source: North West Growth Centre Road Framework

Figure 6-2 Sub-arterial road – typical cross-section



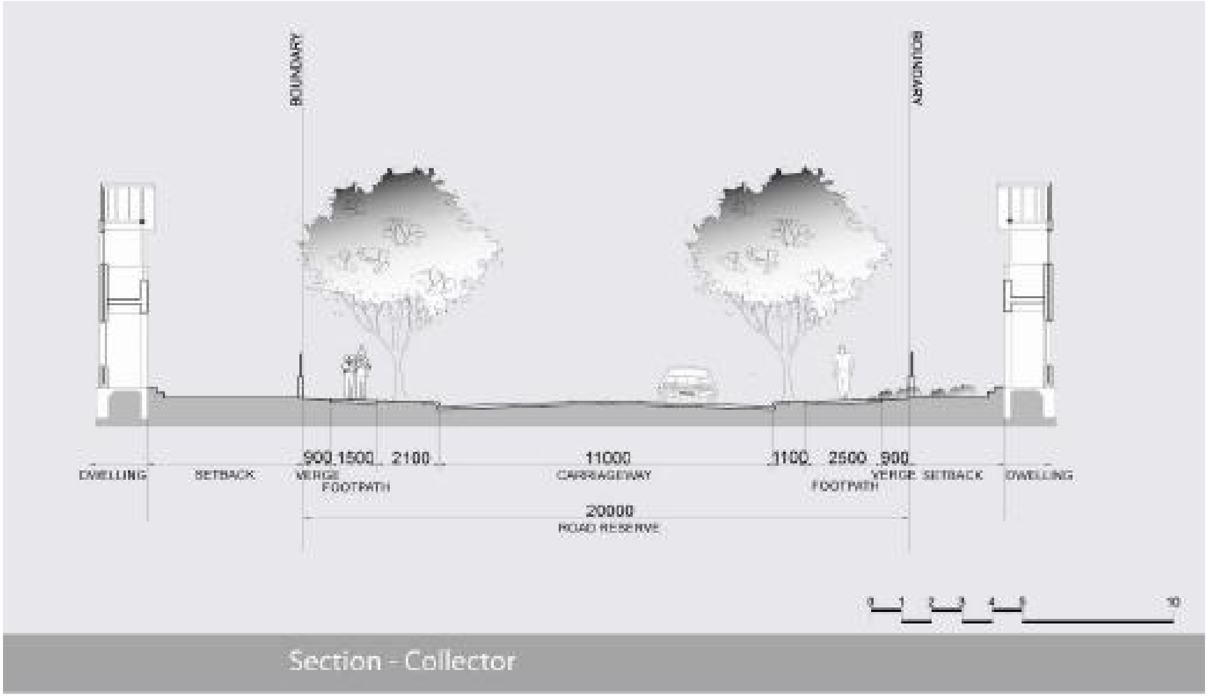
Source: BCC Growth Centre Precincts Development Control Plan, Blacktown City Council, 2010

Figure 6-3 Proposed sub-arterial cross section



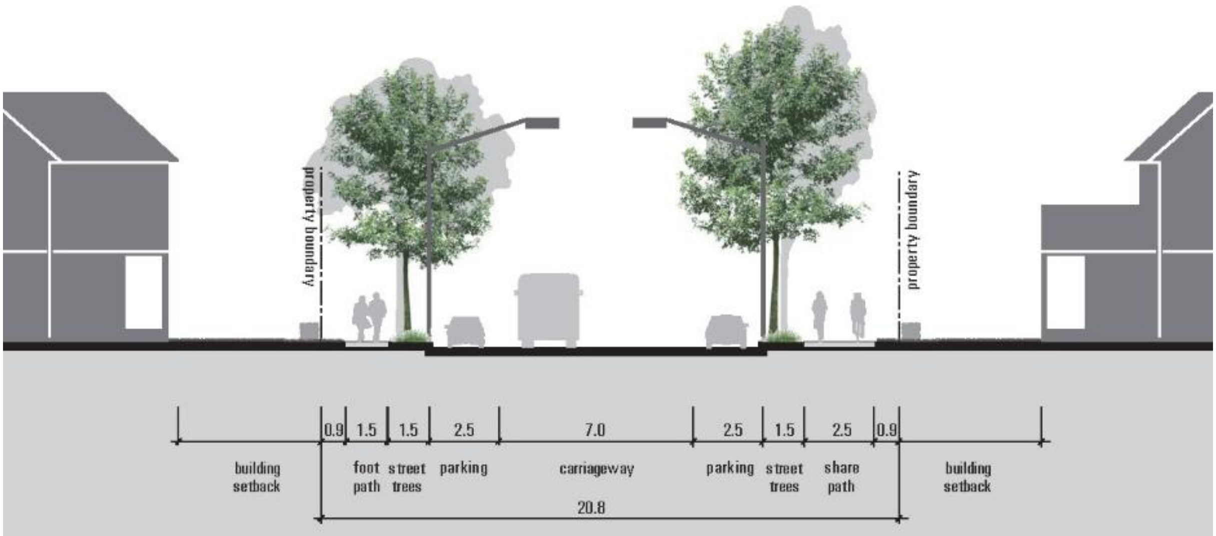
Source: AECOM, 2012

Figure 6-4 Collector road – typical cross-section



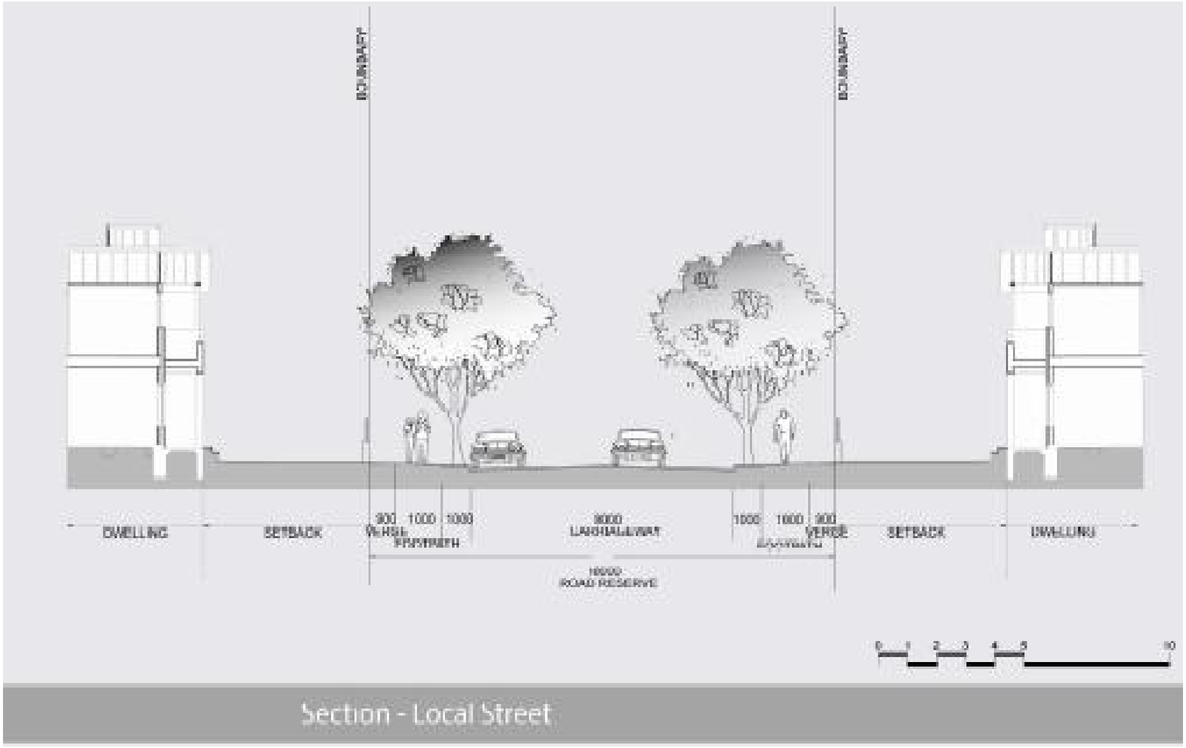
Source: BCC Growth Centre Precincts Development Control Plan, Blacktown City Council, 2010

Figure 6-5 Proposed collector road cross section



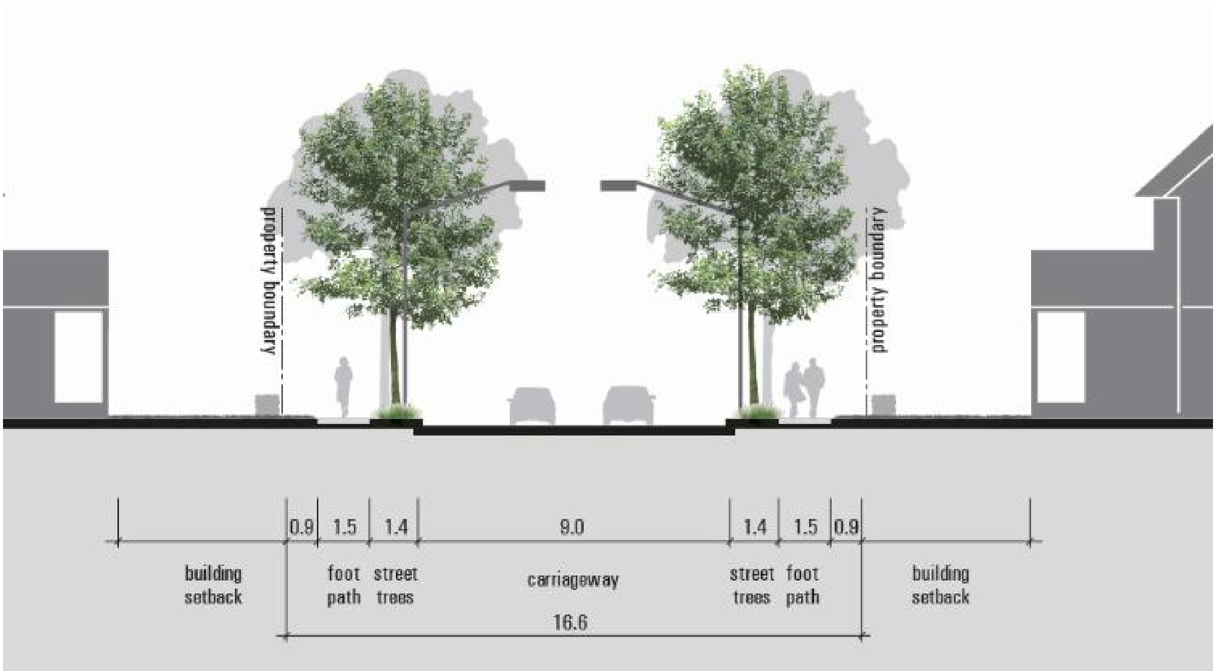
Source: AECOM, 2012

Figure 6-6 Local road – typical cross-section



Source: BCC Growth Centre Precincts Development Control Plan, Blacktown City Council, 2010

Figure 6-7 Proposed local road cross section



Source: AECOM, 2012

7.0 Conclusions

7.1 Road network

At full development of the North West Growth Centre, including Marsden Park Precinct, Richmond Road will require widening to at least two lanes in each direction between South Street and the northern most signalised intersection to the Marsden Park Precinct. This corridor will serve as the primary strategic corridor serving the precinct, facilitating access via six intersections.

