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Ingleside Precinct

Transport and Traffic Assessment

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Transport and Traffic Assessment

Client: NSW Department of Planning & Environment

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Prepared by

AECOM Australia Pty Ltd
Level 21, 420 George Street, Sydney NSW 2000, PO Box Q410, QVB Post Office NSW 1230, Australia
T +61 2 8934 0000 F +61 2 8934 0001 www.aecom.com
ABN 20 093 846 925

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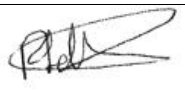
I	21-Oct-2016	Updated Final Report	Roger Jeffries Director, Transport Advisory	

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Executive Summary

Ingleside Development

A Draft Structure Plan (DSP) was developed through an iterative design process over a period of time, involving multiple stakeholders across a range of technical disciplines. The proposed transport network broadly follows the existing road network while seeking to maintain consistency with local and regional transport strategies and maximise opportunities for land use and transport integration.

The proposed development is predominantly low and medium density residential dwellings, with both a neighbourhood centre (North Ingleside) and a community node with small retail offerings (South Ingleside) to serve local residents. Current projections estimate that approximately 3,400 dwellings will be provided as part of the proposed development. Estimates of population density suggest an average of 2.7 persons per dwelling or approximately 9,000 residents for the precinct. The development is also proposed to include a school, open space and recreation facilities.

Mona Vale Road is expected to accommodate the majority of through traffic movements and provide access to the strategic road network, while the remainder of the roads within the precinct will predominantly cater for local traffic.

Mona Vale Road Upgrade

The NSW Government is proposing to upgrade Mona Vale Road from two lanes to four lanes between McCarrs Creek Road at Terrey Hills and Powder Works Road at Ingleside.

Roads and Maritime Services is preparing a Review of Environmental Factors (REF) to examine potential impacts of the proposed upgrade to Mona Vale Road West. The REF will contain measures to reduce and manage the impacts.

Upgrading Mona Vale Road to two lanes in each direction will further enhance the corridor as the major strategic route in the region and will encourage a greater proportion of through traffic to use the route. This will help to reduce the traffic impacts of the proposed Ingleside development on the road network by providing an improved alternative route for through traffic currently using Powderworks Road or Lane Cove Road. Despite Mona Vale Road's likely positive impact on the local road network, overall traffic growth is still expected on roads within Ingleside as a result of the proposed Ingleside development and background traffic growth.

It is considered that a proportion of the vehicles currently accessing Mona Vale Hospital will utilise Mona Vale Road and Forest Way to access the new Northern Beaches Hospital. The impacts of this origin / destination change are not considered significant given that alternate routes such as Wakehurst Parkway offer a more direct travel option for the majority of vehicles in the wider area.

Bus Network

The precinct will receive adequate public transport accessibility through transit corridors that allow access to Mona Vale and the Sydney CBD. In addition, bus routes will link key centres, transport hubs, schools, employment opportunities and residential areas.

Roads and Maritime is improving bus stop infrastructure as part of the Mona Vale Road Upgrade, while Transport for NSW (TfNSW) are proposing an increase in future bus service provision along Mona Vale Road, including a bus service approximately every 5 minutes in the peak hour (peak direction) by 2021 (with further enhancement to services by 2036).

Apart from Mona Vale Road and Powderworks Road; Lane Cove Road, Cabbage Tree Road and Manor Road will be required to accommodate buses to provide improved public transport accessibility for Ingleside. There is also an opportunity to utilise these roads to extend an existing local bus service (potentially the 182 or 185) through Ingleside.

Active Travel Network

The area provides good opportunities for future pedestrian and cycling routes to, from and within the study area considering its existing road and riparian corridors. The proposed utility paths along Mona Vale Road (proposed

as part of the Mona Vale Road Upgrade) will improve the connectivity to the regional active travel network, providing links to Mona Vale Town Centre and neighbourhood centre (North Ingleside).

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 school, parks and sports fields. The proposed local street network is conducive to encouraging pedestrian and cycle trips. There is also opportunity to provide recreational paths along the riparian corridors (subject to feasibility). Providing recreational trails together with linkages to parks and sports fields would encourage cycling and provide facilities for recreational cyclists.

Green Travel Plans for the proposed school could encourage parents and children to walk, cycle or catch public transport for journeys to school. This is also important in establishing behaviours and an important part of the development of healthy, active communities in the precinct.

Infrastructure Provision

The table below summarises the future infrastructure / service improvements in the area as part of proposed works and inclusive of the Ingleside development.

Mode	Infrastructure / Service improvements	Responsibility
Active Travel	Utility path alongside Mona Vale Rd	RMS
Active Travel	Off-road shared paths (collector roads)	Developer / Council
Active Travel	Off-road shared paths (green corridors)	Developer / Council
Public Transport	Bus priority treatment at Mona Vale Rd intersections	RMS
Public Transport	Enhanced bus services along Mona Vale Rd	TfNSW
Public Transport	Enhance local services through Ingleside	TfNSW
Public Transport	Improved stopping facilities along Mona Vale Rd	RMS
Public Transport	New / upgraded bus stops on other local roads	Developer / Council
Private Car	Mona Vale Road Upgrade	RMS
Private Car	Intersection improvements at Powderworks Rd / Garden St	Developer / Council / RMS
Private Car	Intersection improvements at Mona Vale Rd / Pittwater Rd	RMS
Private Car	Provision of roundabouts and intersection re-alignments within the Ingleside Precinct	Developer / Council

Source: AECOM, 2015

Intersection Upgrade Requirements

Intersections upgrades attributable to the Ingleside development predominantly occur as a result of enhanced access requirements, however the intersections of Mona Vale Road / Pittwater Road and Powderworks Road / Garden Street upgrades are necessitated as a result of additional traffic generated by the proposed Ingleside development.

A summary of intersection performance for each scenario showed that all proposed intersections within the study area operate at an acceptable level of service in 2036 (LoS D or better) with the exception of Mona Vale Road / Pittwater Road, which operates at LoS F and will likely require an upgrade (between 2021 and 2036). Given the scale of this intersection, its relative sensitivity to additional traffic and its potential to be impacted by all forms of development in the wider region such as the Mona Vale Town Centre upgrade, a more detailed study is likely to be required in order to fully understand the upgrade options and requirements for this location separate to the Ingleside planning process.

Despite operating at LoS B, the intersection of Powderworks Road / Garden Street does show saturated left turn movements from Garden Street onto Powderworks Road and from Powderworks Road onto Garden Street in the PM peak as a result of additional traffic demand. As such, the practical length of the left turn bay on Powderworks Road should be extended to approximately 50m and a proposed left turn bay on Garden Street should be formalised (50m in length) resulting in the relocation of a bus stop and potential loss of some parking spaces. These upgrades are likely to be required between 2021 and 2036.

It should be noted that the modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/- 10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

The table below summarises the changes likely to be required to intersections as a result of the Ingleside development. This table does not make reference to separate upgrades occurring as part of the Mona Vale Road Upgrade or works being considered or proposed by Pittwater Council.

Location	Existing Layout	Changes Likely to be required	Possible Future Layout
Mona Vale Road / Powderworks Road / Baha'i Temple Way intersection	4-arm signalised intersection	Realignment of Baha'i Temple Way	4-arm signalised intersection
Mona Vale Road / Chiltern Road intersection	3-arm priority intersection	Right turn movements closed	3-arm left in / left out intersection
Mona Vale Road / Lane Cove Road / Manor Road intersection	4-arm signalised intersection	Deviation of Lane Cove Road	4-arm signalised intersection
Mona Vale Road / Pittwater Road	3-arm signalised intersection	Extension of right turn bays on Pittwater Road (150m) and Mona Vale Road (110m)	3-arm signalised intersection (subject to future re-assessment)
Powderworks Road / Wattle Road	4-arm priority intersection	Roundabout provided to facilitate access across Powderworks Road	Roundabout
Powderworks Road / Wilson Avenue	3-arm priority intersection	Roundabout provided to facilitate safer access to Wilga-Wilson	Roundabout
Powderworks Road / Ingleside Road	3-arm priority intersection	Roundabout provided to facilitate safer access to Ingleside Road	Roundabout
Powderworks Road / Wilga Street	3-arm priority intersection	Roundabout provided to facilitate access to Wilga-Wilson	Roundabout
Powderworks Road / Garden Street	3-arm signalised intersection	Extension / formalisation of left turn bays on Garden Street and Powderworks Road	3-arm signalised intersection
Chiltern Road / Neighbourhood centre access Road	N/A	Roundabout provided to facilitate access to the proposed neighbourhood centre	Roundabout
Lane Cove Road / Ingleside Road	3-arm priority intersection	Roundabout provided to facilitate access across Lane Cove Road	Roundabout
Lane Cove Road / View Road	3-arm priority intersection	Roundabout provided to facilitate access across Lane Cove Road	Roundabout
Cabbage Tree Road / Walter Road	4-arm priority intersection	Roundabout provided to facilitate safer access in all directions	Roundabout
Lane Cove Road / Neighbourhood centre access Road	4-arm priority intersection	New intersection created as a result of deviation of Lane Cove Road	Priority Give-way

Source: AECOM, 2015

In May 2016 Pittwater Council was merged into a new body, the Northern Beaches Council. As this report was prepared prior to these changes, it makes reference to the former council. The plans and strategies of the former council continue to apply to the former local government area until the new council prepares its own plans and strategies.

1.0 Introduction

1.1 Background

The NSW Government's "A Plan for Growing Sydney" (December, 2014) reaffirmed the pressures being faced by the metropolitan area in terms of population growth and associated demands for the economy and employment, housing, transport, environment and resources, parks and public places.

Over the next 20 years, Sydney's population is forecast to grow by 1.6 million people, requiring an additional 664,000 homes. The Northern Beaches is also expected to change dramatically during this time. In recent years, a number of locations have been identified by the NSW Government and local Councils across Sydney as potential sites for new precincts / communities to be developed in response to these demands.

The Ingleside Precinct is located approximately 3.2km from the Mona Vale Town Centre and is transected by Mona Vale Road (a 20km arterial road corridor running east-west between the Pacific Highway to the west and Pittwater Road to the east), which Roads and Maritime Services plans to widen to two lanes in each direction between McCarrs Creek Road and Foley Street. As such, the Ingleside Precinct will have much improved accessibility to the surrounding road network and other regions of Sydney.

The key challenge for the planning and development of these precincts / communities is to successfully integrate them with surrounding residential areas, major centres and transport hubs. The forecast increase in population and employment in the Northern Beaches subregion as well as surrounding subregions will increase the need to travel and put pressure on the existing road and transport infrastructure / network that are fast approaching capacity, especially during the peak hours. Extra road network capacity and new public transport services will be needed to move people within and out of the subregion efficiently.

In order to achieve this within the Ingleside Precinct, a balanced approach to precinct planning is needed that considers the natural constraints, such as riparian corridors and topography, and built environment constraints such as the future widening of Mona Vale Road and the function of Powderworks Road. These influence the configuration of the internal road network as well as pedestrian and cyclist circulation.

There is currently limited public transport provision in the area with infrequent bus services currently available along Mona Vale Road and no rail network in the northern beaches region. Similarly, there is a limited pedestrian and cycle network. However these are increasing with surrounding infrastructure upgrades and significant opportunities exist to improve mode share by active and public transport through this precinct planning process.

A previous stand-alone study looking at the potential impacts of development at Ingleside on Powderworks Road was commissioned by Pittwater Council and undertaken by AECOM in 2013 *(Assessment of Powderworks Road Corridor – Preliminary Transport Study)*. The 2013 study assumed no upgrade of Mona Vale Road. This is the main point of difference between the 2013 study and the assessment included within this report and is the main factor in any differences occurring in the results / outcomes generated.

1.2 Purpose

AECOM has been engaged by the Department of Planning & Environment (DP&E) to prepare a traffic and transport assessment and modelling study for the proposed rezoning of the Ingleside Precinct ("the precinct"). The purpose of this study is to provide a transparent and robust assessment of the Draft Structure Plan (DSP) by all modes of transport including walking, cycling, public transport and passenger vehicles. It summarises the additional transport infrastructure and public transport service improvements required to enable and facilitate future development of the precinct. This document constitutes a draft report that will be revised at the next stage of consultation.

The study aims to ensure that the Ingleside Precinct provides suitable facilities for people to walk, cycle, access public transport or use private cars, thus enabling people to make the most appropriate choice of transport mode for their journey and ensuring 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. Ultimately this precinct will be 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, as well as ensure that transport infrastructure provides an appropriate level of service that mitigates the impacts of future development, addresses the requirements of traffic growth on the strategic road network and meets the needs of relevant stakeholders.

The primary outcomes of the traffic and transport assessment 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 DSP.

In broad terms, the following scope of works has been undertaken as part of the Traffic and Transport Assessment:

- To assess and test the transport impacts of the proposed development of the study area, taking into account potential development staging;
- To recommend infrastructure upgrades, service improvements and other measures to address those impacts, with reference to any proposed changes to surrounding transport networks;
- To assess the impacts of any works for upgrades of intersections or roads on amenity, safety and liveability of residents and road users;
- To prepare an agreed implementation framework and concept level costings, in negotiation with relevant government transport agencies, DP&E and Council, for the key infrastructure components;
- To ensure all modes of transport, including private vehicles, public transport, walking and cycling are considered in the planning and development of the Precinct; and
- To assess and recommend options to reduce or limit levels of travel demand and vehicles kilometres travelled.

This traffic and transport assessment has been informed by the recent Mona Vale Road Corridor Studies undertaken by the Roads and Maritime *(Mona Vale to Macquarie Park Corridor Strategy, Mona Vale Road McCarrs Creek Road to Powderworks Road Upgrade Preferred Options Report)* and has considered other strategic publications such as *The Northern Beaches BRT Pre-Feasibility Study* as well as a number of local studies undertaken for Pittwater Council and regional developments such as the Northern Beaches Hospital and Wakehurst Parkway Upgrades. The outcomes of the Ingleside transport study will then be used to inform any ongoing upgrades of the strategic road network and the development capacity of the precinct.

A separate noise and vibration assessment of the existing and future development would also be undertaken to demonstrate the change in noise environment from the proposed changes.

1.3 Report Structure

The report has been structured into the following sections:

- **Section 2** reviews the relevant planning policy documents that guide the development of the traffic and transport assessment.
- **Section 3** reviews and provides a transport appraisal of the Draft Structure Plan.
- **Section 4** summarises the existing road network, provides a traffic modelling assessment of the future road network and undertakes intersection assessments to assess future traffic impacts of the Ingleside Precinct.
- **Section 5** outlines the existing public transport conditions and future public transport requirements associated with the proposed development.
- **Section 6** assesses the existing and proposed walking and cycling networks.
- **Section 7** summarises the conclusions of the assessment.

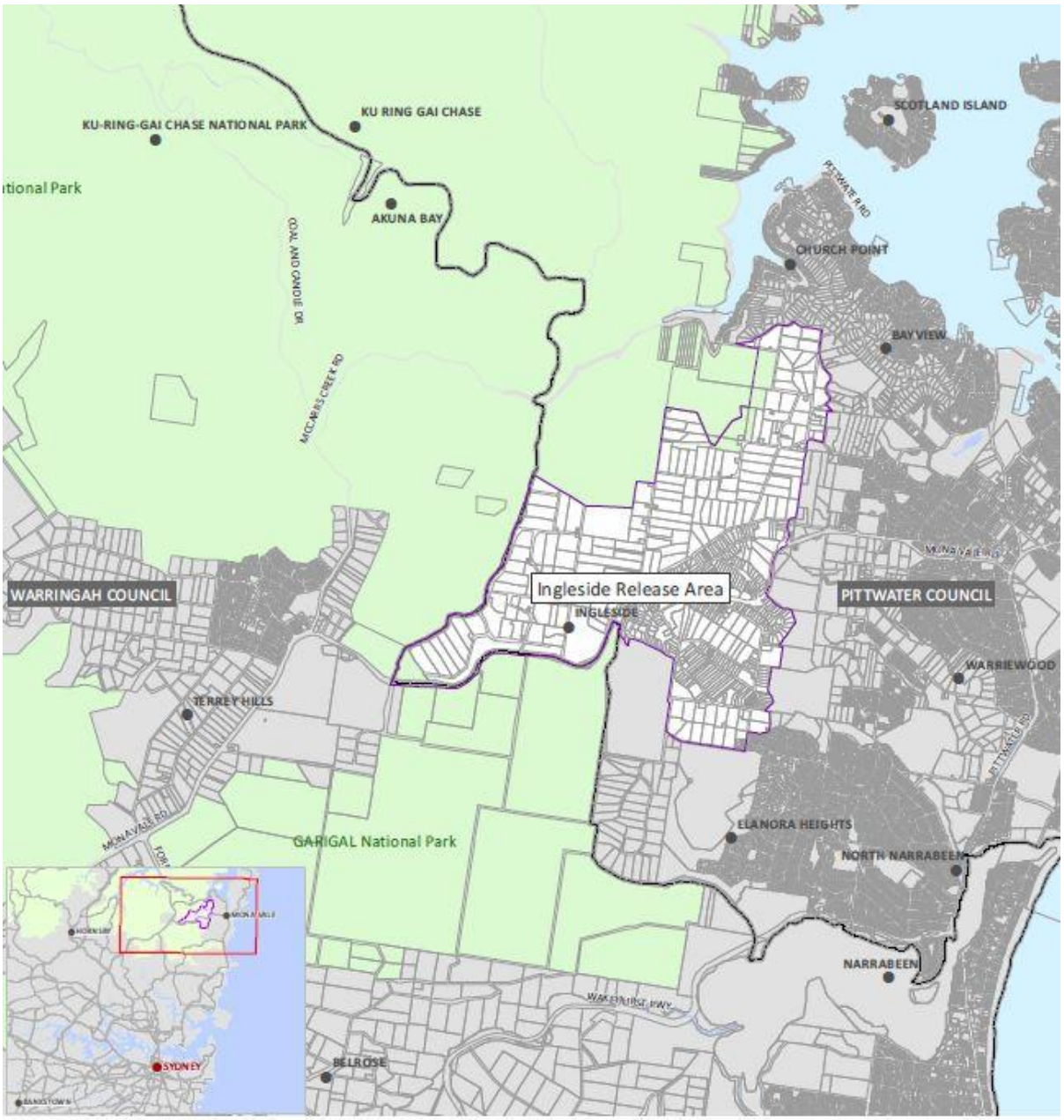
1.4 Study area

The precinct is located within the local government area of Pittwater approximately 28km north of Sydney and is bounded by Ku-Ring-Gai Chase National Park to the north, the suburbs of Bayview Heights and Elanora Heights to the north-west and south-west respectively, the Ingleside Chase Reserve to the east, and Garigal National Park, Monash Country Club and Elanora Country Club to the south. It lies between Terrey Hills and Mona Vale, off the Mona Vale Road, the main road linking the northern beaches to western Sydney. The precinct comprises approximately 715 hectares and will accommodate approximately 3,400 dwellings. The precinct together with regional context is shown in **Figure 1**.

The Ingleside Precinct is semi-rural in nature and includes a mix of existing land uses comprising predominantly lifestyle blocks, recreational land uses, plant nurseries, the equine industry and small scale commercial agriculture. Other land uses include places of worship, a school and conference facility. Neighbouring land uses consist of mostly low density residential (Bayview Heights, Elanora Heights), however also include recreation facilities such as the Monash County Club and Elanora Country Club, a commercial centre (Elanora Heights – small village centre) and schools.

The physical geography of the local area acts as a constraint for both the road network and public transport. This is one of the most significant considerations for this project since it affects the interaction between land use and transport, and the provision of infrastructure. Addressing these issues and integrating the precinct with surrounding residential areas is a key challenge for the development of the precinct.

Figure 1: Regional Context of the Ingleside Precinct



Source: NSW Department of Planning & Environment, 2015

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2.0 Policy Context

2.1 State and Regional Planning Policies

2.1.1 A plan for Growing Sydney (2014)

"A Plan for Growing Sydney" prepared by the NSW Government is an integrated, long-term planning framework that will manage Sydney's growth and strengthen its economic development, providing improved accessibility, and a city capable of supporting more jobs, homes and lifestyle opportunities within the existing urban footprint.

The plan sets out a long term framework to develop Sydney as a city of cities with radial public transport links feeding into each city, as well as cross regional transport connections linking more sub-regional areas to the Global Economic Corridor, stretching from Sydney Airport and Port Botany in the south through the city centre and North Sydney to Macquarie Park in the north.

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

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

A plan for Growing Sydney (NSW Government, 2014) identified an expected growth to 5.6 million people to live in Sydney and a need to plan for 664,000 new homes and 689,000 new jobs in Sydney in the next 20 years.

The priorities for the North Subregion include:

- Promote as a highly accessible and liveable area with outstanding amenity, a growing network of employment areas and a prized natural environment.
- Improve connections to the Global Economic Corridor via North Sydney and cross-regional links with Chatswood via Brookvale–Dee Why.
- Improve connections linking the Orbital Motorway Network to the M1.
- Improve the connecting corridor to the north for freight and passengers to Central Coast, Newcastle and NSW North Coast via the M1 and Main Northern Line, including any future high speed rail corridor.
- Provide for increased housing choice through redevelopment for a variety of new housing types and densities around identified centres along major transport corridors including strategic bus corridors and the North Shore Line and Northern Line.
- Facilitate delivery of the Urban Activation Precinct at Epping.
- Protect the health and resilience of the environmental assets of the subregion, including the Hawkesbury River valley and estuary, the Northern Beaches, Pittwater, Broken Bay and Middle Harbour and the National Parks such as Ku-ring-gai Chase.
- Protect the Harbour and beaches, including significant tourism and cultural locations such as Manly.

The forecast increase in population and employment in the Subregion as well as surrounding Subregions will increase the need to travel and put pressure on the existing road and transport infrastructure / network that are fast approaching capacity, especially during the peak hours. Extra road network capacity and new public transport services will be needed to move people within and out of the subregion efficiently.

The delivery of proposed employment targets in major centres within the North Subregion will aim to increase level of self-containment and to reduce the number of additional trips travelling into and out of the subregion. There are two Major Centres and One Specialised Precinct within the North Subregion that will deliver the major forecast employment targets including:

- Brookvale-Dee Why Major Centre
    - Strengthen as a location for integrated retail, office, employment and service centre for the Northern Beaches and wider subregion

  - Continue to support the mixed-use renewal of Dee Why
  - Provide capacity for at least 3,000 additional jobs to 2031.
- Hornsby Major Centre
  - Enhance as a location for growing retail and office uses for the subregion and a broader catchment extending to the Central Coast
  - Promote residential intensification near the centre
  - Provide for at least 1,000 additional jobs to 2031.
- Frenchs Forest Health Potential Specialised Precinct
- Capitalise on the growing cluster of hospital and health-related uses with associated research/ business park opportunities to stimulate local jobs.

Of the three key centres within the North Subregion, Brookvale-Dee Why Major Centre and Frenchs Forest Health Potential Specialised Precinct are located in proximity to Mona Vale Road and will be expected to generate additional traffic on to this road corridor.

2.1.2 Mona Vale to Macquarie Park Corridor Strategy (September 2009)

The Mona Vale to Macquarie Park Corridor Strategy has been developed by Roads and Maritime as a means of providing *"an overview of the road transport system from Mona Vale, on Sydney's Northern Beaches, to De Burghs Bridge at Macquarie Park"*. Key objectives of the Mona Vale to Macquarie Park Corridor Strategy include addressing road safety, transport efficiency and asset maintenance issues while setting a 25-year framework for management of the corridor.

The Strategy highlights the following issues relevant to the study area:

- Congestion and delays occurring on Mona Vale Road at Ingleside. The causes of these delays are identified as the high volume of heavy vehicles using the route and capacity issues at the intersection of Mona Vale Road and Ponderosa Parade;
- The interface between Mona Vale Road and urban areas. New urban developments along the route of Mona Vale Road could potentially result in modal conflict as the level of associated infrastructure increases;
- The potential for an additional point of access from Ingleside to Mona Vale Road. The strategy notes that this may be necessary due to traffic generated by the Ingleside development;
- Mona Vale Road Cycleway and pedestrian facilities. The strategy suggests that these can be developed and incorporated into any future development at Ingleside.

2.1.3 Northern Beaches Transport Action Plan

The process for reviewing and establish the initial road network within the DSP first requires consideration of the wider strategic context, particularly with regard to what the transport network might look like in the future. As such, planned infrastructure upgrades in the Northern Beaches were reviewed for their potential implications with regard to the local transport network.

The State Government is currently planning a number of transport infrastructure projects as published in the Northern Beaches Transport Action Plan. This includes the Northern Beaches Hospital development, a public transport interchange at Mona Vale, widening of the Narrabeen Bridge to three lanes in each direction and the introduction of Bus Rapid Transit (BRT) on Pittwater Road within the next five years. Longer term planned infrastructure projects include the upgrade of Mona Vale Road to two lanes in each direction through Ingleside, the upgrade of Wakehurst Parkway and further bus network improvements along major corridors (as shown in **Figure 2** and **Figure 3**).

