SCT Consulting

ORCHARD HILLS NORTH REZONING

Transport Management and Accessibility Plan

31 JANUARY 2023

Quality Assurance

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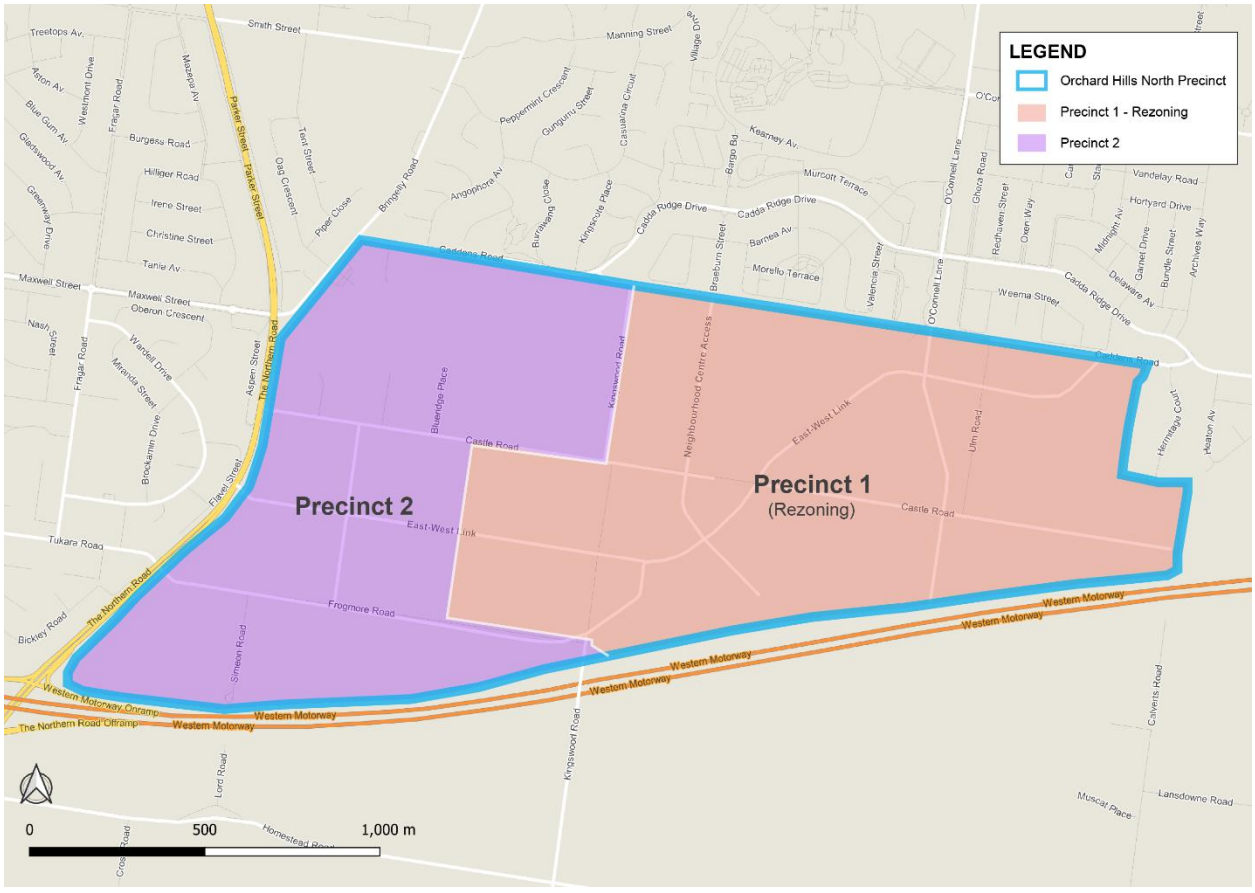
Executive Summary

Proposal

Legacy Property is proposing to rezone a site in Orchard Hills North, located within the Penrith Local Government Area (LGA). The proposed rezoning area is approximately 146.1 hectares (ha) with frontages to Caddens Road to the north, Kingswood Road to the west, the M4 to the south and Claremont Meadows residential lots to the east – this area is referred to as Precinct 1.

This Transport Management and Accessibility Plan (TMAP) covers the Orchard Hills North Precinct, which includes two distinct areas: Precinct 1 and Precinct 2. The rezoning aims to rezone Precinct 1 from agricultural land to mixed land uses, forming up to 1,729 residential lots, a neighbourhood centre, and numerous areas of green and active space.

Precinct 1 is the subject of a gateway-approved planning proposal and Precinct 2 is recognised as an area that will change into the future. While only Precinct 1 would be rezoned with the subject planning proposal, Precinct 2 has been master planned and modelled as well. This ensures Penrith City Council, TfNSW, Department of Planning, Industry and Environment (DPIE) and the public understand what the long term transport infrastructure could look like (subject to further investigation, planning, and funding decisions).



The proposed Precinct 1 area would accommodate the following:

Table E-1 Precinct 1 (rezoning area) land use assumptions

Attribute	Yield
No. of new residential dwellings	1,729 dwellings (1,629 additional)
Business/commercial floor space	7,000 sqm retail floor space in local centre
New school	30 teachers and 507 students
Site area	146.1 Ha
Population per dwelling	3.0 (provided by Council)
Forecast residential population	5,187 people

Source: SCT Consulting, 2020

Precinct 2 could accommodate up to approximately 1,146 additional dwellings (in additional to those in the Precinct 1) and approximately 7 hectares of non-residential uses along The Northern Road, which could offer a combination of small retail, fast foods, community, health, medical, hotel, larger format commercial that may service the journey to the new airport. This would be in addition to the existing schools and residential development within the area. The land use assumptions for Precinct 2 consists of the following components:

Table E-2 Precinct 2 land use assumptions

Attribute	Yield
Residential	1,146 total dwellings (1,061 additional)
Population per dwelling	3.0 (provided by Council)
Forecast residential population	3,438 people
School expansion	65 teachers and 718 students
Service station, strip of shops, fast food, etc. (2 Ha site area)	10,000m^2 GFA, comprising: – 3,000m^2 GFA for service station; – 6,000m^2 GFA of warehouses (self-storage); and – 1,000m^2 GFA of fast food (1x restaurant).
Highway service centre with bulky good uses (5 Ha site area)	25,000m^2 GFA, comprising: – 2 fast food restaurants @ 2,000m^2 GFA total; – 1 service station @ 3,000m^2 GFA; – 6 bulky goods premises @ 13,000m^2 GFA total; – 1 specialty retail shops @ 1,000m^2 GFA total; and – Offices (say for a government agency) @ 6,000m^2 GFA total.
Total site area	Total area: 112.3 hectares: – Area of existing schools: 14.2 hectares – Area of Sydney water reservoirs: 2.5 hectares – Area of telephone exchange: 0.4 hectares – Area of enterprise corridor: 7 hectares

Source: SCT Consulting, 2020

As Precinct 2 is not proposed to be rezoned in this application, these land uses may be subject to change.

Combined, the Orchard Hills North Precinct (Precinct 1 and Precinct 2 combined) could accommodate the yields shown in **Table E-3**, which is the combination of **Table E-1** and **Table E-2**.

Table E-3 Orchard Hills North (Precinct 1 & 2) land use assumptions

Attribute	Yield
No. of new residential dwellings	2,875 dwellings (2,690 additional)
Population per dwelling	3.0 (provided by Council)
Forecast residential population	8,625 people
Business/commercial floor space	7,000 sqm retail floor space in local centre
New school	95 teachers and 1,225 students
Business/commercial floor space	7,000 sqm retail floor space in local centre
Service station, strip of shops, fast food, etc. (2 Ha site area)	10,000m^2 GFA, comprising: – 3,000m^2 GFA for service station; – 6,000m^2 GFA of warehouses (self-storage); and – 1,000m^2 GFA of fast food (1x restaurant).
Highway service centre with bulky good uses (5 Ha site area)	25,000m^2 GFA, comprising: – 2 fast food restaurants @ 2,000m^2 GFA total; – 1 service station @ 3,000m^2 GFA; – 6 bulky goods premises @ 13,000m^2 GFA total; – 1 specialty retail shops @ 1,000m^2 GFA total; and – Offices (say for a government agency) @ 6,000m^2 GFA total.

The access strategy for Precinct 1 and Precinct 2 is shown below:

This strategy is subject to further planning, investigations, and funding decisions.

Traffic modelling

Traffic modelling was undertaken in line with *Scoping Note: Orchard Hills TMAP Methodology Report – Post Gateway – Final, version 4.4 (dated 19 June 2020)*, which is provided in **Appendix A**. The modelling shows that a total of 11 intersections require upgrade, subject to further planning, investigation, and funding decisions.

Modelling was based on the agreed traffic generation rates with TfNSW and Council. SCT Consulting prepared calibrated and validated traffic models (Aimsun and SIDRA) in accordance with the Traffic Modelling Guidelines (2013). The models were used to test the forecast growth provided by LU16 (background growth), the land use changes associated with Precinct 1 and Precinct 2.

Traffic modelling indicates that further expansion of Precinct 1 to the west defined as the balance of structure plan area (Precinct 2) is also feasible. The land use changes proposed for Precinct 1 and Precinct 2 are able to be accommodated with fair and reasonable road upgrades that have been designed to be efficient, economic, and appropriate to road typologies.

A suite of road upgrades is proposed to mitigate the impacts of the development within the combined Precinct 1 and Precinct 2 areas. With these upgrades, the road network will continue to operate at Level of Service D or better. It is recommended that the Section 7.11 plan take these upgrades into consideration as well as the staging outlined.

A summary of the proposed upgrades is provided in **Table E-4**.

Table E-4 Road infrastructure upgrade summary (subject to further planning, investigations, and funding decisions)

Item	Nexus
Caddens Road / Gipps Street / Kent Road	– Background growth – Orchard Hills North Precinct (Precincts 1 & 2)
Great Western Highway / Gipps Street	
Resurfacing of Frogmore Road	
The Northern Road / Frogmore Road	– Precinct 2
The Northern Road / New East-West corridor (new)	
East-West corridor west of the Precinct 1 (to The Northern Road)	
New East-West corridor / Neighbourhood Centre Access (new)	– Background growth – Orchard Hills North Precinct (Precincts 1 & 2)
New East West corridor / O'Connell Lane (North-South corridor) (new)	
Great Western Highway / O'Connell Street / French Street	
O'Connell Lane / O'Connell Street / Western Sydney University entrance	
O'Connell Street / Cadda Ridge Drive	
M4 Motorway Ramps / Kent Road	
The Northern Road / Bringelly Road	
O'Connell Street northbound and southbound from Great Western Highway and O'Connell Street	
O'Connell Street / North-South corridor dual lane upgrades	
Caddens Road / East-West corridor dual lane upgrades	

Item	Nexus
Land dedication for two lanes in each direction for remainder of east-west and north-south corridor	Development beyond Orchard Hills North Precinct (Precincts 1 & 2)
Construction of two lanes in remainder of east-west and north-south corridor	

The only mandatory gateway condition of consultation with Council and Transport for NSW has been fulfilled by way of a Steering Committee with Penrith City Council, TfNSW, DPIE and the proponent that oversaw the preparation of this TMAP.

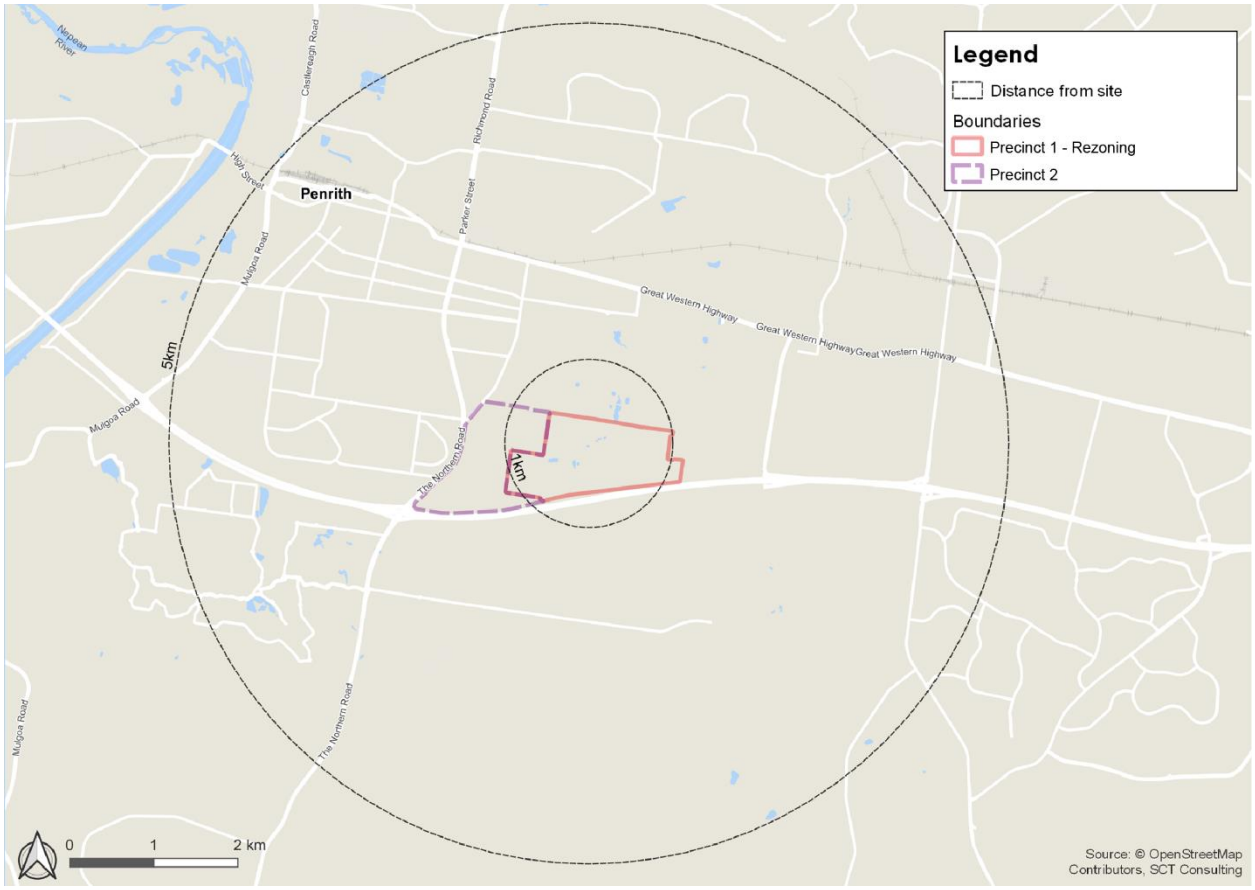
1.0 Introduction

1.1 Orchard Hills North

Legacy Property is proposing to rezone a site in Orchard Hills North, located within the Penrith Local Government Area (LGA). The proposed rezoning area is approximately 146.1 hectares (ha) with frontages to Caddens Road to the north, Kingswood Road to the west, the M4 to the south and Claremont Meadows residential lots to the east (Precinct 1).

Orchard Hills North is well located being north of the M4, in proximity to the University of Western Sydney (to the north), Nepean Hospital (to the north) and Penrith city centre located to the north west within 5 km. South of the Motorway is currently mostly Orchard Hills rural lands, Defence Lands and to the south west is Glenmore Park. Western Sydney Airport is also located south of the M4.

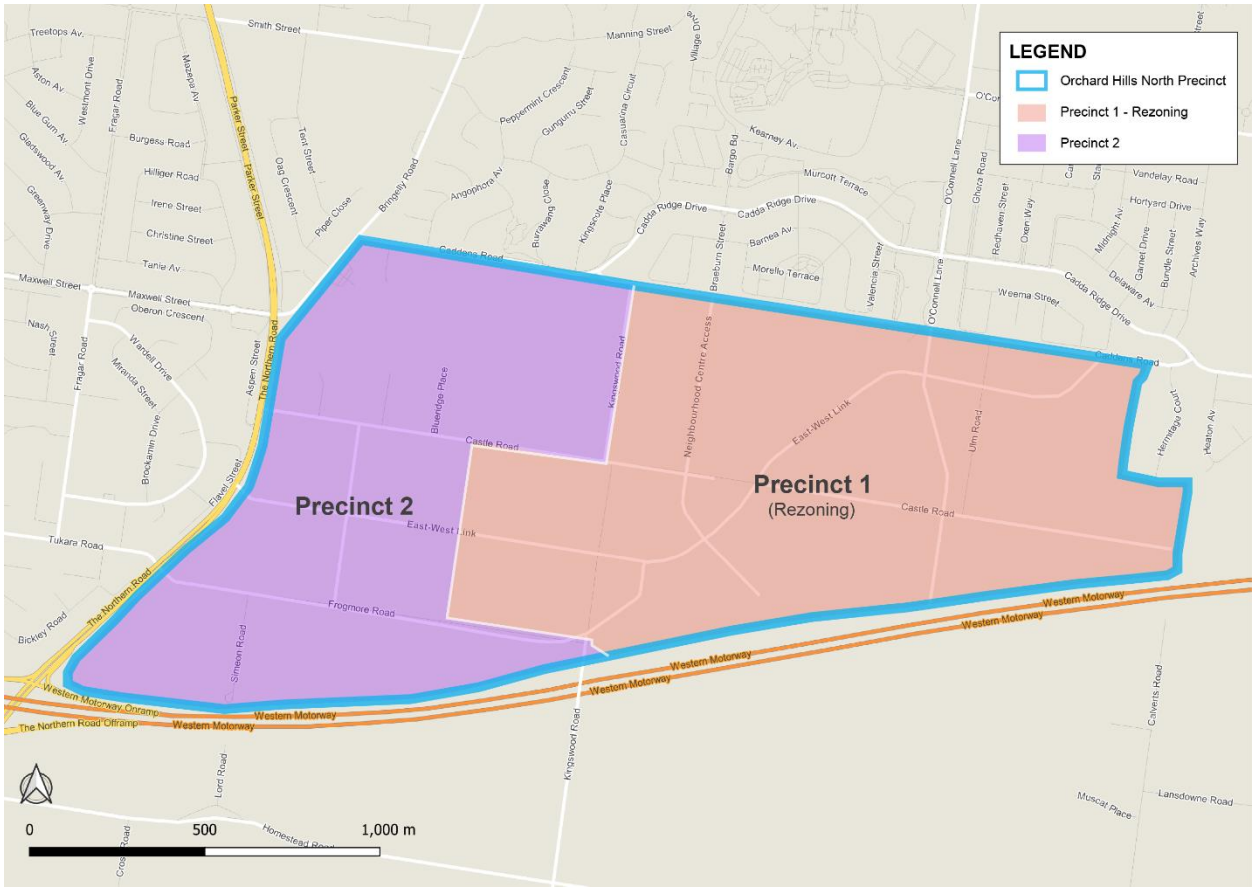
Figure 1-1 Regional context



Source: © OpenStreetMap Contributors, SCT Consulting, 2020

This Transport Management and Accessibility Plan (TMAP) covers the Orchard Hills North Precinct, which includes two distinct areas: Precinct 1 and Precinct 2. Precinct 1 is the subject of a gateway-approved planning proposal and Precinct 2 is recognised as an area that will change into the future. While only Precinct 1 would be rezoned with the subject planning proposal, Precinct 2 has been master planned and modelled as well. This ensures Penrith City Council, TfNSW, Department of Planning, Industry and Environment (DPIE) and the public understand what the long term transport infrastructure could look like (subject to further investigation, planning, and funding decisions).

Figure 1-2 Orchard Hills North Precinct (Precinct 1 & 2)



Source: © OpenStreetMap Contributors, SCT Consulting, 2021

Precinct 1 comprises 54 existing lots (including the school and uniting church), located at the following addresses:

– 80-154 Caddens Road, Orchard Hills
– 26-48 Kingswood Road, Orchard Hills
– 79-101 Kingswood Road, Orchard Hills (school)
– 117-149 Castle Road, Orchard Hills
– 53-105 Castle Road, Orchard Hills
– 182-226 Caddens Road, Orchard Hills
– 2-164 Castle Road, Orchard Hills
– 1-5 Castle Road, Claremont Meadows
– 7 Castle Road, Claremont Meadows
– 5, 9,13,19,23,29,33 and 35 Frogmore Road, Orchard Hill

The existing fragmented ownership of the site has historically been a barrier to coordinated planning or development of the area, however Legacy Property has now secured agreements covering most of Precinct 1.

Legacy Property nominated the Orchard Hills North site under Penrith City Council's Accelerated Housing Delivery Program (AHDP) in October 2017. In November 2017, the site was endorsed by Penrith City Council as a short-term rezoning opportunity to provide for housing delivery over the next 3-5 years.

The site was granted gateway on 22 February 2019. Transport requirements are limited to consultation with Council, (then) Roads and Maritime Services and Transport for NSW.

As part of consultation with these agencies, a modelling methodology was agreed upon by stakeholders, which is summarised in the *Scoping Note: Orchard Hills TMAP Methodology Report – Post Gateway – Final, version 4.4 (dated 19 June 2020)* document, provided in **Appendix A**.

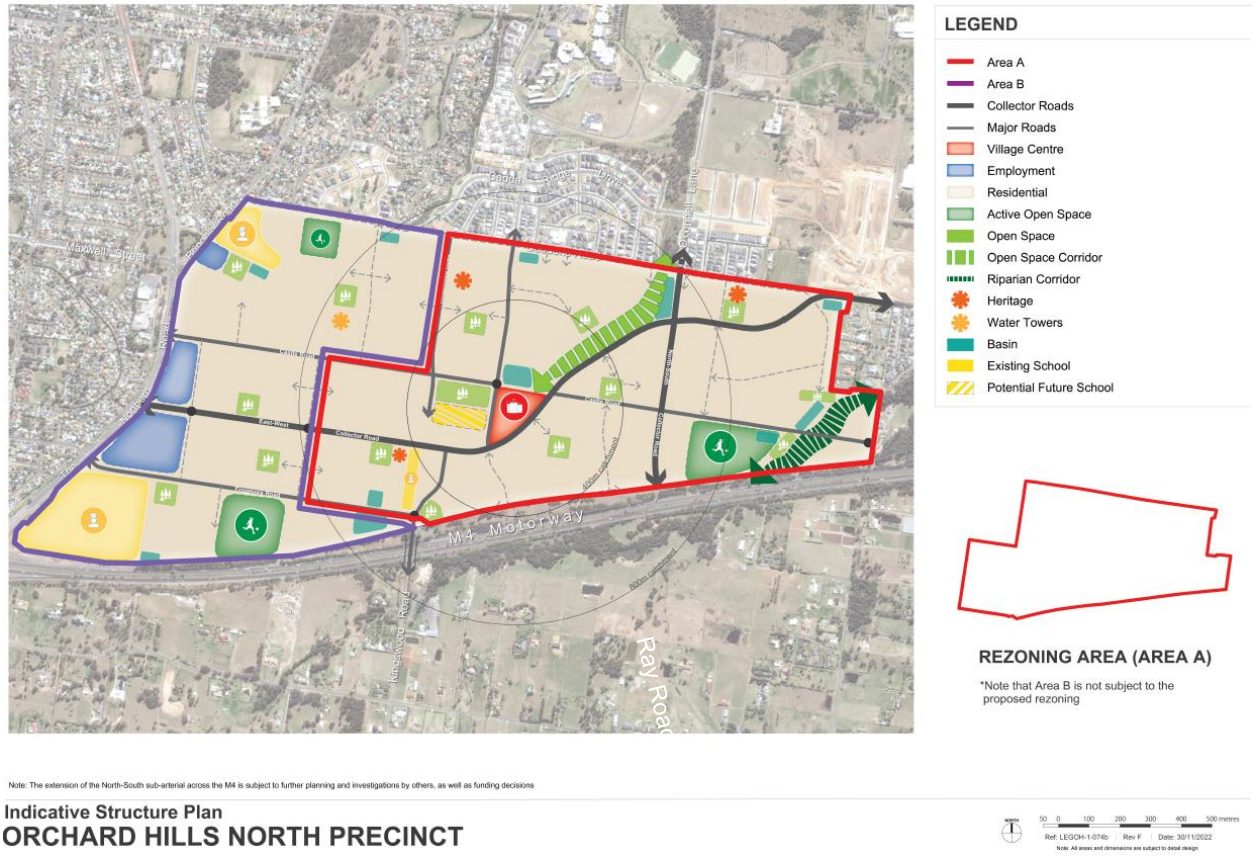
1.2 Concept structure plan

The rezoning of Precinct 1 aims to change agricultural land to mixed land uses, forming around 1,729 residential lots, a neighbourhood centre and green space.

While not a matter in the Gateway Determination, discussions with the Department of Planning, Industry and Environment (DPIE) and Council have highlighted the need to consider the logical extension of Precinct 2 to ensure that future land uses and connections for the entire Orchard Hills North Precinct are planned in a holistic manner.

To ensure that the future development is fully integrated, a high-level Structure Plan has been prepared for the entire Orchard Hills North Precinct, covering an area of approximately 258 ha, presented in **Figure 1-3**. The structure plan considers how the Precinct 1 (146.1 ha) integrates with the balance of the precinct (Precinct 2 with 112.3 ha) and identifies potential future land uses as well as key road connections. It is expected that the structure plan will provide a framework for the future rezoning of Precinct 2, either through a Council Local Environmental Plan (LEP) amendment or a developer/owner led rezoning.

Figure 1-3 Concept Structure Plan of Orchard Hills North Precinct

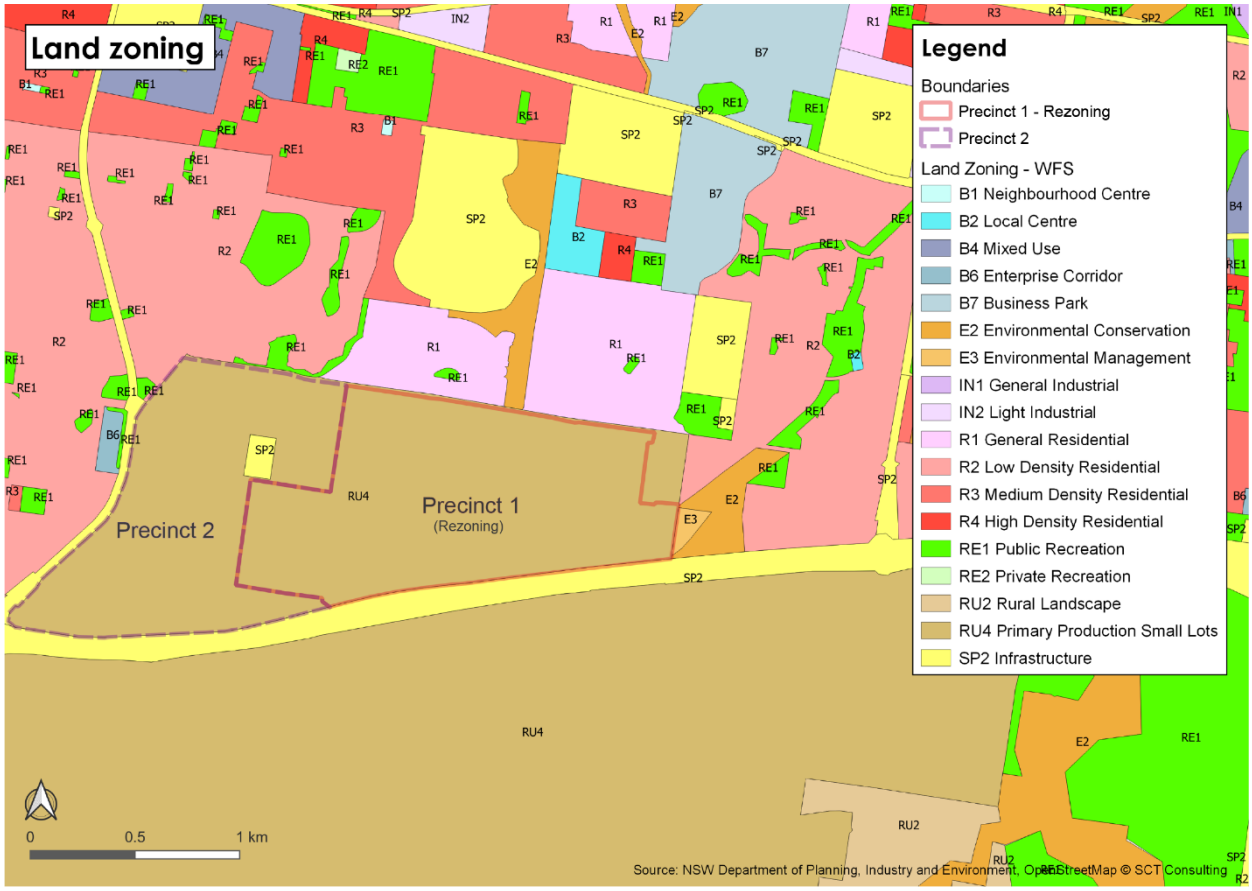


Source: Design + Planning, November 2022

Council has endorsed proceeding with Precinct 1 to meet the objectives of its Accelerated Housing Delivery Program. A significant factor in this approach is that Legacy Property has secured agreements covering most of Precinct 1 and is therefore able to progress with the rezoning and provide greater certainty for coordinated future development.

The current land zoning is presented in **Figure 1-4**.

Figure 1-4 Land zoning around Orchard Hills North



Source: DPIE, SCT Consulting, 2019

1.3 Background

The cultural landscape of the Orchard Hills North site has developed as a rural landscape over the past 100 years with constantly evolving pastoral practices and declining Cumberland Plain Woodland. Within the last 50 years Orchard Hills North has typically been associated with orchard food production, grazing farming practices with some specialisation in agricultural farming and rural residential communities.

Although genuine food production practices have steadily declined over recent years, and only two lots within the site are currently used for any form of agricultural production, the site remains zoned as RU4 Primary Production Small lots. Today, most of the site is utilised for residential purposes and has been substantially cleared.

1.4 Purpose of report

SCT Consulting has been engaged by Legacy Property to undertake a TMAP to support the proposed rezoning of Orchards Hill North. The purpose of this TMAP is to assess traffic, parking, and access plans, based on the design of the proposed concept masterplan, including:

– Undertake a background information and documentation review;

– Collate existing traffic and travel pattern data;

– Review of existing traffic and transport conditions;

– Understand the status of any planned and committed infrastructure upgrades;

– Understand trip generation and trip distribution to understand likely implications of the proposed development;

– Determine likely infrastructure upgrades required to cater for the proposed development; and

– Identify public and active transport measures and sustainable travel initiatives for the development, as well as the likely required parking provision.

1.5 Consultation

To fulfil requirements to consult with Council and Transport for NSW (TfNSW), a Steering Committee was convened with membership from the following organisations:

– Legacy Property

– SCT Consulting

– J. Wyndham Prince

– Department of Planning, Industry and Environment (DPIE)

– Penrith City Council

– TfNSW

The Steering Committee met consistently throughout the preparation of the TMAP to ensure that all concerns could be clearly discussed and communicated. As part of the public exhibition exercise, the final TMAP will be submitted to members of the Group for review and endorsement. This is the only Gateway condition relating to transport.

1.6 Report structure

This report has been structured into the following sections:

– **Section 2** provides a summary of the review of all relevant background documents;

– **Section 3** describes the existing transport conditions for all modes of transport;

– **Section 4** describes the proposed development, its access strategy and a review of Council parking and access requirements;

– **Section 5** outlines the traffic and transport appraisal which describes the modelling undertaken, the likely trip generation and indicative impact because of the proposed development; and

– **Section 6** summarises the report content and presents the final conclusions.

2.0 Strategic Context

2.1 Future Transport 2056

The Future Transport Strategy 2056 (The NSW Government, March 2018) is an update of NSW's Long-Term Transport Master Plan. It is a vision for how transport can support growth and the economy of New South Wales over the next 40 years. The strategy is underpinned by the Regional Services and Infrastructure Plan and the Greater Sydney Services and Infrastructure Plan, as well as several supporting plans including Road Safety and Tourism.

The Future Transport Strategy 2056 sets the long-term vision for mobility and transport provision in NSW, explains how the customer experience of transport will change and what this means for NSW. The Future Transport Strategy 2056 identifies that Sydney will grow as a global metropolis with benefits distributed more evenly across the City. It sets out a vision of three cities to guide many of the planning, investment and customer outcomes including faster, convenient, and reliable travel times to major centres, as shown in **Figure 2-1**.

Existing and potential transit connections, together with new technology and innovation, will make the network surrounding the Site more responsive to demand and better able to manage congestion in the future.

For the three cities identified, more specific outcomes listed as part of the Strategy which will benefit the Site's transport context, including:

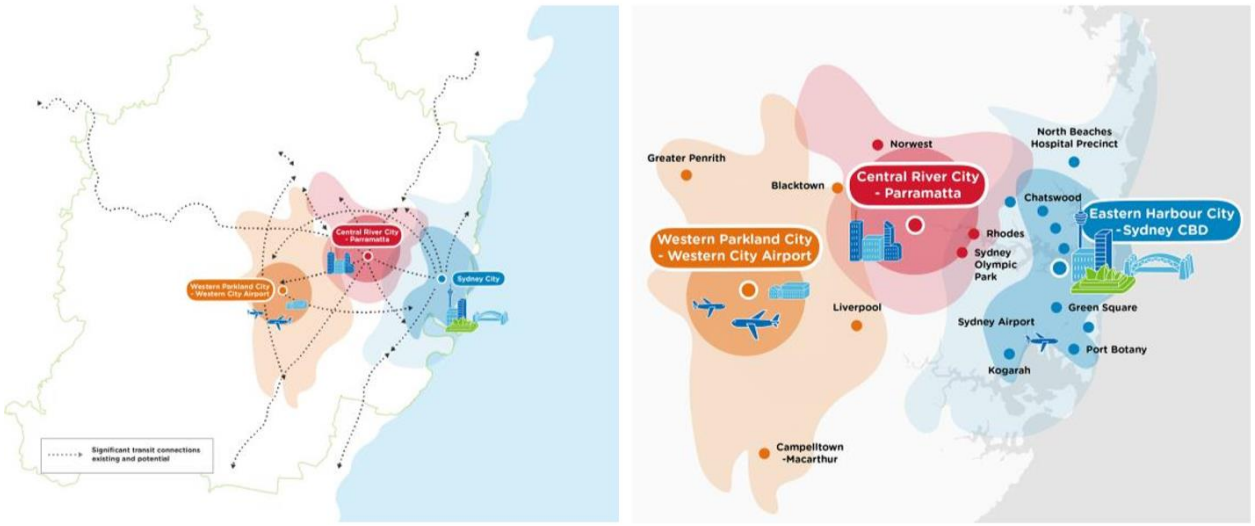
– 30-minute access for customers to their nearest Centre by public transport seven-days a week;

– Fast and convenient interchanging with walking times no longer than five minutes between services;

– Walking or cycling as the most convenient option for short trips around centres and local areas, supported by a safe road environment and attractive paths; and

– Fully accessible transport for all customers.

Figure 2-1 A future metropolis of three cities



Source: The NSW Government Future Transport 2056 Strategy

Implication for Orchard Hills North: The site needs to prioritise access by walking, cycling and public transport to employment destinations.

2.2 Western City District Plan

The Western City District Plan involves the local government areas of Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith, and Wollondilly, as shown in **Figure 2-2**. It aims to ensure future generations have excellent connections to local jobs, housing, services, and great places. Under the Plan, Penrith (located north west of the site) is identified as the economic and service hub of the West District.

The Western Sydney Airport and Badgerys Creek Aerotropolis south of the site is expected to transform the District, creating a once-in-a-generation economic boom for residents, bringing infrastructure, businesses, and knowledge-intensive local jobs to residents.

The Plan establishes a housing target of 39,850 new dwellings from 2016-2021, with 6,600 additional dwellings in Penrith LGA. to accommodate this growth, the Draft District Plan outlines several overarching priorities and actions that will shape the future and guide policy decisions for this District, including:

– Planning a city supported by infrastructure, including infrastructure that supports the new Western Sydney Airport and responds to growth;

– Giving people housing choices by providing housing supply, choice, and affordability, with access to jobs and services;

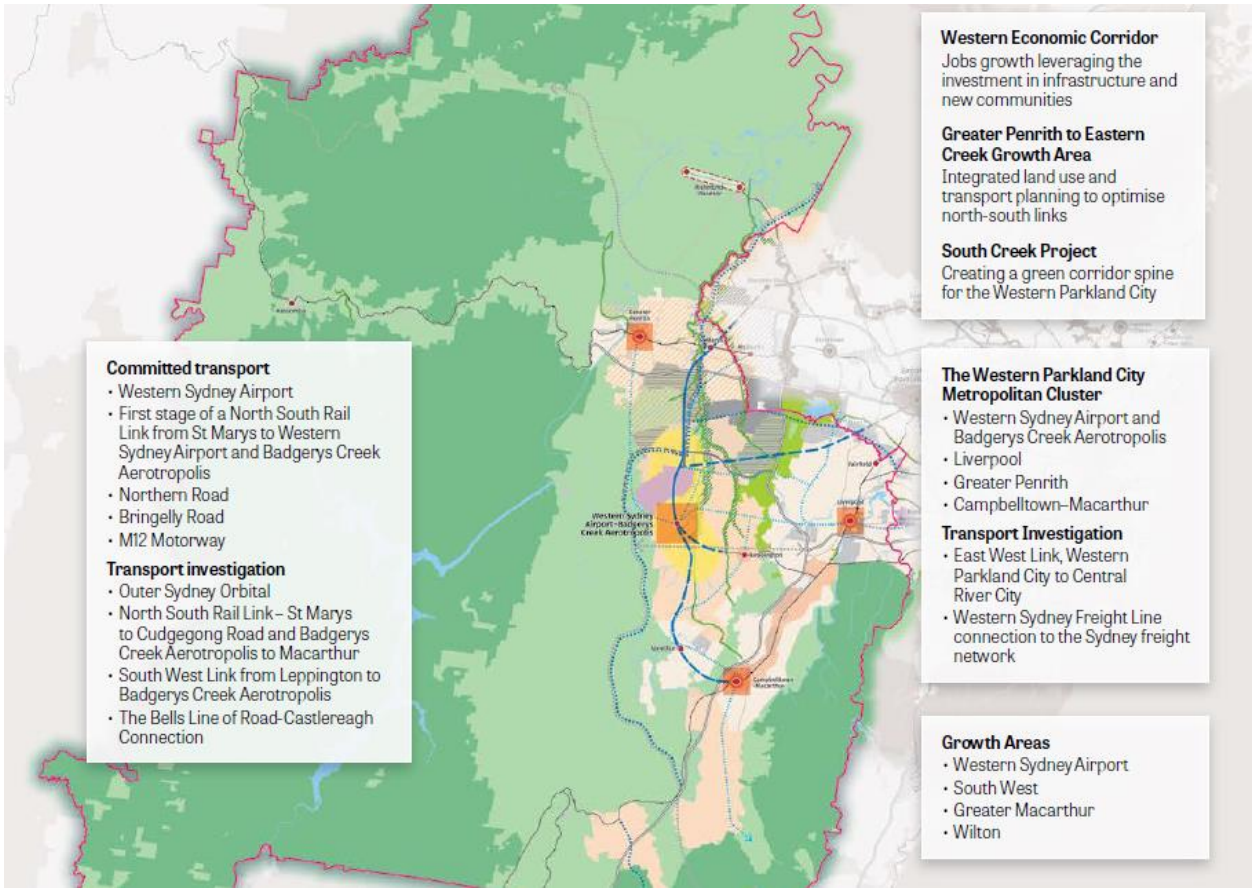
– Designing places for people by creating and renewing great places and local centres, and respecting the district's heritage;

– Developing a more accessible and walkable city by establishing the land use and transport structure to deliver a liveable, productive, and sustainable Western Parkland City;

– Creating the conditions for a stronger economy by actions including leveraging the industry opportunities from the Western Sydney Airport and Badgerys Creek Aerotropolis, planning, and managing industrial and urban services land and growing investment, business opportunities and jobs in strategic centres; and

– Valuing green spaces and landscape by actions including creating a protecting and enhancing bushland and biodiversity Planning Priority, better managing rural areas, and delivering high quality open space.

Figure 2-2 The Western Sydney Infrastructure Plan projects

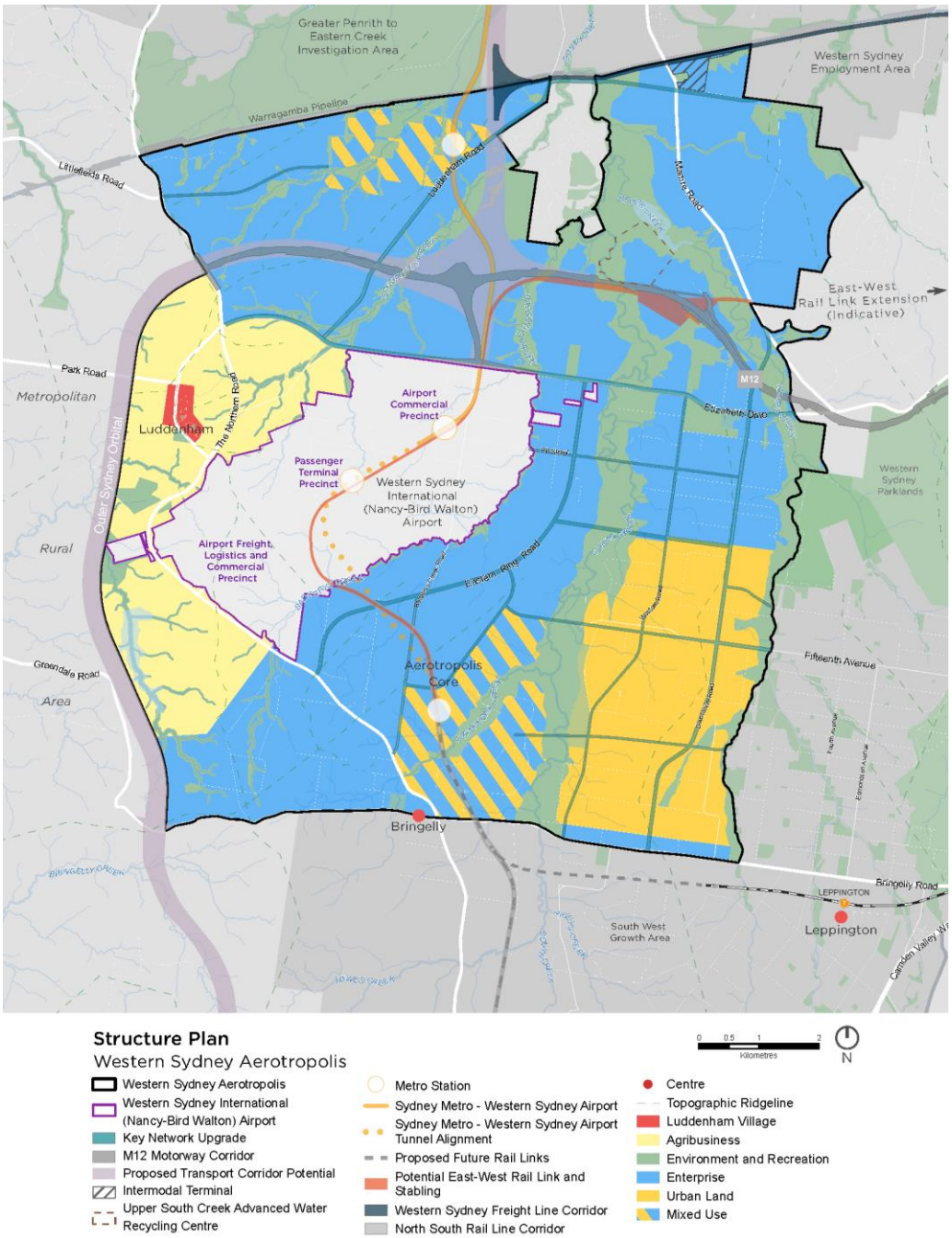


Source: https://www.greater.sydney/draft-western-city-district-plan (February 2018)

2.3 Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan (Stage 1: Initial Precincts)

The Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan (Stage 1: Initial Precincts) (WSALUIIP) was published in August 2018 and covers the land surrounding the Western Sydney Airport – creating an 'aerotropolis'. The policy package was then finalised in September 2020 and includes planning framework components such as a DCP and SEPP. **Figure 2-3** provides a summary of the precincts covered by the plan.

Figure 2-3 Summary of Western Sydney Aerotropolis structure plan



Source: DPIE, 2020

The main implications of this plan on Orchard Hills North are the growth in demands and delivery of a metro connection including to Orchard Hills South.

The scale of the total Aerotropolis growth aspirations is 200,000 jobs over 20 years as the initial focus. The plan outlines forecasts for initial precincts, which are reproduced in **Table 2-1**.

Table 2-1 WSALUIIP Precinct forecasts

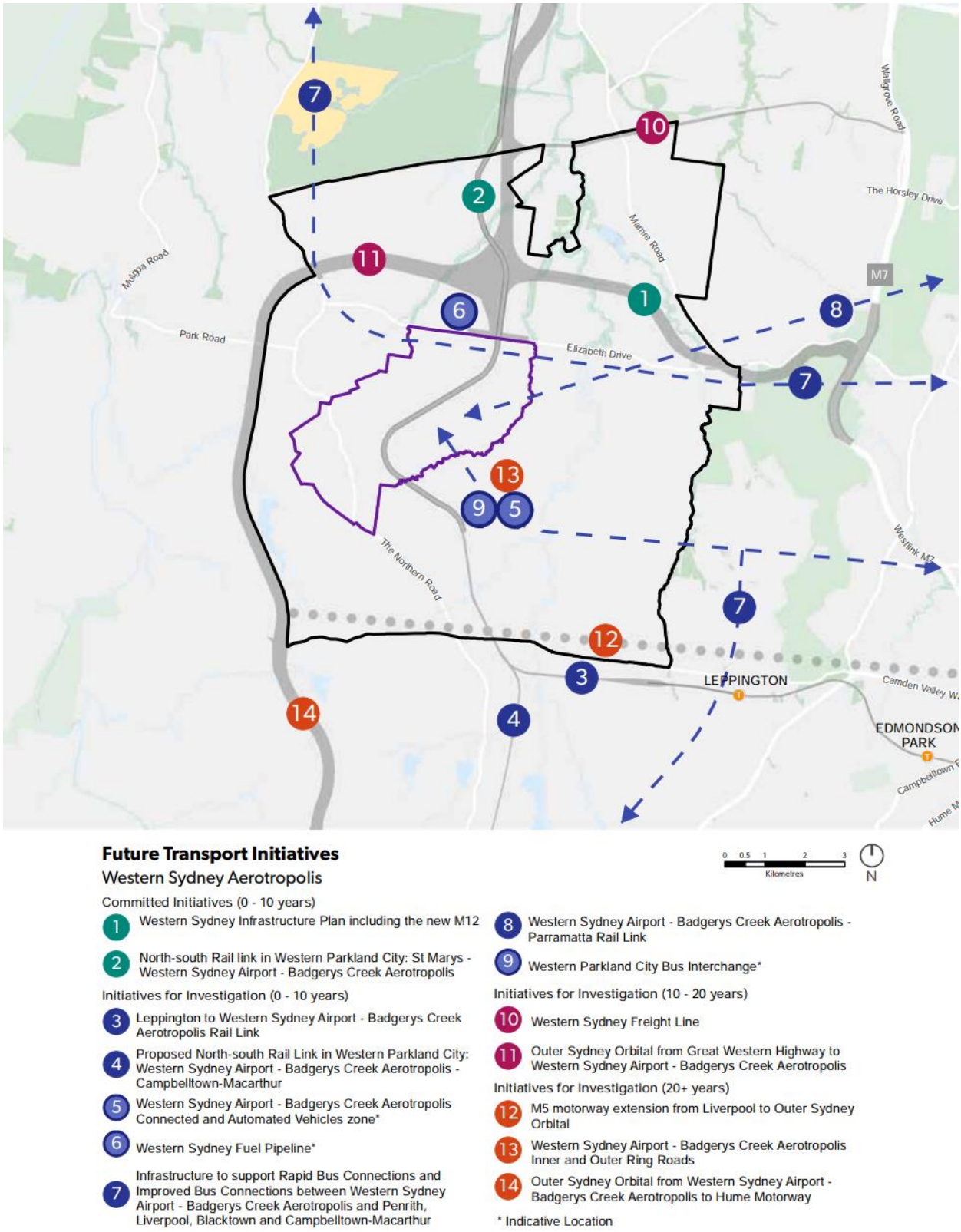
Precinct	Jobs (At full development)	Residents (At full development)
Aerotropolis Core	50,000 to 60,000	20,000 to 24,000
Northern Gateway	19,000 to 21,000	8,000 to 10,000
South Creek	Minimal	No additional dwellings
Badgerys Creek	9,000 to 11,000	No additional dwellings
Mamre Road	17,000	No additional dwellings
Agribusiness	8,000 to 10,000	Minimal, subject to detailed planning

Source: DPIE, 2020

The plan shows a strong focus on employment as the main activity. With a target of 200,000 jobs over 20 years, this target would be in line with a third city. By comparison, the total number of jobs in Parramatta Local Government Area was 137,883 workers. This target would have the Western Parkland City at a level beyond Parramatta's 2016 employment by 2038. An employment transition of this scale would likely result in a redistribution of travel patterns, with more residents in Sydney's west remaining in Sydney's west.

The plan also details transport initiatives to support the aerotropolis, which are reproduced in **Figure 2-4**.

Figure 2-4 WSALUIIP transport initiatives



Source: DPIE, 2018

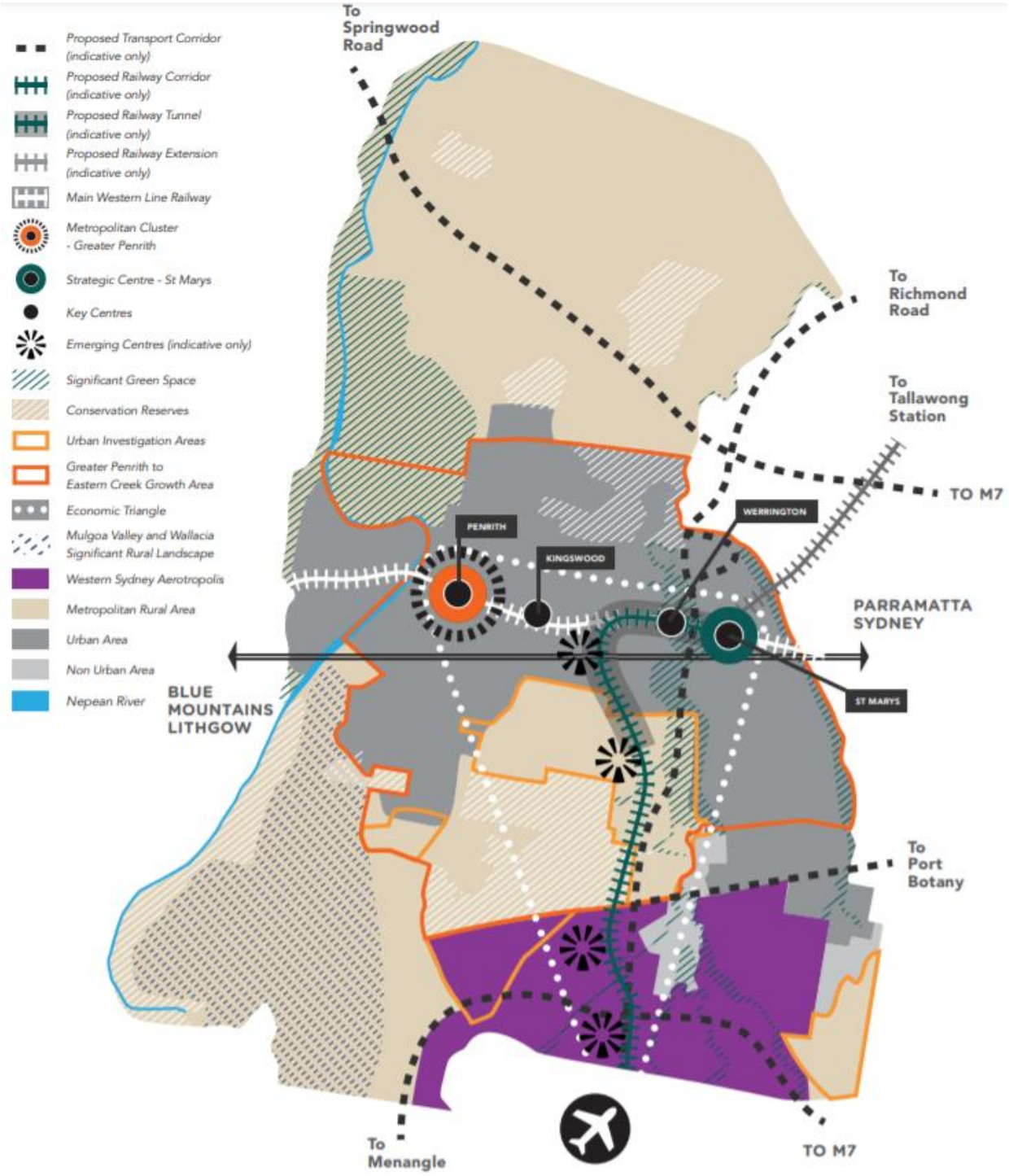
The initiatives comprise a suite of road and public transport projects to deliver multi-modal access to the airport. There are a range of projects that fall into the 0 – 10 year committed initiatives section. The transport initiatives would result in changing travel patterns in Sydney's west.

2.4 Penrith City Council Local Strategic Planning Statement

Penrith City Council's Local Strategic Planning Statement (LSPS) sits below the Greater Sydney Region Plan and Western City District Plan, providing strategic planning policy proposals at the Local Government Area level.

One of the key policy initiatives in the LSPS is to define a 'structure plan', which overlays the indicative north-south rail link alignment with a proposed centre hierarchy and existing land uses. The structure plan is reproduced in **Figure 2-5**.

Figure 2-5 Structure plan for the Local Government Area



Source: Penrith City Council, 2020

The plan identifies a series of planning priorities that are shown in **Figure 2-6**.