At ultimate development the Werrington Arterial as an extension of the South Street corridor will also provide a strategic link towards Penrith and the South West Growth Centre.

The designated road network hierarchy within the precinct will channel vehicular access on the most appropriate routes to arterial roads via higher order corridors. Vehicles are distributed through the precinct via the hierarchical network of Sub-Arterial, and Collector Roads then via local streets to individual land parcels.

Through the precinct, the town centre will be a focal point for activity and will contain a north-south spine. This connection has also been identified as a potential corridor providing increased priority for public transport. The Garfield Road extension to the Werrington Arterial will provide an alternative route to Richmond Road, allowing regional through traffic to bypass the town centre.

An east-west road between Richmond Road and Stony Creek Road will provide a collector function for the majority of residential parcels within the precinct. A north-south collector running will also provide connectivity to a K-12 school and neighbourhood centre, located to the north of the precinct.

In line with RMS guidance all intersections within the precinct which are proposed to be signalised have been assessed to perform at Level of Service (LoS) D or above, at full development in 2036, and therefore will provide adequate capacity and operational efficiency. Along Richmond Road heavy regional traffic demands associated with the surrounding network results in two intersections operating at LoS E, however within capacity DoS <1.

Sensitivity tests were undertaken to identify if additional capacity on Richmond Road through an additional northbound and southbound lane (three lanes in each direction) could improve operational performance, however was only found to attract additional traffic to the route and negatively impact operational performance. Localised widening or signal coordination with the adjacent intersection will be required to improve operational performance at the intersection of Richmond Road | Garfield Road to LOS D. Improving the performance of the Richmond Road / South Street intersection to LoS D was not assessed since the intersection is the subject of the Marsden Park Industrial assessment.

7.2 Public transport network

The precincts will benefit from good public transport accessibility through a comprehensive bus capable road network which links key centres, transport nodes, schools, employment opportunities and residential areas. Key bus operating corridors, such as Schofield Road and Garfield Road, will provide efficient regional connections to connecting rail services such as the Richmond Line and the future North West Rail link. Other notable regional destinations that will be available through public transport connections will include employment areas at Riverstone and Box Hill, and also the Rouse Hill Major Centre.

The proposed bus capable road network provides connectivity to Richmond Road and the future transit boulevards of Schofields Road and Garfield Road, which can accommodate the bus routes identified for investigation in the NSW LTTMP. These bus routes include:

- Rouse Hill to Blacktown via Marsden Park;
- Penrith to Rouse Hill via Marsden Park;
- Marsden Park to Prairiewood; and
- Mount Druitt to Schofields via Marsden Park.

The bus network is also expected to meet the bus planning criteria defined in the NSW Service Planning Guidelines as shown in **Table 4-5** and provide a high level of service to the major commercial and retail centre proposed within the Precinct.

Roads serving bus routes should have two lanes in each direction or one lane in each direction with a parking lane that could accommodate a bus stop. Lane widths need to be a minimum of 3.5 metres. Indented bus stops are not recommended and, where bus stops are located in proximity to education or activity centres, safe pedestrian crossing facilities have been proposed.

Proposed signalised intersection on Richmond Road will also provide for bus priority through bus lanes commencing at the left turn diverge. These short bus lanes will allow opportunity for buses to bypass stop line queues, and direct access to bus stops on the intersection exit. This together with signal coordination in the peak direction will improve bus journey time reliability on the Richmond Road corridor. The central town centre north-south spine has also been identified as a key corridor for bus priority.

To encourage sustainable travel and reduce car dependence within the Precinct, it is recommended each household is to be provided with HIPs which will set out the sustainable travel options available to residents and the specific local initiatives available to encourage sustainable travel.

7.3 Walking and cycling network

Within the precinct on-road cycle paths and shared paths are proposed along sub-arterial roads and collector roads respectively, providing connectivity between the town centre, residential areas and other attractors such as schools, neighbourhood centres and open space. The proposed grid network and residential density increases pedestrian and cycling permeability and is conducive to encouraging pedestrian and cycle trips.

Proposed off-road cycle links on Richmond Road, South Street and transit boulevards: (Schofields Road and Garfield Road) will improve connectivity to the regional cycle network, providing links to Rouse Hill Regional Centre, Blacktown City Centre, Parramatta and also to primary transport infrastructure, such as the Richmond Line and future North West Rail Line.

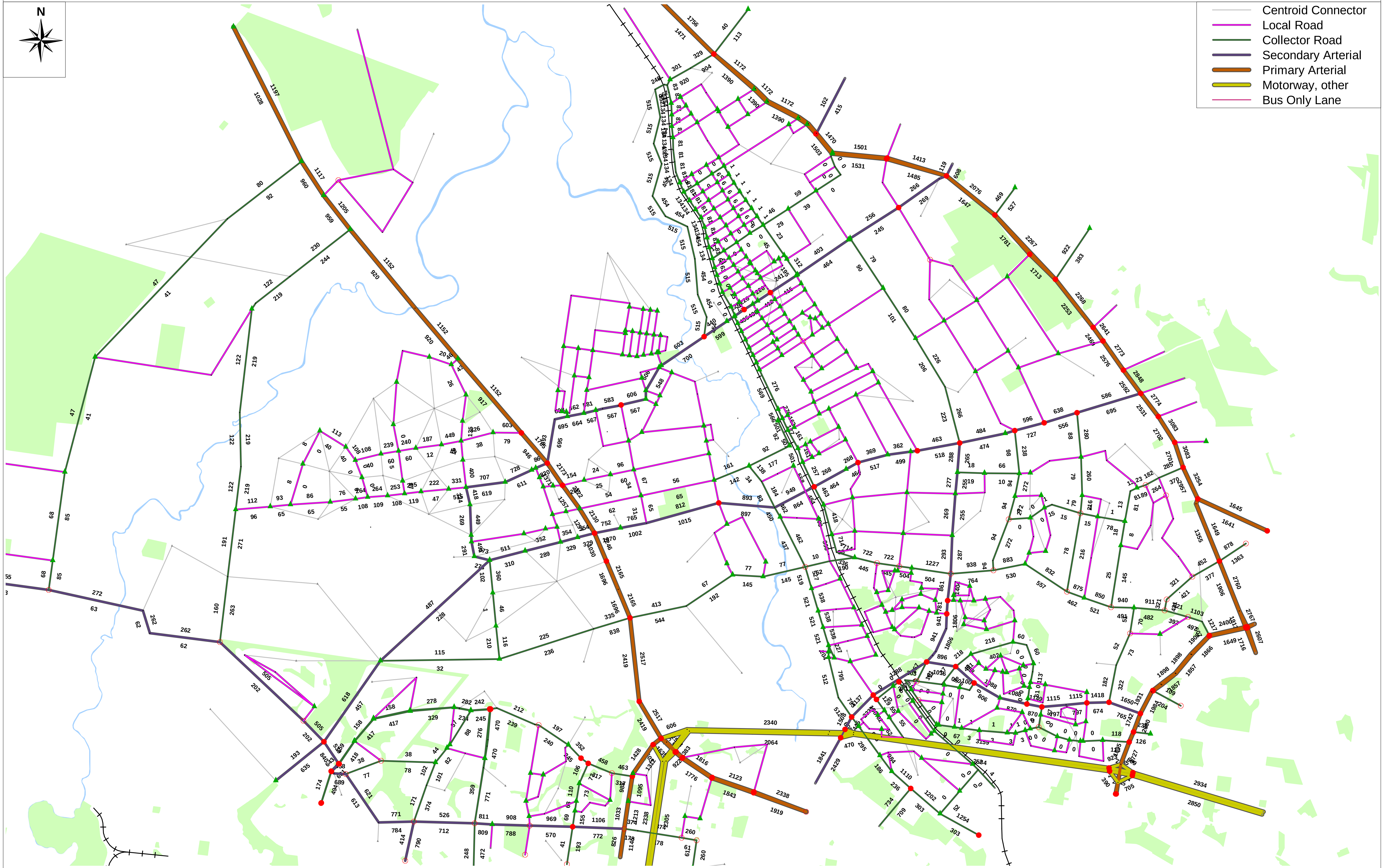
There is also opportunity to provide for recreational walking and cycling by creating links to open space, recreational areas and providing off-road paths within the conservation area towards the south west, under transmission line easements or within the riparian corridor.

Green Travel Plans should be established for schools within the Marsden Park Precinct. These should be integrated into the curriculum for the school and encourage parents and children to walk, cycle or catch public transport for journeys to school. Reducing the number of local car trips to schools is likely to result in better health, better social interaction at the community level, air quality improvements and road safety benefits. This is also important in establishing behaviours which continue later in life and are an important part of the development of healthy, sustainable, active communities in Marsden Park Precinct. Wayfinding signage is also recommended to compliment the pedestrian and cycling network.

