Leppington Precinct

Transport and Access Strategy
Leppington Precinct
Transport and Access Strategy

Client: NSW Department of Planning & Infrastructure
ABN: 38755709681

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10-Mar-2014
Job No.: 60272835

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Quality Information

Document: Leppington Precinct
Ref: 60272835
Date: 10-Mar-2014
Prepared by: Dan Riley
Reviewed by: Andy Yung

Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Revision Date</th>
<th>Details</th>
<th>Authorised</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Name/Position</td>
</tr>
<tr>
<td>A</td>
<td>29-Nov-2013</td>
<td>Draft Report</td>
<td>Andy Yung</td>
</tr>
<tr>
<td>B</td>
<td>10-Mar-2014</td>
<td>Final Report</td>
<td>Andy Yung</td>
</tr>
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Appendix A  
Forecast Traffic Volumes (2026)  

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Forecast Traffic Volumes (2036)
Executive Summary

Context
This report sets out the transport and access components to support the development of an Indicative Layout Plan for the Leppington Precinct in the South West Growth Centre (SWGC). This document will be part of a suite of documents forming the overall Leppington Precinct Plan. It covers a range of transport modes and considers improvements to public transport, walking and cycling networks to ensure accessibility and transport opportunities for these communities in future. An 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 road network classifications and methods of control for intersections across the proposed road network for Leppington Precinct. The designated road network hierarchy focuses vehicular access on the most appropriate routes to arterial roads in the regional road network. Vehicles are distributed through the precinct via the hierarchical network of Sub-Arterial, Transit Boulevard and Collector Roads then via local streets to individual land parcels. The proposed road hierarchy for Leppington Precinct is based upon the South West Growth Centre Road Network Strategy (Roads and Maritime, 2011), neighbouring precincts and the expected traffic flows on the road network.

The key arterial road serving the precinct is Camden Valley Way. At ultimate development of the SWGC Camden Valley Way will have three lanes in each direction and provide a strategic traffic function for the South West Growth Centre for both private vehicles and public transport.

A grid pattern (where possible) of strategic roads will service the precinct and provide connections to the wider SWGC. For the purposes of this assessment, all strategic roads identified within the South West Growth Centre Road Network Strategy are assumed to occur at ultimate development. This includes east / west routes along Ingleburn Road, Heath Road and St Andrews Road, as well as north / south aligned routes along Byron Road, Rickard Road, Dickson Road and Eastwood Road (a number of these routes may be subject to feasibility assessments and more detailed planning at a later stage). The nature and hierarchy of each route will vary, with Ingleburn Road, St Andrews Road, Eastwood Road and Byron Road designated sub-arterial routes. Heath Road, Park Road, and Phillip Road are identified as collector roads, while Rickard Road will act as a Transit Boulevard.

Rickard Road, a designated Transit Boulevard is proposed to run parallel to Camden Valley Way and provide a transit function between the Leppington Major Centre and SWGC precincts to the south. Rickard Road is proposed to continue north into the Austral/Leppington Precincts and south to Oran Park Drive. Rickard Road will ultimately have three lanes in each direction and a strategic public transport function, providing a high frequency bus corridor with one dedicated bus lane and two traffic lanes in each direction. The development of Rickard Road will be staged.

Dickson Road is proposed to provide a direct link to Oran Park Town Centre via Peter Brock Drive. This route will also form an important part of the strategic bus network. Dickson Road is proposed to be a sub-arterial road with one lane in each direction along its length. Dickson Road will have a transit function, however fewer buses will utilise the route in comparison to Rickard Road. Bus services are also proposed to operate on Eastwood Road which has two lanes in each direction.

All collector roads and local roads within the precinct require only one traffic lane in each direction, with localised widening at intersections and parking lanes if required.

Intersections
Intersections within the Leppington Precinct have been designed to accommodate future year traffic demands and wider regional development at 2036. The intersections will operate at an acceptable level of service during the morning peak hour and evening peak hour, with appropriate forms of control.

In line with Roads and Maritime guidance all intersections within the precinct have been assessed to perform at Level of Service D or above in 2036, and therefore will provide adequate capacity and operational efficiency.
However this is not the case for Camden Valley Way which borders the precinct. Excessive queue lengths are identified at Camden Valley Way intersections due to the high volumes of traffic forecast for the future year 2036. Sensitivity testing has shown that additional lanes are likely to attract further vehicles from elsewhere on the strategic road network which is constrained over a wider regional area in 2036. Public transport and active travel uptake will be critical to reducing the pressure on Camden Valley Way and other north/south road corridors in 2036 to ensure the ongoing functionality of the road network.

The following intersections will operate at an acceptable level of service under forecast 2036 AM and PM peak hour demands as signalised intersections:

- Rickard Road | Ingleburn Road; and
- Rickard Road | Heath Road.

Other intersections within the precinct will operate satisfactorily as roundabouts or priority intersections.

**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, Leppington Rail Station, Campbelltown Rail Station, schools, employment opportunities and residential areas. A number of initiatives set by the NSW Government, such the Sydney’s Bus Future (TfNSW, 2013) further support the Leppington Precinct.

The proposed bus strategy for this precinct is broadly consistent with the SWGC Road Network Strategy and follows a revised South West Growth Sector Bus Servicing Strategy specific to the proposed road network. The proposed ultimate bus network for the precinct will comprise a mixture of regional routes and district routes to maximise speed and efficiency of high frequency peak hour services as well as a number of local bus routes to ensure maximum coverage throughout the precincts, facilitating public transport access and travel choice.

It is beneficial for public transport to be available from the outset of the development so that residents are able to build positive public transport behaviours at the earliest stage. This will result in higher public transport mode share in the long-term and act to reduce socially ingrained car dependency within the precinct.

The combination of the Regional/District routes and local routes on the collector road network provides an efficient and flexible bus network to serve the future Leppington precinct.

Key bus operating corridors with services providing fast, efficient regional connections will operate along four north-south routes (Eastwood Road, Dickson Road, Rickard Road and Camden Valley Way) all linking Leppington major centre to other notable regional destinations such as Oran Park Town Centre, Liverpool, Narellan and Campbelltown.

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. Rickard Road is identified as a critical link (with dedicated bus lanes) in the bus network for bus priority measures and has 3 lanes in each direction.

Indented bus stops are not recommended and where bus stops are located in proximity to education or activity centres, safe pedestrian crossing facilities will be proposed.

**Pedestrian and Bicycle Networks**

There are good opportunities for walking and cycling within the study area, however there is limited existing provision of walking and cycling facilities within the precinct. This will not be appropriate to meet future demands.

Providing viable alternatives to the private car for journeys with destinations both within and outside the precinct is essential to encourage the use of more sustainable modes of travel among residents. 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 number of initiatives set by the NSW Government, such the Sydney’s Walking and Cycling Future (TfNSW, 2013) further support the Leppington Precinct.
A comprehensive bicycle network is proposed for the precinct which will link the centres, schools 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)
- Off-Road (Cycle Lane)
- On-Road (Cycle Lane)
- Off-Road (linear shared pathways along Riparian Corridors)

All proposed roads throughout the 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 regular pedestrian crossing opportunities will be provided by dedicated pedestrian crossing facilities throughout the precinct.

The proposed road grid network and block sizes will also work to facilitate pedestrian permeability and be conducive to encouraging walking trips. Regular cross streets with pedestrian footpaths, a grid network and physical crossing points of Kemps Creek and Scalabrini Creek will encourage pedestrian activity, and achieve a high level of permeability.

In addition, Green Travel Plans for schools could 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, active communities in the precinct.
1.0 Introduction

1.1 Background

The Draft Metropolitan Plan for Sydney 2031 (March, 2013) 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 South West Growth Centre (SWGC) comprises 18 precincts, is approximately 17,000 hectares and has capacity for around 110,000 new dwellings for 300,000 people.

A considerable amount of urban development has been completed or is underway in the SWGC including East Leppington, Oran Park, Gregory Hills, Sekisui lands (The Hermitage) and Harrington Park, while Austral and Leppington North (ALN) Precincts and Catherine Field (part) Precinct have recently been re-zoned. A major centre in Leppington will be serviced by the South West Rail Link (SWRL) to be opened in 2015.

The key challenge for the planning and development of these precincts is to successfully integrate the precincts with surrounding residential areas, major centres and transport hubs. To achieve this, a balanced approach is needed that considers the natural constraints, such as riparian corridors and topography, and built environment constraints such as the future widening of Camden Valley Way and heritage buildings located on the site. These influence the configuration of the internal road network as well as pedestrian and cyclist circulation.

The Leppington Precinct is located adjacent to Leppington Major Centre and Leppington Rail Station. These will be a significant drawcard within the SWGC, resulting in considerable access demands across all modes of transport. Due to its proximity to these facilities, the Leppington Precinct will need to cater for significant volumes of through traffic, as people move to and from the precincts in the south (Catherine Field, Catherine Field North, Oran Park), through to Leppington Major Centre and Rail Station in the north as well as locally generated traffic. Rickard Road, Dickson Road and Eastwood Road will be critical to catering for this demand.

There is currently limited public transport provision in the area, although AECOM has recently updated the integrated network plan for Transport for NSW (TfNSW), which will guide future service provision. Similarly, there is a limited pedestrian and cycle network; however these are increasing with surrounding infrastructure upgrades.

1.2 Purpose

AECOM has been appointed by the Department of Planning & Infrastructure to assess the transport and access components for the Leppington Precinct (herein referred to as “the precinct”). The purpose of this study is to provide a transparent and robust assessment of the Indicative Layout Plan by all modes of transport including walking, cycling, public transport and passenger vehicles. Ultimately this will comprise part of a suite of documents forming the Precinct Plan.

The precinct is located approximately 45km south west of Sydney and is bounded by Camden Valley Way to the east and Ingleburn Road to the north. The western and southern boundary of the precinct is located on various property boundaries and roads including Eastwood Road, McCann Road, Cordeaux Road, Anthony Road, Joseph Road, George Road and Hulls Road. The precinct comprises approximately 656 hectares of rural lands and will accommodate approximately 8,000 dwellings.

The precinct together with regional context of the South West Growth Centre is shown Figure 1.
The Transport and Access Strategy identifies suitable facilities for people to walk, cycle, access 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. Precincts 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.

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 continual changes to the Indicative Layout Plan (ILP).
1.3 Study area

The precinct is located within the local government area of Camden and occupies a central position within the SWGC. It is bordered by Austral & Leppington North, Rossmore, Catherine Field North and East Leppington Precincts. Leppington is also bounded by Camden Valley Way to the east and Ingleburn Road to the north.

Figure 2 sets out the extent of the study area for the project, covering the precinct area in relation to neighbouring precincts.

Figure 2: Leppington Precinct Study Area

Source: AECOM, 2013
2.0 Indicative Layout Plan

2.1 Introduction

Precinct plans are a proven approach to the delivery of greenfield residential developments. The intention being to achieve high quality outcomes, including easy access to jobs and major town centres, streets and suburbs so that people can walk to shops, and frequent bus services that link to the rail network for longer journeys.

A preliminary Indicative Layout Plan (ILP) was developed through an iterative process over a period of time, involving multiple stakeholders across a range of technical disciplines providing inputs and guidance as to the precinct development opportunities and constraints. The transport network within the precinct plan broadly follows the South West Growth Centre Road Network Strategy (Roads and Maritime) and the South West Bus Servicing Strategy (TfNSW), while seeking to maintain consistency with other transport strategies developed for surrounding rezoned precincts 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 way that maximises the opportunities for the use of more sustainable modes of transport than the private car. To achieve this outcome it is necessary to plan for a range of land uses that provide a balanced mix of housing, employment 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 the precinct will need easy access to existing and proposed major town centres such as Leppington (immediately adjacent to the Precinct), Oran Park, Liverpool and Campbelltown/Macarthur with a full range of shops, services and recreational facilities. Efficient bus connections and transport hubs at these major centres are required to maximise public transport connectivity to other parts of Sydney.

The precinct will also provide a neighbourhood centre, sporting fields, and education facilities which maximise accessibility to local shops and services for daily needs.
2.3 Preliminary Indicative Layout Plan

A preliminary Indicative Layout Plan (ILP) is provided in Figure 3. The land use details of the precinct are discussed below:

Figure 3: Indicative Layout Plan for the Leppington Precinct

Source: Cox & Richardson, 2013
2.3.1 Residential land uses

Proposed residential land development within the precinct will be largely low density and comprise of approximately 7,200 dwellings. Population density will determine the level of transport demand generated by the residences in various parts of the precinct. Estimates of population density suggest an average of 3.2 persons per dwelling or approximately 23,100 residents for the precinct. This includes:

- Approximately 439ha of residential land proposed as low density providing 88% of homes within the precinct at an average density of 14.4 dwellings per hectare.
- Medium density residential occupying 35ha (12% of homes) at 25 dwellings per hectare, located near centres and other local amenities.

2.3.2 Local and neighbourhood centres

Given the proximity of this precinct to the Leppington Major Centre and other potential centres within other precincts, one neighbourhood centre is proposed within the precinct. This will be located to the west of the precinct at the intersection of Eastwood Road and Heath Road. It is proposed that this neighbourhood centre would include retail, a community centre and a school. The location of the neighbourhood centre to the west of the precinct will ensure it is a commercially viable centre, despite its proximity to the planned Leppington Major Centre. The Leppington Major Centre will act to serve as the major town centre for the precinct.