Figure 2-6 Planning priorities

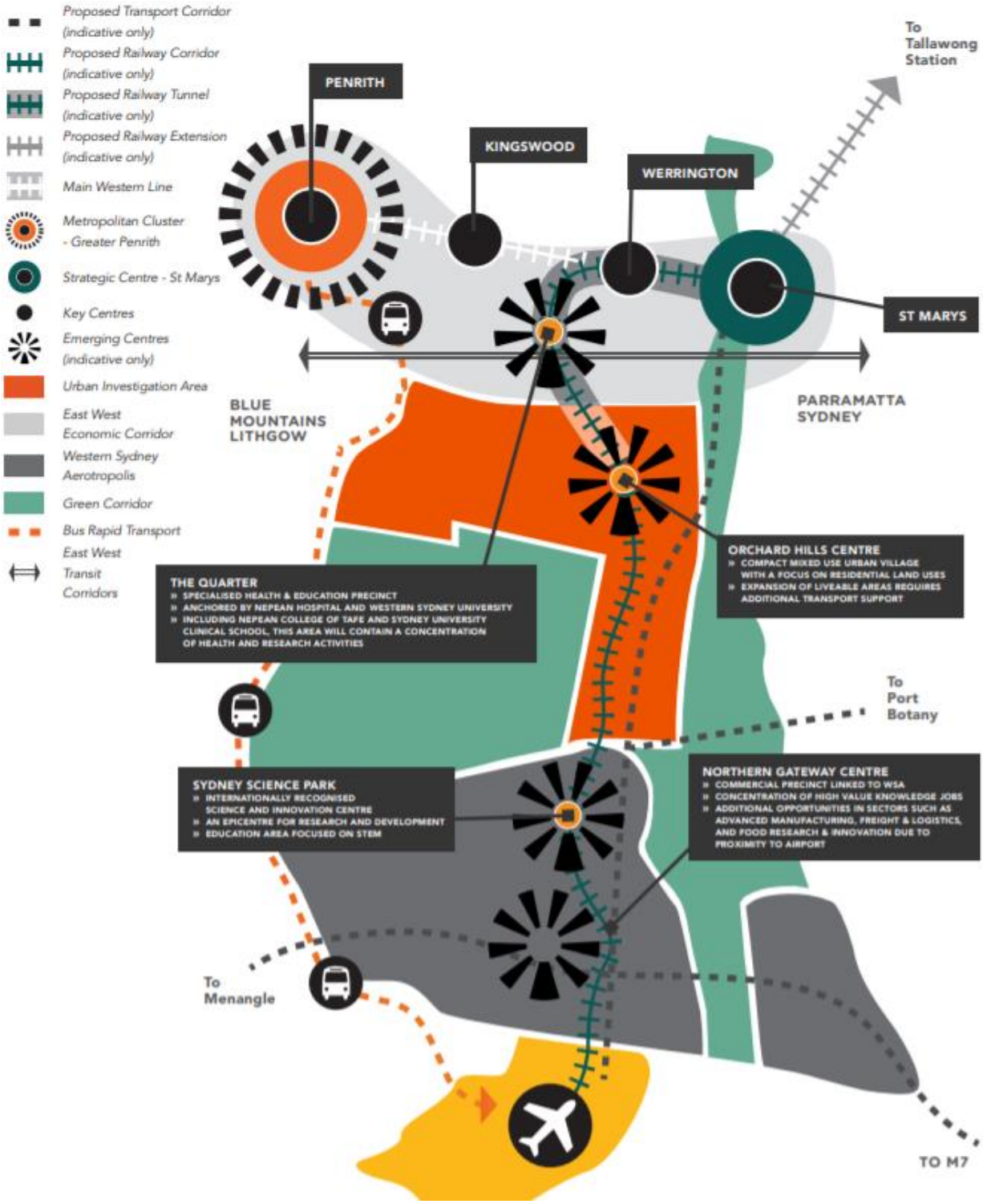
Source: Penrith City Council, 2020

There are several priorities that are relevant to transport – items 1, 9 and 10. These initiatives seek that transport is safe, connected, and efficient.

Implications for Orchard Hills North: transport initiatives need to balance safety, connectivity, and efficiency as well as catering for public transport.

In addition, Penrith City Council included a structure plan along the alignment of the North South Rail link (Sydney Metro Greater West), which is reproduced in **Figure 2-7**.

Figure 2-7 North South Rail Structure Plan



Source: Penrith City Council, 2020

The structure plan illustrates that Orchard Hills North is identified for residential, so too is a precinct to the south of the M4, likely to be Orchard Hills 'South'.

The green corridor also is assumed to align with the conservation reserves identified in **Figure 2-5** as well as the Environmental Conservation zoning in the current Local Environment Plan (**Figure 1-4**).The Orchard Hills Centre also sits to the east of Orchard Hills South, indicatively along the same north-south alignment with Gipps Street/Kent Street and Werrington Road. The note on the Orchard Hills Centre indicates that expansion of liveable areas requires additional transport support.

Housing forecasts for the entirety of the LSPS are stated as follows:

> *A demand of about 6,000 homes within the 2021-2026 period has been established. Of these, approximately 2,200 will be single dwellings; 2,700 medium density dwellings and 1,100 high density dwellings by 2026.*
>
> *Housing demand for 2026-2036 is based on demographic forecasts and increases in higher density housing. The estimated housing demand figures in this period are for the delivery of about 11,000 new homes with approximately 4,000 single dwellings, 5,000 medium density dwellings and 2,000 high density dwellings being delivered over the 10-year period.*

This indicates that majority of the housing stock is likely to be medium or high density – indicating likely proximity to rail or other transit. The total stock of single dwellings up to 2036 is 6,600 dwellings.

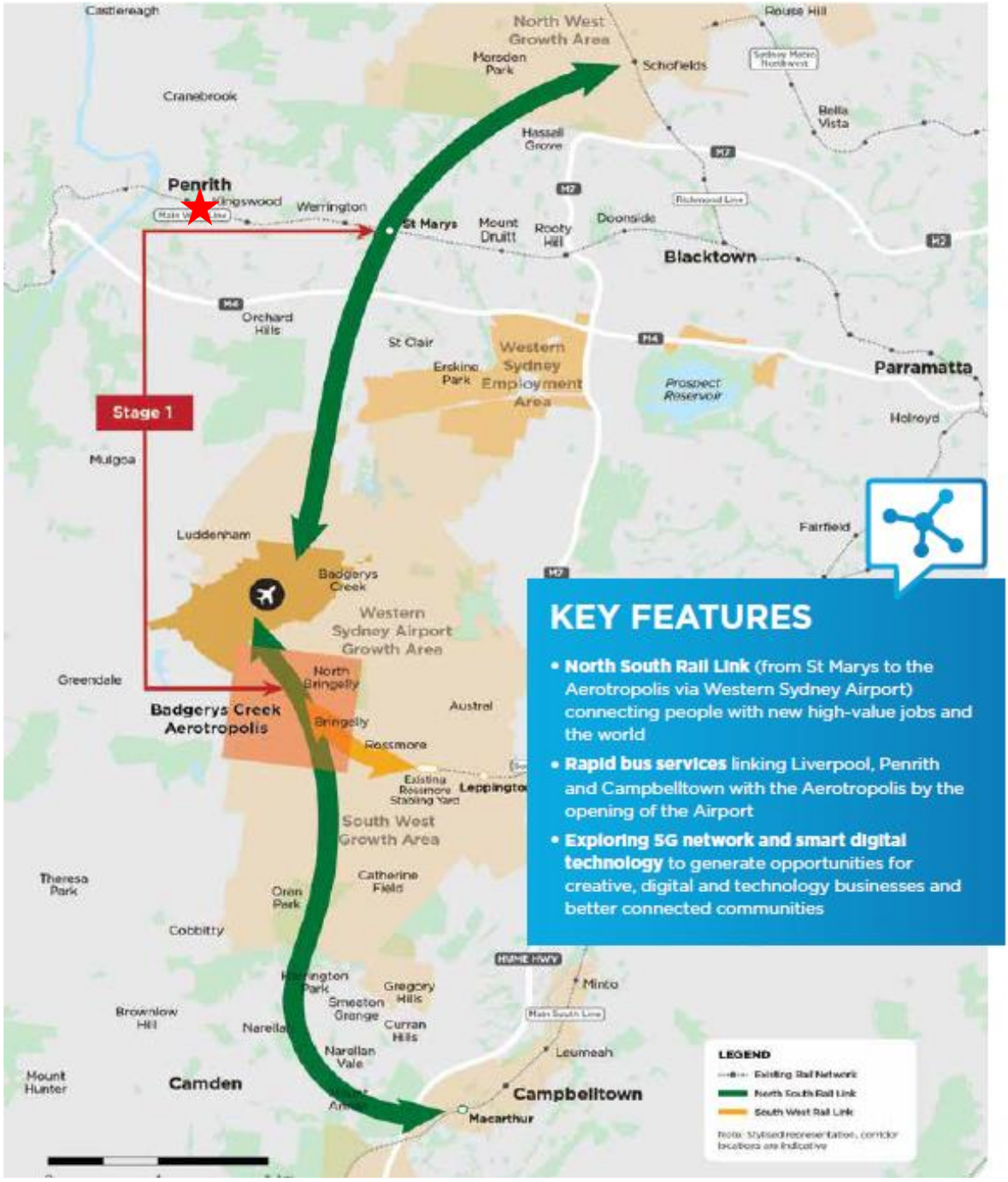
Implications for Orchard Hills North: significant growth is expected to the south of the M4, although the centre of this use appears to be to the east of the precinct.

2.5 Western Sydney City Deal

The Western Sydney City Deal is a partnership between the Australian Government, NSW Government, and local governments of the Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith, and Wollondilly, announced on 4 March 2018.

Of most relevance to this Traffic Study is the committed improvements in connectivity through the Western Sydney City. The new Western Parkland City will be one of Australia's most connected cities. In an emerging 30-minute city, innovative public transport, aviation, and digital infrastructure will bring residents closer to jobs, centres, education, and the world. The key features of transport improvements of the Western Sydney City Deal are shown in **Figure 2-8**.

Figure 2-8 Key features of improved connectivity and public transport options



Source: Western Sydney City Deal, 2018

The Australian and NSW governments jointly commit to deliver the first stage of the North South Rail Link from St Marys to Badgerys Creek Aerotropolis via Western Sydney Airport, with a joint objective of having rail connected to the Western Sydney Airport in time for its opening.

Work will immediately commence on a thorough design and investment case for the North South Rail Link (including the South West Rail Link) as part of an integrated planning and city-shaping approach. Both governments will contribute up to $50 million each to a business case process, in consultation with local government. This will include investigation of integrated transport and delivery options for a full North South Rail Link from Schofields to Macarthur and a South West Rail Link to connect Leppington to the Western Sydney Airport via an interchange at the Badgerys Creek Aerotropolis.

The NSW Government will establish rapid bus services from the metropolitan centres of Penrith, Liverpool, and Campbelltown to the Western Sydney Airport before it opens in 2026, and to the Badgerys Creek Aerotropolis.

2.6 The Western Sydney Infrastructure Plan (WSIP)

The Western Sydney Infrastructure Plan (WSIP) is delivering major road infrastructure upgrades to support an integrated transport solution for the region and capitalise on the economic benefits from developing the Western Sydney Airport at Badgerys Creek. These high-quality road improvements will deliver significant, ongoing safety and congestion-relieving benefits for customers. The WSIP comprises the following projects, as shown in **Figure 2-9**:

– The Northern Road upgrade project which will upgrade approximately 35 kilometres of The Northern Road to a minimum of 4 lanes between The Old Northern Road, Narellan and Jamison Road, South Penrith;

– Bringelly Road upgrade which involves the upgrade of approximately 10 kilometres of Bringelly Road between Camden Valley Way and The Northern Road;

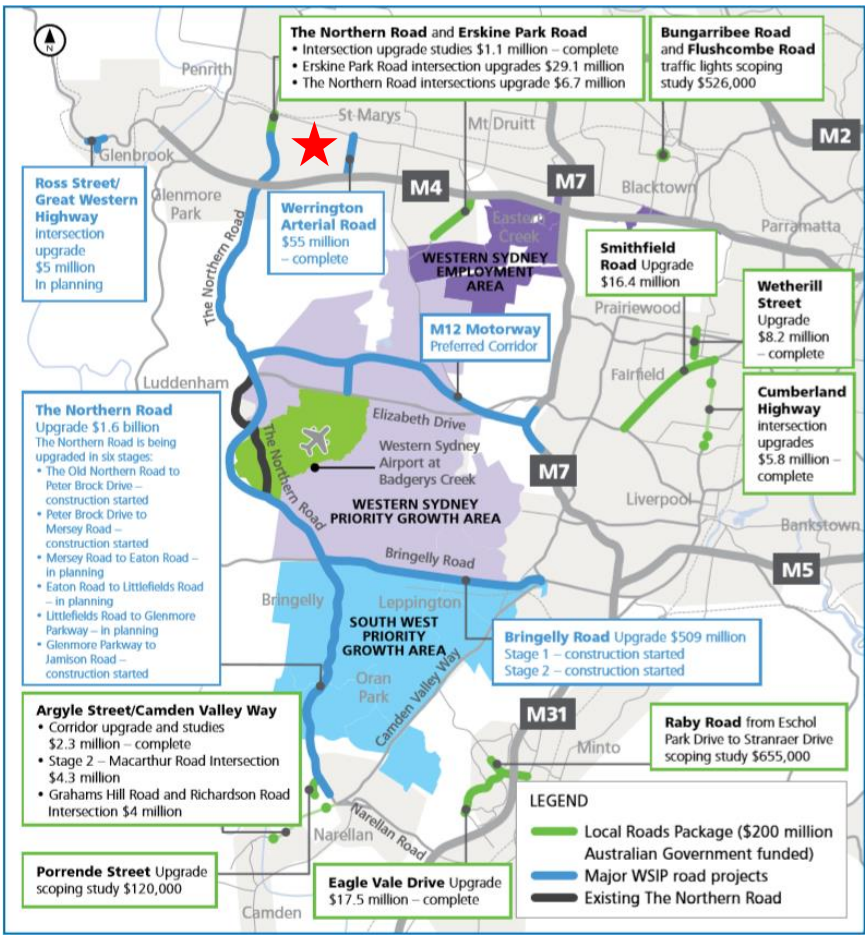
– The M12 Motorway project which will provide an east-west link between the M7 Motorway and The Northern Road, while also providing a connection to the Western Sydney Airport;

– Werrington Arterial Road upgrade which includes road widening, new entry and exit ramps and intersection upgrades;

– Glenbrook Intersection at Ross Street which will upgrade the Great Western Highway and Ross Street intersection at Glenbrook, providing safe access and a gateway to Glenbrook Village; and

– The Local Roads package which is a competitive rounds-based program, which is enabling a range of Western Sydney councils to complete minor road improvement works in the Western Sydney area.

Figure 2-9 The Western Sydney Infrastructure Plan projects



Source: NSW Government, 2017

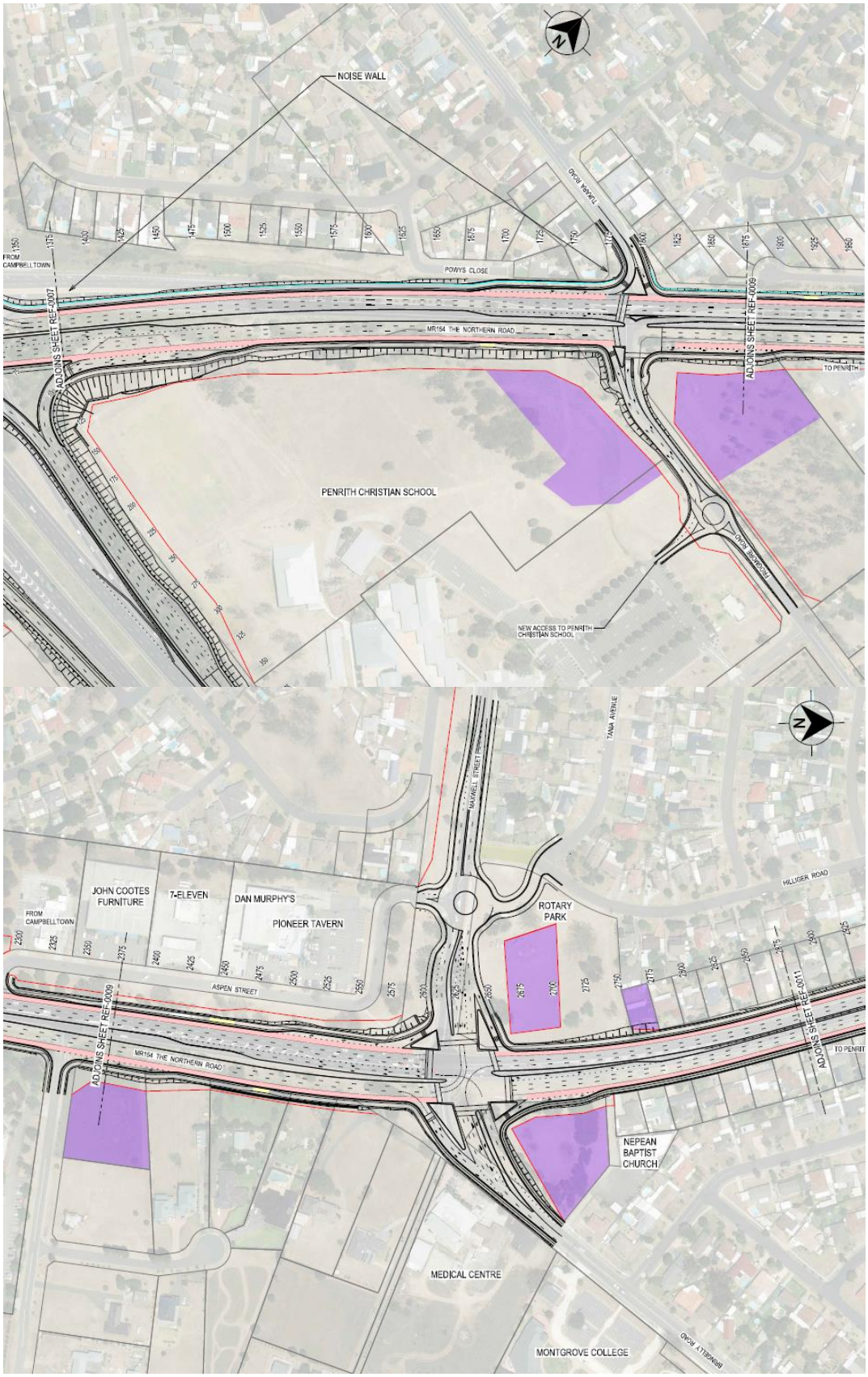
The WSIP road upgrades, in particularly The Northern Road Upgrade and the Werrington Arterial Road Upgrade, are expected to improve accessibility to the site are further described in the following sections. The Northern Road and Erskine Park Road intersection upgrades which are part of the Local Roads Package will also provide improved access to the site.

2.7 The Northern Road Upgrade

The Northern Road upgrade project runs from Jamison Road in the north to Glenmore Parkway in the south. The northern part of The Northern Road upgrade is in proximity of the site and is nearing completion. The upgrade of this section will widen The Northern Road from four lanes to an eight-lane divided road with a kerbside bus lane in each direction, landscaped median and a shared pedestrian and bike path. It will also include a new bridge over the M4 Motorway and new traffic lights and turning lanes at some intersections.

Upgrades in proximity of the site (as shown in **Figure 2-10**) include an extended acceleration lane for motorists turning right from Frogmore Road on to The Northern Road as well as the provision of footpaths along both sides of The Northern Road and Frogmore Road. Benefits for the site because of the road upgrades will include safer road travel conditions, more reliable travel times, improved traffic capacity, improved pedestrian and cyclist access and improved public transport through the provision of a dedicated bus lane. The intersection will be converted to a left-in-left-out configuration with access to Tukara Road from the western approach of The Northern Road.

Figure 2-10 Upgrades in proximity of the site, as part of The Northern Road upgrade project



Source: The NSW Government, 2017. Note: Blue areas shown are proposed stockpile and / or construction office areas.

The Northern Road / Frogmore Road is intended to enable left in, left out, right in and right out. Movements to and from Tukara Road are not permitted, and Tukara Road is treated as a left in left out.

The intersection of The Northern Road / Bringelly Road continues to allow all movements but with additional lanes on approaches.

The forecast traffic flows and results of analysis of future (years 2021, 2031 and 2041) intersection performance with the upgrades proposed as part of The Northern Road upgrade in place, in proximity of the site, are presented in **Table 2-2** and **Table 2-3**, which are from the "Sydney Traffic Assignment Model". As seen in **Table 2-2**, the traffic volumes are forecast to grow between the forecast year 2021 and 2041, along all sections of The Northern Road; however, as shown in **Table 2-3**, the analysed intersections in proximity of the site will (with proposed upgrades) continue to perform satisfactory in all future years with proposed upgrades in place.

Table 2-2 Future traffic flows on The Northern Road with committed upgrades in place

Road	Direction	Year 2021		Year 2031		Year 2041	
		AM	PM	AM	PM	AM	PM
North of the M4	Northbound	3,028	2,593	3,360	2,950	3,626	3,084
	Southbound	2,031	2,826	2,423	3,315	2,662	3,640
South of Maxwell Street	Northbound	2,510	2,107	2,754	2,470	3,033	2,805
	Southbound	1,813	2,557	2,162	3,051	2,415	3,300
North of Maxwell Street	Northbound	1,733	1,588	2,035	1,868	2,157	2,087
	Southbound	1,395	1,913	1,656	2,255	1,889	2,346

Source: The Northern Rd Upgrade, Glenmore Parkway to Jamison Road EIS Traffic and Transport Assessment, (Jacobs, 2016)

Table 2-3 Future intersection performance (Level of Service) with the Northern Road upgrades in place

Intersection	Year 2021		Year 2031		Year 2041	
	AM peak	PM peak	AM peak	PM peak	AM peak	PM peak
The Northern Road / M4	C	C	C	C	C	D
The Northern Rd / Maxwell St / Bringelly Rd	C	C	C	C	D	C
The Northern Road / Frogmore Road / Tukara Road	B	B	B	B	B	B
The Northern Rd / Smith Street	B	B	B	B	B	B

Source: The Northern Rd Upgrade, Glenmore Parkway to Jamison Road EIS Traffic and Transport Assessment, (Jacobs, 2016)

2.8 The Werrington Road Upgrade

The Werrington Road upgrade involves creating a new link between the Great Western Highway and the M4 Motorway, along Kent Road and Gipps Street located to the east of the Site, as shown in **Figure 2-11**. Key features of the upgrade include:

- Widened Gipps Street and Kent Road to four lanes between the M4 Motorway and the Great Western Highway;
- New eastbound entry and westbound exit ramps with traffic lights for the M4 Motorway;
- Three intersection upgrades with traffic lights at Caddens Road / Kent Road, Fowler Street/Gipps Street and Sunflower Drive (north)/Gipps Street;
- Three-metre-wide off-road shared path for pedestrians and cyclists, including a new bridge over the M4 Motorway;
- Bicycle and pedestrian crossings at traffic lights;
- Six bus bays on both sides of Gipps Street and Kent Road; and
- Posted vehicle speed limit of 70 km/h south of Caddens Road.

The upgrades were completed and have provided benefits for the site as a result of the upgrades including improved access to the M4 Motorway, increased road capacity of the surround road network, improved safety for motorists, more reliable travel times and improved access and safety for pedestrians and cyclists through off-road shared path.

Figure 2-11 The Werrington Road upgrades

Source: Roads and Maritime Services (2017)

2.9 M4 Smart Motorway project

The M4 Smart Motorway project introduced intelligent technology, known as a motorway management system, to Sydney's M4 Motorway between Pitt Street, Mays Hill and Russell Street, Lapstone. The M4 Smart Motorway introduces a smarter way of travelling the M4 by using real time information, communication, and traffic management tools to provide motorists with a safer, smoother, and more reliable journey.

The M4 Smart motorway project delivered:

– More reliable trips – controlling the flow of traffic onto the motorway reduces congestion and keeps traffic moving providing a more predictable journey;

– Improved traffic safety – real time monitoring, and remote traffic control reduces crash rates and improves incident response;

– Less vehicle emissions – free flowing traffic conditions result in improved fuel efficiency and reduced emissions compared to 'stop start' traffic; and

– Better decision making – real time information about travel times, incidents and other relevant information will allow motorway users to plan their journeys.

The M4 Smart Motorway REF (Jacobs, 2015) stated that:

> *"With the implementation of the proposal, the average travel time on the M4 Motorway in the peak flows is about 25 per cent less than compared to a Do Minimum (or business as usual) scenario, with corresponding improvements in average travel speed of between 11 and 15 km/hr in 2021.This represents improvements in the peak direction travel speeds of 28 per cent (eastbound) and 42 per cent (westbound). In 2031, the proposal provides a 20 per cent reduction in travel times compared to the Do Minimum scenario in the peak flow directions."*

2.10 Outer Sydney Orbital

Transport for NSW has identified a corridor for the Outer Sydney Orbital to provide a north – south connection for a future motorway, freight rail with supporting Intermodal Terminal and where practical a passenger rail line, as shown in **Figure 2-12**. A key purpose of the project is to expand Sydney's transport network and to serve the growth in the Western Sydney. By identifying and preserving a transport corridor now, it can be assured that land is available to deliver transport links as they are needed in the future.

The Outer Sydney Orbital corridor will run for 80 km between Box Hill in the north and the Hume Motorway at Menangle in the south. In the future, the corridor could be extended as far as to the Central Coast in the north and the Illawarra in the south. The implementation of the Outer Sydney Orbital would significantly improve access from the Site to the surrounding road network, regional centres, growth centres and employment areas in the future.

The corridor preservation map in **Figure 2-12** identifies the proposed corridor.

Figure 2-12 Proposed Outer Sydney Orbital corridor

Source: TfNSW, 2015

The Outer Sydney Orbital would generally cater for north-south movements across Western Sydney in conjunction with The Northern Road.

2.11 Sydney Metro Western Sydney Airport

The Sydney Metro Western Sydney Airport Line (previously called the South West Rail Link Extension Corridor, North South Rail Link and Sydney Metro Greater West) project investigates how to provide transport infrastructure to support the proposed Western Sydney Airport and future urban development in Sydney's West. The proposed route (as seen in **Figure 2-13**) is part of the Western Sydney Rail Needs Scoping Study and initial plans for the route are to:

– Connect Leppington to Bringelly;

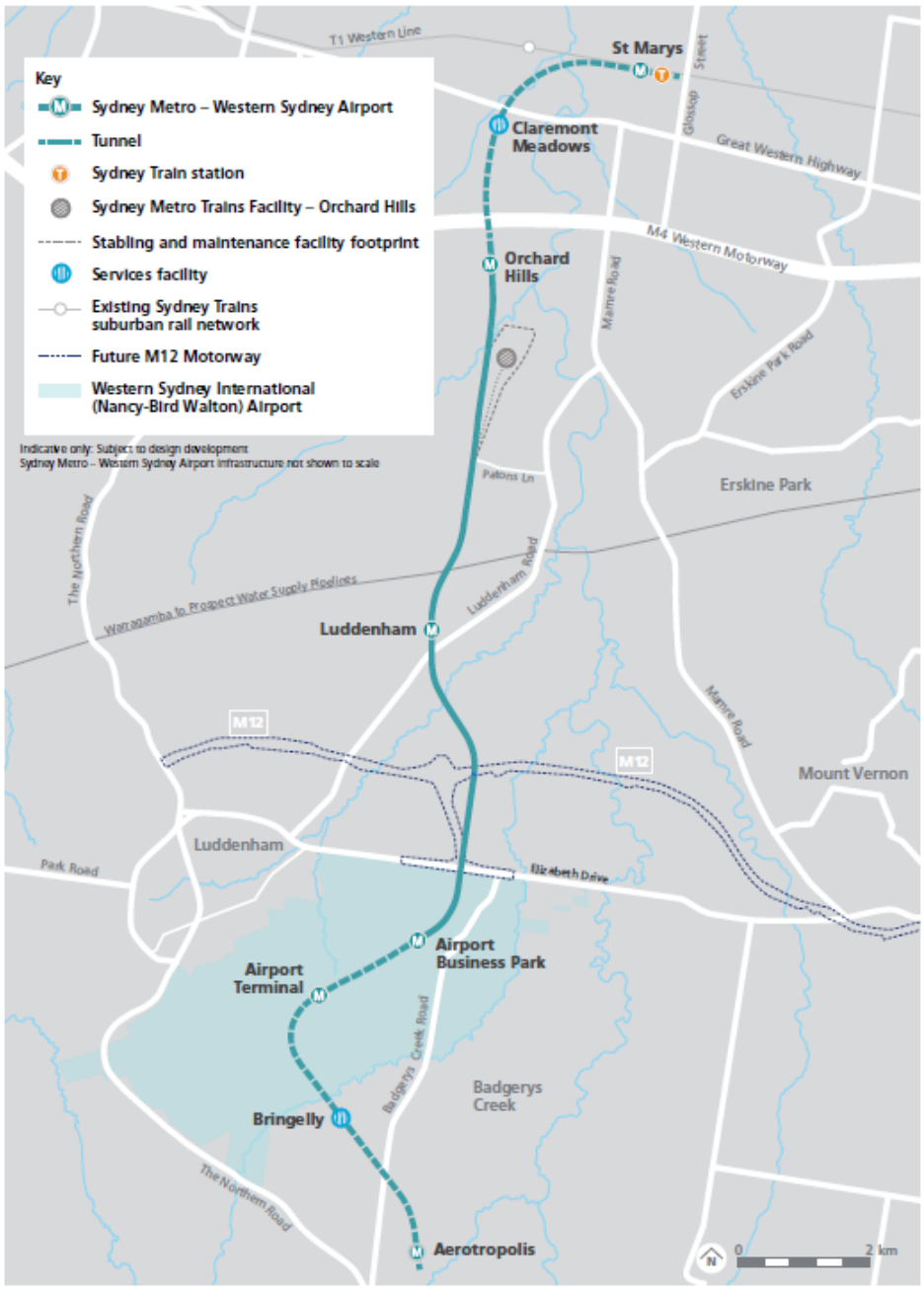
– Extend north to T1 Western Line near St Marys;

– Extend south to T2 South Line near Macarthur;

– Provide new stations planned at Rossmore, Bringelly, North Bringelly, Oran Park and Narellan; and

– Serve a new station at Badgerys Creek for the proposed Western Sydney Airport.

Figure 2-13 Sydney Metro Western Sydney Airport proposed corridor and stations



Source: Transport for NSW, 2020

Like the Outer Sydney Orbital, Sydney Metro Greater West will cater for north-south movement in Sydney's West, connecting into the Western Line to provide access to Blacktown, Penrith, and Parramatta.

A new north-south connection and a station at St Marys would improve rail accessibility from the site to the south's employment areas, the South West Growth Centre, and the Badgerys Creek airport, further reducing the reliance on private vehicles travel to these employment areas.

A station is proposed in the vicinity of Orchard Hills, located to the south of the M4 Motorway, on the eastern side of Kent Road, north of Lansdowne Road. The station would have one entrance on Kent Road with provision for a second entrance east of the station. The station would service a future residential, commercial, and mixed-use precinct. A metro station at Orchard Hills would help transform the area into a compact, high-amenity and walkable new community.

Implications for Orchard Hills North: accommodations need to be made for a future Orchard Hills South and metro station, acknowledging that the details of this scheme aren't planned yet.

2.12 Penrith Integrated Transport and Land Use Strategy

The Penrith Integrated Transport and Land Use Strategy (PITLUS) was prepared in 2008 and lists the plans for integrating transport and land use and provides context for the development of Penrith Council's City's new Local Plan and informs state infrastructure provision plans post 2016.

The strategy area encompasses the entire Penrith City Local Government Area (LGA) and discusses the area in Statistical Local Area (SLAs) of which the Site is within the South Werrington SLA. The following specific actions were identified to be implemented to improve transport and land use integration in the South Werrington (near the site). Council proposed the following:

– Prioritise implementation of the new railway station in Werrington (UWS);

– Provide a link serving the new UWS rail station and stops of the TAFE and UWS campuses; and

– Establish a well-defined bike network in the Urban Release Area (URA) to link up to Werrington, Kingswood, and St Marys URA.

A new railway station at UWS Werrington is not proposed by TfNSW. A station is instead located at nearby Orchard Hills South.

2.13 Caddens Release Area Development Control Plan

The Caddens release area is located within the Werrington Enterprise Living and Learning (WELL) Precinct, and specific controls to this area is provided in the Caddens Release Area DCP.

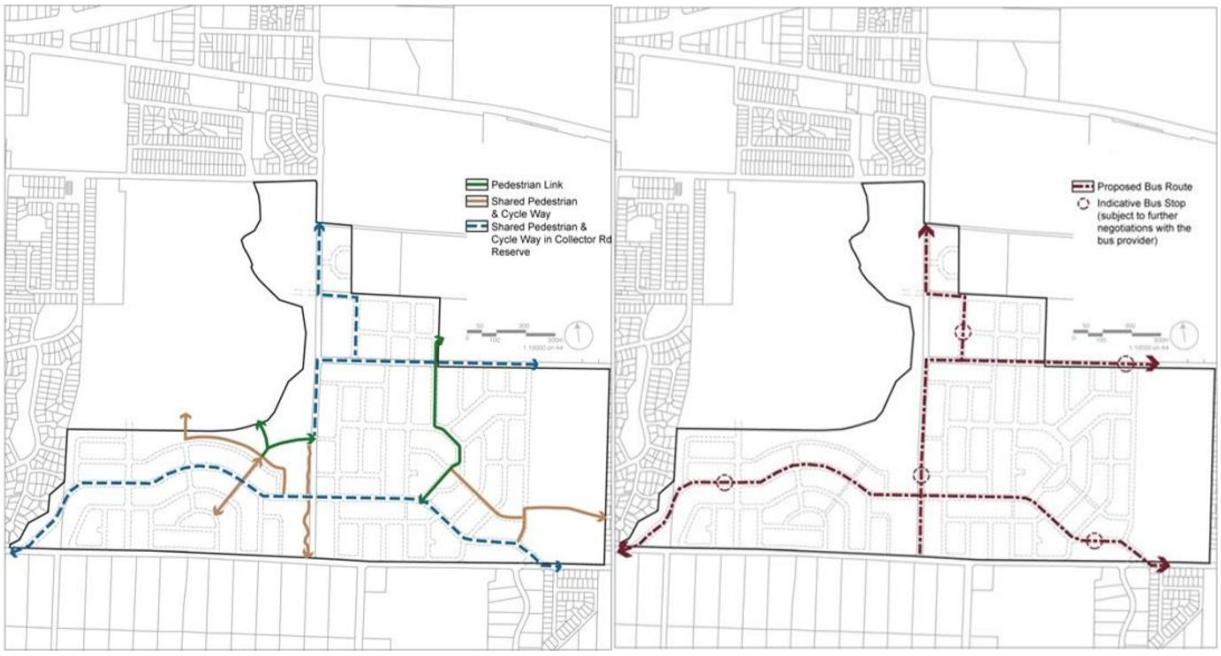
The key elements of the WELL Precinct Vision which apply to Caddens include 'a model for sustainable urban development that captures its potential arising from proximity to transport linkages and tertiary educational facilities', and 'an internationally renowned destination of choice for business, residents, and students. The Caddens area is bounded by Caddens Road to the south and is located directly north of the site.

The DCP provides guidance on active and public transport links to and from the area, which are relevant to the site. The pedestrian and cycle routes and public transport routes are shown in **Figure 2-14**. As seen, links especially relevant to the site include:

– An east-west shared path along Caddens Road and a north west shared path along O'Connell Lane / O'Connell Street; and

– A proposed bus routes along Caddens Road and O'Connell Lane / O'Connell Street.

Figure 2-14 DCP Council-proposed Active and Public Transport Links in Caddens Release Area



Source: Penrith City Council Development Control Plan Section E1, 2014

TfNSW is responsible for bus route planning and will determine bus routes based on the regular program review processes. Routes featured in the above figure are not proposed in this TMAP.

2.14 46-66 & 46A O'Connell St, Caddens Concept Plan DA Transport Impact Assessment

A traffic study was prepared for CWG Development Pty Ltd (CWG) by The Transport Planning Partnership Pty Ltd (February 2017), to support a Development Application (DA) for a proposed residential / mixed use subdivision at 46-66 & 46A O'Connell Street, Caddens (located north of the Orchard Hills Site).

The development proposal is located within the Werrington Enterprise Living and Learning (WELL) Precinct and includes commercial use (2,000 m^2 GFA), specialty / convenience retail use (1,000 m^2 GFA), residential dwellings (400 apartments and 320 townhouses).

The report examines external traffic implications of the Proposal and considers the cumulative impacts from other known developments as envisaged by the WELL Precinct TMAP, along with modifications to the development yields within the Caddens Release Area to the south of the Site. The study concluded that overall, the proposed development (which will generate 430 additional peak hour trips to and from the proposed development) as represented by the Concept Plan is considered acceptable regarding traffic and transport.

Relevant to the site, the 46-66 and 46A O'Connell Street Traffic Study report presented that the:

– Forecast traffic flows with development traffic along O'Connell Street in 2026 will be 986 and 1,036 vehicles per hour during the AM and PM peak hour respectively;

– O'Connell Street / Caddens Road intersection will perform satisfactorily (with a Level of Service A in both AM and PM peak hours) in 2026, with development traffic; and

– The Caddens Precinct DCP (Penrith City Council, 2014) envisages the provision of improved bicycle and pedestrian connections along O'Connell Street.

2.15 The Proposed Caddens Precinct Centre Traffic Report

A traffic study was prepared for the Western Sydney University by Colston Budd Rogers and Kafes Pty Ltd (October 2017), to prepare a report examining the traffic and parking implications of the proposed Caddens Precinct Centre on O'Connell Street in Caddens. The Precinct Centre is located is on the corner of O'Connell Street and O'Connell Lane, north east of the Orchard Hills Site.

The proposed development comprises 9,760 m^2 of mixed used development, with vehicular access provided from O'Connell Street and a new road to be constructed along the northern side of the Site. The proposed development will generate approximately 840 and 1,060 vehicles per hour two-way during weekday afternoon and Saturday peak hours, respectively.

Relevant to the Site, the Caddens Precinct Centre Traffic Study presented that:

– The future traffic flows with development traffic along O'Connell Street (south of Great Western Highway) will be 1,060 and 890 vehicles per hour during the Thursday PM peak hour and Saturday peak hour respectively;

– The future traffic flows with development traffic along O'Connell Lane (south of O'Connell Street) will be 550 and 465 vehicles per hour during the Thursday PM peak hour and Saturday peak hour respectively;

– The Great Western Highway / O'Connell Street / French Street intersection would operate with average delays of less than 35s and a LoS C during weekday afternoon and Saturday peak hours (with development traffic);

– In association with the development, it is proposed to provide a roundabout at the of O'Connell Street / O'Connell Lane / university access intersection (which would result in satisfactory performance); and

– With the proposed road works, the road network will be able to cater for the traffic generation of the proposed development.

3.0 Existing conditions

3.1 Travel behaviour

3.1.1 Journey to Work Data

2016 Journey to work data from id profile was analysed to determine current travel behaviour of a benchmark location that would be like the future Orchard Hills North. Orchard Hills is currently zoned agricultural land, with large lot sizes. It is expected that as the site develops, that the smaller lot sizes would remove any potential for local agricultural industry and instead transition to a mix of professions like adjacent suburbs. In 2016, the suburb of Orchard Hills North had a population of 2,036 people over a suburb area of 4,317 ha – reflective of a population density of 0.47 people per Ha. By comparison, Claremont Meadows had a population of 5,344 over an area of 305 ha – equivalent to 17.5 people per ha.

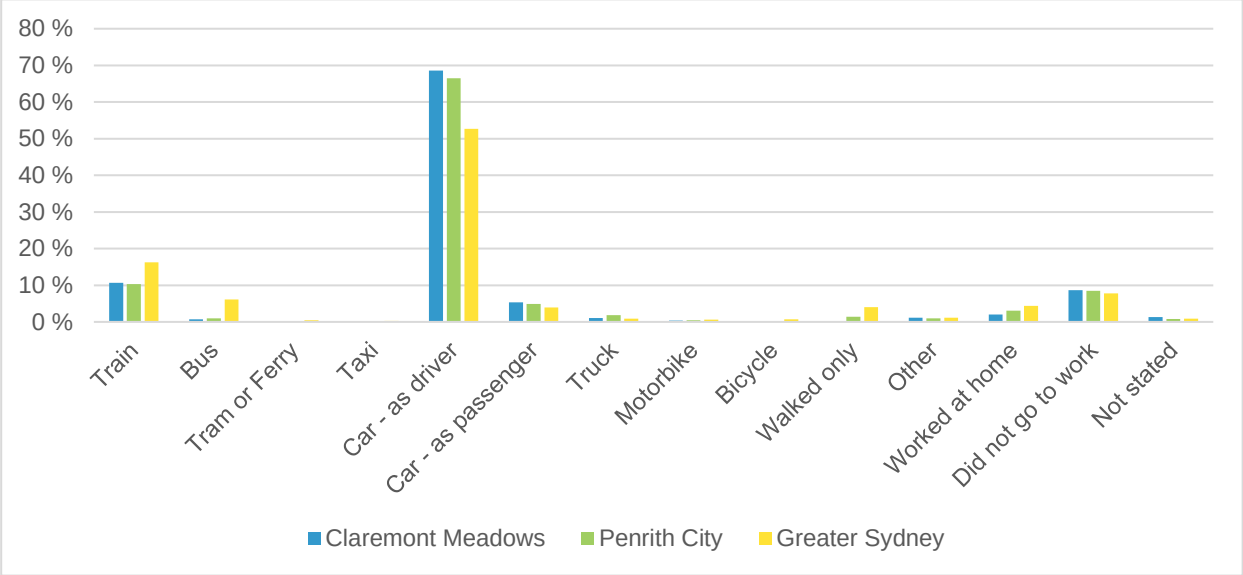
The suburb Claremont Meadows was selected based on comparable distance to Penrith, the M4 and surrounding rail stations. The area of Claremont Meadows is shown in **Figure 3-1**.

Figure 3-1 Claremont Meadows area for analysis of method of travel to work data

Source: Australian Bureau of Statistics, © OpenStreetMap Contributors, SCT Consulting, 2019

The travel behaviours of Claremont Meadows for journey to work trips are shown in **Figure 3-2**.

Figure 3-2 Method of travel to work based on 2016 Journey to Work data

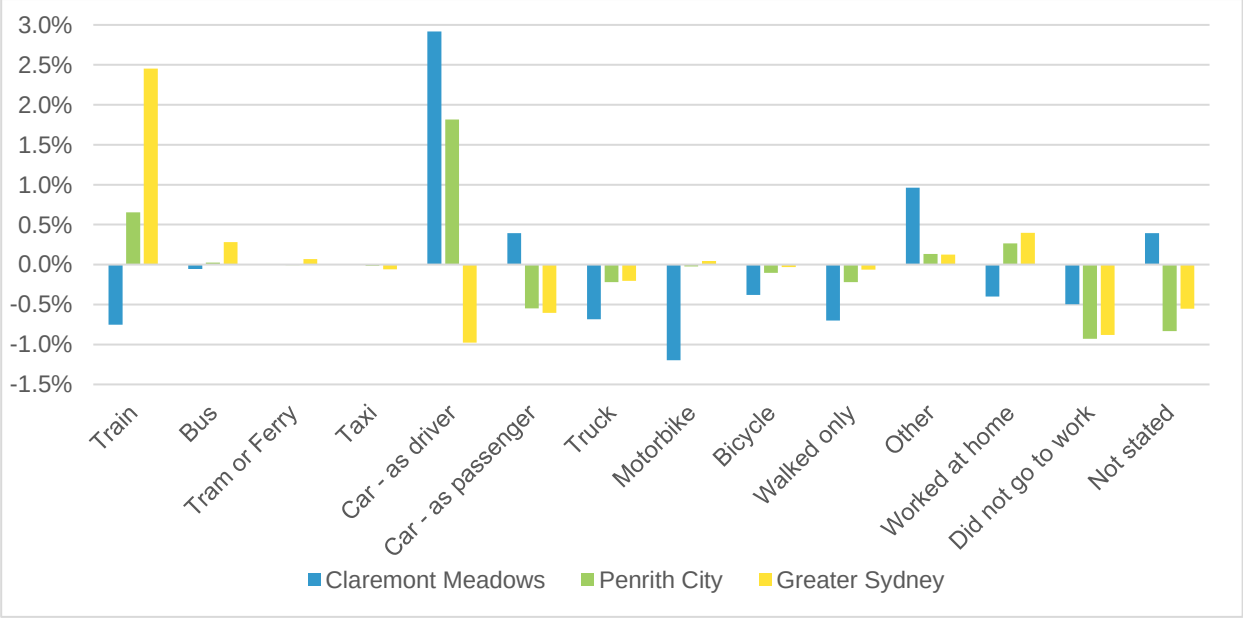


Source: id profile, Australian Bureau of Statistics, 2019

The survey data, based on 2016 Journey to Work data, indicates that workers in this region is more car dependent that the average Sydney worker, with a car driving mode share of 69 percent- higher than Greater Sydney's mode share of 53 percent. Public transport options are not well used, with minimal bus patronage and 11 percent of workers using trains for travel. Given the location of train stations, these trips would likely require the first leg of the journey to be by private vehicle.

It is also important to note that Claremont Meadows is unique in that it experienced an increase in mode share to private vehicles between 2011 and 2016, increasing from 65.7 percent to 68.6 percent. This is consistent with Penrith LGA as a whole, which experienced an increase in car driver mode share from 64.7 percent in 2011 to 66.5 percent in 2016, shown in **Figure 3-3**.

Figure 3-3 Change in method of travel to work from 2011 to 2016



Source: id profile, Australian Bureau of Statistics, 2019

Data is not available to the suburb level for work destinations, it is only available to the Local Government Area level. The top ten work destinations for Penrith City Council area are shown in **Figure 3-4**.

Figure 3-4 Top ten work destinations (Penrith City Local Government Area)

Destination (Local Government Area)	Proportion
Penrith	38.6%
Blacktown	15.1%
Parramatta	8.4%
Sydney	6.3%
No Fixed Address (NSW)	4.9%
Cumberland	4.0%
Fairfield	3.3%
Hawkesbury	2.8%
The Hills Shire	2.2%
Liverpool	2.0%

Source: id profile, Australian Bureau of Statistics, 2019

No fixed address is a survey response that indicates a worker does not have an office address. For the most part, this profile is associated with workers who turn up to a depot and then undertake work at various locations – for example workers in the logistics industry.

The dominance of Penrith as a significant work location shows significant potential for workers to travel by sustainable means – trip distances within the Local Government Area are of a shorter trip distance so could be undertaken by bus or cycling. The low bus and cycling mode shares are likely then due to poor facilities, safety concerns, poor service efficiency and coverage, or simply that driving is much faster as a travel mode and more convenient with the availability of parking spaces at the work destination.

For planning, it has been assumed that method of travel to work data provides a suitable reflection of the travel characteristics during AM and PM peak hour periods, due to the high proportion of trips during this timeframe associated with journey to work trips.

3.1.2 Household Travel Survey

Australian Bureau of Statistics, 2016/2017 Household Travel Survey (HTS) was analysed for Penrith City Local Government Area to understand the aggregate travel patterns across all different trip purposes. **Table 3-1** and **Table 3-2** provides a summary of the purpose of travel and overall mode choice by residents of Penrith associated with these trip purposes.

Table 3-1 Household Travel Survey – Residents within Penrith, Trip purpose

Travel by purpose	Proportion
Commute	15%
Work related business	11%
Education / childcare	10%
Shopping	13%
Personal business	5%
Change mode of travel	5%
Social / recreation	19%
Serve passenger	21%
Other	2%

Source: https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/statistical-area-level-3, December 2017

Table 3-2 Household Travel Survey – Residents within Penrith

Mode	Proportion for Penrith	Proportion for Greater Sydney
Vehicle (Driver)	58%	48%
Vehicle (Passenger)	27%	21%
Train	2%	6%
Bus	3%	5%
Walk only	8%	17%
Other	1%	2%

Source: https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/statistical-area-level-3, December 2017

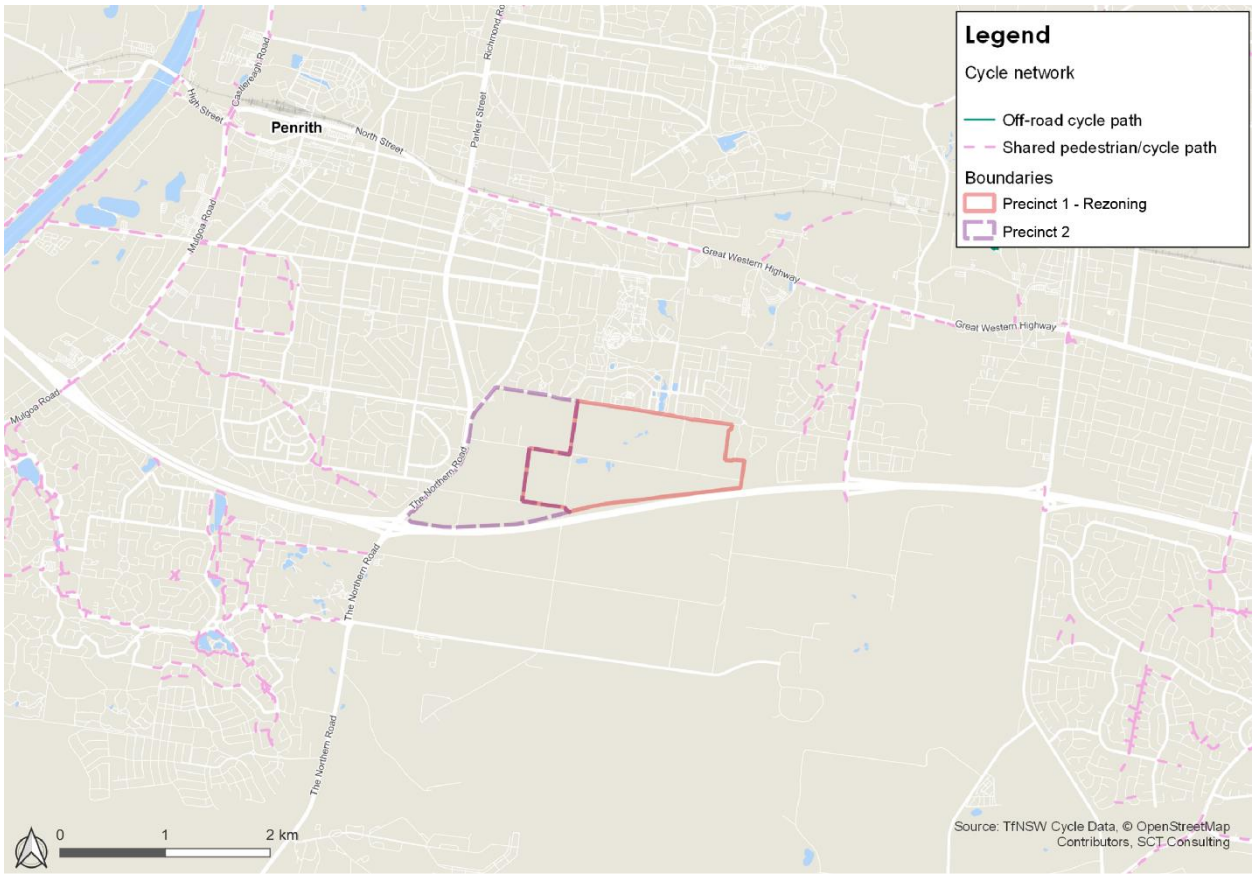
Analysis of the 2016/2017 Household Travel Survey shows most of the travel (85 percent) is by private vehicle, with nominal public transport use. Walk only trips accounted for 8 percent of overall travel. When compared with a typical household in Sydney, travel is more car dependent.

Overall, this indicates increased sustainability for non-journey to work trip purposes.

3.2 Walking and cycling

Cycling facilities are shown within a reasonable cycle distance (up to 5 km) from the site in **Figure 3-5**.

Figure 3-5 Existing cycle paths in proximity of the Site



Source: TfNSW Cycle Data, © OpenStreetMap Contributors, SCT Consulting, 2019

The site is surrounded by local shared paths that support short distance trips within each of the pockets of development. These paths are generally intermixed with driveway accesses, which introduce crossing hazards with vehicles. The site is located within a rural area, surrounded by the major roads the M4, the Great Western Highway and The Northern Road, and so footpaths and pedestrian crossing facilities are currently limited.

There are an emerging range of regional cycle routes such as on Great Western Highway, Gipps Street and Mulgoa Road. The completion of the Werrington Arterial Upgrade delivered a shared path between the M4 and the Great Western Highway.