Appendix A

Traffic Flows

Marsden Park TA
2021 AM Ave Peak Flows (PCUs)
Scenario 1



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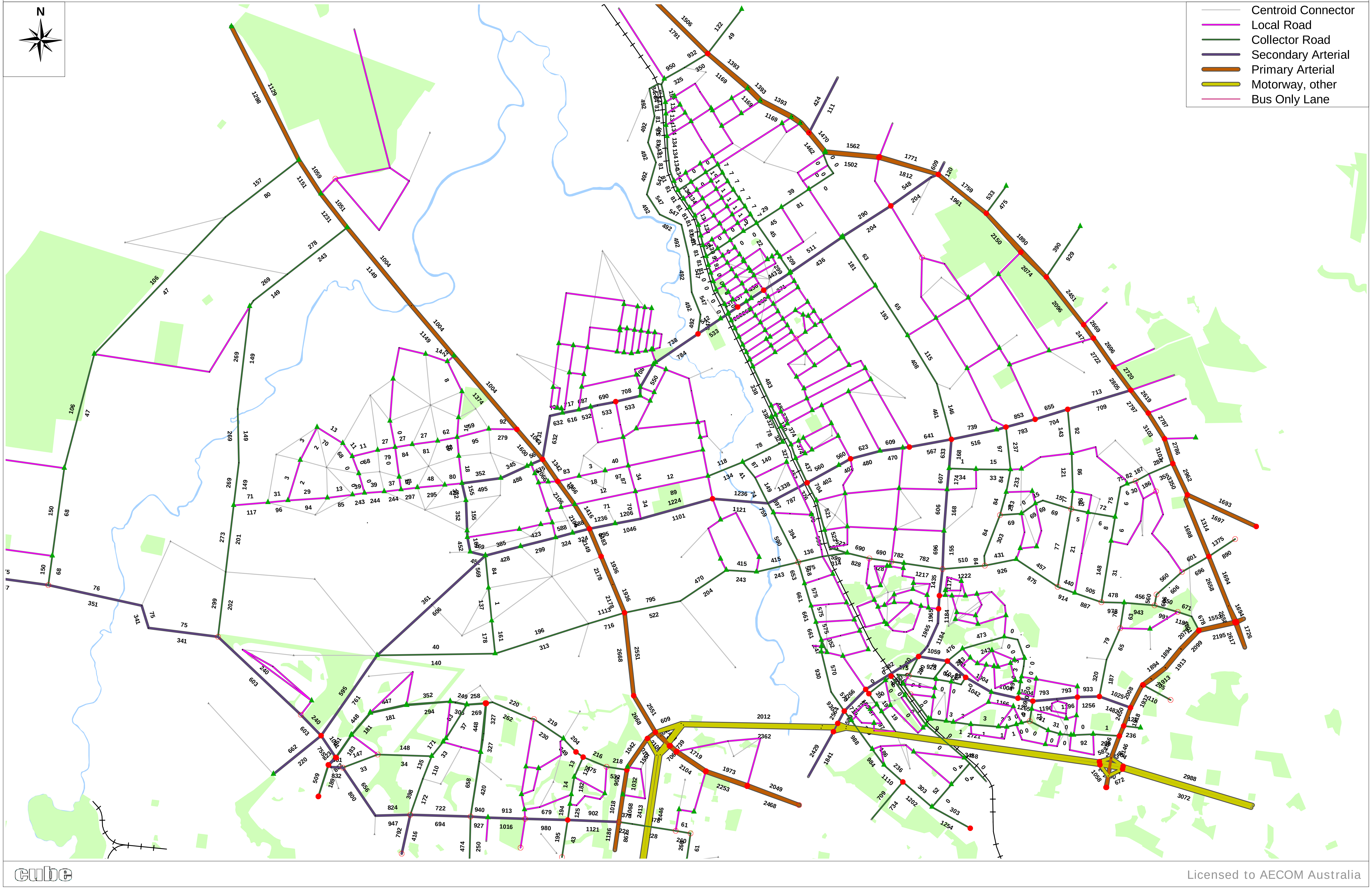
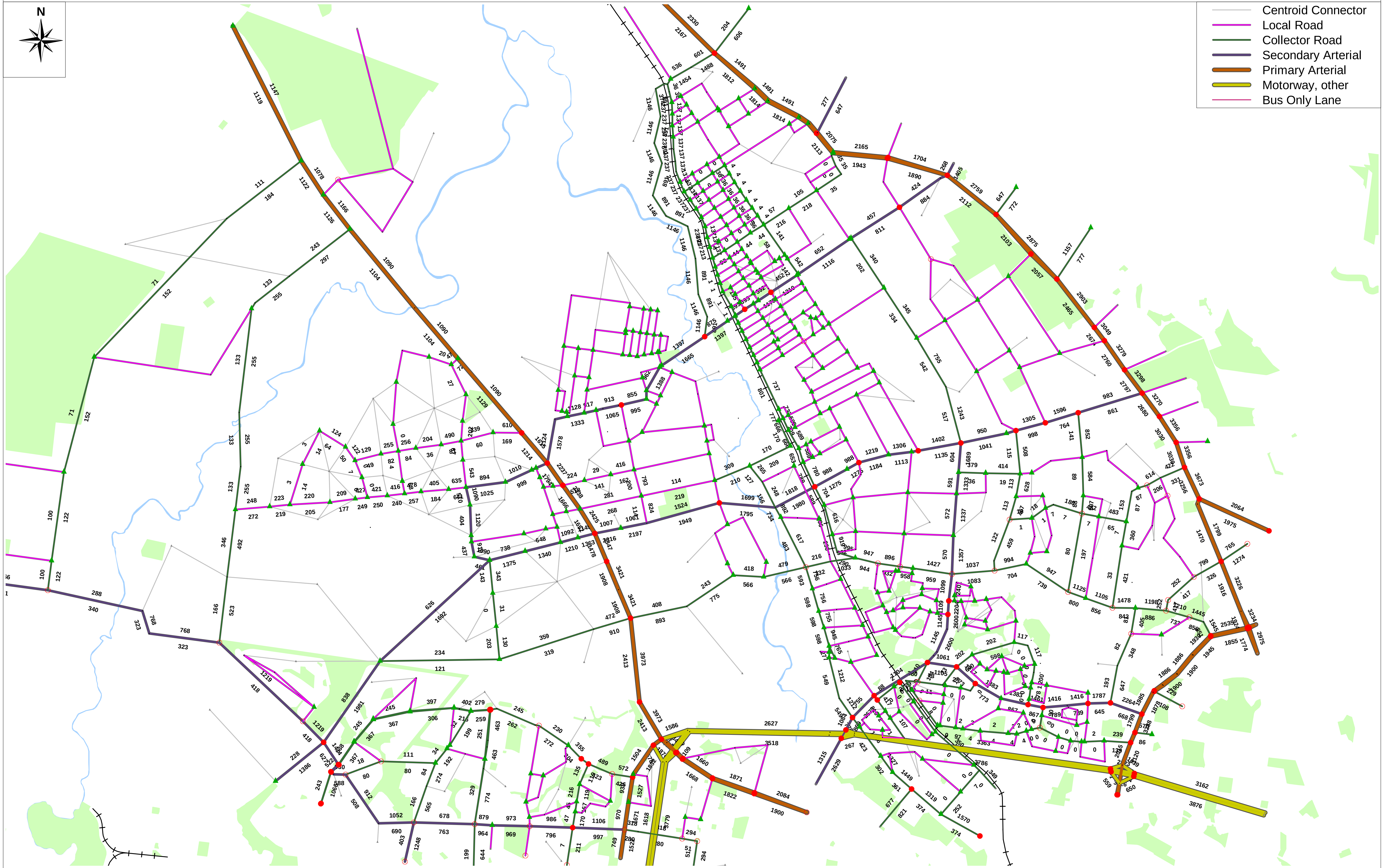
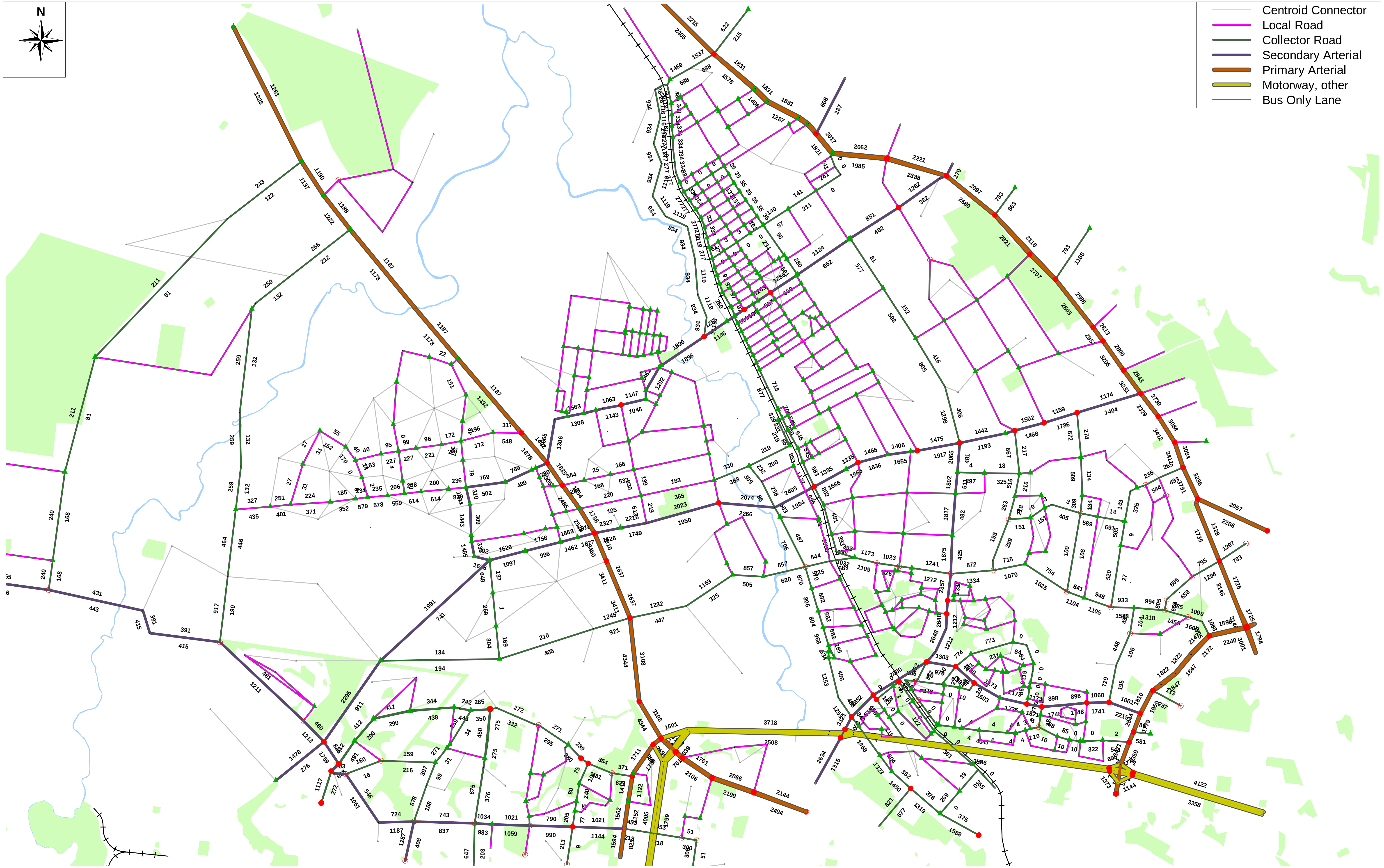
Marsden Park TA
2021 PM Ave Peak Flows (PCUs)
Scenario 1