2.3.3 Educational land uses

It is proposed that five schools will be located within the precinct, including one secondary school in the centre of the precinct, on the corner of Rickard Road and Heath Road. Primary schools would be located at the neighbourhood centre, the intersection of Dickson Road and Joseph Road, along Park Road and at the intersection of Ingleburn Road and Byron Road. The schools are positioned at or near key public transport corridors and would be accessed via local roads to the rear of each site where appropriate. It is important to provide high quality walking and cycling routes to each school.

2.3.4 Community uses and open space

Under the currently proposed ILP there is opportunity to provide several open space areas. A number of parks and sports fields are proposed within the precinct. These will be accessible by public transport, walking and cycling routes. There is also an opportunity to locate leisure cycling and walking routes along riparian corridors.

Two riparian corridors exist within the site:
- Kemps Creek originates near the intersection of Georges Road and Hulls Road and continues north, exiting the site near the intersection of Eastwood Road / McCann Road.
- Scalabrini Creek enters the site near the intersection of Camden Valley Way / Park Road. It continues north and exits the precinct between Rickard Road and Dickson Road.

These corridors have the potential to improve active travel connections to the proposed neighbourhood centre as well as the Leppington Major Centre, encouraging activity and providing health benefits to the community. Provision of walking and cycling routes within these riparian corridors may require resolution of access to the rear of private properties.

2.4 Preliminary transport assessment of ILP

Through the ILP development process, transport design advice and transport infrastructure assessment has been undertaken in collaboration with key stakeholders, including:

- The NSW Department of Planning and Infrastructure (DP&I)
- Camden Council; and
- Transport for NSW (including Roads and Maritime)
A transport assessment was undertaken for the initial road layout plans through an opportunities and constraints analysis. The following transport elements were considered for the preliminary layout:

- Road network connections
- Public transport opportunities
- Walking and cycling opportunities.

Key areas of consideration for Council, TfNSW and Roads and Maritime were identified during preliminary consultation. These generally revolved around the form and function of the road network within the precinct, including the treatment of intersections (Roads and Maritime), location of bus routes (TfNSW) and road corridor lane widths and traffic volumes (council/DP&I). Generally these considerations were subject wider area strategic traffic modelling and impacted by the outcomes from other development in the SWGC. The major outcome of these discussions was an acknowledgement that the Leppington precinct must accommodate considerable through traffic volumes whilst ensuring that the character of the precinct is not compromised by excessive road network provision.

Comments were also provided on the location of different land uses, such as neighbourhood centres, as this can impact upon the accessibility and mode choice within the precinct. Mixed use and proximity to local centres are a key factor in promoting sustainable transport modes such as walking and cycling, a key objective of the Growth Centres Development Code.
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, how is the road designed to accommodate its intended function?
- Road capacity – are adequate lanes provided 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 1 shows the Austroads classifications and a description of the functionality of each road type.

<table>
<thead>
<tr>
<th>Type of Road</th>
<th>Function</th>
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</thead>
<tbody>
<tr>
<td>Controlled access highways (motorways or freeways)</td>
<td>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.</td>
</tr>
<tr>
<td>Urban arterial roads</td>
<td>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.</td>
</tr>
<tr>
<td>Urban collector/distributor roads</td>
<td>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.</td>
</tr>
<tr>
<td>Urban local roads</td>
<td>These are roads intended exclusively for access with no through traffic function.</td>
</tr>
</tbody>
</table>

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

NSW Roads and Maritime (formerly NSW Roads & Traffic Authority) and the Department of Planning and Infrastructure (formerly Growth Centres Commission) have also developed guidelines for classification of roads. Table 2 summarises the Roads and Maritime functional classification system.

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Traffic Volume (AADT)</th>
<th>Through Traffic</th>
<th>Inter-Connections</th>
<th>Speed Limit (km/h)</th>
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<tr>
<td>Arterial/Freeway</td>
<td>No limit</td>
<td>Yes</td>
<td>Sub-arterial</td>
<td>70-110</td>
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<td>Sub-Arterial</td>
<td>&lt;20,000</td>
<td>Some</td>
<td>Arterial/Collector</td>
<td>60-80</td>
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<td>Collector</td>
<td>&lt;5,000</td>
<td>Little</td>
<td>Sub-arterial/Local</td>
<td>40-60</td>
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<tr>
<td>Local</td>
<td>&lt;2,000</td>
<td>No</td>
<td>Collector</td>
<td>40</td>
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Source: Updated Guidelines for Functional Classification of Roads in Urban Areas, Roads and Maritime, 1993
The Growth Centres Development Code classifications, shown in Table 3 are broadly consistent with the Roads and Maritime classifications, except with higher traffic volume (AADT) limits for all road types, reflecting the amount of traffic that have been carried on elements of the Sydney road network.

Table 3: Functional Classification of Roads (DP&I)

<table>
<thead>
<tr>
<th>Road Type</th>
<th>AADT</th>
<th>Functions and Connections</th>
<th>Speed Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial/Freeway</td>
<td>35,000+</td>
<td>Connects large urban areas</td>
<td>Over 80km/h</td>
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| Transit Boulevard   | 30,000 – 35,000 | Located close to centres  
|                     |         | Pedestrian friendly environment  
|                     |         | Allow for long term upgrades & 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, October 2006

3.2.2 Road capacity

Level of Service (LoS) is an index of the operational efficiency of a roadway or intersection. The analysis is essential in planning and design of the transport network and can influence the number of lanes provided or the arrangement of a traffic control system under study.

LoS can be measured mid-block or at intersections. As a midblock measure, LoS is a qualitative measure describing the operational conditions on a road and their perception by a driver. At intersections, LoS is considered in terms of average delay experienced by drivers. Intersection LoS is discussed at Section 3.2.3.

The capacity of urban lanes with interrupted flow is provided in Table 4 for each LoS. These capacities may increase when priority is given to the major traffic flow at intersections or if there is flaring at intersections to accommodate more traffic. The spacing of intersections will differ with the hierarchy and function of the road.

Table 4: Mid-block Level of Service and Capacity

<table>
<thead>
<tr>
<th>LoS</th>
<th>Description</th>
<th>Hourly flow (vehicles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 Lane</td>
</tr>
<tr>
<td>A</td>
<td>A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.</td>
<td>200</td>
</tr>
<tr>
<td>B</td>
<td>In the zone of stable flow and drivers still have the reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with LOS A.</td>
<td>380</td>
</tr>
<tr>
<td>C</td>
<td>Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.</td>
<td>600</td>
</tr>
<tr>
<td>D</td>
<td>Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.</td>
<td>900</td>
</tr>
<tr>
<td>E</td>
<td>Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause break-down.</td>
<td>1,400</td>
</tr>
</tbody>
</table>

It is generally acceptable to provide road capacity at Level of Service D in the peak hour since over-provision of road capacity is not conducive to promoting alternative transport modes to the car.

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 5.

Table 5: Level of Service Criteria for Intersections

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Average Delay / Vehicle (sec/veh)</th>
<th>Traffic Signals, Roundabout</th>
<th>Give Way and Stop Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Less than 14</td>
<td>Good operation</td>
<td>Good operation</td>
</tr>
<tr>
<td>B</td>
<td>15 to 28</td>
<td>Good with acceptable delays and spare capacity</td>
<td>Acceptable delays and spare capacity</td>
</tr>
<tr>
<td>C</td>
<td>29 to 42</td>
<td>Satisfactory</td>
<td>Satisfactory, but accident study required</td>
</tr>
<tr>
<td>D</td>
<td>43 to 56</td>
<td>Operating near capacity</td>
<td>Near capacity and accident study required</td>
</tr>
<tr>
<td>E</td>
<td>57 to 70</td>
<td>At capacity; at signals incidents will cause excessive delays</td>
<td>At capacity; requires other control mode</td>
</tr>
<tr>
<td>F</td>
<td>&gt;70</td>
<td>Roundabouts require other control mode</td>
<td>At capacity; requires other control mode</td>
</tr>
</tbody>
</table>

Source: Guide to Traffic Generating Developments, Roads and Maritime 2002

Level of Service D is generally accepted by Roads and Maritime 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.

3.3 Existing road network connections

A number of roads exist within the precinct (listed below). These are generally two-way with their main function to provide access to rural properties. Roads that provide access to/from the study area are shown in bold. The existing road hierarchy is shown in Figure 4 overleaf.

- Heath Road
- Phillip Road
- Ridge Square
- Park Road
- Woolgen Park Road
- George Road
- Dwyer Road

- Eastwood Road
- Dickson Road
- Rickard Road
- Riley Road
- Byron Road

The following roads border the Precinct but are not fully located within the Precinct at any stage:

- Ingleburn Road
- Anthony Road
- Joseph Road

- Camden Valley Way
- Cordeaux Street
- Hulls Road
Figure 4: Leppington Precinct Existing Road Network

Legend
- Currently undergoing upgrade to four lane arterial road
- 2 way rural road

Source: AECOM, 2013
Annual average daily traffic collected by Roads and Maritime (2005-2011) on the major road network surrounding the precinct is shown in Table 6. One of the major constraints to the road network is the capacity of Camden Valley Way which currently operates with only one travel lane in each direction adjacent to the site.

- Existing intersection control on Camden Valley Way in the vicinity of the precinct consists of a seagull intersection with a left turn slip lane at Ingleburn Drive, T-intersections with left turn slip lanes at Heath Road and George Road, a T-intersection with right turn bay and left slip lane at Dwyer Road and standard T-intersections at Park Road and St Andrews Drive. Note that all intersections are scheduled for upgrade as part of the strategy for widening Camden Valley Way.

- The majority of intersections within the precinct are located on rural roads with low traffic volumes that operate as either 4-arm priority intersections or standard T-intersections. The exception is at the intersection of Rickard Road / Ingleburn Road which operates as a roundabout.

### Table 6: Estimated Average Daily Traffic in the vicinity of the Leppington Precinct

<table>
<thead>
<tr>
<th>Road</th>
<th>Location</th>
<th>Vehicles Per Day</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bringelly Road</td>
<td>Immediately west of Camden Valley Way</td>
<td>9,090</td>
<td>2010</td>
</tr>
<tr>
<td>Camden Valley Way</td>
<td>Leppington – At Sydney Water Supply Line</td>
<td>20,472</td>
<td>2005</td>
</tr>
<tr>
<td>Camden Valley Way</td>
<td>South of Heath Road</td>
<td>20,217</td>
<td>2008</td>
</tr>
<tr>
<td>Bringelly Road</td>
<td>Immediately east of King Street</td>
<td>8,540</td>
<td>2010</td>
</tr>
</tbody>
</table>

Source: Roads and Maritime, 2012

Some of the main challenges with regard to the road network will be:

- Providing vehicular and public transport access to other precincts within the SWGC including Oran Park Town Centre via Rickard Road.

- Maximising accessibility to the road network including Rickard Road and Camden Valley Way.

- Providing sufficient road network access to Leppington Town Centre as the closest employment and retail centre to the precinct.

- Providing a sufficient road network across the Kemps Creek and Scalabrini Creek riparian corridors to ensure that communities are connected internally within the precinct.

- Providing a local road network that provides access to local services, amenities and open space within the precinct.

Several major arterial road upgrades are currently underway in the vicinity of the precinct including:

- Camden Valley Way stage one, two and three upgrades (two lanes in each direction with ultimate upgrade and potential to expand to three lanes as required) as outlined in the South West Road Structure Plan and Camden Valley Way Access Strategy;

- Gregory Hills Drive extension.

Other planned major road network upgrades include:

- Bringelly Road;

- The Northern Road;

- Camden Valley Way Stage three upgrade.
Future highway network and intersection performance will significantly change as the precinct and surrounding SWGC develops. Additional highway and intersection capacity will be required, both through upgrades to existing infrastructure and new or extended links to enable growth. The cumulative traffic impacts of the development of adjacent SWGC precincts and adjacent release areas will need to be taken into account in the assessment of future highway performance. According to the Draft Roads and Maritime Road Network Strategy, key future road connections in the vicinity of the precinct in addition to the arterial roads mentioned above include:

- St Andrews Road is currently a rural access road to the southeast of the precinct that would in future provide the major east/west arterial connection within the Leppington Precinct and link to the F5 and Campbelltown Road (to the east) and The Northern Road (to the west).
- Ingleburn Road is currently a rural road with one lane in each direction between Camden Valley Way and Eastwood Road. In the future it will become a sub-arterial road with 2 lanes in each direction and will be the major access between Camden Valley Way and Leppington Major Centre.
- Eastwood Road is currently a north/south aligned rural road with one lane in each direction connecting to Bringelly Road in the north. In the future this road will become a sub-arterial road with 2 lanes in each direction connecting through to The Northern Road in the west.
- Dickson Road is currently a local rural road between Bringelly Road and Heath Road serving the northern part of the precinct only. In the future it is proposed that this road will connect to Oran Park in the south via George Road to assist Rickard Road in accommodating north/south traffic in the precinct.