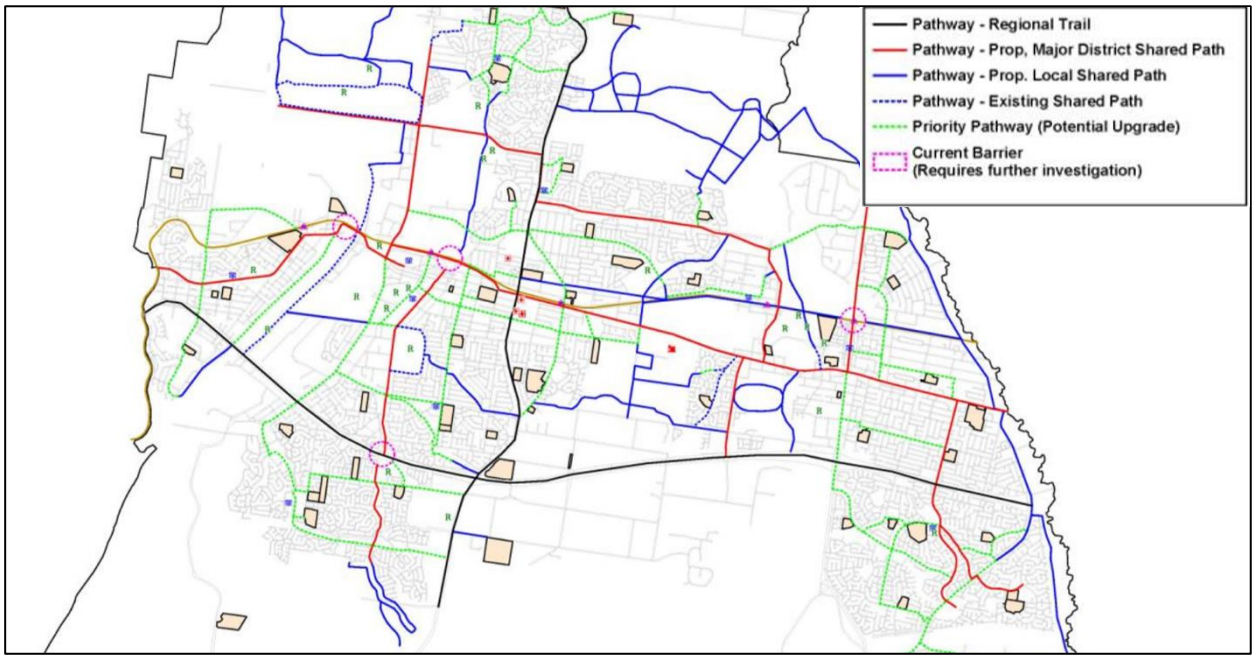
No cycling is permitted along the M4 between the Nepean River in the west and Gipps Road in the east possibly due to existing construction activities associated with The Northern Road Upgrade and the M4 Smart Motorway projects, which restricts cycle access from the site in an east-west direction.

The Penrith City Council's Accessible Trails Hierarchy Strategy (PATHS) (June 2012) aims to deliver a quality "trails" network, with the major trails being designed for 'All Abilities' and providing quality public infrastructure to promote sustainable transport. The proposed key district level routes provide major north - south and east - west trails along key transport and open space corridors.

In proximity of the site, a local and major district shared path is planned along Caddens Road / Cadda Ridge Drive in an east-west direction and along Gipps Street in a north-south direction, as seen in **Figure 3-6**. A priority pathway is planned along Bringelly Road, while The Northern Road and the M4 have been identified as future 'regional trails'. The implementation of these routes would improve cycle access to and from the site and to the surrounding cycle network, in both an east-west and north-south direction.

In addition, the planned The Northern Road upgrade will involve the provision of footpaths along both sides of The Northern Road and Frogmore Road. These upgrades will significantly improve pedestrian access to and from the site.

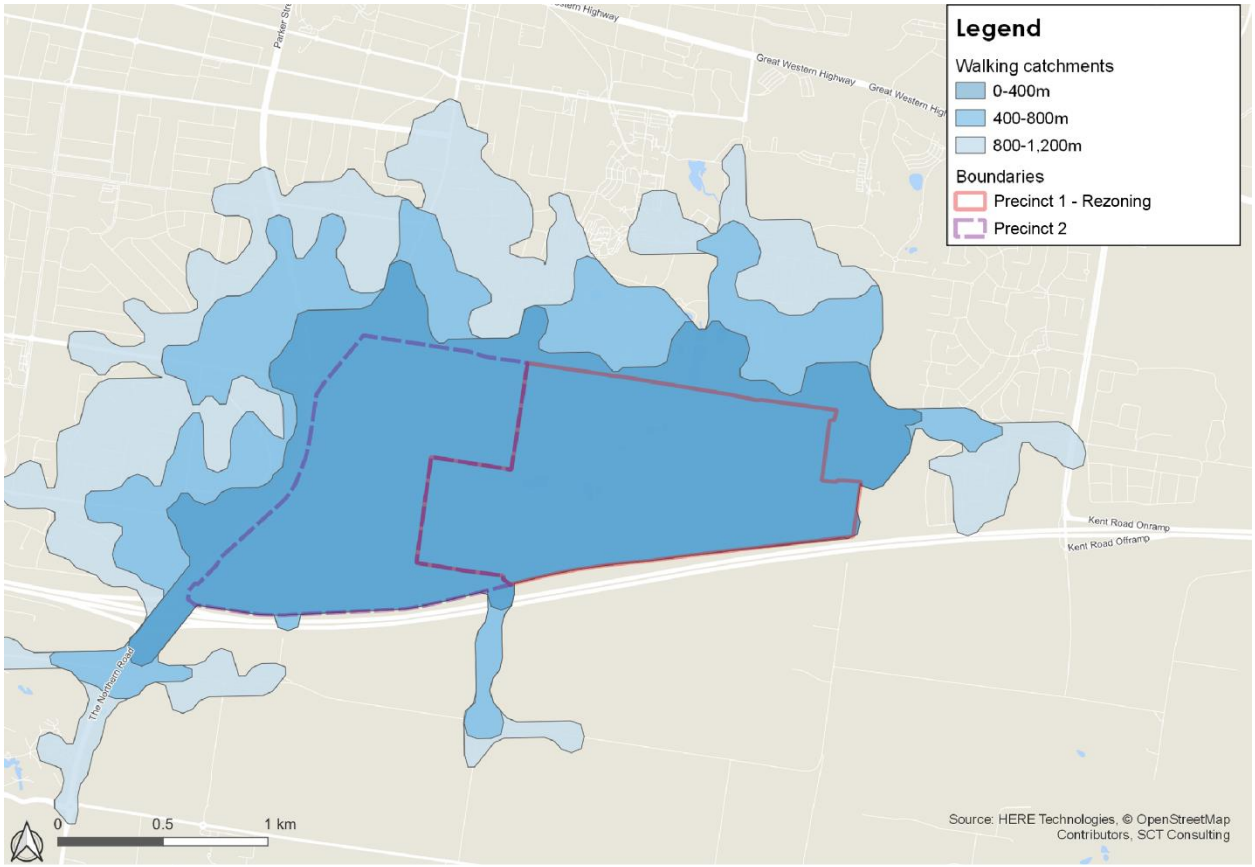
Figure 3-6 Proposed new 'trail' and shared path network in proximity of the site



Source: Penrith Accessible Trails Hierarchy Strategy (PATHS) (Penrith City Council, June 2012)

As the site is currently undeveloped, the street network is coarse and lacking in footpath facilities. The surrounding suburbs are also designed with traffic calming in mind, presenting curved roads rather than a 'grid'-style network. The walking catchments from the site are shown in **Figure 3-7**. These are measured from the corners of the development into the adjacent areas.

Figure 3-7 Walking catchments from the Orchard Hills North boundaries to adjacent suburbs

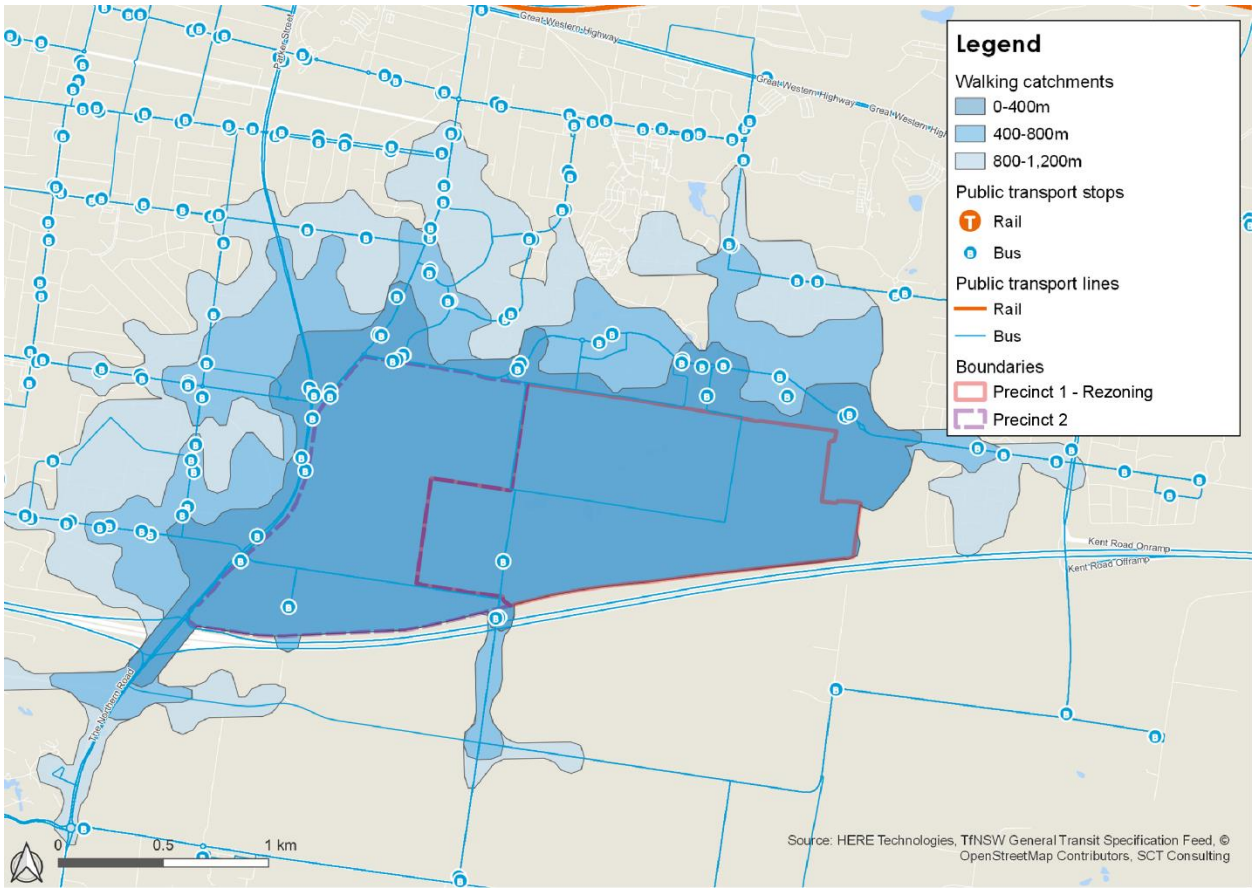


Source: HERE Technologies, © OpenStreetMap Contributors, SCT Consulting, 2020

3.3 Public transport

Bus routes and frequencies around the site are shown in **Figure 3-8**.

Figure 3-8 Bus routes in proximity of the Site



Source: HERE Technologies, TfNSW GTFS, © OpenStreetMap Contributors, SCT Consulting, 2020

The surrounding network is generally characterised by local bus routes, focussing on achieving as much coverage as possible of the broader network within 400 m walk distance from each stop. Route 781 runs through the centre of the precinct, serving Orchard Hills Public School.

Frequencies at each of the bus stops around the site are shown in **Table 3-3**.

Table 3-3 Bus route details for the site

Route	Corridor	To	From	Average number of services (per hour) ^			
				Weekday		Weekend	
				AM	PM	AM	PM
770	Casuarina Circuit	Penrith	Mount Druitt	3	2	1	1
770		Mount Druitt	Penrith	3	3	1	1
774	Bringelly Rd	Mount Druitt	Penrith	2	3	1	1
774		Penrith	Mount Druitt	2	2	1	1
781	O'Connell Lane	St Marys	Penrith	1	0	0	0
781		Penrith	St Marys	1	0	0	0
781		Orchard Hills	Claremont Meadows	0	0	0	0

Route	Corridor	To	From	Average number of services (per hour) ^			
				Weekday		Weekend	
				AM	PM	AM	PM
781		Claremont Meadows	Orchard Hills	0	1	0	0
789	The Northern Rd	Penrith	Luddenham	1	0	0	0
789		Luddenham	Penrith	1	1	0	0
794		Glenmore Park	Penrith	2	3	1	1
794		Penrith	Glenmore Park	3	2	1	1
Total				**17**	**16**	**6**	**6**

Source: TfNSW GTFS, August 2019
^Weekday AM = 6am to 10am, weekday PM = 3pm to 7pm; Weekend = 10am to 2pm

Bus frequencies are generally three or less services per hour during peak periods, consistent with bus services being of a local hierarchy.

3.4 Road network

The Northern Road (which runs west of the site) and The Werrington Arterial (which runs east of the site) provide direct access between the site and the surrounding centres and the strategic road network including the Great Western Highway and the M4. The characteristics of the key road network, as shown in **Figure 3-9**, surrounding the subject site are:

– The M4 (Western Motorway) – a six lane, two-way divided motorway that travels in the east-west direction just south of the Site, linking to the Great Western Highway (A32) at Emu Plains in the west and at to the Great Western Highway (A4) near Strathfield in the east. The M4 in proximity to the site is accessed via The Northern Road (west of the site) and Kent Road / Gipps Street corridor (east of the site). Its proximity to the site means that there is excellent access to the surrounding state / regional road network;

– The Northern Road – an eight lane, two-way undivided arterial road that travels in the north-south direction west of the site, linking Richmond Road in the north to Camden Valley Way in the south. The Northern Road provides direct access from the site through to the Western Sydney and South West Priority Growth Areas and Western Sydney Airport at Badgerys Creek, south of the site. The Northern Road is currently access-controlled, and the site can access The Northern Road via controlled access at Frogmore Road, Castle Road and Caddens Road / Bringelly Road;

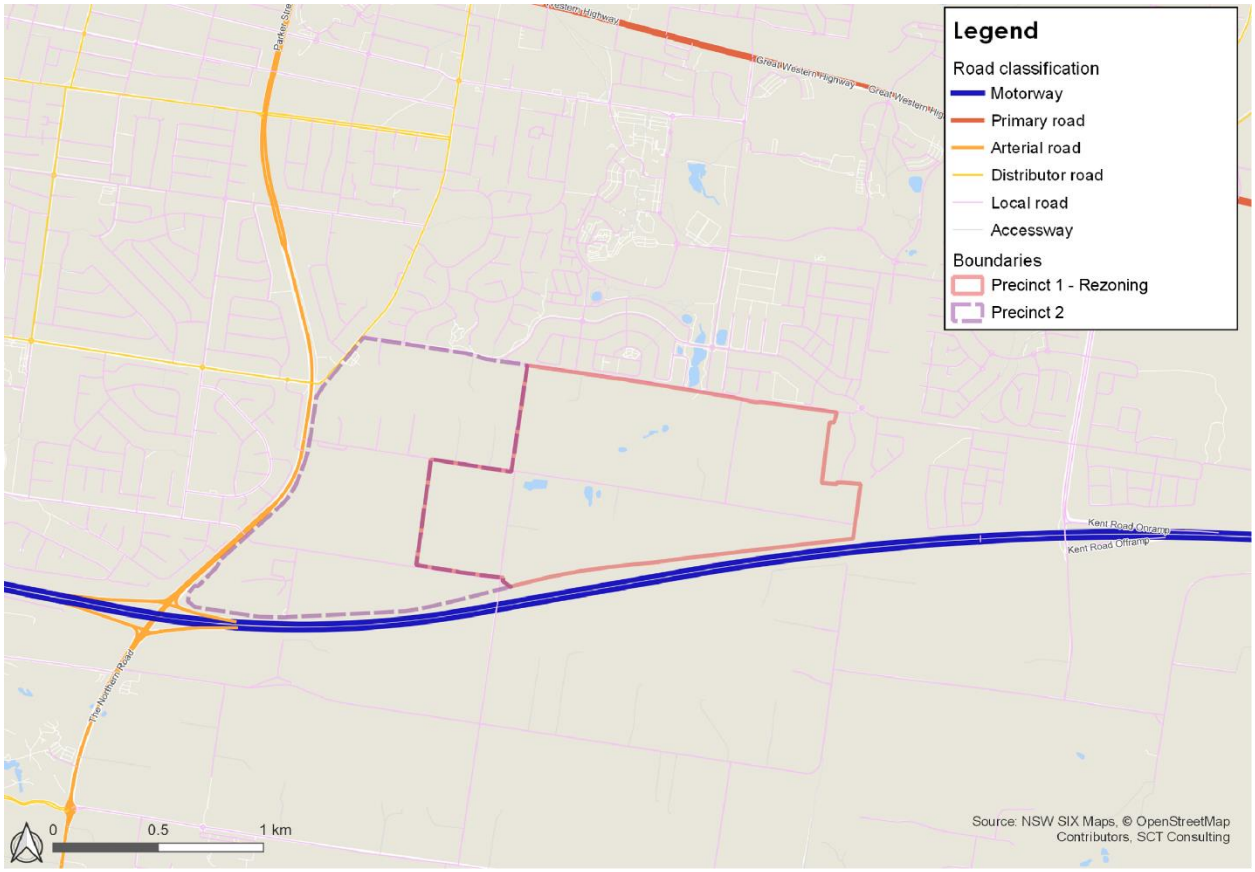
– Caddens Road / Cadda Ridge Drive – Caddens Road is an east-west two-lane, two-way local road that runs along the northern boundary of the Site, between Bringelly Road to the west and Kent Road / Gipps Road to the east. It provides a direct connection from the northern part of the site to the surrounding regional road network via Bringelly Road / Northern Road in the west and Kent Road / Gipps Road in the east. Since the development of the Caddens Release Area, Cadda Ridge Drive has replaced the collector road function of Caddens Road between Kingswood Road and O'Connell Lane due to the rural nature of Caddens Road;

– Gipps Street / Kent Road which runs in a north-south direction east of the site, is part of the Werrington Road Upgrade. It was recently upgraded to a four-lane, two-way divided connection between the M4 Motorway and the Great Western Highway. The upgrade provides improved access to the M4 Motorway and the surrounding regional road network via a new eastbound entry and westbound exit ramps with traffic lights at the M4 Motorway;

– O'Connell Street / O'Connell Lane – a two-lane two-way road that connects the site with the Great Western Highway in a north-south direction. It also extends to the east that connects into Sunflower Drive which collects local traffic in Claremont Meadows to Gipps Street; and

– Kingswood Road – a north-south two-lane, two-way undivided local and collector road that runs between Caddens Road to the north and Wentworth Road to the south.

Figure 3-9 Road network surrounding the Site

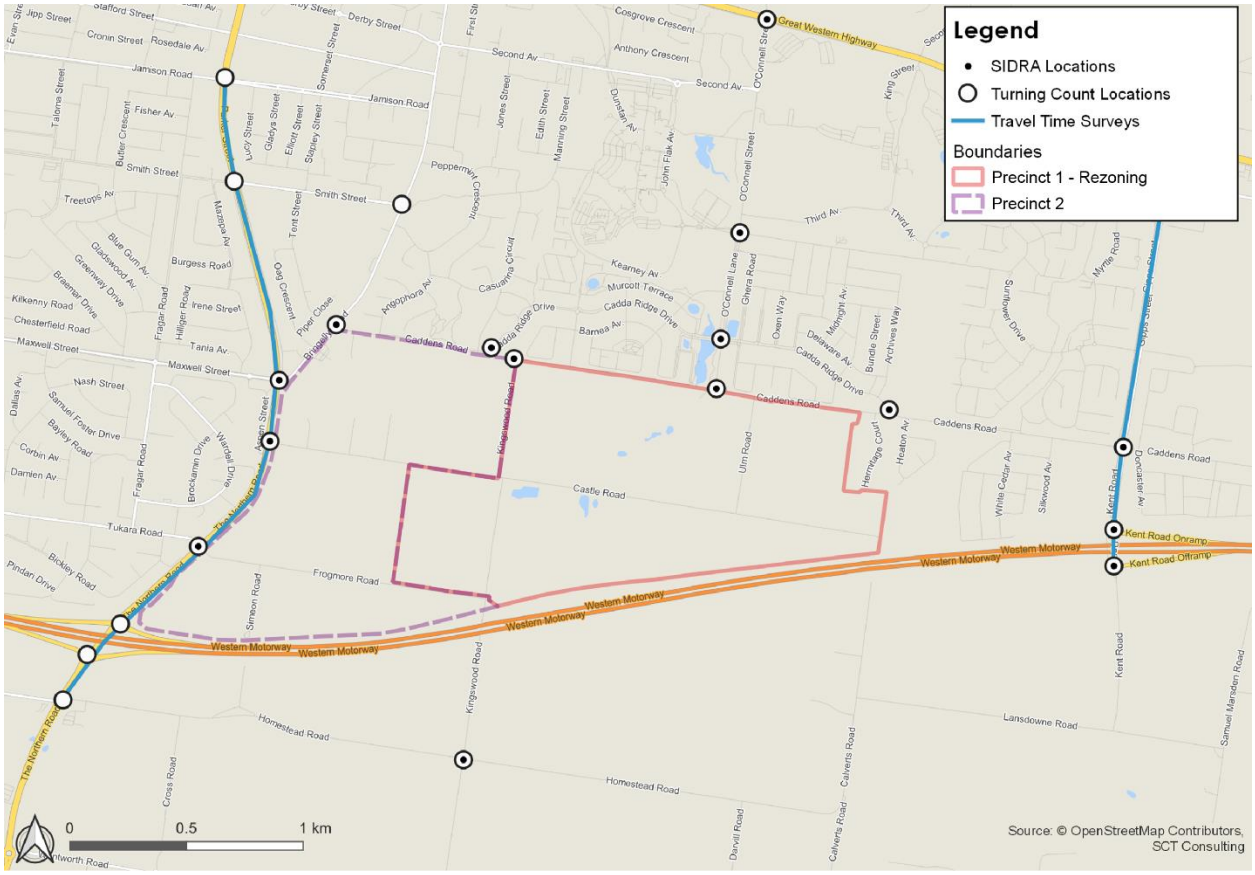


Source: NSW Six Maps, © OpenStreetMap Contributors, SCT Consulting, 2020

3.5 Existing traffic conditions

Traffic surveys were undertaken to serve as inputs to a model on 4 July 2018 and 4 December 2018 to inform traffic modelling. Intersection turning counts and travel time surveys were undertaken the locations shown in **Figure 3-10**.

Figure 3-10 Survey locations



b

Source: © OpenStreetMap contributors, SCT Consulting, 2020

Midblock traffic counts were also undertaken by Penrith City Council. The traffic flows on the local roads in proximity of the site once the ramps were implemented are presented in **Table 3-4**.

Table 3-4 AADT and HV proportion at local roads in proximity of the site (2017)

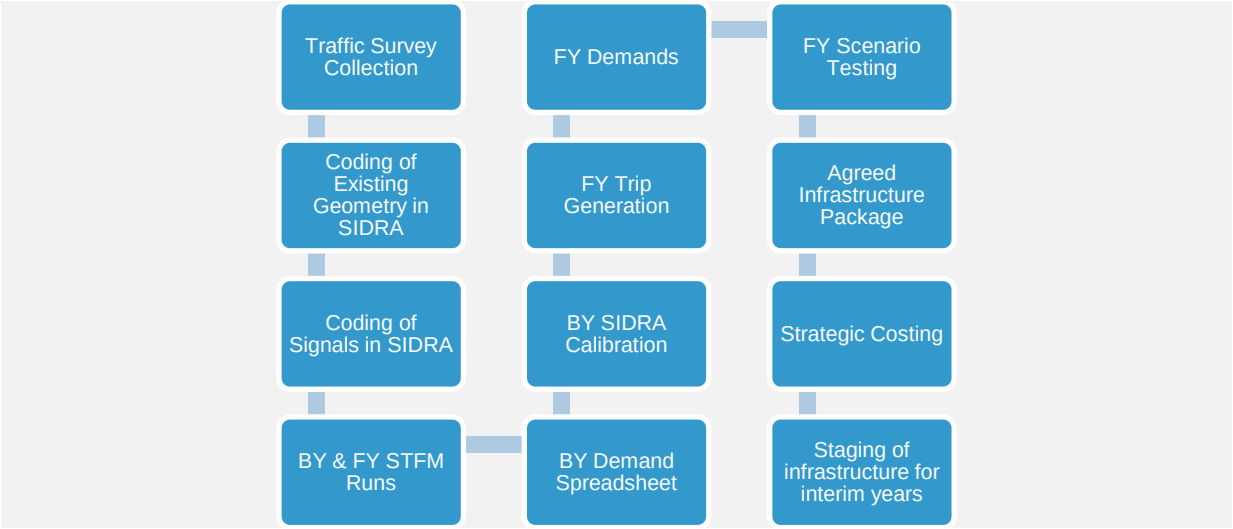
Road	AADT	Heavy vehicles	Proportion HV (%)
Homestead Road	1,852	146	7.9
Lansdowne Road	2,594	148	5.7
Kent Road	2,991	203	6.8
Caddens Road	3,405	167	4.9
Castle Road	1,394	79	5.7
Kingswood Road	1,450	141	9.7
Wentworth Road	1,672	149	8.9

Source: Penrith City Council, February 2018

3.6 Transport modelling

This methodology builds on the previous EMME modelling approach, which identified the strategic level transport demands and impacts. It is proposed to undertake a model framework that includes strategic modelling, mesoscopic and SIDRA modelling to achieve these ends. At this stage, mesoscopic modelling provides generally enough detail to achieve these outcomes – particularly with the large land holdings available to the proponent, which facilitate improvements to generally be on their land. A summary of the overall approach is provided in **Figure 3-11**.

Figure 3-11 Summary of traffic modelling methodology



Source: SCT Consulting, 2018; BY = Base Year, FY = Future Year (2026 and 2036). 2026 modelling will follow endorsement of agreed infrastructure package.

The approach uses a combination of SIDRA Intersection/Network and Aimsun mesoscopic to provide a picture of the distribution and impacts of the proposal. Turning counts at each of the key intersections was extracted from the outputs database of the Aimsun model and inserted into SIDRA for detailed intersection results. The key design year of 2036 was agreed with stakeholders as being sufficiently far into the future to ensure full buildout of the area.

Full details of the modelling framework are provided in **Appendix A**.

3.6.1 Model calibration

Models were calibrated and validated in accordance with Roads and Maritime *Traffic Modelling Guidelines (2013)*. Comments on issues raised by stakeholders in model calibration were fully addressed prior to commencing with future year modelling.

The Aimsun Calibration and Validation Report is provided in **Appendix B**.

3.6.2 Existing traffic volumes

Traffic volumes on the network are provided in **Figure 3-12** to **Figure 3-13**. Aimsun has a feature of being able to export the network into a GIS format. Each of the coloured links in the images correspond to the trafficable roads of the Aimsun mesoscopic model.

Volumes reported are the hourly averages over the two-hour peak period (i.e. (hour 1 + hour 2)/2), which represents the road network condition of typical peak hour. Traffic volumes have been grouped into bands significant for transport planning purposes:

– 300 vehicles per hour, which corresponds to the so-called “Environmental capacity performance standards on residential streets” from the RTA Guide to Traffic Generating Developments (2002) for local streets;

– 900 vehicles per hour, which corresponds to the midblock capacity under interrupted flow conditions[1];

– 1,800 vehicles per hour which is the typically accepted maximum theoretical throughput on a single lane of traffic under uninterrupted conditions; and

– 3,000 vehicles per hour, which corresponds to an order of magnitude maximum for a typical road footprint under maximum widening conditions.

[1] Austroads Guide to Traffic Management, Part 3 Traffic Studies and Analysis, Chapter 5 Interrupted Flow Facilities, Table 5.1: Typical mid-block capacities for urban roads with interrupted flow

Figure 3-12 Existing AM peak traffic volumes (two hour average)

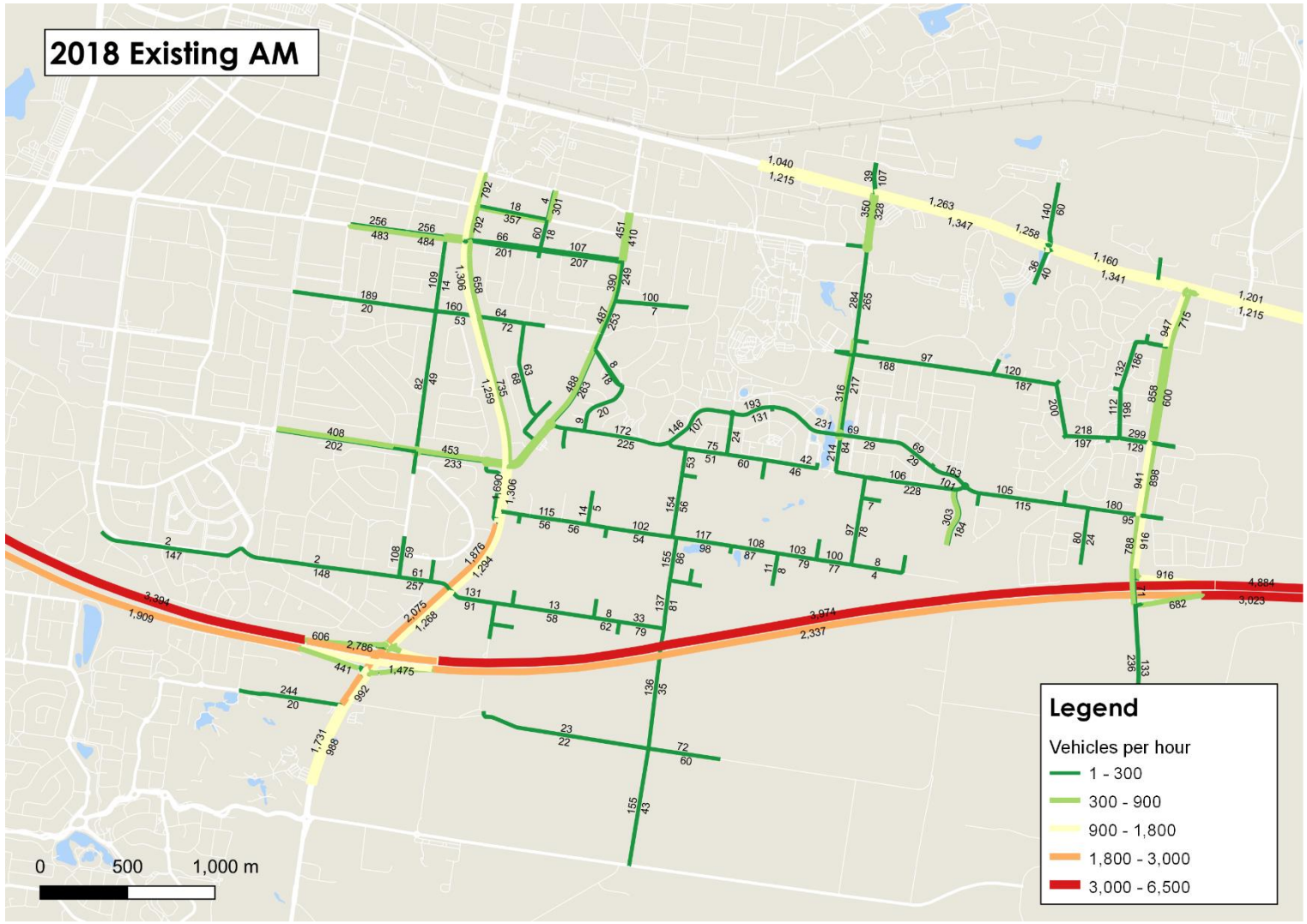
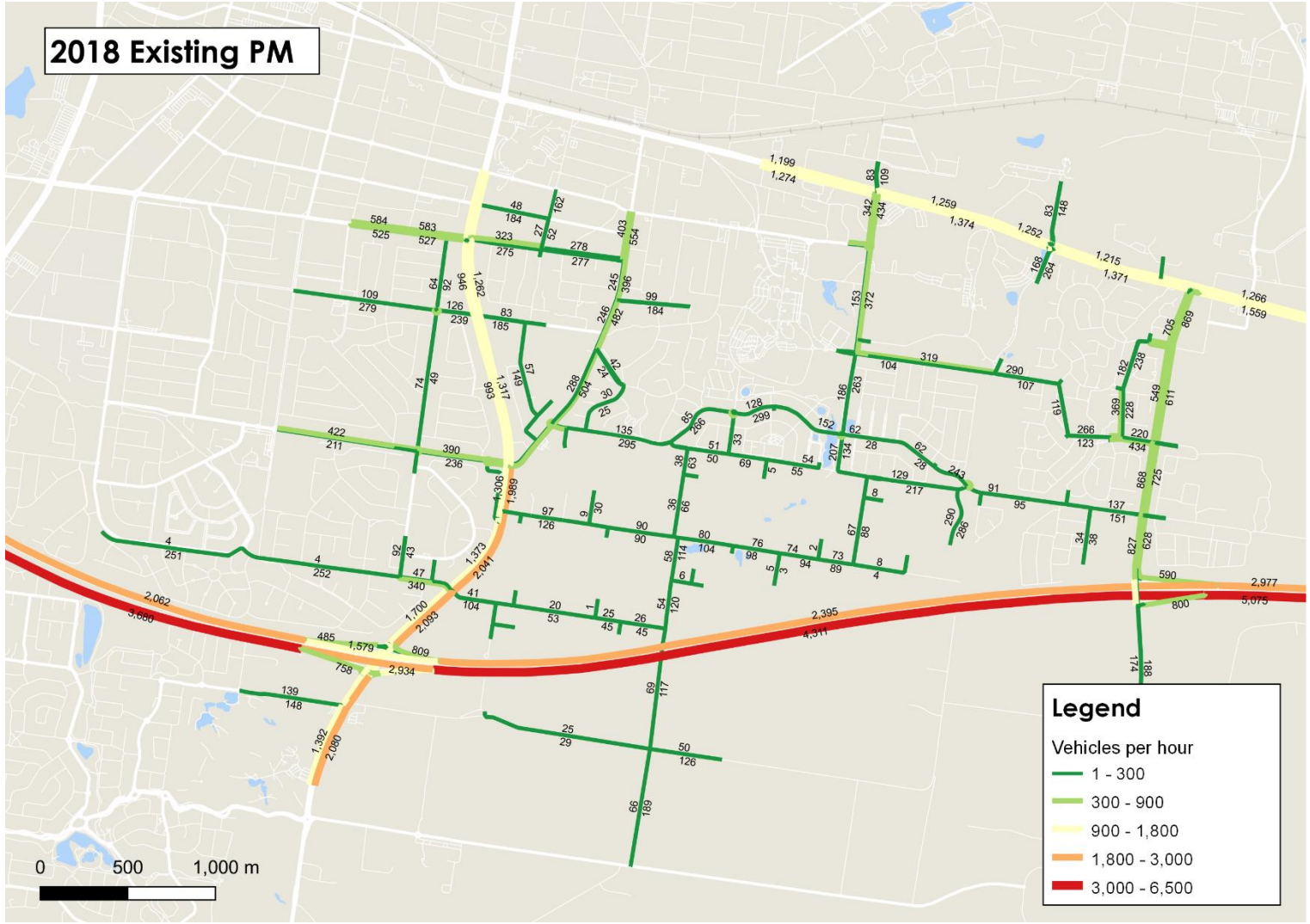


Figure 3-13 Existing PM peak traffic volumes (two hour average)



3.6.3 Midblock performance methodology

It was agreed in consultation with Council and TfNSW to use the *Austroads Guide to Traffic Management (AGTM) Part 3: Traffic Studies and Analysis* methodology for calculating mid-block flows to understand whether roads required widening between intersections. AGTM Part 3 has several capacity figures to use under different road conditions. Section 5.2.1 was agreed to be used, which is the section on urban arterial roads with interrupted flow. The table in this section is reproduced in **Table 3-5**.

Table 3-5 Austroads Guide to Traffic Management Part 3 Traffic Studies and Analysis Typical mid-block capacities for urban roads with interrupted flow

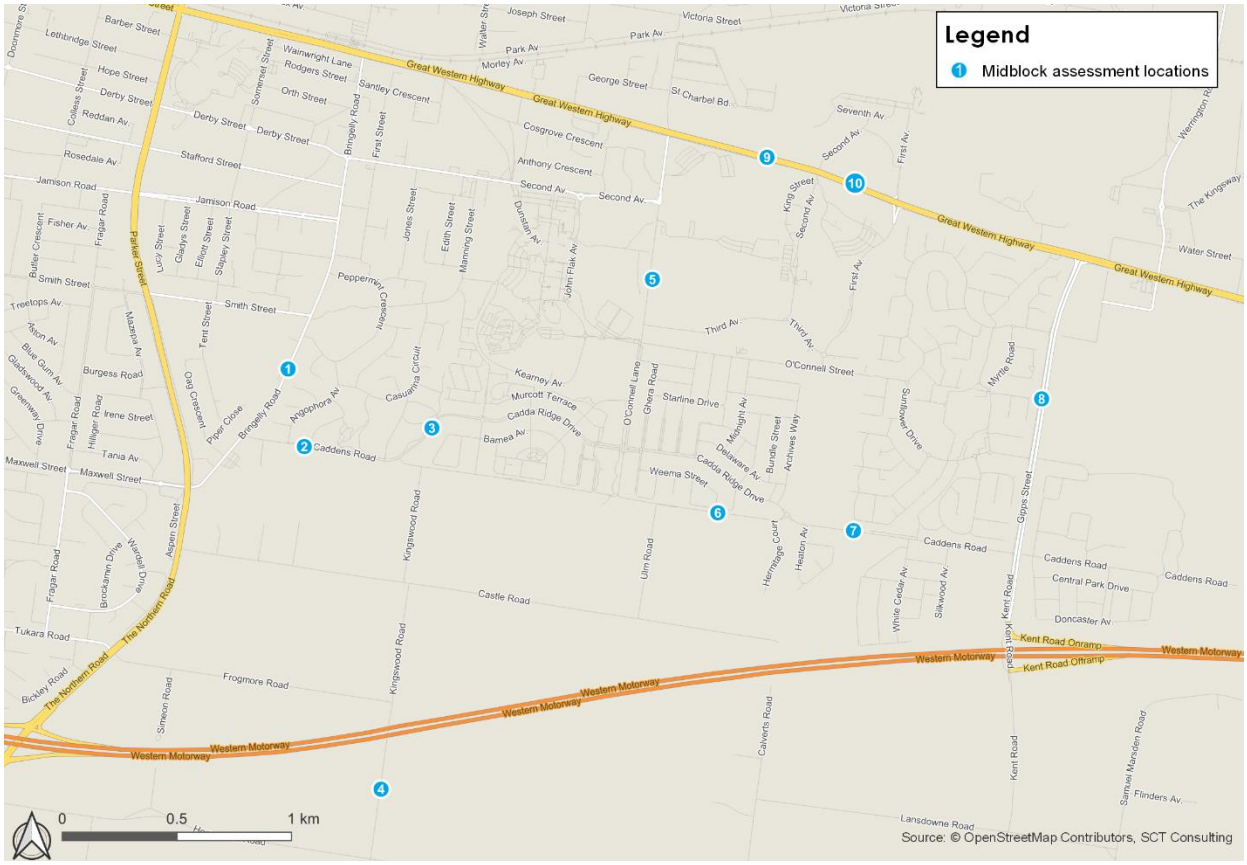
Type of lane	One-way mid-block capacity (pc/h)
Median or inner lane	
Divided road	1,000
Undivided road	900
Middle lane (of a 3-lane carriageway)	
Divided road	900
Undivided road	1,000
Kerb lane	
Adjacent to parking lane	900
Occasional parked vehicles	600
Clearway conditions	900

Source: Austroads, 2013

It was assumed that at all locations where midblock capacity was assessed that capacity was 900 vehicles per hour per lane. It may be the case that at some locations such as Great Western Highway, that midblock capacities are higher, given the smaller number of interruptions occurring to traffic.

Midblock capacity was assessed at the locations shown in **Figure 3-14**.

Figure 3-14 Midblock assessment locations



Source: © OpenStreetMap contributors, SCT Consulting, 2019

3.6.4 Midblock performance

Midblock performance is analysed in **Table 3-6** using outputs of the Aimsun model. The table specified the assumed capacity based on the number of lanes and the "V/C" (volume on capacity ratio), which would yield <1.0 when there is spare capacity, =1 when the link is at capacity and >1.0 when the link is operating above capacity.

Table 3-6 Midblock capacity evaluation – base year

#	Street	Lanes	Capacity	AM volume	AM V/C	PM volume	PM V/C
1	Bringelly Rd northbound	1	900	285	0.32	543	0.60
	Bringelly Rd southbound	1	900	508	0.56	226	0.25
2	Caddens Rd eastbound	1	900	203	0.23	129	0.14
	Caddens Rd westbound	1	900	251	0.28	294	0.33
3	Cadda Ridge Dr eastbound	1	900	179	0.20	85	0.09
	Cadda Ridge Dr westbound	1	900	105	0.12	252	0.28
4	Kingswood Road northbound	1	900	156	0.17	45	0.05
	Kingswood Road southbound	1	900	41	0.05	106	0.12
5	O'Connell St northbound	1	900	298	0.33	161	0.18
	O'Connell St southbound	1	900	264	0.29	383	0.43
6	Caddens Rd eastbound	1	900	132	0.15	143	0.16
	Caddens Rd westbound	1	900	206	0.23	214	0.24
7	Caddens Rd eastbound	1	900	109	0.12	97	0.11
	Caddens Rd westbound	1	900	110	0.12	119	0.13
8	Gipps Street northbound	2	1,800	849	0.47	563	0.31
	Gipps Street southbound	2	1,800	562	0.31	643	0.36
9	Great Western Highway eastbound	3	2,700	1,259	0.47	1,291	0.48
	Great Western Highway westbound	3	2,700	1,345	0.50	1,324	0.49
10	Great Western Highway eastbound	3	2,700	1,256	0.47	1,279	0.47
	Great Western Highway westbound	3	2,700	1,345	0.50	1,324	0.49

Source: SCT Consulting, 2019

The results show that majority of the roads operate at a V/C of 0.50 or below, indicating significant spare capacity. Many roads also operate with traffic levels below 300 vehicles per hour, indicating that they are operating as local streets.

3.6.5 Intersection level of service

Intersection Level of Service is a typical design tool used by traffic engineers to identify when roads are congested and require upgrade. The Level of Service as defined in the Traffic Modelling Guidelines is provided in **Table 3-7**.

Table 3-7 Level of Service definitions

Level of Service	Average Delay per Vehicles (sec/h)	Performance explanation
A	Less than 14.5	Good operation
B	14.5 to 28.4	Good with acceptable delays and spare capacity
C	28.5 to 42.4	Satisfactory
D	42.5 to 56.4	Operating near capacity
E	56.5 to 70.4	At capacity, at signals incidents will cause excessive delays. Roundabouts require other control method.
F	70.5 or greater	At capacity, at signals incidents will cause excessive delays. Roundabouts require other control method.

Source: TfNSW, 2002

As per the modelling framework agreed, Level of Service is reported only from the SIDRA models. The intersection performance for each of the fifteen junctions is shown below in **Table 3-8** and **Table 3-9** for the AM and PM peak periods, respectively.

Modelling indicates that The Northern Road corridor is operating at capacity for intersections between Frogmore Road and Bringelly Road. This is consistent with site observations and travel time surveys, which indicate significant delays for traffic on The Northern Road. Great Western Highway operates close to capacity at Gipps Street, although this has not yet translated to significant delays. It is likely that additional demands at this junction could result in significant increases in delays and queues. The remaining intersections operate with spare capacity and low delays.

Table 3-8 2018 AM peak intersection performance

Site	Control	Control Delay (s)	Level of Service	Degree of Saturation	Queue Length (m)
The Northern Rd / Frogmore Rd	Priority	>100s	F	0.97	62
The Northern Rd / Castle Rd	Priority	>100s	F	1.06	81
The Northern Rd / Bringelly Rd	Signals	>100s	F	1.12	761
Bringelly Rd / Caddens Rd	Roundabout	9.8	A	0.39	20
Caddens Rd / Kingswood Road	Priority	6.7	A	0.16	5
Caddens Road / O'Connell Ln	Priority	5.9	A	0.10	0
O'Connell Ln / Cadda Ridge Dr	Roundabout	9.4	A	0.23	8
O'Connell Ln / O'Connell St	Priority	8.2	A	0.32	10
Great Western Hwy / O'Connell	Signals	20.7	B	0.76	104
Great Western Highway / Gipps St	Signals	24.4	B	0.98	150
Gipps St / Caddens St	Signals	20.5	B	0.56	98
Caddens Rd / Cadda Ridge Dr	Roundabout	8.9	A	0.18	6
Kent Rd / M4 Eastbound On Ramp	Signals	4.4	A	0.43	12
Kent Rd / M4 Westbound Off Ramp	Signals	23.8	B	0.31	41
Homestead Rd / Kingswood Rd	Priority	7.2	A	0.17	4

Source: SCT Consulting, 2019

Table 3-9 2018 PM peak intersection performance

Site	Control	Control Delay (s)	Level of Service	Degree of Saturation	Queue Length (m)
The Northern Rd / Frogmore Rd	Priority	>100	F	1.15	49
The Northern Rd / Castle Rd	Priority	>100	F	0.61	44
The Northern Rd / Bringelly Rd	Signals	>100	F	1.09	630
Bringelly Rd / Caddens Rd	Roundabout	10.2	A	0.41	20
Caddens Rd / Kingswood Road	Priority	6	A	0.06	2
Caddens Road / O'Connell Ln	Priority	5.9	A	0.09	0
O'Connell Ln / Cadda Ridge Dr	Roundabout	9.9	A	0.21	7
O'Connell Ln / O'Connell St	Priority	7.3	A	0.20	6
Great Western Hwy / O'Connell	Signals	27.9	B	0.90	123
Great Western Highway / Gipps St	Signals	25.1	B	0.99	202
Gipps St / Caddens St	Signals	20.7	B	0.52	80
Caddens Rd / Cadda Ridge Dr	Roundabout	9.0	A	0.13	4
Kent Rd / M4 Eastbound On Ramp	Signals	6.3	A	0.40	40
Kent Rd / M4 Westbound Off Ramp	Signals	19.8	B	0.31	39
Homestead Rd / Kingswood Rd	Priority	8.9	A	0.07	2

Source: SCT Consulting, 2019

Further intersection performance summaries are provided in **Appendix C**. Turning count diagrams are provided in **Appendix D**.

4.0 The Proposal

4.1 Our vision

Orchard Hills North Precinct will be a residential community set amongst rolling hills in the rich natural landscape of Western Sydney, offering panoramic views to the Blue Mountains and surrounding areas. The development of Precinct 1 (as part of the rezoning) will incorporate a diverse mix of housing types across 1,729 residential lots, focused on a new neighbourhood centre that forms the focal point of the future community and offers a high level of convenience for residents.

The overarching vision of Orchard Hills North is to support a safe and connected community. This will be achieved through the provision of a wide variety of green spaces and links, connecting each of the future neighbourhood precincts with one another as well as the wider regional community, thereby placing a focus on active transport such as walking and cycling.

4.2 Design principles

A site analysis, supported by extensive technical studies, has informed the following design principles for the Orchard Hills North Precinct:

- Retain key creek lines and capitalise on the opportunity to create a central green link;
- Retain existing significant vegetation as natural bushland;
- Manage and retain views into and out of the site;
- Provide opportunities for a diverse mix of housing types, with medium density housing located around the neighbourhood centre and major open space;
- Create a new neighbourhood centre combined with a relocated primary school to establish a community focal point;
- Respect heritage buildings and the character of the area;
- Integrate with the community to the north, west and east;
- Improve water quality and water flow;
- Utilise landscaping and topography on the southern boundary to manage noise;
- Promote pedestrian and cycle linkages; and
- Generate employment opportunities along The Northern Road.

4.3 The Orchard Hills North Precinct land uses

It is proposed to rezone Precinct 1 from RU4 Primary Production Small Lots, under Penrith Local Environmental Plan (PLEP) 2010, to part R1 General Residential, B2 Local Centre, RE1 Public Recreation, E2 Environmental conservation, and E4 Environmental living in the south-eastern corner of the site, as well as provide for appropriate controls relating to minimum lot size, height, heritage items, and visual landscape.

It is expected that the site will ultimately provide a broad mix of housing types ranging from larger environmental living lots (2,000 m^2) to traditional detached residential lots (primarily 300-600 m^2) and smaller compact and attached housing lots (125-300 m^2). The proposed neighbourhood centre will provide 7,000 m^2 of retail space supported by cycle and pedestrian links with approximately 17.5 ha of open space, bushland, and riparian corridors.

A new / relocated primary school is proposed adjacent to the neighbourhood centre, supported by open space to facilitate share usage. It is assumed this school will comprise 1,000 students and 73 teachers by the time Orchard Hills North Precinct (Precincts 1 & 2) is fully delivered.

The location of parks and open space areas have been carefully selected to enhance the existing value of the natural landscape, such as hill tops and creek lines, and to retain the significant bushland areas, to provide the highest level of amenity for future residents.

The land use assumptions on which the traffic modelling was based are provided in **Table 4-1** and **Table 4-2** for Precincts 1 and 2, respectively.

Table 4-1 Precinct 1 land use assumptions

Attribute	Yield
No. of new residential dwellings	1,729 dwellings (1,629 additional)
Business/commercial floor space	7,000 sqm retail floor space in local centre
New school	30 teachers and 507 students
Site area	146.1 Ha
Density	11.8 dwellings / Ha
Population per dwelling	3.0 (provided by Council)
Forecast residential population	5,175 people

Source: SCT Consulting, 2020

Precinct 2 could accommodate up to approximately 1,146 additional dwellings (in additional to those in Precinct 1) and approximately 7 hectares of non-residential uses along The Northern Road, which could offer a combination of small retail, fast foods, community, health, medical, hotel, larger format commercial that may service the journey to the new airport. This would be in addition to the existing schools and residential development within the area. Refer to **Table 4-2** for more details and assumptions of land use of the balance of the structure plan area (Precinct 2).

Table 4-2 Precinct 2 land use assumptions

Attribute	Yield
Residential	1,146 total dwellings (1,061 additional)
Population per dwelling	3.0 (provided by Council)
Forecast residential population	3,387 people
School expansion	43 teachers and 493 students
Service station, strip of shops, fast food, etc. (2 Ha site area)	10,000m^2 GFA, comprising: – 3,000m^2 GFA for service station; – 6,000m^2 GFA of warehouses (self-storage); and – 1,000m^2 GFA of fast food (1x restaurant).
Highway service centre with bulky good uses (5 Ha site area)	25,000m^2 GFA, comprising: – 2 fast food restaurants @ 2,000m^2 GFA total; – 1 service station @ 3,000m^2 GFA; – 6 bulky goods premises @ 13,000m^2 GFA total; – 1 specialty retail shops @ 1,000m^2 GFA total; and – Offices (say for a government agency) @ 6,000m^2 GFA total.
Total site area	Total area: 112.3 hectares: – Area of existing schools: 14.2 hectares – Area of Sydney water reservoirs: 2.5 hectares – Area of telephone exchange: 0.4 hectares – Area of enterprise corridor: 7 hectares

Source: SCT Consulting, 2020

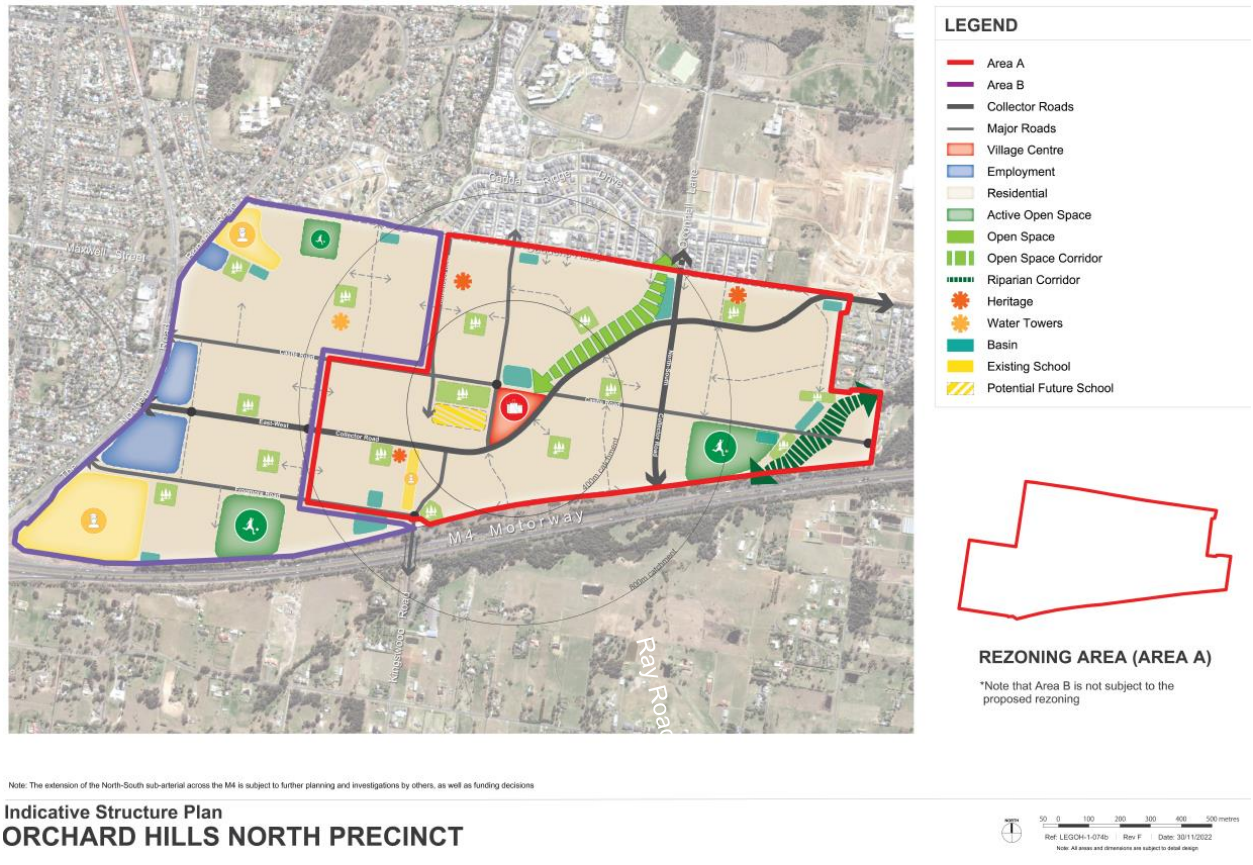
Combined, the Orchard Hills North Precinct (Precincts 1 & 2) could accommodate the yields shown in **Table 4-3**, which is the combination of **Table 4-1** and **Table 4-2**.

