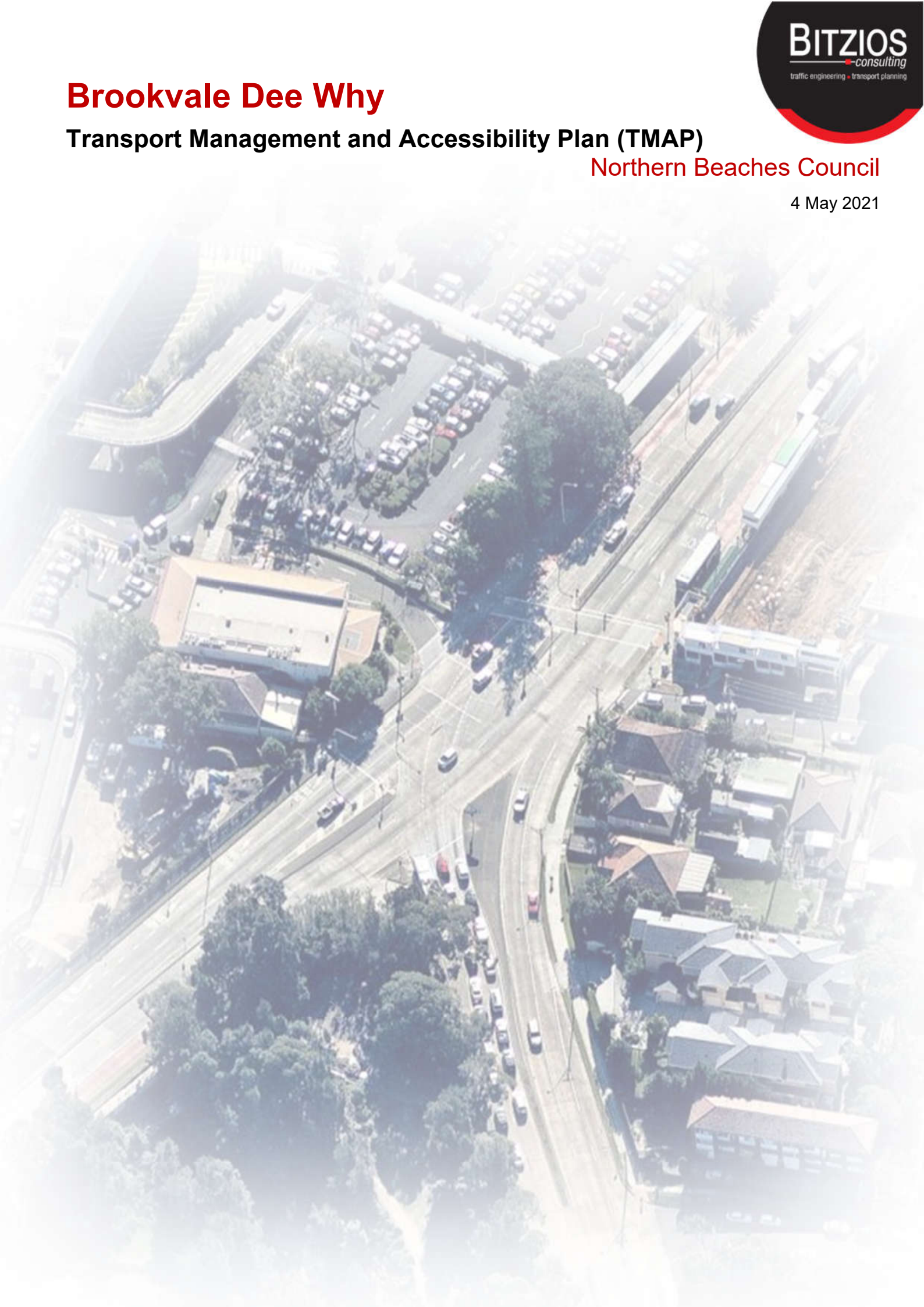
Brookvale Dee Why

Transport Management and Accessibility Plan (TMAP)

Northern Beaches Council

4 May 2021



Gold Coast
Suite 26, 58 Riverwalk Avenue
Robina QLD 4226
P: (07) 5562 5377

Brisbane
Level 2, 428 Upper Edward Street
Spring Hill QLD 4000
P: (07) 3831 4442

Sydney
Studio 203, 3 Gladstone Street
Newtown NSW 2042
P: (02) 9557 6202

W: www.bitziosconsulting.com.au

E: admin@bitziosconsulting.com.au

Document Issue History

Report File Name	Prepared	Reviewed	Issued	Date	Issued to
P3950.001R Brookvale Dee Why TMAP	J.Yang/ A. Giyahi	D. Bitzios	A. Giyahi	17/12/2020	James.brocklebank@northernbeaches.nsw.gov.au
P3950.002R Brookvale Dee Why TMAP	J.Yang/ A. Giyahi	D. Bitzios	A. Giyahi	12/04/2021	James.brocklebank@northernbeaches.nsw.gov.au
P3950.003 Brookvale Dee Why TMAP	J.Yang/ A. Giyahi	D. Bitzios	A. Giyahi	04/05/2021	James.brocklebank@northernbeaches.nsw.gov.au

EXECUTIVE SUMMARY

Background

Bitzios Consulting was engaged by Northern Beaches Council (NBC) in late 2018 to develop a Transport Management and Accessibility Plan (TMAP) for the Brookvale and Dee Why Town Centres, building on the 2012 *Brookvale Dee Why Transport Management and Accessibility Study (TMAS)* and responding to the *Draft Brookvale Structure Plan* and the *Dee Why Town Centre Master Plan*.

The *Greater Sydney Region Plan* (2018) and *Future Transport 2056* both call for population and employment to be increasingly located near major public transport facilities such as the B-Line which runs along Pittwater Road through Brookvale and through Dee Why. NBC is also seeking opportunities to localise and contain employment within Brookvale as well as provide more affordable housing opportunities close to this employment and close to public transport, walking and cycling facilities.

Pittwater Road is congested at peak times with long queues at key intersections, most notably at the key intersection of Pittwater Road / Warringah Road / Harbord Road. Side roads to Pittwater Road and to Warringah Road are consequentially impacted with some of these routes being used as 'rat runs' to bypass congestion.

The data shows that clearways that provide priority for buses along Pittwater Road in peak hours / directions do support service reliability and competitive travel times with private vehicles. Despite the presence of the B-Line, public transport modal shares are relatively low, except for 'commuter' trips by Brookvale-Dee Why residents to outside of the study area which recorded 22% of trips by bus in the 2016 Census. By comparison, for coming into the study area for work only 9% of these trips used public transport. The dispersal of jobs in the study area is a key contributor to proportionately high private vehicle usage. The distances between residences and activities, and the presence of major barriers to walking and cycling is also reflected in low modal shares for those modes.

Study Process

A range of data have been collected and analysed including traffic counts, travel time surveys, Intersection Diagnostic Monitoring (IDM) historical data, Opal ticketing data, PTIPS (Public Transport Information and Priority System) data, Traffic light offset times (LX file), Journey to Work and Household Travel surveys.

The collected data have been used to develop a suite of traffic models that included:

- Strategic Modelling undertaken by TfNSW with inputs from the study team
- AIMSUN micro-simulation modelling for traffic network assessment
- SIDRA intersection modelling for intersection capacity assessment.

The development of this TMAP has firstly considered, through the strategic and intersection modelling (using SIDRA), the likely maximum redevelopment potential of the Brookvale and Dee Why Town centres based on the traffic network with reasonable upgrades to traffic infrastructure in the surrounding area. With this level of population and employment growth confirmed to 2036, more detailed traffic microsimulation modelling (using AIMSUN) has been completed to identify likely network deficiencies in 2036. These deficiencies have been supplemented by other identified issues related to the exacerbation of traffic safety issues with traffic growth and changing local traffic accessibility needs with major redevelopment, particularly in Brookvale.

A number of upgrade options were then devised, tested, optimised and confirmed with the Project Management Group (PMG) through a series of presentations and further correspondence. This work culminated in the year 2036 Road Network Strategy. Following this, a number of supplementary investigations into travel demand management measures, public transport improvements, walking and cycling improvements and parking management were completed to develop a suite of recommended strategies and actions for this TMAP.

In addition, NBC was interested in identifying the maximum development capacity for the Brookvale Structure Plan area based on two network upgrades scenarios and these results are also presented.

This study has culminated in a staged action plan to 2036 for implementation of the TMAP's findings. This report summarises investigations, modelling and analysis which has produced five interim working papers which have informed the progression of the study across its four stages.

Land Use Capacity Findings

The land use capacity assessment investigated *Low*, *Medium* and *High* redevelopment scenarios in Brookvale and in Dee Why. Demographics associated with each scenario was provided to TfNSW to run in its 2036 strategic models and provide the study team with traffic growth to estimate year 2036 turning volumes at 30 key intersections in the study area. This intersection analysis informed the determination of which growth scenarios were supportable based on what intersection upgrades could reasonably be accommodated in the network.

The land use capacity assessment concluded that:

- The '*medium'* development scenario of 3,450 dwellings and 2,500 jobs was supportable in Brookvale
- The '*high'* development scenario of 3,778 persons and 1,000 jobs was supportable in Dee Why
- Intersections in Brookvale had limited residual capacity for growth while more 'spare capacity' was demonstrated to exist in Dee Why in 2019.

The hybrid scenario of '*medium'* growth in Brookvale and '*high'* growth in Dee Why was run by TfNSW in its strategic models with the results used to calculate 2019 to 2026 and 2019 to 2036 traffic growth for the AIMSUN modelling used for detailed network deficiencies analysis and options testing.

Deficiencies Analysis and Options Development

Year 2026 and year 2036 Do Minimum AIMSUN microsimulation traffic models were created. The 2036 models confirmed that the proposed growth scenario could not be accommodated on a traffic network with no major upgrades, even with the effects on B-Line upgrades and Beaches Link reducing the potential scale of traffic growth. A large proportion of the 2036 traffic demand could not enter the AIMSUN network with network gridlock occurring. Key '*pinch points*' and traffic issues that were identified in 2036 included:

- Pittwater Road at Warringah Road, resulting in a 'shockwave' queue that propagates back through the Dee Why Town Centre (AM) and Brookvale (PM)
- Traffic on minor side roads in the Dee Why Town Centre which are prevented from turning onto the Pittwater Road
- Vehicles were observed to bypass Pittwater Road by 'rat-running' through local streets like Victor Road and May Road
- Willandra Road at its intersection with Warringah Road
- The Warringah Road / Allambie Road traffic signals
- Mitchell Road is oversaturated with vehicles departing the Brookvale industrial area in the PM peak
- Northbound traffic on Harbord Road is excessively delayed at the traffic signals at Abbott Road / Winbourne Road and at Pittwater Road / Warringah Road
- Beacon Hill Road northbound showed a 'crawling queue' originating from the traffic signals at Warringah Road due to the left-turn slip lane and its single lane capacity

A number of intersection upgrade options were devised to mitigate the above pinch point effects and to address safety and local accessibility issues identified through site investigations and stakeholder input, as well as through the previous TMAS findings.

Options Modelling

An incremental modelling approach was used where the options were first run at the most critical pinch points, with subsequent downstream effects incrementally assessed and upgrade options applied at those locations until the network operated without excessively worse congestion relative to 2019 conditions.

The options tested ranged from introducing peak period parking restrictions to extending lane lengths, re-arrangement of lane allocation, re-phasing signals and line marking changes and then to major upgrades such as grade separation and additional lanes in some locations.

The preferred suite of upgrades was then run, and the network performance statistics extracted, as follows:

Scenario	2019		2036 Do Minimum		2036 Upgraded Network	
Attribute	AM	PM	AM	PM	AM	PM
Traffic assignment period	0600-1000	1500-1900	0600-1000	1500-1900	0600-1000	1500-1900
VHT	7,024	8,459	5,940[1]	6,796[1]	7,207	8,909
VKT	183,632	229,796	141,877[1]	137,654[1]	199,430	248,623
Completed trips	73,965	86,630	60,002	57,575	83,293	97,120
Commenced but incomplete trips	1,334	1,600	**11,185**	**12,260**	1,568	1,699
Unreleased vehicles	0	0	**13,691**	**29,227**	1	0
Average network speed (km/h)	30	29	27	24	30	29

VHT: Vehicle-Hours travelled for (completed + commenced trips)
VKT: Vehicle-Kilometres Travelled (completed + commenced trips)
[1] No correction applied for incomplete or unreleased trips

The above table confirms that the 2036 Upgraded Network, accounts for the growth in traffic demands from the preferred growth scenario and achieves similar network travel speeds to those identified in 2019.