Note that for the purposes of this assessment, strategic connections such as those outlined above are assumed to exist at ultimate development of the SWGC. The feasibility of these routes will be subject to corridor development and detailed design.

Roads and Maritime is committed to having a road connection (Rickard Road) from Leppington Station through the precinct, linking with Catherine Field (part) Precinct in the south. It is therefore envisaged that Rickard Road will form a major connection between Leppington Major Centre and the southern end of the SWGC, supplementary to Camden Valley Way. Rickard Road will be connected to Ingleburn Road, Heath Road, Park Road, Woolgen Park Road, St Andrews Road, George Road and Dwyer Road within the precinct, providing a high level of accessibility. A strategic corridor study for Rickard Road has been prepared by the state government to determine its alignment and connections. This will provide an important bus priority corridor between Oran Park, Leppington and Leppington Major Centre.

3.3.1 Precinct access

The number of access points to the precinct has been considered based on the Roads and Maritime South West Growth Centre Road Network Strategy with acknowledgement of existing road infrastructure and intersections, connectivity to adjacent precincts, potential bus route access and circulation, proposed schools, neighbourhood centres, precinct planning principals and through traffic demands. Access to the wider Sydney region is provided by Camden Valley Way, a six lane (2036) arterial road at the eastern boundary of the precinct. Details of precinct connectivity are outlined below and summarised in Figure 5.

The final ILP proposes six access points from which residents of the precinct can access Camden Valley Way:

- Ingleburn Road (sub-arterial)
- Heath Road (collector)
- Park Road (collector)
- St Andrews Road (sub-arterial)
- George Road (collector)
- Dwyer Road (collector)
Five connections are provided from the precinct to Ingleburn Road on the northern perimeter of the precinct. These routes fulfil the travel demand between the precinct and Leppington Station / Town Centre:
- Eastwood Road (sub-arterial)
- Dickson Road (sub-arterial)
- Rickard Road (transit boulevard)
- Byron Road (sub-arterial)
- Camden Valley Way (arterial)

Seven connections are provided from the precinct to the western perimeter of the precinct. These routes will fulfil the travel demand between Leppington and the future Rossmore Precinct to the west:
- Ingleburn Road (sub-arterial)
- Heath Road (collector)
- Phillip Road (collector)
- Joseph Road (collector)
- St Andrews Road (sub-arterial)
- George Road (collector)
- Dwyer Road (collector)

Five connections are provided from the precinct to the southern border of the precinct. These routes fulfil the travel demand between the precinct and residential developments to the south and the Oran Park town centre:
- Eastwood Road (sub-arterial)
- Dickson Road (sub-arterial)
- Rickard Road (transit boulevard)
- Hulls Road (collector)
- Camden Valley Way (arterial)
Those routes designated as sub-arterial are anticipated to carry through traffic generated by other precincts. This through traffic is likely to be primarily driven by residents of precincts to the south seeking access to the Leppington Major Centre and Rail Station. A large proportion of future development is proposed to occur to the south of the precinct, a fact reflected in the higher classification of roads required to cater this particular demand.

Given the location of the precinct within the SWGC, the proposed access points will maximise the vehicular and bus permeability of the precinct to allow efficient movement for both those residing within the precinct and those moving through the precinct.

The number of roads crossing the precinct has been restricted by both steep terrain and creek crossings. Upgraded creek crossings are proposed to occur at existing crossing locations along Kemps Creek such as Heath Road, Riley Road (the future Rickard Road) and George Road with a new crossing for Dickson Road. At Scalabrini Creek upgraded crossings would be required at Rickard Road, Heath Road and Park Road.
3.4 Road network analysis (Traffic modelling)

In order to identify the road network and access requirements for the precinct, a traffic model has been developed to forecast future year traffic volumes (2026 and 2036) in the vicinity of the precinct. The model takes into account assignment of vehicle trips on the precinct road network and provides a framework for network and travel demand scenario testing.

The intent of the model is to estimate likely vehicular traffic on the 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 density are appropriate. Forecast traffic volumes are also used to identify access requirements to and from the surrounding local network.

The traffic model is based on Bureau of Transport Statistics (BTS) employment and population data (released in August 2012) and reflects the Draft South West Growth Centre Road Network Strategy (Roads and Maritime, June 2011) as well as the latest regional road network information, such as the assumed alignment of Rickard Road as identified by the recent Rickard Road Alignment Study undertaken by another consultant for Camden Council and the Department of Planning and Infrastructure. Note that routes identified in the Roads and Maritime Draft Strategy such as sub-arterial 4-lane corridors at Raby Road and St Andrews Road have been included as part of the Leppington traffic model. Should expectations of the future road network at ultimate development change, additional traffic modelling may be required.

Following completion of the Leppington traffic model and assessment included as part of this report, the Department of Planning and Infrastructure further refined employment and population data for the wider region (September 2013). As the revised dataset included a reduction in forecast population growth for the South West Growth Centre (in particular the Camden) it is likely that this will reflect a reduction in traffic demand in the local area. It was therefore determined in consultation with the Department of Planning & Infrastructure that the August 2012 dataset would be retained for the purposes of the Leppington assessment as this dataset reflects the likely worst case traffic scenario (i.e. higher traffic forecast) for the modelled years 2026 and 2036.

3.4.1 Development of the strategic traffic model

AECOM has developed a traffic forecast model for the Leppington Precinct using CUBE software. The CUBE model has been prepared to represent two long term land use scenarios, based on BTS employment and population forecasts.

The Leppington Traffic Model was developed by utilising and updating the wider Sydney Strategic Traffic Model (SSTM) previously used as a base for the AECOM Oran Park Precinct Model which has been approved for use by Roads and Maritime for the precinct planning of the Oran Park Precinct. The SSTM model includes all the major arterial roads surrounding the precinct and connections to roads external to the SWGC.

Morning peak hour and evening peak hour models have been developed for the years 2026 and 2036. The modelling assumptions are based upon the Roads and Maritime Guide to Traffic Generating Development (version 2.2, 2002) and the BTS Household Travel Survey.

Traffic forecast on the network is governed by the following:

- Land use
- Road Hierarchy (Capacity)
- Type of intersection control
- Posted Speed
- Access provisions.

Trips in the Leppington Model are based on the Sydney Strategic Traffic Model (SSTM). SSTM is a CUBE based model for Sydney’s greater metropolitan area built and owned by AECOM. Further details in relation to modelling assumptions, trip distribution and road classification are provided in the following sections.

3.4.2 Model scenarios and assumptions

Morning and evening peak hour models have been developed to test road network infrastructure within and adjacent to the precinct. The morning peak hour is assumed to be the average hour between 7.00am and 9.00am, while the evening peak hour is an average hour between 4.00pm to 6.00pm.
3.4.3 Regional land use assumptions

The land use in the SWGC and Western Sydney is expected to change dramatically in the next 30 years according to the latest Metropolitan Plan. This will have significant impacts on the future demand for travel in the SWGC (the Draft Metropolitan Plan for Sydney 2031 identified a need to plan for 545,000 new homes in Sydney between 2006 and 2031).

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

The August 2012 DP&I forecasts for the SWGC include growth of approximately 300,000 people in 110,000 new dwellings, spread over approximately 17,000 hectares of land in 18 precincts. Over 50% of the future residential dwelling supply estimated in the South West Subregion will be provided in the SWGC. Other growth areas are scattered throughout Camden, Campbelltown, Liverpool and Wollondilly LGAs. Note that DP&I further refined employment and population data for the wider region (September 2013), however this has not been included in this report. The August 2012 dataset represents more intensive future land use enabling a ‘worst case’ traffic scenario to be modelled.

The intention for the South West Subregion is to at least maintain, or, increase, the level of self-containment to reduce the number of additional trips outside the subregion. Therefore, the delivery of proposed employment targets in major centres near the SWGC and within the subregion will assist in achieving this policy objective. Through both new development and the intensification of existing activities a rapidly growing population will be serviced, and a range of regionally important activities accommodated such as manufacturing, logistics, warehousing, technology industries and business parks.

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

3.4.4 Road network assumptions

Roads and Maritime has prepared a draft Road Network Strategy for the SWGC in order to enable greater certainty in planning, design and construction of the future regional road network in the SWGC and to cater for the future expected increase in population and employment growth in the region. The draft Road Network Strategy is shown in Figure 6.

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

The potential road upgrades in the SWGC and other major potential road upgrades in Sydney will be reflected in the strategic model based on information published by Roads and Maritime and other motoring bodies. The strategic model has been altered at each of the modelling years to accommodate assumed network upgrades and changes agreed with Roads and Maritime planning. This includes routes such as Raby Road and St Andrews Road. Should expectations of the future road network at ultimate development change, additional traffic modelling may be required.

3.4.5 Traffic Modelling for Rickard Road

A study has been undertaken by others to assess strategic route selection and identify a preferred alignment for Rickard Road. The study includes traffic modelling to support the design development of Rickard Road. AECOM liaised with the consultant undertaking this study in order to align input assumptions (such as road hierarchy and development year) where possible. Although output differences are expected, these are generally quantifiable based on known differences in approach.

The major difference between the two models are in regard to data input, where by AECOM utilised the most recent available population and employment projections (at the time of assessment) released by the BTS in August 2012. This data was also applied to the traffic model and assessment prepared for the Catherine Field (part) Precinct (also undertaken by AECOM). The Rickard Road study utilised BTS 2009 projection series release.
The Leppington traffic model and Rickard Road traffic model have an almost identical geographic scope, with both being calibrated for the SWGC and utilising CUBE software.

Figure 6: SWGC Road Network Strategy

Source: Roads and Maritime, 2011

Road network assumptions in the strategic model developed were in accordance with major road upgrades and the South West Growth Centre Road Network Strategy provided by Roads and Maritime. In proximity to the study area, major road upgrades included within the 2036 model were:

- Widening of Camden Valley Way to 3 lanes in each direction
- Widening of Rickard Road to 2 lanes in each direction from Leppington Major Centre to Oran Park Drive to accommodate safe and efficient strategic bus movements
- Extending Dickson road to connect with Peter Brock Drive in the south
- Extending Eastwood Road to The Northern Road with 2 lanes in each direction
- Widening Ingleburn Road to 2 lanes in each direction
- Extending St Andrews Road to Campbelltown Road in the east and The Northern Road in the west with 2 lanes in each direction.
- Extending Raby Road/North Road to a future North Avenue with 2 lanes in each direction along its length.
- A signalised intersection at Camden Valley Way / Ingleburn Road
- A signalised intersection at Camden Valley Way / Heath Road
- A signalised intersection at Camden Valley Way / St Andrews Road.
In proximity to the study area, major road upgrades included within the 2026 model were:
- Widening of Camden Valley Way to 2 lanes in each direction
- Widening of Rickard Road to 2 lanes in each direction from Leppington Major Centre to Oran Park Drive to accommodate safe and efficient strategic bus movements
- Widening Ingleburn Road to 2 lanes in each direction
- A signalised intersection at Camden Valley Way / Ingleburn Road
- A signalised intersection at Camden Valley Way / Heath Road
- A signalised intersection at Camden Valley Way / St Andrews Road.

3.4.6 Local land use assumptions & trip generation

Population mix and density are important considerations in the transport assessment as they can affect the peak hour trip generation of the precinct and hence the infrastructure requirements. Trip productions within the model have been calculated on the basis of BTS employment and population estimates and the number of residential households in the precincts. The estimated dwelling density is as follows:
- Low density dwelling (including large lots) at 3.2 persons/dwelling
- Medium density dwelling at 2.5 persons/dwelling.

The proposed distribution of dwellings in the precinct is 88% for low density and 12% for medium density. This provides for a forecast population of approximately 23,100 within the precinct.

Critical to the assessment of the impact of the precinct on the surrounding road network is the number of trips generated by the development and the distribution of those trips onto the local and wider strategic road network.

The following trip generation factors prescribed in the Guide to Traffic Generating Developments (Roads and Maritime, 2002) have been applied to estimate the traffic generated by the residential dwellings in the precinct:
- Low density dwelling (including large lots) at 0.85 car trips per dwelling
- Medium density dwelling at 0.6 car trips per dwelling

3.4.7 Trip distribution patterns

Estimates of trip distribution for full development (nominally at 2036) were based on outputs from the strategic model. The model considers trip generation and distribution of surrounding precincts to ensure their impact on the precinct can be assessed accurately. Trips generated by dwellings have been distributed using BTS population projections (August 2012).

Trip distribution analysis has taken into account available links and connections, posted speed, and road hierarchy. In addition, a number of assumptions have been made relating to the trip distribution pattern including:
- Adjustment of future year trip ends to incorporate the new Leppington Rail Station which will have significant park and ride facilities. By 2036, it is estimated that 4,190 people will use the new Leppington Rail Station as part of their commute, half of which will use Park and Ride/Kiss and Ride facilities. It has been assumed that a large proportion of those that utilise these facilities will do so outside the peak periods to take advantage of early train services to commute to major employment centres such as the CBD and Parramatta.
- Adjustment of the trip distribution to reflect the creation of new town centres at Leppington and Oran Park. Allowance of a retail peak during the PM peak hour assignment based on the current understanding of retail mix. Overall this results in a small increase in traffic flows, most of which is assigned to/from town centres.
- Adjustment of the trip distribution to reflect leisure trips in the AM and PM peak periods. This allows for additional multi-purpose trips such as after school sports or visits to the gym.
- Residential trips patterns (it is assumed that 90% of trips are outbound and 10% inbound during AM Peak).
- Employment trip patterns (it is assumed that 90% of trips are inbound and 10% outbound during PM Peak).
- Proximity to Leppington station and impact on trip rates. It is expected that public transport and active travel will play an increasingly important role in the vicinity of Leppington Station, influencing the number of vehicle trips generated.