Table 4-3 Orchard Hills North (Precincts 1 & 2) land use assumptions

Attribute	Yield
No. of new residential dwellings	2,875 dwellings (2,690 additional)
Population per dwelling	3.0 (provided by Council)
Forecast residential population	8,625 people
Business/commercial floor space	7,000 sqm retail floor space in local centre
New school	73 teachers and 1,000 students
Business/commercial floor space	7,000 sqm retail floor space in local centre
Service station, strip of shops, fast food, etc. (2 Ha site area)	10,000m^2 GFA, comprising: – 3,000m^2 GFA for service station; – 6,000m^2 GFA of warehouses (self-storage); and 1,000m^2 GFA of fast food (1x restaurant).
Highway service centre with bulky good uses (5 Ha site area)	25,000m^2 GFA, comprising: – 2 fast food restaurants @ 2,000m^2 GFA total; – 1 service station @ 3,000m^2 GFA; – 6 bulky goods premises @ 13,000m^2 GFA total; – 1 specialty retail shops @ 1,000m^2 GFA total; and Offices (say for a government agency) @ 6,000m^2 GFA total.

The indicative structure plan for Orchard Hills North Precinct is identified in **Figure 4-1**.

Figure 4-1 Concept Structure Plan of Orchard Hills North Precinct (Precincts 1 & 2)



Source: Design + Planning, November 2022

The structure plan envisions the town centre located in the centre of the precinct, with several collector function roads radiating to the peripheral roads. East-west and north-south corridors run through the precinct to support strategic traffic.

The strategic road network principles were identified by Council and Transport for NSW as follows:

North-South road corridor:

– Forms a connection between O'Connell Street and terminates at the M4 Motorway. This may be continued in the future, subject to further planning, investigations and funding decisions, to link Orchard Hills North via a bridge across the M4 Motorway and to the southern expansion area / Orchard Hills South;

– Long term road reservation for 4 lanes, median and cycleway (e.g. Werrington Arterial Stage 1);

– No driveway access in short or long term;

– Can be built in the interim with 2 lanes and reservation to provide ultimate 4 lanes (sections of the four-lane corridor within Orchard Hills North may need to be brought forward dependent on the outcome of the TMAP exercise);

– Serve as a major collector / distributor road;

– Corridor would likely have an intersection with Cadda Ridge Drive, the east-west road corridor, and Castle Road (subject to topography); and

Existing bridge at Kingswood Road over M4 to remain as a local link, and potential for this to be a shared path over the M4 explored at a later stage (closed to vehicular traffic).

East-West road corridor:

– Connects a new signalised intersection at The Northern Road (mid-location intersection between M4 and Bringelly Road) with Caddens Road to the east, that generally follows an appropriate alignment in response to topography;

– Intersections at The Northern Road with Castle Road and Frogmore Road restricted to left-in, left-out ultimately;

– Road to provide 4 lanes and serves as a local collector road, while retaining Cadda Ridge Drive as a 2-lane road with parking on both sides; and

– Access restrictions applied near the new intersection with The Northern Road in anticipation of surrounding business/commercial uses and capacity associated with the new intersection. Could be partially access restricted in Precinct 1.

4.4 Proposed access strategy

4.4.1 Vehicular access

Vehicle access to the site is expected to be the dominant mode given distances to high frequency public transport are not attractive. Vehicular accesses to the site are proposed via Kingswood Road to the south, The Northern Road to the west and Caddens Road to the north, as shown in **Figure 4-2** and described below.

Figure 4-2 The Orchard Hills North access strategy (subject to further planning, investigations, and funding decisions)

Source: SCT Consulting, 2020

1. Multiple accesses are proposed to Caddens Road:
    a. Leveraging existing built intersections at Braeburn Street (to access Cadda Ridge Drive) and O'Connell Lane / Street (to access the Great Western Highway).
    b. Proposing two new accesses: one at the eastern end near Hermitage Court and the other one at the western end near Cadda Ridge Drive (to access existing Gipps Street and Bringelly Road / The Northern Road respectively).
2. Consolidated accesses are proposed to The Northern Road via:
    a. Castle Road (left in / left out to minimise conflicts with traffic on a State arterial road).
    b. Frogmore Road (via traffic signals as part of The Northern Road upgrade initially, which will allow for all movements for access on to The Northern Road). This access will be converted to a left-in left-out intersection eventually once the east-west corridor extends to meet The Northern Road.
    c. East-west corridor (via traffic signals).
3. Access to areas south of Orchard Hill North via Kingswood Road.

Traffic modelling in **Section 5.3** shows that this level of access is workable.

Other vehicular access to the site must be considerate of the following:

– Access arrangements must be discussed early with TfNSW regarding The Northern Road.
– Consideration of a service Road parallel to The Northern Road.
– A road shall be provided linking Castle Road to Frogmore Road.
– The location of new intersections connecting to the new east/west connector must be located to ensure all intersections are functional.

4.4.2 Public transport access and connections

Future residents and employees within the site will be located within 4.5 km of four existing train stations (Penrith, Kingswood, Werrington, St Marys), with the closest one being Kingswood Station, located approximately 2.7 km north of the site. All four stations are on the T1 Western Line which provides access between Emu Plains and Chatswood, via the Sydney CBD. Footpaths are provided between the site and the nearest Kingswood Station, along Caddens Road and Bringelly Road, with a pedestrian crossing provided at the Great Western Highway / Bringelly Road to access the train station.

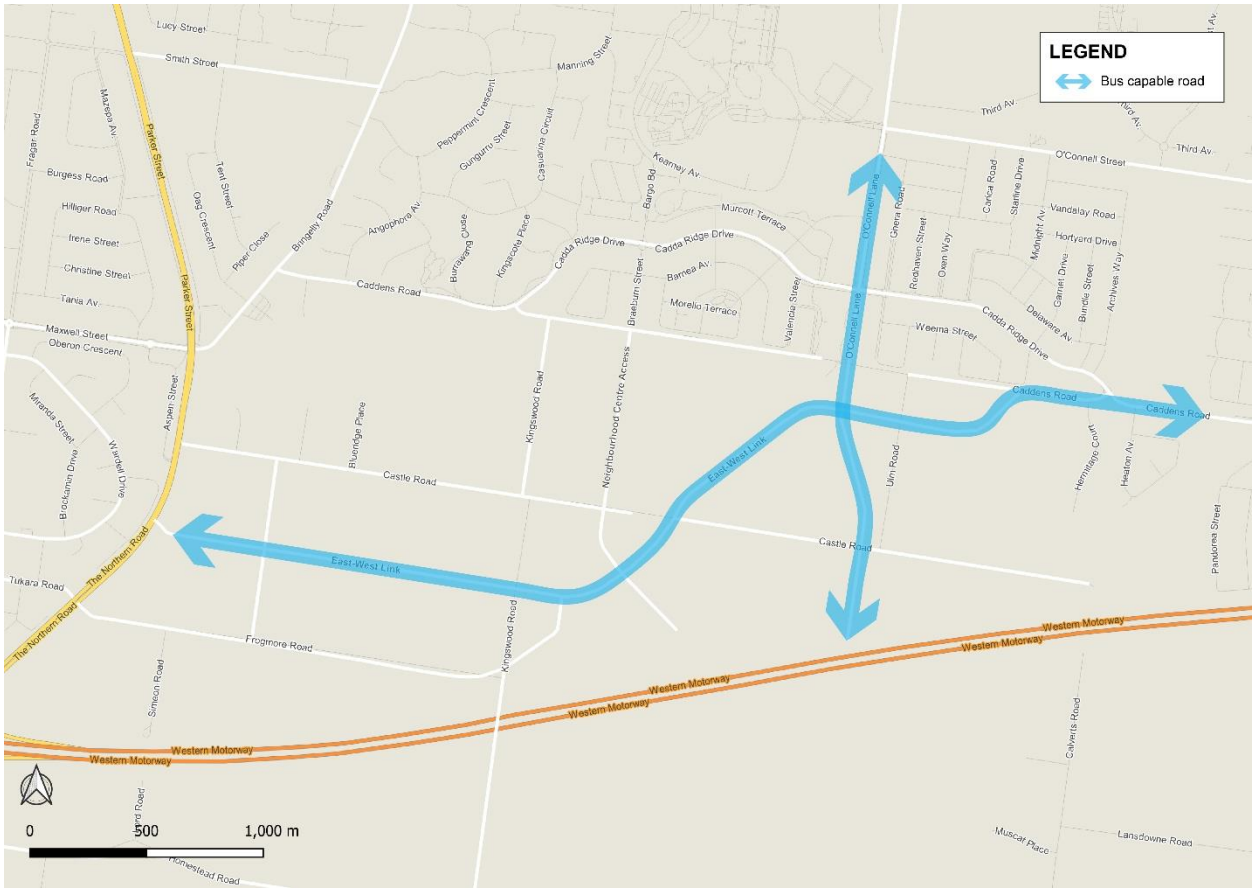
The proposed Sydney Metro Western Sydney Airport could result in a new rail station within 1-2 km of Orchard Hills North, increasing public transport mode share and providing connectivity to Western Sydney Airport. While not critical for this site, this infrastructure could result in significant benefits to this proposal.

Bus routes currently accessible to the site (prior to The Northern Road upgrade) are routes 778, 781, 789 and 794, which travel along Caddens Road / Cadda Ridge Road, Kingswood Road / Castle Hill Road / Ulm Road and The Northern Road, respectively. These bus services provide accessibility between the site and other destinations such as Penrith, St Marys, and Glenmore Park. Subject to further investigations and funding decisions, new or modified services could be provided to improve coverage to the proposed development and more frequent bus services can be provided as the population and demand for improved public transport services increase. The future north-south and east-west links are bus capable roads and illustrated in **Figure 4-3**. Location of bus stops, bus routes and infrastructure (such as indented bus bays) will to be considered and investigated as part of the planning process.

As part of The Northern Road upgrade, a kerbside bus corridor in each direction will be provided, which will improve bus travel time and efficiency to and from the site. Accessibility to bus stops and services has also been improved by the provision of six bus bays on both sides of Gipps Street and Kent Road, as part of the Werrington Road upgrade. These upgrades are all likely to encourage public transport usage to reduce future reliance on private vehicle trips in Orchard Hills North.

As identified in the Caddens Release Area DCP, public transport access to and from the site will also be enhanced by proposed bus routes along Caddens Road and O'Connell Lane / O'Connell Street.

Figure 4-3 Potential future bus corridors (subject to planning, investigation, and funding)



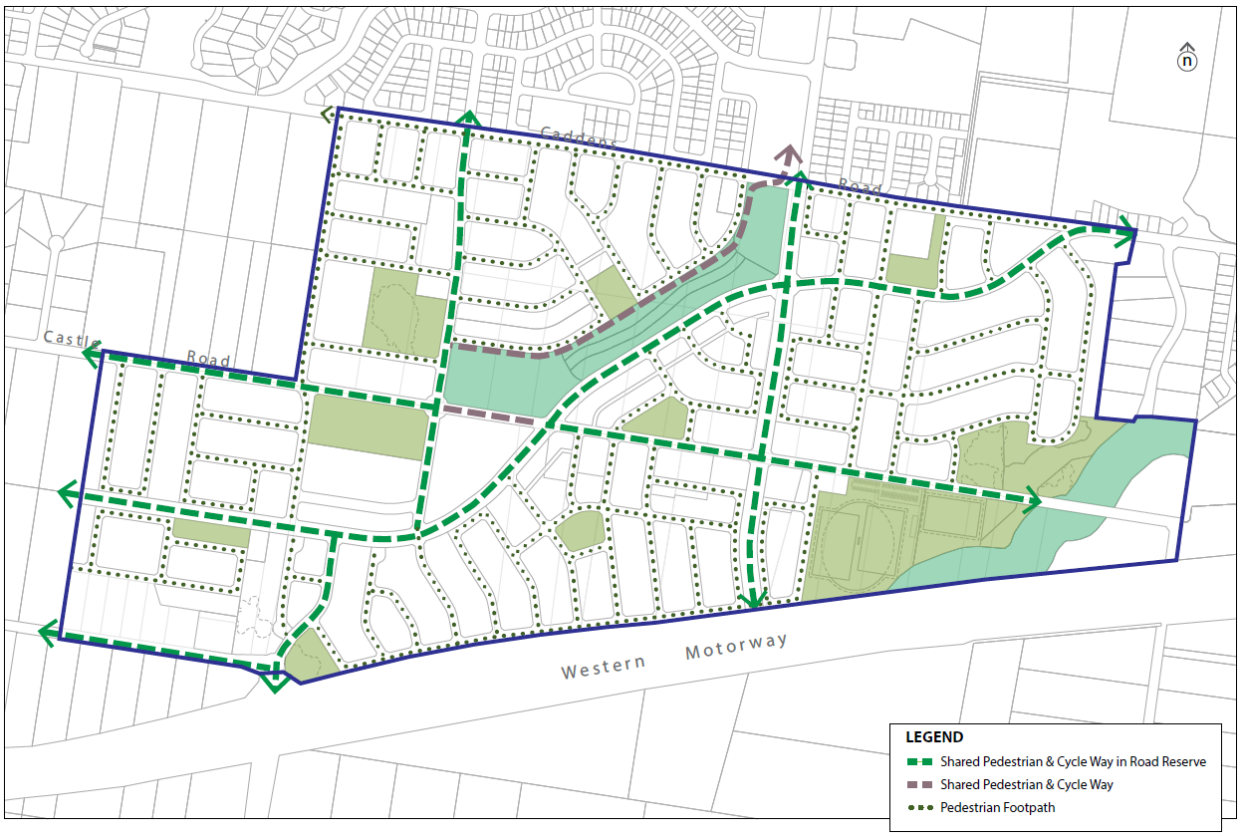
Source: SCT Consulting, 2021, © OSM Contributors

4.4.3 Active transport access and connections

A key element of the Orchard Hills North Structure Plan is to identify key green corridors to provide walking and cycling connections as part of wider regional links.

Pedestrian accesses to the site will be via the existing footpaths and proposed intersections on Caddens Road north of the site and at the upgraded intersections at Frogmore Road and Castle Road with The Northern Road, west of the site (as part of The Northern Road upgrade). Pedestrian access within the development with be provided via footpaths on all streets within the development and with pedestrian and cyclist shared path along key routes, illustrated in **Figure 4-4** below.

Figure 4-4 Pedestrian and cycle network within the development



Source: Design + Planning, November 2022

Cycling access within the development is provided through a mixture of dedicated shared paths as well as shared paths located in the road reserve. The proposed cycle ways provide both east-west and north-south movements, providing access to the neighbourhood centre as well as connectivity with the wider cycle network. The provision of cycling facilities will encourage active transport within the development and for trips to nearby local centres such as Penrith.

Cycling access to the development is currently provided within the Caddens subdivision area north of Orchard Hills North, with localised shared path facilities. Facilities on Gipps Street / Kent Road (including a new bridge over the M4 Motorway), as part of the Werrington Road upgrade provide north-south connectivity although at a location that is not on a desire line from the site.

The planned shared path along the upgraded The Northern Road will provide the missing north-south regional cycle connections to Penrith that could mark a shift in cycling access from the site. One key action for this rezoning is to provide connectivity east-west to link in with this facility.

As identified in **Section 3.2**, the Penrith City Council's Accessible Trails Hierarchy Strategy (PATHS) (June 2012) also aims to deliver a quality "trails" network, with proposed key district level routes providing major north - south and east - west trails along key transport and open space corridors in proximity of the site. As identified in the Caddens Release Area DCP, active transport access to and from the site will also be enhanced by proposed shared paths along Caddens Road and O'Connell Lane / O'Connell Street.

4.5 DCP requirements and compliance

4.5.1 Parking requirements

Minimum parking requirements have been set by the Penrith City Council – Transport Access and Parking to ensure that development functions efficiently and that there is limited impact on street parking and congestion. The controls with regards to parking for residential developments include that:

- For all residential development at least one car parking space for each proposed dwelling shall be covered, while the second space may be "stacked" or "tandem" or located on a driveway;
- All proposed parking provided on site is to meet the AS 2890 (Parking facilities – Off Street Parking), and where appropriate, AS 1428; and
- Stacked parking will not be permitted for visitor spaces for any development.

A summary of the vehicle, accessible and bicycle parking rates as outlined in the Penrith City DCP applicable to residential dwelling houses (for most of the land use of the site within Precinct 1) is presented in **Table 4-4**.

Table 4-4 Penrith City Council parking requirements for residential developments

Type of development	Parking requirements
Dwelling house	2 spaces per dwelling – stack or tandem parking acceptable
Dual Occupancy	2 spaces per dwelling (2 or more bedrooms) – stack or tandem parking acceptable
Multi Dwelling Housing	On-site resident parking for each dwelling: – 1 car space per 1 bedroom – 1.5 car spaces per 2 bedrooms or part thereof – 2 car spaces per 3 or more bedrooms – In addition, visitor parking is to be provided for developments that have 5 or more dwellings: 1 space for every 5 dwellings (or part thereof)
Retail	Supermarkets – 1 space per 10 m^2 of floor area that is to be used for retailing activities Other neighbourhood and specialty shops – 1 space per 30 m^2 GFA
School	No DCP controls and *State Environmental Planning Policy (Educational Establishments and Child Care Facilities) 2017 (NSW)* does not state any parking requirements.
Accessible parking	Accessible car spaces should be in accordance with the Access to Premises Standards, Building Code of Australia and AS2890.
Bicycle parking	Bicycle parking in accordance with the suggested bicycle parking provision rates for different land use types in the document 'Planning Guidelines for Walking and Cycling' (NSW Government 2004). Bicycle parking spaces should comply with *AS2890.3:1993 Bicycle Parking Facilities*

Source: Penrith Development Control Plan – Transport, Access, and Parking (2014)

There are no proposed deviations to these rates. Any amount of parking for schools would be determined by the relevant statutory planning processes for that facility.

4.5.2 DCP access and driveway requirements

DCP requirements that apply to the location of accesses and driveways to dwelling houses relevant to the site include:

- No direct access will be permitted to the M4 and access from properties fronting The Northern Road shall only be permitted if it serves dwellings or domestic outbuildings;
- Driveways and access roads shall follow the contours of the land, as much as possible, and be no wider than is necessary to allow for safe and effective vehicle movements;
- The entry and exit from the site should provide for appropriate traffic sight distance in both directions, in accordance with the provisions of *AS2890.1 and 2:2004* for car parking and commercial vehicles respectively;

– The design of the development driveway should take into consideration the traffic volumes of the surrounding road network;
– Driveways should be located taking into account any services located within the road reserve, such as power poles, drainage inlet pits and existing street trees and setback a minimum of 6 m from the perpendicular of any intersection of any two roads; and
– Driveway widths and grades must comply with the relevant Australian Standards (AS2890.1).

The north-south link would be fully access controlled, with no driveways accessing onto the road. This would ensure safe and efficient operation, providing a reliable bus connection including potentially to the future metro station at Orchard Hills South, subject to further planning, investigations, and funding decisions.

The east-west corridor with be access controlled within the employment area in the balance of structure plan area. Some limited access would be provided onto the east-west corridor within Precinct 1 like a typical sub-arterial road. These principles would be included the draft DCP.

4.5.3 Access and driveway compliance

All residential driveways will be designed in accordance with the AS2890.1, with appropriate sight distance provided at all driveway accesses.

Access points to the development will be provided at Caddens Road, The Northern Road and Kingswood Road, with no direct access provided to the M4. The business / enterprise zone along The Northern Road will also be designed with access via Frogmore Road and Castle Road.

4.5.4 DCP road layout requirements

All roads are to be designed in accordance with the Penrith City Council's Engineering Design Guidelines and conditions of development consent.

Local road means a road or street used primarily for property access and include laneways, access ways and rural residential roads for lots typically less than or equal to 1 hectare, with the following performance objectives:

– Direct access to residential properties and interconnectivity with other local roads and collector roads;
– Provide for heavy- and emergency vehicles, including circulation and manoeuvring of garbage trucks; and
– Ensure only occasional, minor delays or the need for driver co-operation due to vehicles parking on both sides of the road.

Collector road / street means a road which collects and distributes traffic in an area, as well as providing direct property access, and the performance objectives include:

– Be at a scale consistent with the higher order role these roads play in the overall road network;
– Provide for local bus services within the road lane widths;
– Provide an off-road shared path (on road cycle ways will be considered in some circumstances) and pedestrian pathways on both sides of the road with safe crossing points;
– Integrate pedestrian and cycle pathways with the surrounding network; and
– Provide for turning paths of heavy vehicles at intersections.

4.5.5 Road layout compliance

As discussed in **Section 4.2**, it is intended in the structure plan will cater for a North-South and East-West corridor with a future footprint of four lanes (two lanes in each direction) at the request of TfNSW and Council. These roads will be designed to cater for future bus services, with provision for off-road shared paths to integrate with surrounding street network.

The road layout will be considered in more detailed in the DCP.

4.6 Travel Demand Management measures

Sustainable transport and Travel Demand Management (TDM) strategies involve the application of policies, objectives, measures, and targets to influence travel behaviour, to encourage uptake of sustainable forms of

transport, i.e. non-car modes, wherever possible. TDM measures have proven to reduce congestion created by growth within urban areas and unlock urban renewal opportunities. They result in travel behaviour that uses less road space than single occupant vehicle commute and takes advantage of spare transport capacity outside the morning and afternoon peaks.

TDM strategies generally guide all relevant customers (residents, employees, and visitors) in changing the travel behaviour in the following ways:

– Reduce travel;

– Re-mode (consideration of travel via alternative modes);

– Re-time (consideration of travel at alternative times); and

– Re-route.

A Travel Plan should be developed and monitored for the Orchard Hills North development to deliver best practice travel programs and initiatives to manage travel demand for the proposed development. Key initiatives and measures could be developed to:

– Reduce the need to travel

  - Planning for a range of uses are to be provided or integrated in the development to provide a range of services in a single location to maximise trip containment within or in proximity of the site and encourage use of active transport (walking and cycling) for short trips.
  - Encourage the use of internet to reduce the need to travel such as Australia Post, parcel drop-off /pick-up facilities.
  - Encourage the use of internet and technology to facilitate remote working via smart work hubs with high quality facilities or working from home.
  - Develop and use of carpooling for wider precinct and community.

– Re-think the mode of travel

  - Walking and cycling:
    - A highly permeable and safe pedestrian network throughout the development.
    - Dedicated cycle routes that connect to the regional routes and major transport hubs.
    - Key design principles to integrate walking and cycling network and facilities into the planning and delivery of the development.
    - High quality, safe and accessible end-of-trip facilities (centralised cycle hubs that are integrated within development at convenient locations, on-street secure bicycle storage located conveniently at end of cycle destinations, parking hubs for shared bikes, lockers, and showers).
    - Free bicycles for residents, employees, and visitors to travel within the site and nearby transport interchanges (to be agreed with Councils and TfNSW).
    - Promotion of bicycle initiatives – NSW bicycle week, cycle to work day, free bike check-up events.
    - Establishment of a Bicycle User / Consultation Group.
    - ‘Cycle Update’ newsletter.
  - Public transport:
    - Reimbursement of public transport costs such as giving out of Opal card with credits.
    - Early provision of frequent public transport services to establish a non-car travel behaviour.
    - Good quality public transport stops in the vicinity of the development.
    - Tailored information with clear mapping and walking catchments at public transport stops.
    - Provision of public transport information from home via television channel or community app.
  - Parking measures as a mean to encourage alternative modes of travel:
    - Reduced parking rates with flexibility in parking arrangements such as decoupled parking, shared vehicles parking to accommodate parking needs of all residents.

    - Parking spaces dedicated to electric vehicles, with charging stations.
    - Parking spaces dedicated to car share scheme and community car-share vehicles, both on-street and incorporated in easily accessed public car parks.

– Re-time and Re-route journeys:

- Development of specific community app / community engagement program to enable changing travel behaviour which includes:
    - Active and public transport maps
    - Personalised journey planner
    - Notifications to latest travel information
    - Shared vehicles information
    - Car-pooling opportunities
    - Other precinct-related information
- Real-time information embedded into development and public transport stops.
- Employers to promote and encourage flexible working hours and arrangements.

While it is important to develop a Travel Plan that is aimed at managing travel demand and reducing reliance on car travel, it is more important to monitor and evaluate the effectiveness of individual measures and the need to adjust the measures. The planning and implementation of a targeted Travel Plan with the above green travel initiatives / principles for the Orchard Hills North Precinct will provide significant opportunities for alternative travel options and reduce the need of car travel.

5.0 Traffic and transport appraisal

5.1 Traffic modelling assumptions

Details of the modelling approach are covered in **Appendix A**, which describes the modelling framework, which was followed in the preparation of the modelling.

The Orchard Hills North road network was analysed for performance with 2036 forecast traffic with no development, and with the proposed development in Precinct 1 in accordance with the previously agreed future year modelling assumptions paper. EMME results were incorporated into Aimsun, run via a mesoscopic simulation, then transferred to SIDRA for intersection analysis. In addition to the assumptions made in the *Scoping Note: Orchard Hills TMAP Methodology Report – Post Gateway – Final, version 4.4 (dated 19 June 2020)*, some further assumptions were required.

5.1.1 Modelling scenarios

The subject of this rezoning is the yield described in **Table 4-1**, which sits within Precinct 1 as shown in **Figure 4-1**. For modelling purposes, several scenarios (**Table 5-1**) were tested to ensure that infrastructure was appropriately designed to respond to the forecast growth.

Table 5-1 Traffic modelling scenarios summary

Scenario name	Shorthand scenario title	Background growth	Development included
2036 background growth	FY0	✓	Nil
2036 Precinct 1	FY1	✓	Precinct 1 (**Figure 4-1**) outlined in orange, with the yield of this area (**Table 4-1**)
2036 Orchard Hills North Precinct (Precincts 1 & 2)	FY2	✓	The entirety of Orchard Hills North Precinct, including both Precincts 1 and 2 (refer **Figure 4-1**). This includes both Precinct 1 yield (**Table 4-1**) plus Precinct 2 yield (**Table 4-2**)

5.1.2 Modelling year

It has been confirmed that Orchard Hills North Precinct (Precincts 1 & 2) would be fully developed by 2036. For the TMAP, traffic modelling was undertaken with 2036 as the design year.

5.1.3 Network / access assumptions

Traffic models were prepared in line with the latest network configurations assumed by TfNSW to support the land use changes up to year 2036. Within the modelling area, it is confirmed that the following upgrades are included for the purpose of this assessment (as a base case):

– The Northern Road upgrades;

– Werrington Arterial Stage 1 upgrade;

– Upgrade of Caddens Road and Cadda Ridge Drive between Bringelly Road and Gipps Street to a two-lane urban road (including the closure of existing Caddens Road to the west of O'Connell Lane); and

– Upgrade of O'Connell lane and O'Connell Street to a two-lane urban road.

Key access and internal road network assumptions include:

– Multiple accesses to Caddens Road, leveraging existing built intersections at Braeburn Street, O'Connell Street and two new accesses;

– Consolidated accesses to The Northern Road via Castle Road (LILO) and Frogmore Road (traffic signals initially and eventually left-in left-out when the east-west corridor extends to The Northern Road);

– Kingswood Road as a minor access to the south of the development; and

– North-south and east-west corridors were tested at the dimension of two lanes in either direction regardless of whether traffic warranted this widening. Commentary is provided as to the timing of delivery of the full cross section.

On receipt of EMME volumes, it was found that EMME was assigning significant traffic to Glenmore Parkway and Garswood Road, which exceeded the capacity of this junction (being only a give way intersection). More than an additional 300 vehicles per hour growth was forecast for this road. Traffic was diverted onto The Northern Road rather than using this link to avoid traffic being unable to enter the network. Trips entering Garswood Road were redirected to the southern entry of The Northern Road. This was retained in all future year scenarios.

In the AM peak, the diversions totalled 1,010 vehicles over the two hour model. In the PM peak, the diversions totalled 736 vehicles over the two hour model.

In addition, upgrades for The Northern Road were available publicly, but not the signal plans.

It was assumed that the north-south and east-west corridors would be posted at 70 km/h.

The only planned upgrade in the area is the widening of The Northern Road to eight lanes in total as per the scheme available on TfNSW website, https://www.rms.nsw.gov.au/projects/01documents/the-northern-road/the-northern-road-stage-3-project-update-2017-06.pdf.

5.1.4 EMME modelling scenarios

Traffic growth was developed from cordoned matrices from the Sydney Strategic Traffic Forecasting Model (STFM). STFM has been calibrated to HTS and Census Journey to Work data and is run in EMME modelling software.

Demands were taken as volume differences from the scenario year from 2018 and applied for each origin-destination pair. Where zone disaggregation has occurred, any increase in demand will be applied pro-rata at the same rate as the base model division to each disaggregated zone.

Background traffic growth was based on the 2016 Travel Zone Projections (TZP2016) prepared by TfNSW. Trips were distributed using EMME modelling and spreadsheet analysis. It is noted that the updated land use scenario LU20 is understood to be available now but was not available when background growth modelling was being undertaken.

Following updates to the Orchard Hills North Precinct (Precincts 1 & 2) yields, the EMME model outputs were not re-run but were updated using spreadsheet models. EMME modelling was undertaken with the initial rounds of analysis, but the changes to the overall traffic demands are not substantial compared with the previous analysis – for instance, the Precinct 1 scenario did not change.

5.2 Trip generation and distribution

5.2.1 Vehicular trip generation

Trip generation rates for residential uses (for most of the land use of the site within Precinct 1) sourced from Council and TfNSW have been considered for this study:

– Penrith Council rates[2]: 0.76 trips per dwelling in the AM peak and 0.97 trips per dwelling in the PM peak.

– 2002 RMS Guide to Trip Generating Development: 0.85 trips per dwelling for the peak hours.

– 2013 RMS Technical Direction Update: 0.99 trips per dwelling in AM peak and 0.95 trips per dwelling in PM peak.

– Average of three source: 0.86 trips per dwelling in the AM peak and 0.92 trips per dwelling in the PM peak.

The vehicular trip rate of 0.92 per hour in the AM and PM peak is a conservative estimate based on updated surveyed rates outlined in the former RMS Guide to Trip Generating Developments, which is based on trips to/from the adjacent regional road network. Internal trip containment and mode share (public and active transport) are additional trips.

Peak hour generation rates for other potential land uses within Orchard Hills North Precinct (Precincts 1 & 2), sourced from Council and TfNSW have been summarised in **Table 5-2**. All these rates were documented in the

[2] Based on 2016 traffic and residence surveys – 1,897 occupied dwellings at Jordan Springs, 1,376 trips in and out of Jordan Springs at The Northern Road intersections at the AM peak and 1,752 trips in the PM peak.

Scoping Note: Orchard Hills TMAP Methodology Report – Post Gateway – Final, version 4.4 (dated 19 June 2020), approved by Council and TfNSW for the purpose of this TMAP.

Table 5-2 Peak hour trip generation rates

Activity	AM peak hour (In / Out proportion)	PM peak hour (In / Out proportion)
Residential	0.92 per dwelling (20% / 80%)	0.92 per dwelling (80% / 20%)
Retail (local centre) and speciality retail	3.69 per 100 m^2 GLFA (60% / 40%)	12.30 per 100 m^2 GFA (50% / 50%)
Warehouses	0.52 per 100 m^2 GFA	0.56 per 100 m^2 GFA (20% / 80%)
Bulky goods retail* **	1.0 per 100m^2 GFA (80% / 20%)	2.44 per 100m^2 GFA (50% / 50%)
Commercial	1.6 per 100m^2 GFA (80% / 20%)	1.2 per 100m^2 GFA (80% / 20%)
Service station**	4.0 per 100m^2 site area plus 30 per 100m^2 convenience store GFA	4.0 per 100m^2 site area plus 30 per 100m^2 convenience store GFA
Fast food restaurants	180 veh/h per restaurant	180 veh/h per restaurant
School students	0.80 per student (50% / 50%)	-
School teachers	1 per teacher (100% / 0)	1 per teacher (0 / 100%)

Source: Penrith City Council surveyed rates and RMS Guide to Trip Generating Developments
* Values in parentheses indicate in and out proportions
** For service stations, it is expected that trips are all passing trade – i.e. cars already on the network that need to divert through the service station rather than new trips
*** for Bulky Goods sites, the updated traffic generation surveys of existing bulky goods premises across metropolitan Sydney undertaken by former RMS identified an average traffic generation rate of 1.0 per 100m^2 in the AM peak and 2.44 per 100m^2 in the PM peak (maximum of 4.33 and low of 1.42), as advised by TfNSW.

It is noted that the trip generation rate for the industrial/business use is consistent with the "business park and industrial estates" category from Roads and Maritime 2013/04a Technical Direction.

For the retail and school trip generation, it was assumed that these trips originated in the Orchard Hills North Precinct (Precincts 1 & 2) area as the retail is assumed to be servicing local demands.

It is also assumed that weekend, event, and Thursday evening scenarios do not require modelling. Due to the predominately residential land uses proposed and around this precinct, the generation rates during these time periods are expected to be minimal.

5.2.2 Hourly trip generation during peak period

Each peak period was modelled as two hours and multipliers were used to distinguish the different activity levels between each of the individual hours.

The Aimsun mesoscopic model covers a two hour period, with the changing traffic profile over time incorporated in the model. This means that while there are times that the model overall is busier, local intersections have different peak periods. For SIDRA modelling, the worst hour in the Aimsun model was extracted. Turning counts from this process are shown in **Appendix D**. For the midblock assessment, the average over a two hour period was used.

The assumptions used to calculate the share of demands for each peak hour are in **Table 5-3** and **Table 5-4**.The total trip generation by the forecast land uses proposed in **Section 4.3** is highlighted in **Table 5-5** and **Table 5-6** for the Precinct 1 and Orchard Hills North Precinct (Precincts 1 & 2) scenarios, respectively. The trip generation shows that the Precinct 1 scenario is approximately 50% of the demands of the full development.

Table 5-3 AM Peak Period share of demand for each peak hour

Land Use	Dwellings	Students	Teachers	Retail	Warehouses	Bulky Goods	Commercial	Fast Food	Speciality Retail	Service Station
Generation Rate	0.92	0.8	1	0.037	0.0052	0.001	0.016	180	0.0369	
Inbound %	20%	50%	100%	60%	80%	80%	20%	50%	60%	
Outbound %	80%	50%	0%	40%	20%	20%	80%	50%	40%	100%
7AM Multiplier	0.85	0.00	0.40	0.60	0.60	0.60	0.70	1.00	0.60	
8AM Multiplier	1.00	1.00	0.60	1.00	1.00	1.00	1.00	1.00	1.00	

Table 5-4 PM Peak Period share of demand for each peak hour

Land Use	Dwellings	Students	Teachers	Retail	Warehouses	Bulky Goods	Commercial	Fast Food	Speciality Retail	Service Station
Generation Rate	0.92	0	1	0.123	0.0056	0.0101	0.012	180	0.123	
Inbound %	80%	50%	0%	50%	20%	50%	80%	50%	50%	
Outbound %	20%	50%	100%	50%	80%	50%	20%	50%	50%	100%
4PM Multiplier	1.00	0.00	0.50	1.00	1.00	1.00	0.90	1.00	1.00	
5PM Multiplier	1.00	0.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00	

Table 5-5 Car trip generation for Precinct 1 scenario

Centroid Numbers		Yield				Attraction (veh/h)		Production (veh/h)		Attraction (veh/h)		Production (veh/h)	
Aimsun Zone	Area	Dwellings	Students	Teachers	Retail (m^2 GFA)	7AM	8AM	7AM	8AM	5PM	6PM	5PM	6PM
49601	Precinct 1	94	0	0	0	15	17	59	69	69	69	17	17
49602		321	0	0	0	50	59	201	236	236	236	59	59
49603		149	0	0	0	23	27	93	110	110	110	27	27
49604		277	0	0	0	43	51	173	204	204	204	51	51
49605		271	0	0	0	42	50	170	199	199	199	50	50
49606		120	0	0	0	19	22	75	88	88	88	22	22
49607		140	0	0	0	22	26	88	103	103	103	26	26
49608		0	507	30	0	12	221	0	203	0	0	30	0
49609		0	0	0	7,000	93	155	62	103	344	431	344	431
49610		230	0	0	0	36	42	144	169	169	169	42	42
49611		123	0	0	0	19	23	77	91	91	91	23	23
49612	Precinct 2	-	-	-	-	0	0	0	0	0	0	0	0
49613		-	-	-	-	0	0	0	0	0	0	0	0
49614		0	718	65	0	26	326	0	287	0	0	65	0
49615		-	-	-	-	0	0	0	0	0	0	0	0
49616		-	-	-	-	0	0	0	0	0	0	0	0
49617		-	-	-	-	0	0	0	0	0	0	0	0
49618		-	-	-	-	0	0	0	0	0	0	0	0
					Total	**401**	**1019**	**1,141**	**1,863**	**1,614**	**1,700**	**757**	**748**

Source: SCT Consulting, 2020

Note: The existing private school in zone 49614 is the reason for the trip generation occurring despite not being in the rezoning area (Precinct 1).

Table 5-6 Car trip generation for Orchard Hills North Precinct (Precincts 1 & 2) scenario

Centroid Numbers		Yield										Attraction (veh/h)		Production (veh/h)		Attraction (veh/h)		Production (veh/h)	
Zone	Area	Dwellings	Students	Teachers	Retail (m^2 GFA)	Warehouse (m^2 GFA)	Bulky Goods (m^2 GFA)	Commercial (m^2 GFA)	Fast Food (#)	Speciality Retail (m^2 GFA)	Service Station (#)	7AM	8AM	7AM	8AM	5PM	6PM	5PM	6PM
49601	Precinct 1	94	0	0	0	0	0	0	0	0	0	15	17	59	69	69	69	17	17
49602		321	0	0	0	0	0	0	0	0	0	50	59	201	236	236	236	59	59
49603		149	0	0	0	0	0	0	0	0	0	23	27	93	110	110	110	27	27
49604		277	0	0	0	0	0	0	0	0	0	43	51	173	204	204	204	51	51
49605		271	0	0	0	0	0	0	0	0	0	42	50	170	199	199	199	50	50
49606		120	0	0	0	0	0	0	0	0	0	19	22	75	88	88	88	22	22
49607		140	0	0	0	0	0	0	0	0	0	22	26	88	103	103	103	26	26
49608		0	1,000	73	0	0	0	0	0	0	0	29	444	0	400	0	0	37	37
49609		0	0	0	7,000	0	0	0	0	0	0	93	155	62	103	431	431	431	431
49610		230	0	0	0	0	0	0	0	0	0	36	42	144	169	169	169	42	42
49611		123	0	0	0	0	0	0	0	0	0	19	23	77	91	91	91	23	23
49612	Precinct 2	80	0	0	0	0	0	0	0	0	0	13	15	50	59	59	59	15	15
49613		171	0	0	0	0	0	0	0	0	0	27	31	107	126	126	126	31	31
49614		0	718	65	0	0	0	0	0	0	0	26	326	0	287	0	0	33	33
49615		114	0	0	0	0	13,000	6,000	2	1,000	2	18	21	71	84	84	84	21	21
49616		140	0	0	0	6,000	0	0	1	0	2	282	336	344	397	363	413	282	320
49617		327	0	0	0	0	0	0	0	0	0	154	171	298	336	344	352	153	155
49618		296	0	0	0	0	0	0	0	0	0	46	55	185	218	218	218	55	55
											Total	**957**	**1,871**	**2,197**	**3,279**	**2,894**	**2,952**	**1,375**	**1,415**

Source: SCT Consulting, 2020

5.3 Traffic analysis

5.3.1 Forecast traffic increase

Forecast traffic increases were extracted from Aimsun using the output table MESECT and are provided in **Figure 5-1**Figure 5-1 to **Figure 5-6** as an hourly average over the two hour peak period. The hourly average over the two hour peak period was used to measure midblock performance.

The figures show several roads will switch from below the Guide to Traffic Generating Developments definition of environmental capacity with background growth alone. O'Connell Street naturally falls into a higher order collector function road, carrying traffic from other local roads and some minor collectors.

With the introduction of the Orchard Hills North Precinct (Precincts 1 & 2), an increasing proportion of streets transition to collector roads. Demands continue to increase on state roads such as The Northern Road and Great Western Highway. Key locations of traffic growth are shown in **Table 5-7**.

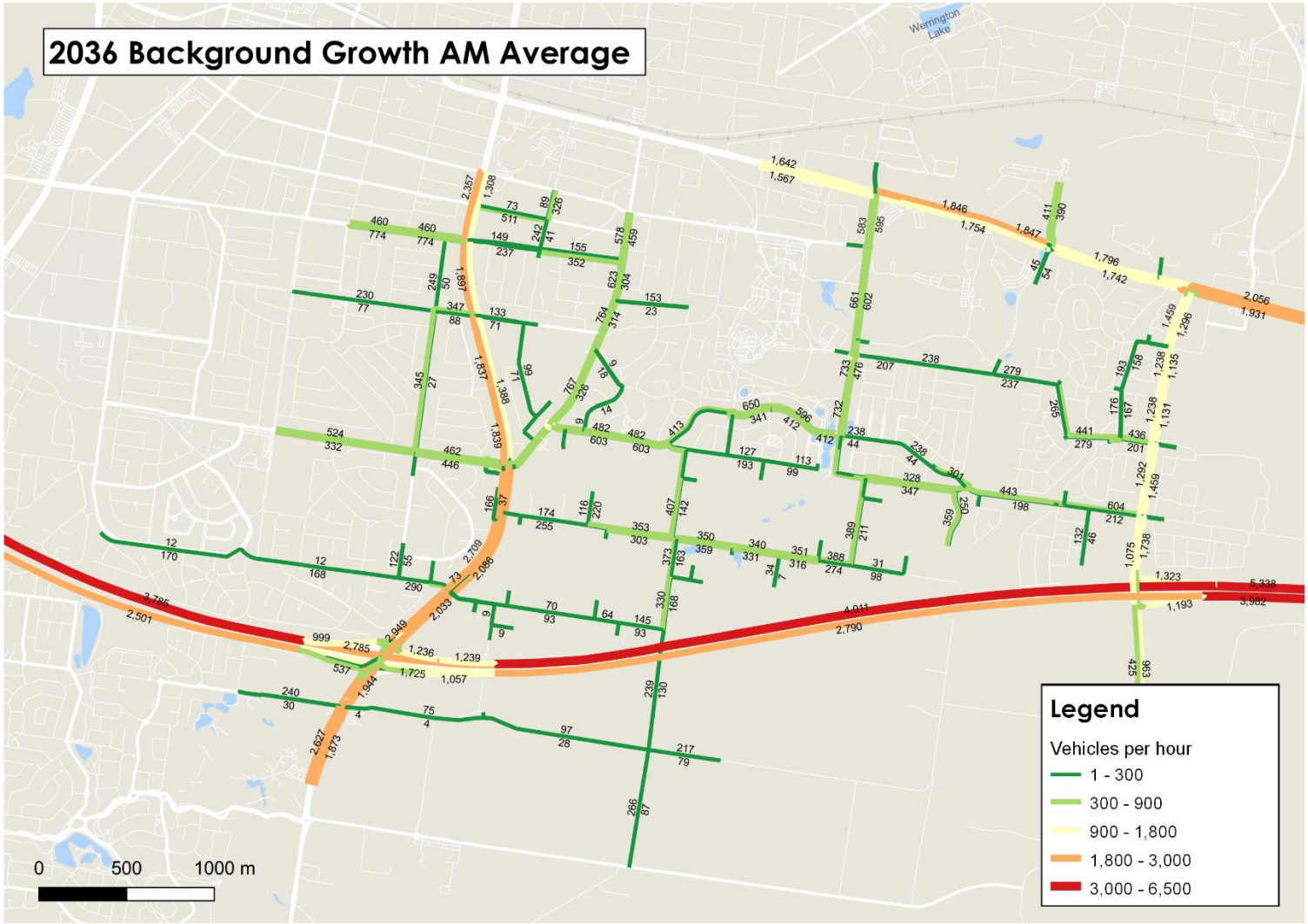
Table 5-7 Summary of growth by corridor

Scenario	Areas of growth
2036 Background Growth	– Great Western Highway by 300– 800 veh/h – The Northern Road by 500 – 1,400 veh/h – Kent Road by 100– 800 veh/h – Local roads by <10 – 500 veh/h
2036 Precinct 1	Growth in addition to the background is: – Great Western Highway by 20 – 300 veh/h – The Northern Road by 20 – 100 veh/h – Kent Road by <10 – 30 veh/h – Local roads by <10 – 300 veh/h
2036 Precinct 2	Growth in addition to the background is: – Great Western Highway by 20 – 200 veh/h – The Northern Road by 30 – 200 veh/h – Kent Road by <10 – 100 veh/h – Local roads by <10 – 300 veh/h
2036 Orchard Hills North Precinct (Precincts 1 & 2)	Growth in addition to the background is: – Great Western Highway by 40 – 500 veh/h – The Northern Road by 50 – 300 veh/h – Kent Road by <10 – 130 veh/h – Local roads by <10 – 600 veh/h

Source: SCT Consulting, 2020

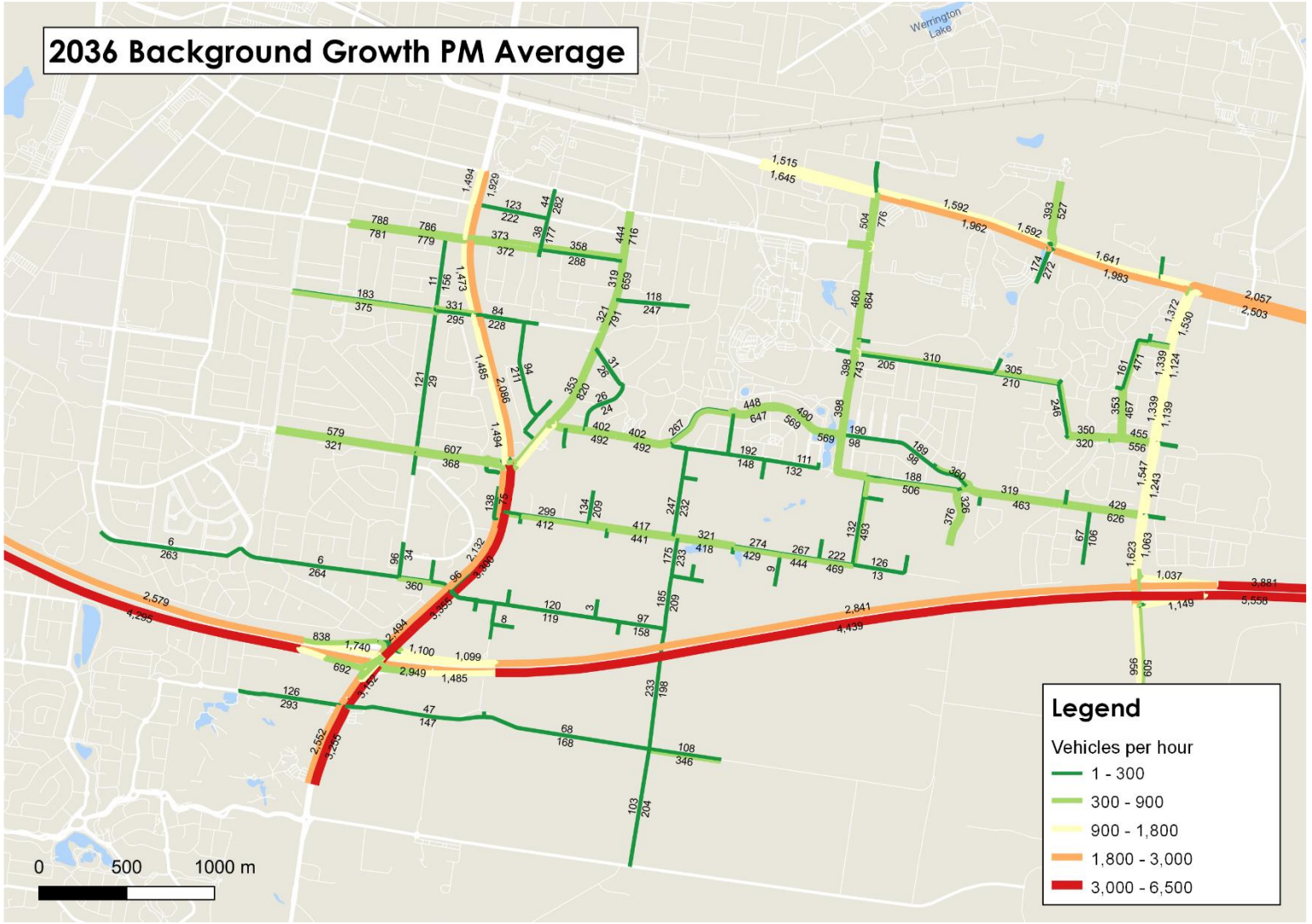
Turning count diagrams are provided in **Appendix D**, which show the turning volumes in SIDRA.