This improved infrastructure across the Northern Beaches will have a number of benefits to the residents of the future Ingleside Precinct, particularly with Mona Vale Road upgraded to two lanes in each direction (where

improved travel times along the corridor can be expected). Mona Vale Road will also become a more attractive route for the through traffic currently utilising other corridors such as Powderworks Road.

2.1.4 Shaping Our Future (SHOROC)

Shaping Our Future is a response to the NSW State Plan and sets out the regional direction and strategy to 2031. It is the core overall strategy for the region and identifies critical issues and infrastructure improvements across the while seeking to maintain and enhance liveability and sustainability with consideration of a projected population increase of 30,000 (including 9,500 in Pittwater, with potentially 4,900 of these located within Ingleside) to 2031. The SHOROC region covers the Pittwater, Warringah, Manly and Mosman local government areas. The principles underpinning Shaping Our Future include:

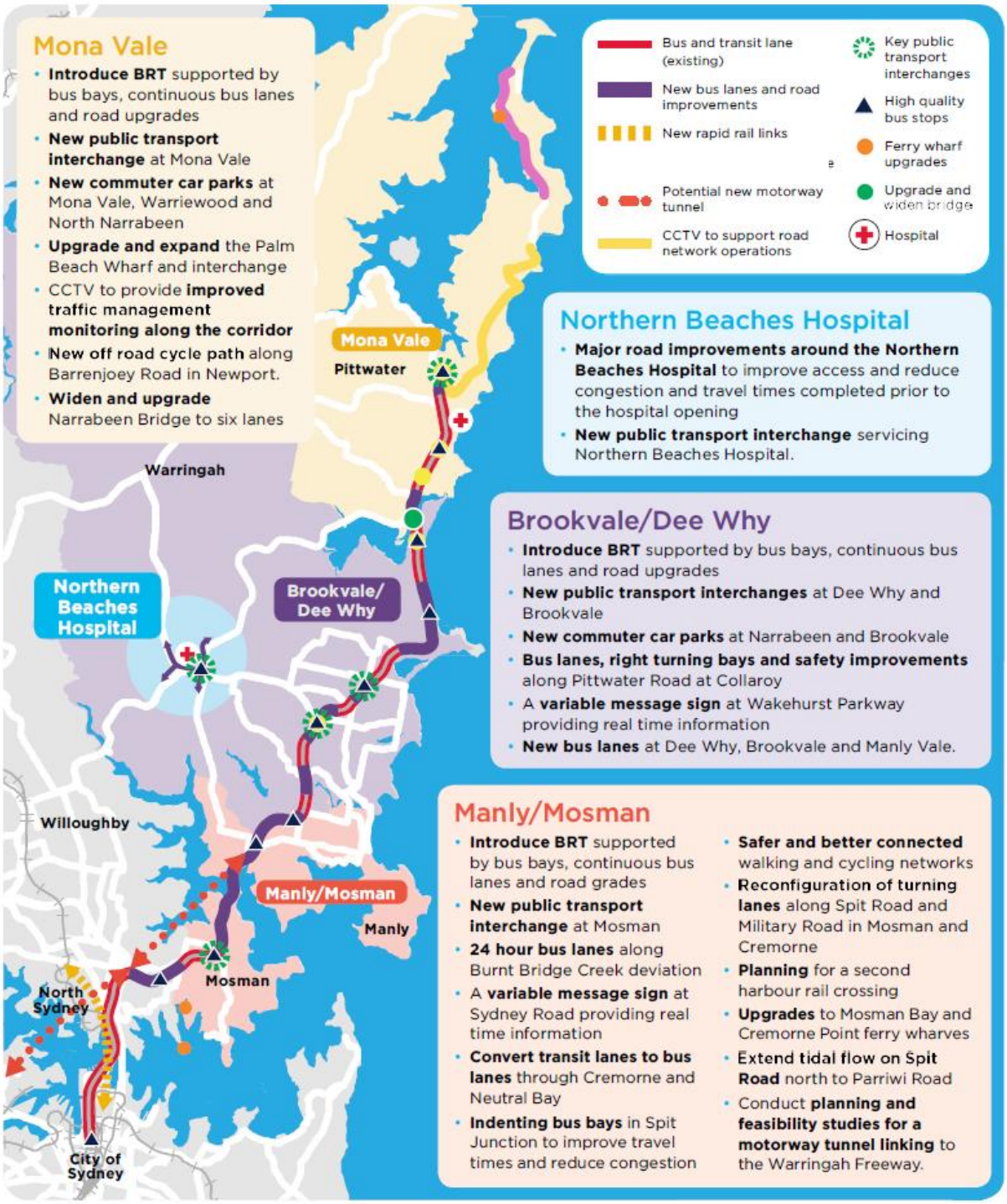
- Maintaining and enhancing quality of life, wellbeing, the high proportion of jobs close to home and access to social services, recreation, infrastructure and transport;
- Increasing engagement, involvement and connectedness of community members and development of social capital;
- Seeking to improve housing choice in response to demographic changes such as the availability of affordable housing for a diversity of households, including key workers;
- Creating more sustainable communities with more appropriate management of the region's water, energy, waste and natural resources including greater residential and business conservation and re-use and investigation of the viability of providing water, energy and waste recycling services within the region;
- Maintaining the biodiversity and quality of bushland and waterways.

The document provides an outline of the major strategic transport directions for the region with a focus on key connections between regional hubs. East / west connectivity has been identified as the highest priority (as this is considered the most cost effective. Major infrastructure includes:

- The Mona Vale Road corridor road upgrade;
- Rapid bus routes along Pittwater Road;
- Improved connectivity to the future Frenchs Forest Hospital;
- Identification of an urban centre at Ingleside.

- Key areas for development have been identified enabling SHOROC Councils to meet NSW Government growth targets for housing and jobs:
- Dee Why / Brookvale (as a major centre for housing and jobs;
- Frenchs Forest (as a new specialised centre for housing, jobs and health);
- Terrey Hill (as an area for jobs);
- Warriewood / Ingleside (as a new centre for housing and jobs).

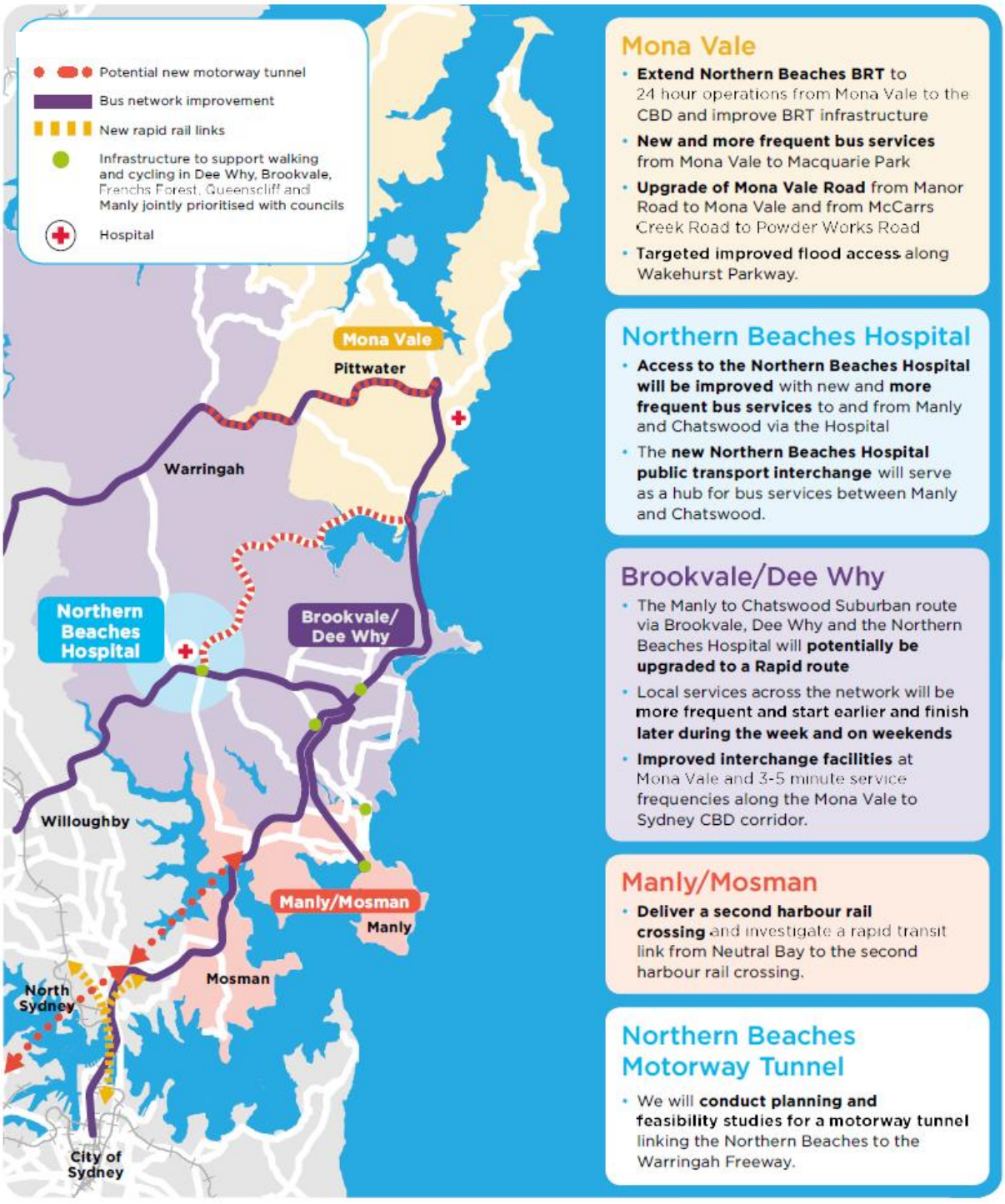
Figure 2: Planned State Government Infrastructure <5 years



Source: Northern Beaches Transport Action Plan, 2014

Proposed upgrades to bus infrastructure and services along Mona Vale Road and elsewhere in the area will benefit residents of Ingleside by providing considerably improved access to public transport and will act to encourage mode shift away from the private car.

Figure 3: Planned State Government Infrastructure >5 years



Source: Northern Beaches Transport Action Plan, 2014

2.2 Local transport planning policies

2.2.1 Pittwater Local Planning Strategy - Planning for Pittwater towards 2031 (Adopted August 2011)

The Pittwater Local Planning Strategy has been developed by Pittwater Council as a means of achieving the vision: "To be a vibrant sustainable community of connected villages inspired by bush, beach and water." Key objectives of the Pittwater Local Planning Strategy include providing for sustainable land use choices and for growth in population and a corresponding growth in dwelling numbers and employment.

Set out below are transport and infrastructure recommendations relevant to the study area:

- Widening of Mona Vale Road to divided dual lane carriageway for its full length;
- Create a new centre in Ingleside;
- Ensure any future development of release area are designed to encourage the use of sustainable forms of transport, including walking and cycling;
- Apply the sustainability criteria (from "A Plan to Grow Sydney") to any future development of release areas;
- Provide an appropriate level of open space provision within any future Ingleside land release area;
- Retain Elanora Heights as a small village in the centres hierarchy for Pittwater;
- A bus rapid transit system on the north-south corridor from Mona Vale using co-located median bus lane to the City or to new modal interchange at Neutral Bay; and
- Review and implement the Walks and Rides Master Plan (including cycleway provision).

2.2.2 Warriewood Valley Strategic Review (2012) and Addendum Report (2014)

The Warriewood Valley Strategic Review is the contemporary planning framework for the majority of the undeveloped residential lands in the Warriewood Valley Release Area. It covers building density, height control, the transport network and infrastructure demands and considers opportunities for the provision of additional housing and an expanded centre in the Warriewood Valley. Key conclusions and recommendations of the Strategic Review include:

- Any increase in dwelling yield across the valley will require an increase in accompanying infrastructure and a new Section 94 Contributions Plan to support it;
- A dwelling density of 32 dwellings per developable hectare is recommended;
- Reducing the Section 94 Contribution rate could have implications for infrastructure provision;
- A flood emergency response must be agreed with State government prior to future rezoning of land.

The Addendum Report aims to identify residential lands with development capability greater than the previously designated capability identified as part of the Warriewood Valley Strategic Review and to identify a 'forward path' for sectors not previously considered. Key conclusions and recommendations of the Strategic Review include:

- Some sectors of the Warriewood Valley Release Area are constrained (to varying degrees) by environmental factors;
- A reconfigured Warriewood Valley Release Area boundary;
- The Addendum Report is consistent with the community's expectations for the Release Area and will ensure continuity across Council's strategic and land use planning documents.

2.2.3 Mona Vale Road Upgrade Summary

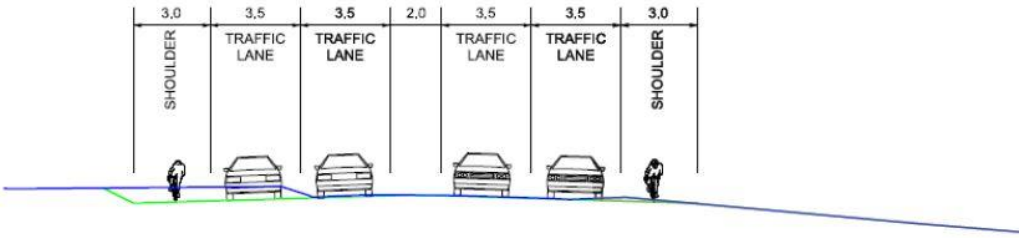
The proposed Mona Vale Road upgrade will result in the widening of the road corridor to two lanes in each direction for the entirety of its length (4-lane divided road). The proposed upgrade pertains to two sections of Mona Vale Road that are currently 1 lane in each direction, from McCarrs Creek Road to Powderworks Road (west) and Lane Cove Road / Manor Road to Foley Street (east).

The proposed Mona Vale Road upgrade would provide the following benefits for Ingleside:

- Improved traffic capacity and efficiency for road users;
- An increased speed limit along the corridor (from 70km/hr up to 80km/hr) allowing for shorter journey times;
- Improved accessibility for local residents to Mona Vale and other destinations;
- The provision of new / improved public transport infrastructure that will allow for enhanced service provision along the corridor, including shorter journey times;
- Reduction in the impact of the gradient by allowing overtaking of slow moving Heavy Goods Vehicles (HGVs);
- Enhanced walking and cycling facilities on / adjacent to the road corridor;
- Intersection improvements;
- Improve safety for all modes.

An example cross section of the proposed Mona Vale Road (west) is shown in **Figure 4**.

Figure 4: Typical Cross-section of Mona Vale Road Upgrade (East)



Source: Roads and Maritime, 2015

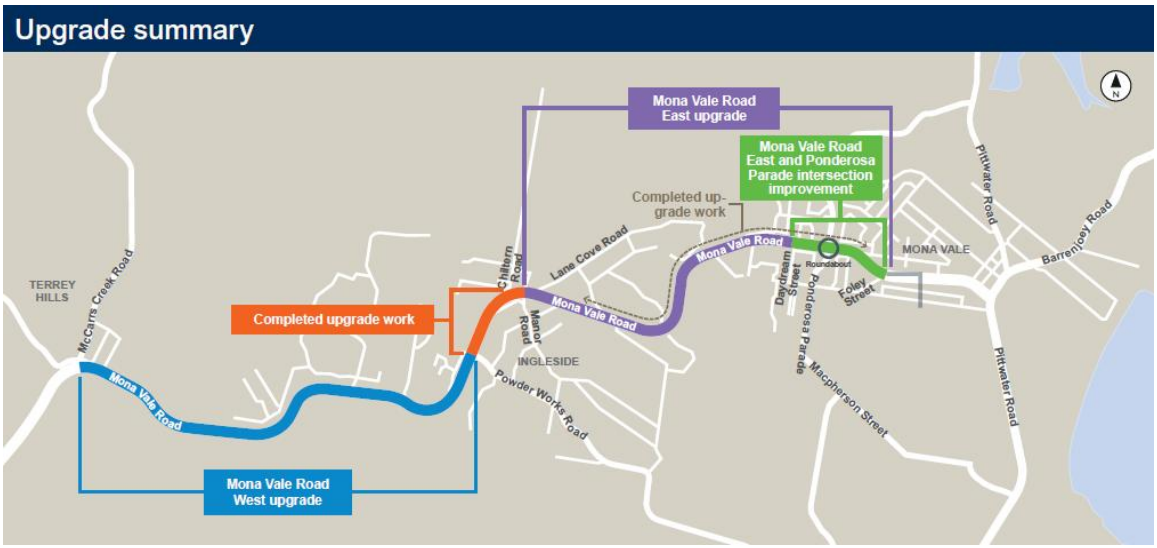
Staging

The Mona Vale Road Upgrade is proposed to occur in two main stages as shown in **Figure 5** and described below:

- Mona Vale Road Upgrade East - estimated for completion in 2019
- Mona Vale Road Upgrade West – estimated for completion in 2021

As per the above, this study assumes that both upgrades will be completed by 2021. As such, all modelling and assessment within this report assumes the full upgrade of Mona Vale Road. Given that only a relatively small proportion of development within Ingleside is expected to have occurred prior to 2021 (approximately 800-1,000 lots based on an estimated rate of development of 200 lots per year commencing 2017), it is not expected that the staging of the Mona Vale Road Upgrade will have a significant impact on the Ingleside development, however it is likely that construction traffic at the early stages of the Ingleside development will need to be managed and coordinated with the development occurring on Mona Vale Road.

Figure 5: Mona Vale Road Upgrade Summary



Source: Roads and Maritime Mona Vale Road Upgrade Summary Map, 2014

Regional Travel Demand

Travel demand scenarios for Mona Vale Road traffic modelling purposes are based on the land use assumptions as proposed by *A Plan for Growing Sydney*. In addition to the Government land use projections, there are specific development proposals that are expected to have direct impacts to the Mona Vale Road study area. These developments have been considered specifically in terms of trip generation and impacts to the Mona Vale Road study area. These developments include Ingleside Release Area and the Northern Beaches Hospital is described in the following sections.

The Northern Beaches Hospital is a new regional hospital being developed in Frenchs Forest. It will serve the Northern Beaches region including Pittwater, Warringah and Manly. Many functions of smaller existing hospitals such as Mona Vale Hospital will relocate to the new facility. A number of road infrastructure upgrades are proposed, including the widening of Wakehurst Parkway. As a result of re-distributed hospital trips and the new road infrastructure, it is expected that travel patterns in the Northern Beaches will be impacted.

The Northern Beaches Hospital and associated transport network upgrades are proposed to occur prior to the completion of the proposed Mona Vale Road Upgrade East (at this stage all associated development related to the hospital is estimated to be completed by 2018). As such, the additional trips generated by the hospital, as well as the re-distribution of trips previously associated with Mona Vale Hospital have been considered as part of the strategic modelling inputs in CUBE, and are therefore reflected in all future year modelling scenarios.

It is considered that a proportion of the vehicles currently accessing Mona Vale Hospital will utilise Mona Vale Road and Forest Way to access the new Northern Beaches Hospital. The impacts of this origin / destination change have been assessed as part of the strategic modelling process, however impacts are not considered significant given that alternate routes such as Wakehurst Parkway offer a more direct travel option for the majority of vehicles.

Approximately seven per cent of all hospital staff are expected to utilise Forest Way (and Mona Vale Road) based on their existing residential addresses *(GTA Consultants, EIS Volume 2 October 2014)*. Including visitors, it is estimated that approximately 70 hospital related trips will utilise Mona Vale Road during the AM peak period. The strategic model has incorporated this additional traffic expected to be using Mona Vale Road.

Impact on Powderworks Road

Upgrading Mona Vale Road to two lanes in each direction would encourage through traffic to utilise the route. This is likely to reduce the appeal for east / west through traffic to use Powderworks Road for some journeys.

Powderworks Road currently accommodates a portion of regional east-west through traffic, particularly as it is the fastest route for residents in parts of Warriewood, North Narrabeen and Narrabeen to access the west. **Table 1** summarises modelling outputs obtained as part of the *Mona Vale Road Upgrade East Traffic and Transport Assessment* conducted by AECOM on behalf of Roads and Maritime (2015), which shows estimated traffic volumes along Powderworks Road in 2036 both with and without the Mona Vale Road upgrade.

The outputs are based on the full development of the Ingleside Precinct and have made assumptions as to the expected road environment in 2036, including a lower speed limit (50km/hr) and new intersections along Powderworks Road. Note that the outputs also represent the location and time period where the highest traffic volumes are forecast.

Table 1: Summary of Powderworks Road traffic volumes with and without the Mona Vale Road Upgrade (AM Peak)

Location	2014 Base Model (Existing)		2036 No Mona Vale Road Upgrade		2036 With Mona Vale Road Upgrade	
	Westbound	Eastbound	Westbound	Eastbound	Westbound	Eastbound
Powderworks Road (Elanora Heights)	498	521	613	821	513	742

Source: Mona Vale Road Upgrade East Traffic and Transport Assessment (2015), AECOM

Despite the decrease in through traffic on Powderworks Road as a result of the Mona Vale Road Upgrade (shown in **Table 1**), the overall volume of traffic on Powderworks Road is expected to increase in 2036. This is due to a combination of background traffic growth and traffic generated as a result of the proposed Ingleside development. Analyses regarding the impacts of the Ingleside development on the road network are provided in **Section 4.7** and **Section 4.8**.

The nature of Powderworks Road through Ingleside should ultimately be similar to Powderworks Road through Elanora Heights, with lower traffic speeds and traffic calming infrastructure. Its function is intended to be more aligned toward local access through South Ingleside, rather than a route for through traffic to be encouraged.

3.0 Draft Structure Plan

3.1 Introduction

Structure and precinct plans are a proven approach for 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 / cycle to shops (or for other short distance journeys), and frequent bus services that link to the rail network for longer journeys.

A Draft Structure Plan (DSP) 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 Draft Structure Plan broadly follows the existing road network while seeking to maintain consistency with local and regional transport strategies with maximised opportunities for land use and transport integration.

3.2 Land use and built form

The NSW Government has clearly identified its vision for residential development 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 proposed centres, as well as to the existing centre at Mona Vale and the small village centre at Elanora Heights. Efficient bus connections and transport hubs at these centres are required to maximise public transport connectivity.

The precinct will also provide a neighbourhood centre, community node, sporting fields, and education facilities which maximise accessibility to local shops and services for daily needs.

3.3 Draft Structure Plan

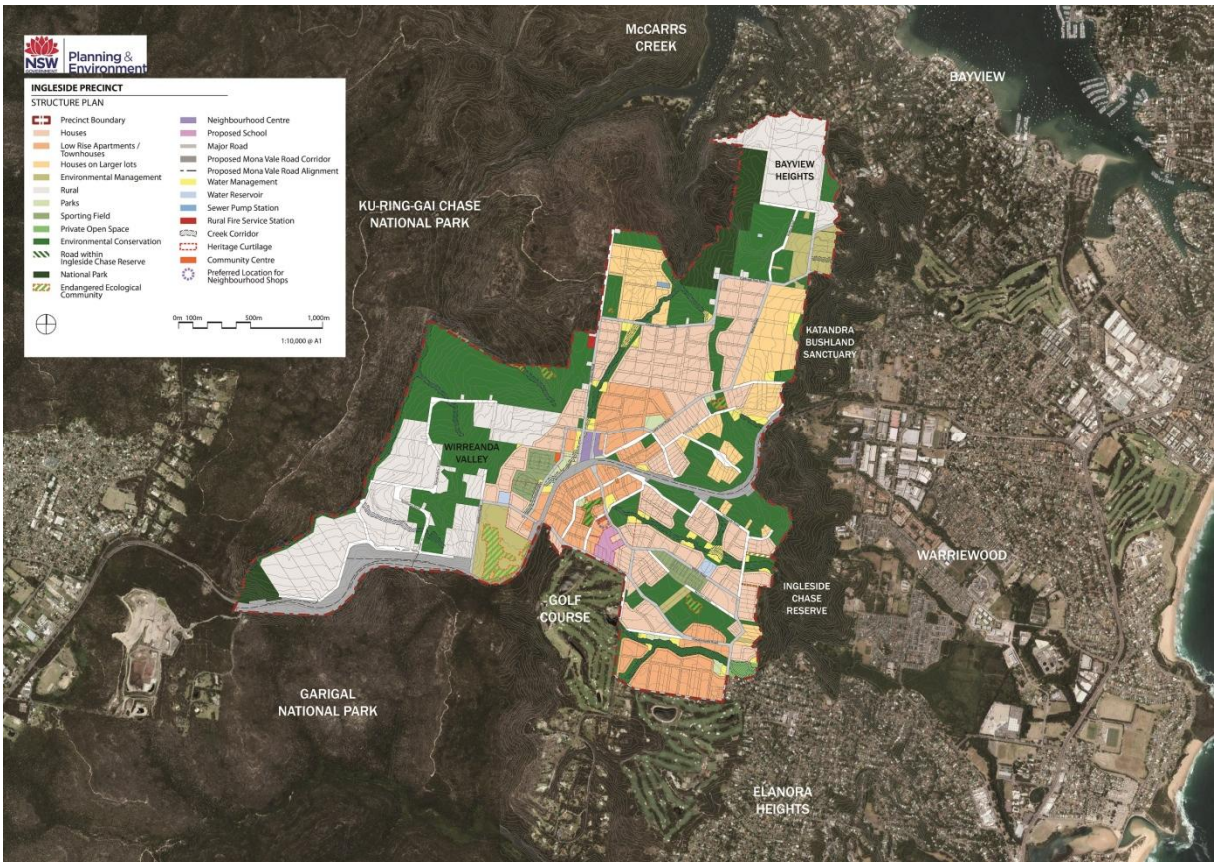
The Draft Structure Plan for Ingleside is shown in **Figure 6**. The majority of development will occur in both North and South Ingleside, with no additional development occurring in Wirreanda Valley. Should the final plans for Ingleside significantly change from the Draft Structure Plan this assessment will be revised accordingly.