3.4.8 Road classification (Hierarchy)

The road classifications for the precinct are determined based on the forecast peak hour traffic flows and proposed function in line with the Growth Centres DCP and also the South West Growth Centre Road Network Strategy. The proposed road hierarchy is illustrated in Figure 7 overleaf.

The outputs of the modelled forecast traffic flows for the preferred ILP road network are provided in Appendix A for both the 2026 and 2036 morning and evening peak hours. The future forecast volumes and the implications of these volumes for the upgrade of the road network are in line with the SWGC network classification system.

DP&I, Roads and Maritime and Austroads have identified various categories of road, ranging from Principal Arterial Roads, such as Camden Valley Way, Sub-Arterial Roads such as Eastwood Road, Transit Boulevards, such as Rickard Road (a road corridor with a transit function), as well as Collector Roads such as Heath Road (within the precinct) and Local Streets.

The road classifications for the precinct are determined based on the forecast peak hour traffic flows and the proposed function and required capacity of the road, determined by the road network classification system for the south west growth sector, as described above.

Under the proposed road hierarchy, the model results show that the majority of the proposed roads within the precinct are likely to operate with acceptable mid-block levels of service in 2036 (better than or equal to LoS D), see Figure 7. Table 7 shows that Camden Valley Way has a considerable volume of traffic in 2036. This volume is likely to be approaching capacity of the road corridor and put strain on its intersections. Rickard Road and Eastwood Road are also approaching capacity, largely due to traffic redistributed from Camden Valley Way (as per the strategic traffic model). It should be noted that forecast traffic volumes are likely to be high in the range of possible future traffic growth outcomes due to the more intensive population and employment forecasts utilised by this study (August 2012 BTS release).

Note that sensitivity testing has shown that additional lanes are likely to attract further vehicles from elsewhere on the strategic road network which is constrained over a wider regional area in 2036. It is therefore not recommended to increase lane capacity beyond that shown below. Public transport and active travel uptake is therefore critical to reducing the pressure on these roads and ensuring the functionality of the road network in 2036.

Table 7: Estimated AM Peak Hour Mid-Block Traffic Flows (per direction) and Level of Service as outlined by Austroads (2009)

<table>
<thead>
<tr>
<th>Road</th>
<th>Location</th>
<th>2036</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AM Flow</td>
</tr>
<tr>
<td>Camden Valley Way</td>
<td>Between Heath Road and St Andrews Road</td>
<td>3,900</td>
</tr>
<tr>
<td>Byron Road</td>
<td>Between Ingleburn Road and Heath Road</td>
<td>550</td>
</tr>
<tr>
<td>Rickard Road</td>
<td>Between Heath Road and St Andrews Road</td>
<td>2,250</td>
</tr>
<tr>
<td>Dickson Road</td>
<td>Between Ingleburn Road and Heath Road</td>
<td>350</td>
</tr>
<tr>
<td>Eastwood Road</td>
<td>Between Ingleburn Road and Heath Road</td>
<td>2,100</td>
</tr>
<tr>
<td>Hulls Road</td>
<td>Between Georges Road and Dwyer Road</td>
<td>250</td>
</tr>
<tr>
<td>Ingleburn Road</td>
<td>Between Byron Road and Camden Valley Way</td>
<td>2,200</td>
</tr>
<tr>
<td>Heath Road</td>
<td>Between Rickard Road and Byron Road</td>
<td>350</td>
</tr>
<tr>
<td>Joseph Road</td>
<td>Between Eastwood Road and Dickson Road</td>
<td>100</td>
</tr>
<tr>
<td>St Andrews Road</td>
<td>Between Rickard Road and Camden Valley Way</td>
<td>1,400</td>
</tr>
<tr>
<td>Georges Road</td>
<td>Between Rickard Road and Hulls Road</td>
<td>250</td>
</tr>
</tbody>
</table>

Source: AECOM 2013, assessed using Austroads Guide to Road Design 2009
Based on forecast traffic demand and precinct planning principles it was agreed that four-lane road corridors would be reserved for Eastwood Road, Ingleburn Road and St Andrews Road. Rickard Road would also have four traffic lanes (plus bus lanes in each direction) and would operate as a transit boulevard given its focus as a public transport corridor. Dickson Road and Byron Road were proposed as 2-lane roads with a sub-arterial functions. Safe and efficient strategic bus movements will be accommodated on the strategic road network (transit boulevards, sub-arterial roads arterial roads and collector roads) however with a focus on Rickard Road as a transit boulevard. Camden Valley Way will require three lanes in each direction at full development of the SWGC.
3.5 Intersection analysis

Intersection analysis has been undertaken for the major intersections into the precinct from the regional road network and key intersections within the precinct with the aid of SIDRA Intersection software. Analysis has been undertaken for future years 2026 and 2036 for AM and PM peak hours.

At key intersections within the precinct traffic signals are 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.

Bus priority facilities (bus lanes or bus jumps) 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. The location of appropriate bus priority treatment will be determined during the detailed design of Rickard Road.

Note that Camden Valley Way intersection layouts have been based on the Camden Valley Access Strategy and not enhanced further to show compliance with level of service guidelines.

A summary of intersection layouts at ultimate development (2036) is shown in Figure 8.

Figure 8: Leppington Precinct Intersection Layouts 2036
3.5.1 Future year 2026

A summary of intersection performance for the 2026 preferred road network is shown in Table 8, while a summary of proposed intersection layouts is provided in Figure 9.

Table 8: 2026 Intersection Performance

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Type</th>
<th>Peak</th>
<th>Vehicles Per Hour</th>
<th>LoS</th>
<th>Average Delay (s)</th>
<th>95th Queue (m)</th>
<th>Degree of Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastwood Road / Ingleburn Road</td>
<td>Priority</td>
<td>AM</td>
<td>533</td>
<td>A</td>
<td>12.2</td>
<td>8 (S Leg)</td>
<td>0.195</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>485</td>
<td>A</td>
<td>10.3</td>
<td>5 (E Leg)</td>
<td>0.169</td>
</tr>
<tr>
<td>Dickson Road / Ingleburn Road</td>
<td>Priority</td>
<td>AM</td>
<td>501</td>
<td>A</td>
<td>13.6</td>
<td>25 (S Leg)</td>
<td>0.487</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>445</td>
<td>B</td>
<td>15.4</td>
<td>8 (N Leg)</td>
<td>0.271</td>
</tr>
<tr>
<td>Rickard Road / Ingleburn Road</td>
<td>Roundabout</td>
<td>AM</td>
<td>3,176</td>
<td>B</td>
<td>17.2</td>
<td>88 (S Leg)</td>
<td>0.836</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>3,365</td>
<td>B</td>
<td>15.3</td>
<td>70 (E Leg)</td>
<td>0.788</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td>AM</td>
<td>3,176</td>
<td>C</td>
<td>32.6</td>
<td>215 (S Leg)</td>
<td>0.768</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>3,365</td>
<td>D</td>
<td>42.8</td>
<td>259 (N Leg)</td>
<td>0.887</td>
</tr>
<tr>
<td>Byron Road / Ingleburn Road</td>
<td>Roundabout</td>
<td>AM</td>
<td>1,936</td>
<td>A</td>
<td>13.8</td>
<td>47 (W Leg)</td>
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<tr>
<td></td>
<td></td>
<td>PM</td>
<td>2,216</td>
<td>A</td>
<td>14.4</td>
<td>45 (E Leg)</td>
<td>0.577</td>
</tr>
<tr>
<td>Camden Valley Way / Ingleburn Road</td>
<td>Signal</td>
<td>AM</td>
<td>5,035</td>
<td>E</td>
<td>62.6</td>
<td>505 (S Leg)</td>
<td>0.967</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>5,345</td>
<td>F</td>
<td>94.1</td>
<td>592 (E Leg)</td>
<td>1.008</td>
</tr>
<tr>
<td>Camden Valley Way / Heath Road</td>
<td>Signal</td>
<td>AM</td>
<td>3,858</td>
<td>A</td>
<td>7.9</td>
<td>100 (S Leg)</td>
<td>0.810</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>3,880</td>
<td>A</td>
<td>5.5</td>
<td>107 (N Leg)</td>
<td>0.787</td>
</tr>
<tr>
<td>Byron Road / Heath Road</td>
<td>Roundabout</td>
<td>AM</td>
<td>625</td>
<td>A</td>
<td>10.0</td>
<td>15 (W Leg)</td>
<td>0.304</td>
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<tr>
<td></td>
<td></td>
<td>PM</td>
<td>446</td>
<td>A</td>
<td>11.5</td>
<td>9 (N Leg)</td>
<td>0.188</td>
</tr>
<tr>
<td>Rickard Road / Heath Road</td>
<td>Roundabout</td>
<td>AM</td>
<td>2,625</td>
<td>B</td>
<td>25.8</td>
<td>78 (S Leg)</td>
<td>0.764</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>2,608</td>
<td>B</td>
<td>22.5</td>
<td>61 (N Leg)</td>
<td>0.685</td>
</tr>
<tr>
<td></td>
<td>Signal</td>
<td>AM</td>
<td>2,625</td>
<td>B</td>
<td>14.9</td>
<td>247 (S Leg)</td>
<td>0.694</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>2,608</td>
<td>B</td>
<td>17.0</td>
<td>251 (N Leg)</td>
<td>0.796</td>
</tr>
<tr>
<td>Dickson Road / Heath Road</td>
<td>Roundabout</td>
<td>AM</td>
<td>486</td>
<td>A</td>
<td>7.7</td>
<td>10 (S Leg)</td>
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<td>PM</td>
<td>458</td>
<td>A</td>
<td>7.7</td>
<td>10 (N Leg)</td>
<td>0.217</td>
</tr>
<tr>
<td>Eastwood Road / Heath Road</td>
<td>Priority</td>
<td>AM</td>
<td>344</td>
<td>A</td>
<td>10.9</td>
<td>6 (S Leg)</td>
<td>0.146</td>
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<td></td>
<td></td>
<td>PM</td>
<td>296</td>
<td>A</td>
<td>10.4</td>
<td>1 (S Leg)</td>
<td>0.125</td>
</tr>
<tr>
<td>Camden Valley Way / St Andrews Road</td>
<td>Signal</td>
<td>AM</td>
<td>3,999</td>
<td>A</td>
<td>4.8</td>
<td>139 (S Leg)</td>
<td>0.858</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PM</td>
<td>4,098</td>
<td>A</td>
<td>5.2</td>
<td>123 (N Leg)</td>
<td>0.847</td>
</tr>
</tbody>
</table>

Source: AECOM, 2013

Note: Highlighted intersection treatments identify the need for upgrade as a result of SWGC and precinct development (currently not committed for upgrade) by agencies.
Figure 9: Proposed Intersection Layouts – 2026

<table>
<thead>
<tr>
<th>Eastwood Road / Ingleburn Road</th>
<th>Dickson Road / Ingleburn Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastwood Rd N Leg</td>
<td>Dickson Rd N Leg</td>
</tr>
<tr>
<td>Ingleburn Rd E Leg</td>
<td>Ingleburn Rd E Leg</td>
</tr>
<tr>
<td>Eastwood Rd S Leg</td>
<td>Dickson Rd S Leg</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rickard Road / Ingleburn Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundabout*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Byron Road / Ingleburn Road</th>
<th>Camden Valley Way / Ingleburn Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byron Rd S Leg</td>
<td>Camden Valley Way S Leg</td>
</tr>
<tr>
<td>Byron Rd E Leg</td>
<td>Camden Valley Way E Leg</td>
</tr>
</tbody>
</table>
Camden Valley Way / Heath Road

Byron Road / Heath Road

Rickard Road / Heath Road

Roundabout*

Signal (recommended)

Dickson Road / Heath Road

Eastwood Road / Heath Road
* Roundabout island diameters have been based on Austroads standards however are subject to detailed design.

Source: AECOM, 2013
3.5.2 Future year 2036

A summary of intersection performance for the 2036 preferred road network is shown in Table 9, while a summary of proposed intersection layouts is provided in Figure 10.