Figure 5-1 2036 Background growth, AM Peak period hourly average



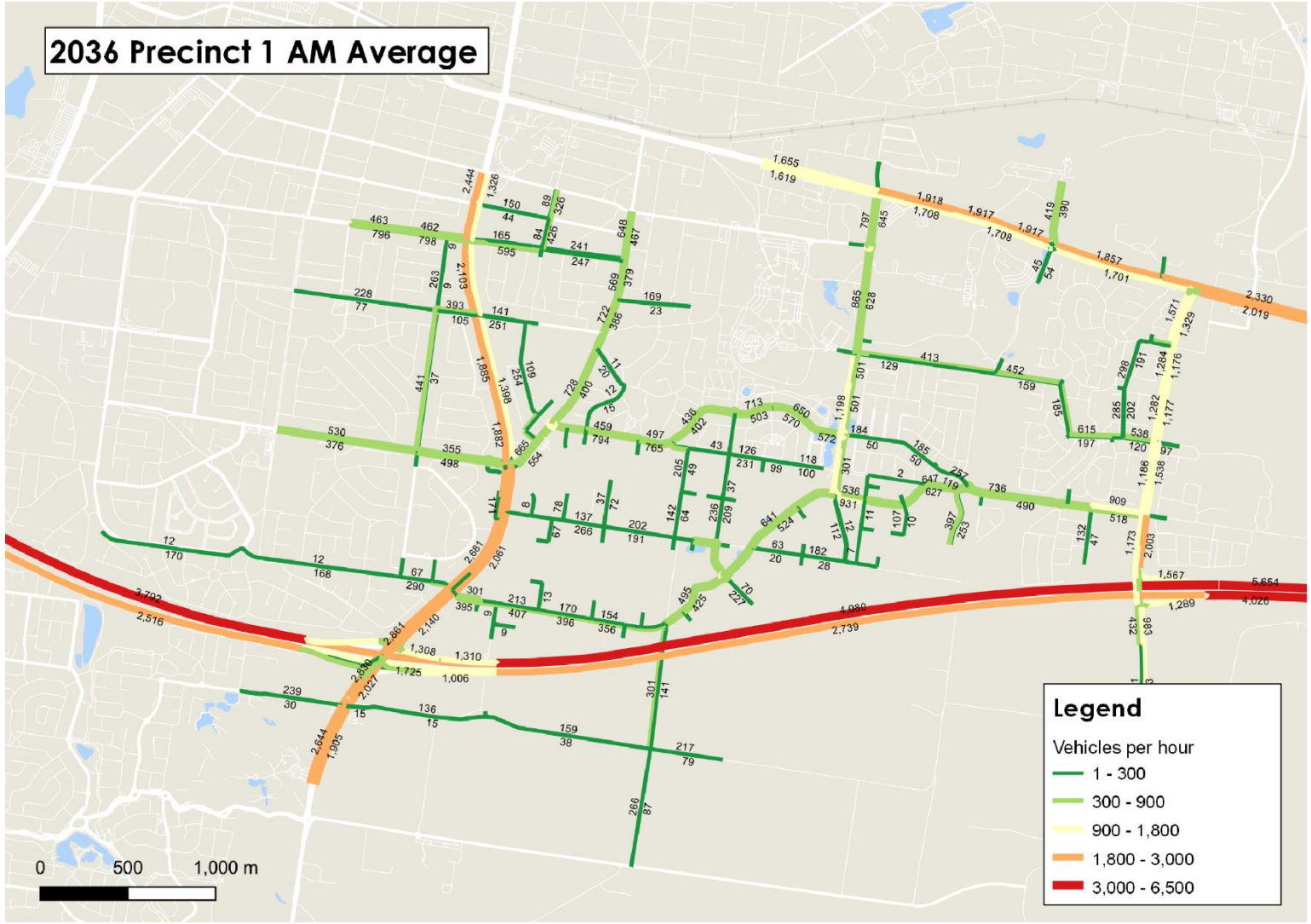
Source: © OpenStreetMap contributors, SCT Consulting, 2020

Figure 5-2 2036 Background growth, PM Peak period hourly average



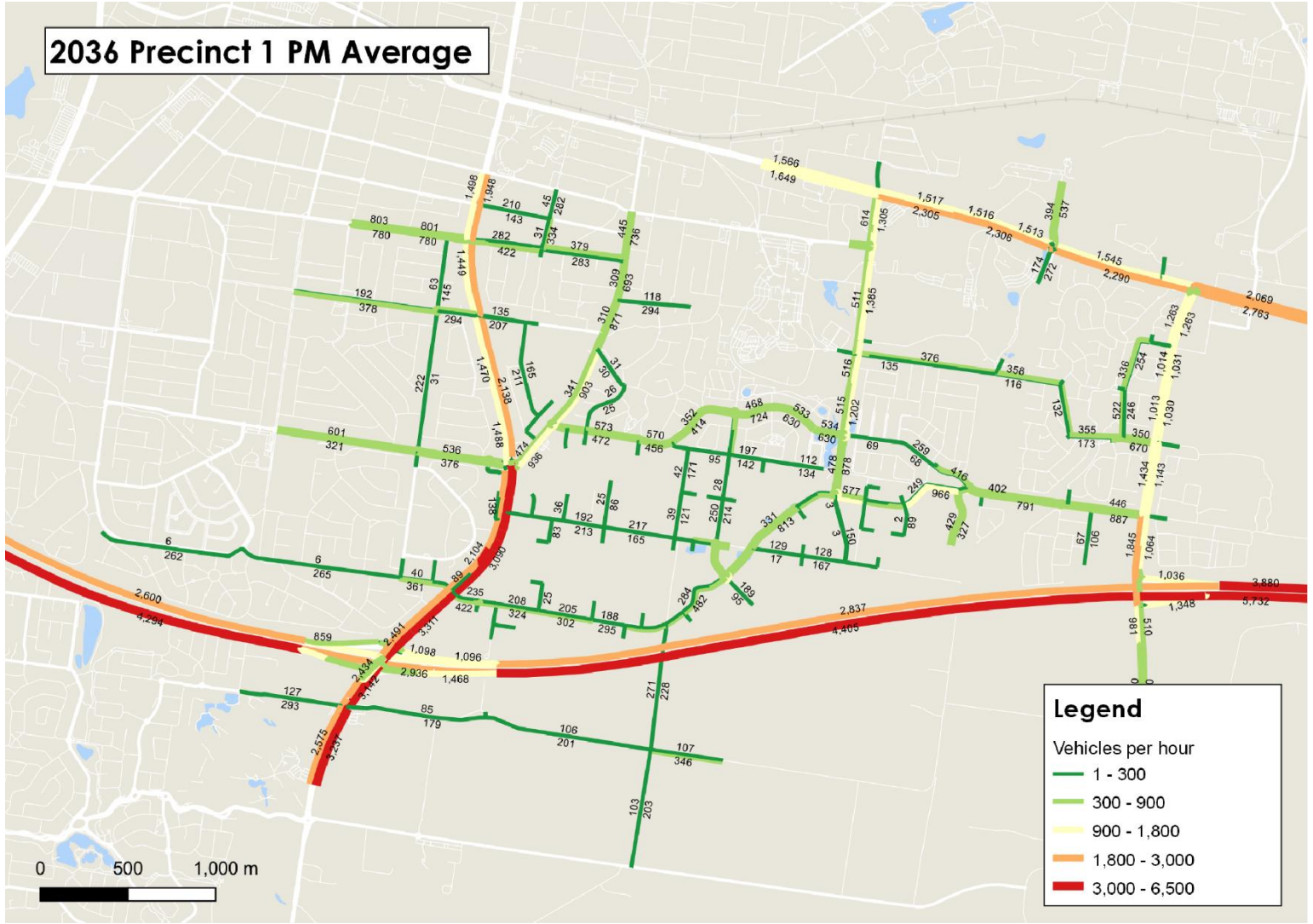
Source: © OpenStreetMap contributors, SCT Consulting, 2020

Figure 5-3 2036 Background growth + Precinct 1, AM Peak period hourly average



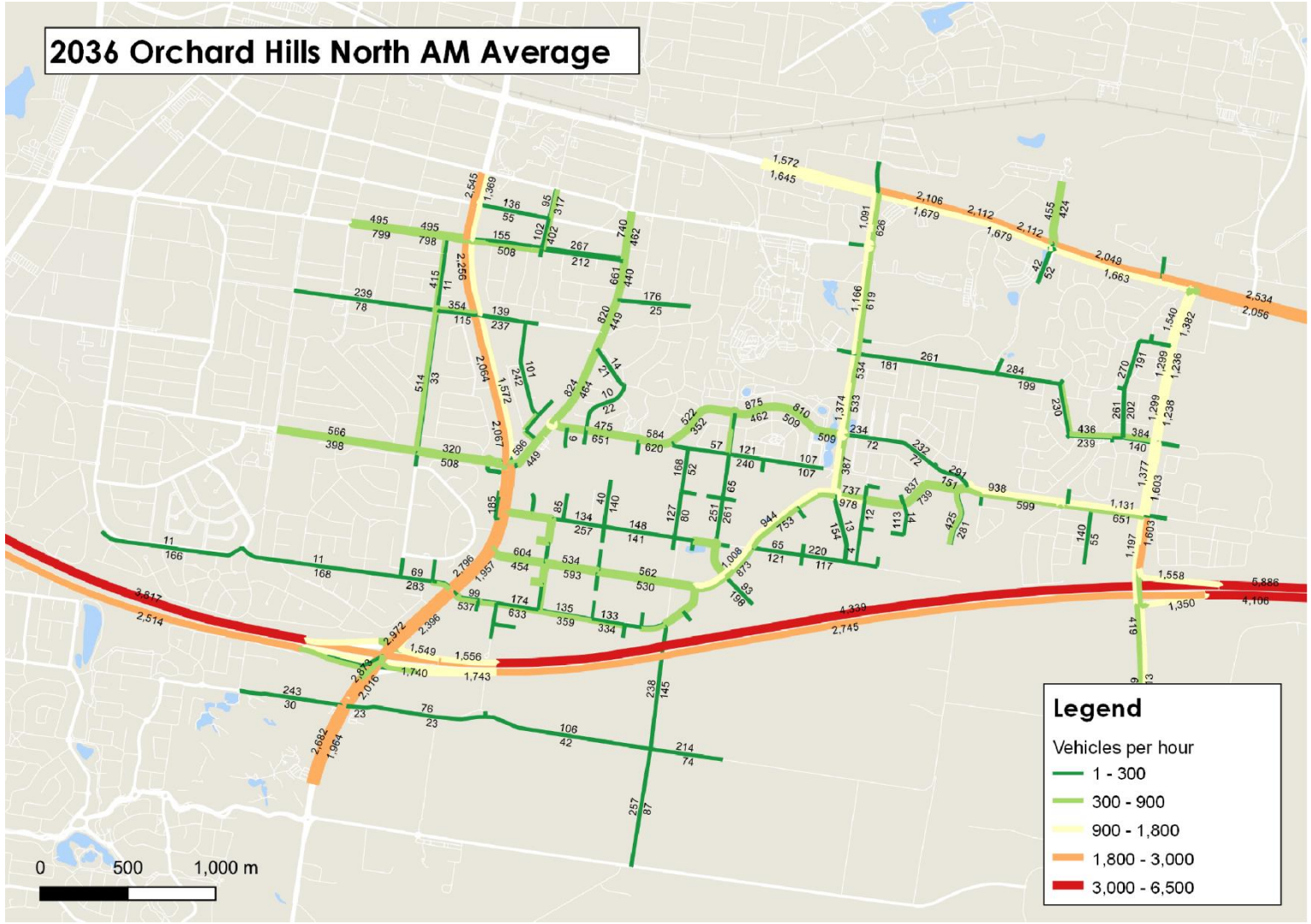
Source: © OpenStreetMap contributors, SCT Consulting, 2020

Figure 5-4 2036 Background growth + Precinct 1, PM Peak period hourly average



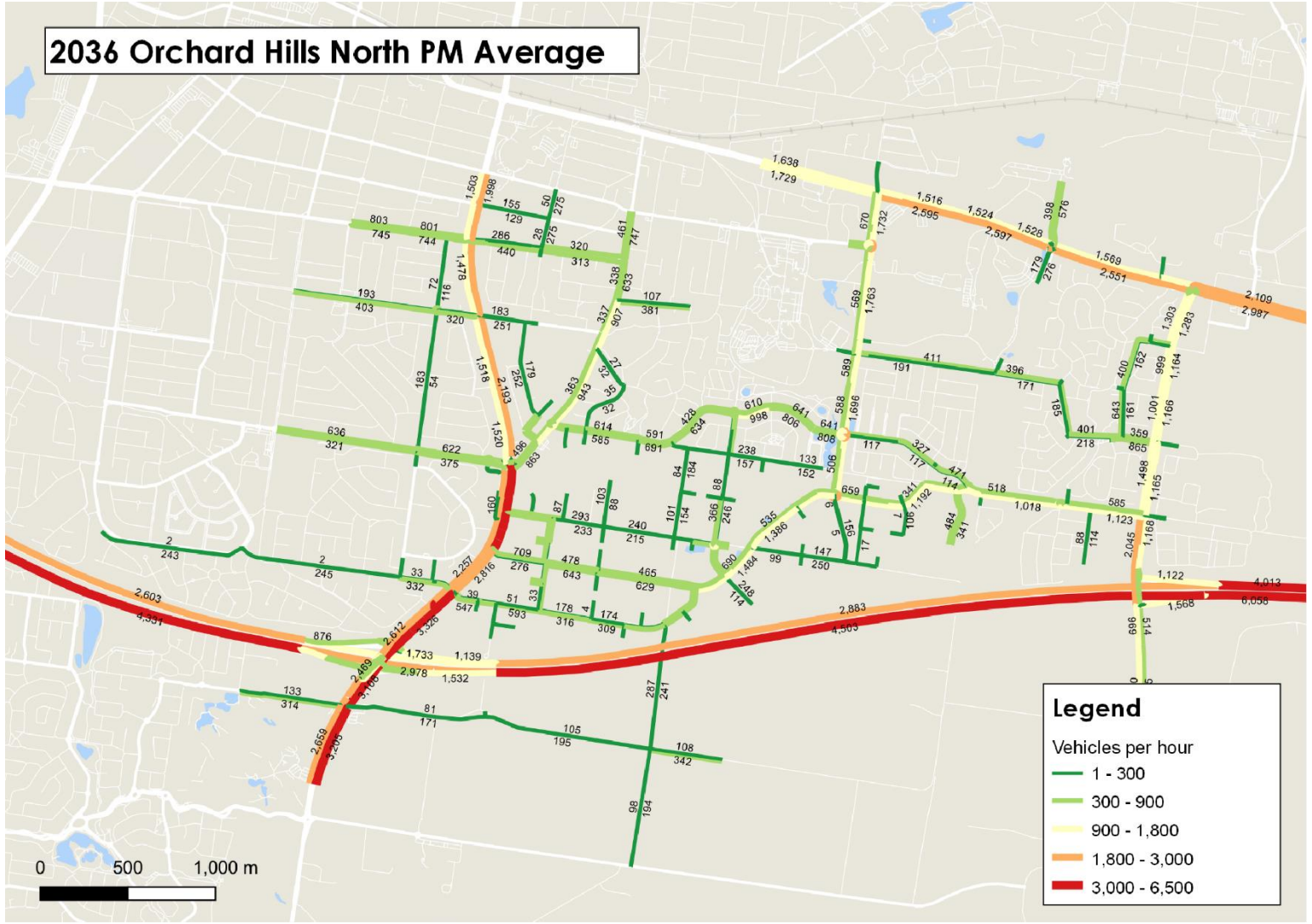
Source: © OpenStreetMap contributors, SCT Consulting, 2020

Figure 5-5 2036 Orchard Hills North Precinct (Precincts 1 & 2), AM Peak period hourly average



Source: © OpenStreetMap contributors, SCT Consulting, 2020

Figure 5-6 2036 Orchard Hills North Precinct (Precincts 1 & 2), PM Peak period hourly average

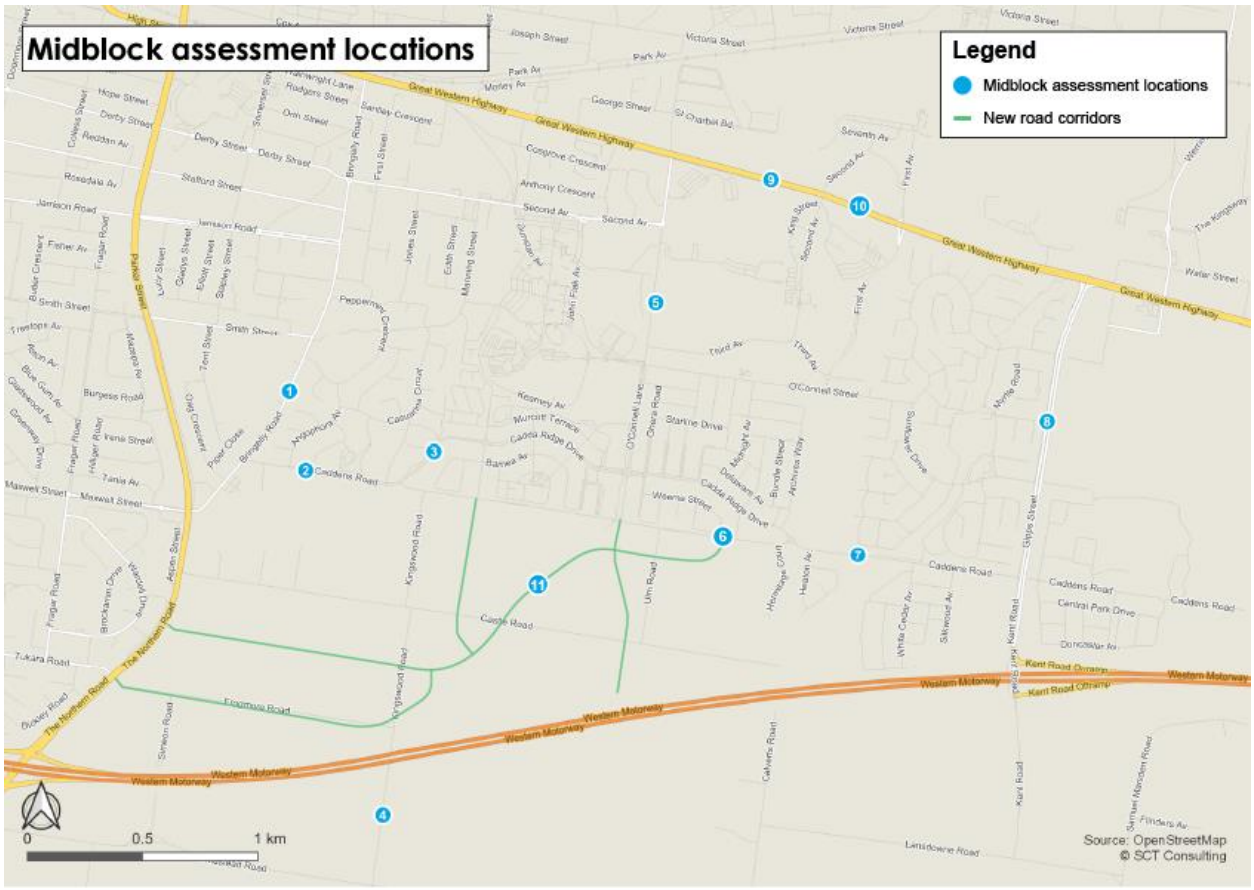


Source: © OpenStreetMap contributors, SCT Consulting, 2020

5.3.2 Midblock capacity

Midblock capacity was assessed at the locations shown in **Figure 5-7**. In scenarios where the east-west link exists (Precinct 1 and beyond), an additional midblock evaluation is conducted on the east-west link between O'Connell Lane and the new Neighbourhood Centre Access. The hourly average over the two hour peak period was used to measure midblock performance.

Figure 5-7 Midblock assessment locations



Source: © OpenStreetMap contributors, SCT Consulting, 2021

Midblock performance is analysed in **Table 5-8** to **Table 5-10** using the hourly average of the peak hour periods produced in the Aimsun model. The table specified the assumed capacity based on the number of lanes and the "V/C" (volume on capacity ratio), which would yield <1.0 when there is spare capacity, =1 when the link is at capacity and >1.0 when the link is operating above capacity.

Table 5-8 Midblock capacity evaluation – 2036 background growth

#	Street	Lanes	Capacity	AM volume	AM V/C	PM volume	PM V/C
1	Bringelly Rd northbound	1	900	767	0.85	353	0.39
	Bringelly Rd southbound	1	900	326	0.36	820	0.91
2	Caddens Rd eastbound	1	900	482	0.54	402	0.45
	Caddens Rd westbound	1	900	603	0.67	492	0.55
3	Cadda Ridge Dr eastbound	1	900	650	0.72	448	0.50
	Cadda Ridge Dr westbound	1	900	341	0.38	647	0.72
4	Kingswood Road northbound	1	900	266	0.30	103	0.11
	Kingswood Road southbound	1	900	87	0.10	204	0.23
5	O'Connell St northbound	1	900	661	0.73	460	0.51
	O'Connell St southbound	1	900	602	0.67	864	0.96
6	Caddens Rd eastbound	1	900	328	0.36	188	0.21
	Caddens Rd westbound	1	900	347	0.39	506	0.56
7	Caddens Rd eastbound	1	900	443	0.49	319	0.35
	Caddens Rd westbound	1	900	198	0.22	463	0.51
8	Gipps Street northbound	2	1,800	1,238	0.69	1,339	0.74
	Gipps Street southbound	2	1,800	1,131	0.63	1,139	0.63
9	Great Western Highway eastbound	3	2,700	1,847	0.68	1,592	0.59
	Great Western Highway westbound	3	2,700	1,754	0.65	1,962	0.73
10	Great Western Highway eastbound	3	2,700	1,796	0.67	1,641	0.61
	Great Western Highway westbound	3	2,700	1,742	0.65	1,983	0.73

Source: SCT Consulting, 2020

The results show that background traffic absorbs capacity in the network and uses many of the roads around the Orchard Hills North Precinct (Precincts 1 & 2).

Table 5-9 Midblock capacity evaluation – 2036 Precinct 1 (over capacity sections in bold)

#	Street	Lanes	Capacity	AM volume	AM V/C	PM volume	PM V/C
1	Bringelly Rd northbound	1	900	728	0.81	341	0.38
	Bringelly Rd southbound	1	900	400	0.44	903	1.00
2	Caddens Rd eastbound	1	900	459	0.51	573	0.64
	Caddens Rd westbound	1	900	794	0.88	472	0.52
3	Cadda Ridge Dr eastbound	1	900	713	0.79	468	0.52
	Cadda Ridge Dr westbound	1	900	503	0.56	724	0.80
4	Kingswood Road northbound	1	900	266	0.30	103	0.11
	Kingswood Road southbound	1	900	87	0.10	203	0.23
5	O'Connell St northbound	1	900	865	0.96	511	0.57
	O'Connell St southbound	**1**	**900**	628	0.70	**1385**	**1.54**
6	Caddens Rd eastbound	1	900	2	0.00	0	0.00
	Caddens Rd westbound	1	900	0	0.00	0	0.00
7	Caddens Rd eastbound	1	900	736	0.82	402	0.45
	Caddens Rd westbound	1	900	490	0.54	791	0.88
8	Gipps Street northbound	2	1,800	1,282	0.71	1,013	0.56
	Gipps Street southbound	2	1,800	1,177	0.65	1,030	0.57
9	Great Western Highway eastbound	3	2,700	1,917	0.71	1,513	0.56
	Great Western Highway westbound	3	2,700	1,708	0.63	2,306	0.85
10	Great Western Highway eastbound	3	2,700	1,857	0.69	1,545	0.57
	Great Western Highway westbound	3	2,700	1,701	0.63	2,290	0.85
11	East-West link eastbound	1	900	641	0.71	331	0.37
	East-West link westbound	1	900	524	0.58	813	0.90

Source: SCT Consulting, 2020

The results show that the north-south and east-west corridors generally operate at a level that is appropriate for a two-lane (one lane in each direction) corridor. The only exception is O'Connell Street southbound, which needs to be widened to two lanes southbound between Great Western Highway and O'Connell Street.

It is recommended that for the remaining areas, only one lane is provided in each direction.

Table 5-10 Midblock capacity evaluation –2036 Orchard Hills North Precinct (Precincts 1 & 2) (over capacity sections in bold)

#	Street	Lanes	Capacity	AM volume	AM V/C	PM volume	PM V/C
1	Bringelly Rd northbound	1	900	824	0.92	362	0.40
	Bringelly Rd southbound	**1**	**900**	464	0.52	**943**	**1.05**
2	Caddens Rd eastbound	1	900	475	0.53	614	0.68
	Caddens Rd westbound	1	900	651	0.72	584	0.65
3	Cadda Ridge Dr eastbound	1	900	875	0.97	610	0.68
	Cadda Ridge Dr westbound	**1**	**900**	462	0.51	**998**	**1.11**
4	Kingswood Road northbound	1	900	257	0.29	287	0.32
	Kingswood Road southbound	1	900	87	0.10	241	0.27
5	**O'Connell St northbound**	**1**	**900**	**1166**	**1.30**	568	0.63
	O'Connell St southbound	**1**	**900**	619	0.69	**1763**	**1.96**
6	Caddens Rd eastbound	1	900	0	0.00	0	0.00
	Caddens Rd westbound	1	900	0	0.00	0	0.00
7	**Caddens Rd eastbound**	**1**	**900**	**938**	**1.04**	518	0.58
	Caddens Rd westbound	**1**	**900**	599	0.67	**1018**	**1.13**
8	Gipps Street northbound	2	1,800	1,299	0.72	1,001	0.56
	Gipps Street southbound	2	1,800	1,238	0.69	1,166	0.65
9	Great Western Highway eastbound	3	2,700	2,112	0.78	1,528	0.57
	Great Western Highway westbound	3	2,700	1,679	0.62	2,597	0.96
10	Great Western Highway eastbound	3	2,700	2,049	0.76	1,568	0.58
	Great Western Highway westbound	3	2,700	1,663	0.62	2,551	0.94
11	East-West link eastbound	2	1,800	944	0.52	535	0.30
	East-West link westbound	2	1,800	753	0.42	1,386	0.77

Source: SCT Consulting, 2020

The results show that the north-south and east-west corridors generally operate at a level that requires two lanes, namely:

– O'Connell Street / O'Connell Lane north-south from Great Western Highway until the east-west link

– The new east-west link from Gipps Street to the intersection with Frogmore Road

The flow volumes are mapped out in more detail above in **Section 5.3.1**, showing that the east-west link only has flow requiring single lane traffic at this stage between The Northern Road and the intersection with Frogmore Road.

5.3.3 Network performance

Intersection results for the 2036 scenarios are reported from SIDRA intersection/network as per the agreed methodology. Volumes were extracted directly from Aimsun using the table METURN, which reports the turning counts for each turning movement in the network. As adopted in the approved calibrated and validated Base Model, the peak hour for export into SIDRA was identified as the largest 60 minute period (highest traffic demand in 4 consecutive 15 minute periods).

Intersection performance in SIDRA is shown in **Table 5-11** to **Table 5-14**, which assume the infrastructure detailed in **Section 5.3.4** are implemented. The volume column refers to the volume of traffic for the entire intersection. The LoS column refers to the intersection Level of Service, following the format in **Section 3.6.5**.

Further intersection performance summaries are provided in **Appendix C**. Turning count diagrams are provided in **Appendix D**.

Table 5-11 2036 Background growth intersection results, AM peak (subject to further planning, investigations, and funding decisions)

Intersection	Background growth Planned upgrades only					Background growth Additional upgrades				
	Volume	Delay (s)	Queue (m)	LoS	DoS	Volume	Delay (s)	Queue (m)	LoS	DoS
TNR / Frogmore Rd	6,037	17	168	B	0.79	6,037	17	168	B	0.79
TNR / Castle Rd	5,081	6	3	A	0.62	5,081	6	3	A	0.63
TNR / Bringelly Rd	5,510	43	178	D	0.78	5,510	45	180	D	0.82
Bringelly Rd / Caddens Rd	1,919	25	59	B	0.90	1,916	12	9	A	0.43
Kingswood Rd / Caddens Rd	906	6	7	A	0.40	906	6	7	A	0.40
Caddens Rd / O'Connell Ln	851	7	0	A	0.29	851	7	0	A	0.29
O'Connell Ln / Cadda Ridge Dr	1,726	12	20	A	0.70	1,726	12	20	A	0.70
O'Connell Lane / O'Connell St	1,582	15	23	B	0.69	1,582	15	23	B	0.69
O'Connell St / GWH / French St	4,358	32	132	C	0.75	4,358	32	132	C	0.75
GWH / Gipps St	5,688	144	384	F	1.20	5,688	43	175	D	0.91
Gipps St / Caddens Rd / Kent Rd	3,320	41	211	C	0.91	3,320	26	149	B	0.74
Caddens Rd / Cadda Ridge Dr	1,045	10	4	A	0.28	1,045	10	4	A	0.28
M4 / Kent Rd (On Ramp)	3,172	10	117	A	0.83	3,172	9	89	A	0.83
M4 / Kent Rd (Off Ramp)	2,396	30	105	C	0.71	2,396	29	109	C	0.69
Homestead Rd / Kingswood Rd	734	10	3	A	0.30	734	10	3	A	0.30

Source: SCT Consulting, 2020

Table 5-12 2036 Background growth intersection results, PM peak (subject to further planning, investigations, and funding decisions)

Intersection	Background growth Planned upgrades only					Background growth Additional upgrades				
	Volume	Delay (s)	Queue (m)	LoS	DoS	Volume	Delay (s)	Queue (m)	LoS	DoS
TNR / Frogmore Rd	6,507	40	468	C	0.98	6,507	77	625	D	1.02
TNR / Castle Rd	5,761	6	4	A	0.85	5,761	6	5	A	0.99
TNR / Bringelly Rd	6,157	59	261	E	0.97	6,157	58	250	D	0.98
Bringelly Rd / Caddens Rd	1,849	23	48	B	0.87	1,848	15	17	B	0.61
Kingswood Rd / Caddens Rd	721	6	3	A	0.21	721	6	3	A	0.21
Caddens Rd / O'Connell Ln	826	6	0	A	0.30	826	6	0	A	0.30
O'Connell Ln / Cadda Ridge Dr	1,796	14	20	A	0.72	1,796	14	20	A	0.72
O'Connell Lane / O'Connell St	1,617	18	23	B	0.70	1,617	18	23	B	0.70
O'Connell St / GWH / French St	4,383	38	169	C	0.85	4,383	38	169	C	0.85
GWH / Gipps St	6,156	115	738	F	1.21	6,156	54	564	D	1.03
Gipps St / Caddens Rd / Kent Rd	3,738	26	110	C	0.90	3,738	35	208	C	0.88
Caddens Rd / Cadda Ridge Dr	994	9	5	B	0.33	994	9	5	A	0.33
M4 / Kent Rd (On Ramp)	3,557	15	135	B	0.89	3,557	7	86	A	0.81
M4 / Kent Rd (Off Ramp)	2,738	159	368	F	1.15	2,738	19	55	D	0.88
Homestead Rd / Kingswood Rd	735	10	2	A	0.17	735	10	2	A	0.17

Source: SCT Consulting, 2021

Table 5-13 2036 Precinct 1 intersection results (subject to further investigations, planning, and funding decisions)

Intersection	AM Peak					PM Peak				
	Volume	Delay (s)	Queue (m)	LoS	DoS	Volume	Delay (s)	Queue (m)	LoS	DoS
TNR / Frogmore Rd	6,237	16	143	B	0.77	6,495	39	416	C	0.98
TNR / Castle Rd	5,013	6	3	A	0.58	5,505	6	2	A	0.73
TNR / Bringelly Rd	5,400	43	175	D	0.81	6,038	56	258	D	0.98
Bringelly Rd / Caddens Rd	2,034	18	60	B	0.89	1,916	29	70	C	0.93
Caddens Rd / Kingswood Rd	594	6	3	A	0.18	491	6	1	A	0.07
O'Connell Ln / Cadda Ridge Dr	2,449	11	10	A	0.57	2,436	13	10	A	0.57
O'Connell Ln / O'Connell St	2,095	13	12	A	0.50	2,254	16	14	B	0.58
GWH / O'Connell St	4,611	43	157	D	0.85	4,846	48	203	D	0.94
GWH / Gipps St	5,980	47	162	D	0.94	6,214	37	274	C	0.97
Gipps St / Caddens Rd	3,829	46	227	D	0.96	3,917	45	219	D	0.99
Caddens Rd / Cadda Ridge Dr	1,611	11	9	A	0.48	1,423	9	14	A	0.62
M4 / Kent St On Ramp	3,608	10	107	A	0.89	3,788	8	98	A	0.76
M4 / Kent St Off Ramp	2,141	39	153	C	0.79	2,847	53	287	D	0.93
Kingswood Rd / Homestead Rd	816	10	3	A	0.31	828	10	2	A	0.19
O'Connell Ln / East West Link (new)	2,331	51	185	D	0.89	2,173	44	134	D	0.85
East West Link / Neighbourhood Centre Access (new)	2,174	19	31	B	0.78	1,926	19	55	B	0.88

Source: SCT Consulting, 2021

Table 5-14 2036 Orchard Hills North Precinct (Precincts 1 & 2) intersection results (subject to further investigations, planning, and funding decisions)

Intersection	AM Peak					PM Peak				
	Volume	Delay (s)	Queue (m)	LoS	DoS	Volume	Delay (s)	Queue (m)	LoS	DoS
TNR / Frogmore Rd	6,289	6	11	A	0.52	6,473	7	9	A	0.51
TNR / Castle Rd	5,514	6	6	A	0.61	5,731	6	23	A	0.49
TNR / Bringelly Rd	5,632	38	177	C	0.77	6,062	48	212	D	0.87
Bringelly Rd / Caddens Rd	1,982	22	58	B	0.90	1,935	54	130	D	1.01
Caddens Rd / Kingswood Rd	506	6	2	A	0.15	502	6	1	A	0.10
O'Connell Ln / Cadda Ridge Dr	2,695	12	14	A	0.70	3,117	20	31	B	0.83
O'Connell Ln / O'Connell St	2,306	14	15	A	0.58	2,803	32	26	C	0.78
GWH / O'Connell St	4,792	51	167	D	0.93	5,362	48	194	D	1.01
GWH / Gipps St	6,157	42	146	C	0.89	6,601	44	463	D	1.01
Gipps St / Caddens Rd	4,256	43	203	D	0.88	4,342	40	219	C	1.01
Caddens Rd / Cadda Ridge Dr	2,000	11	4	A	0.38	1,895	9	6	A	0.44
M4 / Kent St On Ramp	3,640	10	75	A	0.89	4,041	5	836	A	0.64
M4 / Kent St Off Ramp	2,651	33	116	C	0.81	3,178	34	223	C	0.90
Kingswood Rd / Homestead Rd	733	10	3	A	0.29	820	11	2	A	0.21
O'Connell Ln / E-W Link (new)	2,855	56	186	D	0.96	2,958	52	248	D	1.00
East West Link / Neighbourhood Centre Access (new)	2,996	36	157	C	0.77	3,003	48	268	D	0.91
TNR / E-W Link (new)	5,859	29	159	C	0.80	5,936	30	200	C	0.86

Source: SCT Consulting, 2020
*Worst approach by delay

The performance shows that a Level of Service D can generally be achieved for the intersection with the growth if there is an investment in infrastructure, which is detailed in the following section.

5.3.4 Signalised alternative upgrades

Signalised intersections were considered as alternative upgrades for the following intersections:

– O'Connell Street / Cadda Ridge Drive;

– O'Connell Lane / O'Connell Street / Western Sydney University entrance; and

Although these intersections do not meet warrants required by TfNSW for signalisation, the savings in acquisition cost, space requirements, and improvements to social amenity justified an investigation into their performance as signalised intersections. Traffic signals may also be warranted due to future changes in traffic volumes or traffic volumes beyond 2036. **Table 5-15** presents the performance of these intersections as signals.

Table 5-15 2036 signalised alternatives (subject to further planning, investigations, and funding decisions)

Intersection	Peak	Volume	Delay (s)	Queue (m)	LoS	DoS
O'Connell Ln / Cadda Ridge Dr (Model Intersection SG)	AM	2,695	44	185	D	0.96
	PM	3,099	46	279	D	0.91
O'Connell Ln / O'Connell St (Model Intersection SH)	AM	2,306	21	190	B	0.84
	PM	2,809	26	186	B	0.82

Source: SCT Consulting, 2020
*Worst approach by delay

5.3.5 Road network upgrade principles

Road upgrades are required to various extents depending on the level of background growth and development. Upgrades were identified using the below assumptions:

– Preserving road hierarchy: Roads should be strengthened in accordance with their function, ensuring that major arterial links and collector roads provide best volume throughput, while moving traffic away from local roads and minimising disruption to local communities;

– Impact on surrounding communities and facilities: While functions of roads can be changed, such as widening a local road to become a collector / arterial road, the effect of increased thoroughfare on the surrounding should be considered. Educational facilities or entrances to dwelling places would be impacted significantly by an increase in through traffic;

– Upgrades are implemented to ensure that all intersections operate at Level of Service D or better;

– Assessment is based on SIDRA intersection assessment with Aimsun volumes;

– Midblock capacity by itself does not trigger widening if intersection performance is adequate; and

– Assumed Caddens Road will remain closed west of O'Connell Lane due to safety hazards.

Modelling shows that a total of eleven intersections require planning for improvements and are subject to further planning and investigation over the medium to long term and funding decisions:

1. Caddens Road / Gipps Street / Kent Road;
2. Great Western Highway / Gipps Street;
3. The Northern Road / Frogmore Road;
4. The Northern Road / New East-West corridor (new);
5. New east-west corridor / Neighbourhood Centre Access (new);
6. New east-west corridor / O'Connell Lane (north-south corridor) (new);
7. Great Western Highway / O'Connell Street / French Street;
8. O'Connell Lane / O'Connell Street / Western Sydney University entrance;
9. O'Connell Street / Cadda Ridge Drive;
10. M4 Motorway Ramps / Kent Road; and
11. The Northern Road / Bringelly Road.

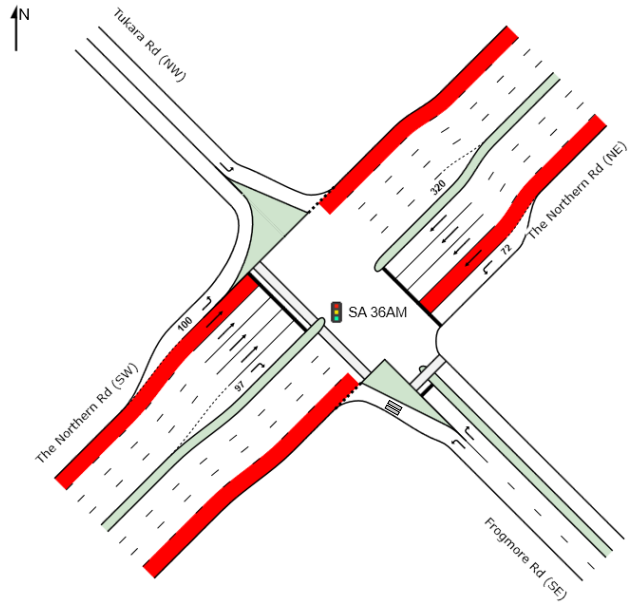
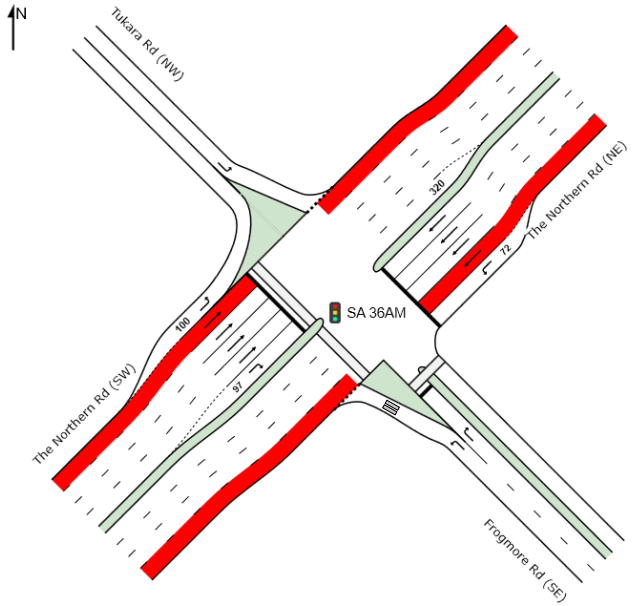
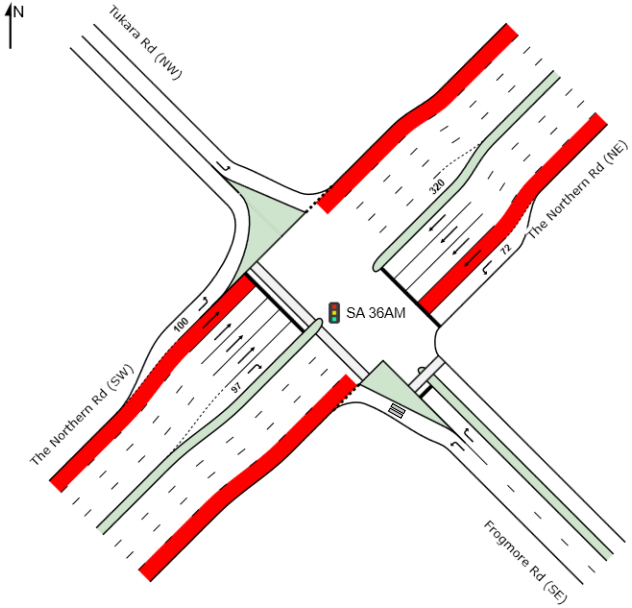
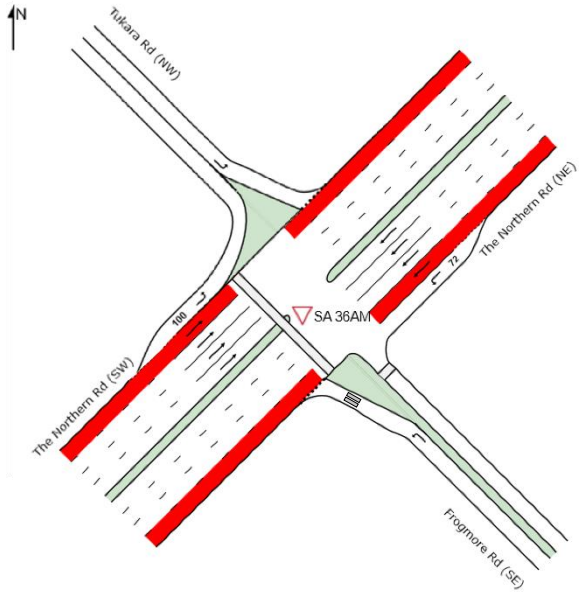
SCT Consulting has considered signal warrants in the preparation of advice and identified alternative schemes where signals warrants are not met. Council noted that roundabouts are not preferred on the intersection with the east-west corridor / neighbourhood centre access and east-west corridor / north-south corridor. In both these cases, while the criteria for signals is not met and is unlikely to gain acceptance by TfNSW the roundabout does provide a reduction in footprint of intersections as well as improving pedestrian safety. Further consultation with TfNSW and Council is sought to address these alternatives.

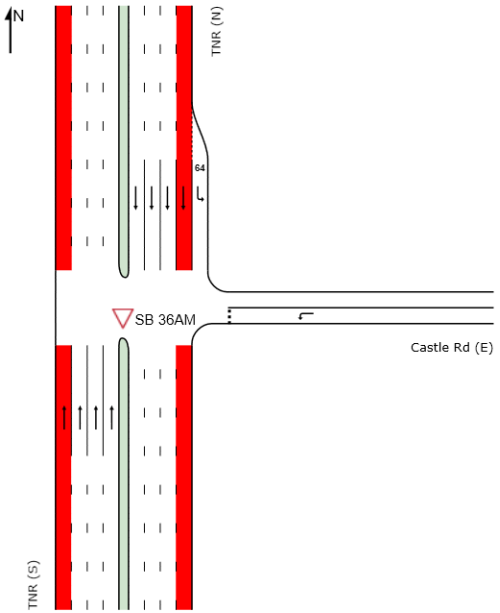
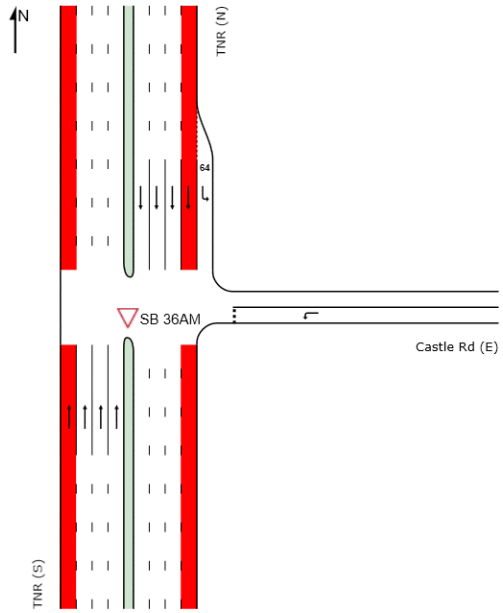
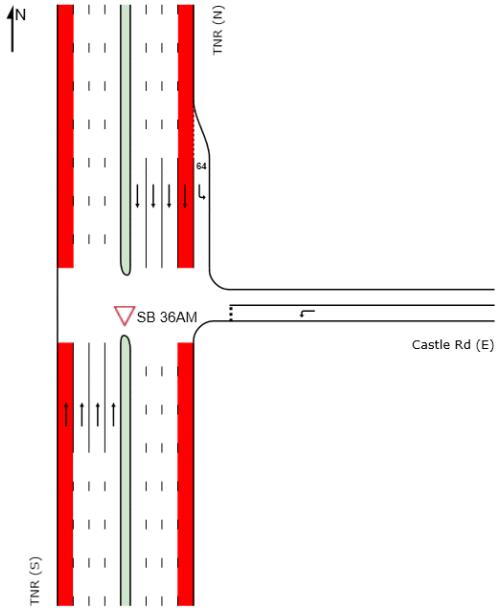
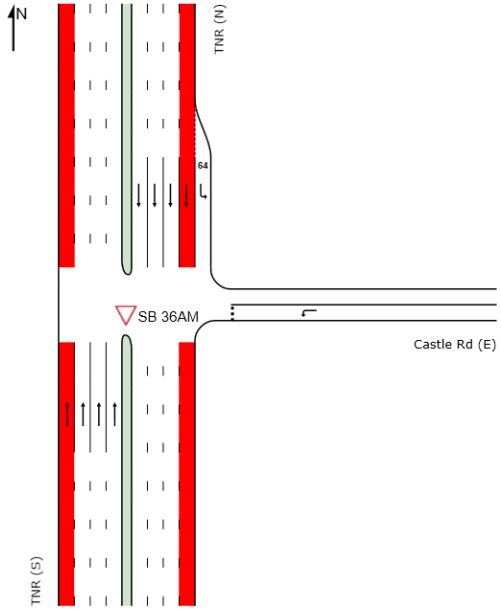
5.3.6 Upgrades by intersection

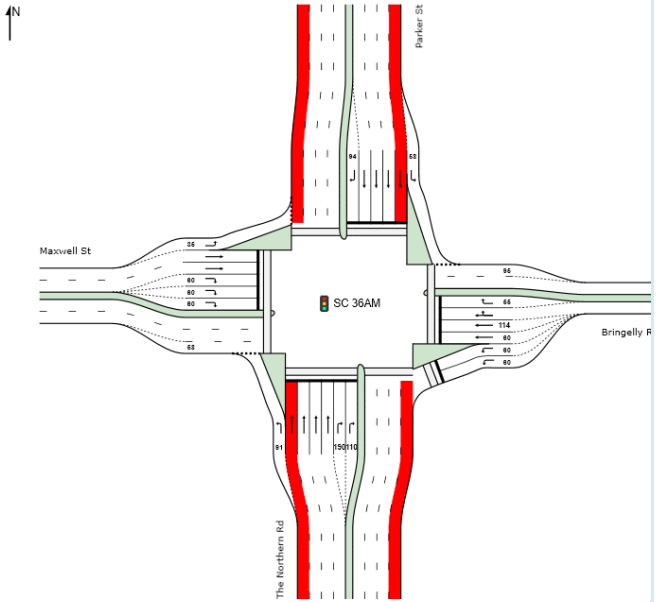
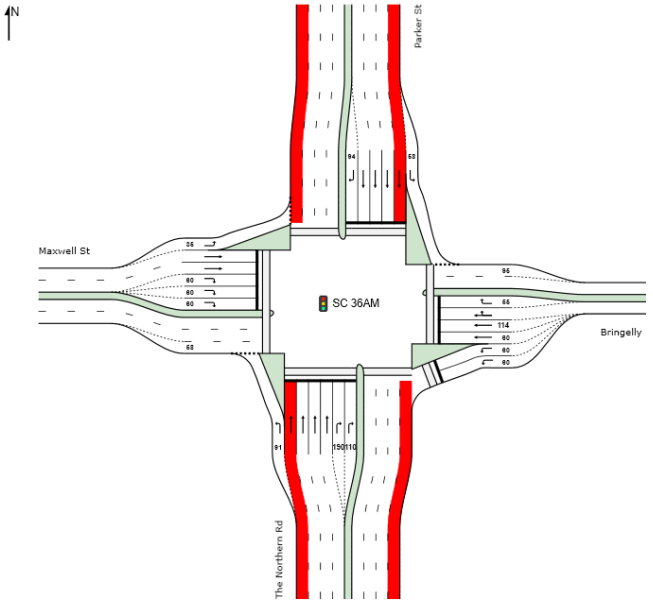
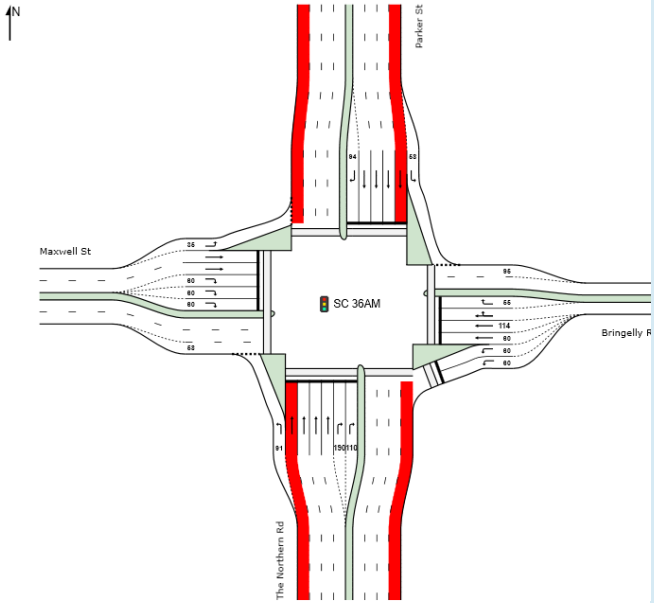
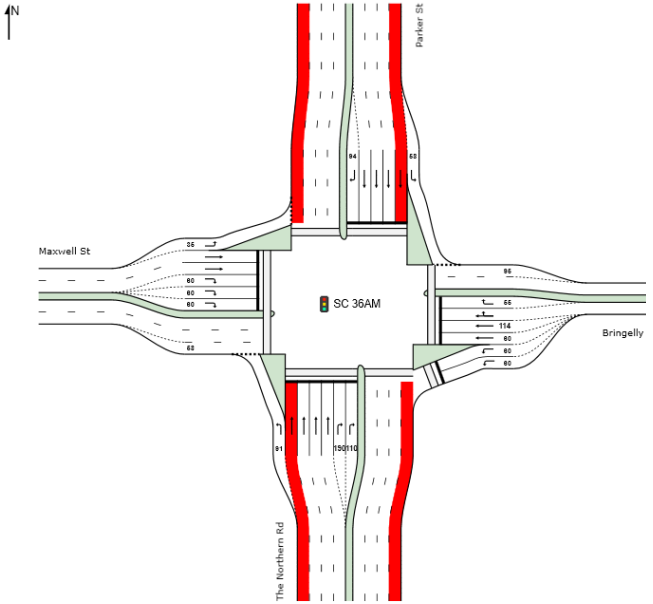
The intersection identified for potential improvements, subject to further planning, investigations and funding decisions are outlined in **Table 5-11** to **Table 5-14**. The following images provide a visual summary of this information **Table 5-16** below provides potential details of each road upgrade, grouped by intersection.

Further traffic modelling and planning for intersections will occur during and post-exhibition, including to tweak local intersection performance.

Table 5-16 Potential upgrades by intersection (subject to further planning, investigations, and funding decisions)

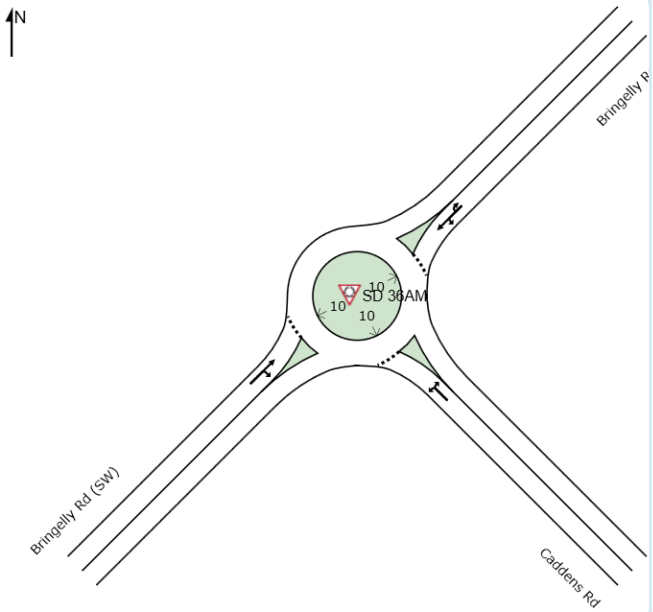
Site SA: The Northern Road / Frogmore Road			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1) **No changes from existing**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **Converted to left in left out for vehicles, signals for pedestrian crossing only.** **North East Approach:** – Removed short exit lane **South East Approach:** – Converted to left-in-left-out configuration **South West Approach:** – Removed right turn short lane	

Site SB: The Northern Road / Castle Road			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1) **No changes from existing**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **No changes from existing**	

Site SC: The Northern Road / Bringelly Road / Maxwell Street			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1) **No changes from existing**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **No changes from existing**	

Site SD: Bringelly Road / Caddens Road

Current infrastructure (FY0 DN)



Background growth road upgrades (FY0 I0)

Roundabout Reconfiguration:

– Roundabout converted to a dual lane roundabout

North Approach:

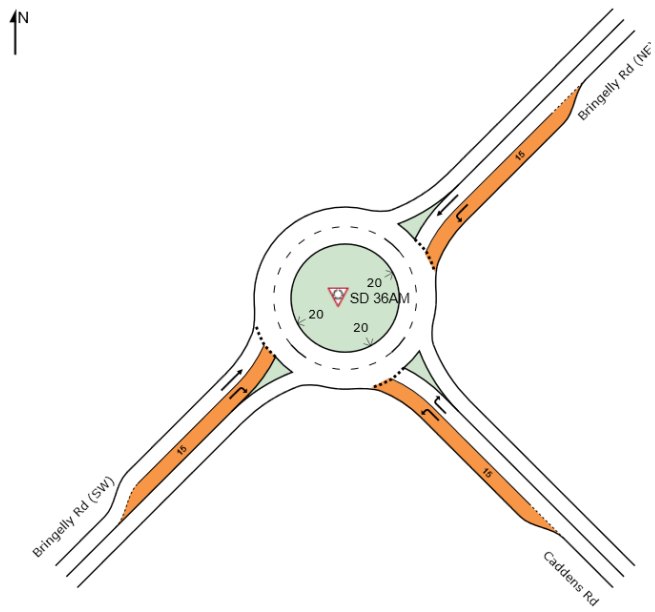
– Added an approach and an exit lane

South Approach:

– Added an approach and an exit lane

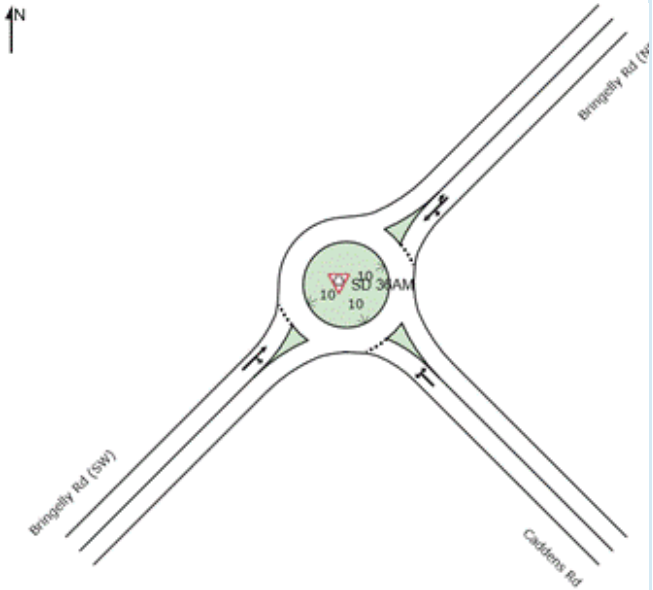
West Approach:

– Added left turn short lane



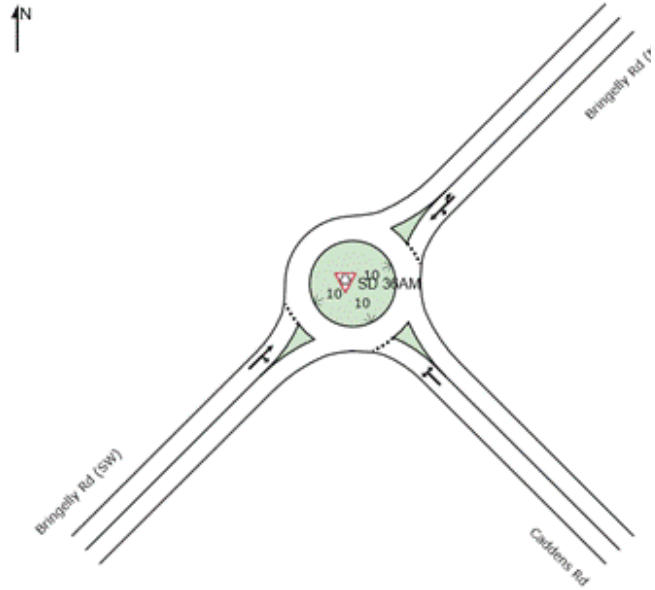
Precinct 1 road upgrades (FY1 I1)

No changes from existing required as the creation of a new East-West link provides traffic with a more attractive alternative to the south of this route, reducing total volume at this intersection.