Other Strategies

There have been recent upgrades along Pittwater Road within the study area at the two B-Line bus stops and there has also been a recent rationalisation of bus routes in the Northern Beaches area. Further improvements of the public transport network to/from the Northern Beaches will be important to consider to further encourage modal shift, including consideration of new east-west express bus routes and associated infrastructure improvements. There is also potential to expand on-demand buses like the existing Keoride service and to encourage the increased uptake of car share in redevelopment area in particular.

There are also opportunities for upgraded footpaths and bus stops near non B-Line bus stops along Pittwater Road, Warringah Road and elsewhere in the study area. With the planned redevelopment in Brookvale, opportunities exist to create a more permeable network of walking / cycling links on either side of Pittwater Road and the creation of more shared paths should be a key priority given the emerging cycling usage opportunities in the area.

Parking demand will also change with the redevelopment of Brookvale and opportunities exist to restrain residential development parking near the B-Line. The B-Line will continue to rely on Park and Ride which could be supported by expanded commuter car parking facilities as catchment demand grows. There is little opportunity to significantly reduce retail, commercial or industrial parking rates in this area compared to the current DCP. In Dee Why, full time bus lanes are likely to require the extension of '2P' zones further into existing residential streets.

Action Plan

In terms of the traffic capacity upgrades, the suite of preferred strategies and upgrades were initially determined based on year 2036 demands. To determine the extent of upgrades required by 2026, upgrade items were progressively removed from what was required for the 2036 network and the operations of the network observed to determine if they were required by 2026 or not. Traffic safety and local accessibility upgrades were assumed to be required by 2026 and the public transport, walking, cycling and parking actions would need to be implemented as re-development occurred in each precinct within the study area.

Beyond the '*by 2026*' and '*by 2036*' staging definition, NBC also requested nomination of specific years to each action / upgrade. These timeframes have been estimated in the recommended action plan **Table E.2** and shown in **Figure E.1** based on traffic model observations. It should be noted that timeframes are estimates only and the interactions between development levels and upgrade needs is complex. It is difficult to nominate precise years for implementation when the specific location, scale and type of each development is not able to be disaggregated with any certainty.

Following endorsement of the action plan, concept designs and cost estimates will be prepared for upgrade items and this may further inform staging timeframes based on cumulative expenditure profiles.

Brookvale Centre Development Capacity

Sensitivity analysis was undertaken to determine the maximum development possible in the Brookvale Structure Plan area if the following two major upgrades were not implemented:

- Pittwater Road / Warringah Road / Harbord Road Interchange
- Powells Road Extension.

The Pittwater Road / Warringah Road / Harbord Road Interchange is by far the most expensive project within the action plan and will rely on state government support for it to progress to implementation. The Powells Road link is through an existing bus depot and will also require state government support..

The development capacity of the Brookvale Centre was investigated by running the 2026 and 2036 models without these two major upgrades and determining at what level of additional development the models reach their capacity. **Table E.1** presents the population and employment growth potential of the Brookvale structure plan area without and with the two project listed above.

Table E.1: Achievable Population and Employment Growth in Brookvale Centre

Demographic	Without Two Major Upgrades	With All Upgrades (Including Two Major Upgrades)
Population	+2,177 persons	+7,258 persons
Dwellings	+1,037 dwellings	+3,456 dwellings
Employment	+810 jobs	+2,700 jobs

Note:
1. Dwellings estimated based on a ratio of 2.1 persons per dwelling
2. Figures are an aggregation of modelled growth in 6 Travel Zones in and around the Brookvale Structure Plan area. Growth is likely to be concentrated in the two Travel zones 2145 and 2144 which encompass most of Brookvale Centre – the industrial, commercial and mixed-use precincts in proximity to the B-line stop.

It is important to note that the Powells Road Link is expected to have limited effect on development capacity within the Brookvale Structure Plan area with the primary determinant of development capacity related to the Pittwater Road / Warringah Road / Harbord Road Interchange project.

Table E.2: Action Plan

ID	Item Description	Agency	Timing
Road Network			
RN1	Pittwater Road / Warringah Road / Harbord Road grade separated intersection.	NBC / TfNSW	Design: Immediate. Construction: When possible.
RN2	Warringah Road / Allambie Road turn bay extension.	NBC / TfNSW	2030
RN3	Warringah Road / Willandra Road reconfiguration.	NBC / TfNSW	2026
RN4	Willandra Road / Cornish Avenue reconfiguration.	NBC / TfNSW	2026
RN5	Harbord Road / Abbott Road / Winbourne Road upgrades.	NBC / TfNSW	2024
RN6	Warringah Road / Beacon Hill Road turn bay duplication.	NBC / TfNSW	Design: Immediate. Construction: When possible
RN7	Allambie Road/Rodborough Road intersection upgrade.	NBC / TfNSW	2030
RN8	Pittwater Road / Victor Road signalisation.	NBC / TfNSW	2024
RN9	Mid-block pedestrian crossing removal between Victor Road and Federal Parade.	NBC / TfNSW	With item RN8.
RN10	Pittwater Road / Cross Street / Powells Road Extension.	NBC / TfNSW	2028
RN11	Pittwater Road / Delmar Parade AM right turn ban.	NBC / TfNSW	2022
RN12	Pittwater Road / Old Pittwater Road / Winbourne Road right turn ban.	NBC / TfNSW	2022
RN13	Harbord Road parking clearway.	NBC / TfNSW	2024
RN14	Pittwater Road bus lane parking clearway.	NBC	TfNSW – dependent.
RN17	Harbord Road / Brighton Street / Amourin Street signalisation.	NBC / TfNSW	2034
Public Transport			
PT1	Review Bus Stop infrastructure along major bus routes and ensure they are compliant with DDA standards and have high quality stop facilities and access paths.	TfNSW	2024
Active Transport (Walking and Cycling)			
AT-W1	Investigate and implement HPAA schemes as Brookvale Town Centre evolves.	NBC / TfNSW	As development occurs.
AT-W2	Review potential reduction of speed limits in residential local traffic areas such as North Manly and Beacon Hill.	NBC / TfNSW	2022
AT-W3	Improvements to pedestrian crossing facilities and increase network permeability as redevelopment occurs.	NBC / TfNSW	As development occurs.
AT-C1	Improvement of local and regional cycling connectivity at/between the main activity centres.	NBC	2022 - 2030
AT-C2	Provision of secure end of trip facilities at major bus stops.	NBC	2022 - 2024
AT-C3	Provision of shared crossing facilities at intersections and traffic signals along major bicycle routes.	NBC / TfNSW	2022 - 2030
Parking			
P-1	Adoption of lower residential parking rates around B-Line stops.	NBC	Immediate.
P-2	Implementation of extension of timed parking restrictions on side streets near the B-Line stops.	NBC / TfNSW	As required.
P-3	Provision of dedicated car share parking and drop-off areas in or near multi-unit redevelopments.	NBC	As development occurs.
P-4	Provision of new or expanded B-Line commuter car parking areas.	NBC	2028 - 2030
P-5	Review and reduce permitted parking times in sections closest to the Brookvale and Dee Why Centres.	NBC	Short Term.

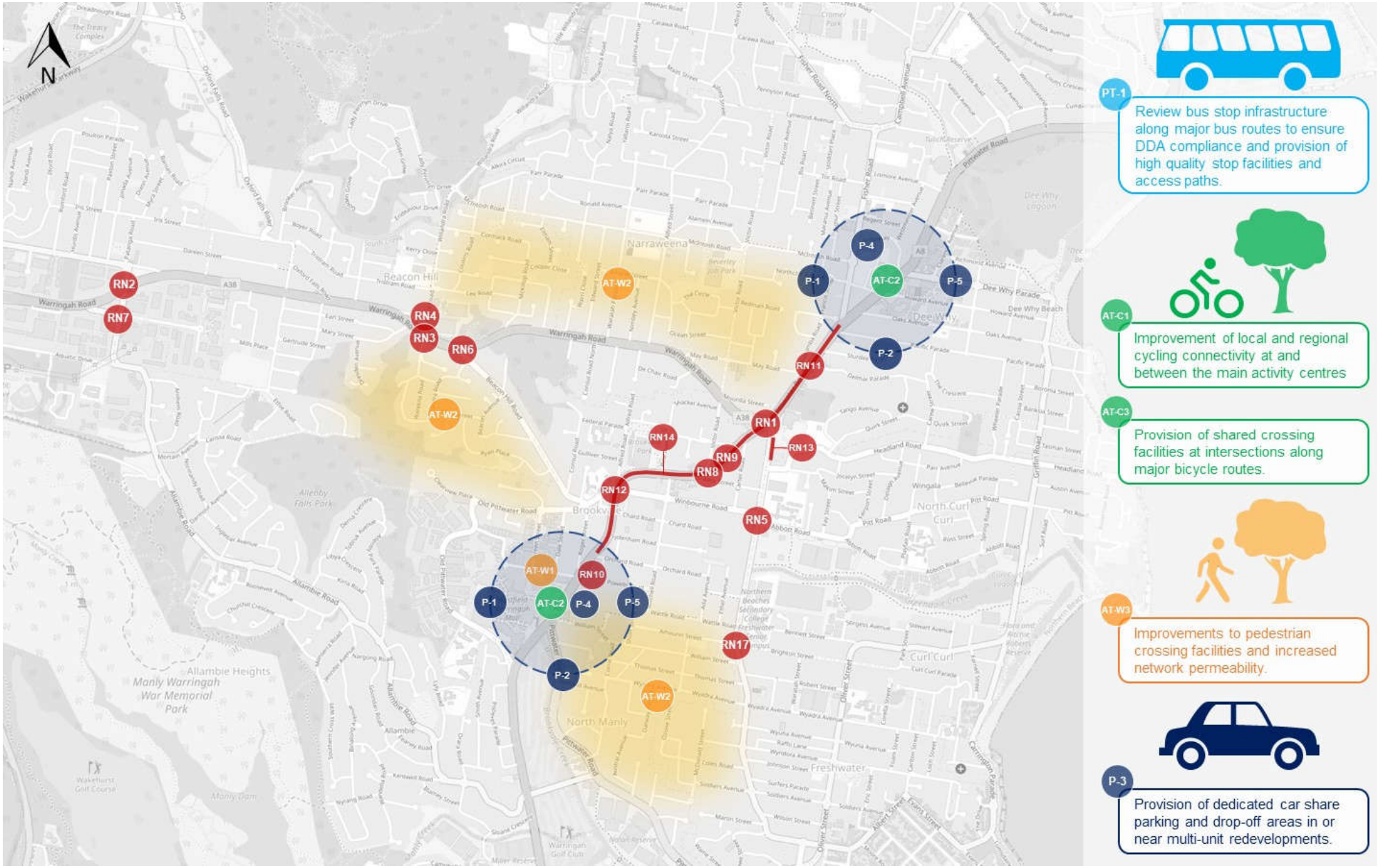


Figure E.1: Locations of Recommended Actions

CONTENTS

Tables

Figures

Glossary of Terms

Term	Definition
95th Percentile	The value which 95 percent of the data falls below.
ABS	Australian Bureau of Statistics.
AIMSUN	A microsimulation modelling software package used for this study.
Average Delay[1]	The average of the additional (excess) travel time experienced by a vehicle or pedestrian relative to a base travel time.
Bus Opal Assignment Model (BOAM)	A TfNSW dataset containing the historical running times of buses and bus occupancy based on satellite tracking and Opal counts.
Calibration	A process where inputs and assumptions to a traffic model are adjusted to ensure the model satisfactorily reflects existing conditions.
Council	Northern Beaches Council.
DA	Development Application.
DCP	Development Control Plan.
Degree of Saturation[2] (DoS)	The ratio of arrival (demand) flow rate to capacity during a given flow period. Also known as the volume to capacity ratio (v/c ratio), utilisation ratio, utilisation factor and sometimes represented as traffic intensity.
EMME	Strategic transport modelling software used in Sydney.
Future Transport	The NSW Government's vision for provision of transport over the next 40 years.
GMA	Greater Metropolitan Area (encompassing Sydney, Newcastle, and the Illawarra).
HTS[3]	Household Travel Surveys. A survey which collects information on personal travel behaviour (how and why people travel) across the Sydney GMA.
JTW	Journey to work data extracted from the ABS census.
LEP	Local Environmental Plan which guides planning decisions for local government areas.
Level of Service (LOS)[4]	An index of the operational performance of traffic on a given roadway, traffic lane, approach, intersection, route, or network, based on measures such as delay, degree of saturation, density, speed, congestion coefficient, speed efficiency or travel time index during a given flow period. Measured on an A to F scale, with LOS A representing the best operating conditions and LOS F the worst.
LGA	Local Government Area.
NBC	Northern Beaches Council.
PP	Planning Proposal.
Public Transport Information and Priority System (PTIPS)	A system that uses satellite technology to locate and record all buses across the Sydney metropolitan bus network in real time.
SA1, SA2, SA3	Statistical areas as designated by the ABS.
SCATS	Sydney Coordinated Adaptive Traffic System. The system that manages the dynamic timing and coordination of traffic signals in Sydney.
STFM	Sydney Traffic Forecasting Model.
STM	Sydney Travel Model.
TfNSW	Transport for New South Wales (formerly Roads and Maritime Services).
TMAP	Transport Management and Accessibility Plan.
TMAP	Transport Management and Accessibility Study,
TPA	Transport Performance and Analytics, a division of TfNSW.
Unreleased Vehicles	Vehicles which are waiting to enter a microsimulation model at the end of the model period.
Validation	The process of ensuring that a model matches a dataset independent of its calibration data set.