**Table 9: 2036 Intersection Performance**

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Type</th>
<th>Peak</th>
<th>Vehicles Per Hour</th>
<th>LoS</th>
<th>Average Delay (s)</th>
<th>95th Queue (m)</th>
<th>Degree of Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastwood Road / Ingleburn Road</td>
<td>Roundabout AM</td>
<td>2,689</td>
<td>A</td>
<td>14.4</td>
<td>80 (S Leg)</td>
<td>0.776</td>
<td></td>
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<td>PM</td>
<td>2,723</td>
<td>A</td>
<td>10.0</td>
<td>37 (N Leg)</td>
<td>0.550</td>
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<tr>
<td>Dickson Road / Ingleburn Road</td>
<td>Roundabout AM</td>
<td>1,943</td>
<td>A</td>
<td>12.6</td>
<td>43 (W Leg)</td>
<td>0.598</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>1,603</td>
<td>A</td>
<td>8.5</td>
<td>21 (E Leg)</td>
<td>0.374</td>
<td></td>
</tr>
<tr>
<td>Rickard Road / Ingleburn Road</td>
<td>Signal AM</td>
<td>4,084</td>
<td>D</td>
<td>50.7</td>
<td>355 (W Leg)</td>
<td>0.916</td>
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</tr>
<tr>
<td></td>
<td>PM</td>
<td>4,556</td>
<td>D</td>
<td>46.8</td>
<td>254 (N Leg)</td>
<td>0.924</td>
<td></td>
</tr>
<tr>
<td>Byron Road / Ingleburn Road</td>
<td>Roundabout AM</td>
<td>3,163</td>
<td>F</td>
<td>209.6</td>
<td>1,052 (W Leg)</td>
<td>1.103</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>3,346</td>
<td>E</td>
<td>67.8</td>
<td>563 (E Leg)</td>
<td>1.018</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roundabout AM</td>
<td>3,163</td>
<td>B</td>
<td>25.8</td>
<td>82 (W Leg)</td>
<td>0.813</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>3,346</td>
<td>B</td>
<td>17.0</td>
<td>86 (E Leg)</td>
<td>0.798</td>
<td></td>
</tr>
<tr>
<td>Camden Valley Way (6 lanes) / Ingleburn Road</td>
<td>Signal AM</td>
<td>7,862</td>
<td>F</td>
<td>229.4</td>
<td>1,453 (S Leg)</td>
<td>1.167</td>
<td></td>
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<td></td>
<td>PM</td>
<td>8,109</td>
<td>F</td>
<td>405.7</td>
<td>2,069 (N Leg)</td>
<td>1.325</td>
<td></td>
</tr>
<tr>
<td>Camden Valley Way (6 lanes) / Heath Road</td>
<td>Signal AM</td>
<td>5,889</td>
<td>F</td>
<td>229.6</td>
<td>1,852 (S Leg)</td>
<td>1.166</td>
<td></td>
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<tr>
<td></td>
<td>PM</td>
<td>6,148</td>
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<td>208.8</td>
<td>1,782 (N Leg)</td>
<td>1.152</td>
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</tr>
<tr>
<td>Byron Road / Heath Road</td>
<td>Roundabout AM</td>
<td>804</td>
<td>A</td>
<td>10.5</td>
<td>19 (W Leg)</td>
<td>0.368</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PM</td>
<td>812</td>
<td>A</td>
<td>12.4</td>
<td>19 (E Leg)</td>
<td>0.365</td>
<td></td>
</tr>
<tr>
<td>Rickard Road / Heath Road</td>
<td>Signal AM</td>
<td>3,007</td>
<td>B</td>
<td>17.7</td>
<td>245 (S Leg)</td>
<td>0.846</td>
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</tr>
<tr>
<td></td>
<td>PM</td>
<td>3,866</td>
<td>B</td>
<td>17.9</td>
<td>253 (N Leg)</td>
<td>0.737</td>
<td></td>
</tr>
<tr>
<td>Dickson Road / Heath Road</td>
<td>Roundabout AM</td>
<td>692</td>
<td>A</td>
<td>6.9</td>
<td>12 (W Leg)</td>
<td>0.246</td>
<td></td>
</tr>
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<td></td>
<td>PM</td>
<td>673</td>
<td>A</td>
<td>7.2</td>
<td>10 (N Leg)</td>
<td>0.223</td>
<td></td>
</tr>
<tr>
<td>Eastwood Road / Heath Road</td>
<td>Roundabout AM</td>
<td>2,434</td>
<td>B</td>
<td>16.3</td>
<td>61 (S Leg)</td>
<td>0.708</td>
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<tr>
<td></td>
<td>PM</td>
<td>2,449</td>
<td>B</td>
<td>15.2</td>
<td>62 (N Leg)</td>
<td>0.691</td>
<td></td>
</tr>
<tr>
<td>Camden Valley Way (6 lanes) / St Andrews Road</td>
<td>Signal AM</td>
<td>7,910</td>
<td>B</td>
<td>226.4</td>
<td>1,613 (S Leg)</td>
<td>1.214</td>
<td></td>
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<td>PM</td>
<td>8,395</td>
<td>F</td>
<td>252.2</td>
<td>1,540 (N Leg)</td>
<td>1.506</td>
<td></td>
</tr>
</tbody>
</table>

Source: AECOM, 2013

Note: Highlighted intersection treatments identify the need for upgrade (further to those identified in 2026) as a result of SWGC and precinct development (currently not committed for upgrade) by agencies.
### Figure 10: Proposed Intersection Layouts – 2036

<table>
<thead>
<tr>
<th>Eastwood Road / Ingleburn Road*</th>
<th>Dickson Road / Ingleburn Road*</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Eastwood Road / Ingleburn Road*" /></td>
<td><img src="image2" alt="Dickson Road / Ingleburn Road*" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rickard Road / Ingleburn Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundabout*</td>
</tr>
<tr>
<td><img src="image3" alt="Rickard Road / Ingleburn Road" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Byron Road / Ingleburn Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundabout*</td>
</tr>
<tr>
<td><img src="image5" alt="Byron Road / Ingleburn Road" /></td>
</tr>
</tbody>
</table>
Dickson Road / Heath Road

Stop Priority

Roundabout* (recommended)

Eastwood Road / Heath Road

Camden Valley Way / St Andrews Road

* Roundabout island diameters have been based on Austroads standards however are subject to detailed design.
3.6 Findings and recommendations

The strategic traffic network analysis has assisted in determining the size of the road network and classification of key corridors to establish the recommended road network hierarchy for each assessment year (2026 and 2036). The road network hierarchy channels vehicular access to arterial roads via higher order corridors.

3.6.1 Road network 2026

Camden Valley Way operates at an acceptable level of service with two traffic lanes in each direction in 2026. Ingleburn Road and Rickard Road also require two traffic lanes in each direction in order to accommodate 2026 traffic volumes. Eastwood Road operates effectively with one traffic lane in each direction as it will not yet be connected to The Northern Road. All other roads within the precinct operate at an acceptable level of service with one traffic lane in each direction.

3.6.2 Intersections 2026

The SIDRA analysis indicates that all intersections within the precinct will operate at an acceptable level of service (better or equal to LoS D) during the 2026 morning and evening peak hour with proposed intersection layouts shown in Figure 9. Those intersections that require full upgrades further to the planned treatment are:

- **Rickard Road / Ingleburn Road** does not warrant signalisation as per ‘Roads and Maritime Traffic Signal Design Section-2: Warrants’, with the intersection performing at an acceptable LoS B as a roundabout. However due to the proximity to the Leppington Major Centre it is recommended that this intersection should be signalised in order to maximise safety for all road users. This is particularly important given the function of Rickard Road as a transit boulevard as pedestrian, cycle and bus functionality can be enhanced. The signalised intersection will perform at an acceptable LoS D in both AM and PM peak periods.

- **Byron Road / Ingleburn Road** requires upgrade to a roundabout in 2026, with the intersection catering for traffic between Camden Valley Way and Leppington Major Centre.

- **Byron Road / Heath Road** requires upgrade to a roundabout in 2026, with the intersection catering for traffic a proportion of Leppington Major Centre traffic.

- **Rickard Road / Heath Road** does not warrant signalisation as per ‘Roads and Maritime Traffic Signal Design Section-2: Warrants’, with the intersection performing at an acceptable LoS B as a roundabout. However due to the proximity to the Leppington Major Centre and schools respectively it is recommended that the intersection should be signalised in order to maximise safety for all road users. This is particularly important given the function of Rickard Road as a transit boulevard as pedestrian cycle and bus functionality can be enhanced. The signalised intersection will perform at an acceptable LoS D in both AM and PM peak periods.

- **Dickson Road / Heath Road** requires upgrade to a roundabout in 2026 in order to operate safely and effectively as a four arm intersection for all road users.

3.6.3 Road network 2036

Capacity should be provided for Camden Valley Way to become three lanes wide in each direction to accommodate 2036 levels of regional traffic.

Forecast traffic flows along Rickard Road, Eastwood Road, Ingleburn Road and St Andrews Road indicate that two lanes will be required in each direction in order to accommodate forecast 2036 traffic flows. In the case of the Rickard Road transit boulevard, dedicated bus lanes will also be provided in each direction in addition to traffic lanes. All collector roads (and Dickson Road) and local roads within the precinct require only one traffic lane in each direction, with localised widening at intersections and parking lanes if required.

3.6.4 Intersections 2036

The analysis indicates that all intersections within the precinct will operate at an acceptable level of service (better or equal to LoS D) during the 2036 morning peak hour and evening peak hour based on the intersection treatments shown in Figure 10. Note that many of the intersection layouts in 2036 include additional lane requirements to those shown in 2026, however full upgrades in 2036 are required at only three intersections:

- **Eastwood Road / Ingleburn Road** requires upgrade to a roundabout in order to accommodate forecast traffic growth.
- **Dickson Road / Ingleburn Road** requires upgrade to a roundabout in order to accommodate forecast traffic growth.

- **Eastwood Road / Heath Road** requires upgrade to a roundabout in order to accommodate forecast traffic growth.

In addition, the intersection of Byron Road / Ingleburn Road may need to be considered as a left-in/left-out priority layout (as an alternative) as the footprint of the roundabout may be considered too large for the road reserve.

Note that the two signalised intersections recommended along Rickard Road (2036 layout) were also assessed as part of a study into the Rickard Road alignment undertaken by another consultant. Although both reports recommend signalised intersections of a similar order, there are different recommendations for some turn bays:

- The recommended layout for the intersection of Rickard Road/Heath Road in the Rickard Road study includes left turn slip lanes for Rickard Road approaches. Such slip lanes have not been deemed necessary as part of this assessment.

- The recommended layout shown for the intersection of Rickard Road/Ingleburn Road as part of this report includes additional left slip lanes on Ingleburn Road approaches as well as an additional right slip lane on the Rickard Road southern approach in comparison to the recommendations made in the Rickard Road study.

These differences are relatively minor and reflect the differences between the two models traffic data inputs and trip distribution methodology (as discussed in Section 3.4.4). The final layout will be determined at the detailed design stage.

Excessive queue lengths are identified at the intersections of Camden Valley Way/Ingleburn Road, Camden Valley Way/St. Andrews Road and Camden Valley Way/Heath Road in morning peak hour (northbound) and in the evening peak hour (southbound). These intersections are subject to high traffic volumes forecast for the wider sub-arterial road network, particularly Camden Valley Way. Given the large size of these intersections, it is not considered appropriate to recommend additional treatments or upgrades to accommodate 2036 traffic forecasts - particularly as Camden Valley Way is strongly influenced by modifications to the wider regional road network.

The findings shown in this report are broadly consistent with the findings of the Catherine Field (part) precinct and East Leppington precinct studies. The East Leppington "high growth scenario" identified similar background traffic volumes on Camden Valley Way and similarly low levels of service.

Public transport and active travel uptake is critical to reducing the pressure on Camden Valley Way (and other north/south road corridors) and ensuring the functionality of the road network in 2036. Further study of the Camden Valley Way corridor is likely to be required prior to 2036 in order to determine the potential need for additional upgrade which is subject to the amount of traffic growth along the corridor.

### 3.6.5 Heavy goods vehicles

The proposed residential land uses within the precinct are not expected to generate a significant amount of heavy goods vehicles. However as the arterial road network within the precinct also caters for significant volumes of through traffic and is close to the Leppington Major Centre a heavy vehicle weight limit may be required to redirect heavy vehicles from residential areas and onto Camden Valley Way. Eastwood Road may also be considered appropriate for catering to heavy vehicles as the road will be two lanes in each direction and provide access to a variety of land uses. Delivery vehicles to retail premises in Leppington Major Centre are expected to use Camden Valley Way, Eastwood Road and Ingleburn Road.
4.0 Public Transport Framework

4.1 Urban design principles

Efficient public transport networks are influenced by four primary factors (TCRP Report 116, TRB, 2006):

- **Density** – the number of people within a given area. Density directly affects patronage potential. The more people in a service catchment, the more opportunity there is 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 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 the following public transport options for the Leppington Precinct.

4.2 Existing conditions

There is limited public transport serving the precinct at present, with no direct rail service and 2 bus services connecting to Liverpool (see Figure 11 below). This reflects the limited demand for services generated by the current land uses.

- Route 856 operates from Bringelly to Liverpool via Ingleburn Road, with five services in each direction per day.

- Route 857 operates from Narellan to Liverpool via Camden Valley Way with five scheduled services to Liverpool and eight toward Narellan.

These bus services are timed to arrive at Liverpool station in order to connect with onward rail services to the City.