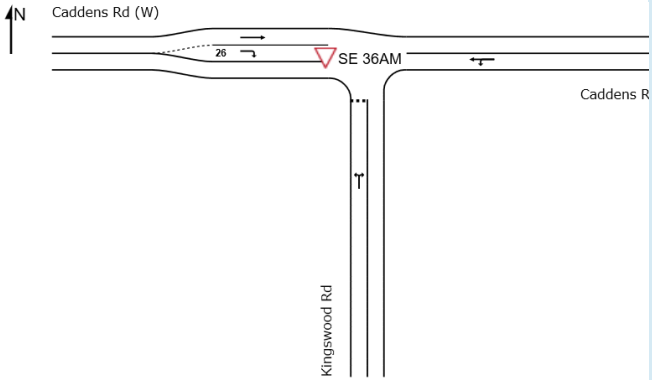
Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2)

No changes from existing required as the creation of a new East-West link provides traffic with a more attractive alternative to the south of this route, reducing total volume at this intersection.



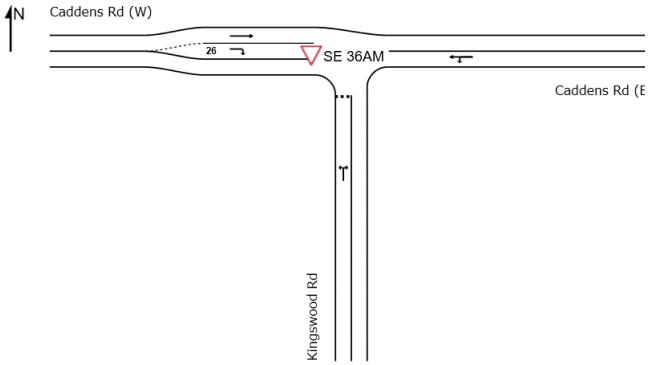
Site SE: Caddens Road / Kingswood Road

Current infrastructure (FY0 DN)



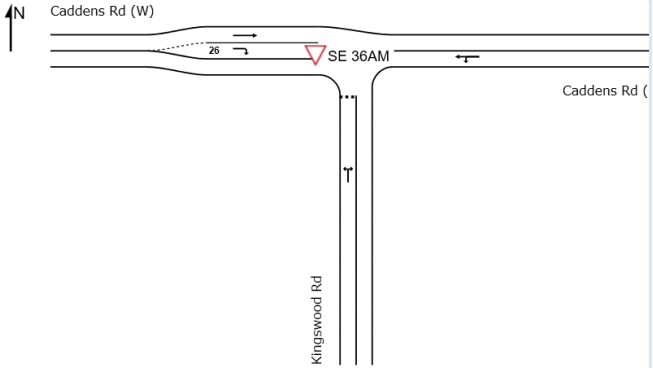
Background growth road upgrades (FY0 I0)

No changes from existing



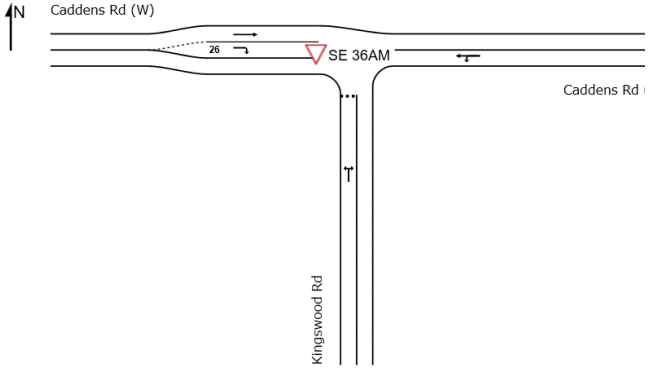
Precinct 1 road upgrades (FY1 I1)

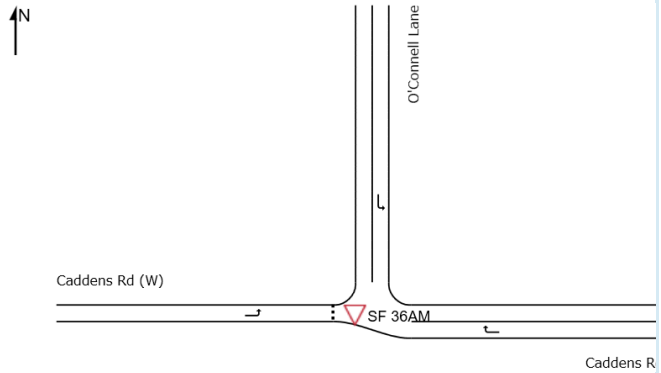
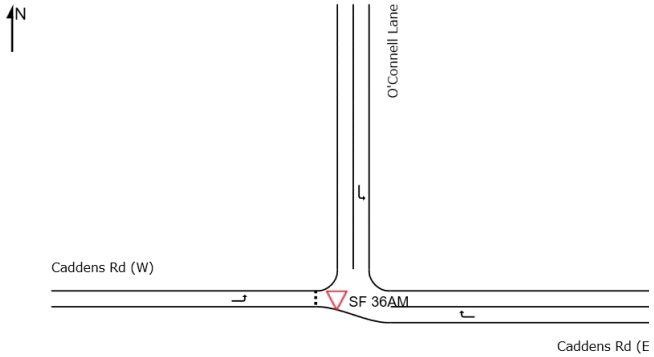
No changes from existing



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2)

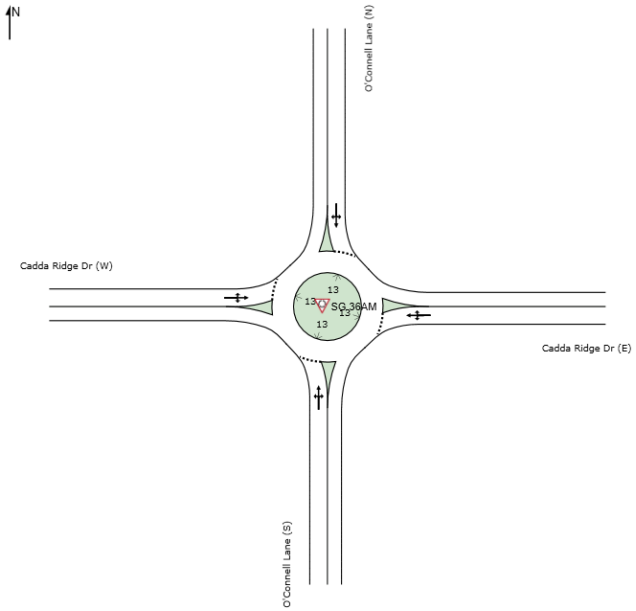
No changes from existing



Site SF: Caddens Road / O'Connell Lane			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1)	No longer an intersection.	Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2)	No longer an intersection.

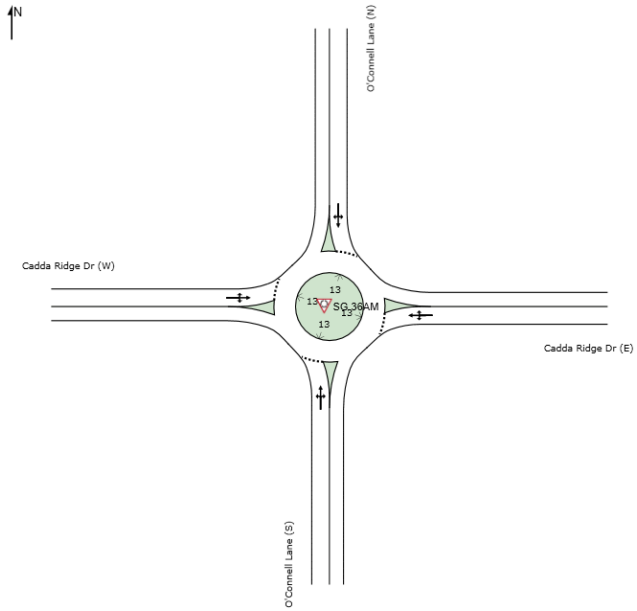
Site SG: Cadda Ridge Drive / O'Connell Lane

Current infrastructure (FY0 DN)



Background growth road upgrades (FY0 I0)

No changes from existing



Precinct 1 road upgrades (FY1 I1)

Roundabout Reconfiguration:

- Roundabout converted to a dual lane roundabout

North Approach:

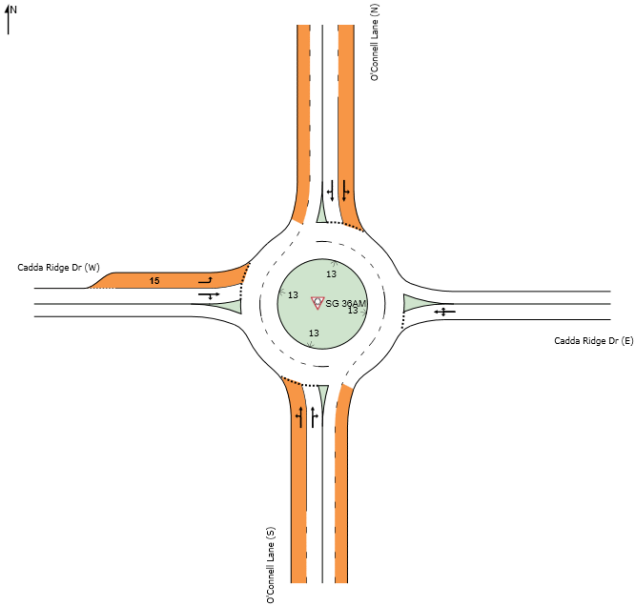
- Added an approach and an exit lane

South Approach:

- Added an approach and an exit lane

West Approach:

- Added left turn short lane



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) (Option 1)

Roundabout Reconfiguration:

- Roundabout converted to a dual lane roundabout

North Approach:

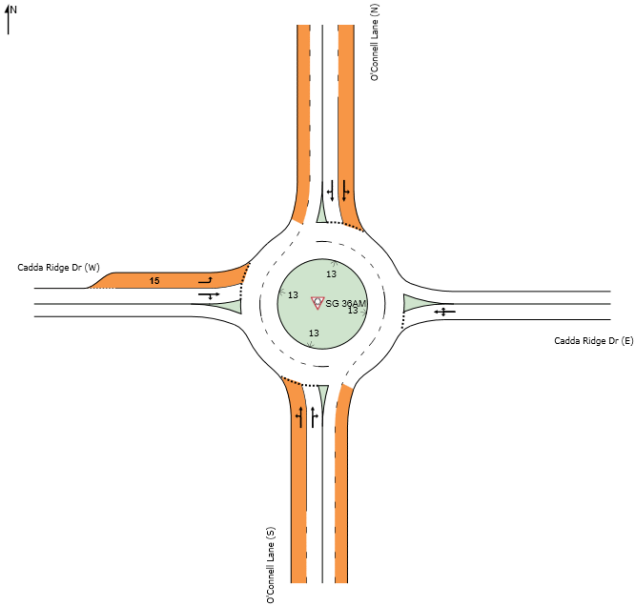
- Added an approach and an exit lane

South Approach:

- Added an approach and an exit lane

West Approach:

- Added left turn short lane



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) (Option 2)

Signalised alternative does not currently meet warrants

North Approach:

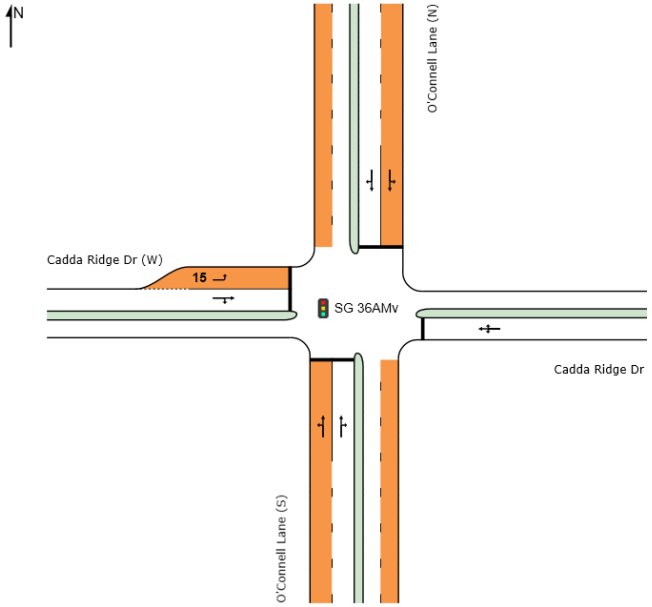
- Added an approach and an exit lane

South Approach:

- Added an approach and an exit lane

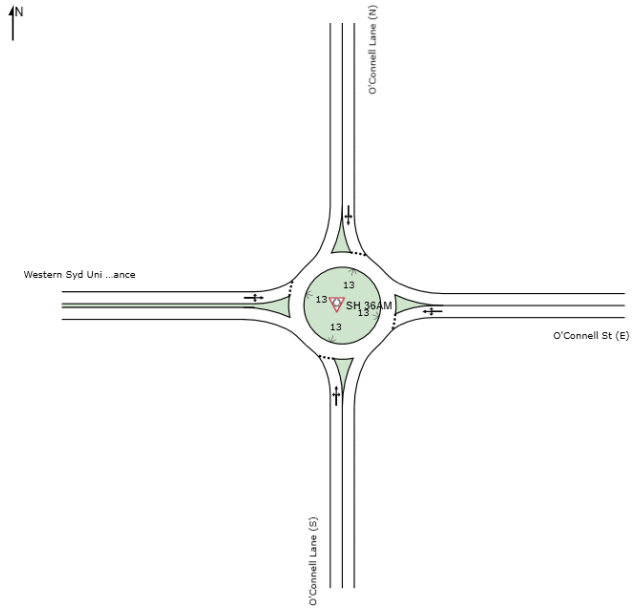
West Approach:

Added left turn short lane



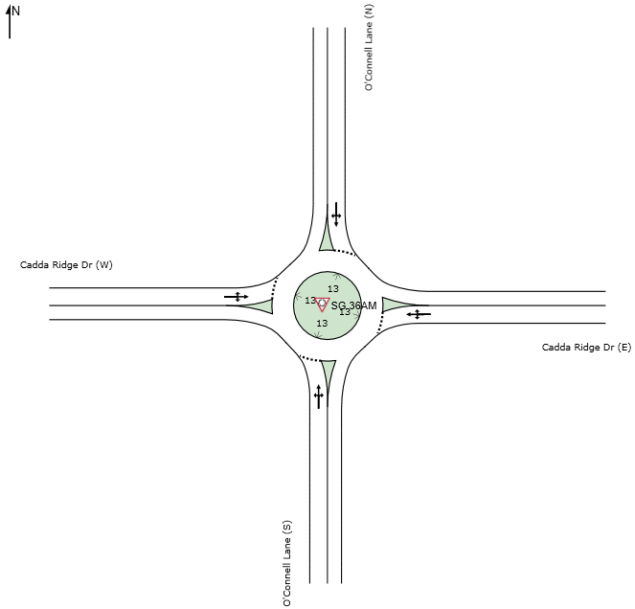
Site SH: O'Connell Lane / O'Connell Street

Current infrastructure (FY0 DN)



Background growth road upgrades (FY0 I0)

No changes from existing



Precinct 1 road upgrades (FY1 I1) (Option 1)

Roundabout Reconfiguration:

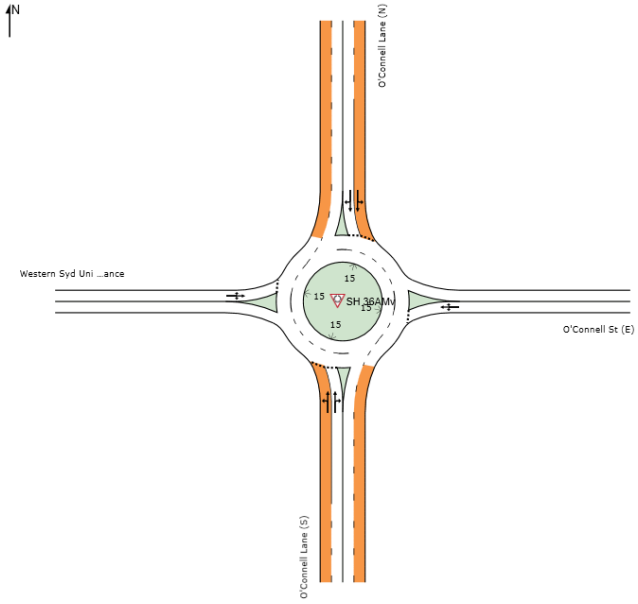
– Roundabout converted to a dual lane roundabout

North Approach:

– Added an approach and an exit lane

South Approach:

– Added an approach and an exit lane

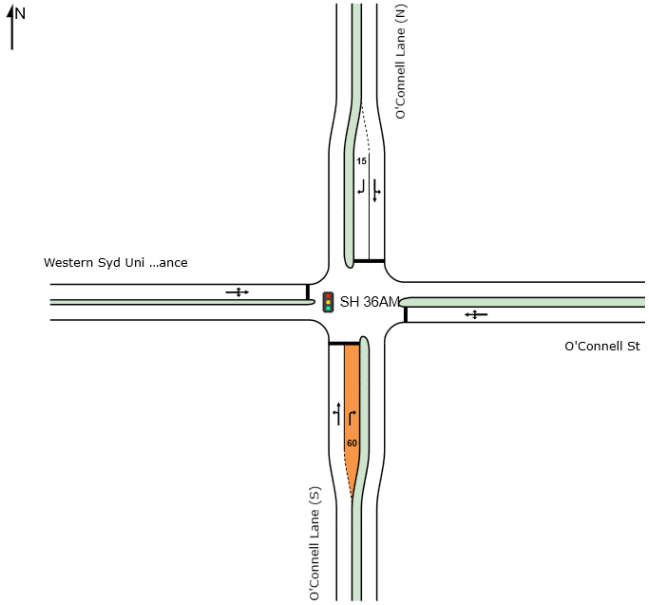


Precinct 1 road upgrades (FY1 I1) (Option 1)

Signalised alternative does not currently meet warrants

South Approach:

– Added a right turn short lane of 60 meters



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) (Option 1)

Roundabout Reconfiguration:

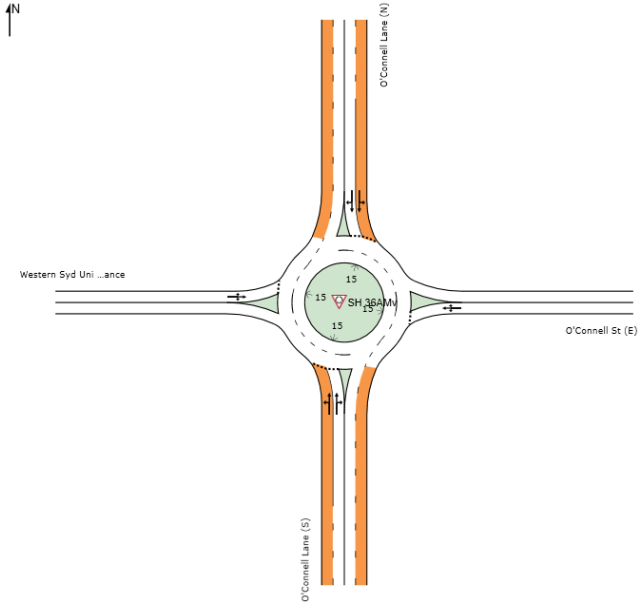
– Roundabout converted to a dual lane roundabout

North Approach:

– Added an approach and an exit lane

South Approach:

– Added an approach and an exit lane



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) (Option 2)

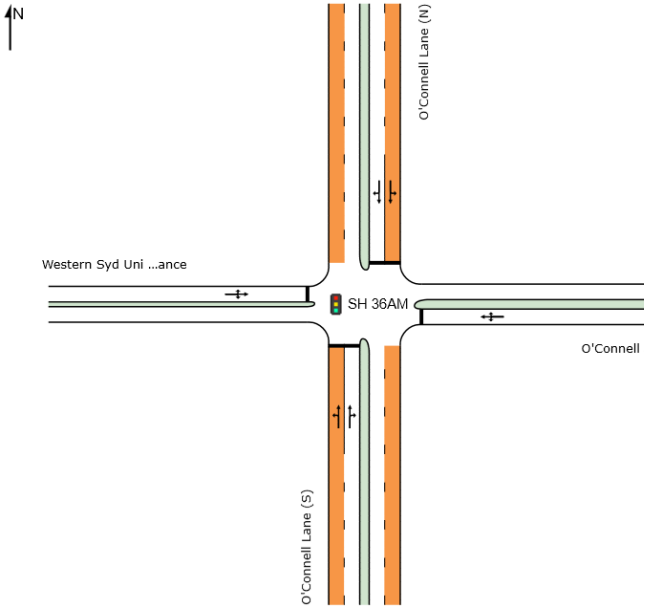
Signalised alternative does not currently meet warrants

North Approach:

– Added an approach and an exit lane

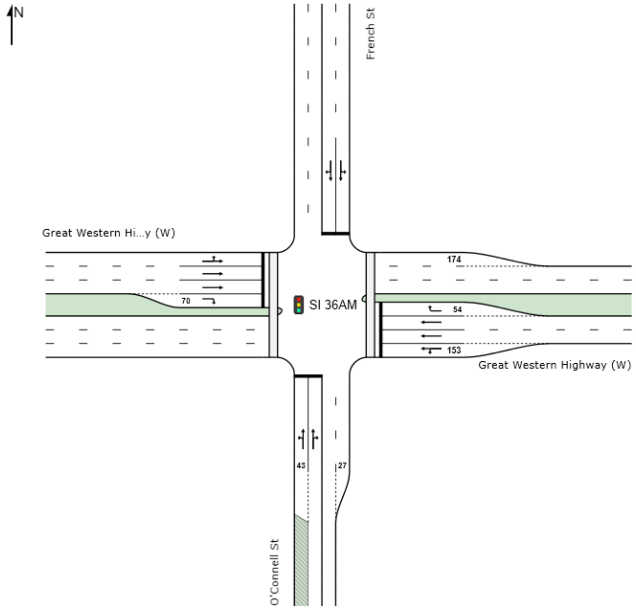
South Approach:

– Added an approach and an exit lane



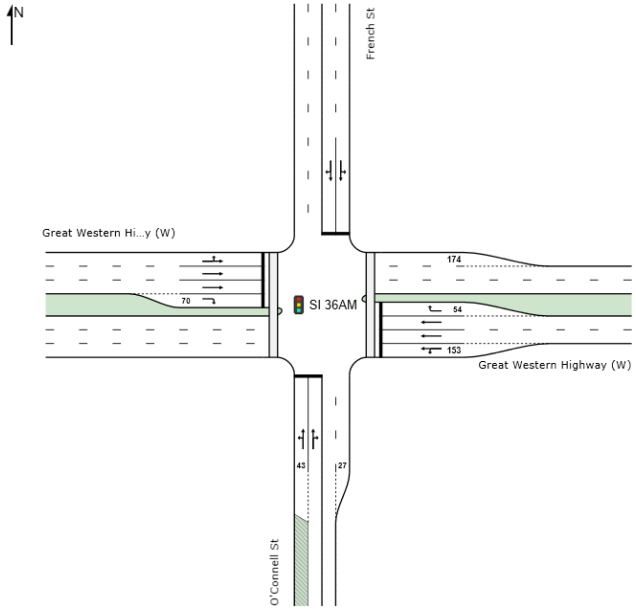
Site SI: Great Western Highway / O'Connell Street / French Street

Current infrastructure (FY0 DN)



Background growth road upgrades (FY0 I0)

No changes from existing



Precinct 1 road upgrades (FY1 I1)

East Approach:

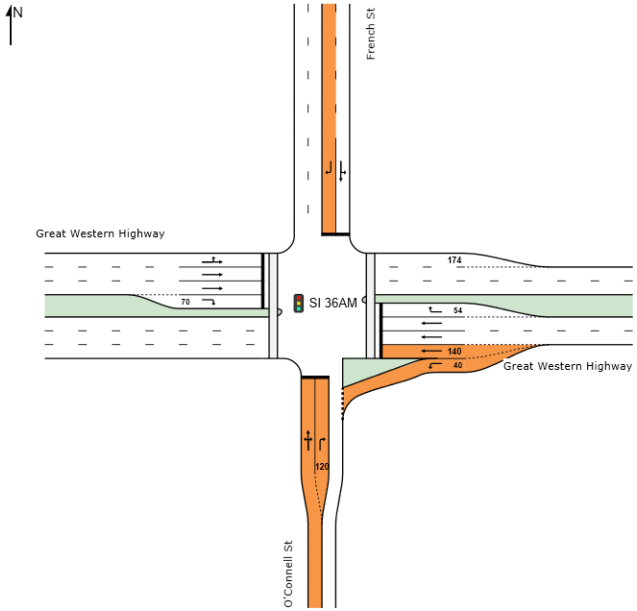
- Added a left turn slip lane
- Shortened through short lane to 140 meters

South Approach:

- Extended left approach lane
- Added right turn short lane of 120 meters
- Removed short exit lane

North Approach:

- Banned through movement from median lane



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2)

East Approach:

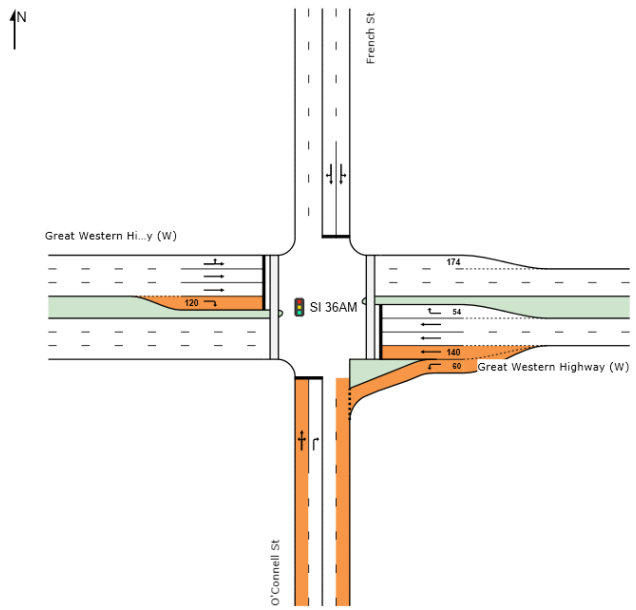
- Added a left turn slip lane
- Shortened through short lane to 140 meters

South Approach:

- Extended left approach lane
- Extended short exit lane

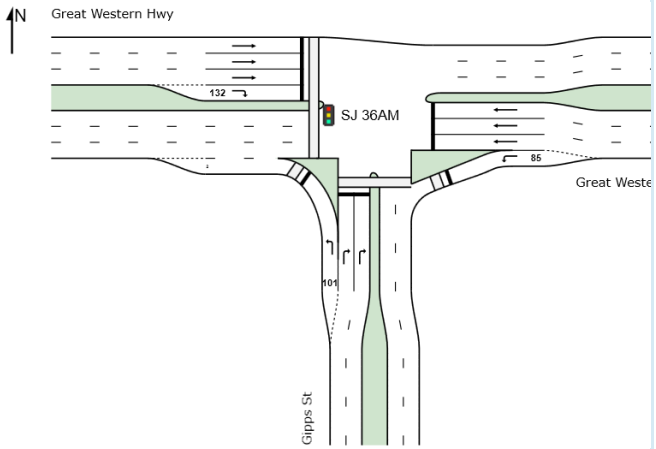
West Approach:

- Extended right turn short lane to 120 meters



Site SJ: Great Western Highway / Gipps Street

Current infrastructure (FY0 DN)



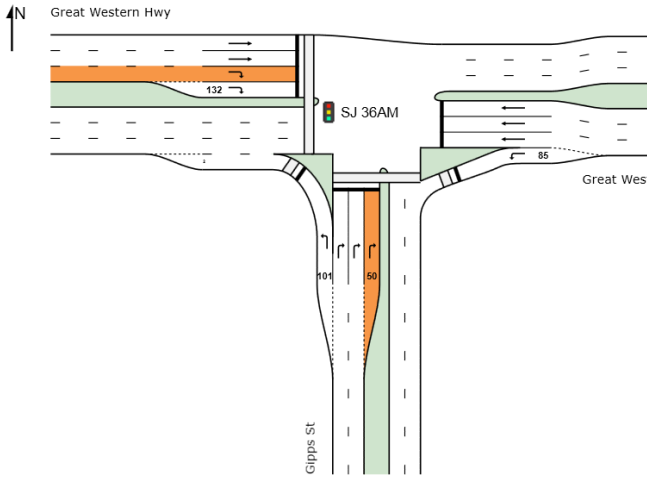
Background growth road upgrades (FY0 I0)

South Approach:

- Added right turn short lane of 50 meters

West Approach:

- Converted through lane to right turn lane



Precinct 1 road upgrades (FY1 I1)

East Approach:

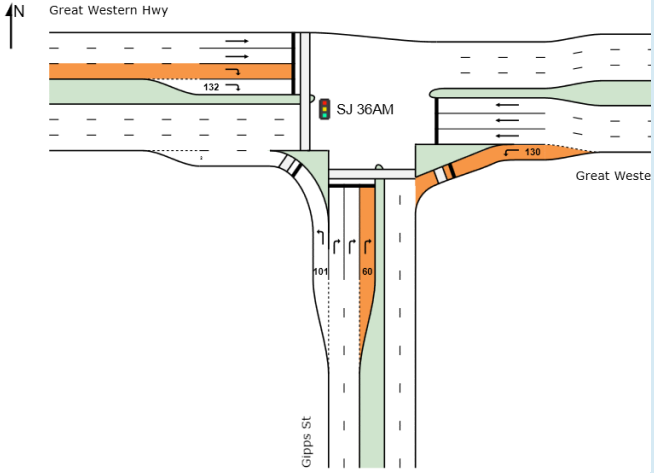
- Extended the left turn slip lane to 130 meters

South Approach:

- Added right turn short lane of 60 meters

West Approach:

- Converted through lane to right turn lane



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2)

East Approach:

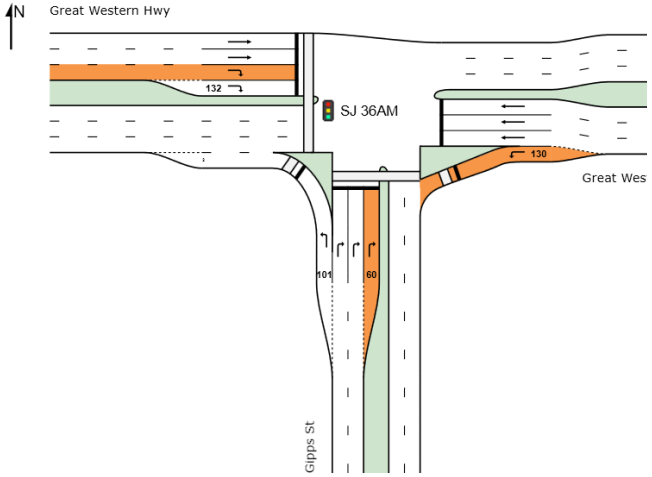
- Extended the left turn slip lane to 130 meters

South Approach:

- Added right turn short lane of 60 meters

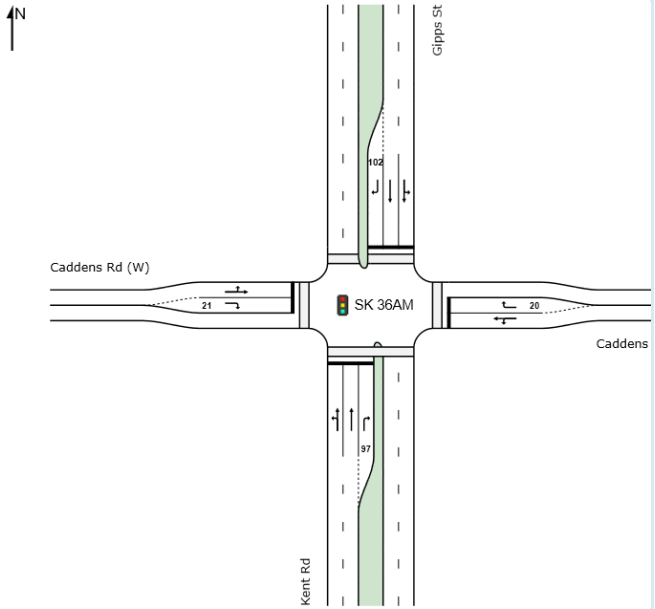
West Approach:

- Converted through lane to right turn lane



Site SK: Gipps Street / Caddens Road / Kent Road

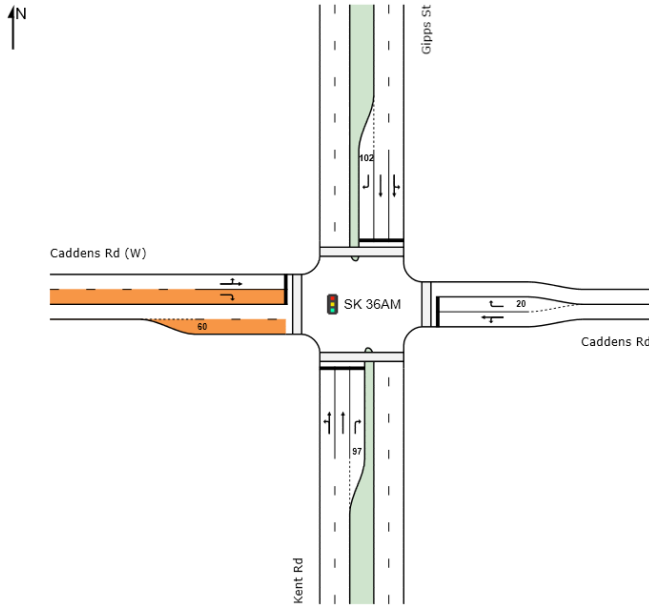
Current infrastructure (FY0 DN)



Background growth road upgrades (FY0 I0)

West Approach:

- Extended right turn short lane to full lane
- Added short exit lane of 60 meters



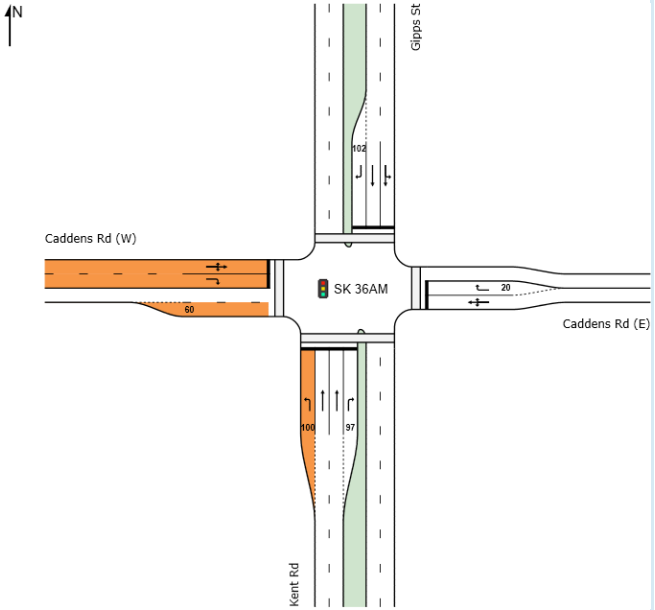
Precinct 1 road upgrades (FY1 I1)

South Approach:

- Added left turn short lane of 100 meters

West Approach:

- Extended right turn short lane to full lane
- Added short exit lane of 60 meters
- Allowed right turn from kerbside lane



Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2)

North Approach:

- Added right turn short lane of 50 meters

East Approach:

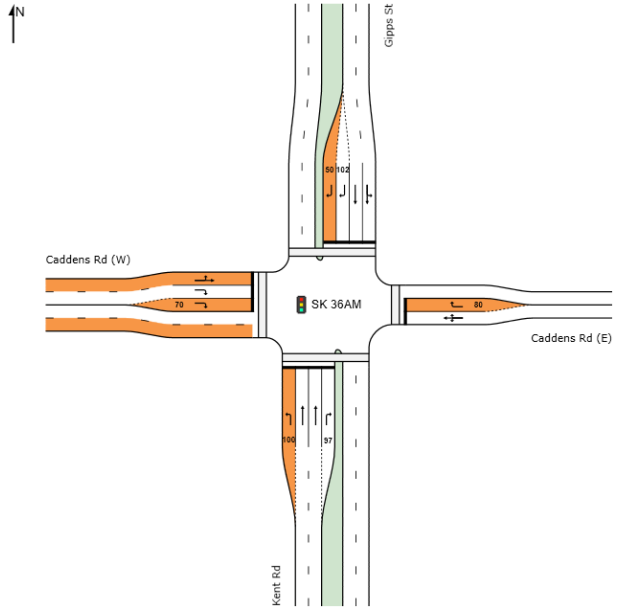
- Extended the right turn short lane to 80 meters

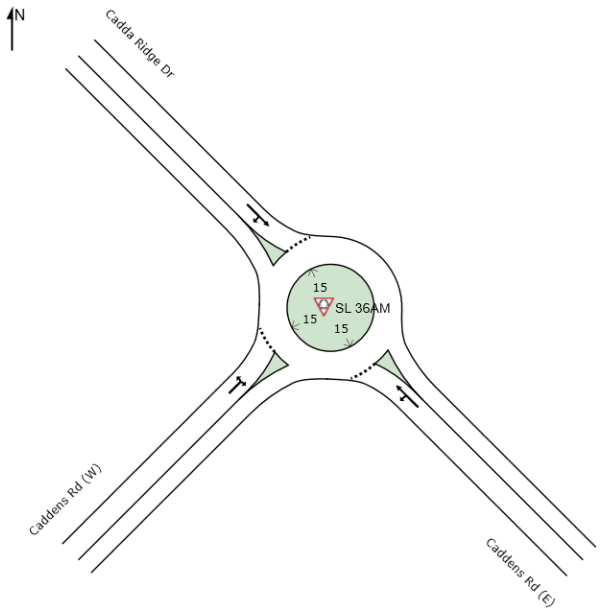
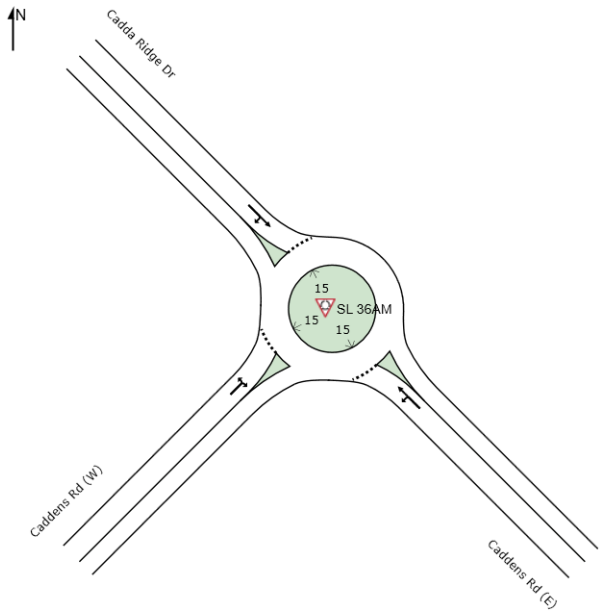
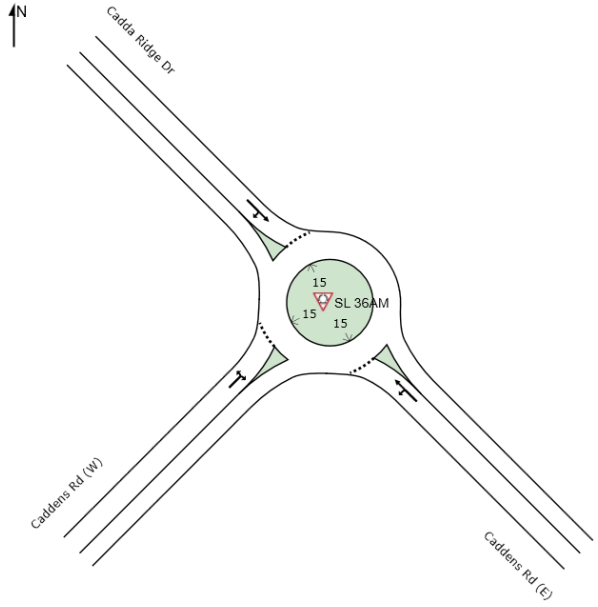
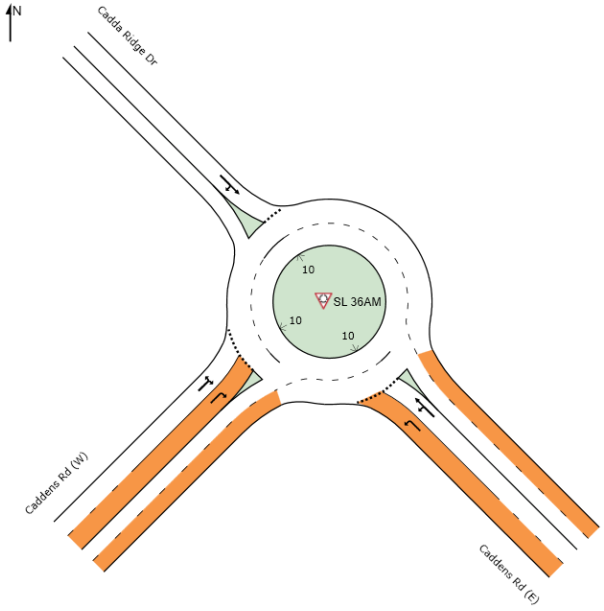
South Approach:

- Added left turn short lane of 100 meters

West Approach:

- Extended right turn short lane to full lane
- Added right turn short lane of 70 meters
- Added exit lane



Site SL: Caddens Road / Cadda Ridge Drive			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1) **No changes from existing**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) (Option 1) **Roundabout Reconfiguration:** – Roundabout converted to a dual lane roundabout **South East Approach:** – Added a left turn lane and an exit lane **South West Approach:** – Added a right turn lane and an exit lane Note that this configuration has a significant impact on Caddens Oval or stormwater drainage facilities installed between Caddens Road and Cadda Ridge Drive.	

Orchard Hills North Precinct (Precincts 1 & 2)road upgrades (FY2 I2) (Option 2)

Signalisation of roundabout:

- Roundabout converted to signalised intersection

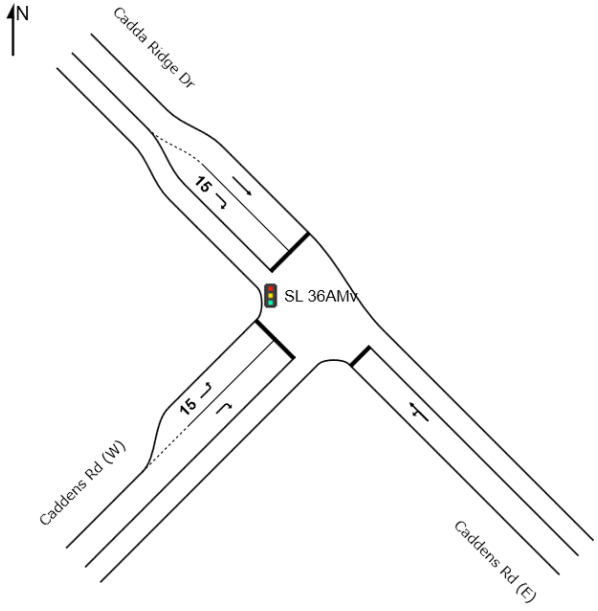
South West Approach:

- Added a left turn lane

North West Approach:

- Added a right turn lane

This option is not forecast to meet warrants as traffic is highly tidal.



Orchard Hills North Precinct (Precincts 1 & 2)road upgrades (FY2 I2) (Option 3)

Reversion to give way control:

- Roundabout converted to give way junction including re-alignment of Caddens Road to original orientation east-west

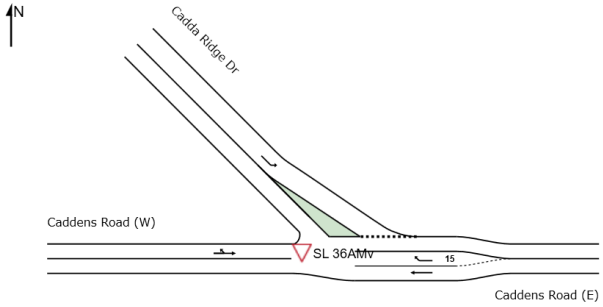
North West Approach:

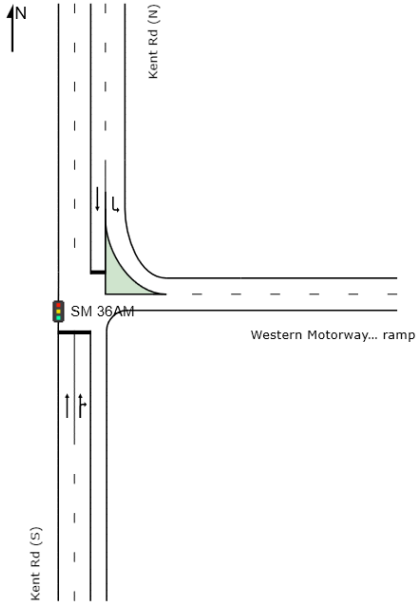
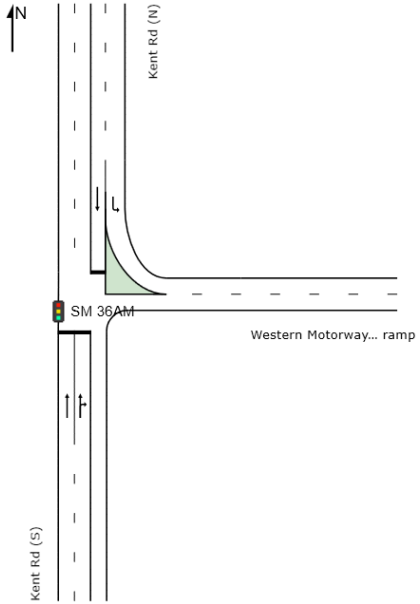
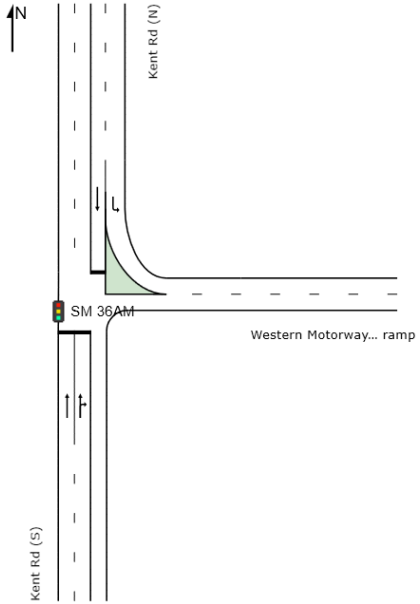
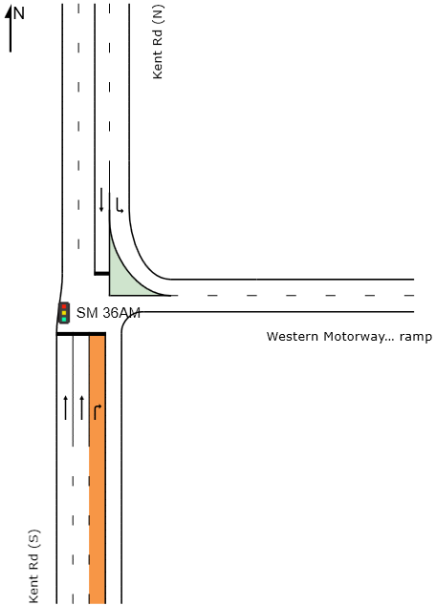
- Ban of right turn based on potential for this to be accommodated elsewhere

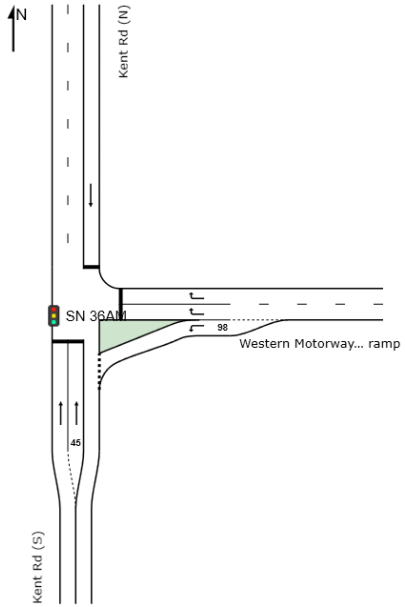
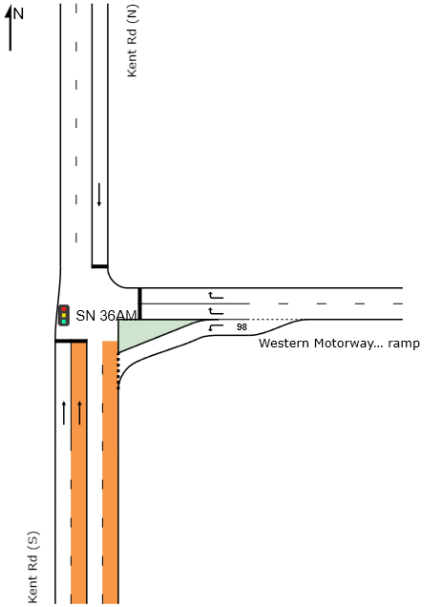
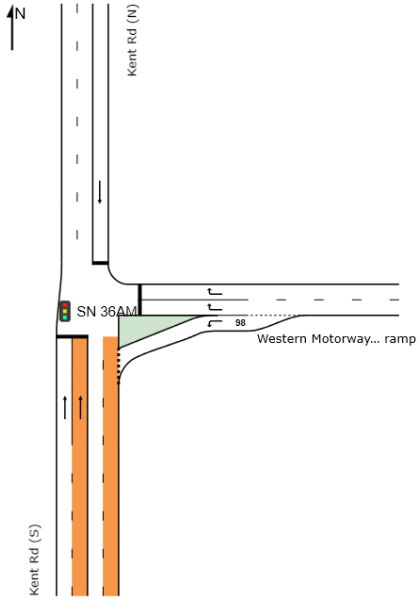
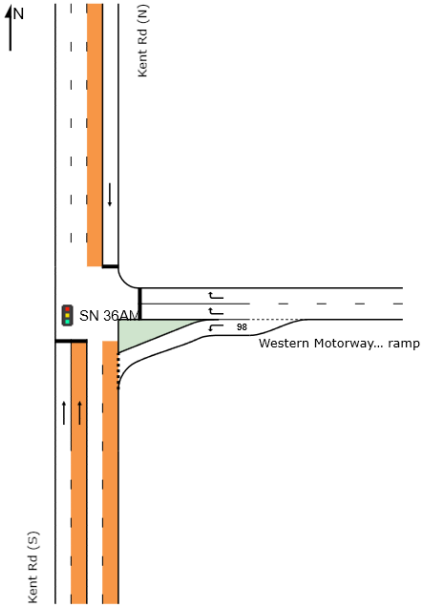
East and west approaches:

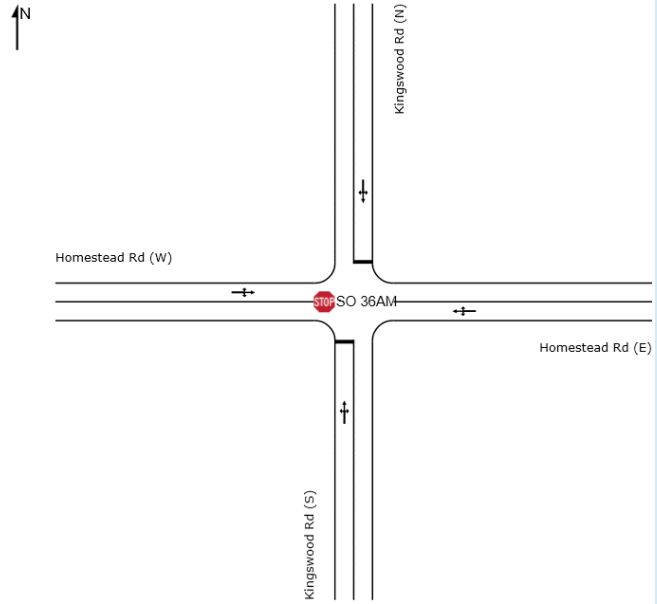
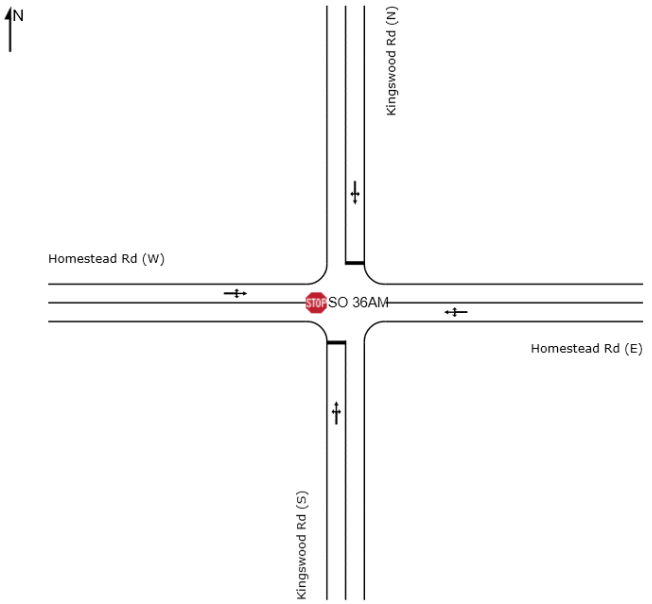
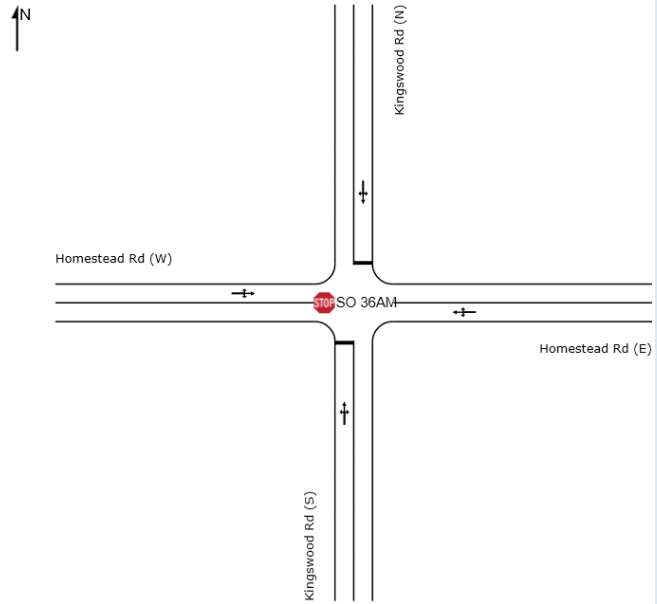
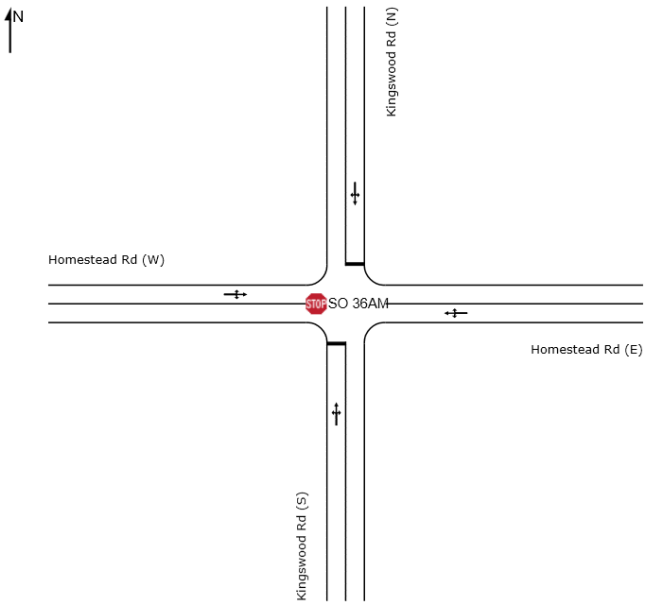
- The east and west approaches would be re-aligned. A right turn bay slot would be provided.