Marsden Park TA
2036 (Full Development) AM Ave Peak Flows (PCUs)
Scenario 1



Marsden Park TA
2036 (Full Development) PM Ave Peak Flows (PCUs)
Scenario 1



Appendix B

Richmond Road Intersection Analysis

Richmond Road / Access Road 1

MOVEMENT SUMMARY

Site: 2036 AM Peak – Richmond Rd / Access Rd 1

Richmond Road / Heritage Access
2036 AM peak - LILO - Scenario 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	72	0.0	0.039	10.1	LOS A	0.0	0.0	0.00	0.71	57.1
2	T	1189	0.0	0.469	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		1261	0.0	0.469	0.6	NA	0.0	0.0	0.00	0.04	78.4
North: Richmond Road (N Leg)											
8	T	1178	0.0	0.302	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		1178	0.0	0.302	0.0	NA	0.0	0.0	0.00	0.00	80.0
West: Heritage Access (W Leg)											
10	L	47	0.0	0.177	22.1	LOS B	0.6	4.0	0.81	0.95	40.2
Approach		47	0.0	0.177	22.1	LOS B	0.6	4.0	0.81	0.95	40.2
All Vehicles		2486	0.0	0.469	0.7	NA	0.6	4.0	0.02	0.04	77.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION 5.1.5.2006

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120314 models - richmond rd intersections\Intersection 1 - Heritage LILO_RD_v2.sip
8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Richmond Rd / Access Rd 1

Richmond Road / Heritage Access
2036 PM peak - LILO - Scenario 1
Signals - Fixed Time Cycle Time = 60 seconds (User-Given Phase Times)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	427	0.0	0.372	9.9	LOS A	2.1	15.0	0.19	0.73	50.3
2	T	1193	0.0	0.543	1.0	LOS A	6.7	47.1	0.25	0.15	71.7
Approach		1620	0.0	0.543	3.3	LOS A	6.7	47.1	0.23	0.30	64.6
North: Richmond Road (N Leg)											
8	T	1265	0.0	0.440	0.9	LOS A	4.7	32.6	0.23	0.14	72.1
Approach		1265	0.0	0.440	0.9	LOS A	4.7	32.6	0.23	0.14	72.1
West: Heritage Access (W Leg)											
10	L	173	0.0	0.699	39.1	LOS C	5.4	37.5	1.00	0.87	31.4
Approach		173	0.0	0.699	39.1	LOS C	5.4	37.5	1.00	0.87	31.4
All Vehicles		3058	0.0	0.699	4.4	LOS A	6.7	47.1	0.28	0.27	63.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120314 models - richmond rd intersections\Intersection 1 - Heritage LILO_RD_v2.sip
8000907, AECOM, ENTERPRISE

Richmond Road / Access Road 2

MOVEMENT SUMMARY

Site: 2036 AM Peak – Richmond Rd / Access Rd 2

Richmond Road / Access Road 2
2036 AM Peak - Scenario 1
Signals - Fixed Time   Cycle Time = 70 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	94	0.0	0.161	28.6	LOS C	2.3	16.4	0.76	0.76	38.6
2	T	1252	0.0	0.832	26.8	LOS B	22.4	157.0	0.97	0.96	39.9
Approach		1346	0.0	0.832	26.9	LOS B	22.4	157.0	0.96	0.94	39.8
North: Richmond Road (N Leg)											
8	T	1104	0.0	0.508	10.3	LOS A	11.7	81.6	0.66	0.59	55.9
9	R	76	0.0	0.477	45.6	LOS D	2.7	18.8	0.99	0.76	29.5
Approach		1180	0.0	0.508	12.6	LOS A	11.7	81.6	0.68	0.60	53.2
West: Access Road 2 (W Leg)											
10	L	9	0.0	0.819	56.7	LOS E	14.4	100.8	1.00	0.98	25.6
12	R	601	0.0	0.819	50.3	LOS D	14.4	100.8	1.00	0.97	27.4
Approach		610	0.0	0.819	50.4	LOS D	14.4	100.8	1.00	0.97	27.4
All Vehicles		3136	0.0	0.832	26.1	LOS B	22.4	157.0	0.86	0.82	40.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	26.6	LOS C	0.1	0.1	0.87	0.87
P5	Across N approach	53	29.3	LOS C	0.1	0.1	0.91	0.91
P7	Across W approach	53	20.1	LOS C	0.1	0.1	0.76	0.76
All Pedestrians		159	25.3	LOS C			0.85	0.85

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

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8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Richmond Rd / Access Rd 2

Richmond Road / Access Road 2
2021 PM Peak - Scenario 1
Signals - Fixed Time Cycle Time = 80 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	509	0.0	0.685	29.1	LOS C	14.8	103.3	0.79	0.83	38.3
2	T	1558	0.0	0.864	23.1	LOS B	28.9	202.2	0.88	0.88	42.6
Approach		2067	0.0	0.864	24.6	LOS B	28.9	202.2	0.86	0.87	41.6
North: Richmond Road (N Leg)											
8	T	1225	0.0	0.513	9.4	LOS A	13.4	93.9	0.61	0.55	57.4
9	R	39	0.0	0.280	50.4	LOS D	1.5	10.8	0.98	0.73	27.7
Approach		1264	0.0	0.513	10.6	LOS A	13.4	93.9	0.62	0.55	55.8
West: Access Road 2 (W Leg)											
10	L	63	0.0	0.469	37.5	LOS C	4.8	33.7	0.94	0.85	32.0
12	R	255	0.0	0.469	40.3	LOS C	5.5	38.8	0.94	0.82	30.9
Approach		318	0.0	0.469	39.8	LOS C	5.5	38.8	0.94	0.83	31.1
All Vehicles		3649	0.0	0.864	21.1	LOS B	28.9	202.2	0.78	0.76	44.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	31.5	LOS D	0.1	0.1	0.89	0.89
P5	Across N approach	53	34.2	LOS D	0.1	0.1	0.93	0.93
P7	Across W approach	53	17.6	LOS B	0.1	0.1	0.66	0.66
All Pedestrians		159	27.8	LOS C			0.83	0.83

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 5.1.5.2006

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8000907, AECOM, ENTERPRISE

Richmond Road / Garfield Road

MOVEMENT SUMMARY

Site: 2036 AM Peak – Richmond Rd / Garfield Rd

Richmond Road / Garfield Road
2036 AM peak - Scenario 1
Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	348	0.0	0.520	27.0	LOS B	10.5	73.5	0.45	0.76	39.8
2	T	1063	0.0	0.771	43.2	LOS D	32.0	224.0	0.89	0.80	31.7
3	R	384	0.0	0.912	94.3	LOS F	15.7	110.2	1.00	0.95	18.0
Approach		1795	0.0	0.912	51.0	LOS D	32.0	224.0	0.83	0.82	28.4
East: Garfield Road (E Leg)											
4	L	521	0.0	0.595	41.5	LOS C	12.9	90.6	0.74	0.79	30.7
5	T	949	0.0	0.961	95.6	LOS F	45.5	318.7	1.00	1.22	16.1
6	R	240	0.0	0.538	77.4	LOS F	8.4	59.1	0.99	0.80	21.1
Approach		1710	0.0	0.961	76.6	LOS F	45.5	318.7	0.92	1.03	19.9
North: Richmond Road (N Leg)											
7	L	221	0.0	0.439	25.6	LOS B	5.9	41.5	0.40	0.73	40.8
8	T	1303	0.0	0.946	69.1	LOS E	55.4	387.8	1.00	1.07	23.7
9	R	180	0.0	0.428	78.1	LOS F	6.1	42.8	0.95	0.78	20.6
Approach		1704	0.0	0.946	64.4	LOS E	55.4	387.8	0.92	0.99	24.6
West: Garfield Road (W Leg)											
10	L	43	0.0	0.135	37.3	LOS C	1.9	13.0	0.64	0.71	32.3
11	T	607	0.0	0.614	53.1	LOS D	19.6	137.1	0.94	0.81	23.5
12	R	414	0.0	0.929	100.9	LOS F	18.0	126.3	1.00	1.05	17.5
Approach		1064	0.0	0.929	71.1	LOS F	19.6	137.1	0.95	0.90	20.8
All Vehicles		6273	0.0	0.961	65.0	LOS E	55.4	387.8	0.90	0.94	23.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	54.6	LOS E	0.2	0.2	0.85	0.85
P3	Across E approach	53	42.6	LOS E	0.2	0.2	0.75	0.75
P5	Across N approach	53	54.6	LOS E	0.2	0.2	0.85	0.85
P7	Across W approach	53	42.6	LOS E	0.2	0.2	0.75	0.75
All Pedestrians		212	48.6	LOS E			0.80	0.80

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 5.1.5.2006

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120314 models - richmond rd intersections\Intersection 3 - Garfield Rd W_RD_v3.sip
8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Richmond Rd / Garfield Rd