[1] Sidra glossary of road traffic analysis terms, Akcelik and Associates Pty Ltd, March 2017

[2] Sidra glossary of road traffic analysis terms, Akcelik and Associates Pty Ltd, March 2017

[3] Household Travel Survey (HTS), Transport for NSW, 2018 (https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey-hts)

[4] Sidra glossary of road traffic analysis terms, Akcelik and Associates Pty Ltd, March 2017

1. INTRODUCTION

1.1 Background

Bitzios Consulting has been engaged by Northern Beaches Council (NBC) to prepare a Transport Management and Accessibility Plan (TMAP) for the Pittwater Road corridor through Brookvale and Dee Why. Pittwater Road has been operating at, or near its capacity during weekday and weekend peak periods for some time.

The NSW Metropolitan Plan for Sydney 2036 set a target for the Brookvale/Dee Why 'Strategic Centre' to accommodate an additional 5,000 jobs. In response, a Transport Management and Accessibility Study (TMAS) was completed in 2012 by NBC. This study concluded that the 5,000 additional jobs could not be accommodated and suggested that '*3,000 to 3,500 jobs across Brookvale and Dee Why can be supported on the transport network at a manageable and serviceable Level of Service, before large-scale network upgrades are required*'.

Since the 2012 TMAS:

- Many of the items in the Dee Why Town Centre Master Plan (NBC, 2013) have progressed to implementation
- NBC has exhibited the Brookvale Structure Plan in 2017 which considers both population and employment growth in Brookvale
- The Greater Sydney Region Plan was finalised in March 2018
- The Northern Beaches hospital and associated roadworks on Warringah Road are being constructed
- The state government has announced improvements to the B-Line along Pittwater Road, including more clearways / bus lanes and implemented some improvements around its stops in Brookvale and in Dee Why
- The state government has undertaken planning for a second proposed B-Line connecting between Dee Why and Chatswood, although there are no commitments as to certainty of this proposal
- The Beaches Link EIS has been put on exhibition (December 2020)

NBC is reconsidering its planning, employment and population targets for Brookvale and Dee Why and transport system capacity is a key factor in determining what levels of redevelopment can be accommodated and what pragmatic upgrades are required to cater for this redevelopment. NBC has identified the need to increase local employment opportunities in order to influence more self-containment of jobs within Northern Beaches and has also recognised the benefits of increasing affordable housing opportunities in the Pittwater Road corridor given its access to the B-Line. The intensification of local activity around the Pittwater Road corridor will create more local traffic turning movements, more local pedestrian and cyclist movements and more access to bus stops from local areas, which will all need to be catered for in the future and managed against continued through trip growth along Pittwater Road and Warringah Road in particular.

NBC has initiated this TMAP to:

- Identify the scale of population and employment growth that can be accommodated in Brookvale and in Dee Why with 'reasonable' traffic infrastructure upgrades
- For the scale of redevelopment identified, determine the suite of traffic capacity, traffic safety and local accessibility upgrades needed to support this development
- Identify public transport, walking and cycling initiatives which could be implemented, or investigated further, as redevelopment occurs

A study area for the assessment of traffic and transport needs has been defined by NBC and is shown in Figure 1.1.

Source: Google Earth

Figure 1.1: Study Area

1.2 TMAP Development Process

This TMAP is the culmination of a four-stage study which commenced in December 2018. The study has been guided by a Project Management Group (PMG) comprised of representatives of NBC and TfNSW who have provided input and endorsement of key outcomes in each stage through five workshops. The four stage process is shown in Figure 1.2 and involved:

- **Stage 1**: A review of previous studies and agreement on the modelling methodology to be used. *Working Paper #1 Modelling Methodologies* was produced
- **Stage 2**: Included traffic surveys, building the base year 2019 AIMSUN and SIDRA models and completing an existing conditions assessment. *Working Paper #2 Existing Conditions Assessment* was produced. Modelling Calibration and Validation reports were also produced in this stage
- **Stage 3:** Involved testing future year land use scenarios using strategic modelling and intersection modelling to identify a reasonable growth scenario to take forward and assess in detail. Deficiencies analyses followed considering capacity, safety and local accessibility needs and options were identified to overcome the deficiencies. Microsimulation modelling was used to test the options and evaluate them in order to prepare a road network upgrade strategy which was generally endorsed by the PMG. *Working Paper #3 Land Use Testing and Mode Share*, *Working Paper #4 Deficiencies and Options* and *Working Paper #5 Interventions and Road Network Strategy* were produced.
- **Stage 4**: Involved supplementing the road network upgrades strategy with demand management strategies, public and private parking management strategies, public transport improvements and active transport improvements and culminated with this TMAP.

Following the endorsement of this Draft TMAP report, concept designs and cost estimates are proposed to be prepared along with a refined staging plan for implementation, although a draft staging plan is included in this report at the request of NBC.

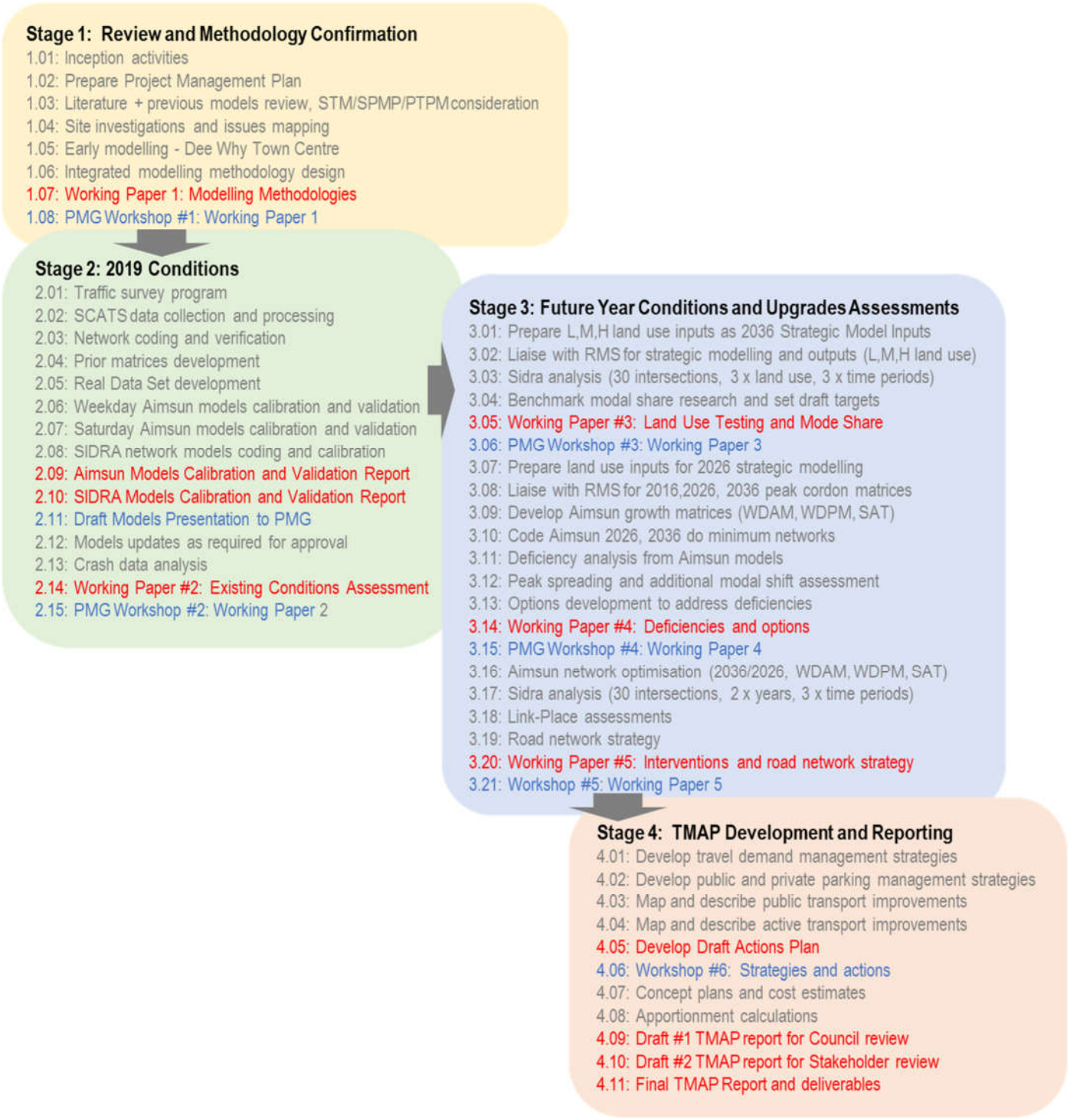


Figure 1.2: Study Process

1.3 Report Structure

This TMAP report is structured as shown in Table 1.1.

Table 1.1: Report Structure

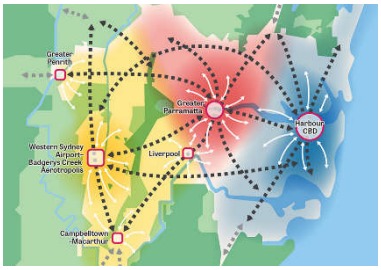
Section	Description
1	**Introduction.**
2	**Transport Planning Context:** A summary of Regional and Local planning documents and previous studies relevant to the TMAP.
3	**Travel Patterns and Transport Systems:** A summary of existing travel patterns, transport infrastructure and traffic conditions.
4	**Movement and Place Assessment:** An analysis of the relationship current and proposed future movement needs and place needs across the study area used to guide the improvement strategies and action plans.
5	**Transport Modelling:** Explanation of modelling process and assumptions.
6	**Stage 1 - Land Use Scenario Assessment:** Explains the strategic modelling and intersection modelling used to confirm the preferred levels of 2036 land use development in the study area.
7	**Stage 2 - Network Upgrade Modelling:** Explains the option development and modelling processes for traffic capacity analysis.
8	**Preferred Strategies and Upgrades:** Summarises the preferred road infrastructure upgrades, as well as demand management, public transport, walking and cycling improvement strategies.
9	**Upgrades Considerations:** Documents the upgrades staging methodology.
10	**Recommended Action Plan:** Summarises the action plan for implementation.

2. TRANSPORT PLANNING CONTEXT

This section summarises the policies and strategies which guide the development of the TMAP along with relevant findings of previous studies used to inform specific strategies and actions within the TMAP.

2.1 Regional Planning

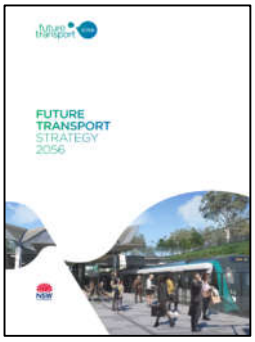
2.1.1 Greater Sydney Region Plan, A Metropolis of Three Cities



The Greater Sydney Region Plan outlines the NSW Government's commitment to the delivery of transport solutions that match Sydney's population and employment needs through to 2056. The plan aims to create employment centres in Western Sydney to improve access to jobs and essential services for the growing population. A key focus on public transport is highlighted as a solution for current and emerging traffic congestion.