3.3.1 Residential land uses

The proposed development is predominantly low and medium density residential dwellings, with both a neighbourhood centre (North Ingleside) and a community node with small retail offerings (South Ingleside) to serve local residents. Current projections estimate that approximately 3,400 dwellings will be provided as part of the proposed development. Estimates of population density suggest an occupancy rate of 2.7 persons per dwelling or approximately 9,000 residents for the precinct.

- Approximately 50ha of residential land proposed as large lot residential living providing seven percent of homes within the precinct at an average density of five dwellings per hectare.
- Approximately 121ha of residential land proposed as low density providing 45 percent of homes within the precinct at an average density of 12.5 dwellings per hectare.
- Medium density residential occupying 63ha (47 percent of homes) at 25 dwellings per hectare, located near centres, public transport routes and other local amenities.
- Approximately 2ha of land is proposed to provide one percent of homes within the precinct.

Figure 6: Draft Structure Plan for Ingleside



Source: Cox, Dec 2015

3.3.2 Neighbourhood Centre

Given the physical constraints of the precinct, access to the Mona Vale Town Centre and the small village centre at Elanora Heights may be difficult for residents seeking to travel by non-car modes. As such, one neighbourhood centre and one community node with small retail offerings are proposed within the precinct. The proposed neighbourhood centre will be located in North Ingleside, at the intersection of Mona Vale Road / Chiltern Road. A smaller community node is proposed in South Ingleside at the intersection of Manor Road / King Road. It is proposed that this would include with small retail offerings and a community centre.

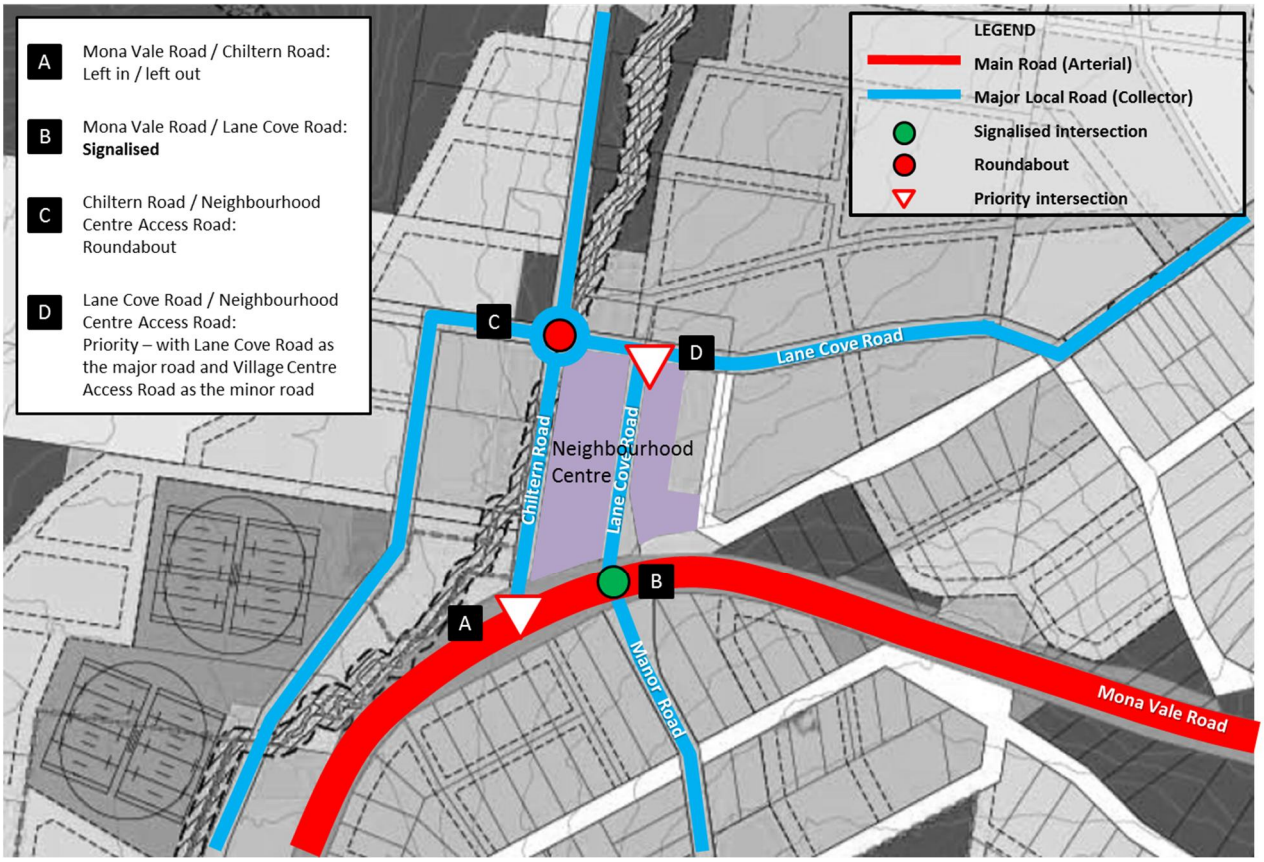
The location of the neighbourhood centre will necessitate changes to the existing road network in order to feasibly accommodate and access the development. This includes the deviation of the Lane Cove Road and its intersection with Mona Vale Road / Manor Road as well as changing the Mona Vale Road / Chiltern Road intersection to left in / left out only. The proposed deviation will provide better access to the proposed neighbourhood centre and improve safety on the northern arm of the intersection (Lane Cove Road).

A roundabout is proposed for the intersection of Chiltern Road / Neighbourhood Centre access road to facilitate access to the proposed neighbourhood centre. With the deviation of Lane Cove Road the intersection of Lane Cove Road / Neighbourhood Centre Access Road is proposed as a priority intersection with Lane Cove Road as the major road and Neighbourhood Centre access road as the minor road.

Bus stops are provided on Mona Vale Road in proximity to the Neighbourhood Centre and will facilitate public transport connections to and from the centre. The bus stops provide residents access to the Mona Vale Road bus corridor and presents an opportunity for a park and ride facility to be provided.

Detailed analysis of the access arrangements (including to any proposed parking facility) as well as local intersection performance surrounding the neighbourhood centre will be undertaken as part of the detailed planning of the neighbourhood centre.

Figure 7 Neighbourhood Centre Access Arrangement



Source: AECOM, 2015

3.3.3 Educational land uses

It is proposed that one new school will be located within the precinct, located in South Ingleside between Manor Road and Powderworks Road. The school is positioned at or near key public transport corridors and would be accessed via local roads where appropriate. It is important to provide high quality walking and cycling routes to the proposed school.

3.3.4 Community uses and open space

Under the currently proposed DSP 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 (subject to feasibility).

There are a number of riparian corridors within the site. The most significant of these are:

- Cicada Glen Creek is located in North Ingleside. It originates near Chiltern Road and continues north, exiting the site north of Cicada Glen Road.
- Mullet Creek is located in South Ingleside. It originates near King Road and continues east exiting the precinct east of Ingleside Road.

These corridors have the potential to improve active travel connections to the proposed North Ingleside neighbourhood centre as well as the South Ingleside community node, encouraging activity and providing health benefits to the community. It is noted that provision of walking and cycling routes within these riparian corridors is subject to feasibility as they may require resolution of bio-certification issues or resolution of access to the rear of private properties.

3.4 Preliminary transport review of the DSP

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

- The NSW Department of Planning and Environment (DP&E)
- Pittwater Council;
- The Ingleside Community Reference Group;
- Transport for NSW; and
- Roads and Maritime Services.

A preliminary transport review was undertaken for the initial road layout plans through an ‘access review’. The following transport elements were considered for the preliminary layout:

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

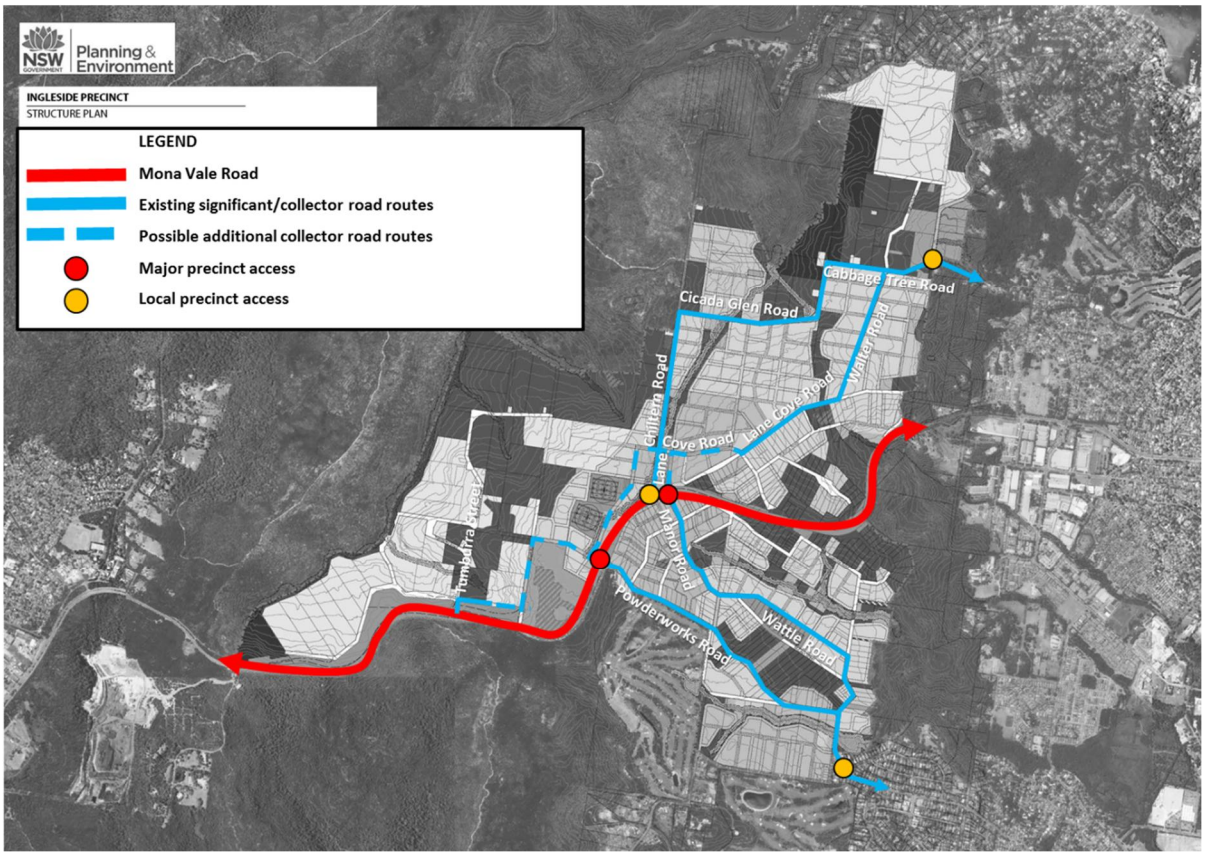
Key areas of consideration for the community, Council, TfNSW and Roads and Maritime were identified during preliminary consultation. These generally revolved around the form and function of the road network within the precinct, including concerns relating to through traffic on Powderworks Road, as well as ensuring adequate public transport and active travel provision within the precinct.

Comments were also provided on the location of different land uses, such as a neighbourhood centre and community node, as this can impact upon the accessibility and mode choice within the precinct. Medium density housing and proximity to local centres are key factors in promoting sustainable transport modes such as walking and cycling, a key objective of state transport policy.

3.4.1 Access onto the local road network

There are currently five access points from Mona Vale Road into the Ingleside Precinct. The proposed local road network is predominantly based on the existing road network, utilising the corridors already in place (particularly for proposed collector roads). Access to the strategic road network is provided via Mona Vale Road. There are three main controlled accesses proposed from North and South Ingleside onto Mona Vale Road (at Baha'i Temple Way / Powderworks Road, Chiltern Road and Lane Cove Road / Manor Road). Precinct access is shown in **Figure 8**.

Figure 8: Key accesses to North and South Ingleside Precincts



Source: AECOM, 2015

3.4.2 Traffic movements

Mona Vale Road is expected to accommodate an increased proportion of through traffic movements, while the remainder of the roads within the precinct will predominantly cater for local traffic. It is likely that Manor Road / Wattle Road and Lane Cove Road / Walter Road will operate as collector roads in South Ingleside and North Ingleside respectively, with options for Manor Road / Wattle Road to be enhanced to encourage traffic away from Powderworks Road.

3.4.3 Local traffic access options – North Ingleside

Mona Vale Road is designed to provide the main access to North Ingleside (at Chiltern Road and Lane Cove Road). However, with Cicada Glen Road / Cabbage Tree Road and Lane Cove Road / Walter Road becoming main internal collector road routes, they could potentially carry some additional traffic to access Mona Vale Town Centre and other areas to the east.

There are options for the internal road network to mitigate against the potential over-use of collector roads in North Ingleside through the use of traffic calming measures to slow the speed through the precinct. These could

include changes to the alignment of roads, roundabouts, pedestrian crossings, speed humps, traffic islands, or 's-curves' along straight sections of road to slow traffic.

Due to the location of the proposed neighbourhood centre in North Ingleside (adjacent to Mona Vale Road), the alignment of the intersection of Mona Vale Road / Lane Cove Road / Manor Road will need to be considered as part of any review of the proposed centre.

3.4.4 Local traffic access options – South Ingleside

Powderworks Road currently accommodates a portion of regional east-west through traffic, particularly as it is the fastest route for residents of North Narrabeen and Narrabeen to access the west. With the development of Ingleside, measures to dissuade through traffic from using Powderworks Road should inform the development of the South Ingleside local road network and the final Structure Plan. Potential options for mitigating the traffic impacts along Powderworks Road will need to consider:

1. Traffic calming along Powderworks Road (within the Ingleside Precinct);
2. Re-directing the collector road corridor to make it more circuitous;
3. Closing Powderworks Road to through traffic in favour of using Manor Road and Wattle Street as the primary collector route in South Ingleside.

The nature of Powderworks Road through Ingleside should ultimately be similar to Powderworks Road through Elanora Heights, with lower traffic speeds and traffic calming infrastructure. Its function is intended to be more aligned toward local access through South Ingleside, rather than a route for through traffic to be encouraged. There will be limited direct access from individual properties onto Powerworks Road.

3.4.5 Public transport and active travel

As part of the preliminary assessment of the DSP, all collector road routes were identified as requiring bus capability and cycle routes. At a minimum, this would ensure connectivity and access for all modes of travel within the precinct and particularly for residents not in proximity to Mona Vale Road. Other potential bus and cycle routes have been identified as part of this assessment, following development of the DSP.

4.0 Road Network

4.1 Introduction

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

4.2 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 precinct? 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?

4.2.1 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 2** shows the Austroads classifications and a description of the functionality of each road type.

Table 2 : Urban Road Functional Classification (Austroads)

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

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

Roads and Maritime Services (formerly NSW Roads & Traffic Authority) also provide guidelines for both the administrative and functional classification of roads. **Table 3** summarises the Roads and Maritime functional classification system.

Table 3: Functional Classification of Roads (Roads and Maritime)

Functional Classification	Administrative System	Role and Network Management Principles
Motorway	State roads	- Highest form of arterial road that is considered separately due primarily to traffic function and strict access control via grade separated interchanges. - Major inter-regional traffic movement in a safe and operationally efficient manner. - Traffic movement function and related aspects of capacity, congestion, speed and safety dominate network management.
Arterial roads	State Roads	- Major regional and inter-regional traffic movement in a safe and operationally efficient manner. - Provide connection between motorways and sub-arterial roads. - Commercial, industrial access requirements and public transport initiatives need special consideration in developing network management strategies. On modern arterial roads, where possible, access to land should be limited. - Balance between traffic function and access should favour traffic movement, focusing on capacity and congestion management. - Planning and design of new arterials should consider the desired balance in terms of types of abutting land-use, land-use interactions, level of access control and encourage developments that are compatible with road function.
Sub-arterial Roads	Regional Roads	- Higher order sub-arterial roads may provide a support role to urban arterial roads for the movement of traffic during peak periods. - Provide connection between arterial roads and local roads. - Distribute traffic and bus services within residential, commercial and industrial built-up areas. - May have been designed as local streets, but which have additional traffic functions, usually serving major traffic generators or non-local traffic movements. - Strategies require managing the balance between the traffic movement function, and the need for access. - Appearance should be appropriate to the surrounding 'living' environment.
Collector roads and local roads	Local roads	- Serve several functions to varying degrees. Typical functions include: · Providing vehicular access to abutting property and surrounding streets. · Providing access for emergency and service vehicles. · Providing network for the movement of pedestrians and cyclists. · Providing a means to enable social interaction within a neighbourhood, e.g. serving as a play area or community open space. · Contributing visually to the 'living' environment. - Should connect where practicable, only to sub-arterial roads. - Strategies and design should convey to users that the local road is not the sole domain of the motor vehicle.

Source: Network and Corridor Planning Practice Notes, Roads and Maritime, 2008

4.2.2 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 4.2.3**.

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

LoS	Description	Hourly flow (vehicles)	
		1 Lane	2 Lanes
A	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.	200	900
B	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.	380	1,400
C	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.	600	1,800
D	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.	900	2,200
E	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.	1,400	2,800

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

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.

4.2.3 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

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

Source: Guide to Traffic Generating Developments, 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.

4.3 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 10** overleaf. The following roads are located within North Ingleside / Bayview Heights:

- **Minkara Road**
- Walter Road
- **Chiltern Road**
- **Cabbage Tree Road**
- Cicada Glen Road
- **Lane Cove Road**
- View Road
- Boronia Road
- Ingleside Road
- Laurel Road West

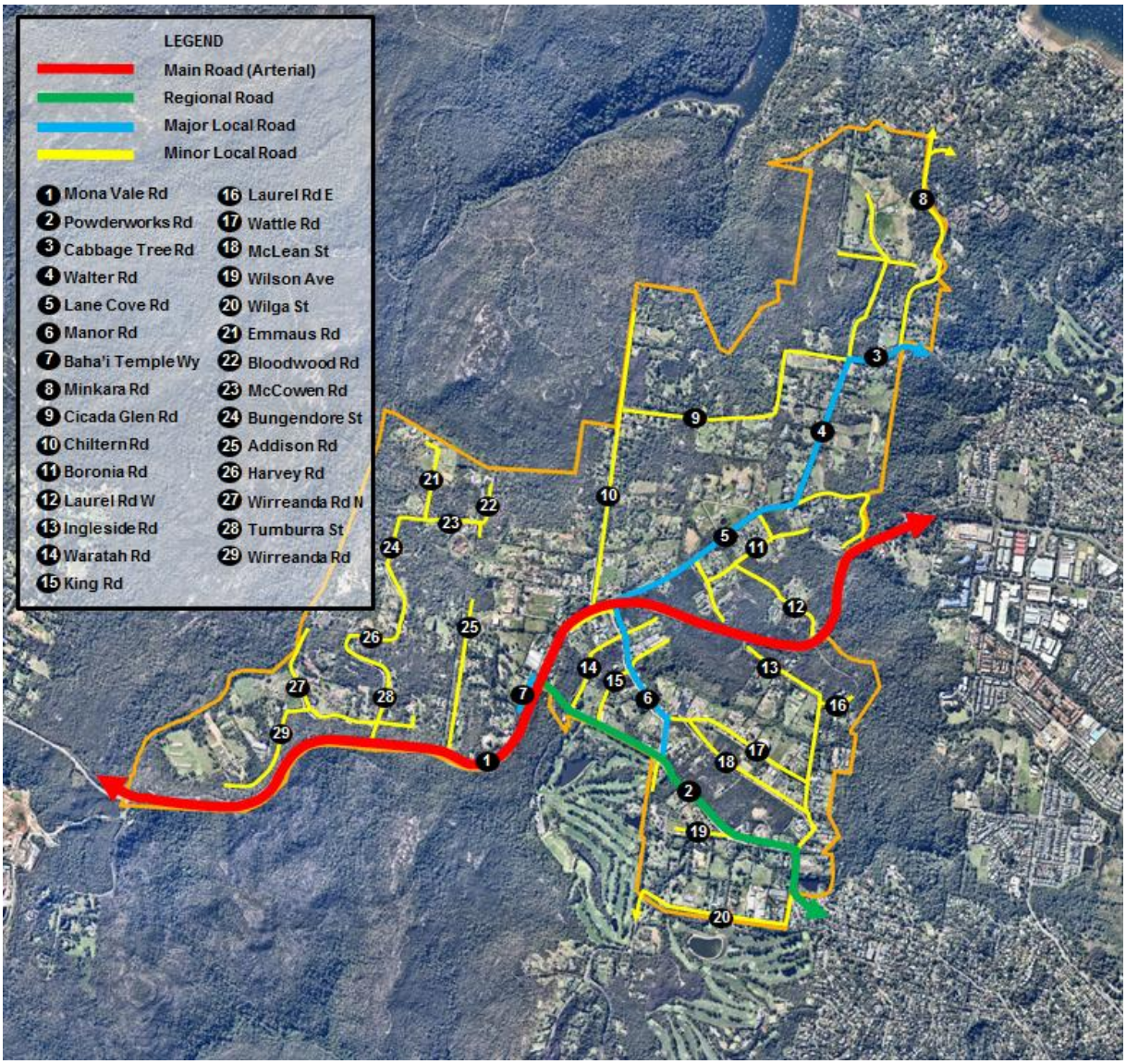
The following roads are located within South Ingleside:

- **Manor Road**
- **Mona Vale Road**
- Waratah Road
- King Road
- Ingleside Road
- Laurel Road East
- **Powderworks Road**
- Wattle Road
- McLean Street
- Wilson Avenue
- Wilga Street

The following roads are located within Wirreanda Valley:

- Emmaus Road
- Bloodwood Road
- McCowen Road
- **Addison Road**
- Bungendore Street
- Wirreanda Road North
- Harvey Road
- **Tumburra Street**
- **Baha'i Temple Way**
- Wirreanda Road

Figure 9: Ingleside Precinct Existing Road Network



Source: AECOM, 2015

The key transport corridor within the study area is Mona Vale Road. This route links Pittwater Road in the east to Chatswood and Macquarie Park in the west. Powderworks Road also runs through the precinct connecting Mona Vale Road to Garden Street. This route offers an alternate east/west route through the precinct. Lane Cove Road and Cabbage Tree Road also provide a connection between Mona Vale Road and Pittwater Road via a lower order circuitous route.

4.3.1 Description of key roads within Ingleside

Mona Vale Road

Mona Vale Road runs 20km from Mona Vale (at the intersection with Pittwater Road) to the Pacific Highway at Pymble, passing through the study area at Ingleside, as well as the suburbs of Terrey Hills and St Ives. The road is an integral component of the transport network in the north-east region of Sydney and plays a crucial role linking major urban areas. It is a classified main road under the control of Roads and Maritime Services and varies in size from two to four lanes. Adjacent to the Ingleside Precinct accesses, Mona Vale Road is four lanes wide. It narrows to become two lanes east of Manor Road through the steep terrain of the Ingleside Chase Reserve and between Powderworks Road and Terrey Hills. Mona Vale Road has a speed limit of 70 km/h through Ingleside.

Mona Vale Road provides five existing accesses to Ingleside, including the Wirreanda Valley sub-precinct via Tumburra Street, Addison Road, Powderworks Road / Baha'i Temple Way, Chiltern Road and Lane Cove Road / Manor Road. The Roads and Maritime has a permanent traffic counter location on Mona Vale Road 300m east of Kimbriki Road showing that daily vehicle movements are currently in the order of 18,000 per day in each direction. The key signalised intersections at Powderworks Road / Baha'i Temple Way, Lane Cove Road / Manor Road, are near capacity during peak hours.

Bus stops exist in both directions on Mona Vale Road south of Powderworks Road and at Chiltern Road in the form of indented bus bays. Provision of services is low, with route 196 and 197 providing approximately four peak hour services in each direction on weekdays.

Powderworks Road

Powderworks Road is a Regional Road (Regional Roads are under the care of the Council with part funding provided by Roads and Maritime) running east / west through Ingleside / Elanora Heights between Garden Street and Mona Vale Road. It is two lanes wide and has a speed limit of 50 km/h east of Wilga Street and 60 km/h west of Wilga Street. Powderworks Road is identified by the Mona Vale to Macquarie Park Corridor Strategy (2009) as the only parallel route to Mona Vale Road that can act as an alternative route to Mona Vale Road. In this regard, Powderworks Road currently accommodates a portion of through traffic, particularly for those accessing Narrabeen, North Narrabeen and Elanora Heights where it provides the fastest route towards Sydney's west.