Richmond Road / Garfield Road
2036 PM peak - Scenario 1
Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	29	0.0	0.025	11.3	LOS A	0.1	0.7	0.05	0.67	55.4
2	T	1557	0.0	0.868	18.8	LOS B	40.6	284.1	0.76	0.71	46.6
3	R	718	0.0	0.967	87.4	LOS F	31.5	220.7	1.00	0.99	19.0
Approach		2304	0.0	0.967	40.1	LOS C	40.6	284.1	0.82	0.80	33.0
East: Garfield Road (E Leg)											
4	L	435	0.0	0.465	35.7	LOS C	9.7	67.6	0.66	0.77	33.0
5	T	634	0.0	0.762	61.4	LOS E	22.3	156.1	1.00	0.88	21.6
6	R	426	0.0	0.956	111.3	LOS F	19.8	138.5	1.00	1.11	16.3
Approach		1495	0.0	0.956	68.1	LOS E	22.3	156.1	0.90	0.92	21.8
North: Richmond Road (N Leg)											
7	L	198	0.0	0.449	30.3	LOS C	6.2	43.7	0.47	0.74	37.6
8	T	1166	0.0	0.975	92.3	LOS F	56.0	392.3	1.00	1.16	19.5
9	R	117	0.0	0.675	91.5	LOS F	4.5	31.5	1.00	0.78	18.3
Approach		1481	0.0	0.975	83.9	LOS F	56.0	392.3	0.93	1.08	20.6
West: Garfield Road (W Leg)											
10	L	83	0.0	0.302	49.8	LOS D	4.4	30.7	0.77	0.75	27.8
11	T	827	0.0	0.994	125.0	LOS F	44.9	314.4	1.00	1.37	13.2
12	R	235	0.0	0.527	77.3	LOS F	8.3	57.8	0.99	0.80	21.1
Approach		1145	0.0	0.994	109.8	LOS F	44.9	314.4	0.98	1.21	15.1
All Vehicles		6425	0.0	0.994	69.1	LOS E	56.0	392.3	0.89	0.96	22.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	59.9	LOS E	0.2	0.2	0.89	0.89
P3	Across E approach	53	48.0	LOS E	0.2	0.2	0.80	0.80
P5	Across N approach	53	59.9	LOS E	0.2	0.2	0.89	0.89
P7	Across W approach	53	48.0	LOS E	0.2	0.2	0.80	0.80
All Pedestrians		212	53.9	LOS E			0.85	0.85

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 5.1.5.2006

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8000907, AECOM, ENTERPRISE

Richmond Road / Vine Street

MOVEMENT SUMMARY

Site: 2036 AM Peak – Richmond Rd / Vine St

Richmond Road / Vine Street
2036 AM peak - Scenario 1
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	1	0.0	0.003	16.4	LOS B	0.0	0.1	0.30	0.64	49.1
2	T	1601	0.0	0.724	25.2	LOS B	42.2	295.2	0.80	0.74	41.5
3	R	65	0.0	0.813	97.6	LOS F	3.3	23.2	1.00	0.78	17.3
Approach		1667	0.0	0.813	28.0	LOS B	42.2	295.2	0.81	0.74	39.6
East: Vine Street (E Leg)											
4	L	234	0.0	0.591	66.3	LOS E	15.5	108.3	0.96	0.83	23.4
5	T	110	0.0	0.385	62.9	LOS E	7.4	51.5	0.95	0.76	21.3
6	R	174	0.0	0.937	104.6	LOS F	15.4	107.5	1.00	1.06	17.1
Approach		518	0.0	0.937	78.4	LOS F	15.5	108.3	0.97	0.89	20.4
North: Richmond Road (N Leg)											
7	L	156	0.0	0.125	11.4	LOS A	0.7	5.1	0.07	0.67	55.2
8	T	2081	0.0	0.942	26.4	LOS B	68.8	481.3	0.82	0.85	40.6
9	R	1	0.0	0.020	90.4	LOS F	0.1	0.5	0.98	0.58	18.4
Approach		2238	0.0	0.942	25.4	LOS B	68.8	481.3	0.77	0.84	41.2
West: Vine Street (W Leg)											
10	L	19	0.0	0.062	58.8	LOS E	1.1	7.6	0.82	0.71	25.2
11	T	4	0.0	0.014	58.1	LOS E	0.2	1.7	0.88	0.57	22.4
12	R	123	0.0	0.662	81.9	LOS F	9.0	63.1	1.00	0.82	20.3
Approach		146	0.0	0.662	78.2	LOS F	9.0	63.1	0.97	0.79	20.9
All Vehicles		4569	0.0	0.942	34.1	LOS C	68.8	481.3	0.81	0.81	35.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
P3	Across E approach	53	18.8	LOS B	0.1	0.1	0.50	0.50
P5	Across N approach	53	66.3	LOS F	0.2	0.2	0.94	0.94
P7	Across W approach	53	18.8	LOS B	0.1	0.1	0.50	0.50
All Pedestrians		212	43.2	LOS E			0.73	0.73

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

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8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Richmond Rd / Vine St

Richmond Road / Vine Street
2036 PM peak - Intersection 1
Signals - Fixed Time Cycle Time = 140 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	85	0.0	0.086	10.9	LOS A	0.3	2.1	0.06	0.67	55.9
2	T	2009	0.0	0.839	12.2	LOS A	38.9	272.2	0.63	0.59	53.8
3	R	391	0.0	0.869	76.8	LOS F	17.6	123.2	0.98	0.87	20.8
Approach		2485	0.0	0.869	22.4	LOS B	38.9	272.2	0.67	0.64	44.0
East: Vine Street (E Leg)											
4	L	77	0.0	0.171	47.0	LOS D	3.8	26.5	0.77	0.75	28.7
5	T	82	0.0	0.392	64.2	LOS E	5.3	37.4	0.97	0.76	21.0
6	R	124	0.0	0.850	87.1	LOS F	9.3	65.0	1.00	0.94	19.4
Approach		283	0.0	0.850	69.6	LOS E	9.3	65.0	0.93	0.84	21.8
North: Richmond Road (N Leg)											
7	L	54	0.0	0.113	21.0	LOS B	1.4	9.9	0.42	0.71	44.6
8	T	1756	0.0	0.914	47.9	LOS D	63.9	447.6	1.00	1.02	29.7
9	R	26	0.0	0.490	89.2	LOS F	1.9	13.5	1.00	0.71	18.6
Approach		1836	0.0	0.914	47.7	LOS D	63.9	447.6	0.98	1.01	29.8
West: Vine Street (W Leg)											
10	L	172	0.0	0.557	65.6	LOS E	10.7	75.2	0.96	0.81	23.6
11	T	109	0.0	0.522	65.3	LOS E	7.2	50.6	0.99	0.78	20.7
12	R	21	0.0	0.144	75.7	LOS F	1.4	9.6	0.96	0.71	21.4
Approach		302	0.0	0.557	66.2	LOS E	10.7	75.2	0.97	0.79	22.4
All Vehicles		4906	0.0	0.914	37.3	LOS C	63.9	447.6	0.82	0.80	34.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	64.1	LOS F	0.2	0.2	0.96	0.96
P2	Across S approach	53	59.4	LOS E	0.2	0.2	0.92	0.92
P3	Across E approach	53	23.4	LOS C	0.1	0.1	0.58	0.58
P5	Across N approach	53	62.2	LOS F	0.2	0.2	0.94	0.94
P6	Across N approach	53	59.4	LOS E	0.2	0.2	0.92	0.92
P7	Across W approach	53	23.4	LOS C	0.1	0.1	0.58	0.58
All Pedestrians		318	48.7	LOS E			0.82	0.82

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

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8000907, AECOM, ENTERPRISE

Richmond Road / Grange Avenue

MOVEMENT SUMMARY

Site: 2036 AM Peak – Richmond Rd / Grange Ave

Richmond Road / Grange Avenue
2036 AM Peak - Scenario 1
Signals - Fixed Time Cycle Time = 60 seconds (User-Given Phase Times)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	1	0.0	0.001	8.9	LOS A	0.0	0.0	0.15	0.66	48.2
2	T	1652	0.0	0.498	1.3	LOS A	6.3	43.8	0.28	0.19	54.9
Approach		1653	0.0	0.498	1.3	LOS A	6.3	43.8	0.28	0.19	54.9
East: Grange Avenue (E Leg)											
4	L	268	0.0	0.962	63.3	LOS E	12.3	85.8	1.00	1.33	21.8
Approach		268	0.0	0.962	63.3	LOS E	12.3	85.8	1.00	1.33	21.8
North: Richmond Road (N Leg)											
7	L	281	0.0	0.209	9.0	LOS A	1.4	10.1	0.19	0.70	48.0
8	T	2157	0.0	0.651	1.6	LOS A	10.6	73.9	0.36	0.24	53.5
Approach		2438	0.0	0.651	2.5	LOS A	10.6	73.9	0.34	0.29	52.8
West: Grange Avenue (W Leg)											
10	L	14	0.0	0.050	32.5	LOS C	0.4	2.5	0.88	0.69	31.6
Approach		14	0.0	0.050	32.5	LOS C	0.4	2.5	0.88	0.69	31.6
All Vehicles		4373	0.0	0.962	5.8	LOS A	12.3	85.8	0.36	0.32	49.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

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MOVEMENT SUMMARY

Site: 2036 PM Peak – Richmond Rd / Grange Ave

Richmond Road / Grange Avenue
2036 PM Peak - Scenario 1
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	204	0.0	0.110	8.2	LOS A	0.0	0.0	0.00	0.67	49.0
2	T	2323	0.0	0.596	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		2527	0.0	0.596	0.7	NA	0.0	0.0	0.00	0.05	58.9
East: Grange Avenue (E Leg)											
4	L	105	0.0	0.220	15.1	LOS B	0.7	4.9	0.78	0.94	42.3
Approach		105	0.0	0.220	15.1	LOS B	0.7	4.9	0.78	0.94	42.3
North: Richmond Road (N Leg)											
7	L	220	0.0	0.118	8.2	LOS A	0.0	0.0	0.00	0.67	49.0
8	T	1633	0.0	0.419	0.0	LOS A	0.0	0.0	0.00	0.00	60.0
Approach		1853	0.0	0.419	1.0	NA	0.0	0.0	0.00	0.08	58.4
West: Grange Avenue (W Leg)											
10	L	162	0.0	0.742	38.6	LOS C	3.0	20.9	0.97	1.17	29.1
Approach		162	0.0	0.742	38.6	LOS C	3.0	20.9	0.97	1.17	29.1
All Vehicles		4647	0.0	0.742	2.4	NA	3.0	20.9	0.05	0.12	56.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

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Richmond Road / South Street