Brookvale-Dee Why is identified as a strategic centre within the Eastern Harbour City. Strategic centres are important for employment and services but are smaller than metropolitan centres and clusters. A key objective is to increase the percentage of dwellings located within 30 minutes (by public transport) of a metropolitan centre. This underlines the importance of the B-Line and its public transport services between Brookvale-Dee Why and the Sydney CBD and the benefits of increasing population density around it.

2.1.2 Future Transport 2056

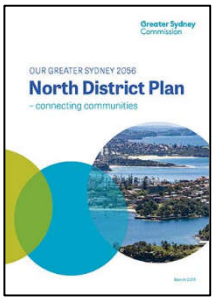


Future Transport 2056 guides the NSW government's transport infrastructure investments and was prepared in collaboration with the Greater Sydney Region Plan. It is a planned and coordinated framework designed to guide transport plans and policy decisions, prioritising key routes and transport network structures across NSW.

The key transport projects and proposals within the report relevant to the study area are the Northern Beaches B-line and improved bus services between the Northern Beaches and Chatswood. The B-line bus services are a committed initiative, while investigations are planned for improved bus services between the Northern Beaches and Chatswood within the 0-10 year timeframe.

While Brookvale-Dee Why is defined as a strategic centre, it is not served by a rail line and there are no new or upgraded strategic roads planned for the area, except for some influence by the proposed Beaches Link.

2.1.3 North District Plan



The North District Plan sets out the planning priorities and actions for improving quality of life for residents of the North District of Sydney, which includes Brookvale - Dee Why. The key transport initiatives identified in the plan include ride sharing, car sharing and local bus services.

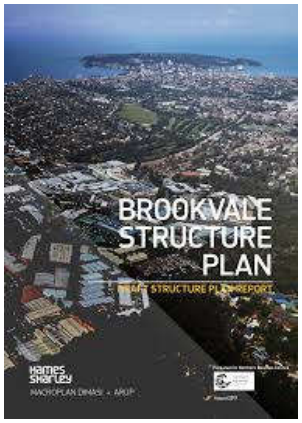
The plan identifies Brookvale as an industrial area supporting niche manufacturing and wholesale industries, and Dee Why as a mixed-use area which offers a vibrant local night-time economy. Warringah Mall and TAFE NSW Northern Beaches are also identified as key locations for jobs and services.

Key actions in the Plan for the Brookvale-Dee Why area include:

- Increasing employment within the existing retail and industrial areas, including Warringah Mall, Brookvale industrial area, Dee Why town centre, and along Pittwater Road
- Improving public and active transport connectivity between the above locations
- Improving connections between Brookvale-Dee Why and Northern Beaches Hospital at Frenchs Forest.

2.2 Local Planning

2.2.1 Brookvale Structure Plan (2017)



The Brookvale Structure Plan (2017) is the strategic land use planning framework which aims to guide future development, housing affordability and diversity. Major land use changes in the plan include the Brookvale Town Centre which targets increased local employment and more job self-containment. With the B-line service providing an efficient public transport option, redevelopment along the Pittwater Road corridor can leverage off its public transport accessibility and contestability against private vehicle travel.

The structure plan recognises the need to review the growth capacity of the area considering the implementation of the B-Line Service, other road improvements, the development of surrounding areas and broader trends in travel demand growth. The Structure Plan is based on the following key principles:

- Recognise the importance of Brookvale's employment lands to the Northern Beaches
- Create green links and green destinations
- Leverage the B-Line
- Activate the Brookvale Town Centre.

These principles have shaped the Plan's recommendations. The preferred growth scenario in the plan was a balance of employment (60%) and residential growth (40%) to ensure sufficient residential growth is provided to support and encourage employment in the town centre. Employment growth was planned to be focused on the retail, wholesale, health care and educational sectors, with an expected shift away from manufacturing and industrial land uses.

An estimated 1,700 jobs and 1,200 residents were forecast for the town centre by 2031. The identified limitations included complications of mixing employment and residential uses exacerbating congestion. Land fragmentation was also identified as a key constraint on site amalgamation, which is evident with industrial lands with multiple owners. The report identified that a balanced development framework is needed, which takes into consideration the ability to incorporate public transport, road infrastructure and active transport initiatives within the town centre. The plan has been on exhibition and is awaiting finalisation pending this study and an employment lands study.

This TMAP has considered the development potential of the structure plan area without and with two key upgrade projects which are uncertain because of their scale and need for funding beyond just NBC's means.

2.2.2 Dee Why Town Centre Planning Proposal and Draft Development Control Plan

Council has publicly exhibited the Dee Why Town Centre Planning Proposal and amendments to the Warringah Development Control Plan 2011 (WDCP). The amendments were deemed by Council to be required to reflect the recommendations from the Dee Why Town Centre Masterplan in 2013. The amendments included:

- Applying specific planning controls to a wider area of the town centre
- Introducing floor space ratio standards to better control development potential
- Including a 3-metre increase in overall height limits (one storey) in exchange for a one storey reduction in podium height limits
- Introducing special provisions for four new key sites in exchange for community infrastructure.

The planning control changes in relation to parking included the inclusion of electric vehicle charging points and specific delivery requirements. Also, the allowance for one level of above ground parking has been removed and will be considered on a case-by-case basis.

The WDCP amendments have been approved and came into effect on 28 February 2020.

2.2.3 Dee Why Town Centre Masterplan (2013)

Dee Why has undergone and is undergoing urban renewal and the master plan aimed to identify the best way to achieve feasible and sustainable outcomes for the area.

The centre's urban pattern features a combination of rectilinear and curved roads in relation to the topography of the area. As a result, the area has a varied built form providing straight east-west roads and north-south orientations. The masterplan noted that the town centre is characterised by a lack of land use cohesion, connection, and visibility due to Pittwater Road running through the centre.

Key issues relevant to this TMAP include:

- The town centre is dissected
- There is limited pedestrian connectivity and priority, particularly across Pittwater Road
- There is a lack of access to open space
- There is poor amenity and streetscape definition, although this is being progressively improved via the master plan implementation

The masterplan proposed key principles for development of the area. Those relevant to this TMAP were:

- Ensure a well-connected town centre
- Provide a safe and enjoyable public realm.

The plan targeted opportunities to amend the streetscape design by creating usable and connected open spaces through the provision of mid-block pedestrian links. A strong emphasis on providing good public spaces is evident through the masterplan by highlighting Dee Why's identity and defining its character. Short term public domain improvements were recommended and included the Walter Gors Park pedestrian corridor upgrade.

2.3 Other Reference Studies

2.3.1 Brookvale Dee Why Transport Management and Access Study (TMAS)

Source: Brookvale Dee Why Transport Management & Accessibility Study (TMAS), GHD, June 2012

The Transport Management and Accessibility Study (TMAS) assessed the traffic-related impacts of an additional 5,000 jobs within the Brookvale and Dee Why areas as identified in the Metropolitan Plan for Sydney 2036. A transport management framework was created based on three land use scenarios which were then tested in a traffic model. The study analysed the relationship between the proposed land uses and its associated traffic demands and identified the limitations within the current network.

The study found that large-scale network upgrades would be required to support the predicted employment growth beyond those that can reasonably be delivered by 2036 and that traffic congestion is likely to restrict the amount of development that can be achieved in Brookvale and Dee Why.

This was identified as being predominately due to the limited capacity along Pittwater Road and the poor east-west connectivity between West Brookvale and Harbord / Freshwater; although it is evident that congestion along these corridors is as much a result of increasing through traffic in the corridor as from traffic generation associated with additional jobs in the area.

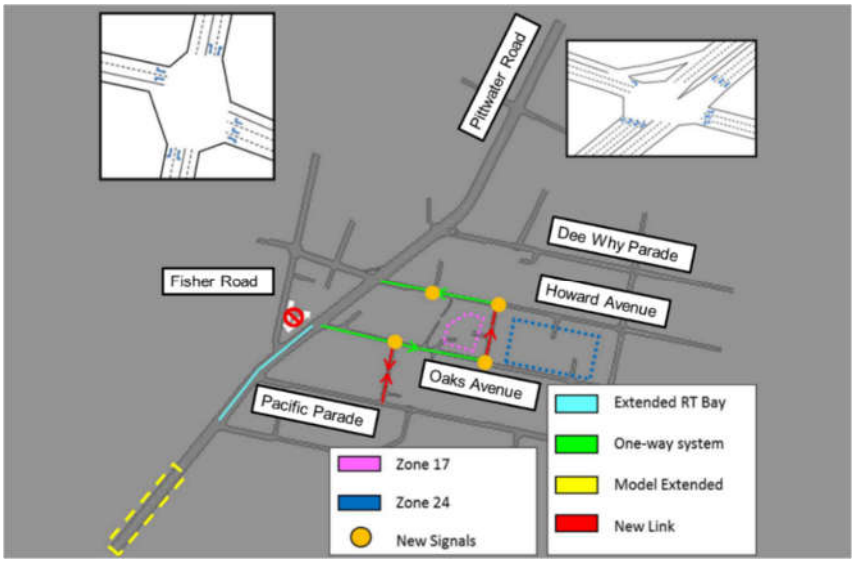
Based on these key conclusions from the study, recommendations were formed in relation to land use management, such as:

- Monitoring employment growth
- Reviewing parking policies to ensure that parking restrictions are implemented where needed
- Integrating public and active transport provisions as a priority.

2.3.2 Dee Why Town Centre PARAMICS Modelling (2016)

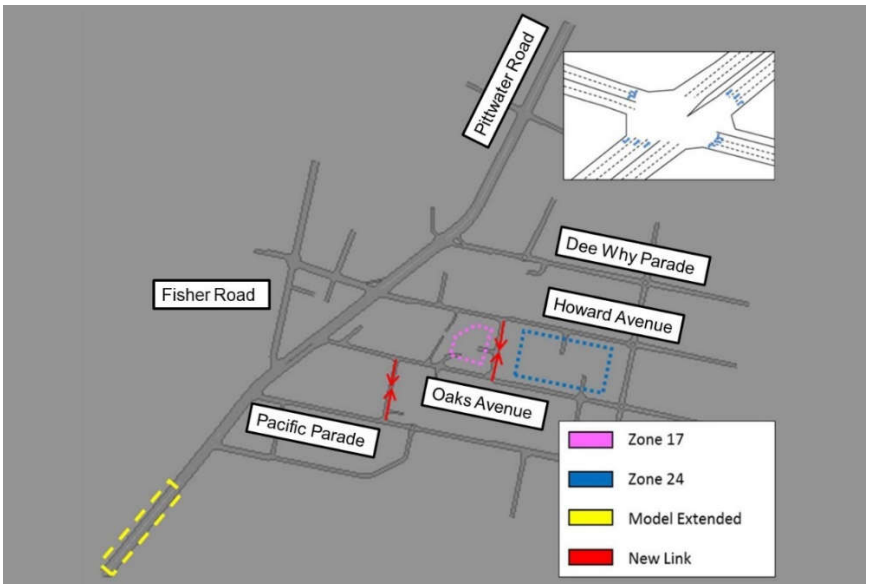
The Dee Why Town Centre Summary Report outlines the Paramics modelling outcomes from the work undertaken by GTA in 2008 which was then further revised by GHD in 2014. In 2008, a one-way anti-clockwise loop system was recommended to improve traffic operations within the Dee Why Town Centre. The review by GHD in 2014 identified some issues with the model and made revisions based on the one-way system to improve its feasibility.

Further traffic modelling was then undertaken (WSP Parsons Brinckerhoff, 8 April 2016) including varying road network systems, options testing, and sensitivity testing. This work indicated that both the one-way and two-way systems performed similarly. Figure 2.1 illustrates the one-way Oaks Avenue to Howard Avenue loop and Figure 2.2 shows the two-way revised system with improvement to the Howard / Pittwater intersection.



Source: WSP Parsons Brinkerhoff

Figure 2.1: One-way Oaks Avenue / Howard Avenue Loop



Source: WSP Parsons Brinkerhoff

Figure 2.2: Two-way Howard Avenue / Pittwater Road Intersection

The two-way system was reported to be the better option in relation to route choice flexibility and accessibility, reduced travel times and reduced stops. In addition, the two-way system was shown to have greater feasibility in terms of infrastructure requirements and minimising local community impacts. The report recommended modifications needed to achieve the two-way system and that this was the preferred layout.