The government has acknowledged the need for improved public transport services to cater for growth in the SWGC including the completion of the South West Rail Link and a future bus network strategy. This will be further discussed in Section 4.4.
Figure 11: Existing Local Bus Services

Leppington Precinct

4.3 NSW Bus Service Planning Guidelines

Sydney’s Bus Future, release in December 2013, outlines a new three-tiered structure for Sydney’s future bus services. Future bus services will be defined as either Rapid, Suburban, or Local service routes. Rapid service routes will form the backbone of the new bus network, offering fast, reliable bus travel for customers between major centres. Rapid routes provide customers with mass transit level services between centres which are not linked by trains or light rail. Suburban service routes and Local service routes will build on this foundation to improve access to local, neighbourhood destinations. Across metropolitan Sydney, 13 Rapid bus routes will operate and 20 Suburban routes have also been confirmed, with more to be added.

In NSW, bus network planning is directed by the NSW Service Planning Guidelines (Transport for NSW, 2005-2012). These contract areas may be revised in the future, however at this stage the existing framework identifies 15 contract regions within the Sydney metropolitan area, with bus services undertaken on a contract basis by operators on behalf of TfNSW. The precinct is currently located in contract region two as shown in Figure 12.

Figure 12: Metropolitan Sydney Contract Regions, 2012

Source: Transport for NSW, 2013
The NSW Government, in consultation with the bus operator, has developed an Integrated Network Plan for the contract region “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
- Meet the network planning principles.

Going forward, the existing 15 regional contracts may be consolidated into eight. The precinct will then become part of the newly formed contract region three (as shown in Figure 13).

Figure 13: Future Metropolitan Sydney Contract Regions

Table 10 sets out a summary of the service planning from the NSW bus planning guidelines, restated in the South West Sector Bus Servicing Strategy. This sets the criteria and benchmarks which were adopted in the development and planning of the bus route network to cover the entire south west sector, including those routes which serve the precinct.
Table 10: Service Planning Guidelines Summary

<table>
<thead>
<tr>
<th>Bus Planning Characteristics</th>
<th>Benchmark/Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network (Area) Coverage</td>
<td>- 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.</td>
</tr>
<tr>
<td></td>
<td>- 90% of households to be within 800m of a rail line and/or a Regional or District bus route at other times.</td>
</tr>
<tr>
<td>Network Legibility</td>
<td>- Peak and off-peak services should use the same route wherever possible.</td>
</tr>
<tr>
<td>Route Design</td>
<td>- Regional Routes to be between 10 and 25 kilometres in length.</td>
</tr>
<tr>
<td></td>
<td>- Routes to be between 30 and 60 minutes in duration.</td>
</tr>
<tr>
<td></td>
<td>- Maximum diversion from the fastest or shortest route (between termini) to be no more than 20%.</td>
</tr>
<tr>
<td>Accessible Buses</td>
<td>- Low floor, wheelchair accessible buses to be allocated to Strategic Transport Corridor routes.</td>
</tr>
<tr>
<td></td>
<td>- Accessible buses to be evenly timetabled on the corridors and advertised as “accessible” trips in the public timetable.</td>
</tr>
<tr>
<td>Dedicated School Services</td>
<td>- Dedicated school services should be kept to a minimum in order to maximise the frequency and availability of normal route services.</td>
</tr>
<tr>
<td></td>
<td>- Average 5 boardings per revenue kilometre.</td>
</tr>
<tr>
<td></td>
<td>- 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.</td>
</tr>
<tr>
<td>Section Points</td>
<td>- The range of section point lengths to be between 1.3 km and 1.9 km.</td>
</tr>
<tr>
<td></td>
<td>- The average length of section points within each route to be 1.6 km.</td>
</tr>
<tr>
<td>Patronage</td>
<td>- Average 1.5 to 2.5 boardings per revenue kilometre (based on an average operating speed of 24 kph).</td>
</tr>
<tr>
<td></td>
<td>- 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.</td>
</tr>
<tr>
<td></td>
<td>- Passengers not to stand for more than 30” of a timetabled service.</td>
</tr>
</tbody>
</table>

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

4.4 Future public transport service provision

4.4.1 Overview

The planning of future public transport services will need to provide connections within the precinct and to surrounding precincts including Oran Park, Catherine Field, East Leppington, Austral and Leppington North. In particular, the planning of public transport for the precinct needs to integrate regular bus services with the new rail station at Leppington as well as the existing rail station at Campbelltown, as this will help to provide access to local opportunities for employment, retail, and recreational trips. The staged rollout of bus services also needs to be considered so that service provision is in line with the staged development of the precincts and that early provision of bus services is facilitated to maximise potential uptake of public transport from the outset. Bus connection(s) to Leppington Station and/or Campbelltown Station in the early phase of development of this precinct will be critical in establishing a 'non-car culture' to assist in achieving State mode shift targets.
4.4.2 South West Rail Link

In 2009, the NSW Government announced the construction of a new 11 kilometre rail line – South West Rail Link (SWRL) from Glenfield to Leppington in South West Sydney. The project includes two new stations at Edmondson Park and Leppington. The delivery of the two new stations includes bus interchanges, pedestrian and cyclist facilities as well as kiss and ride zones and commuter car parking. Major construction of the Glenfield to Leppington rail line component of the South West Rail Link commenced at the beginning of 2012 and revenue services are set to commence in 2015. A map of the SWRL project is shown in Figure 14.

Figure 14: Proposed South West Rail Link

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

TfNSW proposes an initial four services per hour throughout the day with up to 12 trains per hour in peak periods (subject to change as a result of detailed design and/or the ability to meet future standards). Furthermore, the frequency of service is likely to be increased over time as demand increases and service provision is influenced by patronage demand as well operating requirements of the network. Options for a potential future extension of the project beyond Rossmore have been investigated by the NSW Government, but there is no commitment to an extension at this stage.

As part of the construction of SWRL and Leppington Station, a total of 850 commuter car parking spaces and bus stops will be provided on both sides of the station on the day of opening of services. The main vehicular access to the station interchange will be provided via Rickard Road.

The SWRL would significantly enhance opportunities for public transport travel to and from the precinct, as such the planning of the precinct should maximise the opportunity presented by this new infrastructure to minimise the need for car travel.

Measures to improve accessibility to Leppington Station include:

- Provision of frequent bus routes between the precinct and the station via Oran Park.
- Design of appropriate cycling routes and crossing facilities along Rickard Road as well as in the vicinity of the station.
- Provision of good interchange facilities at the station, catering for all modes of transport.

4.4.3 Improved accessibility to existing rail stations

Future residents of the precinct also have the opportunity for improved access to existing rail stations via Denham Court Road (Ingleburn Station), Gregory Hills Drive (Campbelltown Station) and possibly via a future St Andrews

10-Mar-2014
Prepared for – NSW Department of Planning & Infrastructure – ABN: 38755709681
Road (Minto Station) assuming this route is developed. Both Ingleburn and Minto Stations have regular rail services to major centres including Sydney CBD.

4.4.4 Future bus provision

Forward planning of a comprehensive network of future bus routes is a priority to provide equitable access to local and regional opportunities for employment, retail and recreational trips. It is important that future services provide sufficient connections within the precinct but also to/from surrounding precincts and to/from major destinations such as employment, retail centres, and health, education and leisure facilities.

To serve the major centre and SWRL station at Leppington, Rickard Road, as the primary north-south route to Leppington major centre has been designated as a Transit Boulevard to provide public transport priority opportunities to the town centre. In addition to Rickard Road, Dickson Road, Eastwood Road and Camden Valley Way will also provide bus connections between Leppington and locations to the south such as Oran Park and Campbelltown.

The South West Bus Servicing Strategy ultimate bus network was updated by TfNSW in November 2013. The revised strategy consists of seven regional bus routes to provide a network that would link the proposed major centres (Liverpool, Campbelltown, Rossmore, Narellan, Oran Park and Leppington) and support accessibility to each of the SWGC precincts. The revised TfNSW ‘ultimate’ bus network plan is not yet publicly available, however routes have been shown in Figure 15 following consultation with TfNSW. The proposed routes would provide a significant enhancement to existing bus services, in line with the proposed development of the precinct to serve future residential and employed populations. Note that the strategy does not include local bus routes, which can be specified at a later date and included on any collector road within the precinct.

The South West Bus Servicing Strategy proposed likely peak hour headways of 30 minutes for District Bus Routes and 15 minutes for Regional and Peak Bus Routes. This ensures that local residents will have access to frequent bus services from all locations across the precinct.

According to the South West Bus Network Strategy, the proposed network indicates five bus routes servicing the precinct:

- Liverpool to Narellan (via Ingleburn Road and Camden Valley Way)
- Liverpool to Campbelltown (via Rickard Road)
- Liverpool to Narellan (via Rickard Road)
- Leppington to Campbelltown (via Eastwood Road)
- Leppington to Oran Park (via Dickson Road)

Further bus coverage will be provided by local bus routes/services that can be operated along the collector road network. The combination of the Regional and District routes and the potential for local routes on the collector road network provides an efficient and flexible bus network to serve the future Leppington precinct.

The coverage achieved by the proposed routes covers all centres, schools, all medium density housing and at least 90% of low density residential, providing feasible public transport options for all land uses. No property will be more than 600m from a proposed bus service. Therefore, the proposed bus strategy will achieve efficient penetration of the precinct by public transport and ensure accessibility, without comprising service efficiency.
Figure 15: Potential Ultimate South West Sector Bus Servicing Strategy (Leppington)

Source: TfNSW, 2013
Table 11 below sets out the key criteria and benchmarks for network, service and route performance set out in the planning guidelines.

Table 11: Bus Network Evaluation

<table>
<thead>
<tr>
<th>Bus Planning Characteristics</th>
<th>Benchmark/Criteria</th>
<th>Met*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network (Area) Coverage</td>
<td>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.</td>
<td>Yes</td>
</tr>
<tr>
<td>Network Legibility</td>
<td>Peak and off-peak services use the same routes.</td>
<td>Yes</td>
</tr>
<tr>
<td>Route Design</td>
<td>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%.</td>
<td>Yes</td>
</tr>
<tr>
<td>Section Points</td>
<td>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.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Subject to development of the final ILP

It is important to establish public transport early in the development stage in order to foster more sustainable behaviour amongst residents. Any proposed short term bus network for the precinct will rely on the completion of proposed infrastructure upgrades for the connection into different major centres and transport hubs such as the Rickard Road extension.

Prior to the completion of the South West Rail Link:

- Existing routes (856 & 857) that connecting to Liverpool Station to potentially divert services to improve bus coverage (no reliance on additional road infrastructure).
- Potential bus service to Oran Park with the completion of the Camden Valley Way upgrade.

With the commission of the South West Rail Link at Leppington Station:

- Additional direct services to Leppington Station.
- Additional service to Oran Park bus hub.

The number and frequency of the short term services listed above will depend on the timing of roll out and location of residential dwellings in Leppington and neighbouring precincts.

### 4.5 Public transport framework analysis

#### 4.5.1 Rail network

The precinct will be accessible to the new South West Rail Link via Leppington Railway Station when it is expected to be operational in 2015. The precinct will be accessible to Leppington Station via bus, cycling and walking with the station located only 1km from the northern precinct boundary (Ingleburn Road). Furthermore, the precinct is also 6km from Ingleburn Rail Station which provides services on the Cumberland Line and Airport, Inner West and South Line to the wider Sydney area.

#### 4.5.2 Bus network

The precinct will be well served by buses, with five bus routes likely to service the precinct according to the revised South West Bus Servicing Strategy. Further bus coverage will be provided by local bus routes / services that can be operated along the collector road network. The combination of the five routes and the potential for
local routes on the collector road network provides an efficient and flexible bus network to serve the future Leppington Precinct.

These bus routes will provide access to both local and regional centres such as the Oran Park Town Centre, Leppington Major Centre, Liverpool, Narellan and Campbelltown. In addition, the bus network will provide links to the wider transportation network via Leppington Station. Leppington in particular will be served by all five bus routes, increasing the overall frequency of buses linking to the precinct to the South West Rail Link.

4.5.3 School buses

It is expected that local bus services will be established to provide connection between the schools and major transport nodes as well as the developed residential areas within the precincts. Separate dedicated school bus services could be introduced or extended as appropriate to serve the primary schools located within the precincts, where demand exceeds maximum passenger loadings. However, in general students would be encouraged to travel on scheduled public transport routes. All proposed schools are located on collector roads that are capable of accommodating bus routes.

4.5.4 Bus stops

Bus stop locations would be defined during detailed planning as land uses become more refined. However, at this stage any routes identified as bus corridors need to have space within the road reserve to accommodate bus stops or shelters. Bus stops in the proximity of traffic signals on arterial roads would be located on the departure side of signalised intersections.

Stops should be provided approximately every 400m to maintain vehicle speeds while providing sufficient access for passengers. This requires routes to have either two lanes in each direction (for example the future Eastwood Road) or one lane in each direction for collector roads with a parking lane that could accommodate a bus stop. Lane widths on bus routes are at a minimum of 3.5m.

Whilst indented bus stops are a possible solution where a cross-section has one lane in each direction, they do not allow flexibility in bus stop location as land uses and patronage demands change. Therefore, indented bays should be avoided. Adequate seating and shelter is also recommended at bus stops located on the major transit routes, such as Rickard Road, Eastwood Road and Ingleburn Road.
4.6 Findings and recommendations

The precinct will receive adequate public transport accessibility through transit corridors that allow access to local rail services at Leppington. In addition, bus routes should link key centres, transport hubs, schools, employment opportunities and residential areas.