MOVEMENT SUMMARY

Site: 2036 AM Peak – Richmond Rd /South St

Richmond Road / South Street / Schofields Road
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	141	0.0	0.265	24.0	LOS B	4.8	33.5	0.51	0.71	36.3
2	T	1192	0.0	0.509	35.9	LOS C	21.6	151.0	0.81	0.71	29.0
3	R	145	0.0	0.732	89.2	LOS F	5.6	39.5	1.00	0.84	17.5
Approach		1478	0.0	0.732	40.0	LOS C	21.6	151.0	0.80	0.72	27.8
East: Schofields Road (E Leg)											
4	L	649	0.0	0.971	58.6	LOS E	46.6	326.4	1.00	0.91	23.2
5	T	1215	0.0	0.779	56.0	LOS D	27.9	195.2	0.99	0.88	22.8
6	R	452	0.0	0.608	66.9	LOS E	15.2	106.1	0.97	0.83	21.3
Approach		2316	0.0	0.971	58.9	LOS E	46.6	326.4	0.99	0.88	22.6
North: Richmond Road (N Leg)											
7	L	133	0.0	0.112	12.7	LOS A	1.5	10.7	0.17	0.64	44.6
8	T	2285	0.0	0.976	71.3	LOS F	73.1	511.6	1.00	1.11	19.6
9	R	7	0.0	0.071	82.7	LOS F	0.5	3.5	0.96	0.66	18.5
Approach		2425	0.0	0.976	68.1	LOS E	73.1	511.6	0.95	1.08	20.3
West: South Street (W Leg)											
10	L	7	0.0	0.019	48.5	LOS D	0.4	2.5	0.75	0.66	25.9
11	T	729	0.0	0.668	61.4	LOS E	16.6	116.4	0.99	0.83	21.6
12	R	412	0.0	0.924	98.2	LOS F	17.8	124.7	1.00	1.06	16.4
Approach		1148	0.0	0.924	74.5	LOS F	17.8	124.7	0.99	0.91	19.4
All Vehicles		7367	0.0	0.976	60.6	LOS E	73.1	511.6	0.94	0.92	22.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	68.2	LOS F	0.2	0.2	0.95	0.95
P3	Across E approach	53	41.1	LOS E	0.2	0.2	0.74	0.74
P5	Across N approach	53	65.3	LOS F	0.2	0.2	0.93	0.93
P7	Across W approach	53	41.1	LOS E	0.2	0.2	0.74	0.74
All Pedestrians		212	53.9	LOS E			0.84	0.84

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2036 PM Peak – Richmond Rd / South St

Richmond Road / South Street / Schofields Road
Signals - Fixed Time Cycle Time = 120 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Richmond Road (S Leg)											
1	L	760	0.0	0.692	11.5	LOS A	6.4	44.7	0.28	0.69	45.8
2	T	2122	0.0	0.946	38.3	LOS C	45.8	320.6	0.99	1.05	27.9
3	R	577	0.0	0.932	66.1	LOS E	19.1	133.4	1.00	0.99	21.5
Approach		3459	0.0	0.946	37.1	LOS C	45.8	320.6	0.83	0.96	28.9
East: Schofields Road (E Leg)											
4	L	151	0.0	0.184	29.1	LOS C	5.3	37.0	0.64	0.75	33.5
5	T	1072	0.0	0.814	52.3	LOS D	21.3	149.4	1.00	0.94	23.7
6	R	403	0.0	0.930	84.8	LOS F	14.5	101.4	1.00	1.10	18.1
Approach		1626	0.0	0.930	58.2	LOS E	21.3	149.4	0.97	0.97	22.6
North: Richmond Road (N Leg)											
7	L	311	0.0	0.468	33.7	LOS C	12.6	88.4	0.75	0.80	31.4
8	T	1383	0.0	0.946	75.6	LOS F	35.3	246.8	1.00	1.22	18.9
9	R	44	0.0	0.711	77.2	LOS F	2.9	20.0	1.00	0.81	19.4
Approach		1738	0.0	0.946	68.1	LOS E	35.3	246.8	0.95	1.13	20.4
West: South Street (W Leg)											
10	L	2	0.0	0.004	34.1	LOS C	0.1	0.5	0.67	0.62	31.2
11	T	1439	0.0	0.922	65.7	LOS E	34.1	238.9	1.00	1.14	20.7
12	R	477	0.0	0.811	66.0	LOS E	14.7	102.7	1.00	0.92	21.5
Approach		1918	0.0	0.922	65.7	LOS E	34.1	238.9	1.00	1.08	20.9
All Vehicles		8741	0.0	0.946	53.5	LOS D	45.8	320.6	0.92	1.02	23.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	54.2	LOS E	0.2	0.2	0.95	0.95
P3	Across E approach	53	51.3	LOS E	0.2	0.2	0.93	0.93
P5	Across N approach	53	51.3	LOS E	0.2	0.2	0.93	0.93
P7	Across W approach	53	51.3	LOS E	0.2	0.2	0.93	0.93
All Pedestrians		212	52.0	LOS E			0.93	0.93

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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Appendix C

Internal Intersection Analysis

Stony Creek Road / Garfield Road

MOVEMENT SUMMARY

Site: 2036 AM Peak - Intersection A

2036 AM Peak – Intersection A
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Stony Creek Road (S Leg)											
1	L	21	0.0	0.237	10.1	LOS A	0.0	0.0	0.00	1.60	57.1
2	T	441	0.0	0.237	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	228	0.0	0.412	17.6	LOS B	2.5	17.2	0.73	0.99	47.6
Approach		690	0.0	0.412	6.1	LOS A	2.5	17.2	0.24	0.38	65.8
East: Garfield Road extension (E Leg)											
4	L	257	0.0	0.600	21.4	LOS B	4.0	28.3	0.82	1.11	40.6
5	T	21	0.0	0.197	26.9	LOS B	0.8	5.4	0.87	0.96	34.2
6	R	15	0.0	0.197	29.1	LOS C	0.8	5.4	0.87	0.98	36.3
Approach		293	0.0	0.601	22.2	LOS B	4.0	28.3	0.83	1.09	39.9
North: Stony Creek Road (N Leg)											
7	L	20	0.0	0.408	14.7	LOS B	7.6	53.0	0.79	0.33	59.0
8	T	729	0.0	0.409	4.6	LOS A	7.6	53.0	0.79	0.00	58.0
9	R	21	0.0	0.413	14.8	LOS B	7.6	53.0	0.79	1.19	59.4
Approach		770	0.0	0.409	5.1	LOS A	7.6	53.0	0.79	0.04	58.0
West: Shanes Park Road (W Leg)											
10	L	21	0.0	0.319	29.8	LOS C	1.4	9.6	0.83	1.00	35.7
11	T	21	0.0	0.319	27.6	LOS B	1.4	9.6	0.83	0.96	33.8
12	R	21	0.0	0.319	29.8	LOS C	1.4	9.6	0.83	0.99	35.8
Approach		63	0.0	0.319	29.1	LOS C	1.4	9.6	0.83	0.98	35.1
All Vehicles		1816	0.0	0.601	9.1	NA	7.6	53.0	0.59	0.37	55.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

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MOVEMENT SUMMARY

Site: 2036 PM Peak Intersection A

2036 AM Peak – Intersection A
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Stony Creek Road (S Leg)											
1	L	1	0.0	0.333	10.1	LOS A	0.0	0.0	0.00	1.75	57.1
2	T	713	0.0	0.366	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	274	0.0	0.340	13.9	LOS A	2.1	14.7	0.59	0.91	51.8
Approach		988	0.0	0.366	3.9	LOS A	2.1	14.7	0.16	0.26	70.4
East: Garfield Road extension (E Leg)											
4	L	366	0.0	0.553	15.7	LOS B	4.4	31.1	0.67	1.03	44.9
5	T	1	0.0	0.333	32.1	LOS C	1.7	12.1	0.90	1.01	31.4
6	R	69	0.0	0.394	34.3	LOS C	1.7	12.1	0.90	1.03	33.4
Approach		436	0.0	0.553	18.7	LOS B	4.4	31.1	0.70	1.03	42.6
North: Stony Creek Road (N Leg)											
7	L	53	0.0	0.268	16.8	LOS B	4.9	34.4	0.87	0.20	55.9
8	T	462	0.0	0.267	6.7	LOS A	4.9	34.4	0.87	0.00	56.1
9	R	1	0.0	0.250	16.9	LOS B	4.9	34.4	0.87	1.10	56.3
Approach		516	0.0	0.267	7.8	LOS A	4.9	34.4	0.87	0.02	56.1
West: Shanes Park Road (W Leg)											
10	L	1	0.0	0.018	28.7	LOS C	0.1	0.5	0.85	0.86	36.3
11	T	1	0.0	0.018	26.5	LOS B	0.1	0.5	0.85	0.93	34.4
12	R	1	0.0	0.018	28.7	LOS C	0.1	0.5	0.85	0.96	36.4
Approach		3	0.0	0.018	28.0	LOS B	0.1	0.5	0.85	0.92	35.7
All Vehicles		1943	0.0	0.553	8.3	NA	4.9	34.4	0.47	0.37	57.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

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Intersection B

MOVEMENT SUMMARY

Site: 2036 AM Peak – Intersection B

2036 AM Peak – Intersection B
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: Garfield Road ext (E Leg)											
5	T	238	0.0	0.138	6.4	LOS A	1.0	7.0	0.03	0.53	50.8
6	R	19	0.0	0.139	10.9	LOS A	1.0	7.0	0.03	0.88	46.4
Approach		257	0.0	0.138	6.8	LOS A	1.0	7.0	0.03	0.55	50.4
North: Western North-South Collector (N Leg)											
7	L	66	0.0	0.075	9.4	LOS A	0.4	2.9	0.49	0.66	47.4
9	R	2	0.0	0.004	14.6	LOS B	0.0	0.1	0.53	0.66	43.2
Approach		68	0.0	0.075	9.6	LOS A	0.4	2.9	0.49	0.66	47.3
West: Garfield Road ext (W Leg)											
10	L	4	0.0	0.007	7.7	LOS A	0.0	0.2	0.11	0.59	49.2
11	T	412	0.0	0.261	6.5	LOS A	1.8	12.6	0.10	0.52	50.4
Approach		416	0.0	0.261	6.5	LOS A	1.8	12.6	0.10	0.52	50.4
All Vehicles		741	0.0	0.261	6.9	LOS A	1.8	12.6	0.11	0.54	50.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

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SIDRA INTERSECTION

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MOVEMENT SUMMARY

Site: 2036 PM Peak – Intersection B

2036 PM Peak – Intersection B
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: Garfield Road ext (E Leg)											
5	T	555	0.0	0.329	6.4	LOS A	2.7	19.1	0.06	0.52	50.6
6	R	59	0.0	0.330	10.9	LOS A	2.7	19.1	0.05	0.86	46.4
Approach		614	0.0	0.329	6.9	LOS A	2.7	19.1	0.06	0.55	50.2
North: Western North-South Collector (N Leg)											
7	L	6	0.0	0.007	8.3	LOS A	0.0	0.2	0.33	0.57	48.1
9	R	4	0.0	0.004	11.9	LOS A	0.0	0.2	0.35	0.63	45.2
Approach		10	0.0	0.006	9.7	LOS A	0.0	0.2	0.34	0.59	46.9
West: Garfield Road ext (W Leg)											
10	L	4	0.0	0.007	8.0	LOS A	0.0	0.2	0.21	0.57	48.7
11	T	202	0.0	0.147	6.7	LOS A	0.9	6.3	0.18	0.52	49.9
Approach		206	0.0	0.147	6.7	LOS A	0.9	6.3	0.18	0.52	49.9
All Vehicles		830	0.0	0.329	6.9	LOS A	2.7	19.1	0.09	0.54	50.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model used.