2.3.3 B-Line Traffic & Transport Assessment (2016)

Source: Brookvale Dee Why B-Line On-Road Infrastructure, Traffic & Transport Assessment, November, AECOM, 2016

This report assessed the traffic and transport-related elements of the Northern Beaches B-Line Program as part of the Review of Environmental Factors (REF). This program provides an integrated bus service and infrastructure improvements which aim to deliver more frequent and reliable services for customers between the Northern Beaches and the Sydney CBD.

Journey to Work (JTW) data showed that a significant proportion of the population use private vehicle (54%). While public transport patronage is relatively low at 24% of trips, it predominately comprised of bus usage (18%). The report claimed that further improvements to public transportation accessibility, connectivity, and efficiency are required to increase the attractiveness of 'green' modes of travel.

Traffic impacts and forecast traffic growth were assessed associated with the implementation of the B-line service. The report concluded:

- The majority of key intersections along the Pittwater Road corridor are not expected to deteriorate when compared to the Do-nothing 2021 scenario
- The B-Line proposal in the Brookvale and Dee Why areas will provide travel time savings of approximately one – three minutes, particularly in the southbound direction
- There are no significant bus travel time savings in the northbound direction during the PM peak, due to the limited targeted bus improvement measures on the western side of the carriageway
- The travel time and network performance improvements are due to reduce travel times resulting from the proposed clearways.

3. TRAVEL PATTERNS AND TRANSPORT SYSTEMS

This section presents a summary of the existing travel patterns, transport infrastructure and traffic conditions within the study area.

3.1 Travel Demand

3.1.1 Household Travel Survey (2016)

The Household Travel Survey (HTS) is a survey undertaken by TfNSW which provides data on household travel patterns and transport usage within Greater Sydney. The survey currently has a sample size of approximately 3,000 households, and survey data is stratified by Statistical Area Level 3 (SA3) as defined by the Australian Bureau of Statistics (ABS).

Figure 3.1 shows modal splits for the four SA3 regions north of the Sydney CBD as well as for the CBD. The suburbs of Brookvale and Dee Why fall within the Warringah SA3 region. The SA3 region of Manly is to the south of Warringah, Ku-ring-gai is to the west, and Chatswood-Lane Cove is to the south-west

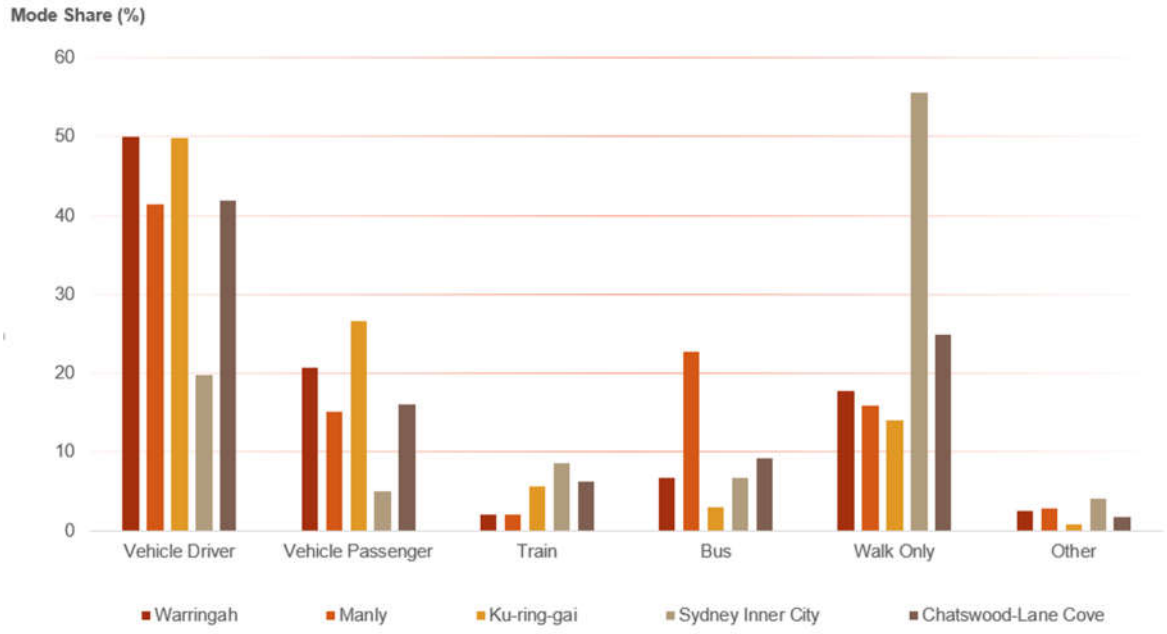


Figure 3.1: HTS Travel Modes

The Warringah area is not serviced by any railway lines, and the primary mode of travel is via private vehicles. The area also has a low percentage of bus usage compared to the adjacent LGA of Manly, which may be attributed to relatively long bus travel times between Warringah and the Sydney CBD.

The trip purpose breakdown is presented in Figure 3.2. This figure shows that the distribution of travel purposes for Warringah is similar to Ku-ring-gai and Chatswood, which have a similar land use profile. Approximately 14% of trips are commuter trips, while a much larger proportion of trips are for social / recreation purposes.

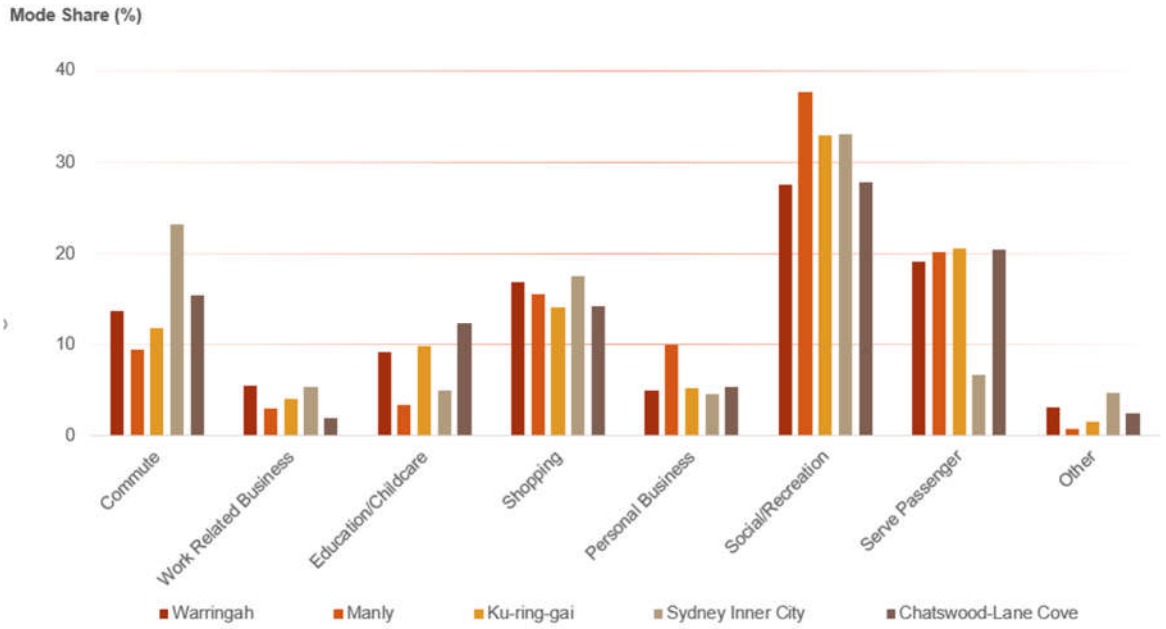
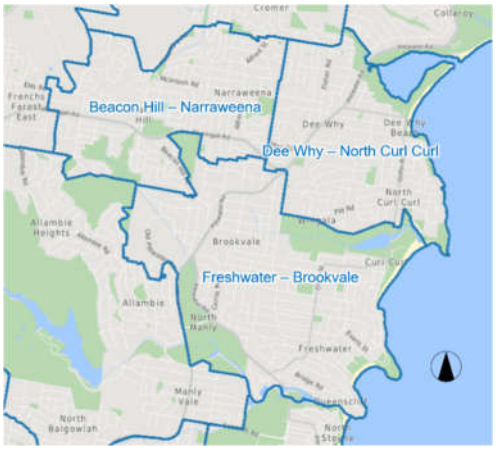
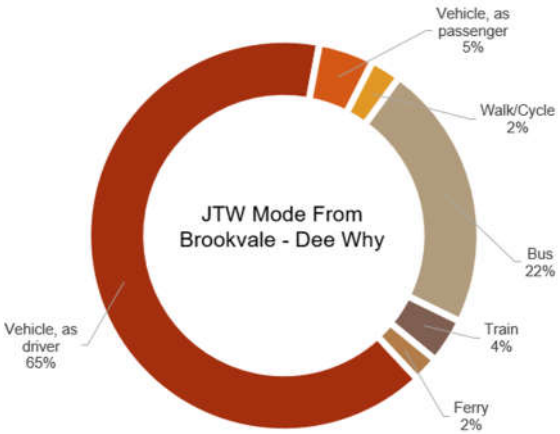


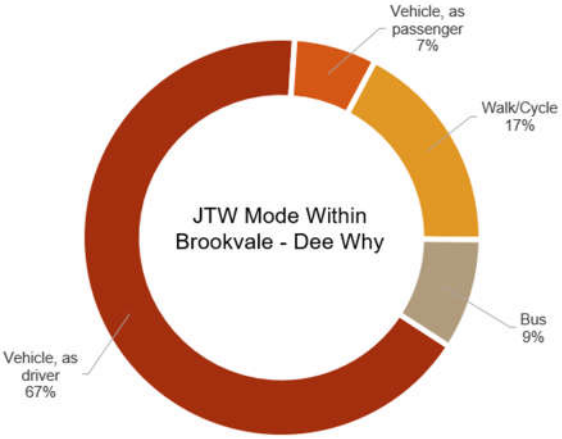
Figure 3.2: HTS Travel Purposes

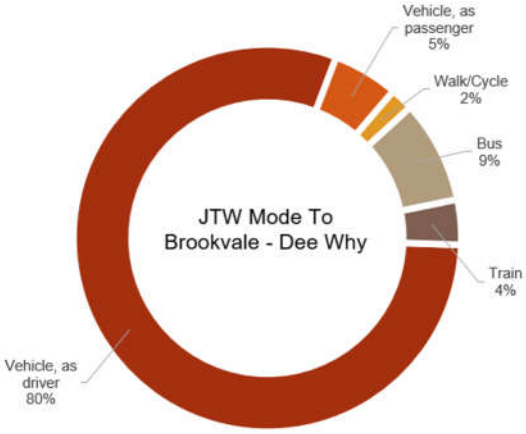
3.1.2 Journey to Work

Census statistics from 2016 were analysed to determine the JTW patterns for residents within the study area. The statistics were taken from three SA2 regions which overlap the study area, and the SA2 regions are shown in Figure 3.3.









Source (map): Australian Bureau of Statistics

Figure 3.3: JTW Travel Modes

The JTW statistics indicate that the majority of commuters travelling to and from the study area use private vehicles. Buses are an important mode of transport for commuters with 22% of JTW trips by Brookvale - Dee Why residents using them. However, for trips to work within the study area, bus comprises 9% of all trips. This reflects the broader residence location distribution expected for residents working in this study area and the challenges for buses to efficiently compete with private vehicles for these dispersed-origin trips.

Transport mode share was also summarised for residents of the study area travelling to different parts of Sydney, and the results are presented in Table 3.1. The results show a majority of commuters travelling into the Sydney CBD choose public transport, with reasonable public transport mode shares as well for commuters travelling to areas just outside the CBD. For most other work destinations private vehicles are overwhelmingly preferred. This is unsurprising given the dispersal of job locations and the difficulty in public transport competing with car travel times for these locations.