Where Powderworks Road passes through South Ingleside it is relatively unconstrained currently, with few property accesses or traffic calming measures and minimal pedestrian infrastructure. However within Elanora Heights, Powderworks Road is constrained by topography, has a high number of property accesses, and significant traffic calming and pedestrian islands. Delays can occur at the intersections on each end of the road corridor where Powderworks Road meets Mona Vale Road and Garden Street at signalised intersections. Sydney bus routes 183 and E83 utilise Powderworks Road (east of Kalang Road) however these services do not extend into Ingleside. Powderworks Road also accommodates a school bus route.

Lane Cove Road / Walter Road

Lane Cove Road and Walter Road are classified as local roads and form a connection between Mona Vale Road and Cabbage Tree Road. They are two lanes wide and have a speed limit of 50km/h. Although these are local roads, they form an alternate route (to Mona Vale Road) for connecting between Ingleside and Mona Vale. As such, they accommodate a proportion of through traffic and together function more like a collector road or regional route.

Chiltern Road / Cicada Glen Road / Cabbage Tree Road

Chiltern Road, Cicada Glen Road and Cabbage Tree Road are classified as local roads and form a connection between Mona Vale Road and Samuel Street. To the west of Walter Road, they are narrow, rural roads, however Cabbage Tree Road to the east of Walter Road is two lanes wide. They have a speed limit of 50km/h. Although these are local roads, they also form an alternate route (to Mona Vale Road) for connecting between Ingleside and Mona Vale. As this route is slightly less direct, and with a narrower carriageway in comparison to the Lane Cove Road / Walter Road corridor, it accommodates a lower proportion of through traffic.

Manor Road / Wattle Road

Manor Road and the portion of Wattle Road located between Manor Road and Powderworks Road are classified as local roads and provide a connection between Mona Vale Road / Lane Cove Road in the north, and Powderworks Road in the south. They are two lanes wide and have a speed limit of 50km/hr. This route functions more like a collector road as it has the widest carriageway of all roads located between Mona Vale Road and Powderworks Road.

Baha'i Temple Way

Baha'i Temple Way is a local road that provides access to the Baha'i Temple from Mona Vale Road and Powderworks Road. The road is three lanes wide, with one lane southbound and two lanes northbound (as this is the approach to the signalised intersection with Mona Vale Road and Powderworks Road. It has a speed limit of 50km/hr.

Minkara Road

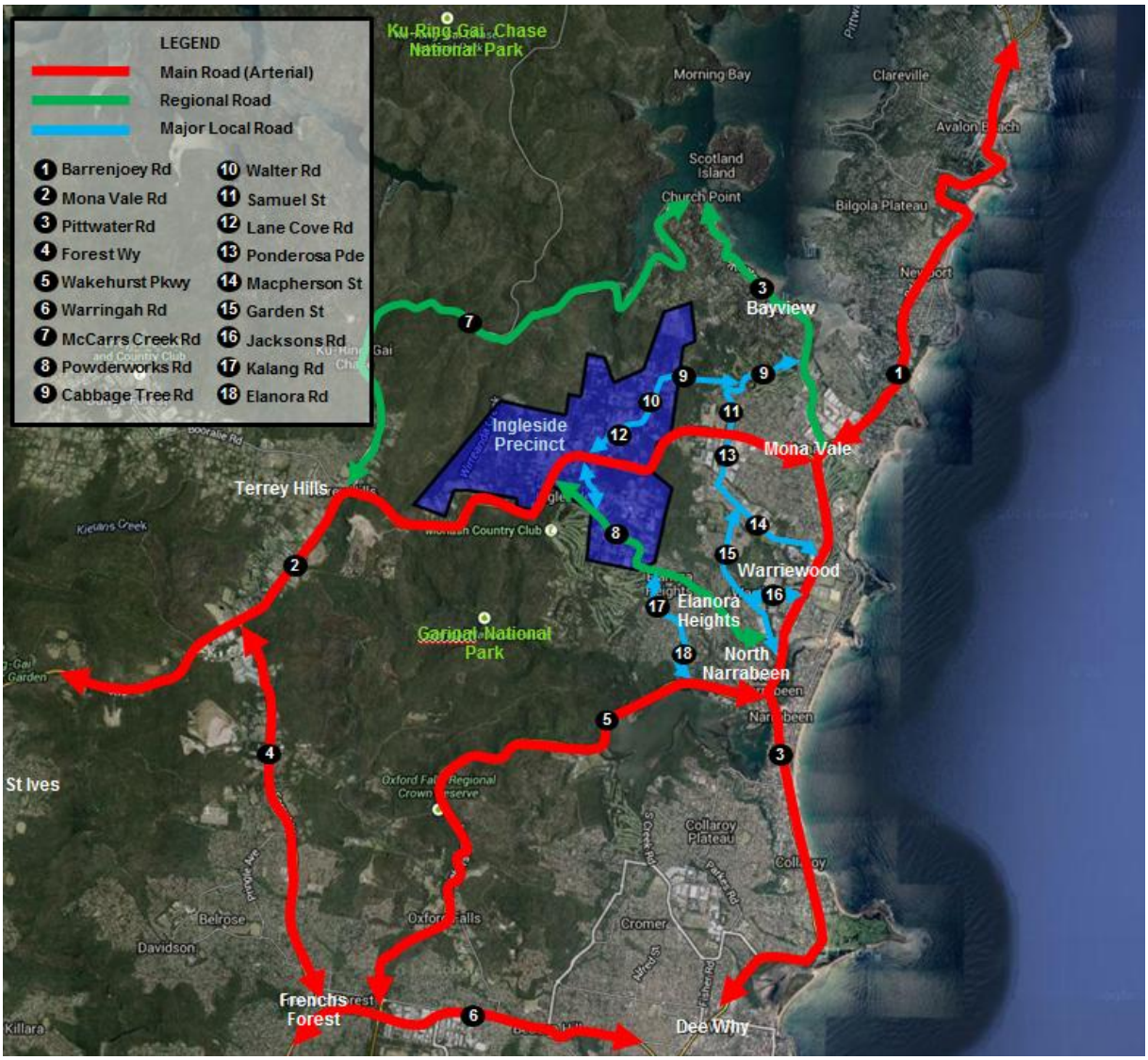
Minkara Road is classified as a local road and provides a connection between Ingleside and Bayview Heights. South of Narla Road, the carriageway is two lanes wide and functions more like a collector road. To the north of Narla Road the carriageway becomes narrower as it does not cater for through traffic. It has a speed limit of 50km/hr.

Tumburra Street

Tumburra Street is classified as a local road and is the primary access to Wirreanda Valley (from Mona Vale Road). Like all roads in Wirreanda Valley, Tumburra Street is a narrow rural road with a speed limit of 50km/hr.

4.3.2 Description of key roads within wider study area

Figure 10: Wider Strategic Road Network



Source: AECOM, 2015

Wakehurst Parkway

Wakehurst Parkway runs from North Narrabeen to North Balgowlah, passing through the suburbs of Oxford Falls and Frenchs Forest (where it provides a connection to Warringah Road). It is a classified main road under the control of Roads and Maritime and is two lanes wide along the majority of its length (other than a six lane section between Warringah Road and Frenchs Forest Road). It has a speed limit of 70 km/h east of Elanora Road and 80 km/h west of Elanora Road. Wakehurst Parkway connects to the study area via Elanora Road and Pittwater Road and is also an option for travel between the study area and Central Sydney.

Pittwater Road

Pittwater Road is located on the northern beaches and runs from Manly in the south to Mona Vale in the north, passing through a number of centres including Brookvale, Dee Why, Collaroy and Narrabeen. It is a Classified Main Road (controlled by Roads and Maritime) between Narrabeen Lagoon and Barrenjoey Road and varies in size from two to six lanes. It has a speed limit of 70 km/h within Pittwater (other than a small 60 km/h section north of Vineyard Street. North of Mona Vale, Pittwater Road continues as a regional route (under care of Pittwater Council) to Church Point with a speed limit of 50 km/h.

Garden Street

Garden Street is a sub-arterial road which runs from Macpherson Street at its northern end to Pittwater Road in the south, intersecting with Jacksons Road (Warriewood Square) and Powderworks Road en-route. It has two to four lanes and a speed limit of 50 km/h.

Ponderosa Parade

Ponderosa Parade runs from Mona Vale Road at its northern end and becomes Macpherson Street prior to the Forest Road roundabout at its southern end. It provides connectivity to new development in the area, has two lanes and a speed limit of 50 km/h. Ponderosa Parade also forms part of the "Garden Street corridor" referred to as part of this study. The Garden Street corridor includes Garden Street and Macpherson Street, and provides a parallel northbound route to Pittwater Road.

Macpherson Street

Macpherson Street is a sub-arterial road running from Warriewood Street at its eastern end in a North West direction to its intersection with Ponderosa Parade. It provides connectivity to new development in the area, has two lanes and a speed limit of 50 km/h. To the west of Garden Street, Macpherson Street forms part of the "Garden Street corridor" referred to within this study. The Garden Street corridor also includes Garden Street and Ponderosa Parade, and provides a parallel northbound route to Pittwater Road.

Jacksons Road

Jacksons Road gives access to Warriewood Square shopping centre, and goes from Garden Street in the west to Pittwater Road in the east. It has a speed limit of 40 km/h due to high pedestrian activity around the shopping centre, and has two to four lanes.

Elanora Road

Elanora Road is a local road running north / south through Elanora Heights connecting Powderworks Road to Wakehurst Parkway. It has two lanes but is narrow in places and has a speed limit of 50 km/h. Elanora Road climbs steeply between Wakehurst Parkway and Weeroona Avenue, with a number of sharp bends requiring a low speed. North of Weeroona Avenue, Elanora Road is a more typical local road, with pedestrian infrastructure, traffic calming measures and residential accesses on both sides. Elanora Road is the fastest route for residents of Elanora Heights and Ingleside to access Wakehurst Parkway. As Elanora Road is a local road, this route can be considered a rat-run.

Kalang Road

Kalang Road is a local road connecting Elanora Road to Powderworks Road, with two lanes and a speed limit 50 km/h. Kalang Road also provides access to the small village centre at Elanora Heights which has a number of angle parking spaces (restricted to 2 hours between 8am and 5pm). This study refers to "Elanora / Kalang" corridor, as this route provides access between Ingleside and Wakehurst Parkway.

4.4 Existing traffic volumes

4.4.1 Roads and Maritime historical data

The most recent average daily traffic (ADT) data for Mona Vale Road was collected by Roads and Maritime in 2013. The data was obtained from two non-permanent mid-block counting stations located along Mona Vale Road (as shown in **Figure 2.6**) and provide ADT data in both directions. The counting stations are located at the following locations:

- Mona Vale Road, Ingleside – west of Tumburra Street (57.017)
- Mona Vale Road, Ingleside – 300m east of Kimbriki Road (57.024).

Table 6 shows the historical growth experienced at the two counting stations. These two stations are located approximately 600m apart (as shown in **Figure 11**) which are considered to be comparable as one location.

Table 6: Roads and Maritime historical traffic data

Station	Two-way traffic volumes						
	Location	1999	2002	2005	2012	2013	% Growth p/a
57.017	Mona Vale Road, Ingleside, West of Tumburra Street	29,170*	30,548*	28,584*	-	-	-0.34% (1999-2005)
57.024	Mona Vale Road, Ingleside, 300m east of Kimbriki Road	-	-	-	30,700**	30,839**	0.45% (2012-2013)

Source: Roads and Maritime 2014

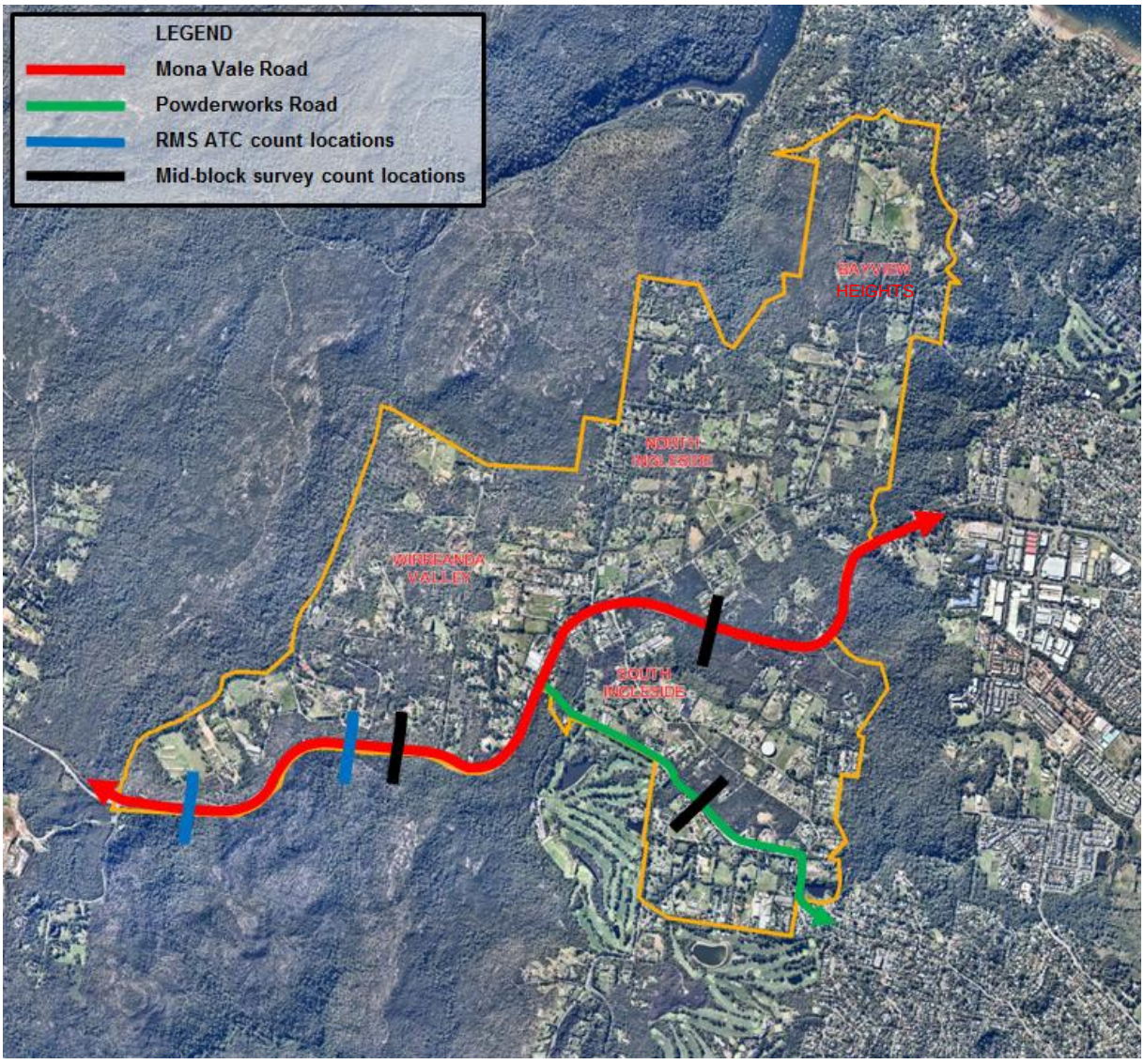
Note: *count in axle pairs **count in vehicles

The table shows that the average annual historical traffic growth for Mona Vale Road is very low ranging from -0.34 per cent to 0.45 per cent per annum.

4.4.2 Mid-block traffic counts

Mid-block traffic surveys have been undertaken in December 2013 to measure current traffic volumes at the key locations. The automatic traffic count (ATC) tubes were located on Mona Vale Road 500m east of Lane Cove Road / Manor Road, on Mona Vale Road between Foley Street and Oliver Way and on Powderworks Road between Wattle Road and Wilson Avenue as shown in **Figure 11**.

Figure 11: Mid-block traffic count locations



Source: AECOM, 2015

Table 7: 2013 Mid-block traffic summary

Location	Two-way traffic volumes			
	Average Weekday Traffic (veh/day)	Average Daily Traffic (veh/day)	AM Weekday Peak Hour Traffic (veh/hr) (hour beginning)	PM Weekday Peak Hour Traffic (veh/hr) (hour beginning)
Mona Vale Road, 150m east of Tumburra Street	36,907	36,071	2,778 (08:00)	3,009 (08:00)
Mona Vale Road, 500m east of Lane Cove Road / Manor Road	21,978	21,585	1,550 (06:00)	1,765 (16:00)
Powderworks Road, between Wattle Road and Wilson Avenue	12,164	11,800	962 (08:00)	1032 (16:00)

Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

Table 5 indicates that the average weekday traffic volume on Mona Vale Road, 150m east of Tumburra Street is 36,910, while the average weekday traffic flow on Mona Vale Road, 500m east of Lane Cove Road / Manor Road is 21,980 vehicles. The difference in traffic volumes between the two count locations on Mona Vale Road largely reflects the average weekday traffic flow of 12,160 vehicles using Powderworks Road, which absorbs a considerable proportion of the through traffic.

It was also observed that the average weekday traffic is very similar to the average daily traffic implying that similar traffic occurs on weekdays and weekends.

The peak hour for traffic volumes in the study area is between 8 and 9am in the morning and between 4pm and 5pm in the afternoon.

Mode split data for neighbouring suburbs shows that a high proportion of trips are made by private car. This presents a challenge for future development of the Ingleside Precinct to ensure that suitable alternatives are provided to the private car in the form of public transport services and active travel infrastructure

4.4.3 Existing Traffic Distribution

Journey to Work data for neighbouring residential suburbs (Elanora Heights and North Narrabeen) shows that approximately one third of journeys are within the Pittwater LGA, another third are south to Warringah / Manly, with the remaining third travelling to the west toward Chatswood and the Sydney CBD.

The existing daily trip distribution pattern along the major road corridors within the precinct is summarised in **Table 8**. The counts at the surveyed sites have an approximate 50 / 50 eastbound / westbound split of the average daily traffic distribution.

Table 8: 2013 Traffic Distribution

Location	ADT traffic distribution				
	ADT	EB	WB	EB%	WB%
Mona Vale Road, 150m east of Tumburra Street	36,071	17,877	18,194	50%	50%
Mona Vale Road, 500m east of Lane Cove Road / Manor Road	21,585	10806	10,778	50%	50%
Powderworks Road, between Wattle Road and Wilson Avenue	11,800	5,801	5,999	49%	51%

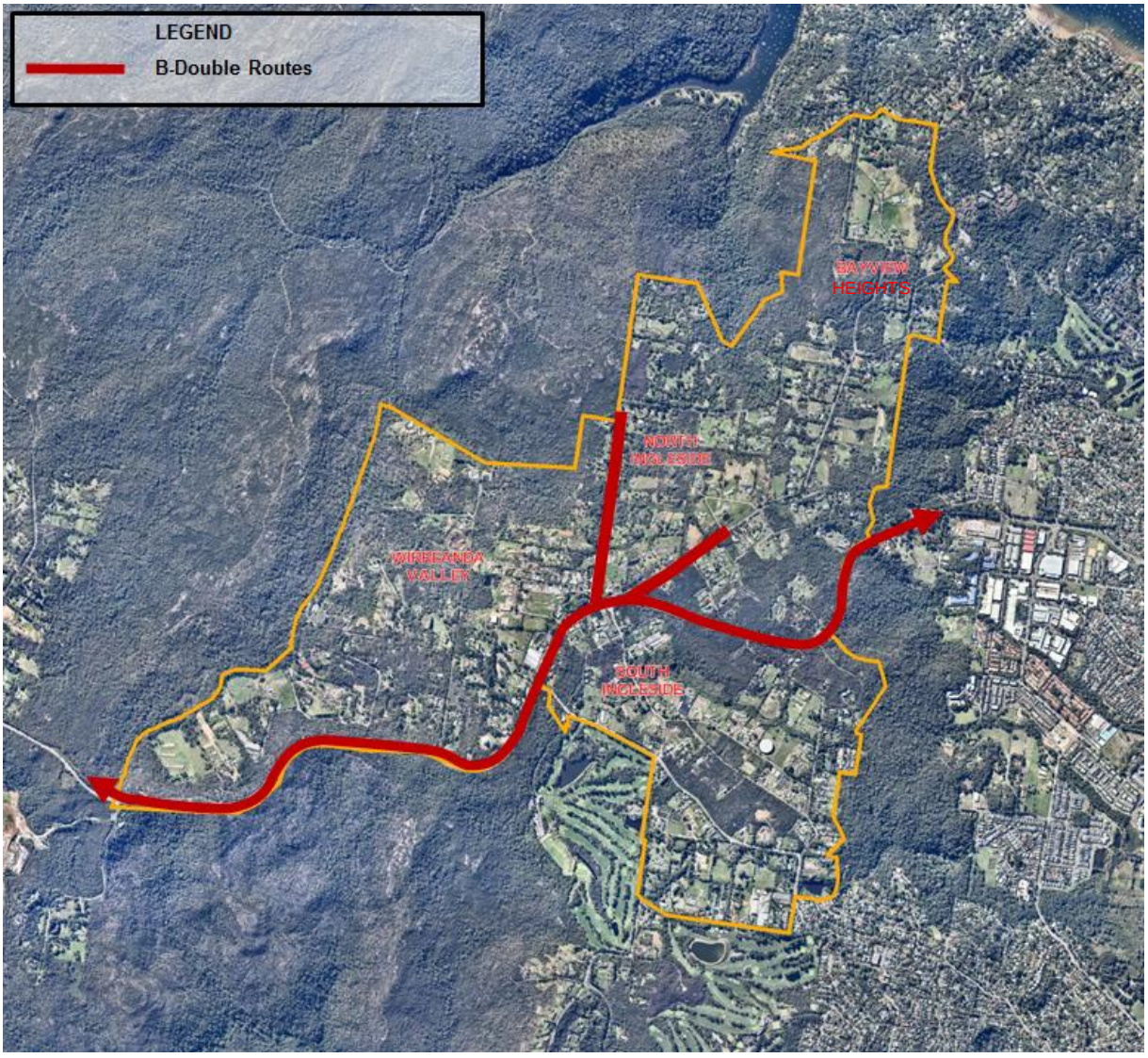
Source: AECOM, based on traffic data collected between 3/12/13 and 9/12/13

4.4.4 Heavy Goods Vehicles

Mona Vale Road is frequently used by Heavy Good Vehicles (HGVs) and is the main east-west connector in northern Sydney for HGVs. As a designated B-Double route it is capable of accommodating large HGVs. Key connecting B-Double routes include Pittwater Road, Barrenjoey Road, Forest Way and the Pacific Highway. Within the Ingleside Precinct, Chiltern Road is also classified as a B-Double route.

Figure 12 shows designated B-Double routes. Mona Vale Road is designated a B-Double route for trucks up to 26m in length with connections to other B-Double routes in the wider area. In addition the southern sections of Chiltern Road and Lane Cove Road are designated B-Double routes for trucks up to 19m. The route caters to demand servicing the equine industry.

Figure 12: B-Double Routes



Source: AECOM, 2015

4.4.5 Existing Intersection Controls within Ingleside

Existing intersection controls within the vicinity of the precinct consist of two signalised intersections at Mona Vale Road / Powderworks Road / Baha'i Temple Way and Mona Vale Road / Lane Cove Road / Manor Road, Seagull intersections at Mona Vale Road / Tumburra Street (including a left turn slip lane into Tumburra Street) and Mona Vale Road / Chiltern Road. Note that the intersection of Mona Vale Road / Tumburra Street is scheduled for upgrade as part of the proposed Mona Vale Road upgrade. **Table 9** provides a more detailed summary of the most significant intersections.

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.