Processed: Wednesday, 4 July 2012 1:41:51 PM
SIDRA INTERSECTION 5.1.5.2006

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120223 models - internal intersections\B - 2036 Intersection 22 Sc1 - roundabout.sip
8000907, AECOM, ENTERPRISE

Intersection C

MOVEMENT SUMMARY

Site: 2036 AM Peak – Intersection C

2036 AM Peak – Intersection C
Signals - Fixed Time Cycle Time = 110 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Central North-South Collector (S Leg)											
1	L	129	0.0	0.209	12.4	LOS A	3.0	21.2	0.37	0.68	44.8
2	T	82	0.0	0.243	42.9	LOS D	5.3	36.8	0.90	0.70	26.5
3	R	299	0.0	0.805	66.7	LOS E	10.4	72.5	1.00	0.91	21.2
Approach		510	0.0	0.805	49.1	LOS D	10.4	72.5	0.82	0.82	25.4
East: Garfield Road ext (E Leg)											
4	L	513	0.0	0.844	42.0	LOS C	26.1	182.5	0.97	1.05	28.2
5	T	512	0.0	0.844	46.2	LOS D	26.1	182.5	0.99	1.00	25.2
6	R	50	0.0	0.196	40.9	LOS C	3.0	20.7	0.79	0.73	28.2
Approach		1075	0.0	0.844	43.9	LOS D	26.1	182.5	0.97	1.01	26.6
North: Central North-South Collector (N Leg)											
7	L	370	0.0	0.435	27.5	LOS B	15.0	105.2	0.69	0.82	34.2
8	T	173	0.0	0.435	40.7	LOS C	15.0	105.2	0.90	0.74	27.0
9	R	50	0.0	0.269	59.2	LOS E	3.7	25.8	0.96	0.75	22.8
Approach		593	0.0	0.435	34.0	LOS C	15.0	105.2	0.78	0.79	30.6
West: Garfield Road ext (W Leg)											
10	L	7	0.0	0.243	43.3	LOS D	6.5	45.7	0.84	0.84	28.6
11	T	225	0.0	0.242	35.5	LOS C	6.6	46.1	0.84	0.67	29.1
12	R	403	0.0	0.823	54.5	LOS D	23.0	160.9	1.00	0.93	24.1
Approach		635	0.0	0.823	47.6	LOS D	23.0	160.9	0.94	0.84	25.7
All Vehicles		2813	0.0	0.844	43.6	LOS D	26.1	182.5	0.90	0.89	26.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	41.9	LOS E	0.1	0.1	0.87	0.87
P3	Across E approach	53	49.2	LOS E	0.2	0.2	0.95	0.95
P5	Across N approach	53	41.9	LOS E	0.1	0.1	0.87	0.87
P7	Across W approach	53	49.2	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		212	45.5	LOS E			0.91	0.91

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Thursday, 1 March 2012 4:25:48 PM
SIDRA INTERSECTION 5.1.5.2006

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120223 models - internal intersections\C - 2036 Intersection 23 Sc1.sip
8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Intersection C

2036 PM Peak – Intersection C
Signals - Fixed Time Cycle Time = 90 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Central North-South Collector (S Leg)											
1	L	572	0.0	0.652	9.6	LOS A	7.8	54.4	0.36	0.70	47.4
2	T	344	0.0	0.454	22.0	LOS B	12.8	89.5	0.79	0.68	35.7
3	R	528	0.0	0.582	40.9	LOS C	12.0	84.2	0.93	0.83	28.2
Approach		1444	0.0	0.652	24.0	LOS B	12.8	89.5	0.67	0.74	35.8
East: Garfield Road ext (E Leg)											
4	L	240	0.0	0.455	19.9	LOS B	7.5	52.4	0.80	0.81	39.3
5	T	258	0.0	0.455	28.0	LOS B	9.0	63.2	0.89	0.73	32.0
6	R	4	0.0	0.032	52.2	LOS D	0.3	1.9	0.96	0.64	24.6
Approach		502	0.0	0.455	24.3	LOS B	9.0	63.2	0.85	0.77	35.1
North: Central North-South Collector (N Leg)											
7	L	33	0.0	0.087	34.1	LOS C	2.1	14.8	0.77	0.75	31.2
8	T	46	0.0	0.087	29.8	LOS C	2.1	14.8	0.82	0.61	31.3
9	R	1	0.0	0.008	51.5	LOS D	0.1	0.5	0.95	0.59	24.8
Approach		80	0.0	0.087	31.8	LOS C	2.1	14.8	0.80	0.67	31.2
West: Garfield Road ext (W Leg)											
10	L	4	0.0	0.258	39.8	LOS C	5.3	37.3	0.87	0.83	30.1
11	T	208	0.0	0.257	32.0	LOS C	5.4	37.6	0.87	0.69	30.5
12	R	24	0.0	0.194	53.5	LOS D	1.6	11.4	0.98	0.71	24.3
Approach		236	0.0	0.257	34.3	LOS C	5.4	37.6	0.88	0.69	29.7
All Vehicles		2262	0.0	0.652	25.4	LOS B	12.8	89.5	0.74	0.74	34.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	39.2	LOS D	0.1	0.1	0.93	0.93
P3	Across E approach	53	39.2	LOS D	0.1	0.1	0.93	0.93
P5	Across N approach	53	39.2	LOS D	0.1	0.1	0.93	0.93
P7	Across W approach	53	39.2	LOS D	0.1	0.1	0.93	0.93
All Pedestrians		212	39.2	LOS D			0.93	0.93

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Wednesday, 29 February 2012 5:28:27 PM
SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120223 models - internal intersections\C - 2036 Intersection 23 Sc1.sip
8000907, AECOM, ENTERPRISE

Intersection D

MOVEMENT SUMMARY

Site: 2036 AM Peak – Intersection D

2036 AM Peak – Intersection D
Signals - Fixed Time Cycle Time = 70 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Central North-South Collector (S Leg)											
1	L	6	0.0	0.103	22.0	LOS B	0.9	6.6	0.64	0.84	39.0
2	T	60	0.0	0.314	15.8	LOS B	3.2	22.6	0.71	0.55	38.8
3	R	100	0.0	0.314	27.8	LOS B	3.2	22.6	0.85	0.79	34.2
Approach		166	0.0	0.314	23.2	LOS B	3.2	22.6	0.79	0.70	35.9
East: Access Road 2 (E Leg)											
4	L	50	0.0	0.142	31.7	LOS C	1.4	9.7	0.83	0.74	32.0
5	T	60	0.0	0.431	29.5	LOS C	3.6	24.9	0.94	0.75	30.6
6	R	50	0.0	0.431	37.7	LOS C	3.6	24.9	0.94	0.80	30.3
Approach		160	0.0	0.431	32.8	LOS C	3.6	24.9	0.90	0.76	30.9
North: Central North-South Collector (N Leg)											
7	L	160	0.0	0.459	33.5	LOS C	4.8	33.3	0.89	0.79	31.2
8	T	186	0.0	0.480	26.0	LOS B	6.2	43.2	0.91	0.75	33.1
9	R	16	0.0	0.480	34.2	LOS C	6.2	43.2	0.91	0.84	32.6
Approach		362	0.0	0.480	29.7	LOS C	6.2	43.2	0.90	0.77	32.2
West: Access Road 2 (W Leg)											
10	L	6	0.0	0.207	21.1	LOS B	1.9	13.5	0.63	0.88	39.7
11	T	337	0.0	0.633	16.3	LOS B	11.0	76.9	0.82	0.68	38.2
12	R	148	0.0	0.633	25.8	LOS B	11.0	76.9	0.89	0.86	36.4
Approach		491	0.0	0.633	19.2	LOS B	11.0	76.9	0.84	0.74	37.7
All Vehicles		1179	0.0	0.633	24.8	LOS B	11.0	76.9	0.86	0.75	34.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	29.3	LOS C	0.1	0.1	0.91	0.91
P3	Across E approach	53	29.3	LOS C	0.1	0.1	0.91	0.91
P5	Across N approach	53	29.3	LOS C	0.1	0.1	0.91	0.91
P7	Across W approach	53	29.3	LOS C	0.1	0.1	0.91	0.91
All Pedestrians		212	29.3	LOS C			0.91	0.91

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Monday, 15 April 2013 2:18:46 PM
SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120223 models - internal intersections\D - 2036 Intersection 24 Sc1.sip
8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Intersection D