The proposed bus strategy for this precinct is consistent with the SWGC Road Network Strategy and broadly follows the South West Growth Sector Bus Servicing Strategy. The proposed long term bus network for the precinct will comprise a mixture of regional routes and district routes to maximise speed and efficiency of high frequency peak hour services as well as a number of local bus routes to ensure maximum coverage throughout the precincts, facilitating public transport access and travel choice.

The combination of the Regional and District routes are to be confirmed, while the potential for local routes on the collector road network provides an efficient and flexible bus network to serve the future Leppington precinct. This bus strategy was recently updated by TfNSW following ongoing development in other SWGC precincts.

Key bus operating corridors with services providing fast, efficient regional connections will operate along the north-south corridors (Rickard Road, Camden Valley Way, Dickson Road and Eastwood Road), with links between notable regional destinations such as Leppington major centre, Oran Park Town Centre, Liverpool, and Campbelltown.

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. Rickard Road, Eastwood Road and Ingleburn Road are both identified as critical links in the bus network for bus priority measures, with Rickard Road proposed to be a 6-lane corridor within the Leppington precinct including one dedicated bus lanes in each direction. Further details on the proposed cross-sections are provided in Section 6.0.
5.0 Walking and Cycling Networks

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 (NSW 2021) aims to double the mode share of bicycle trips made in the Greater Sydney region at a local and district level by 2016. Walking is also a smart travel choice and a viable option for a significant number of smaller trips.

Mixed use development and proximity to local centres are a key factor in promoting more sustainable transport modes such as walking and cycling, 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 Leppington Precinct, and integrating these into adjacent areas (Austral, Leppington North, and East Leppington) and regional cycle routes.

5.2 Existing conditions
Within the precinct there is currently limited provision of dedicated walking and cycling infrastructure and a lack of consolidated network planning, which has been in keeping with its existing land uses but which will not be appropriate to future demands.

5.3 Opportunities and constraints
Terrain within the precinct varies, generally with undulating slopes located to the south and flatter terrain to the north. Some locations, such as in the vicinity of Ridge Square, are somewhat steep however the majority of the precinct is relatively flat ensuring good opportunities for walking and cycling within the study area.

Providing viable alternatives to the private car for journeys with destinations both within and outside the precinct is essential to encourage more ecologically sustainable development of the precinct. 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.

The future widening of Camden Valley Way could create a barrier to east-west pedestrian and cycle movements. Therefore this corridor needs to be planned in such way to minimise the impedance to east-west pedestrian and cycle connectivity i.e. by minimising corridor width and incorporating sufficient pedestrian and cycle priority wherever possible. The upgrade of Camden Valley Way will, however, provide associated upgrades to pedestrian and bicycle facilities in a north-south direction. This includes a cycle path along the western side of Camden Valley Way. Camden Valley Way should also provide better crossing opportunities at consolidated locations at each of the traffic signals.

An on-road cycle route is planned to operate in a north/south direction on Rickard Road. This will provide residents of the precinct with viable cycle access to adjacent town centres including Leppington and Oran Park.

The riparian corridors at Kemps Creek and Scalabrini Creek could provide an additional barrier to east/west movements within the precinct. Heath Road can provide pedestrian and cycle connections across the riparian corridors, however additional pedestrian and cycle links may be needed to improve pedestrian and cycle access across the creek at different locations.

There are good opportunities to provide for recreational walking and cycling by enhancing links to the various parks and sports fields located within the precinct. There is also potential to develop recreational pedestrian and cycle pathways within the riparian corridors.

5.4 Principles and guidelines
Five documents guide the provision of pedestrian and cyclist networks in this area. The Growth Centres Development Code (Growth Centres Commission, 2006) includes guidelines for all aspects of urban design from street layout to open space and water use. The other key documents guiding the design of cycle networks are the NSW Bicycle Guidelines (Roads Maritime, 2005) Camden Council Walking & Cycling Strategies (2006), Sydney's...
Cycling Future (TfNSW, 2013) and Sydney’s Walking Future (TfNSW, 2013). A review of these documents follows.

5.4.1 Sydney Cycling Future

Sydney’s Cycling Future (TfNSW, 2013) outlines the way cycling in Sydney is planned, prioritised and provided with an overarching goal of making cycling a safe, convenient and enjoyable transport option for short trips.

To make bicycle riding a feasible transport option three pillars have been identified which include:

- **Connect**: Safe, connected networks;
- **Promote**: Better use of existing infrastructure; and
- **Engage**: Policy and Partnership

As part of the strategy, the Connecting Centres Program aims to help councils complete local bicycle networks to major centres of metropolitan Sydney. Bicycle network plans will be developed with Councils within a five kilometre catchment of major centres, including Leppington.

The NSW Government will work in partnership with developers to deliver bicycle networks to new communities such as Leppington as part of linking cycling to urban growth.

5.4.2 Sydney Walking Future

Sydney’s Walking Future seeks to make walking a more convenient, better connected and safer mode of transport. The plan for the future supports the integration of walking into the transport system through three pillars of activity;

- **Promote** benefits and provide information;
- **Connect** through infrastructure and technology; and
- **Engage** through policy and partnership.

There is a focus on investing in connected walking routes within two kilometres of centres and public transport interchanges, aiming to increase opportunities for people to walk longer distances and help reduce congestion. Sydney’s Walking Future will support Sydney’s population growth by encouraging people to choose walking as their preferred mode of transport to nearby centres.

5.4.3 Growth Centres Development Code

Salient objectives of the Growth Centres Development Code that relate to pedestrian and cycle planning are to improve:

- Facilities at a local level (i.e. walking/cycling distance from residences).
- Access to public transport.
- Encourage reduction of the reliance of 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 will be carried forward for consideration during later planning stages (through DCP’s).

It is important to ensure that these ‘later’ elements are not precluded by design decisions at this stage including:

- 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 walking and cycling.
- Limit use of culs-de-sac (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.

5.4.4 NSW Bicycle Guidelines

The NSW Bicycle Guidelines (NSW Roads and Traffic Authority, 2005) assist in the design of bicycle facilities and the principles of network design are also relevant when designing pedestrian networks. 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.

Other principles to be considered that are not included in the guidelines are:

- **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/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 large developments). Storage facilities should provide for both long and short term storage of cycles and related equipment. Design should be such that storage is not only secure and provides weather protection, but also conveys a sense of high priority for the treatment of cycles and cyclists.

Commuter cyclists would 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 and travel time is less of a consideration than a pleasant ride.
5.4.5 Camden Council Integrated Transport Strategy

The core objective of the Camden Council Integrated Transport Strategy (2006) is to encourage greater use of walking and cycling as a means of transport and recreation. This is because of the low cost, low impact, wide suitability and health benefits associated with walking and cycling. Camden Council’s pedestrian and bicycle strategy is to integrate these modes with Land Use, Road Network, Parking and Public Transport Strategies to assist access to existing and potential bus and rail networks.

These strategic objectives will ideally be achieved through provision and management of walking and cycling facilities and opportunities in a way that:

- Understands the key walking and cycling needs in the region.
- Recognises the role walking and cycling plays in the reduction of car-based trips in the Campbelltown and Camden region, and how the provision of improved facilities and opportunities can help promote mode change in the future.
- Understands the need for the separation of pedestrians and cyclists from motor vehicle traffic.
- Identifies mechanisms for the community to have regular input into the provision of walking and cycling facilities.
- Recognises that all trips involve walking at either the beginning or end of the journey, resulting in the need for connections between parking and public transport areas and destinations.
- Incorporates walking and cycling issues into the Land Use, Road Network, Parking and Public Transport Strategies.
- Recognises that walking and cycling paths can form key routes between destinations.
- Understands that walking and cycling trips perform a variety of functions, not only travel from an origin to a destination, but such trips are also undertaken for recreation and/or health benefits, which can be influenced by the amenity of the route.

5.5 Proposed bicycle and pedestrian networks

5.5.1 Bicycle network

A comprehensive bicycle network is proposed for the precinct which will link the neighbourhood centre, schools, and 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)
- On-Road (Cycle Lane)
- Off-Road (Shared Path – Green Corridor).

Camden Valley Way, designated as a principal arterial road, will have shared path bicycle facilities in addition to a 2m wide shoulder on both carriageways that could potentially be used by on-road cyclists. An on-road cycle lane is proposed along Rickard Road providing a network of high order bicycle facilities for fast, efficient connections for both local travel within the precinct; travel to Oran Park Town Centre and Leppington Major Centre and to regional destinations such as Liverpool and Campbelltown.

All sub-arterial roads and collector roads connecting key origins and destinations within the precinct and onto other external destinations will have dedicated shared path bicycle facilities. The proposed cycling connections are designed to create a continuous network of facilities removing obstacles and barriers to cycling, both physical and perceived. Physical crossing points of the creeks have been included in the bicycle network plan to ensure route connectivity and network permeability.

There are also further opportunities to create additional recreational cycle routes along the riparian corridors. However these are likely to require access behind property boundaries and are in a zone liable to flooding. These can be considered in future if opportunities arise for further development and consolidation to create additional bicycle paths. The proposed future cycle network is shown in Figure 16.
Figure 16: Proposed Cycle Network

Source: AECOM
5.5.2 Pedestrian network

All proposed roads throughout the precinct will have dedicated pedestrian footpaths to create a comprehensive network following proposed road alignments.

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

There is also an opportunity to provide recreational paths on the riparian corridors along Kemps and Scalabrinian Creek to encourage leisure walking within the precinct.

5.5.3 Network analysis

The proposed networks for the precinct are assessed against the planning guidelines and the results are shown in Table 12.

Table 12: Assessment of the ILP against planning principles

<table>
<thead>
<tr>
<th>Development Code Principle</th>
<th>Leppington Precinct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recreational uses along drainage lines</td>
<td>Opportunity exists</td>
</tr>
<tr>
<td>“Recreational trails” will connect to public open space using on or off road routes</td>
<td>√</td>
</tr>
<tr>
<td>Pedestrian movement should not be inhibited by parking areas in town centres</td>
<td>√</td>
</tr>
<tr>
<td>Net lot density of &gt;15 lots per hectare</td>
<td>√</td>
</tr>
<tr>
<td>Smaller lots/higher densities close to centres/public transport</td>
<td>√</td>
</tr>
<tr>
<td>Lots will front open space and major streets to provide casual surveillance</td>
<td>√</td>
</tr>
<tr>
<td>Link cycle routes to those outside the site</td>
<td>√</td>
</tr>
<tr>
<td>Limit use of cul-de-sacs. Cul-de-sacs should be used only where other options are not available.</td>
<td>√</td>
</tr>
<tr>
<td>High level of pedestrian amenity, with active streets and links between parks</td>
<td>√</td>
</tr>
<tr>
<td>Streets and lanes will be shared spaces</td>
<td>√</td>
</tr>
<tr>
<td>Grid like street network pattern where possible to facilitate walking and cycling routes</td>
<td>√</td>
</tr>
<tr>
<td>Clearly delineated routes for pedestrians / bicycles / vehicles</td>
<td>√</td>
</tr>
<tr>
<td>Direct, continuous and well lit pedestrian/cycle routes</td>
<td>√</td>
</tr>
</tbody>
</table>

Other Design Principles

| Coherence                                      | √   |
| Directness                                    | √   |
| Safety                                        | √   |
| Attractiveness                                | √   |
| Comfort                                       | √   |
| Capacity                                      | √   |
| Integration                                   | √   |
| Storage                                       | √   |

Source: AECOM, 2013

Key points to consider during the next stages of planning include:

- Allow ‘space’ for cycle paths through intersections.
- Allow ‘space’ for pedestrian waiting areas at bus stops/ interchanges.
- Allow space for cycle route to follow behind bus stop.
- Retain pathways in linear green spaces.
5.6 Findings and recommendations

Providing viable alternatives to the private car for journeys within and outside the precinct is essential for the achievement of sustainable outcomes. In keeping with its existing land uses, there is currently limited provision of dedicated walking and cycling infrastructure within the precinct. The area does however provide good opportunities for future pedestrian and cycling routes to, from and within the study area considering its existing road and riparian corridors. 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.

Natural and built constraints within the precinct include:

- Kemps Creek which divides the site.
- Scalabrini Creek which also cuts through the site.
- Steep terrain to the southeast of the site.
- Camden Valley Way (located along the eastern border of the study area) restricts opportunities for cycle and pedestrian connectivity to the east.

Existing proposals, including shared paths and pedestrian overbridges, would significantly improve pedestrian and cycling connectivity to the surrounding network. The proposed cycle routes on Camden Valley Way and Rickard Road will improve the connectivity to the regional cycle network, providing links to Leppington major centre, Oran Park Town Centre and other centres such as Liverpool. It is important for proposed pedestrian and cycle facilities within the precinct to integrate with these planned facilities.

Within the precinct, cycle routes are proposed along all collector roads, providing connectivity within the precinct and to other main attractors including neighbourhood centres, proposed schools, parks and sports fields. The proposed street network is conducive to encouraging pedestrian and cycle trips.

There is also opportunity to provide recreational paths along the riparian corridors. Providing a recreational trail together with linkages to parks and sports fields would encourage cycling and provide facilities for recreational cyclists.