Table 3.1: JTW From Brookvale – Dee Why Area

Local Council Area	Vehicle	Train	Bus	Ferry	Bicycle	Walk	Total	Vehicle	PT	Active
Northern Beaches Council	11,449	44	1,677	19	256	1,234	14,679	78%	12%	10%
City of Sydney	1,591	442	2,630	431	96	24	5,214	31%	67%	2%
North Sydney Council	833	27	515	5	28	17	1,425	58%	38%	3%
City of Willoughby	1,021	18	178	0	6	0	1,223	83%	16%	0%
City of Ryde	647	53	23	0	4	0	727	89%	10%	1%
Miosman Council	328	0	83	0	0	0	411	80%	20%	0%
Ku-ring-gai Council	350	9	3	0	0	0	362	97%	3%	0%
City of Parramatta	266	40	15	0	0	0	321	83%	17%	0%
Bayside Council (Botany Bay)	190	26	8	0	0	0	224	85%	15%	0%
Inner West Council	196	22	11	0	0	0	229	86%	14%	0%
Lane Cove Council	186	0	20	0	0	0	206	90%	10%	0%
Hornsby Shire	148	8	0	0	0	0	156	95%	5%	0%
City of Randwick	114	5	9	3	0	0	131	87%	13%	0%
The Hills Shire	112	0	4	0	0	0	116	97%	3%	0%
Blacktown City Council	105	4	0	0	0	0	109	96%	4%	0%
City of Canada Bay	84	12	0	0	0	0	96	88%	13%	0%
Woollhara Municipal Council	74	3	8	0	0	0	85	87%	13%	0%
City of Canterbury-Bankstown	78	8	0	0	0	0	86	91%	9%	0%
Cumberland City Council	91	4	0	0	0	0	95	96%	4%	0%
Waverley Council	58	20	3	0	0	0	81	72%	28%	0%
Bayside Council (Rockdale)	49	0	0	0	0	0	49	100%	0%	0%
Liverpool City Council	30	0	0	0	0	0	30	100%	0%	0%
Municipality of Strathfield	37	4	0	0	0	0	41	90%	10%	0%
Sutherland Shire	37	4	0	0	0	0	41	90%	10%	0%
City of Fairfield	34	0	3	0	0	0	37	92%	8%	0%
Central Coast Council	32	7	0	0	0	0	39	82%	18%	0%
Hunters Hill Council	31	0	3	0	0	0	34	91%	9%	0%
Burwood Council	20	11	0	0	0	0	31	65%	35%	0%
Georges River Council	14	10	6	0	0	0	30	47%	53%	0%
City of Penrith	21	3	0	0	0	0	24	88%	13%	0%

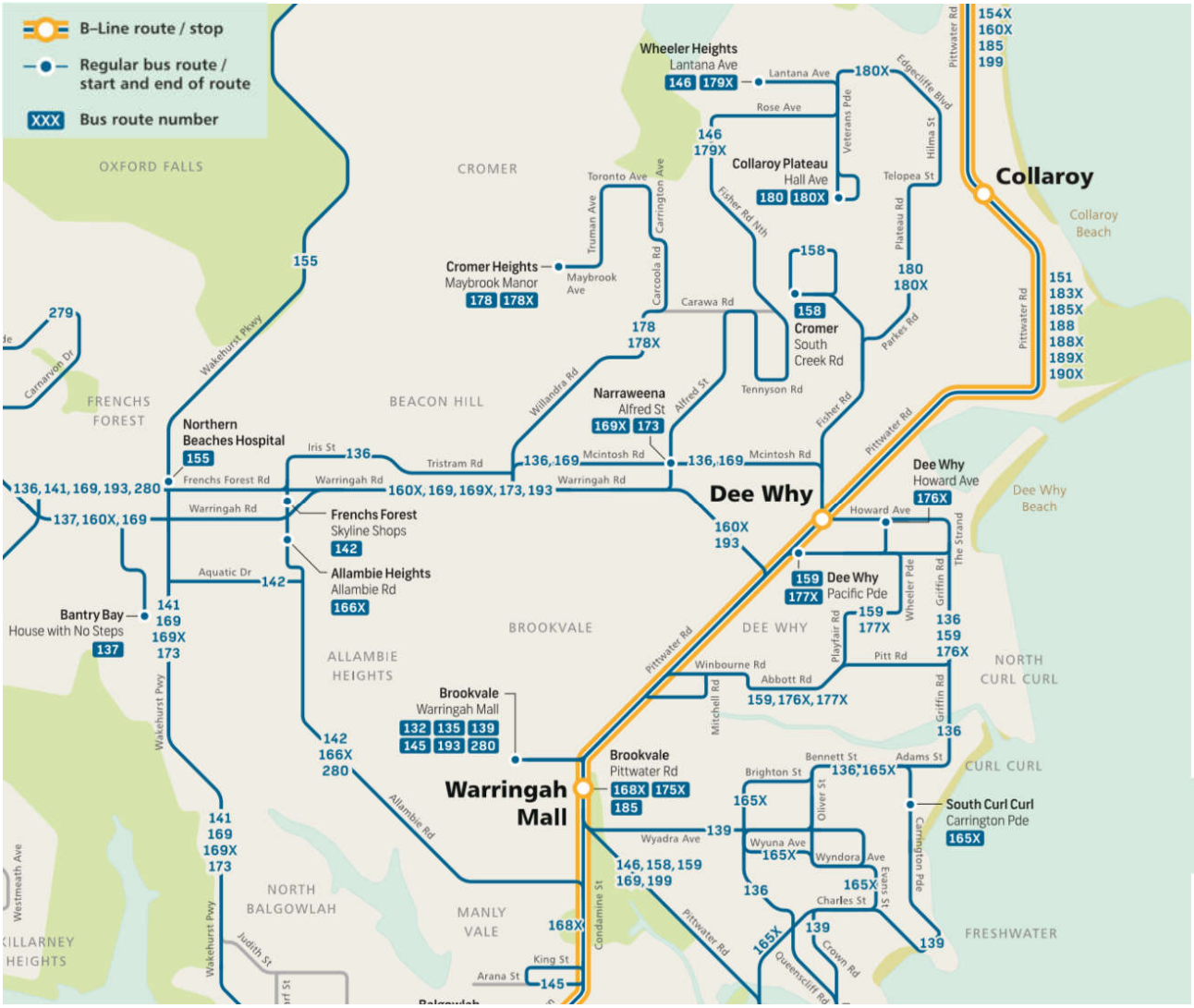
3.2 Public Transport

3.2.1 Rail Network

The nearest railway station is located at North Sydney approximately 12km away from the study area, serviced by the T1 and T9 rail lines. Bus services connect the study area to North Sydney station.

3.2.2 Bus Services

The study area is well-serviced by buses. The Pittwater Road corridor carries a large number of high frequency bus routes including the B-Line, which is the primary bus route for the Northern Beaches. In addition to these public bus services, there are also a number of school bus services. The bus routes travelling through the study area are illustrated in Figure 3.4.



Source: Transport for New South Wales

Figure 3.4: Brookvale Dee Why and Surrounds Public Bus Network

The scheduled and actual bus arrival times for bus services across NSW are recorded in the TfNSW Bus Opal Assignment Model (BOAM). Data from the previous year is available from the NSW *OpenData* portal. The BOAM data from six typical weekdays during February 2020 was analysed to determine the typical delays experienced by bus passengers within the study area. This analysis was completed for the following main routes through the study area:

- B1 - City to Mona Vale
- 159 - Dee Why to Manly
- 169 - City to Manly via Frenchs Forest

- 193 - Warringah Mall to Belrose.

3.2.3 Bus Service Delays

Route B1 is an express service along Condamine Street and Pittwater Road that only stops at the major stops at Warringah Mall and Dee Why. With limited stops, it is representative of traffic conditions along Pittwater Road. The average delays for the B1 are presented in Figure 3.5 and Figure 3.6.

In the southbound direction, buses reported greater delays during the AM peak and PM peak and ran ahead of time during off peak periods. In the northbound direction, delays were shown throughout the day, with slightly increased delays during peak traffic periods.

In both directions, B1 services tend to gain lost time against the timetable as they travel through the study area, with the exception of the AM peak in the northbound direction, where services are slightly further delayed.

B1 services are very frequent, with services every 2 or 3 minutes during peak periods, and delays between Dee Why and Brookvale are small. There were occasions where buses were fully occupied, with following services that were not. The data suggests that overall, bus 'seat' capacity between the two centres is considered to be sufficient at this time.

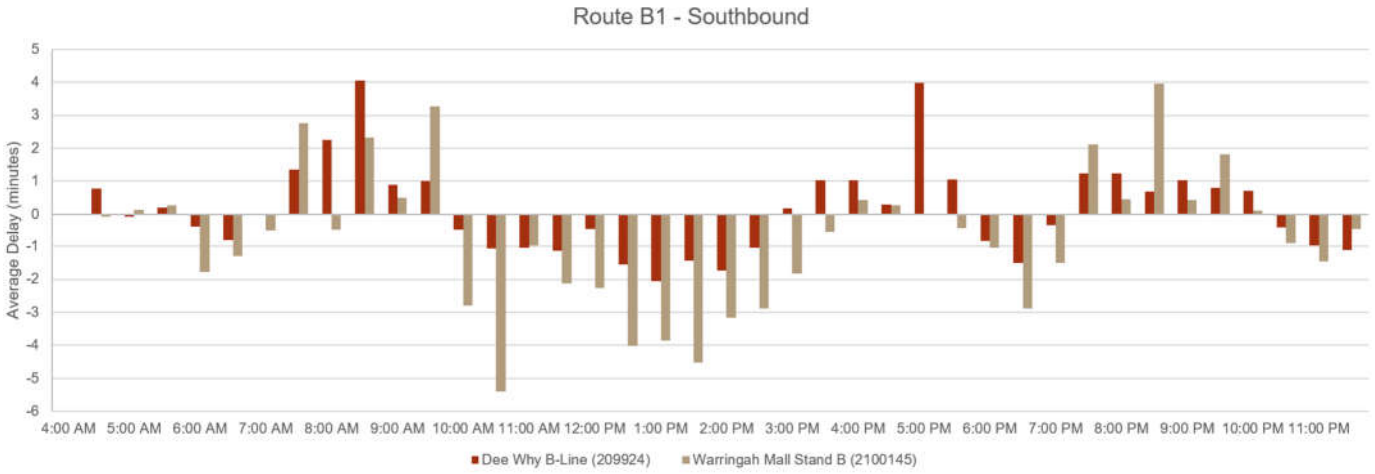


Figure 3.5: Route B1 Typical Delays – Southbound

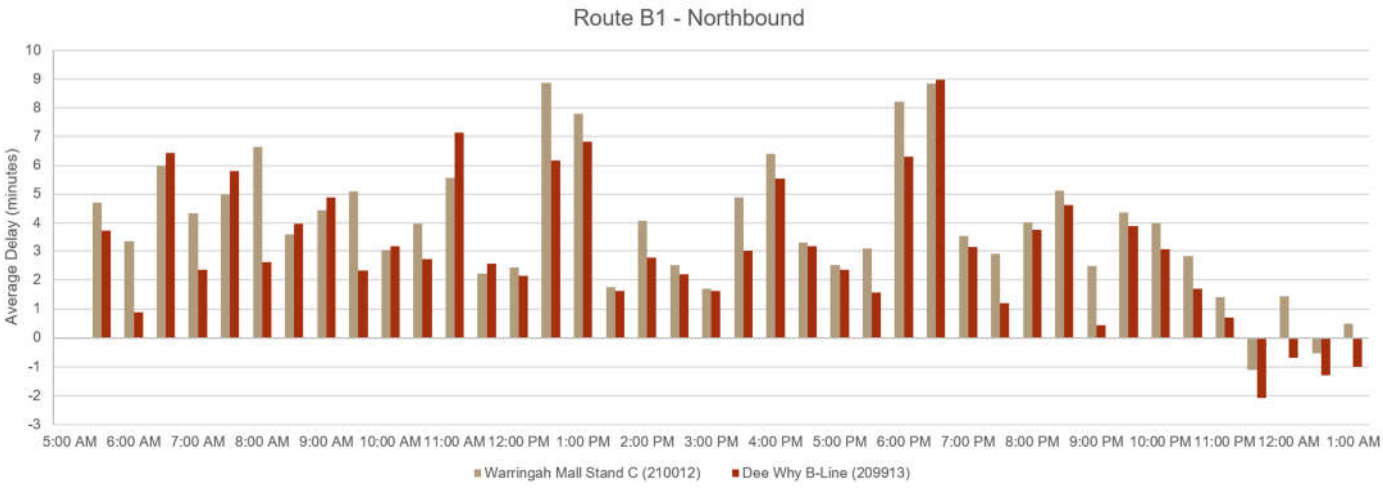


Figure 3.6: Route B1 Typical Delays – Northbound

Route 159 links Dee Why and Manly via North Curl and its usage includes residents of eastern Dee Why and North Curl to travel to and from Warringah Mall. The typical delays are detailed in Figure 3.7 and Figure 3.8. The service does not run during the commuter peaks with this route instead serviced by the 176X and 177X. Route 159 services tend to run slightly behind schedule, but delays are within four minutes which is not significant. Buses generally ran below their seat capacity.