2036 AM Peak – Intersection D
Signals - Fixed Time Cycle Time = 05 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Central North-South Collector (S Leg)											
1	L	56	0.0	0.108	17.6	LOS B	0.9	6.5	0.58	0.73	40.4
2	T	238	0.0	0.331	11.1	LOS A	5.1	35.6	0.69	0.57	43.2
3	R	33	0.0	0.331	19.3	LOS B	5.1	35.6	0.69	0.89	41.0
Approach		327	0.0	0.331	13.1	LOS A	5.1	35.6	0.67	0.63	42.5
East: Access Road 2 (E Leg)											
4	L	200	0.0	0.450	24.6	LOS B	4.5	31.3	0.79	0.79	35.7
5	T	171	0.0	0.716	21.6	LOS B	9.4	65.9	0.93	0.86	34.4
6	R	160	0.0	0.716	29.8	LOS C	9.4	65.9	0.93	0.92	34.0
Approach		531	0.0	0.716	25.2	LOS B	9.4	65.9	0.88	0.85	34.8
North: Central North-South Collector (N Leg)											
7	L	100	0.0	0.243	27.0	LOS B	2.3	16.3	0.81	0.76	34.4
8	T	37	0.0	0.114	19.2	LOS B	1.1	7.6	0.80	0.61	36.8
9	R	10	0.0	0.114	27.4	LOS B	1.1	7.6	0.80	0.79	35.7
Approach		147	0.0	0.243	25.1	LOS B	2.3	16.3	0.81	0.73	35.1
West: Access Road 2 (W Leg)											
10	L	1	0.0	0.075	22.9	LOS B	0.7	4.8	0.71	0.83	38.8
11	T	163	0.0	0.229	15.6	LOS B	3.0	20.8	0.75	0.59	39.8
12	R	8	0.0	0.229	24.0	LOS B	3.0	20.8	0.76	0.87	38.1
Approach		172	0.0	0.229	16.0	LOS B	3.0	20.8	0.75	0.61	39.7
All Vehicles		1177	0.0	0.716	20.5	LOS B	9.4	65.9	0.79	0.74	37.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	20.8	LOS C	0.1	0.1	0.83	0.83
P3	Across E approach	53	24.3	LOS C	0.1	0.1	0.90	0.90
P5	Across N approach	53	20.8	LOS C	0.1	0.1	0.83	0.83
P7	Across W approach	53	24.3	LOS C	0.1	0.1	0.90	0.90
All Pedestrians		212	22.6	LOS C			0.87	0.87

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Friday, 19 April 2013 4:10:54 PM
SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120223 models - internal intersections\D - 2036 Intersection 24 Sc1 - roundabout.sip
8000907, AECOM, ENTERPRISE

Intersection E

MOVEMENT SUMMARY

Site: 2036 AM Peak – Intersection E

2036 AM Peak – Intersection E
Signals - Fixed Time Cycle Time = 95 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Marsden Park Industrial Access (S Leg)											
1	L	1	0.0	0.003	30.2	LOS C	0.0	0.3	0.69	0.60	33.0
2	T	11	0.0	0.011	28.2	LOS B	0.3	2.1	0.77	0.51	32.4
3	R	50	0.0	0.163	42.8	LOS D	2.9	20.1	0.87	0.74	27.7
Approach		62	0.0	0.163	40.0	LOS C	2.9	20.1	0.85	0.70	28.5
East: South Street (E Leg)											
4	L	143	0.0	0.301	24.7	LOS B	5.4	37.8	0.64	0.74	36.0
5	T	1067	0.0	0.753	38.4	LOS C	17.3	121.3	0.99	0.89	27.9
6	R	50	0.0	0.426	57.6	LOS E	3.5	24.2	1.00	0.74	23.3
Approach		1260	0.0	0.753	37.6	LOS C	17.3	121.3	0.95	0.87	28.4
North: Town Centre N-S Collector (N Leg)											
7	L	444	0.0	0.733	39.8	LOS C	19.7	138.1	0.95	0.87	28.6
8	T	190	0.0	0.386	32.0	LOS C	9.1	63.5	0.88	0.72	30.5
9	R	274	0.0	0.779	51.4	LOS D	14.5	101.8	1.00	0.91	25.0
Approach		908	0.0	0.779	41.7	LOS C	19.7	138.1	0.95	0.85	27.7
West: South Street (W Leg)											
10	L	1	0.0	0.001	23.0	LOS B	0.0	0.3	0.57	0.61	37.0
11	T	648	0.0	0.458	33.5	LOS C	10.3	72.4	0.90	0.75	29.9
12	R	50	0.0	0.426	57.5	LOS E	3.5	24.2	1.00	0.74	23.3
Approach		699	0.0	0.458	35.2	LOS C	10.3	72.4	0.91	0.75	29.3
All Vehicles		2929	0.0	0.779	38.3	LOS C	19.7	138.1	0.94	0.83	28.4

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	38.0	LOS D	0.1	0.1	0.89	0.89
P3	Across E approach	53	41.7	LOS E	0.1	0.1	0.94	0.94
P5	Across N approach	53	38.0	LOS D	0.1	0.1	0.89	0.89
P7	Across W approach	53	41.7	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		212	39.9	LOS D			0.92	0.92

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

Processed: Wednesday, 29 February 2012 6:59:31 PM
SIDRA INTERSECTION 5.1.5.2006

SIDRA INTERSECTION

Project: P:\60236418_Marsden_Park\4. Tech work area\4.5 Planning\SIDRA\20120223 models - internal intersections\E - 2036 Intersection 26 Sc1.sip
8000907, AECOM, ENTERPRISE

MOVEMENT SUMMARY

Site: 2036 PM Peak – Intersection E

2036 PM Peak – Intersection E
Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Marsden Park Industrial Access (S Leg)											
1	L	1	0.0	0.004	48.8	LOS D	0.1	0.6	0.74	0.60	25.8
2	T	154	0.0	0.247	59.5	LOS E	6.5	45.6	0.92	0.71	22.0
3	R	46	0.0	0.195	50.1	LOS D	3.5	24.7	0.77	0.73	25.4
Approach		201	0.0	0.247	57.3	LOS E	6.5	45.6	0.88	0.72	22.7
East: South Street (E Leg)											
4	L	1	0.0	0.002	21.2	LOS B	0.0	0.3	0.43	0.60	38.1
5	T	992	0.0	0.344	15.8	LOS B	12.8	89.3	0.65	0.56	40.0
6	R	470	0.0	0.825	40.8	LOS C	23.4	163.9	0.99	0.90	28.3
Approach		1463	0.0	0.825	23.8	LOS B	23.4	163.9	0.76	0.67	35.3
North: Town Centre N-S Collector (N Leg)											
7	L	218	0.0	0.429	56.2	LOS D	14.5	101.5	0.87	0.82	23.5
8	T	10	0.0	0.032	56.7	LOS E	1.0	6.7	0.87	0.60	22.7
9	R	10	0.0	0.135	86.7	LOS F	1.2	8.1	0.99	0.67	17.8
Approach		238	0.0	0.429	57.5	LOS E	14.5	101.5	0.88	0.80	23.2
West: South Street (W Leg)											
10	L	359	0.0	0.654	50.8	LOS D	22.1	154.7	0.88	0.84	25.3
11	T	1399	0.0	0.815	55.6	LOS D	33.0	231.2	1.00	0.92	22.8
12	R	50	0.0	0.252	75.3	LOS F	4.8	33.3	0.96	0.75	19.6
Approach		1808	0.0	0.815	55.2	LOS D	33.0	231.2	0.97	0.90	23.2
All Vehicles		3710	0.0	0.825	43.1	LOS D	33.0	231.2	0.88	0.79	26.8

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P1	Across S approach	53	47.2	LOS E	0.2	0.2	0.79	0.79
P3	Across E approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
P5	Across N approach	53	47.2	LOS E	0.2	0.2	0.79	0.79
P7	Across W approach	53	69.1	LOS F	0.2	0.2	0.96	0.96
All Pedestrians		212	58.2	LOS E			0.88	0.88

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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Intersection F

MOVEMENT SUMMARY

Site: 2036 AM Peak – Intersection F

2036 AM Peak – Intersection F
Signals - Fixed Time Cycle Time = 70 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: South Street (E Leg)											
5	T	1114	0.0	0.476	16.9	LOS B	9.5	66.5	0.79	0.68	38.9
6	R	249	0.0	0.782	47.4	LOS D	4.8	33.3	1.00	0.91	26.1
Approach		1363	0.0	0.782	22.5	LOS B	9.5	66.5	0.83	0.72	35.7
North: Central North-South Collector (N Leg)											
7	L	512	0.0	0.459	16.5	LOS B	9.7	67.6	0.59	0.80	41.2
9	R	577	0.0	0.870	40.4	LOS C	22.9	160.1	1.00	1.01	28.5
Approach		1089	0.0	0.870	29.2	LOS C	22.9	160.1	0.81	0.91	33.3
West: South Street (W Leg)											
10	L	211	0.0	0.145	8.8	LOS A	1.2	8.1	0.27	0.67	48.3
11	T	415	0.0	0.310	24.8	LOS B	4.0	28.2	0.87	0.70	34.0
Approach		626	0.0	0.310	19.4	LOS B	4.0	28.2	0.67	0.69	37.8
All Vehicles		3078	0.0	0.870	24.2	LOS B	22.9	160.1	0.79	0.78	35.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	26.6	LOS C	0.1	0.1	0.87	0.87
P5	Across N approach	53	29.3	LOS C	0.1	0.1	0.91	0.91
P7	Across W approach	53	23.2	LOS C	0.1	0.1	0.81	0.81
All Pedestrians		159	26.3	LOS C			0.87	0.87

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: 2036 PM Peak – Intersection F

2036 PM Peak – Intersection F
Signals - Fixed Time Cycle Time = 100 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
East: South Street (E Leg)											
5	T	483	0.0	0.135	8.7	LOS A	3.3	22.9	0.45	0.37	46.7
6	R	904	0.0	0.839	50.7	LOS D	23.2	162.7	1.00	0.94	25.1
Approach		1387	0.0	0.839	36.1	LOS C	23.2	162.7	0.81	0.75	29.9
North: Central North-South Collector (N Leg)											
7	L	135	0.0	0.117	16.4	LOS B	2.6	18.5	0.43	0.74	41.3
9	R	257	0.0	0.513	41.5	LOS C	10.7	75.2	0.90	0.82	28.1
Approach		392	0.0	0.513	32.9	LOS C	10.7	75.2	0.74	0.79	31.6
West: South Street (W Leg)											
10	L	721	0.0	0.614	15.2	LOS B	17.0	119.1	0.62	0.79	42.3
11	T	1271	0.0	0.836	44.0	LOS D	21.8	152.4	1.00	0.98	26.0
Approach		1992	0.0	0.836	33.5	LOS C	21.8	152.4	0.86	0.91	30.3
All Vehicles		3771	0.0	0.839	34.4	LOS C	23.2	162.7	0.83	0.84	30.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue Pedestrian	Average Back of Queue Distance	Prop. Queued	Effective Stop Rate
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	44.2	LOS E	0.1	0.1	0.94	0.94
P5	Across N approach	53	35.3	LOS D	0.1	0.1	0.84	0.84
P7	Across W approach	53	40.5	LOS E	0.1	0.1	0.90	0.90
All Pedestrians		159	40.0	LOS D			0.89	0.89

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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