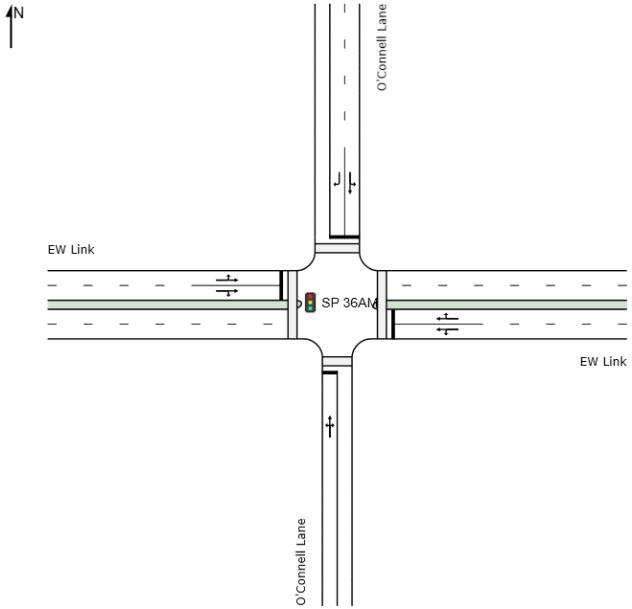
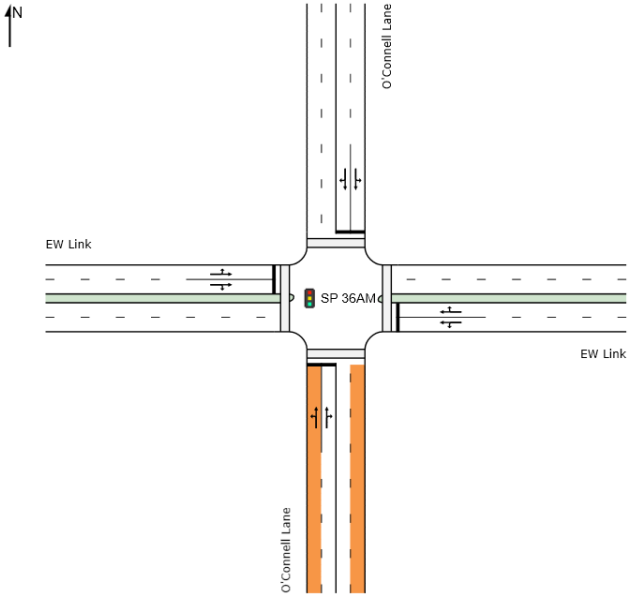
This requires a right turn ban from Cadda Ridge Drive

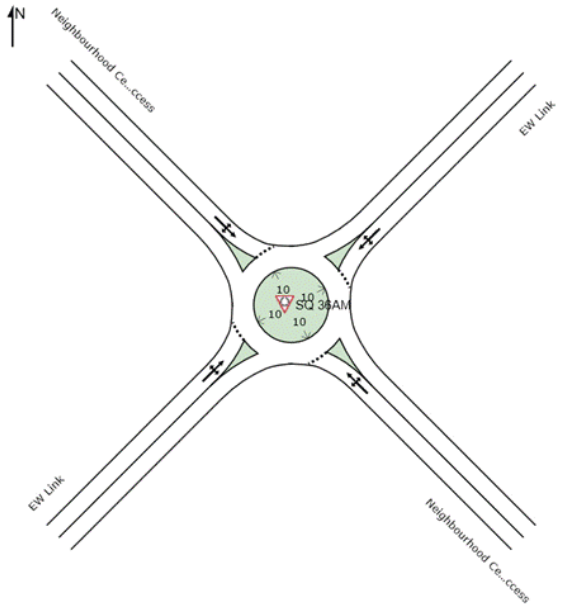
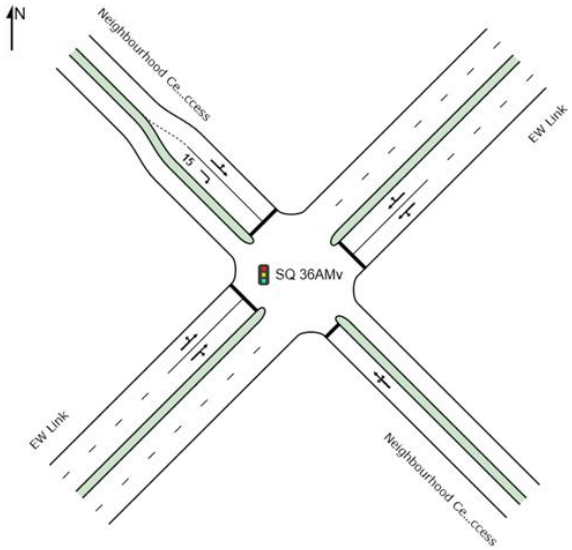


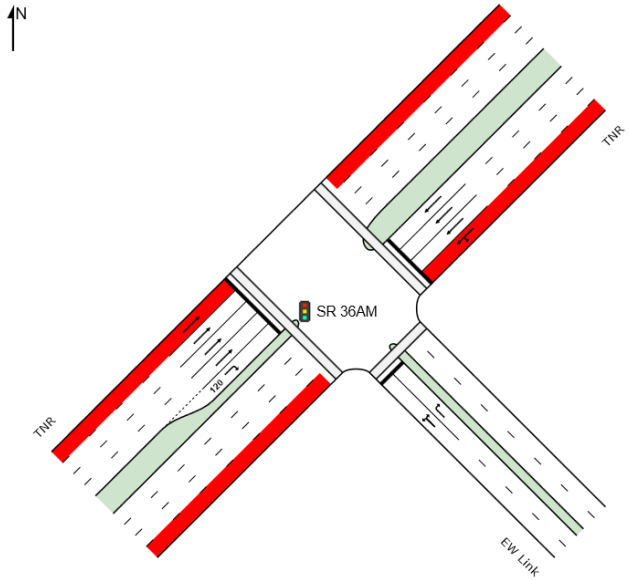
Site SM: Kent Road / M4 On-Ramp			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1) **No changes from existing**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **South Approach:** – Added right turn lane	

Site SN: Kent Road / M4 Off-Ramp			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **South Approach:** – Added an approach and an exit lane	
Precinct 1 road upgrades (FY1 I1) **South Approach:** – Added an approach and an exit lane		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **North Approach:** – Added right turn lane from Site SM **South Approach:** – Added an approach and an exit lane	

Site SO: Kingswood Road / Homestead Road			
Current infrastructure (FY0 DN)		Background growth road upgrades (FY0 I0) **No changes from existing**	
Precinct 1 road upgrades (FY1 I1) **No changes from existing**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **No changes from existing**	

Site SP: O'Connell Lane / East-West Link (New)			
Current infrastructure (FY0 DN)	Not an intersection in this modelling scenario	Background growth road upgrades (FY0 I0)	Not an intersection in this modelling scenario
Precinct 1 road upgrades (FY1 I1) **New intersection**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **South approach:** – Added approach and exit lane	

Site SQ: East-West Link (New) / Neighbourhood Centre Access (New)			
Current infrastructure (FY0 DN)	Not an intersection in this modelling scenario	Background growth road upgrades (FY0 I0)	Not an intersection in this modelling scenario
Precinct 1 road upgrades (FY1 I1) **New intersection**		Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) – Signalisation is now warranted due to higher traffic flows. – Widening of Neighbourhood Centre Access approach	

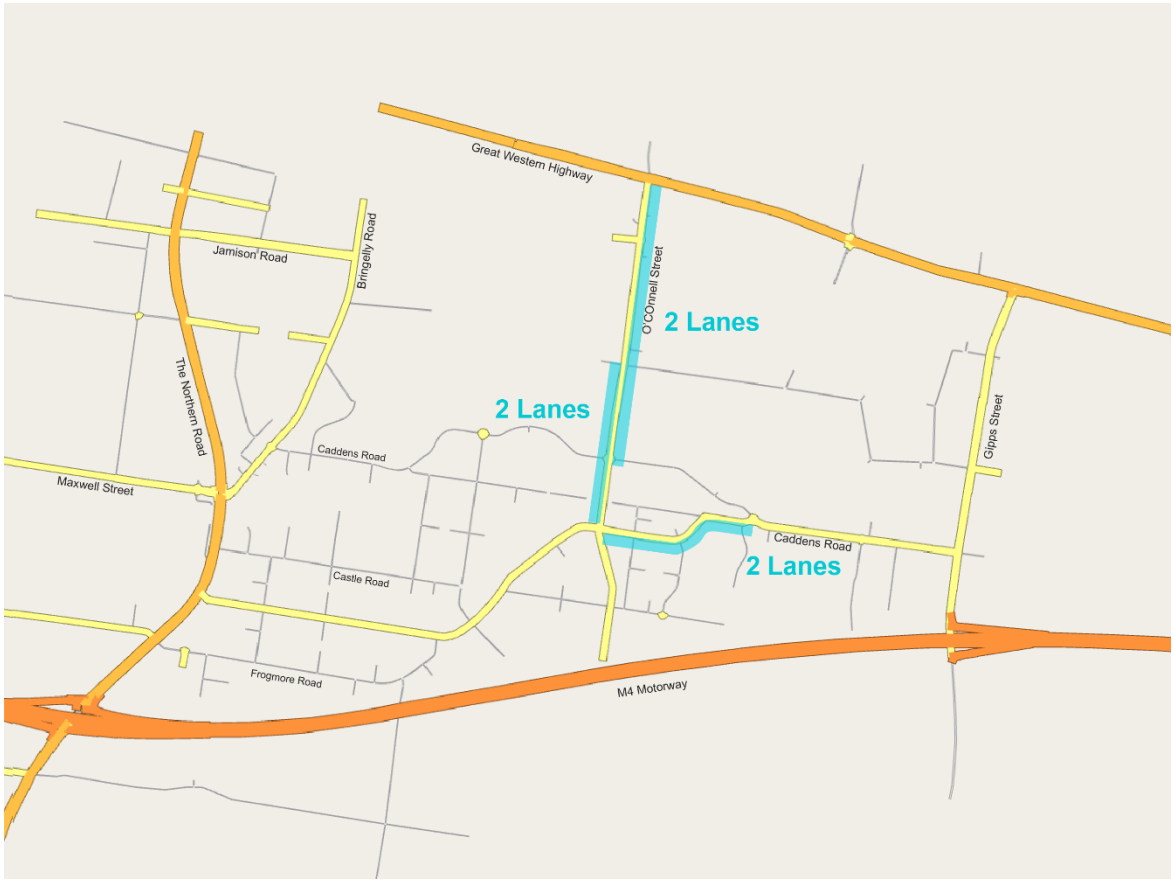
Site SR: The Northern Road / East-West Link (New)			
Current infrastructure (FY0 DN)	Not an intersection in this modelling scenario	Background growth road upgrades (FY0 I0)	Not an intersection in this modelling scenario
Precinct 1 road upgrades (FY1 I1)	Not an intersection in this modelling scenario	Orchard Hills North Precinct (Precincts 1 & 2) road upgrades (FY2 I2) **New intersection**	

Source: SCT Consulting, 2021

5.3.7 Precinct 1 – Dual lane requirements

Traffic modelling for the Precinct 1 infrastructure assumed that the East-West and North-South corridors would only be constructed in their full footprint if required from a traffic perspective. The mapped traffic demand volume shows that the east-west corridor is not required west of Precinct 1 until the structure plan is delivered. Additionally, flows along the east-west link (new) and Caddens Road only requires dual lane in the westbound direction between Cadda Ridge Drive and O'Connell Lane. It also suggests dual lanes are required on O'Connell Lane / O'Connell Street at certain locations, highlighted in **Figure 5-8**.

Figure 5-8 Two lane sections based on midblock analysis – Precinct 1

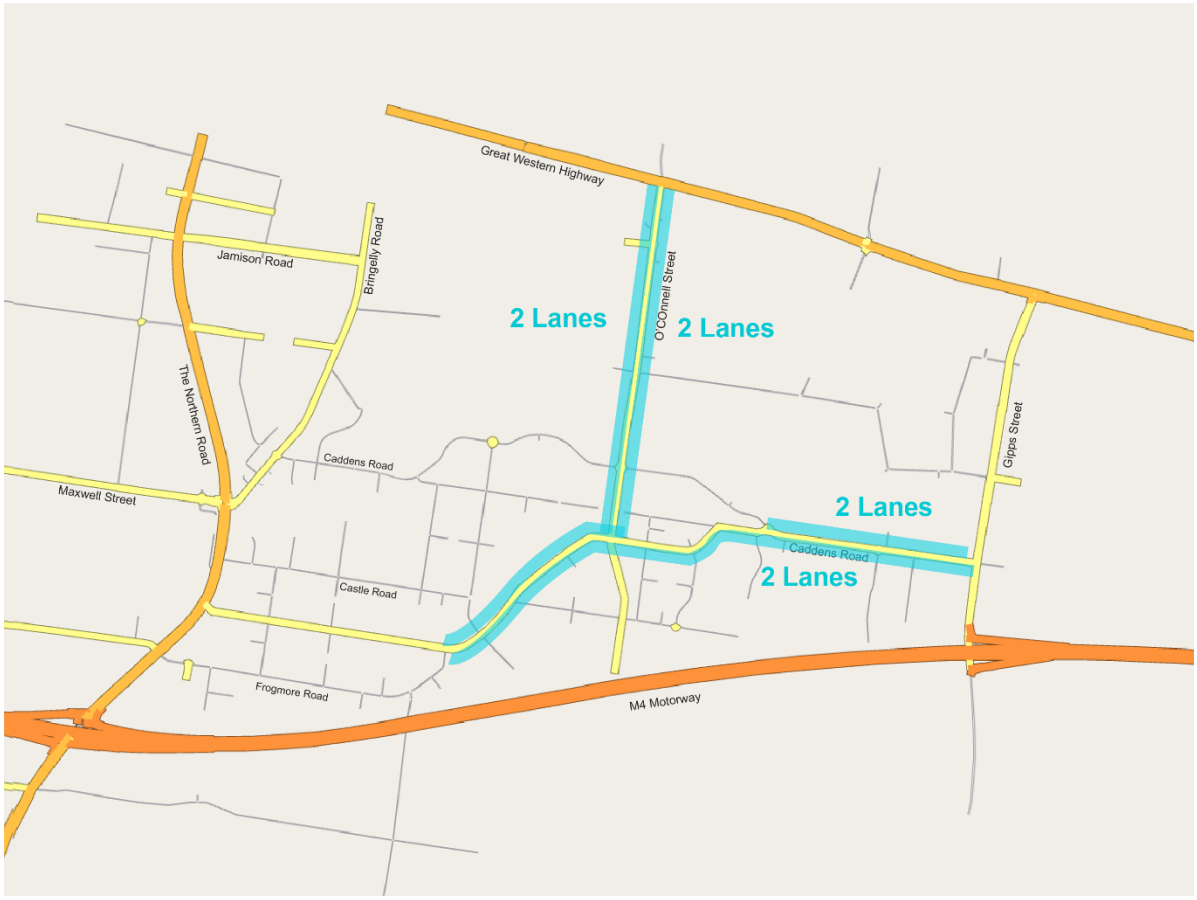


Source: © OpenStreetMap Contributors, SCT Consulting, 2020

5.3.8 Orchard Hills North Precinct (Precincts 1 & 2) – Dual lane requirements

Traffic modelling for the Orchard Hills North Precinct (Precincts 1 & 2) scenario infrastructure assumed that the East-West and North-South corridors was generally delivered within the Orchard Hills North Precinct (Precincts 1 & 2) area. Traffic volumes show that dual lanes are recommended along both these corridors except for the east-west link between The Northern Road and the intersection with Frogmore Road. This is due to some southbound traffic taking Frogmore Road rather than using the east-west link from this point onward. The areas that require two lanes in the Orchard Hills North Precinct (Precincts 1 & 2) scenario is shown in **Figure 4-1**.

Figure 5-9 Two lane sections based on midblock analysis – Orchard Hills North Precinct (Precincts 1 & 2)



Source: © OpenStreetMap Contributors, SCT Consulting, 2020

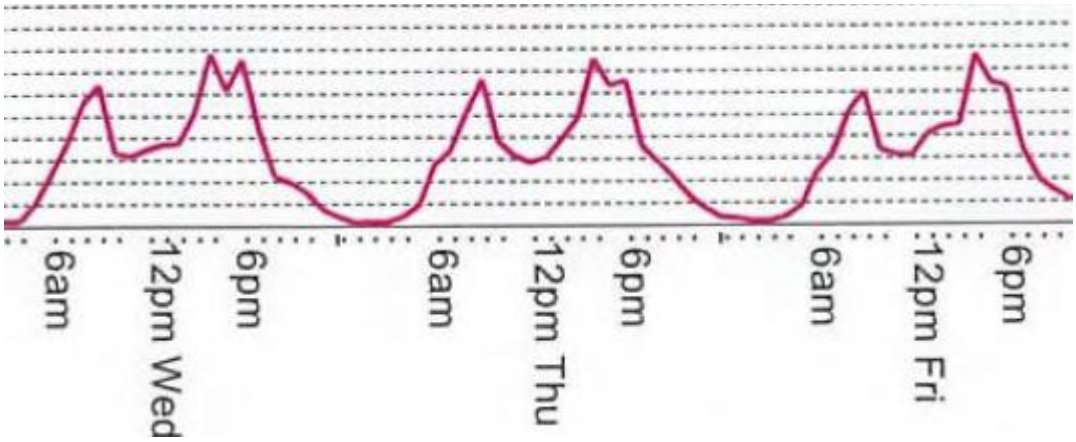
Despite the dual lane requirements identified from the traffic volume triggers considered in in Section 5.3.2 and above, the full extent of the East-West corridor will have a road reserve with 2 lanes provided in each direction.

5.4 Caddens Road sensitivity

A sensitivity test in SIDRA was conducted based on higher traffic demands for Caddens Road to address comments by Council. This was be tested as a sensitivity with traffic increased along Caddens Road in the SIDRA models only.

SCT Consulting engaged an additional tube count to confirm the traffic numbers weren't due to unique circumstances. Counts were conducted on 2 February 2020 for 7 days. The result was that the westbound AM was slightly lower than the week of 4 September 2019, which had some uniquely busy days. It is observed that the traffic increase from 2018 (which was when the data collection for modelling commenced) is substantial and could be associated with construction traffic. The traffic profile shows a distinct peak at approximately 2-3pm that is larger than the PM peak rush, indicating that the traffic is due to a "trades" peak or school pick-ups.

Figure 5-10 Excerpt from 4 September 2019 count data



As such, it is possible that this traffic is temporary in nature and will not persist after completion of subdivisions.

The proposed sensitivity for the increase in traffic volumes is calculated in **Table 5-17**.

Table 5-17 Traffic counts on Caddens Road and proposed sensitivity demand increase

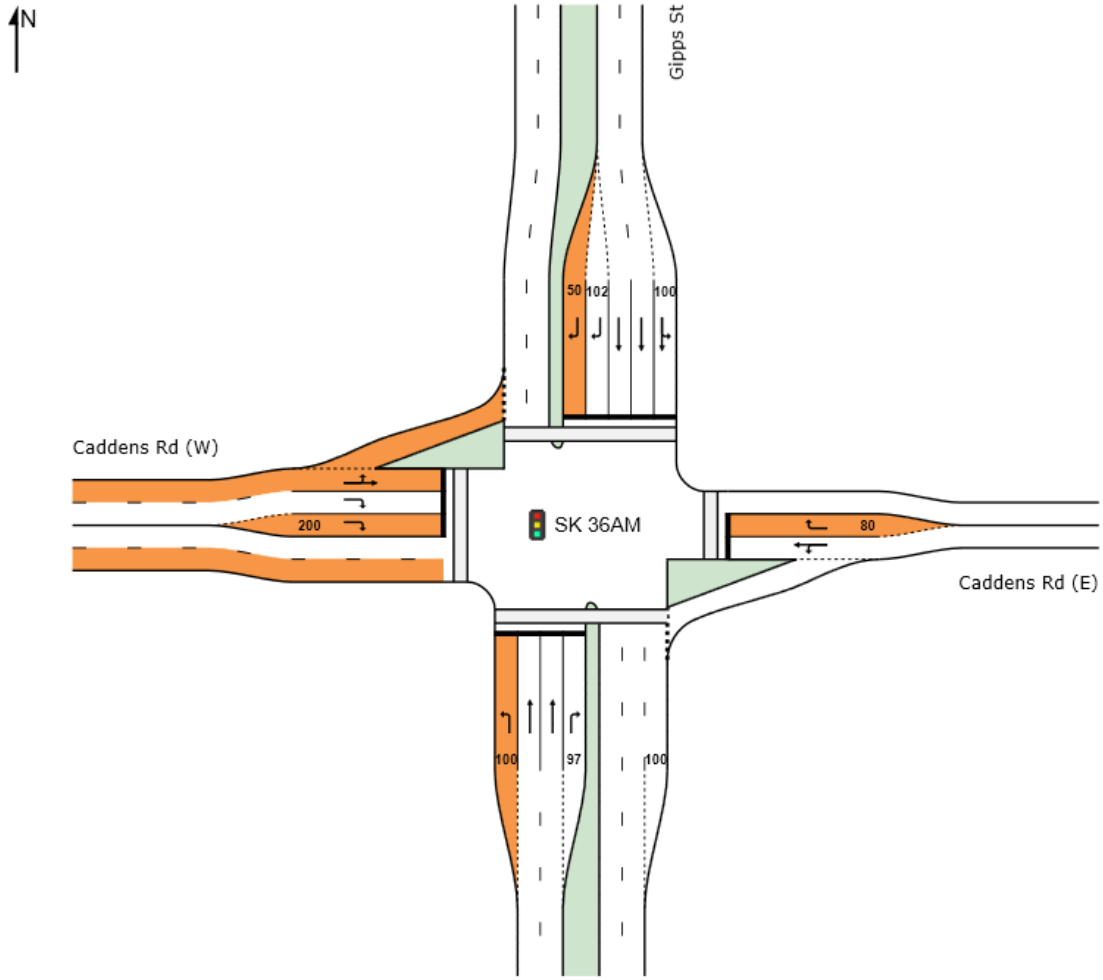
Direction	Turning counts	Tube count (Weekday average)	Tube count (Weekday average)	Proposed additional traffic in sensitivity test
Date	4-Jul-18	4-Sep-19	2-Feb-20	
Eastbound AM	57	314	323	266
Westbound AM	204	400	358	154
Eastbound PM	80	~200	273	193
Westbound PM	96	~200	296	200

Source: SCT Consulting for 2018 and 2020 data, Penrith Council for 2019 data

The result of this test is that the only intersection requiring upgrade is Caddens Road / Gipps Street / Kent Road, which may require significant upgrades (subject to further planning, investigations, and funding decisions), as shown in **Figure 5-11** (orange marks modifications from existing). The intersection requires left turn slip lane and increase turning bay length for right turns on the west approach. It also requires an additional (short) southbound lane for through traffic from the north. This is a significant upgrade and shows that the intersection was already near capacity, with conflicting southbound demand from the north and west approach, as well as the westbound traffic from the north.

Further consultation and investigation are required between the proponent, Council and TfNSW to determine the scope of intersection works required over the short, medium, and long term including feasibility and funding sources.

Figure 5-11 Larger footprint intersection of Caddens Road / Gipps Street / Kent Road (subject to further planning, investigation, and funding decisions)



Source: SCT Consulting, 2020

A targeted excerpt of results is provided in **Figure 5-12**.

5.5 Sensitivity testing of Kent Road M4 Motorway bridge

The Orchard Hills North Precinct (Precincts 1 & 2) scenario identifies that the bridge of Kent Road over the M4 Motorway needs to be widened to address the scale of growth. However, a review of the sources of growth show that background traffic results in growth of Kent Road to almost 1,000 vehicles per hour from approximately 200 vehicles per hour at present. This is reflective of a substantial change in the hierarchy of Kent Road from local traffic to an arterial road corridor.

A test was conducted of the traffic generated by the Orchard Hills North Precinct (Precincts 1 & 2) without background traffic given the scales of the upgrade, with the results provided in **Figure 5-13**.

This sensitivity shows that the timing of the bridge widening could be deferred until the growth on Kent Road associated with Western Sydney airport, aerotropolis mature.

Figure 5-12 Intersection performance for Caddens Road sensitivity test

Site: SL 36AM [CAD_CAD_36_AM_O1 - SL]

Caddens Rd / Cadda Ridge Dr
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
SouthEast: Caddens Rd (E)												
21	L2	897	2.0	0.387	6.1	LOS A	1.9	13.5	0.33	0.61	0.33	52.1
22	T1	49	0.0	0.387	5.3	LOS A	1.9	13.4	0.33	0.61	0.33	53.6
Approach		946	1.9	0.387	6.1	LOS A	1.9	13.5	0.33	0.61	0.33	52.2
NorthWest: Cadda Ridge Dr												
28	T1	146	0.7	0.379	7.2	LOS A	1.4	10.1	0.50	0.82	0.54	51.9
29	R2	168	4.4	0.379	10.5	LOS A	1.4	10.1	0.50	0.82	0.54	51.4
Approach		315	2.7	0.379	9.0	LOS A	1.4	10.1	0.50	0.82	0.54	51.6
SouthWest: Caddens Rd (W)												
30	L2	187	5.1	0.322	5.7	LOS A	1.4	9.8	0.14	0.61	0.14	51.4
32	R2	714	0.1	0.322	8.1	LOS A	1.4	9.8	0.14	0.63	0.14	52.2
Approach		901	1.2	0.322	7.6	LOS A	1.4	9.8	0.14	0.62	0.14	52.0
All Vehicles		2162	1.7	0.387	7.1	LOS A	1.9	13.5	0.27	0.65	0.28	52.0

Site: SL 36PM [CAD_CAD_36_PM_O1 - SL]

Caddens Rd / Cadda Ridge Dr
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
SouthEast: Caddens Rd (E)												
21	L2	1187	0.2	0.508	6.3	LOS A	2.8	19.5	0.39	0.64	0.39	52.0
22	T1	56	0.0	0.508	5.5	LOS A	2.8	19.5	0.39	0.64	0.39	53.4
Approach		1243	0.2	0.508	6.3	LOS A	2.8	19.5	0.39	0.64	0.39	52.1
NorthWest: Cadda Ridge Dr												
28	T1	204	0.0	0.405	5.8	LOS A	1.6	11.1	0.37	0.68	0.37	52.7
29	R2	202	1.6	0.405	9.1	LOS A	1.6	11.1	0.37	0.68	0.37	52.3
Approach		406	0.8	0.405	7.4	LOS A	1.6	11.1	0.37	0.68	0.37	52.5
SouthWest: Caddens Rd (W)												
30	L2	142	3.0	0.156	5.7	LOS A	0.6	4.1	0.13	0.60	0.13	52.0
32	R2	274	2.3	0.156	8.1	LOS A	0.6	4.1	0.13	0.63	0.13	52.1
Approach		416	2.5	0.156	7.3	LOS A	0.6	4.1	0.13	0.62	0.13	52.1
All Vehicles		2065	0.8	0.508	6.7	LOS A	2.8	19.5	0.34	0.64	0.34	52.2

Site: SK 36AM [GIP_CAD_36_AM_O1 - SK - DL2] — **Network: N101 [Gipps St/Kent Rd]**

Gipps St / Caddens St / Kent Rd
Site Category: (None)
Signals - Fixed Time Coordinated Cycle Time = 110 seconds (Network Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kent Rd														
1	L2	422	1.2	422	1.2	0.443	16.4	LOS B	5.5	38.9	0.71	0.80	0.71	46.4
2	T1	771	16.0	771	16.0	0.648	35.7	LOS C	10.6	84.7	0.89	0.81	0.89	37.1
3	R2	15	28.6	15	28.6	0.150	59.2	LOS E	0.5	4.0	0.91	0.69	0.91	29.5
Approach		1207	11.0	1207	11.0	0.648	29.2	LOS C	10.6	84.7	0.82	0.80	0.82	39.5
East: Caddens Rd (E)														
4	L2	219	3.4	219	3.4	0.659	36.6	LOS C	6.1	43.7	0.96	0.88	1.10	28.2
5	T1	48	3.8	48	3.8	0.659	30.9	LOS C	6.1	43.7	0.96	0.88	1.10	34.9
6	R2	111	6.7	111	6.7	0.440	53.3	LOS D	3.4	25.3	0.96	0.78	0.96	30.3
Approach		378	4.4	378	4.4	0.659	40.7	LOS C	6.1	43.7	0.96	0.85	1.06	29.9
North: Gipps St														
7	L2	93	6.8	93	6.8	0.549	38.3	LOS C	9.0	66.2	0.87	0.77	0.87	36.2
8	T1	1369	5.6	1369	5.6	0.961	62.6	LOS E	25.4	186.1	0.98	1.15	1.33	17.3
9	R2	221	1.4	221	1.4	0.945	80.7	LOS F	4.5	31.8	1.00	1.05	1.69	20.7
Approach		1683	5.1	1683	5.1	0.961	63.7	LOS E	25.4	186.1	0.98	1.11	1.36	18.9
West: Caddens Rd (W)														
10	L2	563	0.5	563	0.5	0.805	29.1	LOS C	15.6	109.8	0.88	0.96	1.16	36.0
11	T1	103	2.5	103	2.5	0.805	23.5	LOS B	15.6	109.8	0.88	0.96	1.16	38.2
12	R2	763	0.3	763	0.3	0.985	91.6	LOS F	17.9	125.4	1.00	1.14	1.61	10.4
Approach		1429	0.5	1429	0.5	0.985	62.1	LOS E	17.9	125.4	0.95	1.06	1.40	19.9
All Vehicles		4698	5.2	4698	5.2	0.985	52.5	LOS D	25.4	186.1	0.93	1.00	1.21	24.4

Site: SK 36PM [GIP_CAD_36_PM_O1 - SK - DL2] — **Network: N101 [Gipps St/Kent Rd]**

Gipps St / Caddens St / Kent Rd
Site Category: (None)
Signals - Fixed Time Coordinated Cycle Time = 100 seconds (Network Site User-Given Phase Times)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kent Rd														
1	L2	901	0.2	901	0.2	0.972	61.6	LOS E	30.6	214.9	1.00	1.08	1.51	25.2
2	T1	1299	1.2	1299	1.2	0.972	63.7	LOS E	27.9	197.4	0.98	1.14	1.39	27.3
3	R2	46	0.0	46	0.0	0.277	55.0	LOS D	1.4	9.5	0.97	0.74	0.97	30.9
Approach		2246	0.8	2246	0.8	0.972	62.7	LOS E	30.6	214.9	0.99	1.11	1.43	26.6
East: Caddens Rd (E)														
4	L2	112	0.0	112	0.0	0.731	40.8	LOS C	4.7	33.5	1.00	0.90	1.25	27.0
5	T1	87	5.0	87	5.0	0.731	35.2	LOS C	4.7	33.5	1.00	0.90	1.25	33.8
6	R2	204	3.2	204	3.2	0.994	92.4	LOS F	8.8	63.4	1.00	1.20	1.84	22.4
Approach		403	2.7	403	2.7	0.994	65.7	LOS E	8.8	63.4	1.00	1.06	1.55	25.1
North: Gipps St														
7	L2	108	0.0	108	0.0	0.336	29.9	LOS C	4.9	35.2	0.76	0.71	0.76	39.5
8	T1	961	5.4	961	5.4	0.587	26.4	LOS B	10.0	73.5	0.84	0.74	0.84	29.3
9	R2	266	0.4	266	0.4	0.799	59.9	LOS E	4.3	30.5	1.00	0.91	1.27	24.9
Approach		1336	3.9	1336	3.9	0.799	33.3	LOS C	10.0	73.5	0.87	0.77	0.92	28.9
West: Caddens Rd (W)														
10	L2	281	2.6	281	2.6	0.687	35.8	LOS C	8.3	59.6	0.91	0.93	1.29	33.2
11	T1	104	2.8	104	2.8	0.687	30.2	LOS C	8.3	59.6	0.91	0.93	1.29	35.5
12	R2	371	1.2	371	1.2	0.671	51.1	LOS D	5.5	38.8	1.00	0.84	1.05	16.4
Approach		756	1.9	756	1.9	0.687	42.5	LOS D	8.3	59.6	0.95	0.88	1.17	25.9
All Vehicles		4741	2.0	4741	2.0	0.994	51.4	LOS D	30.6	214.9	0.95	0.97	1.26	26.8

Source: SCT Consulting, 2020

Figure 5-13 Intersection performance summary for Kent Road sensitivity

MOVEMENT SUMMARY

Site: SM 36AM [M4_KEN_36_AM_O2 - SM] — **Network: N101 [Gipps St/Kent Rd]**

Western Motorway / Kent Rd
Site Category: (None)
Signals - Fixed Time Coordinated Cycle Time = 60 seconds (Network Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kent Rd (S)														
2	T1	959	8.7	959	8.7	0.449	3.4	LOS A	4.0	29.5	0.55	0.44	0.55	33.9
3	R2	100	0.0	100	0.0	0.449	13.2	LOS A	4.0	29.5	0.73	0.66	0.73	42.2
Approach		1059	7.9	1059	7.9	0.449	4.3	LOS A	4.0	29.5	0.57	0.46	0.57	36.4
North: Kent Rd (N)														
7	L2	1229	8.3	1229	8.3	0.677	5.8	LOS A	0.0	0.0	0.00	0.52	0.00	53.0
8	T1	127	0.0	127	0.0	0.159	11.8	LOS A	1.3	9.3	0.61	0.49	0.61	39.7
Approach		1357	7.5	1357	7.5	0.677	6.4	LOS A	1.3	9.3	0.06	0.52	0.06	52.2
All Vehicles		2416	7.7	2416	7.7	0.677	5.5	LOS A	4.0	29.5	0.28	0.50	0.28	49.6

MOVEMENT SUMMARY

Site: SM 36PM [M4_KEN_36_PM_O2 - SM] — **Network: N101 [Gipps St/Kent Rd]**

Western Motorway / Kent Rd
Site Category: (None)
Signals - Fixed Time Coordinated Cycle Time = 92 seconds (Network Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kent Rd (S)														
2	T1	1320	2.2	1320	2.2	0.421	0.7	LOS A	2.0	14.3	0.22	0.18	0.22	49.7
3	R2	58	0.0	58	0.0	0.421	6.1	LOS A	2.0	14.0	0.22	0.21	0.22	52.6
Approach		1378	2.1	1378	2.1	0.421	0.9	LOS A	2.0	14.3	0.22	0.18	0.22	50.2
North: Kent Rd (N)														
7	L2	622	4.1	622	4.1	0.333	5.7	LOS A	0.0	0.0	0.00	0.53	0.00	53.3
8	T1	111	0.0	111	0.0	0.132	16.6	LOS B	1.8	12.6	0.63	0.51	0.63	35.0
Approach		733	3.4	733	3.4	0.333	7.3	LOS A	1.8	12.6	0.10	0.52	0.10	51.2
All Vehicles		2111	2.6	2111	2.6	0.421	3.1	LOS A	2.0	14.3	0.18	0.30	0.18	51.0

MOVEMENT SUMMARY

Site: SN 36AM [M4_KEN_36_AM_O2 - SN] — **Network: N101 [Gipps St/Kent Rd]**

Kent Rd / Kent Rd Off ramp
Site Category: (None)
Signals - Fixed Time Coordinated Cycle Time = 60 seconds (Network Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kent Rd (S)														
2	T1	247	0.0	247	0.0	0.381	25.1	LOS B	2.1	14.5	0.93	0.74	0.93	25.9
Approach		247	0.0	247	0.0	0.381	25.1	LOS B	2.1	14.5	0.93	0.74	0.93	25.9
East: Western Motorway Off ramp														
4	L2	95	0.0	95	0.0	0.068	7.7	LOS A	0.3	2.0	0.28	0.64	0.28	47.0
6	R2	860	8.8	860	8.8	0.389	12.3	LOS A	3.8	28.4	0.52	0.77	0.52	47.9
Approach		955	7.9	955	7.9	0.389	11.8	LOS A	3.8	28.4	0.50	0.76	0.50	47.7
North: Kent Rd (N)														
8	T1	123	0.0	123	0.0	0.379	29.2	LOS C	2.3	15.9	1.00	0.79	1.00	25.9
Approach		123	0.0	123	0.0	0.379	29.2	LOS C	2.3	15.9	1.00	0.79	1.00	25.9
All Vehicles		1325	5.7	1325	5.7	0.389	15.9	LOS B	3.8	28.4	0.62	0.76	0.62	38.8

MOVEMENT SUMMARY

Site: SN 36PM [M4_KEN_36_PM_O2 - SN] — **Network: N101 [Gipps St/Kent Rd]**

Kent Rd / Kent Rd Off ramp
Site Category: (None)
Signals - Fixed Time Coordinated Cycle Time = 92 seconds (Network Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

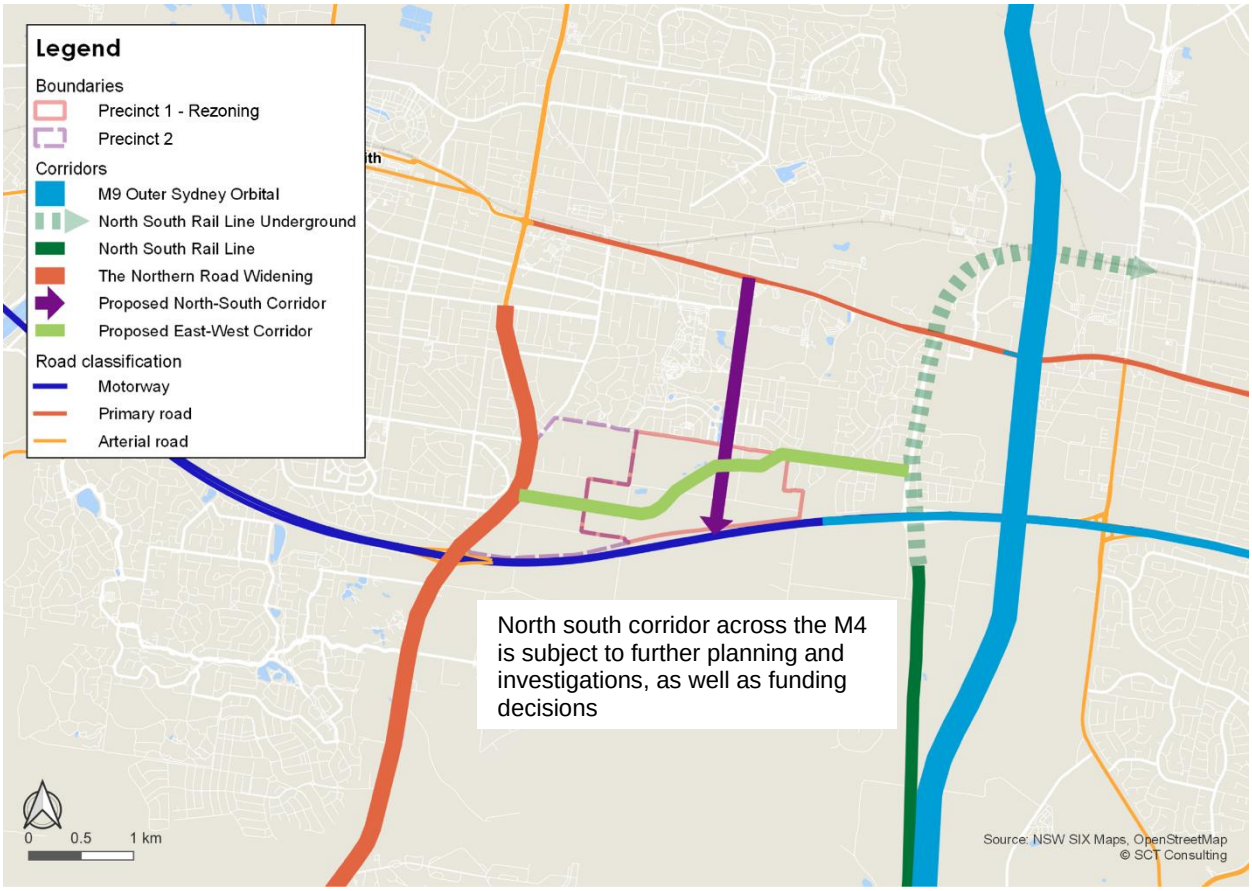
Mov ID	Turn	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	Aver. Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kent Rd (S)														
2	T1	137	0.0	137	0.0	0.070	12.6	LOS A	1.0	6.7	0.54	0.43	0.54	31.4
Approach		137	0.0	137	0.0	0.070	12.6	LOS A	1.0	6.7	0.54	0.43	0.54	31.4
East: Western Motorway Off ramp														
4	L2	86	1.2	86	1.2	0.061	7.0	LOS A	0.2	1.2	0.14	0.62	0.14	47.4
6	R2	1218	0.0	1218	0.0	0.891	47.9	LOS D	19.3	135.0	1.00	0.96	1.24	24.8
Approach		1304	0.1	1304	0.1	0.891	45.2	LOS D	19.3	135.0	0.94	0.94	1.17	26.3
North: Kent Rd (N)														
8	T1	104	0.0	104	0.0	0.107	0.8	LOS A	0.1	0.7	0.04	0.03	0.04	39.4
Approach		104	0.0	104	0.0	0.107	0.8	LOS A	0.1	0.7	0.04	0.03	0.04	39.4
All Vehicles		1545	0.1	1545	0.1	0.891	39.3	LOS C	19.3	135.0	0.85	0.83	1.03	27.4

Source: SCT Consulting, 2020

5.6 Long term transport corridors

The Orchard Hills North Precinct is surrounded by several major transport corridors which would benefit the site and alleviate traffic on the network. The remaining need for corridors would fall into the category of feeder services, providing bus, walking, and cycling connections to connect residents with the Metro station. The proposed north-south corridor provides this connectivity between Great Western Highway and the Metro station to the south of the M4 and is subject to further planning, investigations and funding decisions. Because of the number of other corridors in the vicinity, a four-lane corridor long term should provide sufficient capacity for the intended function. No traffic forecasts are available yet on the scale of Orchard Hills South nor the broader road network upgrades. TfNSW and Council have agreed to the maximum width of two lanes in each direction. **Figure 5-14** shows the coverage of planned corridors.

Figure 5-14 Planned transport corridors



Source: TfNSW, SIX maps, © OpenStreetMap contributors, SCT Consulting, 2020

5.7 Travel demand management measures

To achieve the mode shift targets towards public and active transport as well as to reduce the reliance of future residents on private vehicles, the travel demand management measures should continue to be developed in all future planning and delivery phase of Orchard Hills North Precinct:

– Development of sustainable travel initiatives as shown in **Section 4.6** at the early planning stage to set the guiding principles of a sustainable development reducing the reliance on private vehicle travel.

– Continual development and refinement of these sustainable initiatives into a Travel Plan as the planning stages of the development evolves.

– Early implementation of the Travel Plan to establish a non-car travel behaviour for future residents and employees.

– Continuous monitoring and refinement of the Travel Plan as travel behaviour of future residents and employees adjust to maximise the effectiveness of the Travel Plan.

5.8 Forecast public transport demand and network implications

5.8.1 Public transport demand

Journey-to-work travel mode data indicates that during the peak hour period public transport trips currently accounts for approximately eight per cent of trips, of which the majority are train trips.

It is targeted that a five percent mode shift towards public transport and active transport and can be expected because of the potential improvements in public transport services, implementation of TDM measures as well as a Green Travel Plan for the development.

Based on these assumptions, a summary of the additional train and bus trips that area likely to be generated by the proposed development is presented in **Table 5-18**. At full development, this accounts for a total of 650-750 additional public trips during the AM and PM peak hour trips.

Table 5-18 Public transport net trip generation for the site, by mode

Mode of Transport	Targeted mode share	AM peak hour	PM peak hour
Vehicular traffic	75%	2,794	2,448
Train	15%	559	490
Bus	5%	186	163
Total public transport trips	**20%**	**745**	**653**

Source: SCT Consulting; 2019

It is noted that while this is a minor level of public transport mode shift, the delivery of Sydney Metro Western Sydney Airport Line could significantly change behaviours at this location.

5.8.2 Public transport initiatives / opportunities

The following initiatives / opportunities will be further considered in the next phase of the study to cater for the public transport demand expected to be generated by the Orchard Hills North proposal:

– As part of The Northern Road upgrade, a kerbside bus lane in each direction will be provided, which will improve bus accessibility to the site, travel time and efficiency.

– Accessibility to bus stops has been improved by the provision of six bus bays on both sides of Gipps Street and Kent Road as part of the Werrington Arterial Road upgrade.

– Subject to consultation with TfNSW and further investigations, the 778 and 781 services can be extended and re-routed respectively to provide improve coverage to the proposed development and more frequent bus services can be provided as the population and demand for improved public transport services increase. To enable improved coverage of public transport in Orchard Hills North, all the collector streets will be planned and designed to be bus capable with 3.5 m wide travel lanes in each direction, with appropriate bus stop facilities.

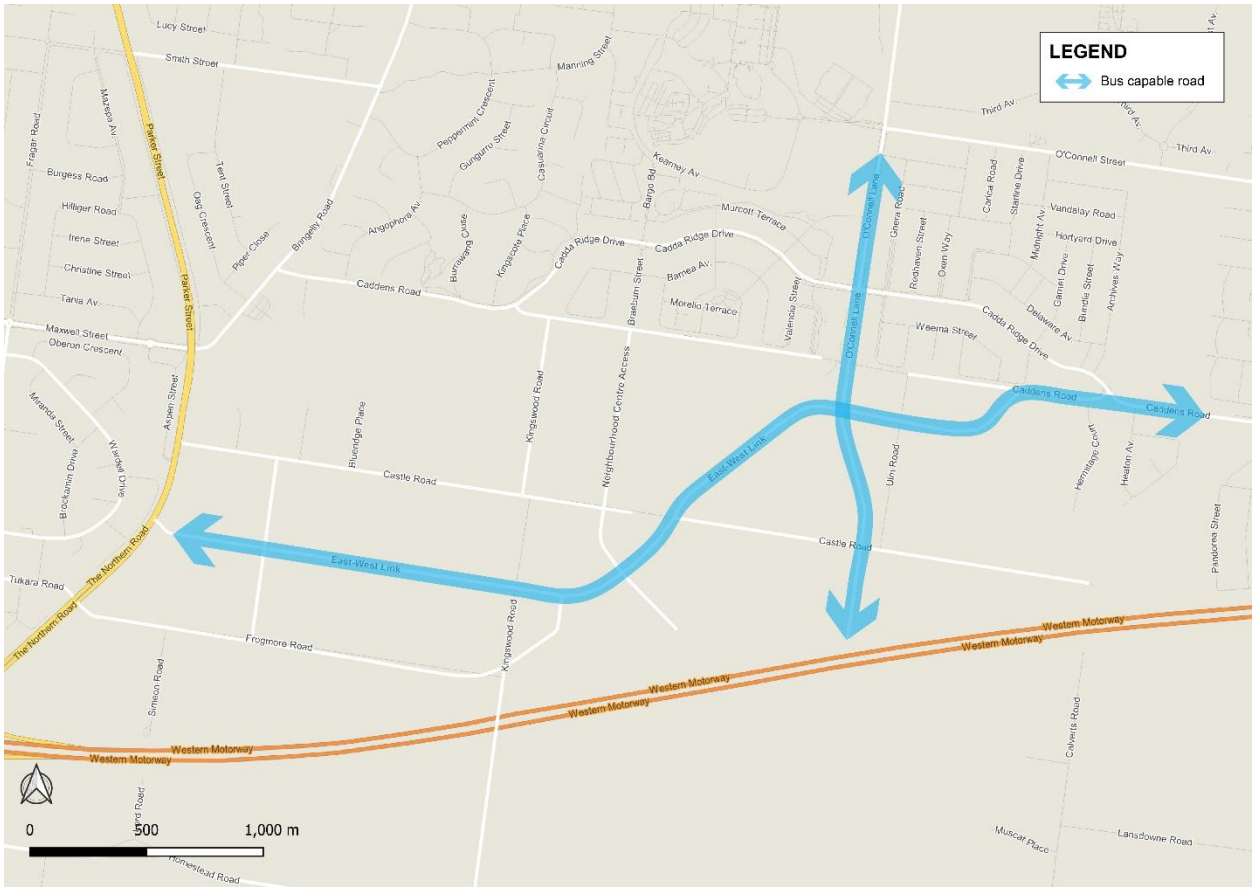
– On-demand transport can further investigate to determine feasibility (including funding source) of a trial between Orchard Hills North (jointly with Caddens and Claremont Meadows) and surrounding transport interchanges and rail stations to improve connectivity of future residents and employees.

– A new north-south connection and metro stations at St Marys and Orchard Hills South, as part of the Sydney Metro Western Sydney Airport project would improve rail accessibility to the South West Growth Centre and the Western Sydney airport. This would significantly enhance the site's accessibility to surrounding employment / educational facilities via public transport. This would also reduce the site's vehicular travel demand and improve the site's public transport mode share targets and should be further considered in the traffic modelling post-gateway. A new station at Orchard Hills South would also provide access to jobs via public transport in connection with the north-south corridor.

Further planning and consultation with Council and TfNSW is required around the short term bus routes during and post exhibition. This needs to include planning for bus routes for the scenario where Precinct 1 is delivered by Precinct 2 is not.

The north-south and east-west corridors are both bus-capable. The potential roads for bus services are shown in **Figure 5-15**.

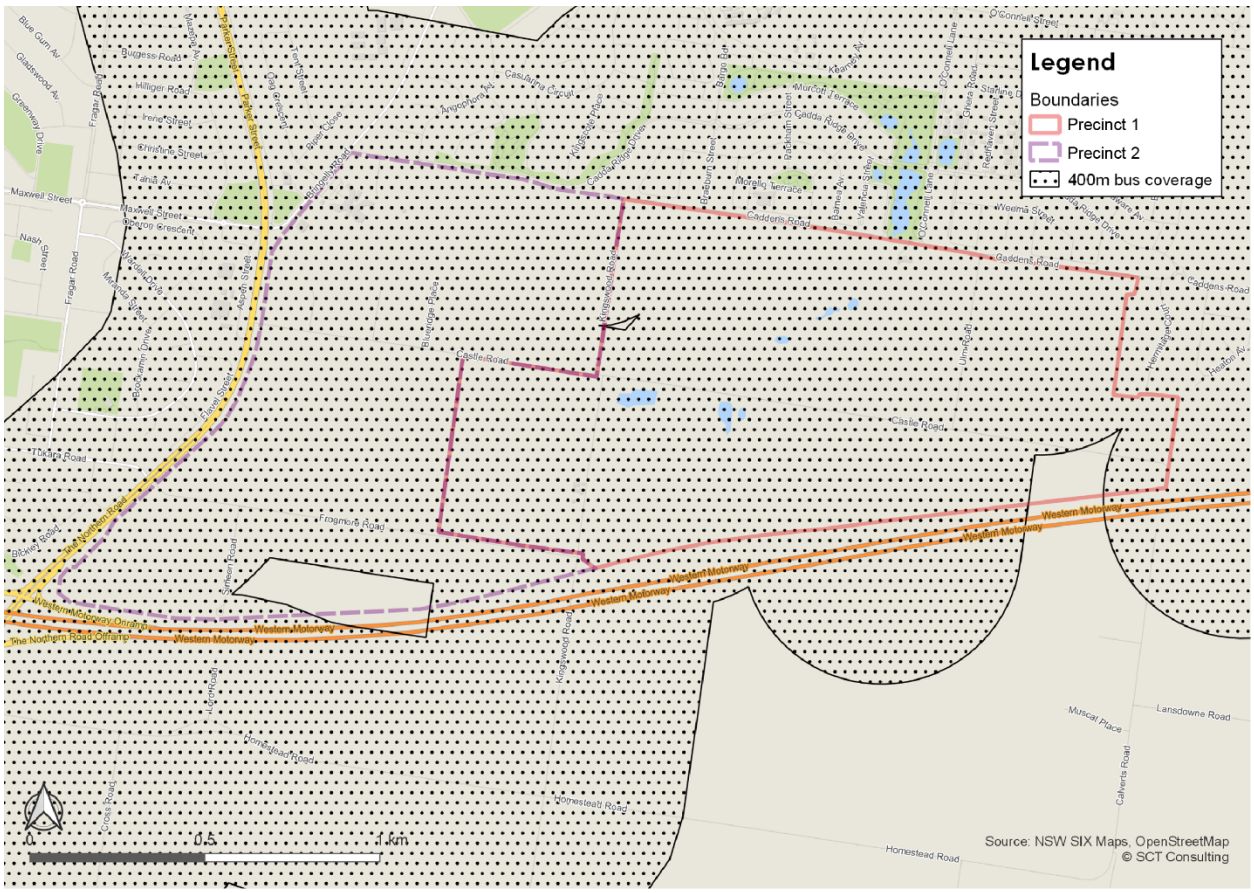
Figure 5-15 Potential future bus corridors (subject to planning, investigation, and funding)



Source: SCT Consulting, 2021, © OSM Contributors

If potential bus services run on these roads in addition to current public routes, the 400m bus coverage is shown in **Figure 5-16**.