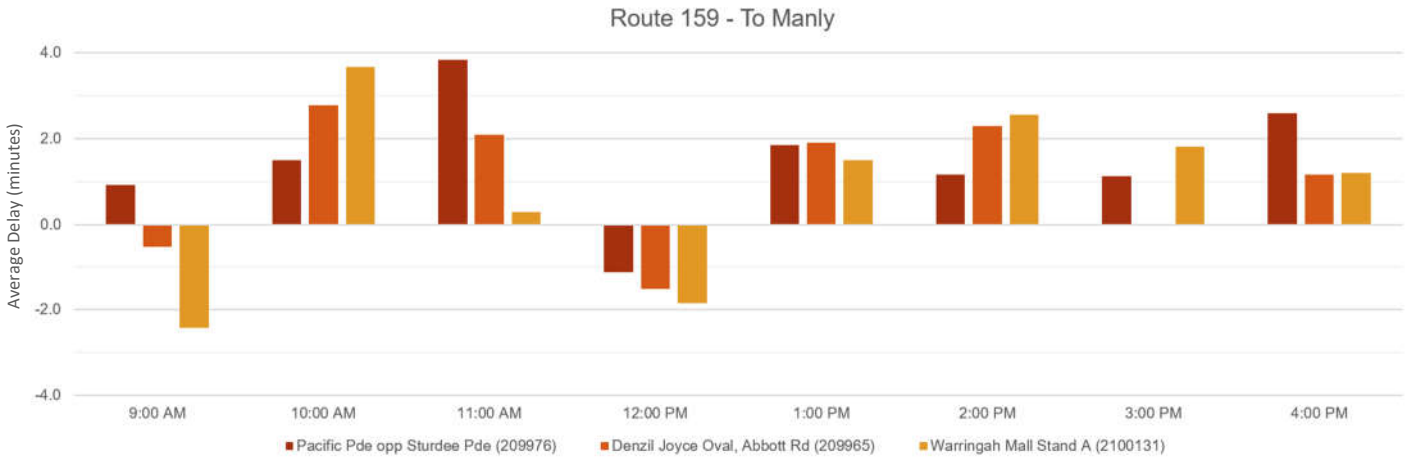


Figure 3.7: Route 159 Typical Delays – Towards Manly

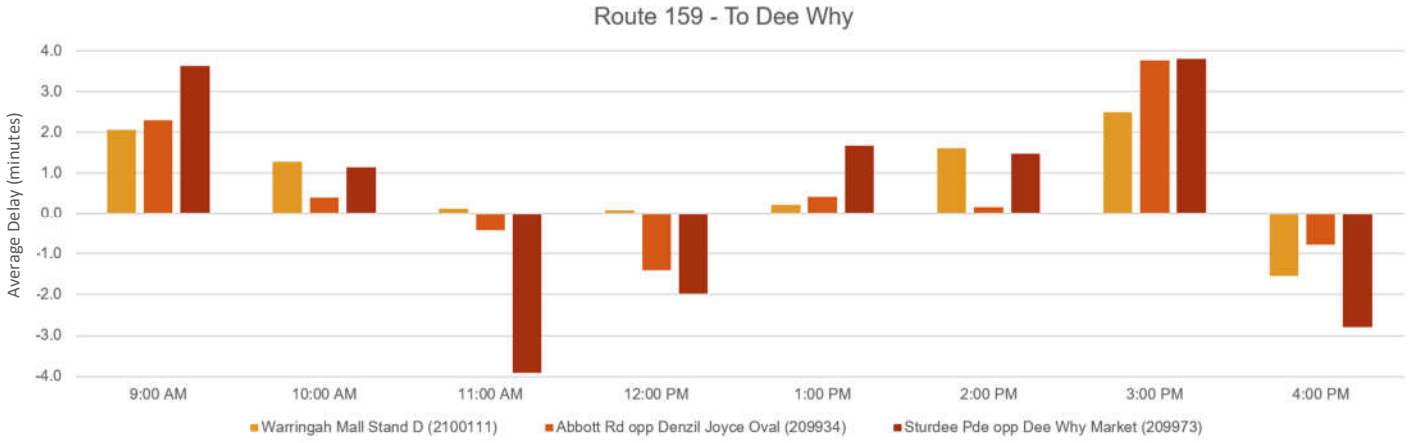


Figure 3.8: Route 159 Typical Delays – Towards Dee Why

Route 169 travels between Manly and the City via Dee Why and Frenchs Forest and also passes through the residential area west of Dee Why. Delays in the southbound direction are typically very long during the AM peak. These are a result of delays between the City and Frenchs Forest. Buses tend to gain time against their schedule travelling through the study area. In the northbound direction, buses are delayed throughout the day, and these delays remain steady between Warringah Mall and Dee Why. Bus seat capacity was not an issue for this route, and the route did not run during the PM peak (*or no data was available*). The typical delays are detailed in Figure 3.9 and Figure 3.10.

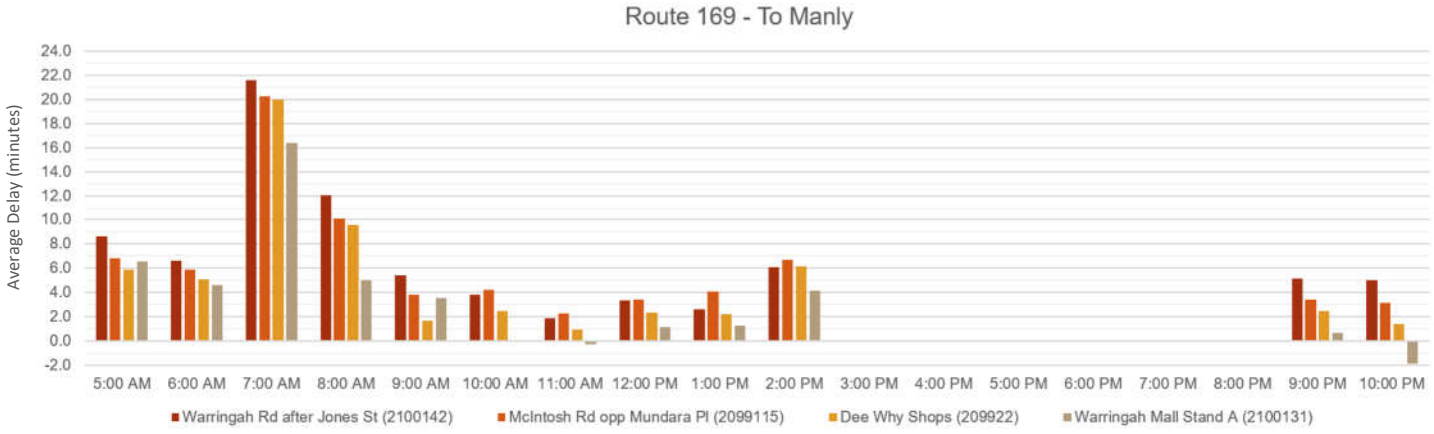


Figure 3.9: Route 169 Typical Delays – Towards Manly

Figure 3.10: Route 169 Typical Delays – Towards Frenchs Forest then City

Route 193 travels between Warringah Mall and the Belrose Super Centre, passing through Frenchs Forest. Its typical delays are detailed in Figure 3.11 and Figure 3.12. Delays are long during the AM peak in both directions. The route appears to be used by students of The Forest High School, as the bus arriving before 8:20 tends to reach its seat capacity before arriving at the school. Otherwise, the route operates adequately.

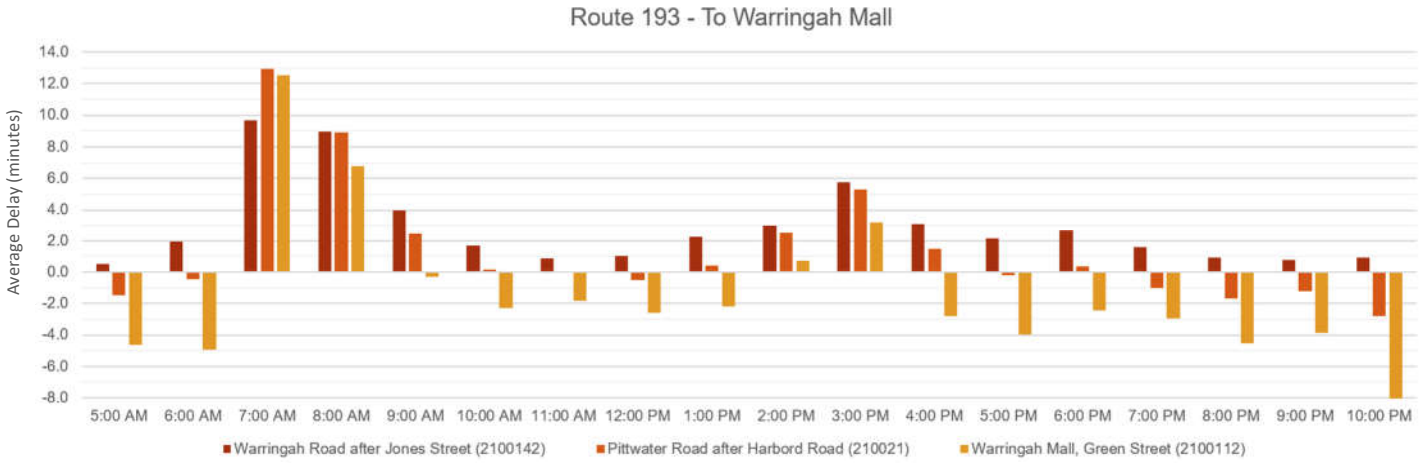


Figure 3.11: Route 193 Typical Delays – Towards Warringah Mall

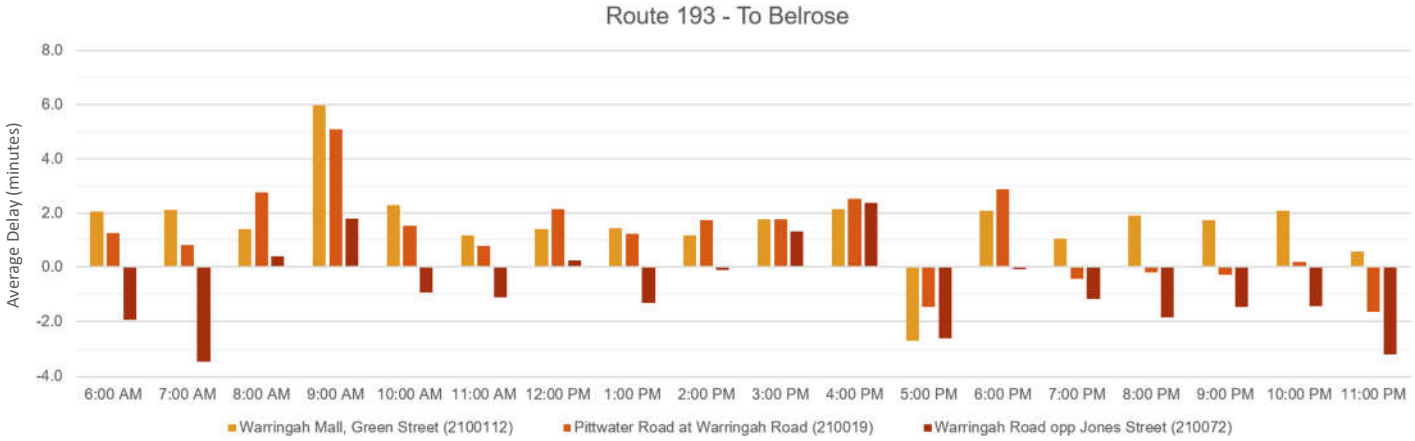


Figure 3.12: Route 193 Typical Delays – Towards Belrose

3.2.4 Bus Service Usage - Opal Card Analysis

Opal card counts were provided by TPA for a number of bus stops within the study area. This data shows bus usage is spatially distributed across the study area. The counts were an average of Tuesdays, Wednesdays and Thursdays in February 2020 (*pre-COVID influence*). The bus stops on Pittwater Road which service the B-Line are the most popular, with patronage greatly exceeding any other bus stops within the study area. The Opal counts for the Dee Why bus stops are presented in Figure 3.13 and the counts for the Warringah Mall stops in Brookvale are presented in Figure 3.14.

During the AM peak, Dee Why shows a sharp peak for citybound boardings at 7:00 AM. During the PM peak, northound alightings peak at 6:00 PM.