Table 9: Details of existing key access intersections within the precinct

Key Intersection	Control Type	Access Description
Mona Vale Road / Tumburra Street	3-Arm Priority	Mona Vale Road forms the major east and west arms, with Tumburra Street forming the north arm. This intersection operates as a seagull intersection with turning bays located on Mona Vale Road as well as a left-turn slip lane into Tumburra Street. Although this intersection is relatively minor, it provides the only access to Wirreanda Valley.
Mona Vale Road / Powderworks Road / Baha'i Temple Way	Signals	This four arm intersection facilitates collector and local road connections to Mona Vale Road. Powderworks Road, which forms the eastern intersection arm, is a regional road linking Mona Vale Road at Ingleside to Pittwater Road at Narrabeen, while providing local access to Mona Vale Road from Ingleside and Elanora Heights, including the small village centre at Elanora Heights. Baha'i Temple Way forms the western intersection arm and provides direct access to the National Baha'i Centre, as well as a limited local residential connection. Mona Vale Road forms the major north and south arms of the intersection.
Mona Vale Road / Chiltern Road	3-Arm Priority (Seagull)	This priority intersection is located a short distance to the west of the Mona Vale Road / Lane Cove Road / Manor Road intersection. Mona Vale Road forms the major east and west arms, with Chiltern Road the north arm. A seagull priority arrangement is in operation at this intersection (turning bays located on Mona Vale Road.
Mona Vale Road / Lane Cove Road / Manor Road	Signals	At this intersection Lane Cove Road forms the northern arm, providing collector access extending towards Church Point in the north. Manor Road forms the south intersection arm, and is a local road which provides alternate access to Powderworks Road in the south east, and also connects through low density residential areas at the eastern end of Ingleside. Mona Vale Road forms the major east and west arms of the intersection.
Walter Road / Cabbage Tree Road	4-arm Priority	This four arm priority intersection consists of local roads only, however it is important because all 'rat running' traffic through North Ingleside utilises the intersection regardless of whether they use the Chiltern Road route or the Lane Cove Road / Walter Road route.
Powderworks Road / Wattle Road	4-arm priority	This four arm priority intersection does not provide a strategic traffic function other than serving the primary local route between Powderworks Road and North Ingleside.
Powderworks Road / Ingleside Road	3–arm priority	This three arm priority intersection does not provide a strategic traffic function. However It's position on a 90 degree bend in Powderworks Road makes it an important strategic location for access to parts of South Ingleside.

Source: AECOM, 2015

4.4.6 Rat Running

Rat running occurs at a number of locations in the wider area. The primary rat runs relevant to Ingleside have been identified at the following locations:

- Within **Elanora Heights**, a proportion of vehicles utilise the local road network to access Wakehurst Parkway and travel via Frenchs Forest. This involves driving along the steep and windy Elanora Road. It is unlikely that vehicles from Ingleside will utilise this route, as an upgraded Mona Vale Road will represent a faster route to the Northern Beaches Hospital at Frenchs Forest for Ingleside residents.
- Within **North Ingleside**, Lane Cove Road / Walter Road / Cabbage Tree Road and Chiltern Road / Cicada Glen Road / Cabbage Tree Road provide an alternate route (in addition to Mona Vale Road) between Ingleside and Bayview Heights. The Ingleside development is likely to increase the local use of these routes, but is also likely to dissuade some through traffic given that traffic will move more slowly through North Ingleside once it is developed and the Mona Vale Road Upgrade has been completed.
- **Powderworks Road** provides an alternate route (in addition to Mona Vale Road) between Ingleside and North Narrabeen (and neighbouring suburbs). This represents the fastest and shortest route between these locations, with a relatively high volume of through traffic utilising the route in comparison to other rat runs in the area. The Ingleside development is likely to increase the local use of these routes, but is also likely to dissuade some through traffic given that traffic will move more slowly once South Ingleside has been developed and the Mona Vale Road Upgrade has been completed. Overall traffic volumes are still expected to rise.
- **Warraba Road** is a local road that allows vehicles travelling east on Powderworks Road to access Garden Street without passing through the signalised intersection of Powderworks Road / Garden Street. The Ingleside development is unlikely to have a significant impact on this route, as the majority of vehicles accessing the Warriewood Valley are expected to utilise the upgraded Mona Vale Road.

4.5 Network Performance

4.5.1 Mid-block capacity

The volume to capacity (V/C) ratio is a method of assessing congested conditions on road links between intersections and is summarised in **Table 10**. A V/C ratio greater than 1.00 indicates the section of roadway is over capacity and will not operate efficiently. For uninterrupted linkages, the *Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis* identifies mid-block capacity. The following mid-block capacities and categories were assumed:

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

Table 10: Midblock counts on local road network in study area

Location	AM peak hour (veh/hr)		PM peak hour (veh/hr)	
	Peak direction flow (westbound)	Volume capacity ratio	Peak direction flow (eastbound)	Volume capacity ratio
Mona Vale Road 150m east of Tumburra Street	1,654	0.97	1,723	1.01
Mona Vale Road 500m east of Lane Cove Road	941	0.55	869	0.51
Powderworks Road east of Wattle Road	620	0.36	643	0.38

Source: AECOM, based on traffic data collected between 3/12/13 to 9/12/13

During the AM peak, Mona Vale Road immediately to the east of Tumburra Street is operating at or over capacity with congestion problems in the westbound direction. In the PM peak, traffic volumes are generally higher in the eastbound direction and congestion is experienced at this location. The traffic data also suggests that current traffic flows on Mona Vale Road east of Lane Cove Road are relatively low and there is reserve capacity on the corridor. However, the actual capacity of the road is reduced due to limiting capacity at intersections as well as lack of overtaking opportunities, especially when heavy vehicles are climbing the grade and slowing down all other vehicles.

The difference in traffic flows between the two locations on Mona Vale Road is largely due to vehicles utilising Powderworks Road instead of Mona Vale Road to the east of Lane Cove Road. It can be seen from the traffic data that the equivalent of 37 percent of the traffic on Mona Vale Road east of Tumburra Street utilises Powderworks Road. The traffic data also suggests that current traffic flows along Powderworks Road are relatively low and there is reserve capacity on the corridor. However, the actual capacity of the road is reduced due to the changed nature of the road through the Elanora Heights residential area and limited capacity at intersections.

Local and collector roads within the Ingleside Precinct currently have low traffic volumes befitting the rural nature of the area.

4.5.2 Existing Intersection Performance

Intersection turning count surveys recorded by SkyHigh Traffic were used as inputs to estimate the existing traffic demands within the Ingleside Precinct. The data was recorded in fifteen (15) minute segments during the AM peak and PM peak periods between 07:00 - 09:00 and 16:00 - 18:00 respectively at key intersections.

The assessment of intersection performance is typically based on the Level of Service as defined in the *Guide to Traffic Generating Developments, NSW, RMS 2002*. **Table 11** outlines the six levels of service for intersections, with LoS A representing optimum operating conditions and LoS F the poorest.

Table 11: Level of Service Criteria

Level of Service	Average delay per vehicle (seconds)	Traffic signals / Roundabouts	Give way / Stop signs
A	< 14	Good operation	Good operation
B	15 to 28	Good with acceptable delay	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays	At capacity; requires other control mode
F	> 70	Extra capacity required	At capacity; requires other control mode

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

Intersection turning count surveys recorded by SkyHigh Traffic were used as inputs to estimate the existing traffic demands at key intersections. The traffic demands were assessed using a combination of VISSIM modelling (for Mona Vale Road intersections) and SIDRA (for non-Mona Vale Road intersections). The performance of key intersections is shown in **Table 12**.

Table 12: Existing peak hour intersection performance summary

Intersection	AM Peak		PM Peak	
	Avg. Delay (s)	LOS	Avg. Delay (s)	LOS
Mona Vale Road / Powderworks Road / Baha'i Temple Way*	20.0	LOS B	15.2	LOS B
Mona Vale Road / Chiltern Road*	10.1	LOS A	13.1	LOS A
Mona Vale Road / Lane Cove Road / Manor Road*	16.2	LOS B	10.4	LOS A
Mona Vale Road / Samuel Street / Ponderosa Parade*	53.0	LOS D	88.4	LOS F
Mona Vale Road / Pittwater Road***	21.8	LOS B	37.2	LOS C
Powderworks Rd & Wattle Rd**	15.4	LOS B	14.1	LOS B
Powderworks Rd & Ingleside Rd**	13.2	LOS A	13.8	LOS A
Powderworks Rd & Garden Street**	17.1	LOS B	22.5	LOS B
Pittwater Road & Garden Street**	19.1	LOS B	21.7	LOS B
Cabbage Tree Road / Walter Road***	10.0	LOS A	10.0	LOS A
Cabbage Tree Road / Samuel Street***	7.7	LOS B	7.0	LOS B

Source: AECOM, 2013

* Sourced from Draft Mona Vale Road Upgrade Study for RMS, February 2015 (VISSIM modelling)

** Sourced from the Powderworks Road Corridor Assessment for Pittwater Council, February 2013 (SIDRA)

*** 2015 SIDRA outputs (in the case of Mona Vale Road / Pittwater Road this is to reflect a changed layout)

The majority of the intersections in the study area operate within capacity at level of service (LoS D or better) with the exception of the intersection of Mona Vale Road | Samuel Street | Ponderosa Parade under existing traffic conditions during the PM peak. This intersection will be upgraded to a signalised intersection as part of the proposed Mona Vale Road Upgrade East.

It should be noted that the results presented in **Table 12** reflect intersections operating in isolation (opposed to within a network), as such they do not reflect constraints at merges along Mona Vale Road. These merges often cause traffic to queue back through some intersections (particularly at Mona Vale Road / Power Works Road / Baha'i Temple Way). Therefore this queueing should not be attributed to the actual performance or function of the intersections assessed.

4.6 Proposed Road Network

This section outlines considerations for the development of the road network within Ingleside, which is based on the existing road network with some adjustments and additions, as shown in **Figure 13**.

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

- Maximising accessibility to the road network
- Access across Mona Vale Road, which divides the precinct
- Providing sufficient road network access to proposed neighbourhood and local centres
- Providing a sufficient road network across the Cicada Glen Creek and Mullet 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
- Considering proposed new infrastructure such as the Mona Vale Road upgrade, Northern Beaches Hospital and major bus improvements

4.6.1 Precinct access

Access to the wider Sydney region is provided by Mona Vale Road, a four lane arterial road through the centre of the precinct. The number of access points to the precinct is limited by the proposed Mona Vale Road upgrade design as well as topography. Details of precinct connectivity are outlined below and summarised in **Figure 13**.

The final DSP includes three access points from which the North and South Ingleside recincts can be accessed from Mona Vale Road:

- Powderworks Road / Baha'i Temple Way
- Chiltern Road
- The deviated Lane Cove Road / Manor Road.

Three further connections are provided to the precinct (without utilising Mona Vale Road):

- Minkara Road / Narla Road
- Cabbage Tree Road
- Powderworks Road.

Table 13 provides a summary of existing and proposed Ingleside Precinct access and identifies the changes likely to be required as a result of the proposed Mona Vale Road Upgrade and Ingleside development.

Table 13: Precinct Access – Upgrades Proposed

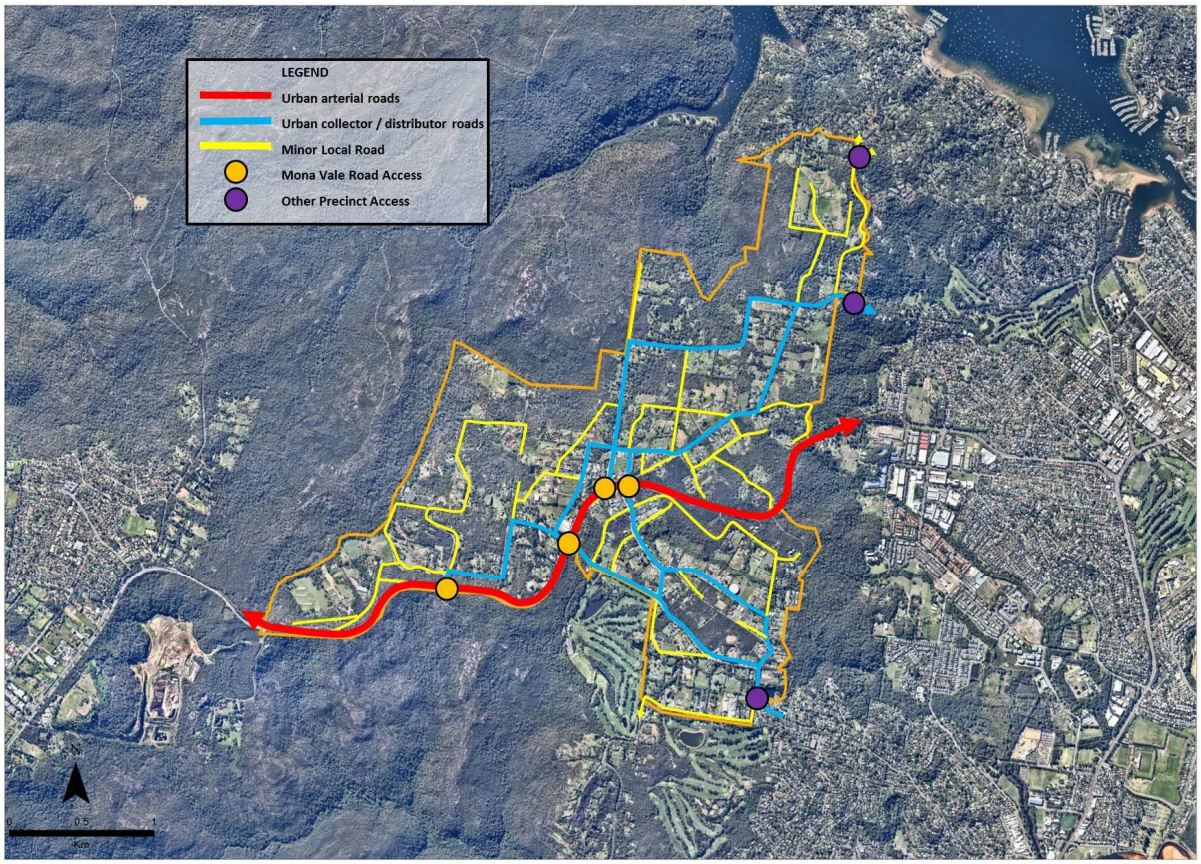
Location	Existing Layout	Changes Likely to be required	Possible Future Layout
Powderworks Road / Baha'i Temple Way intersection	4-arm signalised intersection	Realignment of Baha'i Temple Way as part of Ingleside development	4-arm signalised intersection
Chiltern Road intersection	3-arm seagull priority intersection	Right turn movements closed as part of Ingleside development	3-arm left in / left out intersection
Lane Cove Road / Manor Road intersection	4-arm signalised intersection	Deviation of Lane Cove Road as part of Ingleside development	4-arm signalised intersection
Minkara Road / Narla Road	Local Road	No changes	Local Road
Cabbage Tree Road	Collector Road	No changes	Collector Road
Powderworks Road at Wilga Street	Sub-arterial road	Roundabout provided to facilitate access to Wilga-Wilson as part of Ingleside development	Sub-arterial Road / roundabout

Source: AECOM, 2015

Mona Vale Road provides the main access to North Ingleside (at Chiltern Road and Lane Cove Road). However, with Cicada Glen Road / Cabbage Tree Road and Lane Cove Road / Walter Road becoming main internal collector road routes, they could potentially carry some additional traffic to access Mona Vale Town Centre and other areas to the east

There are options for the internal road network to mitigate against the potential over-use of collector roads in North Ingleside through the use of traffic calming measures to slow the speed through the precinct (thus making other routes, such as Mona Vale Road, more attractive for through traffic). These could include roundabouts, pedestrian crossings, speed humps, traffic islands, or 's-curves' along straight sections of road to slow traffic.

Figure 13: Proposed precinct access and outline road network



Source: AECOM, 2015

4.7 Road network analysis (Traffic modelling)

In order to confirm the road network and access requirements for the precinct, a traffic model has been developed to estimate future year traffic volumes (2021 and 2036) in the vicinity of the precinct. This model was developed in conjunction with Roads and Maritime and also informs the Mona Vale Road Upgrade REF studies.

A two-staged traffic modelling approach was adopted in order to determine intersection performance and recommended sizing and lane configuration as well as any opportunities to improve active and public transport infrastructure such as pedestrian crossings and bus priority measures.

- Stage 1 - Strategic traffic demand modelling (using CUBE) to estimate future traffic demand as a result of expected future population and employment growth estimated by the State Government (including the proposed Ingleside Precinct) as well as planned and committed road and public transport infrastructure improvements in the region.
- Stage 2 – Micro-simulation modelling (using VISSIM) to quantify the performance of the network and its intersections.

The intent of the model is to estimate likely vehicular traffic on the road network within the precinct such that the form of the Draft Structure Plan can be confirmed as being appropriate.

4.7.1 Development of the strategic traffic model

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

The key aspects of the CUBE model are listed below:

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

The traffic model developed for the project is a strategic, link-based model reflecting all-vehicle demand for an average peak hour. These screenline definitions broadly align with published Roads Maritime screenlines across the Sydney road network. Screenline counts are sourced from Roads Maritime permanent and sample sites for 2008, with supplementary counts sourced or estimated by AECOM to complete screenlines.

The model has been used to provide traffic forecasts on all major links in the Sydney Metropolitan Area road network. As such, considerable past effort has been invested in the model, ensuring the veracity of network coding, and land use assumptions in the vicinity of the Ingleside study area.

The guide also sets out peak hour trip generation rates for each land use type, which has been incorporated into the traffic model.

Road network

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

- Zone centroid connector - a special link which does not physically exist but is used in modelling as zone loading points for the travel demand
- Residential street – e.g. Wesley Street, Elanora Heights
- Collector road – e.g. Samuel Street, Mona Vale
- Secondary arterial – e.g. Powderworks Road, Ingleside
- Primary arterial – e.g. Mona Vale Road, Ingleside
- Toll road and motorways – e.g. the M1 Motorway

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

The proposed Mona Vale Road upgrade is reflected in the strategic model based on information provided by Roads and Maritime.

Travel demand and zoning system

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

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

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

Model Assignment Procedure

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

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

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

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

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

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

4.7.2 Peak Hour Mid-Block traffic flows

Peak hour mid-block traffic flows for the AM and PM peaks have been generated using CUBE for three separate scenarios:

- 2021 with development
- 2036 no development
- 2036 with development

The assessment year 2021[1] has been provided in lieu of a base year scenario for the purpose of benchmarking the performance of the road network in 2036, as this is the year in which the proposed Mona Vale Road Upgrade between McCarrs Creek Road and Foley Street is scheduled for completion. As such, this represents the earliest year in which Mona Vale Road operates with two lanes in each direction.

Given the proposed Ingleside development would be at an early stage in 2021, the 'no development' scenario does not represent a significant change in traffic volumes compared to the 'with development' scenario. As such, a 'no development' scenario has not been reported as part of this assessment.

The 2036 assessment year represents ultimate development of the Ingleside Precinct. As there is considerable background traffic growth on the road network up to 2036, the traffic impact of the Ingleside development is best gauged by comparing the 2036 'no development' scenario to the 2036 'with development' scenario.

It should be noted that the 2036 'no development' scenario still assumes some level of development within Ingleside in line with housing growth forecasts from the NSW Bureau of Transport Statistics. This equates to approximately 1,000 additional dwellings.

The trip rate used for the 'with development' scenario is lower than the trip rate used for the 'no development' scenario, reflecting the mode shift expected to occur as a result of the enhanced public and active transport infrastructure provided as part of the proposed Ingleside development. It should be noted that the level of detail in the current modelling does not include internal trips within the Ingleside Precinct.

It should be noted that the modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/- 10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

[1] The 2021 traffic models were developed based on a calibrated base year model using current year traffic data as described in Section 4.7.1.

Table 14: Ingleside Precinct Peak Hour Mid-Block Flows for the AM Peak (8:00-9:00)

Road	Location	Direction	2021 with development	2036 no development	2036 with development
Mona Vale Road	South of Powderworks Road	NB	1472	1665	1706
		SB	2254	2389	2434
Mona Vale Road	East of Lane Cove Road / Manor Road	WB	1418	1652	1520
		EB	1178	1337	1509
Powderworks Road	East of Mona Vale Road	WB	664	635	728
		EB	368	408	519
Powderworks Road	West of Garden Street	WB	447	485	513
		EB	587	540	742
Lane Cove Road	North of Mona Vale Road	NB	77	90	128
		SB	248	228	402
Cabbage Tree Road	East of Walter Road	WB	193	123	135
		EB	63	84	195
Manor Road	South of Mona Vale Road	NB	89	45	147
		SB	17	14	32
Tumburra Street	North of Mona Vale Road	NB	35	49	49
		SB	58	136	136
Pittwater Road	South of Mona Vale Road	NB	1187	1334	1339
		SB	1704	1882	2094
Samuel Street	North of Mona Vale Road	NB	101	117	135
		SB	151	182	251
Ponderosa Parade	South of Mona Vale Road	NB	425	466	468
		SB	578	669	704
Garden Street	South of Powderworks Road	NB	702	665	676
		SB	781	819	1004
Elanora Road	South of Powderworks Road	NB	280	259	228
		SB	216	264	279

Note: The modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/-10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

Source: AECOM, 2015

Table 15: Ingleside Precinct Peak Hour Mid-Block Flows for the PM Peak (4:30-5:30)

Road	Location	Direction	2021 with development	2036 no development	2036 with development
Mona Vale Road	South of Powderworks Road	NB	2337	2424	2412
		SB	1450	1635	1677
Mona Vale Road	East of Lane Cove Road / Manor Road	WB	1160	1302	1489
		EB	1564	1806	1705
Powderworks Road	East of Mona Vale Road	WB	386	443	593
		EB	613	631	720
Powderworks Road	West of Garden Street	WB	653	672	884
		EB	494	557	552
Lane Cove Road	North of Mona Vale Road	NB	288	196	454
		SB	87	105	156
Cabbage Tree Road	East of Walter Road	WB	60	78	150
		EB	232	143	152
Manor Road	South of Mona Vale Road	NB	13	11	26
		SB	66	12	106
Tumburra Street	North of Mona Vale Road	NB	54	192	203
		SB	37	40	40
Pittwater Road	South of Mona Vale Road	NB	1912	2062	2195
		SB	1439	1629	1601
Samuel Street	North of Mona Vale Road	NB	207	270	316
		SB	129	157	199
Ponderosa Parade	South of Mona Vale Road	NB	491	569	631
		SB	542	583	585
Garden Street	South of Powderworks Road	NB	684	774	987
		SB	810	825	796
Elanora Road	South of Powderworks Road	NB	184	218	239
		SB	326	351	330

Note: The modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/-10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

Source: AECOM, 2015

The results in **Table 14** and **Table 15** show that the largest increases in traffic as a result of the Ingleside development occur at Powderworks Road (West of Garden Street) travelling eastbound in the AM peak, Pittwater Road (South of Mona Vale Road) southbound during the AM peak, Lane Cove Road (North of Mona Vale Road) northbound during the PM peak and Garden Street (South of Powderworks Road) northbound during the PM peak. This highlights the relatively even spread of traffic impacts across the road network. Note that Manor Road is forecast to have relatively low traffic volumes, enabling it act as an alternate route to Powderworks Road should Powderworks Road ever be closed for any period of time.

Note that in some locations, the results in **Table 14** and **Table 15** may show a reduction in traffic volumes with the Ingleside development. This is a result of natural variation within the model and is not considered to be significant. The overall traffic volumes still rise as a result of the Ingleside development.

4.8 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 VISSIM and SIDRA Intersection software. Analysis has been undertaken for future years 2021 and 2036 for AM and PM peak hours.

For this assessment it is assumed that the intersection of Mona Vale Road / Samuel Street / Ponderosa Parade will be upgraded to a signalised intersection as part of the proposed Mona Vale Road Upgrade East, while the intersection of Cabbage Tree Road / Samuel Street will be upgraded to a roundabout. In addition, the following intersections are assumed to be upgraded to roundabouts within the Ingleside Precinct to facilitate improved access to sub-precincts.

- Powderworks Road / Wattle Road
- Powderworks Road / Ingleside Road
- Cabbage Tree Road / Walter Road

This is consistent with the recommendations made as part of the Assessment of the Powderworks Road corridor undertaken by AECOM for Pittwater Council in 2013 which concluded that roundabout provision would provide traffic calming along Powderworks Road and would ensure the Powderworks Road corridor within Ingleside is consistent with the Powderworks Road corridor within Elanora Heights. A roundabout is preferred at Cabbage Tree Road / Walter Road to facilitate 4-way traffic movements.

When considering the results in **Table 16, Table 17** and **Table 18**, it is important to note that the following have an influence on results:

- **The positive impact of the proposed Mona Vale Road Upgrade**. Upgrading Mona Vale Road to two lanes in each direction has relieved some of the pressure on other roads in the study area, including Powderworks Road.
- VISSIM modelling of the Mona Vale Road corridor **identified pinch points at the intersections of Mona Vale Road / McCarrs Creek Road and Mona Vale Road / Pittwater Road** in 2036.
    - These pinch points act to restrict vehicles from accessing Mona Vale Road within the Ingleside Precinct. As such, traffic volumes on Mona Vale Road intersections may not reflect the actual traffic demand in 2036. This is likely to have an impact on both the ‘with development’ and ‘no development’ scenarios.
    - Should these two intersections receive an upgrade in the future, it is likely that traffic volumes along Mona Vale Road will increase, at which time further assessment may be required at intersections along Mona Vale Road and elsewhere to assess the impact of any additional traffic impacts.
        - The potential impact on Powderworks Road (and other corridors) of improvements to these intersections is unknown. Additional traffic would be encouraged to utilise the Mona Vale Road corridor (potentially reducing traffic on Powderworks road), however it may also act to encourage more vehicles onto the road in general (adding vehicles to the network).
- Intersections within the Ingleside Precinct are expected to operate at LoS A due to the low traffic volumes anticipated on the local road network. These intersections have been assumed as roundabouts from a precinct planning and safety perspective.