Figure 5-16 Potential bus coverage (400m)



97% of the planning proposal area is covered within 400m of a potential bus route. For the 3% that remains not covered, the majority (located at the south-east of the site) is predominately open space. As such, the road network is considered able to achieve appropriate bus coverage (which would be subject to further planning, investigation, and funding decisions).

5.9 Forecast active transport demand and network implications

5.9.1 Active transport demand

Journey-to-work travel mode data indicates that during the peak hour period “walked only” trips accounts for approximately four per cent of trips respectively during the peak hour periods.

However, as mentioned above, a mode shift towards active transport can be expected based on factors such as proposed improvements to the cycle and walking networks. As a result, walking and cycling is expected to account for approximately five percent of all trips, which equates to approximately 200 additional walking / cycling trips in the AM and PM peak hours.

5.9.2 Active transport initiatives / opportunities

The following initiatives / opportunities will be further considered in the next phase of the study to cater for the active transport demand expected to be generated by the Orchard Hills North proposal:

– As part of the Werrington Road upgrade, a three-metre-wide off-road shared path, including a new bridge over the M4 Motorway and bicycle and pedestrian crossings at traffic lights has improved cycle access to the site.

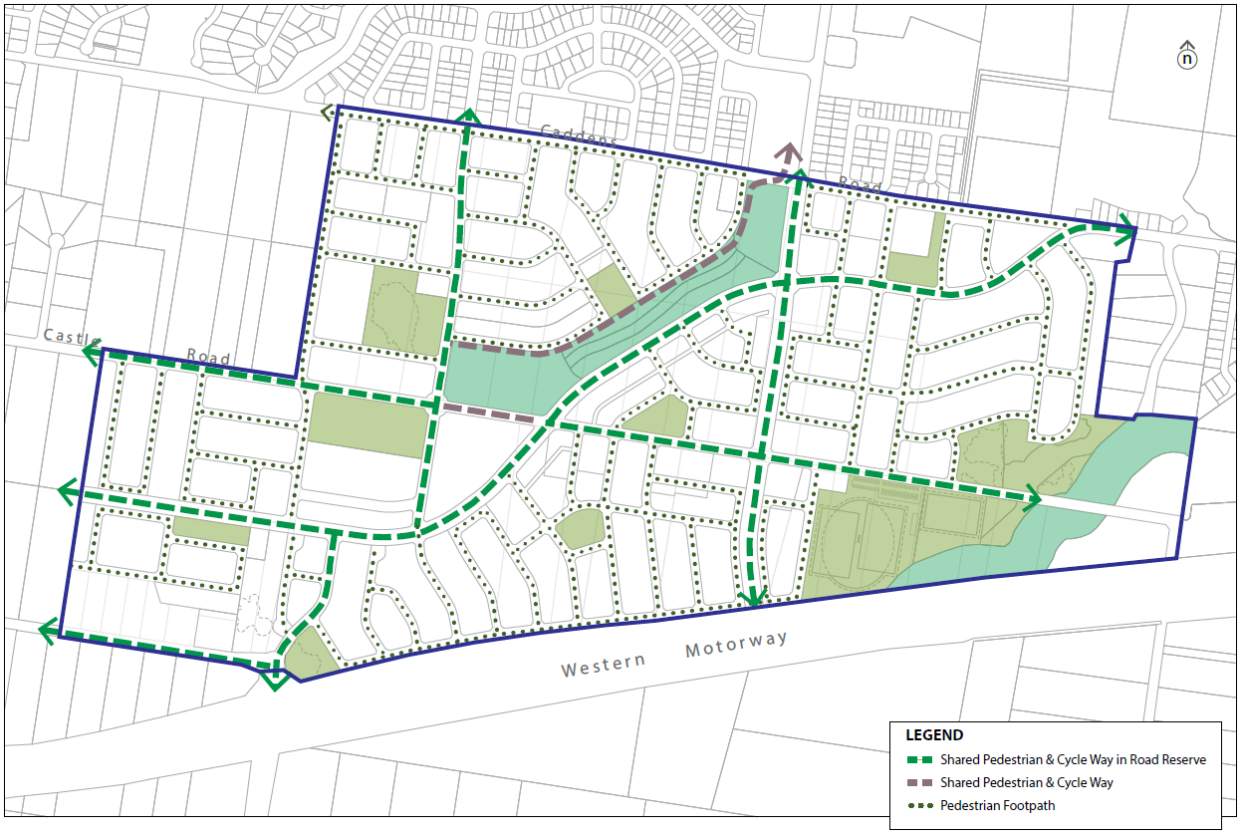
– As part of The Northern Road upgrade, improved facilities such as a shared path and footpaths along both sides of The Northern Road and Frogmore Road will significantly improve pedestrian and cycling access for the site.

– The green grid connection proposed as part of the open space corridor (identified in the Structure Plan) could provide an active transport link to the surrounding network and to locations including the Kingswood Railway Station, Western Sydney University, and the Nepean Hospital.

– The Penrith Integrated Transport and Land Use Strategy identified the need to establish a well-defined bike network in the Urban Release Area (URA) to link up to Werrington, Kingswood, and St Marys URA, which would improve active transport access to the site.

– The main collector streets within the proposed Orchard Hills North development will be designed to cater for off-road shared paths to integrate with surrounding street network. **Figure 5-17** illustrates the active transport network within the development.

Figure 5-17 Pedestrian and cycle network within the development

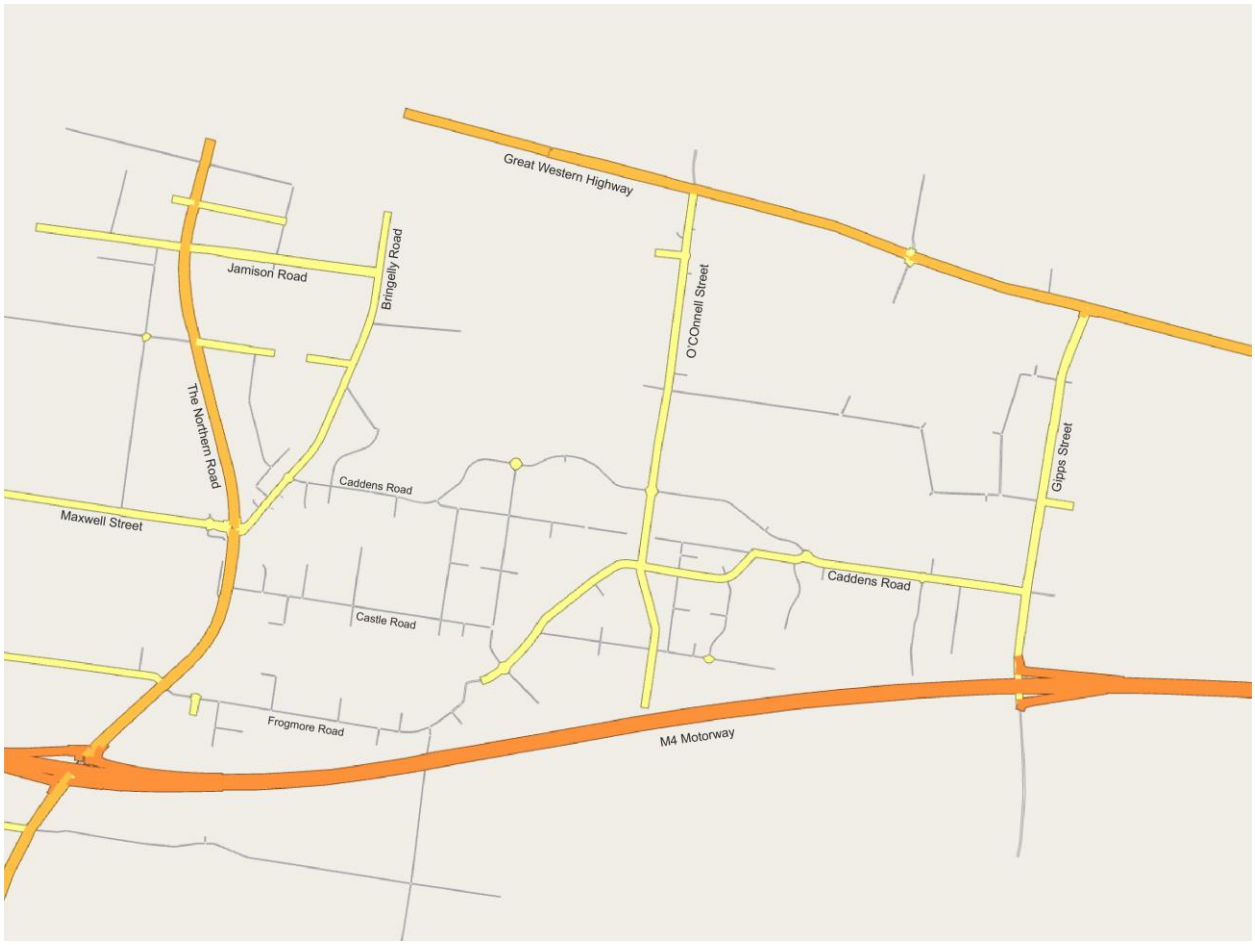


Source: Design + Planning, November 2022

5.10 Staging

Precinct 1 could be delivered in advance of Precinct 2 and other broader infrastructure. The corridors for the east-west and north-south links that fall within Precinct 1 would be delivered and connected into the existing transport network. This is illustrated in **Figure 5-18**.

Figure 5-18 Proposed staging of north-south and east-west links



Source: SCT Consulting, 2020

Many of the roads would operate satisfactorily with a cross-section of only one lane in each direction, minimising the need for upfront investment in infrastructure that is not required from a traffic operational perspective. Land could be either dedicated or reserved for the future footprint or roads could be delivered with a wide median that minimises changes to the intersection footprint when widening in the future.

The connection to Orchard Hills South would be further designed and planned by the relevant road authority.

As is shown in **Section 5.3.1**, traffic volumes on Frogmore Road are 400 vehicles per hour or less during both peak periods, which is acceptable for a single lane of traffic. The condition of Frogmore Road would not be suitable for carrying traffic of 400 vehicles per hour in its current condition, with poor pavement quality. This road would require upgrade as part of the rezoning application.

6.0 Summary and conclusions

6.1 Conclusions

This TMAP provides evidence that the rezoning is feasible within the study area. Traffic modelling indicates that further expansion of the Orchard Hills North area to the west defined as Precinct 2 is also feasible. Together with background growth, the Orchard Hills North Precinct (Precincts 1 & 2) are able to be accommodated with road upgrades that have been designed to be efficient, economic, and appropriate to road typologies.

A suite of potential road upgrades (subject to further investigations, planning, and funding decisions) is proposed to mitigate the impacts of the development. With these upgrades, the road network will continue to operate at Level of Service D or better. It is recommended that the Section 7.11 plan and State Contributions Framework take these upgrades into consideration as well as the staging outlined.

A summary of the proposed upgrades is provided in **Table 6-1**. A full description of the proposed works is suppled in the above report in **Section 5.3.6** to **Section 5.3.8**.

Table 6-1 Road infrastructure upgrade summary (subject to further planning, investigations, and funding decisions)

Item	Nexus
Caddens Road / Gipps Street / Kent Road	– Background growth – Orchard Hills North Precinct (Precincts 1 & 2)
Great Western Highway / Gipps Street	
Resurfacing of Frogmore Road	
The Northern Road / Frogmore Road	– Precinct 2
The Northern Road / New East-West corridor (new)	
East-West corridor west of Precinct 1 (to The Northern Road)	
New East-West corridor / Neighbourhood Centre Access (new)	– Background growth – Orchard Hills North Precinct (Precincts 1 & 2)
New East West corridor / O'Connell Lane (North-South corridor) (new)	
Great Western Highway / O'Connell Street / French Street	
O'Connell Lane / O'Connell Street / Western Sydney University entrance	
O'Connell Street / Cadda Ridge Drive	
M4 Motorway Ramps / Kent Road	
The Northern Road / Bringelly Road	
O'Connell Street / North-South corridor dual lane upgrades	
Caddens Road / East-West corridor dual lane upgrades	
Land dedication for two lanes in each direction for remainder of east-west and north-south corridor	Development beyond Orchard Hills North Precinct (Precincts 1 & 2)
Construction of two lanes in remainder of east-west and north-south corridor	

A key element of the Orchard Hills North Structure Plan is to identify key green corridors to provide walking and cycling connections as part of wider regional links. Pedestrian access to the site will be via the existing footpaths and proposed intersections on Caddens Road north of the site and at the upgraded intersections at Frogmore Road and Castle Road with The Northern Road, west of the site (as part of The Northern Road upgrade). Pedestrian access within the development with be provided via footpaths on all streets within the development and with pedestrian and cyclist shared path along key routes. Cycling access within the development is provided through a mixture of dedicated shared paths as well as shared paths located in the road reserve. The proposed cycle ways provide both east-west and north-south movements, providing access to the neighbourhood centre as well as connectivity with the wider cycle network. The provision of cycling facilities will encourage active transport within the development and for trips to nearby local centres such as Penrith.

To enable improve coverage of public transport in Orchard Hills North, all the collector streets, the north-south and east-west links are planned and designed to be bus capable with 3.5 m travel lanes in each direction, meaning that future bus services can be accommodated in any of the higher order road network within the subdivision.

The only mandatory gateway condition of consultation with Council and Transport for NSW has been fulfilled as is evidenced by minutes of the steering committee provided in this report.

6.2 Next steps

This report is recommended for exhibition. During and following the exhibition period, further refinements will be considered in collaboration with Council and TfNSW.

Further traffic modelling and planning for intersections will occur during and post-exhibition, including to tweak local intersection performance.

APPENDIX A

Modelling Framework

APPENDIX B

Traffic Modelling Calibration and Validation Reports

APPENDIX C

Traffic models and detailed results

Table C-1 2036 Background growth intersection results, AM peak, subject to further planning, investigation, and funding decisions

Intersection	Background growth Planned upgrades only							Background growth Additional upgrades						
	Vol	Worst*	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS	Vol	Worst*	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS
TNR / Frogmore Rd	6,037	Tukara Rd (NW)	C	17	168	B	0.79	6,037	Tukara Rd (NW)	C	17	168	B	0.79
TNR / Castle Rd	5,081	Castle Rd (E)	A	6	3	A	0.62	5,081	Castle Rd (E)	A	6	3	A	0.63
TNR / Bringelly Rd	5,510	Maxwell St	F	43	178	D	0.78	5,510	Maxwell St	F	45	180	D	0.82
Bringelly Rd / Caddens Rd	1,919	Bringelly Rd (SW)	B	25	59	B	0.90	1,916	Bringelly Rd (SW)	A	12	9	A	0.43
Kingswood Rd / Caddens Rd	906	Kingswood Rd	A	6	7	A	0.40	906	Kingswood Rd	A	6	7	A	0.40
Caddens Rd / O'Connell Ln	851	Caddens Rd (W)	A	7	0	A	0.29	851	Caddens Rd (W)	A	7	0	A	0.29
O'Connell Ln / Cadda Ridge Dr	1,726	Cadda Ridge Dr (W)	A	12	20	A	0.70	1,726	Cadda Ridge Dr (W)	A	12	20	A	0.70
O'Connell Lane / O'Connell St	1,582	Western Syd Uni entrance	A	15	23	B	0.69	1,582	Western Syd Uni entrance	A	15	23	B	0.69
O'Connell St / GWH / French St	4,358	French St	D	32	132	C	0.75	4,358	French St	D	32	132	C	0.75
GWH / Gipps St	5,688	Great Western Hwy	F	144	384	F	1.20	5,688	Gipps St	D	43	175	D	0.91
Gipps St / Caddens Rd / Kent Rd	3,320	Caddens Rd (W)	D	41	211	C	0.91	3,320	Caddens Rd (W)	D	26	149	B	0.74
Caddens Rd / Cadda Ridge Dr	1,045	Cadda Ridge Dr	A	10	4	A	0.28	1,045	Cadda Ridge Dr	A	10	4	A	0.28
M4 / Kent Rd (On Ramp)	3,172	Kent Rd (S)	A	10	117	A	0.83	3,172	Kent Rd (N)	D	9	89	A	0.83
M4 / Kent Rd (Off Ramp)	2,396	Kent Rd (N)	C	30	105	C	0.71	2,396	Kent Rd (N)	C	29	109	C	0.69
Homestead Rd / Kingswood Rd	734	Kingswood Rd (S)	A	10	3	A	0.30	734	Kingswood Rd (S)	A	10	3	A	0.30

Source: SCT Consulting, 2020

*Worst approach by delay

Table C-2 2036 Background growth intersection results, PM peak, subject to further planning, investigation, and funding decisions

Intersection	Background growth Planned upgrades only							Background growth Additional upgrades						
	Vol	Worst*	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS	Vol	Worst*	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS
TNR / Frogmore Rd	6,507	The Northern Rd (NE)	E	40	468	C	0.98	6,507	The Northern Rd (NE)	F	77	625	D	1.02
TNR / Castle Rd	5,761	Castle Rd (E)	A	6	4	A	0.85	5,761	Castle Rd (E)	A	6	5	A	0.99
TNR / Bringelly Rd	6,157	Maxwell St	F	59	261	E	0.97	6,157	Maxwell St	F	58	250	D	0.98
Bringelly Rd / Caddens Rd	1,849	Bringelly Rd (NE)	B	23	48	B	0.87	1,848	Caddens Rd	A	15	17	B	0.61
Kingswood Rd / Caddens Rd	721	Kingswood Rd	A	6	3	A	0.21	721	Kingswood Rd	A	6	3	A	0.21
Caddens Rd / O'Connell Ln	826	Caddens Rd (W)	A	6	0	A	0.30	826	Caddens Rd (W)	A	6	0	A	0.30
O'Connell Ln / Cadda Ridge Dr	1,796	Cadda Ridge Dr (E)	A	14	20	A	0.72	1,796	Cadda Ridge Dr (E)	A	14	20	A	0.72
O'Connell Lane / O'Connell St	1,617	O'Connell St (E)	B	18	23	B	0.70	1,617	O'Connell St (E)	B	18	23	B	0.70
O'Connell St / GWH / French St	4,383	O'Connell St	D	38	169	C	0.85	4,383	O'Connell St	D	38	169	C	0.85
GWH / Gipps St	6,156	Great Western Hwy	F	115	738	F	1.21	6,156	Great Western Hwy	E	54	564	D	1.03
Gipps St / Caddens Rd / Kent Rd	3,738	Caddens Rd (E)	C	26	110	C	0.90	3,738	Caddens Rd (E)	E	35	208	C	0.88
Caddens Rd / Cadda Ridge Dr	994	Cadda Ridge Dr	A	9	5	B	0.33	994	Cadda Ridge Dr	A	9	5	A	0.33
M4 / Kent Rd (On Ramp)	3,557	Kent Rd (N)	B	15	135	B	0.89	3,557	Kent Rd (N)	A	7	86	A	0.81
M4 / Kent Rd (Off Ramp)	2,738	Kent Rd (S)	F	159	368	F	1.15	2,738	Kent Rd (N)	D	19	55	D	0.88
Homestead Rd / Kingswood Rd	735	Kingswood Rd (S)	A	10	2	A	0.17	735	Kingswood Rd (S)	A	10	2	A	0.17

Source: SCT Consulting, 2021
*Worst approach by delay

Table C-3 2036 Precinct 1 intersection results (subject to further investigations, planning, and funding decisions)

Intersection	AM Peak							PM Peak						
	Vol	Worst* App.	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS	Vol	Worst* App.	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS
TNR / Frogmore Rd	6,237	Tukara Rd (NW)	C	16	143	B	0.77	6,495	The Northern Rd (NE)	E	39	416	C	0.98
TNR / Castle Rd	5,013	Castle Rd (E)	A	6	3	A	0.58	5,505	Castle Rd (E)	A	6	2	A	0.73
TNR / Bringelly Rd	5,400	Maxwell St	F	43	175	D	0.81	6,038	Maxwell St	F	56	258	D	0.98
Bringelly Rd / Caddens Rd	2,034	Caddens Rd	B	18	60	B	0.89	1,916	Bringelly Rd (NE)	B	29	70	C	0.93
Caddens Rd / Kingswood Rd	594	Kingswood Rd	A	6	3	A	0.18	491	Kingswood Rd	A	6	1	A	0.07
O'Connell Ln / Cadda Ridge Dr	2,449	Cadda Ridge Dr (W)	A	11	10	A	0.57	2,436	Cadda Ridge Dr (E)	A	13	10	A	0.57
O'Connell Ln / O'Connell St	2,095	Western Syd Uni entrance	A	13	12	A	0.50	2,254	O'Connell St (E)	B	16	14	B	0.58
GWH / O'Connell St	4,611	O'Connell St	D	43	157	D	0.85	4,846	O'Connell St	F	48	203	D	0.94
GWH / Gipps St	5,980	Great Western Hwy	D	47	162	D	0.94	6,214	Gipps St	D	37	274	C	0.97
Gipps St / Caddens Rd	3,829	Caddens Rd (W)	F	46	227	D	0.96	3,917	Caddens Rd (E)	F	45	219	D	0.99
Caddens Rd / Cadda Ridge Dr	1,611	Cadda Ridge Dr	A	11	9	A	0.48	1,423	Cadda Ridge Dr	A	9	14	A	0.62
M4 / Kent St On Ramp	3,608	Kent Rd (N)	A	10	107	A	0.89	3,788	Kent Rd (N)	A	8	98	A	0.76
M4 / Kent St Off Ramp	2,141	Kent Rd (N)	D	39	153	C	0.79	2,847	Kent Rd (S)	E	53	287	D	0.93
Kingswood Rd / Homestead Rd	816	Kingswood Rd (S)	A	10	3	A	0.31	828	Kingswood Rd (S)	A	10	2	A	0.19
O'Connell Ln / East West Link (new)	2,331	O'Connell Ln	E	51	185	D	0.89	2,173	O'Connell Lane	D	44	134	D	0.85
East West Link / Neighbourhood Centre Access (new)	2,174	EW Link	B	19	31	B	0.78	1,926	EW Link	B	19	55	B	0.88

Source: SCT Consulting, 2021
*Worst approach by delay

Table C-4 2036 Orchard Hills North Precinct (Precincts 1 & 2) intersection results (subject to further investigations, planning, and funding decisions)

Intersection	AM Peak							PM Peak						
	Vol	Worst* App.	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS	Vol	Worst* App.	Worst * LoS	Delay (s)	Queue (m)	Int. LoS	DoS
TNR / Frogmore Rd	6,289	Tukara Rd (NW)	A	6	11	A	0.52	6,473	Tukara Rd (NW)	A	7	9	A	0.51
TNR / Castle Rd	5,514	Castle Rd (E)	A	6	6	A	0.61	5,731	Castle Rd (E)	A	6	23	A	0.49
TNR / Bringelly Rd	5,632	Maxwell St	E	38	177	C	0.77	6,062	Maxwell St	F	48	212	D	0.87
Bringelly Rd / Caddens Rd	1,982	Caddens Rd	B	22	58	B	0.90	1,935	Bringelly Rd (NE)	D	54	130	D	1.01
Caddens Rd / Kingswood Rd	506	Kingswood Rd	A	6	2	A	0.15	502	Kingswood Rd	A	6	1	A	0.10
O'Connell Ln / Cadda Ridge Dr	2,695	Cadda Ridge Dr (W)	A	12	14	A	0.70	3,117	Cadda Ridge Dr (E)	B	20	31	B	0.83
O'Connell Ln / O'Connell St	2,306	Western Syd Uni entrance	A	14	15	A	0.58	2,803	O'Connell St (E)	C	32	26	C	0.78
GWH / O'Connell St	4,792	O'Connell St	D	51	167	D	0.93	5,362	French St	E	48	194	D	1.01
GWH / Gipps St	6,157	Gipps St	D	42	146	C	0.89	6,601	Gipps St	D	44	463	D	1.01
Gipps St / Caddens Rd	4,256	Caddens Rd (E)	E	43	203	D	0.88	4,342	Caddens Rd (E)	F	40	219	C	1.01
Caddens Rd / Cadda Ridge Dr	2,000	Cadda Ridge Dr	A	11	4	A	0.38	1,895	Cadda Ridge Dr	A	9	6	A	0.44
M4 / Kent St On Ramp	3,640	Kent Rd (S)	A	10	75	A	0.89	4,041	Kent Rd (N)	A	5	836	A	0.64
M4 / Kent St Off Ramp	2,651	Kent Rd (N)	D	33	116	C	0.81	3,178	M4 Off ramp	C	34	223	C	0.90
Kingswood Rd / Homestead Rd	733	Kingswood Rd (S)	A	10	3	A	0.29	820	Kingswood Rd (S)	A	11	2	A	0.21
O'Connell Ln / E-W Link (new)	2,855	O'Connell Lane	F	56	186	D	0.96	2,958	EW Link	E	52	248	D	1.00
East West Link / Neighbourhood Centre (new)	2,996	Neighbourhood Centre	D	36	157	C	0.77	3,003	EW Link	D	48	268	D	0.91
TNR / E-W Link (new)	5,859	EW Link	D	29	159	C	0.80	5,936	EW Link	F	30	200	C	0.86

Source: SCT Consulting, 2020
*Worst approach by delay

Table C-5 2036 signalised alternatives subject to further planning, investigations, and funding decisions

Intersection	Peak	Volume	Worst* App.	Worst* LoS	Delay (s)	Queue (m)	Int. LoS	DoS
O'Connell Ln / Cadda Ridge Dr (Model Intersection SG)	AM	2,695	Cadda Ridge Dr (E)	F	44	185	D	0.96
	PM	3,099	Cadda Ridge Dr (E)	E	46	279	D	0.91
O'Connell Ln / O'Connell St (Model Intersection SH)	AM	2,306	O'Connell St (E)	F	21	190	B	0.84
	PM	2,809	O'Connell St (E)	E	26	186	B	0.82

Source: SCT Consulting, 2020
*Worst approach by delay

APPENDIX D

SIDRA Turning Movement Summary

Figure D-1 SIDRA turn movements, Base Year AM

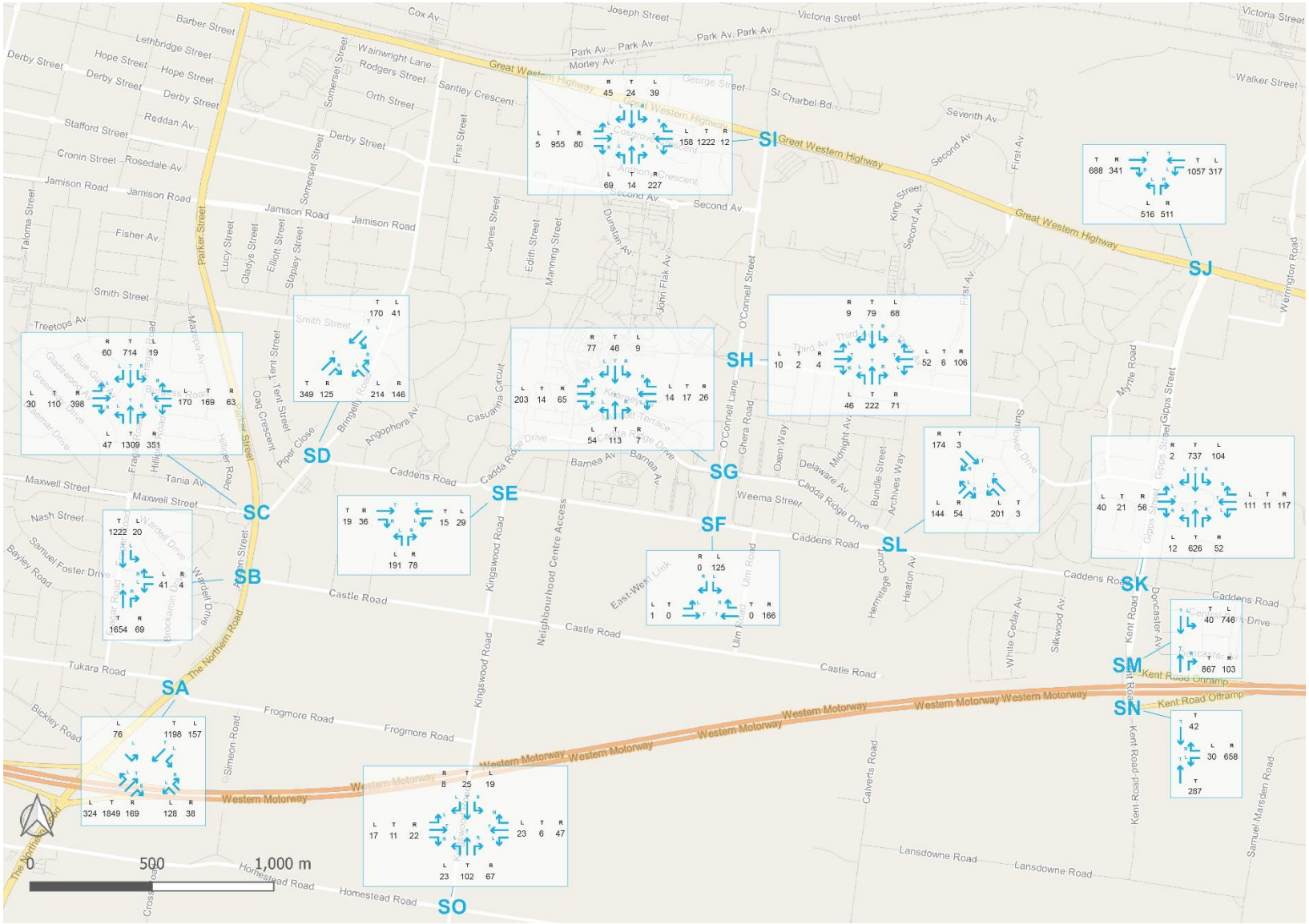


Figure D-2 SIDRA turn movements, Base Year PM

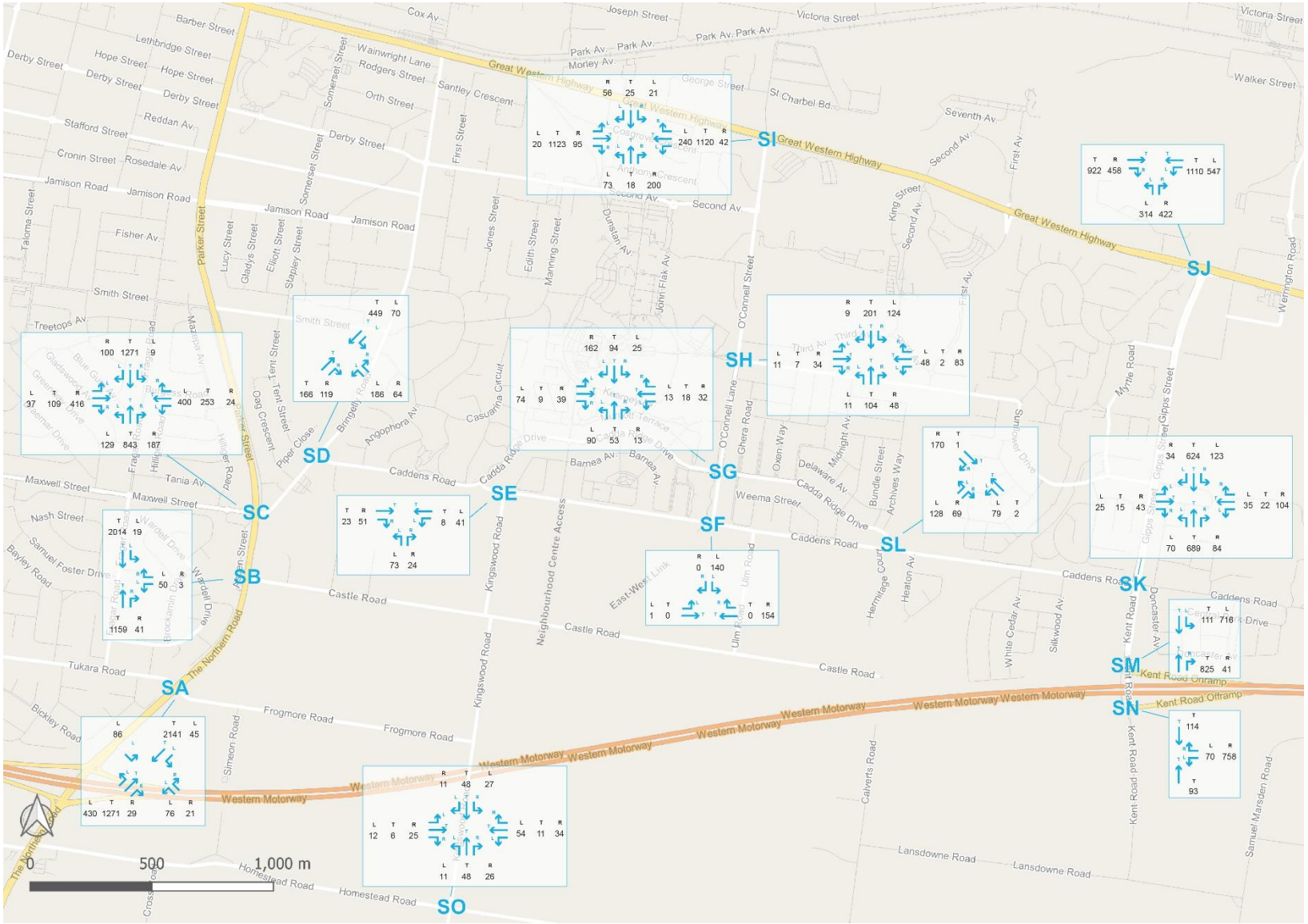


Figure D-3 SIDRA turn movements, FY0 AM

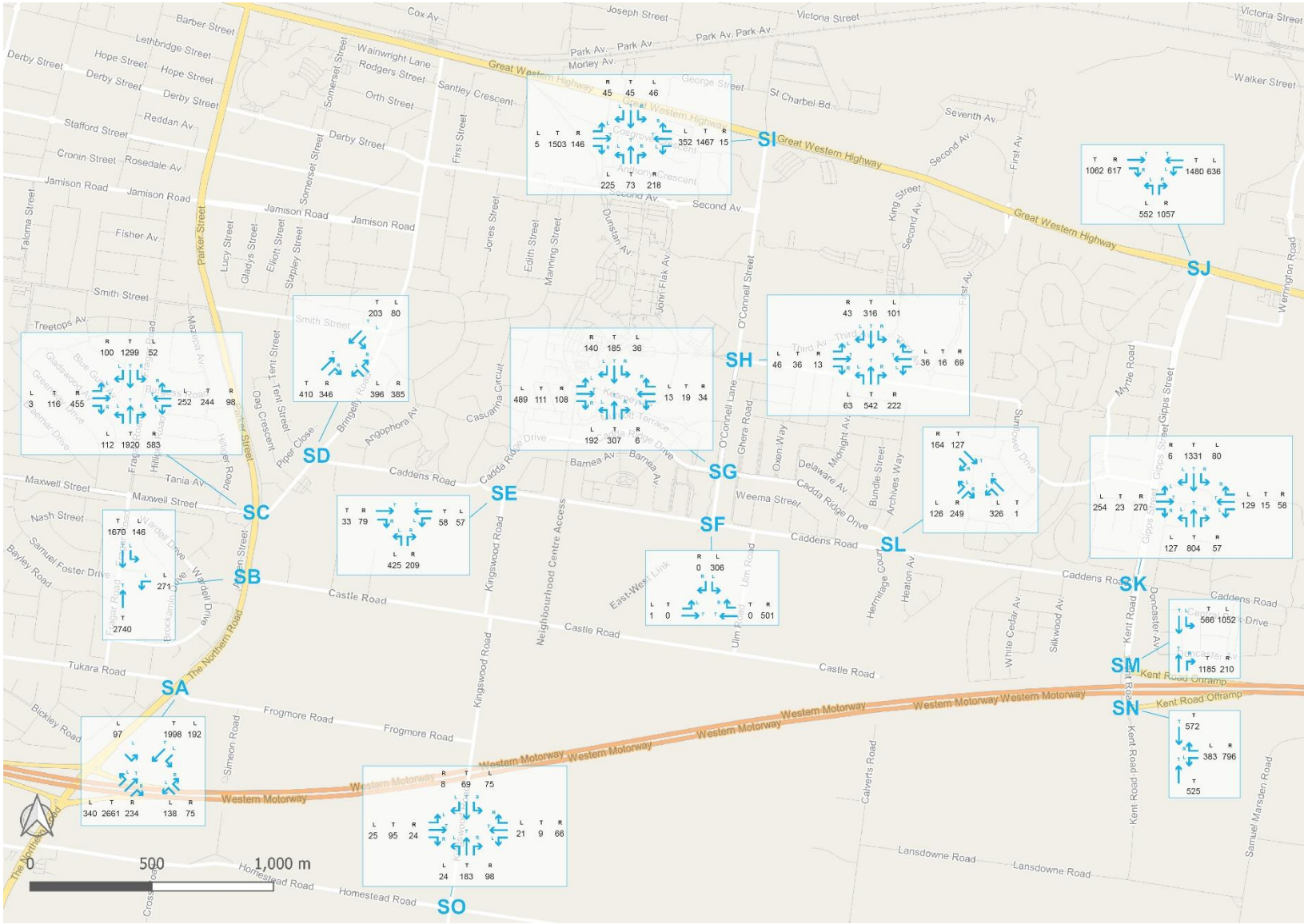


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Figure D-4 SIDRA turn movements, FY0 PM

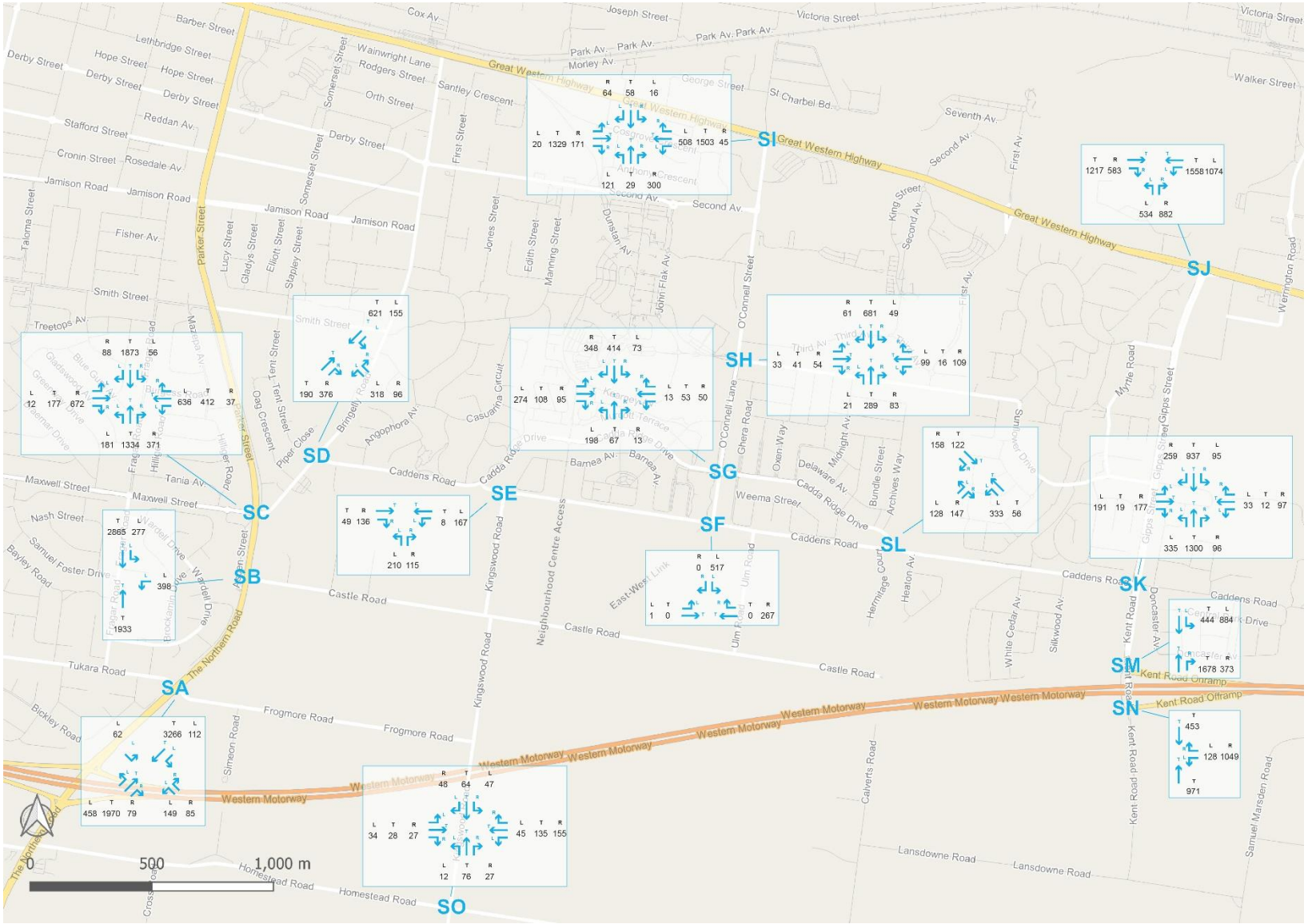

Figure D-5 SIDRA turn movements, FY1 AM

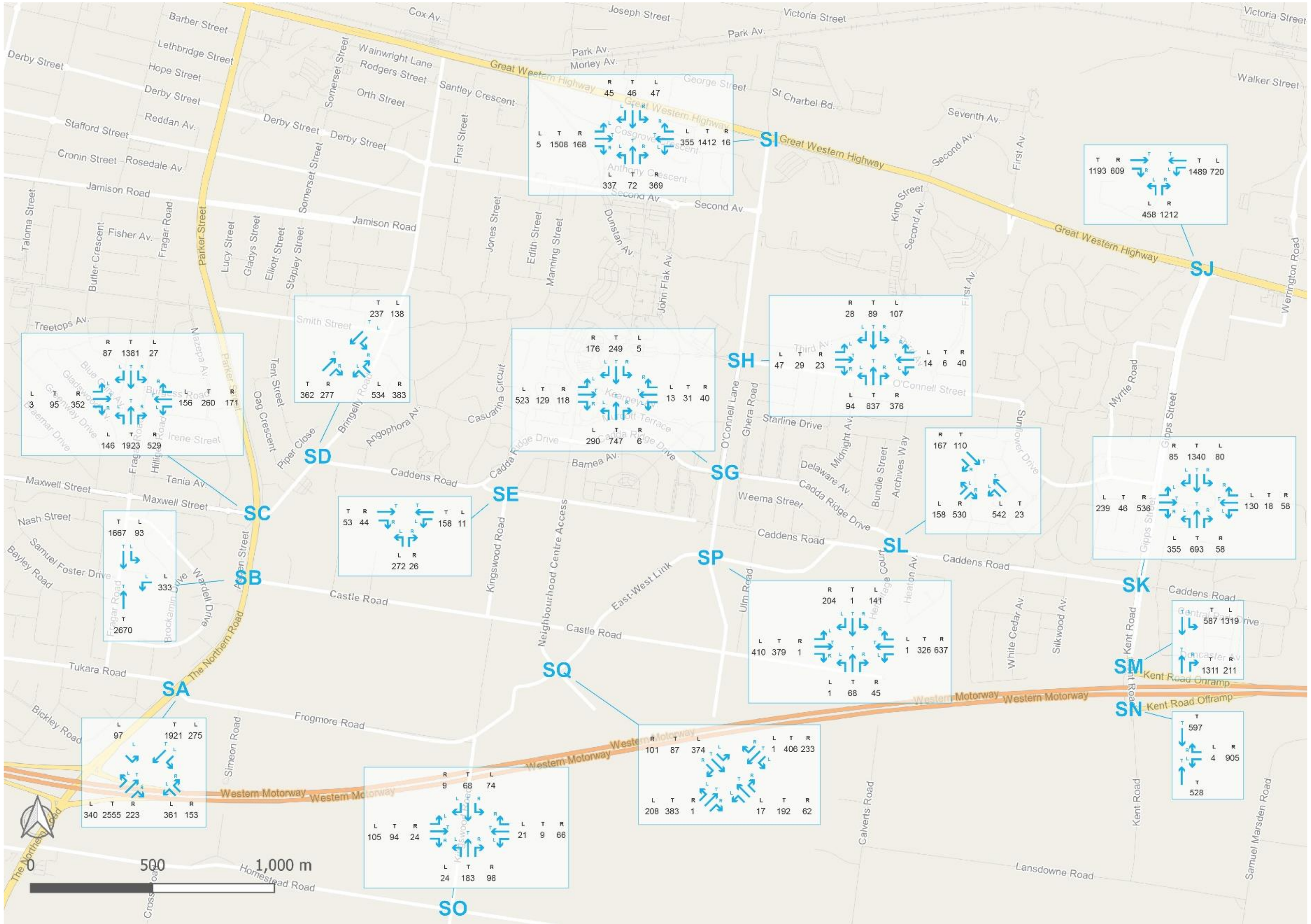

Figure D-6 SIDRA turn movements, FY1 PM

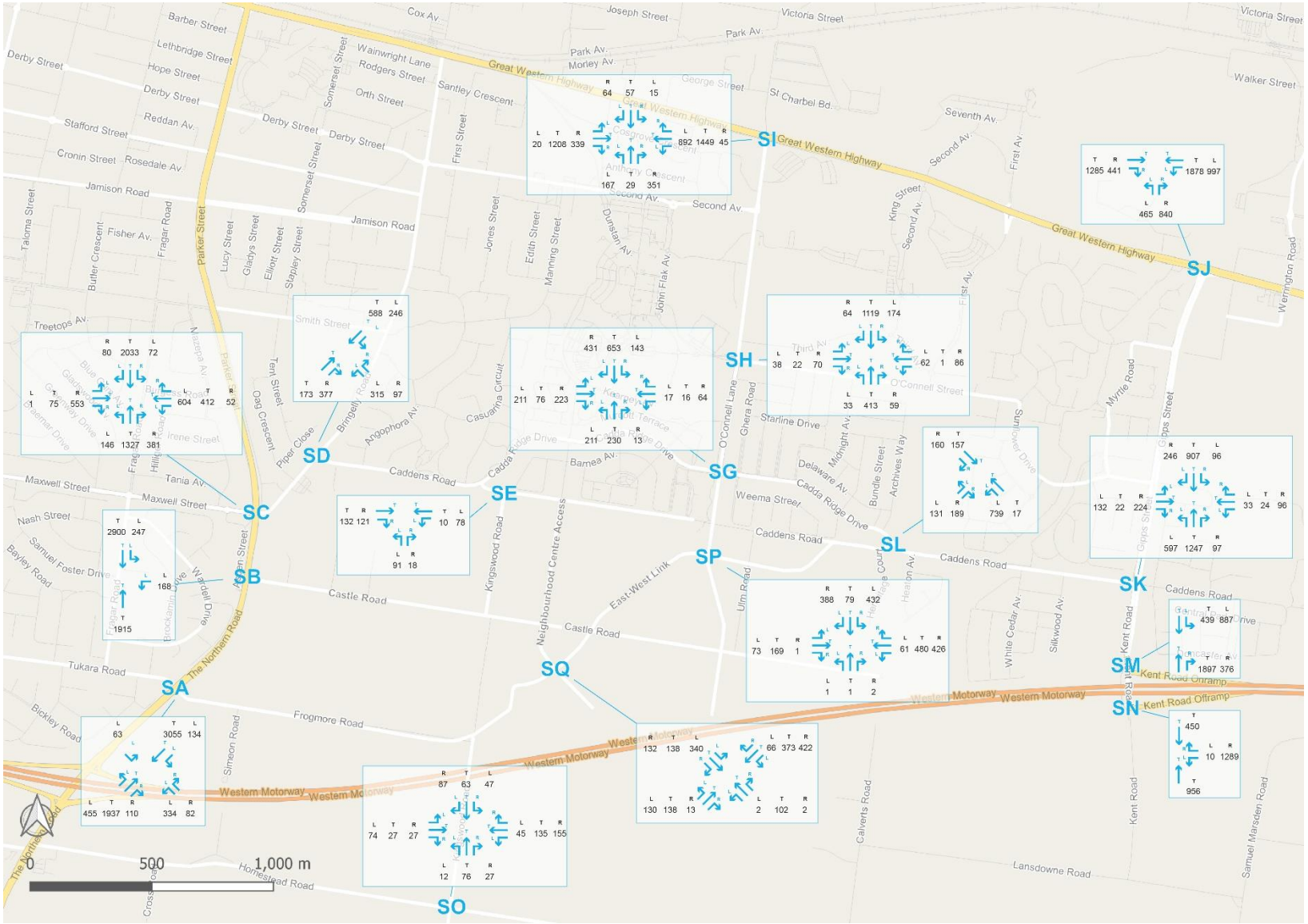

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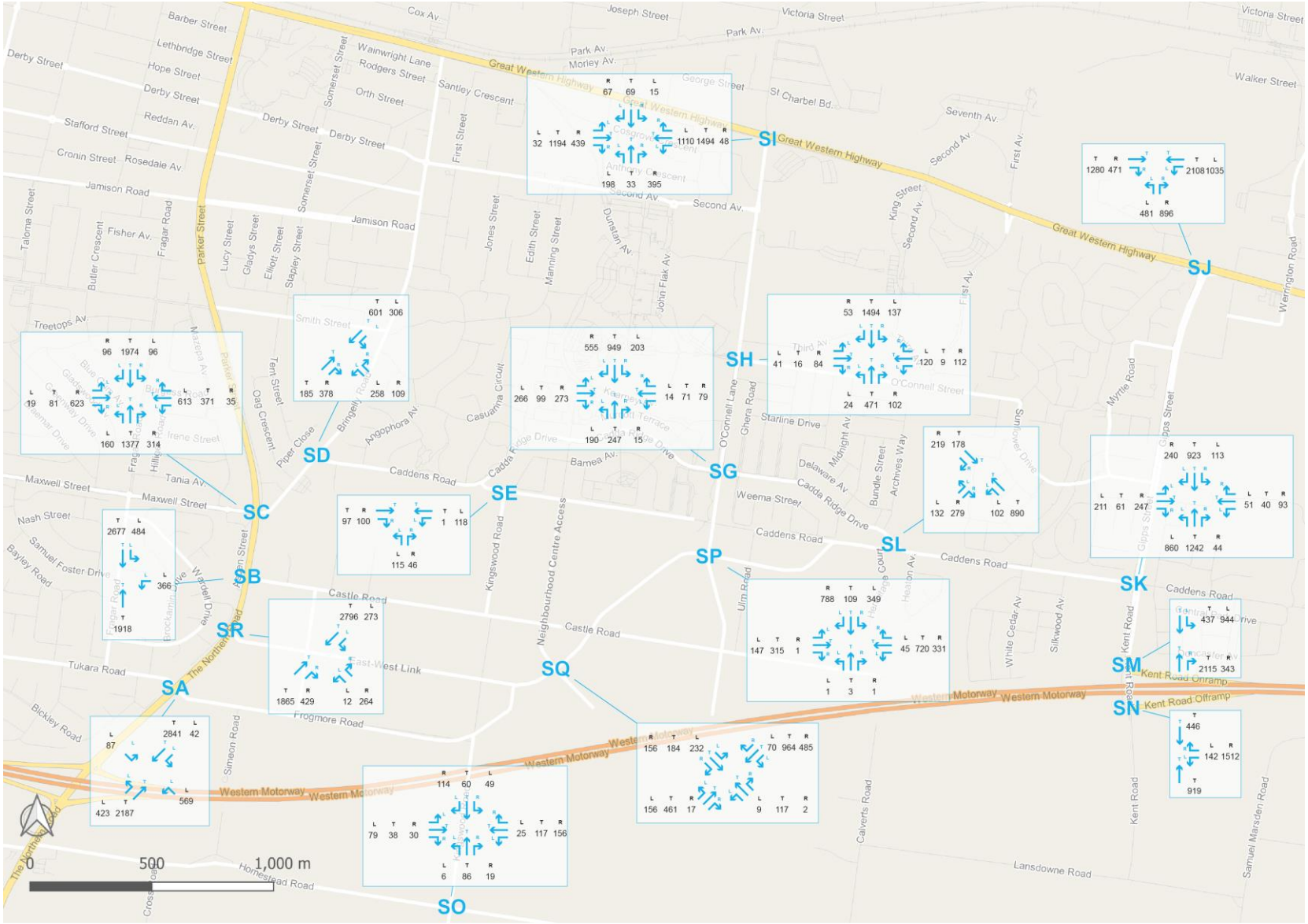
Figure D-7 SIDRA turn movements, FY2 AM

Figure D-8 SIDRA turn movements, FY2 PM

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