In order to ensure connectivity of the pedestrian network the provision of regular pedestrian crossing opportunities will be provided through the provision of dedicated pedestrian crossing facilities.

Green Travel Plans for schools could 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, active communities in the precinct.
6.0 Cross-sections

6.1 Introduction

Cross-sections for roads within the Leppington Precinct have been based on the Camden Growth Centres DCP with the exception of Rickard Road which has been based on a separate Rickard Road alignment study prepared for the Department of Planning & Infrastructure and Camden Council by another consultant. Knowledge gained from other precincts and advice from TfNSW has also been considered. In addition, as Austral & Leppington North is the neighbouring precinct (to the north of the study area), with important road links to Leppington Precinct such as Eastwood Road, Dickson Road, Rickard Road and Byron Road, cross-sections should be kept consistent across both precincts where possible. Note that some good design principles have also been adopted from the cross-sections developed for the Catherine Field (part) Precinct more recently.

The following sections set out (for each of the functional classification road types) the proposed cross-section width and composition of vehicle travel lanes (including bus lanes), parking, landscaping and verge, footpath and cycle facilities.

Given the nature of Leppington Precinct as a predominantly residential precinct, the entire road network within the precinct comprises of two-lane collector roads and local roads, with the exception of Eastwood Road and St Andrews Road which will be reserved as 4-lane corridors and Rickard Road, a 6-lane transit boulevard. The cross-section of these roads, collector roads and local roads will be highlighted in the following sections.

6.2 Rickard Road (Transit Boulevard)

A Transit Boulevard is intended to provide public transport facilities and pedestrian-friendly environments on arterial corridors. Rickard Road will be classified as a Transit Boulevard and will have two vehicle travel lanes in each direction, an additional bus lane in each direction, widening at intersections to provide for turn lanes, a median strips, off road cycle share-paths and verges.

The recommended cross-section of Rickard Road within the precinct is consistent with that identified in the Rickard Road study prepared for the Department of Planning & Infrastructure and Camden Council in 2013.

The proposed cross-section for Rickard Road is shown in Figure 17:

![Figure 17: Rickard Road extension cross-section](Source: ARUP, 2013)
The following should be noted when considering the cross section in Figure 17:

- **No on street parking provision.** On-street parking would reduce the functionality of Rickard Road as a Transit Boulevard and require the provision of a wider road reserve. Parking for local residents would instead be provided via rear laneways;

- **No direct property access.** This will reduce vehicle conflicts and improve the efficiency of both bus operations and the off-road cycleway. Property access will instead be provided via rear laneways;

### 6.3 Sub-Arterial Road

Sub-arterial roads within the precinct are proposed to function as both four lane and two lane corridors. Four lane Sub-arterial roads with two lanes in each direction include Eastwood Road, Ingleburn Road and St Andrews Road. The total travel lane width of these roads is wide enough to allow buses to pass other broken down or stopped buses, while the median is wide enough to accommodate bus turning bays.

Corridors limited to one lane in each direction but retaining sub-arterial functionality within the precinct are Dickson Road and Byron Road. The reduction in lane width of these two corridors is primarily designed to address urban planning principles and reduce the overall impact of the road network on the character of the Leppington Precinct. Shared paths are provided for pedestrians and cyclists on both sides of the road.

The cross-section for a four lane sub-arterial road is shown in Figure 18 while Table 13 highlights the reduced road reserve applicable to Dickson Road and Byron Road. These are closer to collector roads in width however on-street parking is removed and a median retained to accommodate bus movements and cater for higher volumes of traffic.

**Table 13: Collector Road Cross Section (indicative)**

<table>
<thead>
<tr>
<th>Street type</th>
<th>Shared Paths</th>
<th>Planting/Landscape</th>
<th>Travel Lanes</th>
<th>Median</th>
<th>Travel Lanes</th>
<th>Planting/Landscape</th>
<th>Shared Paths</th>
<th>Total Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four lane sub-arterial road</td>
<td>4.7m</td>
<td>7.75m</td>
<td>4.2m</td>
<td>7.75m</td>
<td>4.7m</td>
<td>29.1m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two lane sub arterial road</td>
<td>4.7m</td>
<td>3.5m</td>
<td>4.2m</td>
<td>3.5m</td>
<td>4.7m</td>
<td>20.6m</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: AECOM, 2013

**Figure 18: Typical 4-lane Sub-Arterial Road Cross-section**
6.4 Collector Road

Collector roads have a balance of traffic and urban functions, linking local streets to the strategic road network. These roads should be designed to accommodate public transport routes. Amenity and safety on collector roads should be maintained by restricting vehicle speeds through traffic-calming measures and intersection design. Internal roads that link local roads have been classified as collector roads within the precinct. Intermittent parking with landscaping is provided on both sides of the street. All the collector roads are designed to facilitate safe and efficient bus movements.

It is anticipated that the majority of Collector Roads within the precinct will retain a 20m road reserve consistent with the Camden Growth Centres DCP. There is likely to be some variation in the carriageway width within the road reserve in order to accommodate safe bus movements at bus stops as well as to meet any other location specific requirements. **Figure 19** represents the regular cross-section, while the cross-section at bus stops is subject to detailed design and likely to include:

- A wider carriageway to ensure buses can overtake other stopped buses;
- Removal of planting;
- Bus shelters incorporated into shared paths.

The cross-section for collector roads within the precinct is shown in **Table 14**.

**Table 14: Collector Road Cross-section**

<table>
<thead>
<tr>
<th>Street type</th>
<th>Planting</th>
<th>Shared path</th>
<th>Parking/Landscape</th>
<th>Travel Lanes</th>
<th>Travel Lanes</th>
<th>Parking/Landscape</th>
<th>Planting</th>
<th>Shared Path</th>
<th>Total Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Road (Camden GC DCP)</td>
<td></td>
<td>4.5m</td>
<td>5.5m</td>
<td>5.5m</td>
<td>4.5m</td>
<td></td>
<td></td>
<td></td>
<td>20.0m</td>
</tr>
<tr>
<td>Collector Road at Bus Stops</td>
<td>3.3m</td>
<td>6.7m</td>
<td>6.7m</td>
<td>3.3m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20.0m</td>
</tr>
</tbody>
</table>

Source: AECOM, 2013

Figure 19: Collector Road cross-section

Source: Camden Council South West Growth Centres DCP
6.5 Local Roads

Local roads provide an urban function and are intended to carry low volumes of traffic and be amenable for cycling without needing dedicated bicycle facilities, whilst providing a comprehensive network to aid and encourage walking. They also provide local residential access and one lane of on-street parking and therefore have a high level of amenity.

Table 15: Local Street Cross-section

<table>
<thead>
<tr>
<th>Street type</th>
<th>Footpath</th>
<th>Planting</th>
<th>Parking</th>
<th>Vehicle Lane</th>
<th>Vehicle Lane</th>
<th>Planting</th>
<th>Footpath</th>
<th>Total Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical local roads</td>
<td>3.5m</td>
<td>9.0m</td>
<td>3.5m</td>
<td>16.0m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Camden Council Growth Centres DCP

Figure 20: Local Street Typical Cross-section

Source: Camden Council Growth Centres DCP 2013
6.6 Access Street

Access Streets are intended to provide property access and are not designed as through routes. They are often used adjacent to higher order road corridors with no direct property access. Access Streets link with local roads only. Note that the width of an Access Street may be reduced to 6.5m subject to considerations of traffic volumes and road safety.

Table 16: Access Street Cross-section

<table>
<thead>
<tr>
<th>Street type</th>
<th>Footpath</th>
<th>Planting</th>
<th>Parking</th>
<th>Vehicle Lane</th>
<th>Planting</th>
<th>Footpath</th>
<th>Total Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical local roads</td>
<td>3.5m</td>
<td>8.0m</td>
<td>3.6m</td>
<td>13.1m</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Camden Council Growth Centres DCP

Figure 21: Local Street Typical Cross-section

Source: Camden Council Growth Centres DCP 2013
7.0 Conclusions

7.1 Road network

The strategic road network analysis has assisted in determining appropriate future road hierarchy and methods of control for intersections across the proposed road network for the Leppington Precinct. The designated road network hierarchy focuses vehicular access on the most appropriate routes onto arterial roads via higher order corridors. Vehicles are distributed through the precinct via the network of collector roads then via local streets to individual land parcels.

The key strategic route serving the precinct is Camden Valley Way, a principal arterial road providing services in a north-south direction. Rickard Road links to Leppington major centre by providing a high frequency bus corridor with bus priority and dedicated travel lanes, while Eastwood Road and Dickson Road will also have a strategic public transport function. At full development of the South West Growth Centre, Camden Valley Way will require widening to three lanes in each direction in order to accommodate regional and local traffic (2036), and ensure minimal delay to buses on the Principal Arterial.

Two traffic lanes in each direction are recommended on Rickard Road and Eastwood Road to accommodate future traffic growth, with an additional bus lane in each direction provided along Rickard Road to facilitate safe and efficient bus movements. All other collector roads and local roads within the precinct require only one traffic lane in each direction, with localised widening at intersections, bus stops and parking lanes as required. In addition, two sub-arterial routes (Dickson Road and Byron Road) are proposed to have only one traffic lane in each direction and retain a sub-arterial function with elimination of on-street parking and retention of the median.

All the intersections within the precinct have been designed so they will accommodate future year traffic volumes associated with the proposed full development of the Leppington Precinct (2036) as well as wider regional development. The intersections within the precinct will operate at an acceptable level of service during the morning peak hour and evening peak hour, with appropriate forms of control.

Excessive queue lengths are identified at the intersection of Camden Valley Way / Ingleburn Road, Camden Valley Way / Heath Road and at Camden Valley Way / St Andrews Road. In 2036 these intersections are operating at Level of Service F. This is generally due to the high volumes of traffic forecast for Camden Valley Way. Sensitivity testing has shown that additional lanes are likely to attract further vehicles from elsewhere on the strategic road network which is constrained over a wider regional area in 2036. It is therefore not recommended to increase lane capacity in response to the forecast future traffic constraint. Rather, public transport and active travel uptake will be critical to reducing the pressure on Camden Valley Way and other north/south road corridors in 2036 to ensure the ongoing functionality of the road network.

Within the precinct, signalisation is proposed for the intersections of Rickard Road | Ingleburn Road and Rickard Road | Heath Road. These intersections are both four-arm with traffic volumes in 2036 forecast to exceed the minimum Roads and Maritime signal warrant requirements in the PM peak. While these intersections fail to meet the warrants in the AM peak period, the strategic function of Rickard Road as well as the proximity of the intersections to the town centre and schools means that signalisation has been recommended for these intersections.

A heavy vehicle weight limit may be required within the precinct to limit the amount of through traffic and heavy vehicles traversing the residential area.

7.2 Public transport network

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

The proposed bus strategy for this precinct was revised by TfNSW in November 2013 as part of consultation for this study. It broadly follows the previous South West Growth Sector Bus Servicing Strategy however has been adapted to the proposed road network. The proposed ultimate bus network for the precinct will comprise a mixture of regional routes and district routes to maximise speed and efficiency of high frequency peak hour services as well as a number of local bus routes to ensure maximum coverage throughout the precincts, facilitating public transport access and travel choice. The revised bus strategy also provides greater acknowledgement of the Oran Park bus hub and Rickard Road transit corridor.
Key bus operating corridors with services providing fast, efficient regional connections will operate along north-south routes (Camden Valley Way, Rickard Road, Dickson Road, Eastwood Road), with links between notable regional destinations such as Leppington major centre, Oran Park Town Centre, Liverpool, Narellan and Campbelltown. The combination of the Regional/District routes and the potential for local routes on the collector road network provides an efficient and flexible bus network to serve the future Leppington 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. Rickard Road is identified as a critical link (as a designated transit boulevard) in the bus network for bus priority measures and is proposed to have dedicated bus lanes in each direction.

7.3 Walking and cycling

A comprehensive bicycle network is proposed for the 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)
- On-Road (Cycle Lane)
- Off-Road (linear shared pathways along Riparian Corridors)

Camden Valley Way, designated as principal arterial road, will have shared path bicycle facilities in addition to a 2m wide shoulder on both carriageways that could potentially be used by on-road cyclists. On-road cycle lanes are proposed along Rickard Road providing for fast, efficient connections both within the precinct; travel to Oran Park Town Centre and Leppington Major Centre and to regional destinations such as Liverpool and Campbelltown.

All sub arterial and collector roads connecting key origins and destinations within the precinct and onto other external destinations will have dedicated shared path bicycle facilities. The proposed cycling connections are designed to create a continuous network of facilities removing obstacles and barriers to cycling, both physical and perceived. Physical crossing points of riparian corridors have been included in the bicycle network plan to ensure route connectivity and network permeability.

It is also proposed to provide recreational paths along the Kemps Creek and Scalabrini Creek riparian corridors. This would act to improve linkages to parks and sports fields across the precinct.

All proposed roads throughout the 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 regular pedestrian crossing opportunities will be provided through the provision of dedicated pedestrian crossing facilities throughout the precinct.

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.

In addition, Green Travel Plans for schools could 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, 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, active communities in the precinct.
Appendix A

Forecast Traffic Volumes (2026)
Appendix B

Forecast Traffic Volumes (2036)