4.8.1 Future year 2021 with development

A summary of intersection performance for the 2021 preferred road network is shown in **Table 16**. This shows that all intersections within the study area operate at level of service (LoS C or better) with proposed road network upgrades during the early stages of Ingleside development. A long queue length expected at the Mona Vale Road / Pittwater Road intersection, reflecting the high volume of traffic utilising this intersection.

Table 16: 2021 Intersection Performance (with development)

Intersection	Type	Peak	LoS	Average Delay (s)	95th Queue (m)
Mona Vale Road / Powderworks Road	Signal	AM	B	15.1	112 (E Leg)
		PM	A	12.8	123 (S Leg)
Mona Vale Road / Lane Cove Road / Manor Road	Signal	AM	A	10.1	54 (E Leg)
		PM	A	13.6	118 (E Leg)
Mona Vale Road / Samuel Street / Ponderosa Parade	Signal	AM	B	24.9	95 (W Leg)
		PM	C	38.3	160 (S Leg)
Mona Vale Road / Pittwater Road	Signal	AM	B	20.5	159 (S Leg)
		PM	C	38.5	424 (S Leg)
Powderworks Road / Wattle Road	Roundabout	AM	A	7.5	28 (E Leg)
		PM	A	7.4	25 (W Leg)
Powderworks Road / Ingleside Road	Roundabout	AM	A	8.4	29 (S Leg)
		PM	A	8.9	21 (W Leg)
Powderworks Road / Garden Street	Signal	AM	B	21.1	95 (W Leg)
		PM	B	21.9	77 (N Leg)
Garden Street / Pittwater Road	Signal	AM	B	20.9	132 (S Leg)
		PM	B	23.2	166 (S Leg)
Cabbage Tree Road / Walter Road	Roundabout	AM	A	7.7	6 (E Leg)
		PM	A	9.0	7 (S Leg)
Cabbage Tree Road / Samuel Street	Roundabout	AM	A	5.7	4 (N Leg)
		PM	A	5.5	4 (S Leg)

Note: The modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/-10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

Source: AECOM, 2015

4.8.2 Future year 2036 no development

A summary of intersection performance for 2036 without the Ingleside development is shown in **Table 17**. This shows that all intersections within the study area operate at level of service (LoS D or better) with proposed road network upgrades.

Despite operating at LoS B, the intersection of Powderworks Road / Garden Street does show a saturated left turn movement from Garden Street onto Powderworks Road in the PM peak (not visible in **Table 17**) . As such, improvements to the left turn movement at this location may need to be considered in the future to accommodate estimated traffic volumes. This would be likely to involve the relocation of the bus stop on the western side of Garden Street. The Mona Vale Road / Pittwater Road intersection is shown to be operating near capacity.

Table 17: 2036 Intersection Performance (no development)

Intersection	Type	Peak	LoS	Average Delay (s)	95th Queue (m)
Mona Vale Road / Powderworks Road	Signal	AM	B	16.8	84 (N Leg)
		PM	A	12.8	50 (E Leg)
Mona Vale Road / Lane Cove Road / Manor Road	Signal	AM	A	11.5	78 (E Leg)
		PM	B	14.9	146 (E Leg)
Mona Vale Road / Samuel Street / Ponderosa Parade	Signal	AM	B	27.6	91 (W Leg)
		PM	C	34.9	248 (S Leg)
Mona Vale Road / Pittwater Road	Signal	AM	C	29.5	239 (S Leg)
		PM	D	45.4	493 (S Leg)
Powderworks Road / Wattle Road	Roundabout	AM	A	7.5	33 (W Leg)
		PM	A	7.5	33 (W Leg)
Powderworks Road / Ingleside Road	Roundabout	AM	A	8.4	27 (S Leg)
		PM	A	8.8	23 (W Leg)
Powderworks Road / Garden Street	Signal	AM	B	21.3	84 (W Leg)
		PM	B	25.2	119 (N Leg)
Garden Street / Pittwater Road	Signal	AM	B	22.2	157 (S Leg)
		PM	B	25.1	215 (S Leg)
Cabbage Tree Road / Walter Road	Roundabout	AM	A	7.7	4 (E Leg)
		PM	A	8.2	3 (S Leg)
Cabbage Tree Road / Samuel Street	Roundabout	AM	A	5.9	5 (N Leg)
		PM	A	5.7	6 (S Leg)

Note: The modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/-10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

Source: AECOM, 2015

4.8.3 Future year 2036 with development

A summary of intersection performance for 2036 with the Ingleside development is shown in **Table 18**. This shows that all intersections within the study area operate at an acceptable level of service (LoS C or better, with proposed road network upgrades) with the exception of Mona Vale Road / Pittwater Road.

Despite operating at LoS C, the intersection of Powderworks Road / Garden Street does show a saturated left turn movement from Powderworks Road onto Garden Street in the PM peak (not visible in **Table 18**) that can be attributed to the additional traffic generated by the Ingleside development . As such, improvements to the left turn movement at this location may need to be considered between 2021 and 2036 to accommodate estimated traffic volumes. This would be likely to include the removal of on-street parking adjacent to retailers on Powderworks Road.

The Mona Vale Road / Pittwater Road intersection is shown to require further capacity between 2021 and 2036 in order to operate at capacity.

Table 18: 2036 Intersection Performance (with development)

Intersection	Type	Peak	LoS	Average Delay (s)	95th Queue (m)
Mona Vale Road / Powderworks Road	Signal	AM	B	19.1	124 (S Leg)
		PM	B	15.6	126 (S Leg)
Mona Vale Road / Lane Cove Road / Manor Road	Signal	AM	B	19.1	120 (N Leg)
		PM	B	15.1	118 (E Leg)
Mona Vale Road / Samuel Street / Ponderosa Parade	Signal	AM	B	27.9	103 (W Leg)
		PM	C	41.3	200 (S Leg)
Mona Vale Road / Pittwater Road	Signal	AM	C	28.9	255 (S Leg)
		PM	F	88.0	807 (s Leg)
Powderworks Road / Wattle Road	Roundabout	AM	A	7.5	27 (E Leg)
		PM	A	7.4	27 (W Leg)
Powderworks Road / Ingleside Road	Roundabout	AM	A	8.8	34 (S Leg)
		PM	A	8.7	28 (W Leg)
Powderworks Road / Garden Street	Signal	AM	B	27.2	154 (W Leg)
		PM	C	32.1	165 (N Leg)
Garden Street / Pittwater Road	Signal	AM	B	26.2	182 (S Leg)
		PM	B	26.5	270 (S Leg)
Cabbage Tree Road / Walter Road	Roundabout	AM	A	8.1	6 (N Leg)
		PM	A	8.3	6 (S Leg)
Cabbage Tree Road / Samuel Street	Roundabout	AM	A	7.2	6 (N Leg)
		PM	A	6.2	8 (S Leg)

Note: The modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/-10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

Source: AECOM, 2015

A summary of intersection layouts at ultimate development (2036 with development) is shown in **Figure 14**. Note that modifications have been made to the existing intersection layout at Powderworks Road / Garden Street. This is to accommodate an increase in the practical length of left turn bays from approximately 25m to approximately 50m as a result of expected traffic volumes in 2036. The proposed left turn bay extension on Garden Street is necessitated by background traffic growth and would likely result in the relocation of a bus stop.

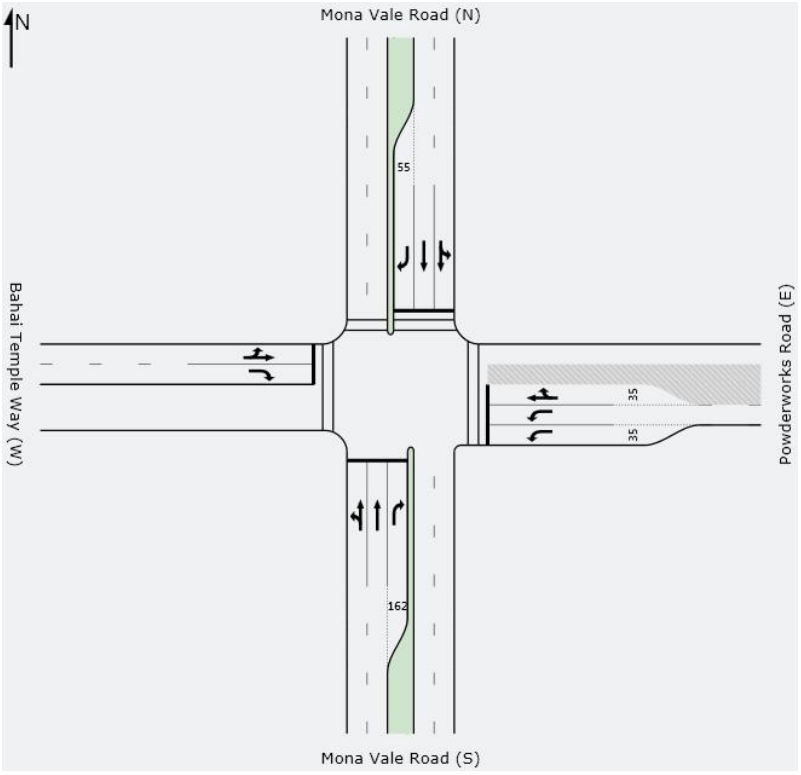
The proposed left turn bay extension on Powderworks Road is necessitated by traffic volumes resulting from the development of Ingleside and would likely result in some loss of parking on Powderworks Road. When considering this left turn bay, it should be noted that some traffic is currently utilising Warraba Road as a rat run in order to avoid turning left from Powderworks Road onto Garden Street. As such, not extending the left turn bay on Powderworks Road would likely result in additional vehicles utilising Warraba Road as traffic volumes increase.

In order to accommodate forecast traffic volumes with the addition of Ingleside development traffic, this study shows the intersection of Mona Vale Road / Pittwater Road is likely to require additional lane capacity for right turn traffic movements. Extending the right turn bay on Mona Vale Road to 110m and the right turn bay on Pittwater Road to 150m would see the intersection perform at a satisfactory LoS D, although delays on some movements would still occur.

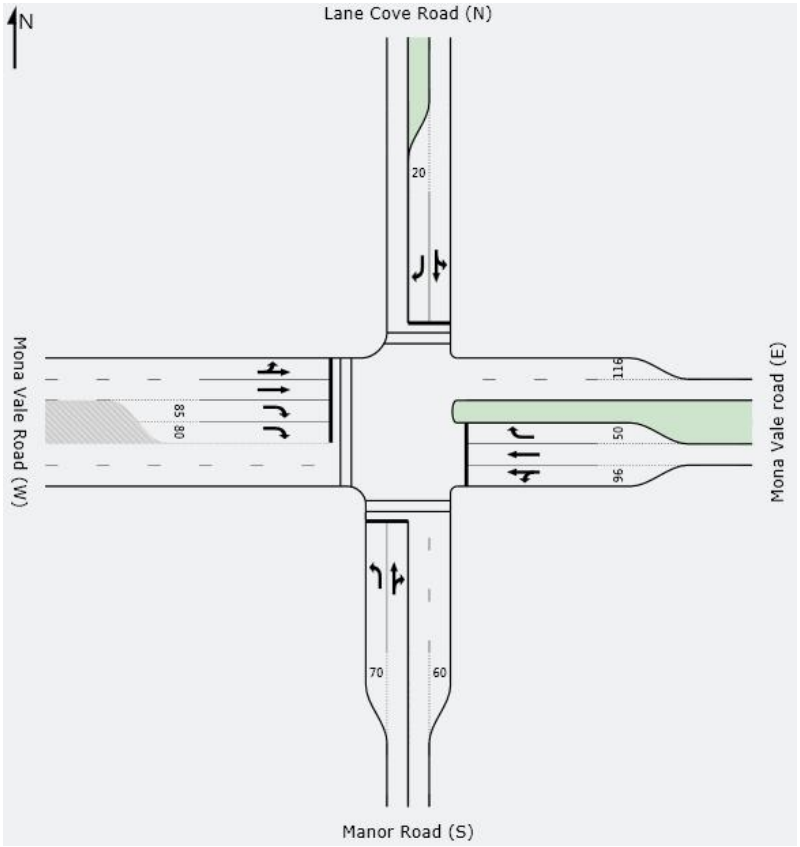
All the proposed modifications to the intersections assessed are shown in **Figure 14.** Given the scale of this intersection, its relative sensitivity to additional traffic and its potential to be impacted by all forms of development in the wider region, a further more detailed study is likely to be required in order to fully understand the upgrade requirements for this location.

Figure 14: Intersection Layouts – 2036

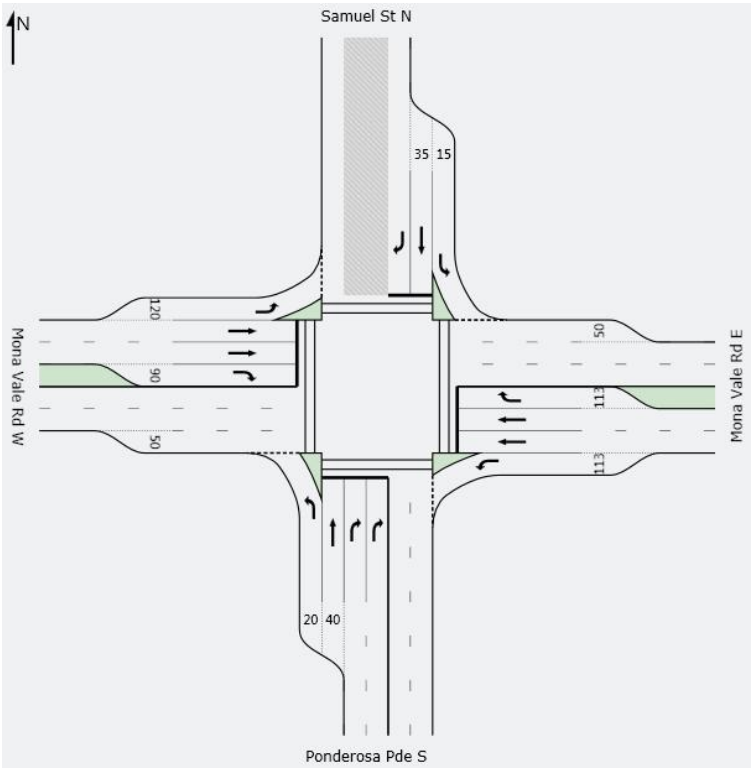
Mona Vale Road / Powderworks Road



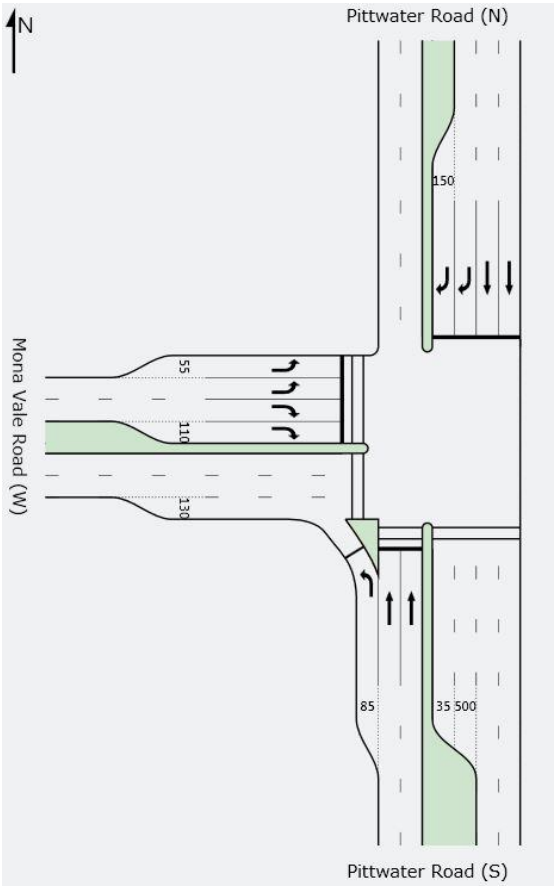
Mona Vale Road / Lane Cove Road / Manor Road



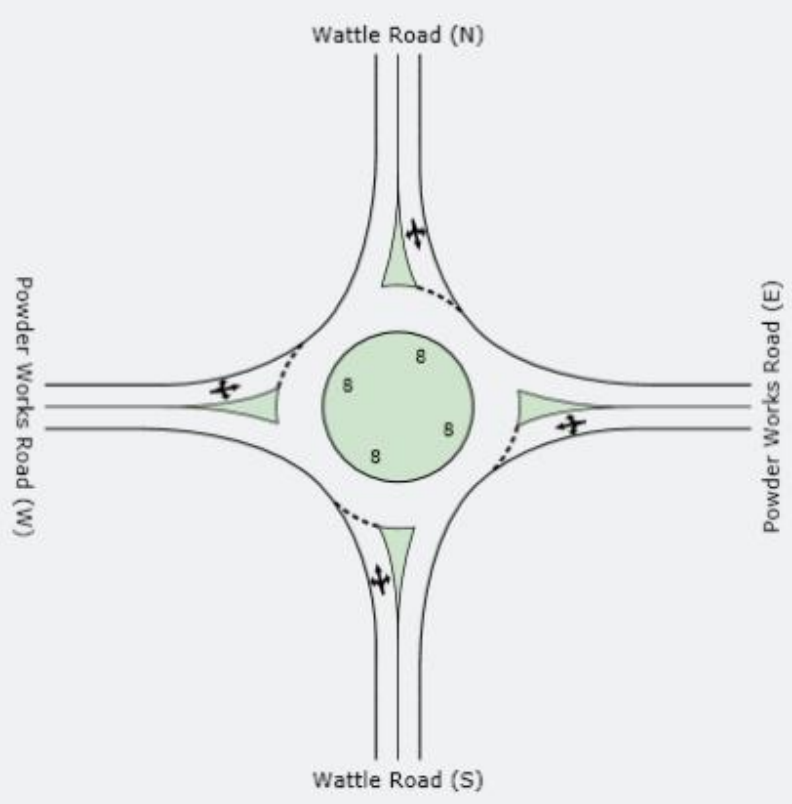
Mona Vale Road / Samuel Street / Ponderosa Parade



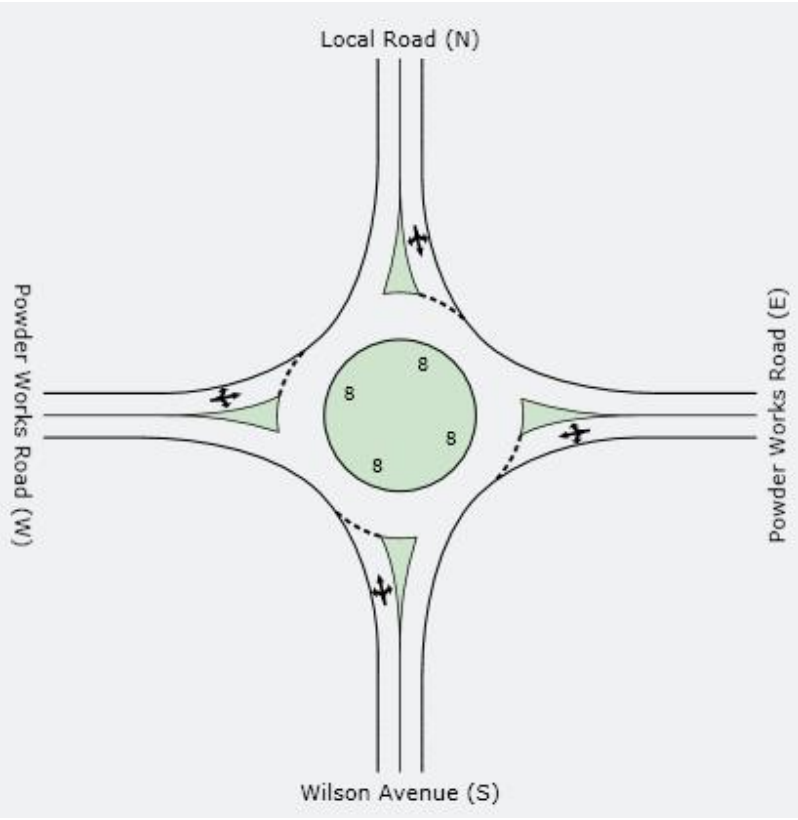
Mona Vale Road / Pittwater Road



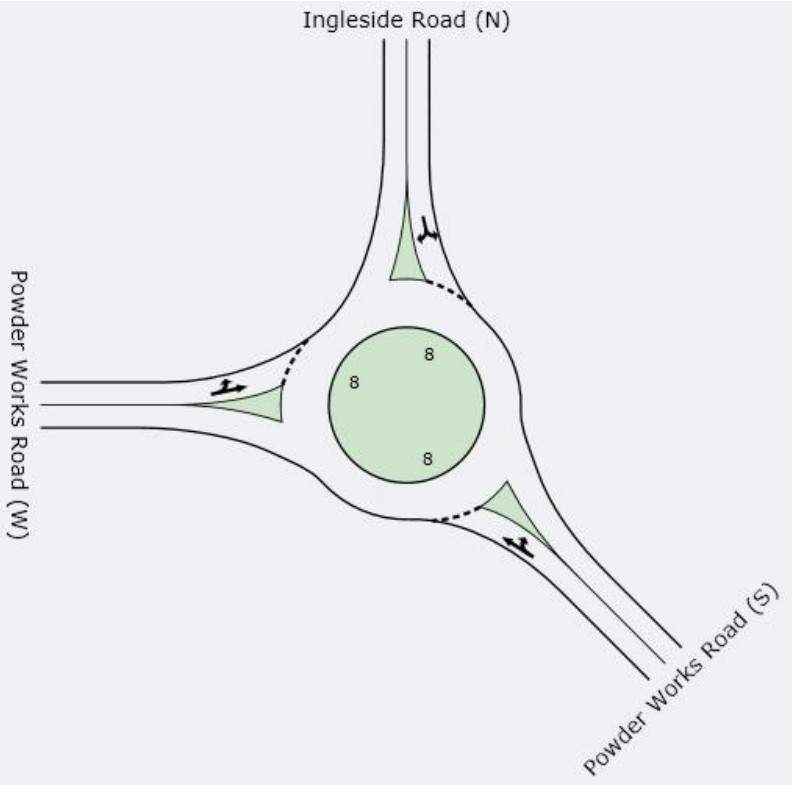
Powderworks Road / Wattle Road*



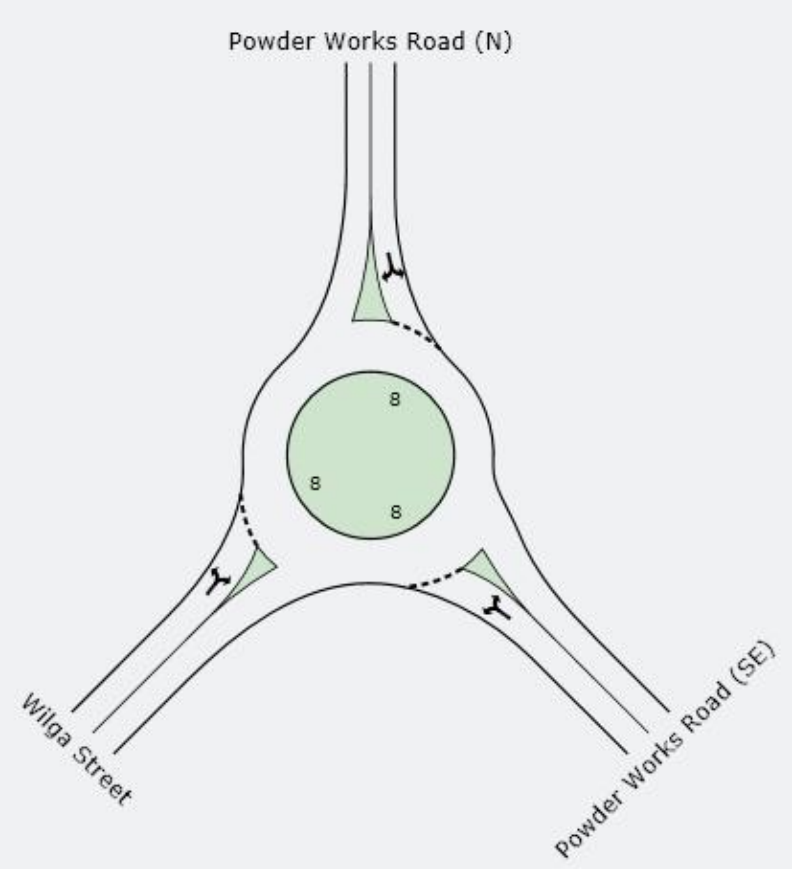
Powderworks Road / Wilson Avenue*



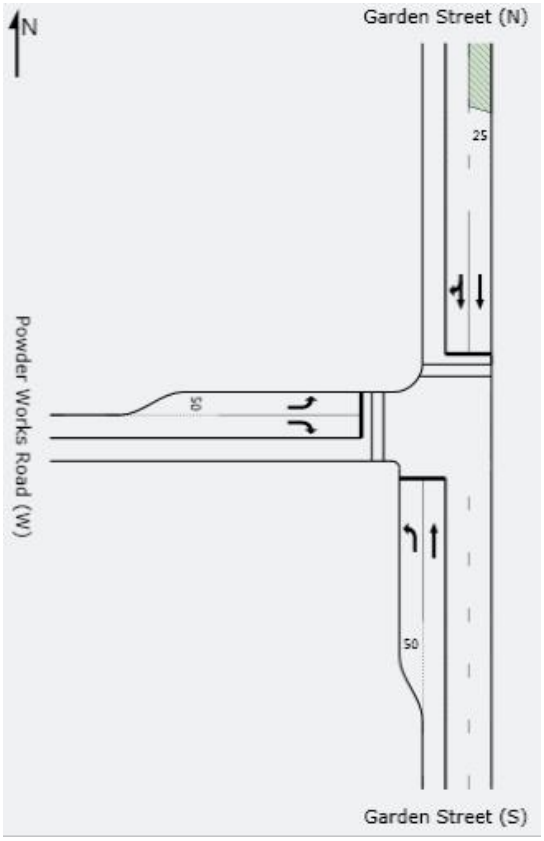
Powderworks Road / Ingleside Road*



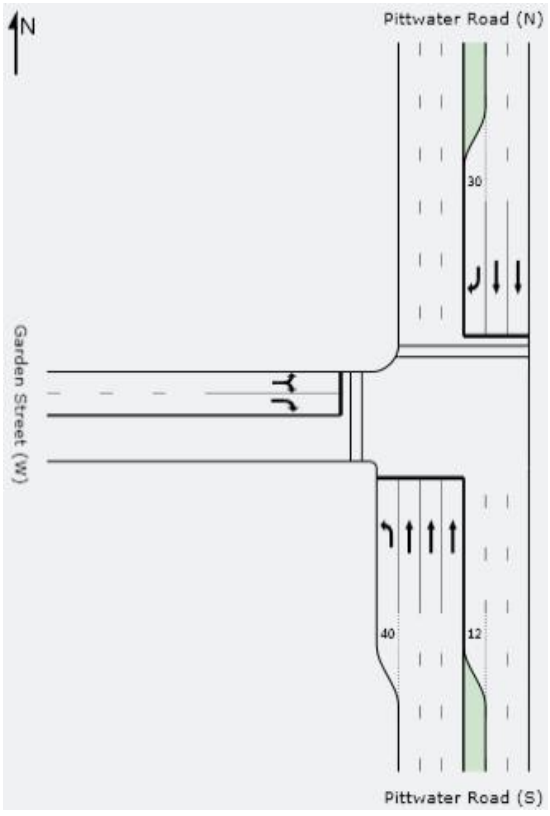
Powderworks Road / Wilga Street*



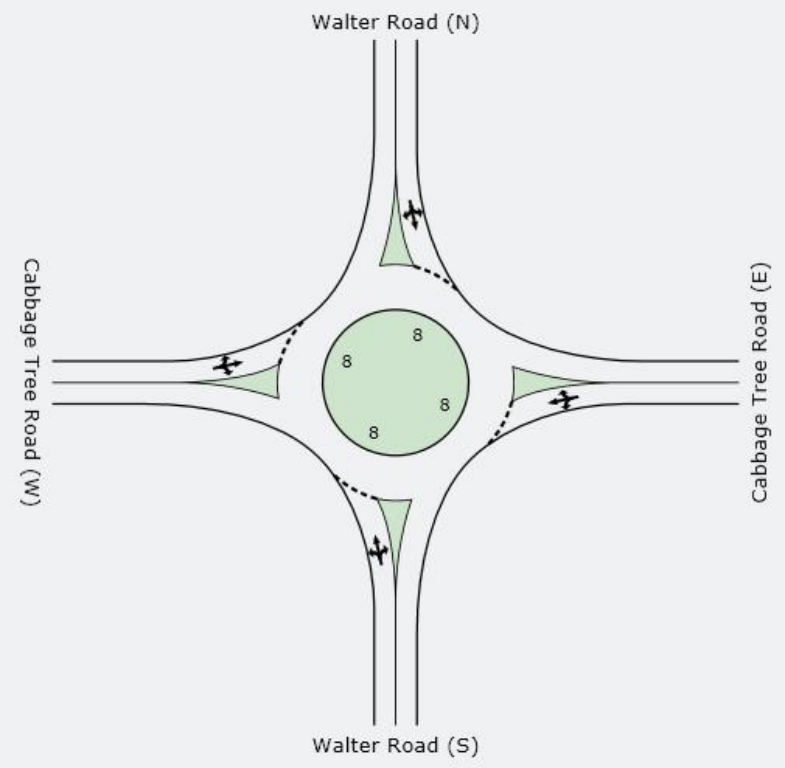
Powderworks Road / Garden Street



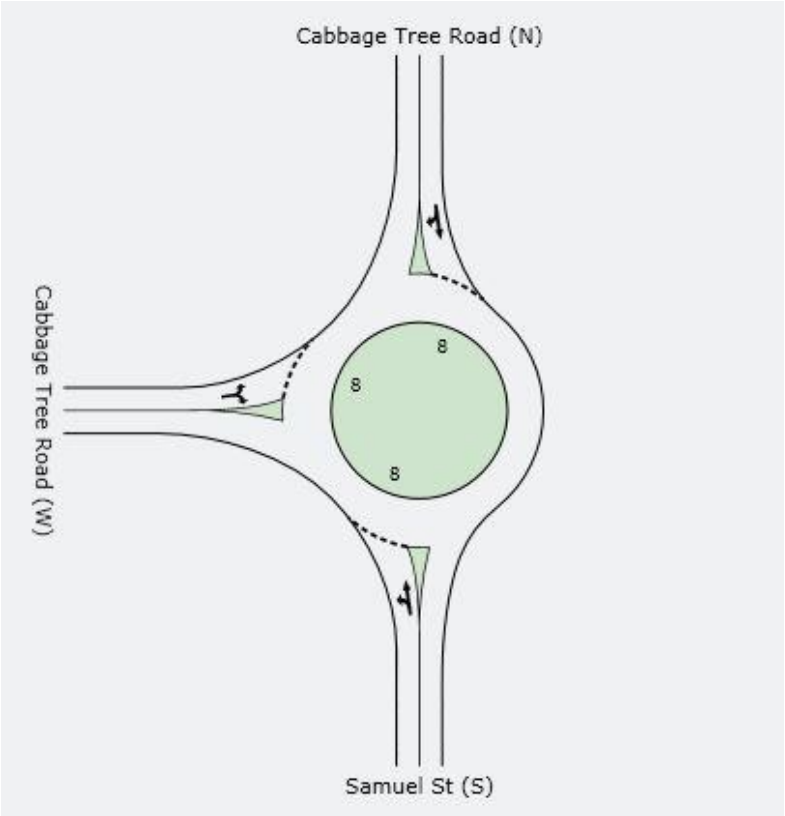
Garden Street / Pittwater Road



Cabbage Tree Road / Walter Road*



Cabbage Tree Road / Samuel Street

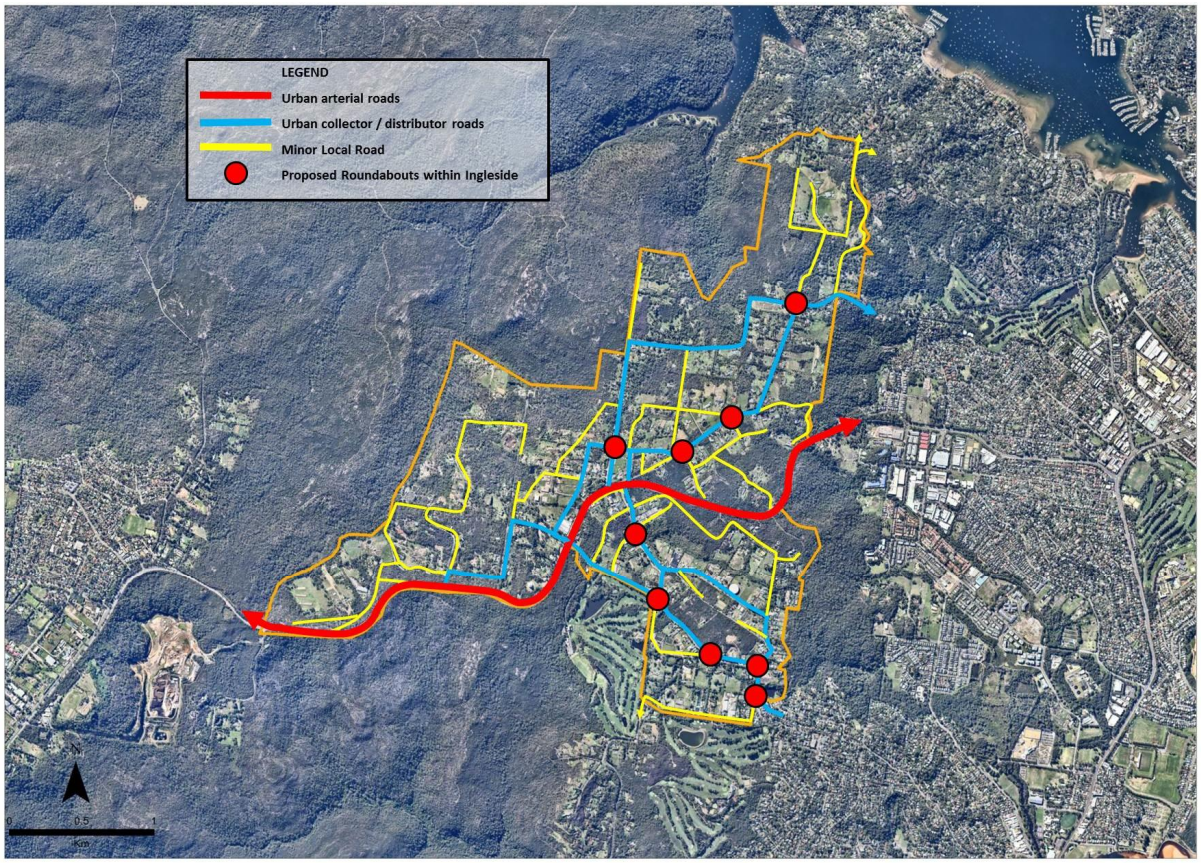


* Roundabout island diameters reflect roundabouts in nearby suburbs and are not based on Austroads standards.

Source: AECOM, 2015

A number of intersections within the Ingleside Precinct that have not been assessed due to low estimated traffic volumes are also proposed to become roundabouts in order to achieve desired precinct planning, safety and traffic calming outcomes. As a result, a total of nine new roundabouts are proposed as part of the development. These roundabouts have been assumed as part of the traffic modelling undertaken for this study and are shown in **Figure 15**.

Figure 15: Proposed Roundabouts within the Ingleside Precinct



Source: AECOM, 2015

4.9 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. The road network hierarchy channels vehicular access to arterial roads via higher order corridors.

4.9.1 Existing road network connections

The key transport corridor within the study area is Mona Vale Road. This route links Pittwater Road in the east to Chatswood and Macquarie Park in the west. Powderworks Road also runs through the precinct connecting Mona Vale Road to Garden Street. This route offers an alternate east/west route through the precinct. Lane Cove Road and Cabbage Tree Road also provide a connection between Mona Vale Road and Pittwater Road via a lower order circuitous route.

The average weekday traffic volume on Mona Vale Road, 150m east of Tumburra Street is 36,910, while the average weekday traffic flow on Mona Vale Road, 500m east of Lane Cove Road / Manor Road is 21,980 vehicles. The difference in traffic volumes between the two count locations on Mona Vale Road reflects the average weekday traffic flow of 12,160 vehicles using Powderworks Road, which absorbs a considerable proportion of the through traffic. Local Roads within the Ingleside Precinct accommodate low traffic volumes.

During the peak periods, Mona Vale Road immediately to the east of Tumburra Street is operating at or over capacity. The traffic data also suggests that current traffic flows on Mona Vale Road east of Lane Cove Road and on Powderworks Road are relatively low and there is reserve capacity on both sections of road.

The majority of the intersections in the study area operate at an acceptable level of service (LoS D or better) with the exception of the intersection of Mona Vale Road | Samuel Street | Ponderosa Parade under existing traffic conditions during the PM peak. This intersection will be upgraded to a signalised intersection as part of the proposed Mona Vale Road Upgrade East.

4.9.2 Future year traffic forecast

Results show that the largest increases in traffic (to 2036) as a result of the Ingleside development occur at Powderworks Road (West of Garden Street) travelling eastbound in the AM peak, Pittwater Road (South of Mona Vale Road) southbound during the AM peak, Lane Cove Road (North of Mona Vale Road) northbound during the PM peak and Garden Street (South of Powderworks Road) northbound during the PM peak. This highlights the relatively even spread of traffic impacts across the road network.

It should be noted that the modelling undertaken is based on an assumption of 3,500 residential dwellings. At the preliminary stage of the planning process (rezoning stage), this should be considered acceptable as traffic forecasts are generally estimated based on traffic volumes on a typical weekday that have a daily variance of +/- 10%. Further detailed traffic modelling will be undertaken at the future planning stages of the precinct to accurate quantify the impacts of the proposed development as the DSP refines with any changes in the overall development yield.

4.9.3 Future year intersection analysis

A summary of intersection performance for each scenario showed that all intersections within the study area operate at an acceptable level of service (LoS D or better) in an urban environment with proposed intersection upgrades, with the exception of Mona Vale Road / Pittwater Road, which operates at LoS F. In order to operate at LoS D, this intersection would require (at a minimum) extended right turn bays on Mona Vale Road (to 110m) and on Pittwater Road (to 150m) between 2021 and 2036. Given the scale of this intersection, its relative sensitivity to additional traffic and its potential to be impacted by all forms of development in the wider region, a further more detailed study is likely to be required in order to fully understand the upgrade options and requirements for this location.

Despite operating at LoS B, the intersection of Powderworks Road / Garden Street does show saturated left turn movements from Garden Street onto Powderworks Road and from Powderworks Road onto Garden Street in the PM peak. As such, improvements to the left turn movements at this location may need to be considered between 2021 and 2036 in order to accommodate estimated traffic volumes. This would be likely to involve the relocation of the bus stop on the western side of Garden Street and removal of parking on the north side of Powderworks Road on the approach to the intersection.

4.9.4 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, a heavy vehicle weight limit may be required to redirect heavy vehicles from residential areas and onto Mona Vale Road. Delivery vehicles to retail premises are expected to use Mona Vale Road, Powderworks Road, Manor Road and the deviated Lane Cove Road route.

5.0 Public Transport Framework

5.1 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.).
- Quality and availability of public transport services.
- Streetscapes that discourage walking or limit access to facilities (rear fences, noise walls, etc.).
- Steep terrain which can be a deterrent to walking and cycling, or for accessing bus stops.

These factors have been considered in defining the following public transport options for the Ingleside Precinct.

5.2 Modes of travel

BTS 2011 Journey to Work data (JTW) has been analysed to form a picture of existing mode share patterns for trips to and from Pittwater and Warringah LGAs. A mode share breakdown for the two LGAs in comparison to greater Sydney is shown in **Table 19**.

Private vehicles are the predominant mode of transport utilised in both Pittwater and Warringah LGAs. This is attributed to relatively limited local public transport network coverage across the Northern Beaches, and the lack of public transit corridors linking to the other areas of Sydney.

Table 19: Average weekday mode share for Journey to Work origin and destination trips

LGAs	Vehicle driver	Vehicle passenger	Public transport	Walk only	Other modes
Pittwater	80%	5%	9%	5%	1%
Warringah	74%	5%	15%	4%	2%
Greater Sydney	64%	5%	25%	5%	1%

Source: 2011 BTS Journey to Work Dataset

Findings from the JTW dataset show that of total trips on a typical weekday, 80 per cent of trips to and from Pittwater LGA and 74 per cent or trips to and from Warringah LGA are car-based. These figures 10 to 15 per cent higher than the Greater Sydney average of 64 per cent.

5.3 Existing public transport provision

There is limited public transport serving the precinct at present, reflecting the limited demand for services generated by the current land uses. Mona Vale Road and Powderworks Road provide bus services at a low frequency.

As shown in **Table 19**, public transport accounts for less than ten per cent of the mode share in Pittwater LGA, and approximately 15 per cent of transport mode share in Warringah LGA. These are both well below the Greater Sydney average of 25 per cent.

There is currently limited public transport along, and in the vicinity of the Ingleside Precinct. The 2012 NSW Long Term Transport Master Plan identified no mass transit corridors connecting to the Northern Beaches. The plan identified an Intermediate transit corridor connecting from Mona Vale towards the Sydney CBD via Dee Why, but no connections to the east or west.

There are three bus routes which currently operate along Mona Vale Road. Bus route 185 / L85; Mona Vale to Sydney CBD via Warriewood Valley and Warringah Mall, and 182; Mona Vale to Narrabeen, are operated by Sydney Buses. These routes currently operate along Mona Vale Road between Ponderosa Parade / Samuel Street and Pittwater Road. In addition to these two Sydney Buses routes, Forest Coach Lines operates bus route 196/197 between Macquarie University and Mona Vale. This route travels along the entire length of Mona Vale Road. As shown in **Table 20**, frequency of routes is low, with peak period wait times ranging from 20 minutes to up to one hour.

Table 20: Table of bus routes in the area

Bus route number and description	Frequency AM Peak (8-9am)		Frequency PM Peak (4:30-5:30pm)	
	Westbound	Eastbound	Westbound	Eastbound
Route 185/ L85: Mona Vale to Sydney CBD via Warriewood Valley and Warringah Mall	2	2	2	2
Route 182: Mona Vale to Narrabeen	1	2	1	1
Route 196/ 197: Mona Vale to Macquarie University	1	3	1	1

Source: Sydney Buses & Forest Coach Line timetables

Two public bus routes (Routes 182 and E83) currently service Elanora Heights adjacent to the Ingleside Precinct. These routes are operated by Sydney Buses and are shown in **Figure 16**.

Figure 16: Bus routes (Sydney Buses)

Source: Sydney Buses, 2015

Route 182 is a local bus route that connects Elanora Heights to Narrabeen and Mona Vale Town Centre. Two services run from Elanora Heights to Mona Vale Town Centre during the morning peak hour with journey times of approximately 16 minutes.

Routes E83 is a commuter bus route offering services between North Narrabeen and Elanora Heights to the Sydney CBD. Four morning services and six evening services are provided with journey times of approximately 1 hour.

Routes 185 and L85 do not service Elanora Heights; however these routes do connect to Garden Street via Warriewood Road and Macpherson Street (east). Along this section, there are 10 bus stops. On Garden Street, between Macpherson Street and Jacksons Road, there are four bus stops, and on Jacksons Road there are two bus stops, one close to the central access into Centro, and one close to Pittwater Road. From Jacksons Road the routes continue along Pittwater Road to the south.

In addition to the routes operated by Sydney buses through Elanora Heights and Warriewood, a private bus operator (Forest Coach Lines) provides services to the Ingleside Precinct. These services travel along the Mona Vale Road corridor and are shown in **Figure 17**.

Figure 17: Bus routes (Forest Coach Lines)

Source: Forest Coach Lines, 2015

Route 196 offers services between Mona Vale and Gordon via Ingleside, while Route 197 connects Mona Vale and Ingleside to Macquarie Park and Macquarie University. A total of 17 bus services travel from Mona Vale Town Centre to Macquarie University each weekday, six of which occur prior to the AM peak period. In the opposite direction (towards Mona Vale) 13 services are provided (hourly) with a journey time of approximately 55 minutes.

The routes servicing the Warriewood area are also mostly constricted to a north-south movement providing a link to the main bus corridor travelling along Pittwater Road to Sydney's CBD. There is a lack of bus services cross regionally from Warriewood Valley connecting to areas to the west as well as to other areas in the Manly, Warringah and Pittwater areas that are not serviced by the Pittwater Road corridor.

In addition to these services, 23 bus routes run along Pittwater Road to the east of the study area, providing frequent bus services, however residents of Elanora Heights and Ingleside have to travel to Pittwater Road to access these bus services. Details of service frequencies are given in **Table 21**.

Table 21: Frequency of bus routes along Pittwater Road

Bus Route	AM peak (0800-0900)			PM peak (1700-1800)			Off peak (0900-1700)		
	Weekday	Sat	Sun	Weekday	Sat	Sun	Weekday	Sat	Sun
Pittwater and Palm Beach to City	<5 mins	25 mins	20 mins	10 mins	20 mins	25 mins	15 mins	15 mins	20 mins
City to Pittwater and Palm Beach	20 mins	15 mins	30 mins	15 mins	25 mins	25 mins	5 mins	25 mins	20 mins

Source: Sydneybuses.info, 2011

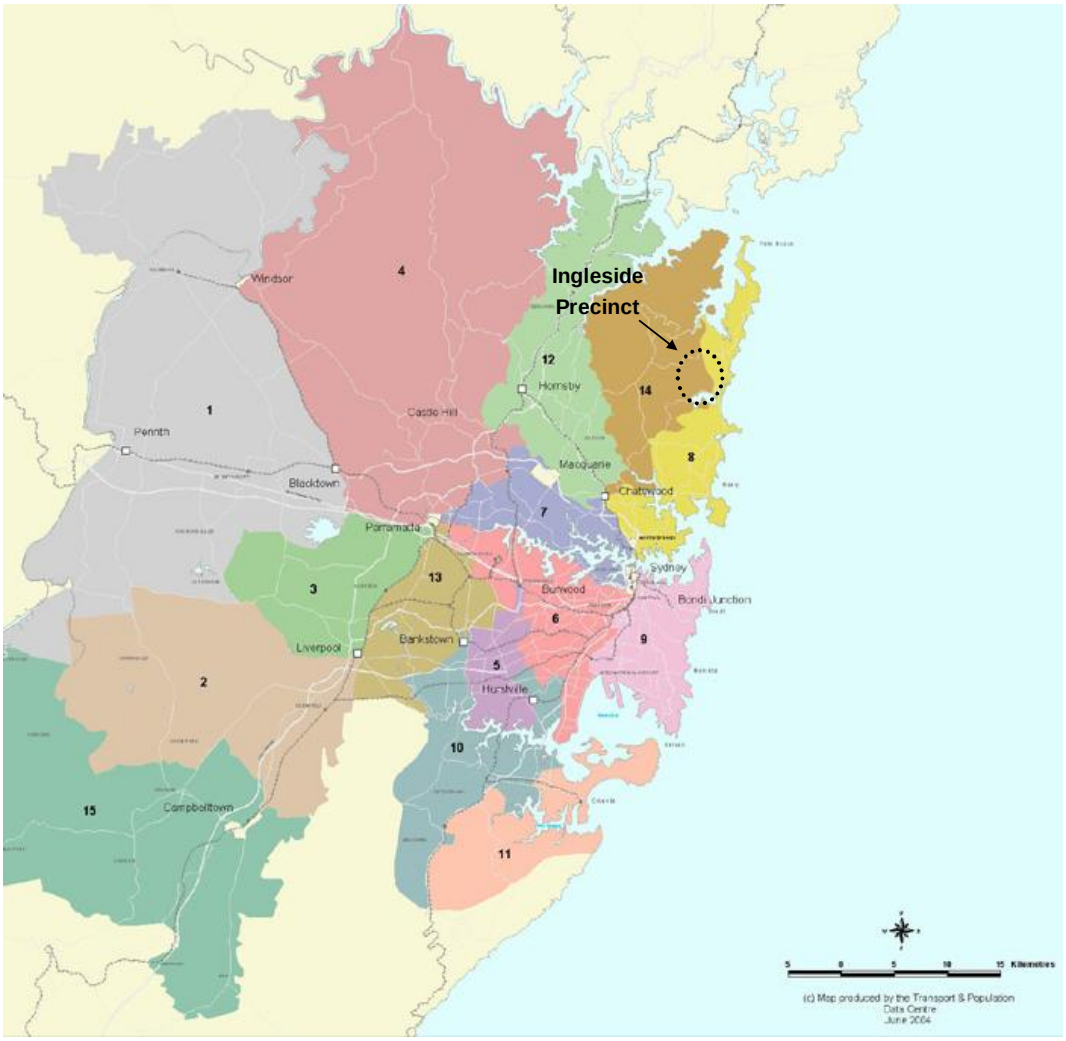
5.4 NSW Bus Service Planning Guidelines

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 14 as shown in **Figure 18**.

Going forward, the existing 15 regional contracts may be consolidated. For the Ingleside Precinct, this means that potential bus routes could be more easily coordinated across a wider area and will potentially be more inclusive of the Ingleside Precinct (the same bus operator will administer a wider area). It is noted that currently, Ingleside is not well serviced by buses.

Figure 18: Metropolitan Sydney Contract Regions, 2012



Source: Transport for NSW, 2015

5.5 Future public transport service provision

Sydney's Bus Future and the Northern Beaches Transport Action Plan identify Bus Rapid Transit (BRT) for Pittwater Road, including a bus hub at Mona Vale and extended bus priority lanes between Mona Vale Road and Garden Street. The proposed BRT system for Sydney's northern beaches has the potential to attract strategic road network trips onto public transport.

Roads and Maritime are improving bus stop infrastructure as part of the Mona Vale Road Upgrade, while Transport for NSW (TfNSW) is proposing an increase in future service provision. The key changes relevant to this study include additional services along the Mona Vale Road corridor. It is estimated that this will include a bus service approximately every 5 minutes in the peak hour (peak direction) by 2021, with further enhancement to services by 2036. Estimated future bus service provision is shown in **Table 22**.

Table 22: Bus provision estimates in 2021 and 2036

Bus route number and description	2021 AM peak		2036 AM peak	
	Westbound	Eastbound	Westbound	Eastbound
E83 CBD-Mona Vale Express via Elanora Heights and Ingleside	4	0	6	0
183 CBD-Mona Vale via Elanora Heights and Ingleside	0	2	0	4
196 Gordon-Mona Vale via Mona Vale Road	0	0	4	4
E97 Macquarie University-Mona Vale Express via Mona Vale Road	4	0	4	0
197 Macquarie University-Mona Vale via Gordon and Mona Vale Road	4	4	4	4

Source: TfNSW future bus provision estimates

Bus facility improvements along Mona Vale would be included through provision of short 'bus only' lanes at the approaches to the signalised intersection at Ponderosa Parade / Samuel Street, along with bus bays on the departure sides of the intersection.

It is important to establish public transport early in the development stage in order to foster more sustainable behaviour amongst residents. With the initial development of South Ingleside, a short term extension of routes E83, 182 and 185 from should be considered.

Apart from Mona Vale Road, each of Powderworks Road, Lane Cove Road, Cabbage Tree Road, Wattle Road and Manor Road will be required to accommodate buses to provide improved public transport accessibility to the Ingleside Precinct.

5.5.1 School buses

It is expected that local bus services will be established to provide connection between the school and major transport nodes as well as the developed residential areas within the precincts. A dedicated school bus service could be introduced or extended as appropriate to serve the proposed school located within the precinct, however, in general students would be encouraged to travel on scheduled public transport routes. The proposed school is located on roads that are capable of accommodating bus routes. Ideally, access to the school would also be provided via a bus capable local road, either on the school site itself or on a neighbouring local road.

5.5.2 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.

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.

It is recommended that bus bays must be a minimum of 3m wide and of a length to suit an articulated bus (bus stops with no part of the bus extending into the traffic lane). They must be located close to each other on both sides of the road, adjacent to intersections and be along bus capable roads. They should also be located approximately 400m apart, if appropriate.

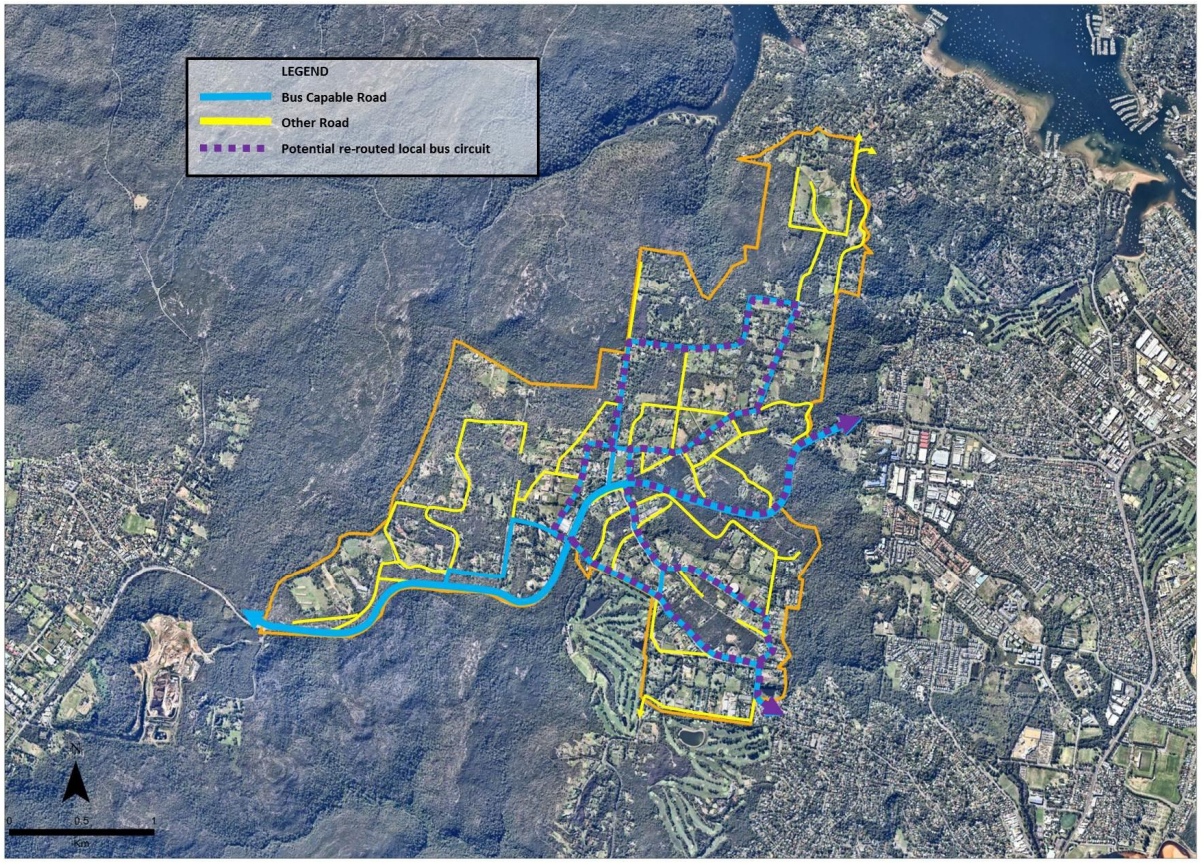
5.5.3 Park and Ride Facility

There may be an opportunity to provide a small parking facility adjacent to Mona Vale Road near the intersection with Lane Cove Road in North Ingleside. This would be subject to feasibility given the grade in this location. Should it prove feasible, the facility would provide an alternative way for residents of Ingleside to access to Mona Vale Road bus corridor for regional bus services. This would be particularly beneficial for local residents of Ingleside living further away from Mona Vale Road. The car park would not have the capacity to act as a regional park and ride facility and therefore would be likely to have minimal traffic impact.

5.5.4 Bus capable routes

Apart from Mona Vale Road; Powderworks Road, Lane Cove Road, Cabbage Tree Road (within Ingleside), Wattle Road and Manor Road will be required to accommodate buses to provide improved public transport accessibility to the Ingleside Precinct – as shown in **Figure 19**. 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. There is also an opportunity to provide a local bus loop around the precinct by extending the 182 or 185 bus route.

Figure 19: Bus capable roads



Source: AECOM, 2015

5.6 Findings and recommendations

Private vehicles are the predominant mode of transport utilised in both Pittwater and Warringah LGAs. This is attributed to relatively limited local public transport network coverage across the Northern Beaches, and the lack of public transit corridors linking to the other areas of Sydney.
There is currently limited public transport along, and in the vicinity of the Ingleside Precinct. There are three bus routes which currently operate along Mona Vale Road.

Roads and Maritime are improving bus stop infrastructure as part of the Mona Vale Road Upgrade, while Transport for NSW (TfNSW) is proposing an increase in future service provision. The key changes relevant to this study include additional services along the Mona Vale Road corridor. It is estimated that this will include a bus service approximately every 5 minutes in the peak hour (peak direction) by 2021, with further enhancement to services by 2036.

The precinct will receive adequate public transport accessibility through transit corridors that allow access to Mona Vale and the Sydney CBD. In addition, bus routes should link key centres, transport hubs, school, employment opportunities and residential areas.

Key bus operating corridors with services providing fast, efficient regional connections will operate along Mona Vale Road with links between notable regional destinations such as Macquarie Park, Gordon and St Ives.

Apart from Mona Vale Road; Powderworks Road, Lane Cove Road, Cabbage Tree Road (within Ingleside) and Manor Road will be required to accommodate buses to provide improved public transport accessibility to the Ingleside 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.

6.0 Walking and Cycling Networks

6.1 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 Ingleside Precinct, and integrating these into adjacent areas (Mona Vale, Bayview Heights, and Elanora Heights) and regional cycle routes.

6.2 Principles and guidelines

6.2.1 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.

6.2.2 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.

6.2.3 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.

Pittwater Walks and Rides Strategy Masterplan Review (March 2012)

The Pittwater Walks and Rides Strategy Masterplan was developed for Pittwater Council as a means of assessing the best way forward to develop the Walk and Ride network. Key objectives of the Pittwater Walks and Rides Strategy Masterplan include;

- Facilitating walking and bicycling as a viable transport choice;
- Afford the public the opportunity to experience the Council's unique scenic and natural amenities;
- Provide access to healthy recreational and commuter activities;
- Link major centres, schools, places of work, parks and open spaces with Pittwater neighbourhoods;
- To augment on the work done in previous studies;

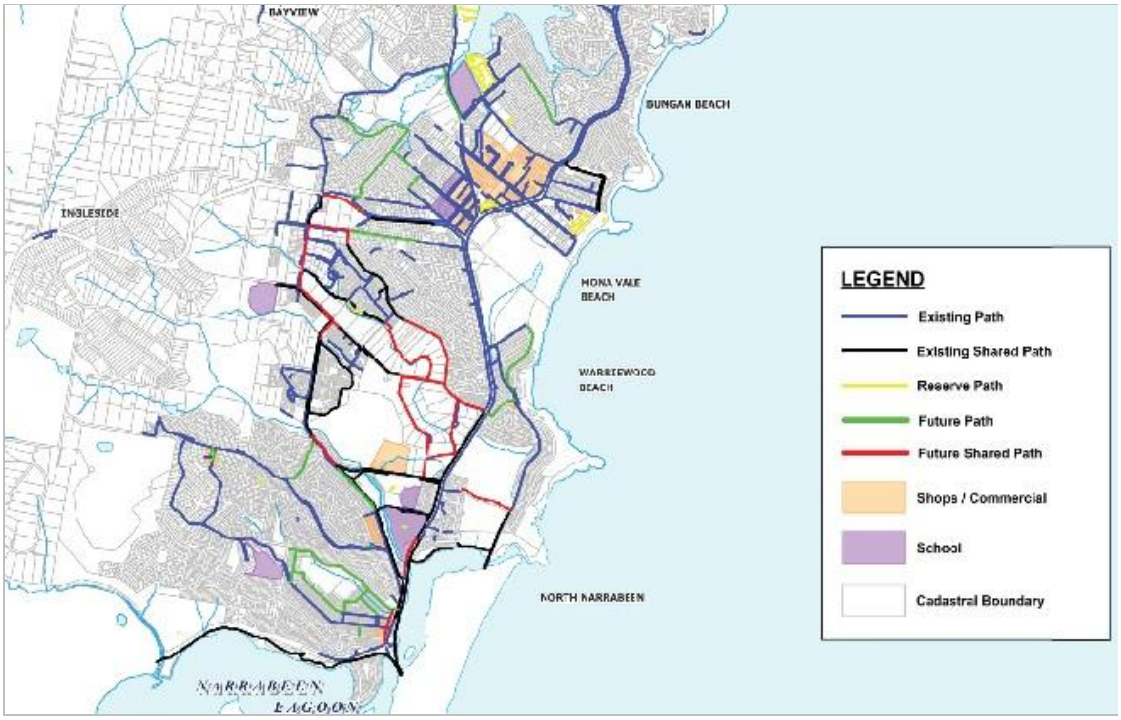
Review the Priority Weighting System to better facilitate improved decision making.

6.3 Existing active travel provision

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. Mona Vale Road also has an on-road cycle lane that is proposed to become a link in the Metro Sydney Bike Network.

Ingleside and Elanora Heights are currently not connected to surrounding suburbs via shared paths (pedestrian and cyclist). However, a network of shared paths exists in the Warriewood area that includes Garden Street, Macpherson Street, Pittwater Road and Jacksons Road. A shared cycle path also exists adjacent to Wakehurst Parkway alongside Narrabeen Lagoon. These shared cycle routes are shown in **Figure 20**.

Figure 20: Existing shared paths for cyclists and pedestrians



Source: Pittwater Walks and Rides Strategy Masterplan, March 2012

6.4 Opportunities and constraints

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.

The future widening of Mona Vale Road could create a barrier to pedestrian and cycle movements. Therefore this corridor needs to be planned in such way to minimise the impedance to pedestrian and cycle connectivity i.e. incorporating sufficient pedestrian and cycle priority wherever possible. The upgrade of Mona Vale Road will, however, provide associated upgrades to pedestrian and bicycle facilities along the corridor through multi-use paths.

The Pittwater Walks and Rides Strategy Masterplan 2012 includes a number of upgrades to the existing local cycle network. This includes connecting existing shared paths in the Warriewood Valley and providing new cycle paths in North Narrabeen. There is currently no proposed cycle infrastructure for Ingleside and Elanora Heights. This is a reflection of both the current land use in Ingleside and the challenging topography of Elanora Heights.

The riparian corridors at Cicada Glen Creek and Mullet Creek could provide an additional barrier to active travel movements within the precinct, however there are good opportunities to provide for recreational walking and

cycling by enhancing links along or adjacent to riparian corridors to the various parks and sports fields located within the precinct.

Green Travel Plans for the proposed school 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.

6.5 Proposed bicycle and pedestrian networks

6.5.1 Bicycle network

A comprehensive bicycle network is proposed for the precinct which will link the neighbourhood centre, school, 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).

On road cyclists will have improved facilities as part of the Mona Vale Road Upgrade East, with shoulders extended to provide a consistent 3m width on both sides of the road throughout the length of the upgrade. This will act to increase safety for cyclists in comparison to sections of the existing road where the shoulder width is limited and will enable Mona Vale Road to fulfil its role as a regional cycle route.

A 3.5m shared path will be provided between Ponderosa Parade and Foley Street on the south side of Mona Vale Road as per the Pittwater Walks and Rides Strategy 2012. This section of road is constrained by residential properties on its north side, as such the 3m shoulder catering for cyclists proposed elsewhere along the corridor will not be provided on the north side of Mona Vale Road in this section of the upgrade.

A 3.0m multi-use path between Ingleside and Mona Vale Road will cater for cyclists, pedestrians, utilities and horse riders. This provides cyclists with a more scenic route away from the traffic along Mona Vale Road and is ideal for use by leisure cyclists. It also removes the need for providing cycle infrastructure along Cabbage Tree Road (in Mona Vale), as this is undesirable due to the steep grade. The location of the proposed multi-use path is not yet known.

An off-road shared path will be provided along Powderworks Road and all proposed collector roads to facilitate safe and efficient travel by non-car modes throughout the precinct and connect to the wider bicycle network. These connections will facilitate improved connectivity to neighbouring locations, including the small village centre at Elanora Heights.

6.5.2 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.

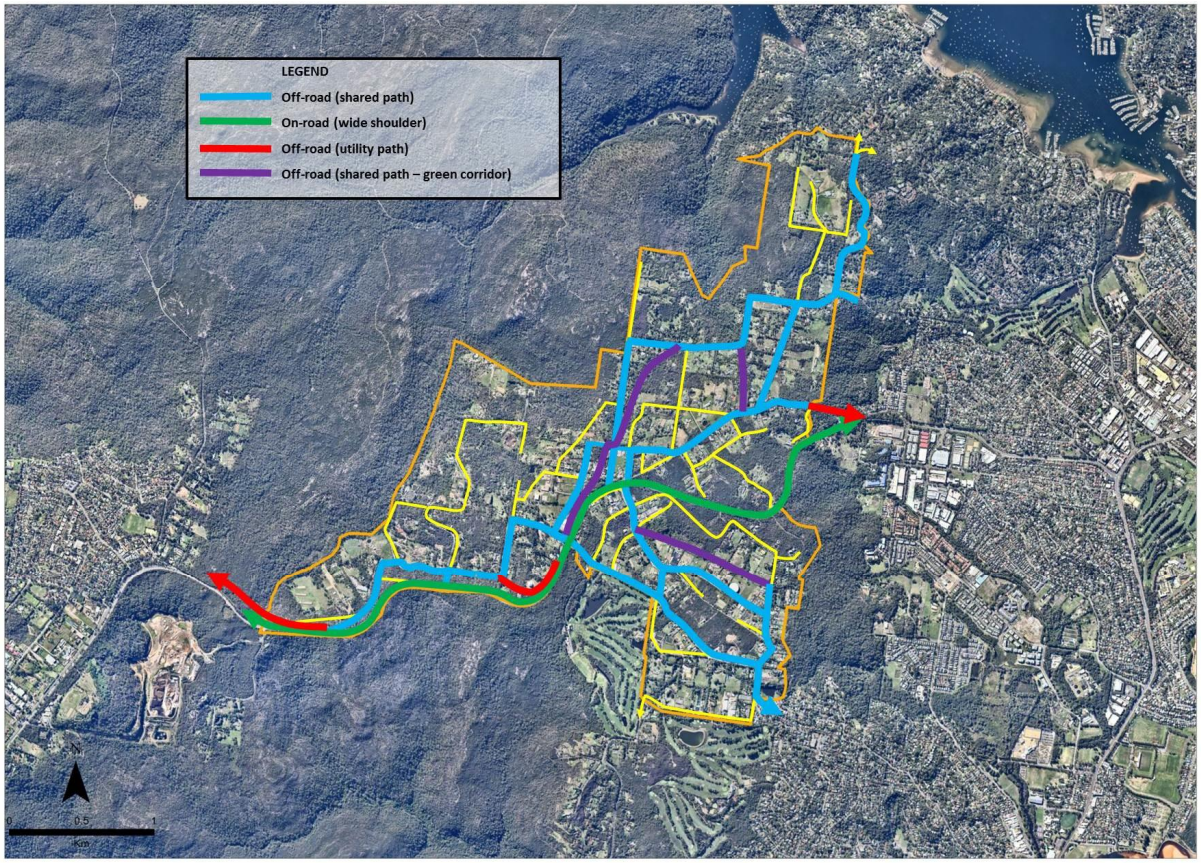
There is also an opportunity to provide recreational paths on the riparian corridors adjacent to Cicada Glen Creek and Mullet Creek to encourage leisure walking within the precinct.

As part of the proposed Mona Vale Road Upgrade East there will be a 3.5m shared path provided between Ponderosa Parade and Foley Street on the south side of Mona Vale Road. This is consistent with the Pittwater Walks and Rides Strategy 2012.

A multi-use path is also proposed to connect between Lane Cove Road in Ingleside and Walana Crescent in Mona Vale. This path will cater for cyclists, pedestrians, utilities and horse riders. Details of the multi-use path are not yet available, however it is anticipated that it will deviate from Mona Vale Road and be located adjacent to the Katandra Bushland Sanctuary. This connection will provide future residents of Ingleside with a considerably shorter walking route to the Mona Vale Town Centre.

An off-road shared path will be provided along Powderworks Road and all proposed collector roads to facilitate safe and efficient travel by non-car modes throughout the precinct and connect to the wider pedestrian network. This will extend to the small village centre in Elanora Heights in order to facilitate access to the shops at this location and improve connectivity to neighbouring locations, including Elanora Heights and North Narrabeen. The proposed active travel network is shown in **Figure 21**.

Figure 21: Proposed active travel network



Source: AECOM, 2015

It is also recommended that pedestrian refuges should be provided along collector roads at appropriate locations between intersections to facilitate pedestrian/cyclicts safety and amenity and act as traffic calming. They must have a 3m minimum width to ensure sufficient deviation of traffic.

6.6 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, school, retail, employment, public transport nodes and other trip attractors in the area.

Natural and built constraints within the precinct include:

- Riparian corridors
- Steep terrain
- Mona Vale Road

Existing proposals, including shared paths and pedestrian overbridges, would significantly improve pedestrian and cycling connectivity to the surrounding network. The proposed utility paths along Mona Vale Road will improve the connectivity to the regional active travel network, providing links to Mona Vale Town Centre and the proposed neighbourhood centre in North Ingleside. 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 school, 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 (subject to feasibility). 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. It is recommended that pedestrian refuges should be provided along collector roads at appropriate locations between intersections to facilitate pedestrian/cyclicts safety and amenity and act as traffic calming.

Green Travel Plans for the proposed school 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.

7.0 Summary

Over the next 20 years, Sydney's population is forecast to grow by 1.6 million people, requiring an additional 664,000 homes. The Northern Beaches is also expected to change dramatically during this time. In recent years, a number of locations have been identified by the NSW Government and local Councils across Sydney as potential sites for new precincts/communities to be developed in response to these demands.

The study aims to ensure that the Ingleside Precinct provides suitable facilities for people to walk, cycle, access public transport or use private cars, thus enabling people to make the most appropriate choice of transport mode for their journey and ensuring 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. Ultimately this precinct will be 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, as well as ensure that transport infrastructure provides an appropriate level of service that mitigates the impacts of future development, addresses the requirements of traffic growth on the strategic road network and meets the needs of relevant stakeholders.

This traffic and transport assessment has been informed by the recent Mona Vale Road Corridor Studies undertaken by the Roads and Maritime *(Mona Vale to Macquarie Park Corridor Strategy, Mona Vale Road McCarrs Creek Road to Powderworks Road Upgrade Preferred Options Report)* and has considered other strategic publications such as *The Northern Beaches BRT Pre-Feasibility Study* as well as a number of local studies undertaken for Pittwater Council and regional developments such as the Northern Beaches Hospital and Wakehurst Parkway Upgrades. The outcomes of the Ingleside transport study will then be used to inform any ongoing upgrades of the strategic road network and the development capacity of the precinct.

A summary of the transport infrastructure provision associated with the proposed development is summarised in **Table 23**.

Table 23: Summary of infrastructure provision

Mode	Infrastructure / Service improvements	Responsibility
Active Travel	Utility path alongside Mona Vale Road	Roads and Maritime
Active Travel	Off-road shared paths (collector roads)	Developer / Council
Active Travel	Off-road shared paths (green corridors)	Developer / Council
Public Transport	Bus priority treatment at Mona Vale Road intersections	Roads and Maritime
Public Transport	Enhanced bus services along Mona Vale Road	TfNSW
Public Transport	Enhance local services through Ingleside	TfNSW
Public Transport	Improved stopping facilities along Mona Vale Road	Roads and Maritime
Public Transport	New / upgraded bus stops on other local roads	Developer / Council
Private Car	Mona Vale Road Upgrade	Roads and Maritime
Private Car	Intersection improvements at Powderworks Road / Garden Street	Developer / Council / RMS
Private Car	Intersection improvements at Mona Vale Road / Pittwater Road	Roads and Maritime
Private Car	Provision of roundabouts within the Ingleside Precinct	Developer / Council

Source: AECOM , 2015

Intersections upgrades attributable to the Ingleside development predominantly occur as a result of enhanced access requirements, however the intersections of Mona Vale Road / Pittwater Road and Powderworks Road / Garden Street are necessitated as a result of additional traffic generated by the proposed Ingleside development

between 2021 and 2036. A summary of the intersection upgrades associated with the proposed development is summarised in **Table 24**.

Table 24: Summary of intersection upgrades

Location	Existing Layout	Changes Likely to be required	Possible Future Layout
Mona Vale Road / Powderworks Road / Baha'i Temple Way intersection	4-arm signalised intersection	Realignment of Baha'i Temple Way	4-arm signalised intersection
Mona Vale Road / Chiltern Road intersection	3-arm seagull priority intersection	Right turn movements closed	3-arm left in / left out intersection
Mona Vale Road / Lane Cove Road / Manor Road intersection	4-arm signalised intersection	Deviation of Lane Cove Road	4-arm signalised intersection
Mona Vale Road / Pittwater Road	3-arm signalised intersection	Extension of right turn bays on Pittwater Road (150m) and Mona Vale Road (110m)	3-arm signalised intersection (subject to re-assessment at a later date)
Powderworks Road / Wattle Road	4-arm priority intersection	Roundabout provided to facilitate access across Powderworks Road	Roundabout
Powderworks Road / Wilson Avenue	3-arm priority intersection	Roundabout provided to facilitate safer access to Wilga-Wilson	Roundabout
Powderworks Road / Ingleside Road	3-arm priority intersection	Roundabout provided to facilitate safer access to Ingleside Road	Roundabout
Powderworks Road / Wilga Street	3-arm priority intersection	Roundabout provided to facilitate access to Wilga-Wilson	Sub-arterial Road / roundabout
Powderworks Road / Garden Street	3-arm signalised intersection	Extension / formalisation of left turn bays on Garden Street and Powderworks Road	3-arm signalised intersection
Chiltern Road / Neighbourhood centre access Road	N/A	Roundabout provided to facilitate access to the proposed neighbourhood centre	Roundabout
Lane Cove Road / Ingleside Road	3-arm priority intersection	Roundabout provided to facilitate access across Lane Cove Road	Roundabout
Lane Cove Road / View Road	3-arm priority intersection	Roundabout provided to facilitate access across Lane Cove Road	Roundabout
Cabbage Tree Road / Walter Road	4-arm priority intersection	Roundabout provided to facilitate safer access in all directions	Roundabout
Lane Cove Road / Neighbourhood centre access Road	4-arm priority intersection	New intersection created as a result of deviation of Lane Cove Road	Priority Give-way

Source: AECOM, 2015