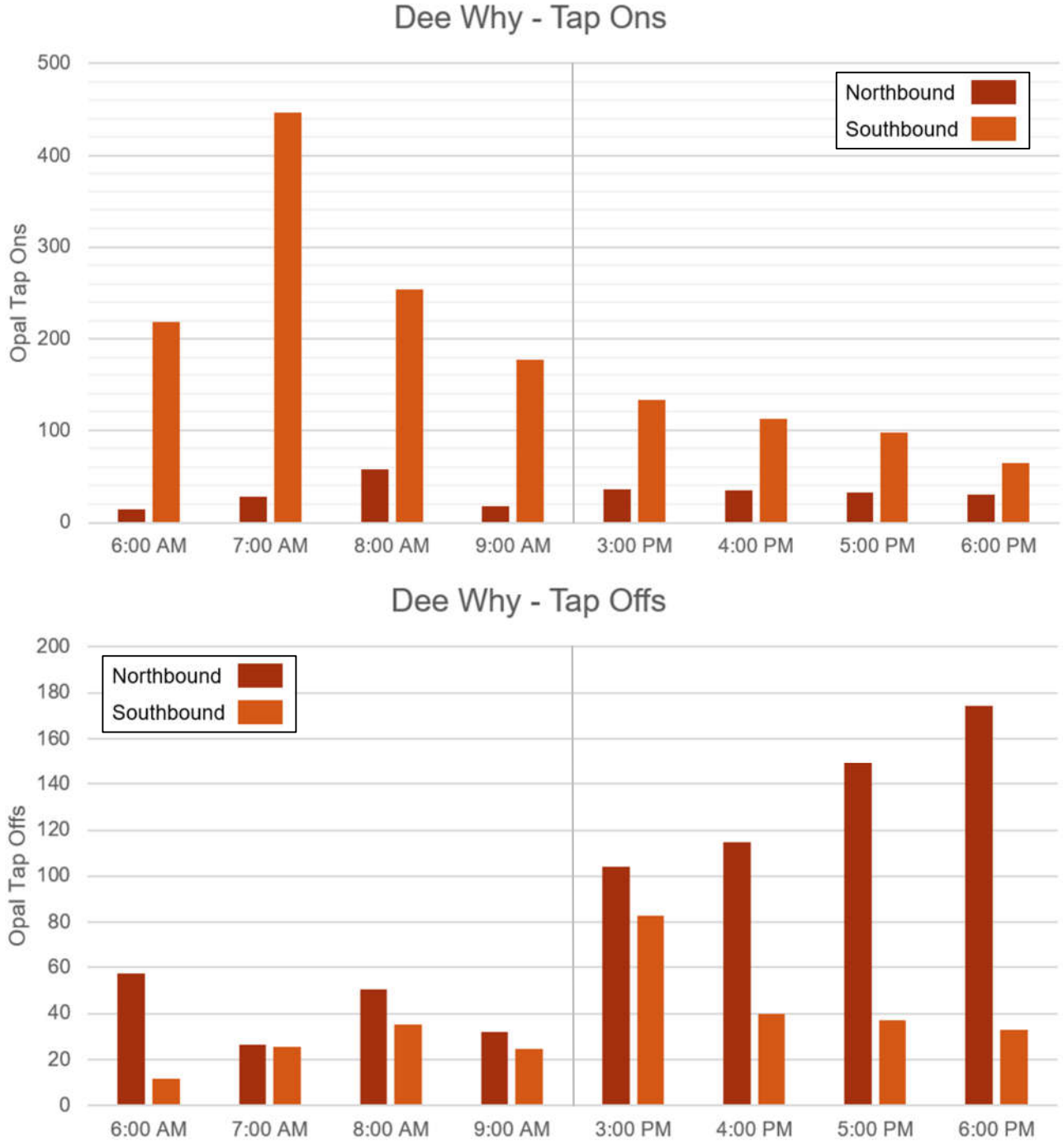


Figure 3.13: Opal Card Data – Dee Why

The Opal counts during the AM peak for the Warringah Mall bus stops (Brookvale) shows a boarding (*tap-on's*) peak at 7:00 AM for citybound commuters, while the peak for northound alightings (*tap off's*) is 6:00 PM.

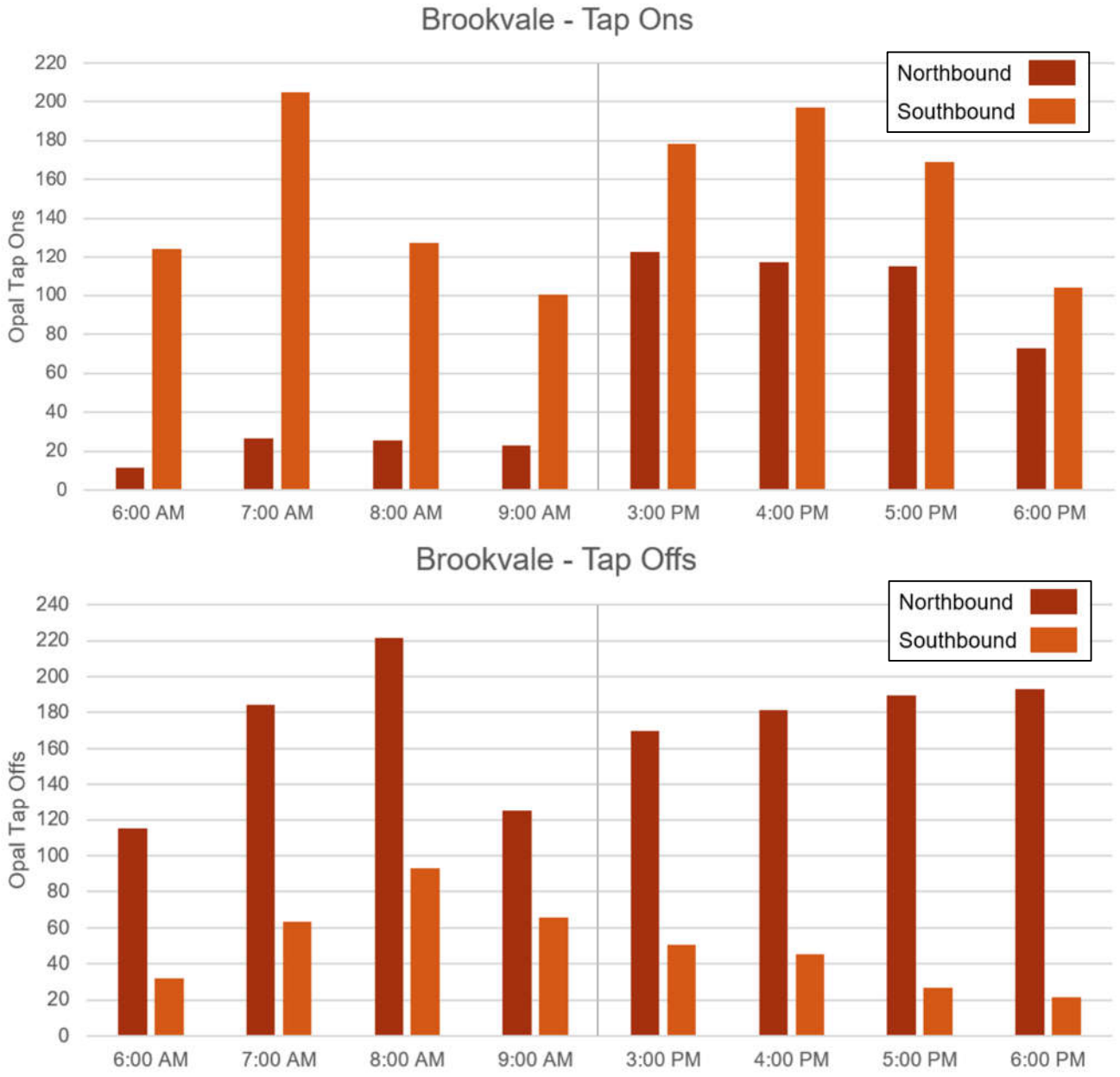


Figure 3.14: Opal Card Data – Brookvale (Warringah Mall)

3.2.5 Bus Usage Growth

The growth of bus patronage within the study area was estimated with historical monthly Opal tap on and tap off data obtained from the TfNSW. The Opal data was collected from between January 2017 and December 2020 for selected major bus stops in the area. The bus stops include the B-Line bus stops within the study area, and are mainly located in three clusters along the Pittwater Road corridor:

- Near Warringah Mall
- Near Manly Leagues Club
- Dee Why Town Centre.

The stop locations and TSN ID numbers are shown in Figure 3.15.

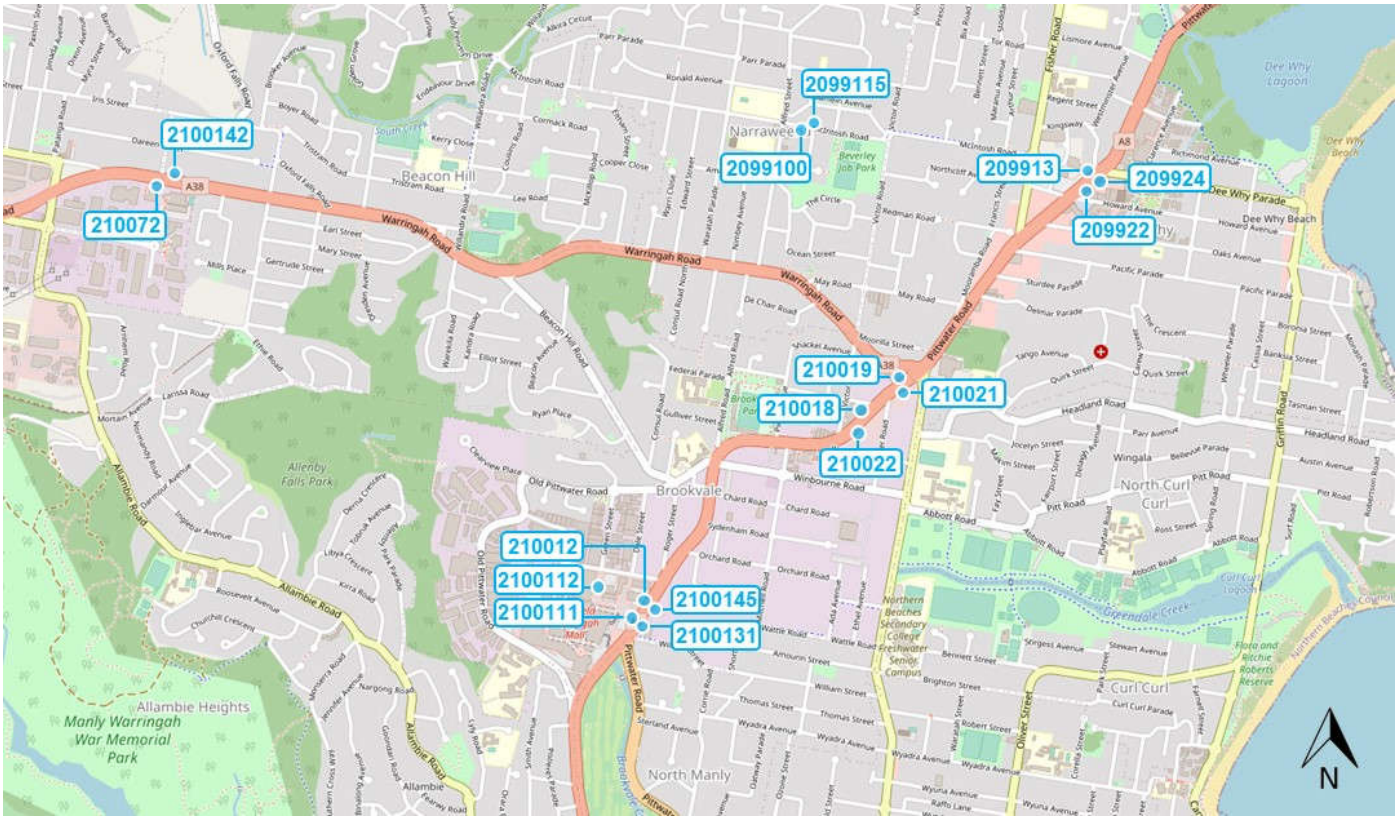


Figure 3.15: Opal Data Bus Stop Locations

The total 'tap-ons' and 'tap-offs' for these bus stops by month across the three-year period is shown in Figure 3.16. Overall, there can be seen a relatively consistent upwards trend across the time period, with the exception of a sharp decrease once COVID-19 restrictions were introduced.

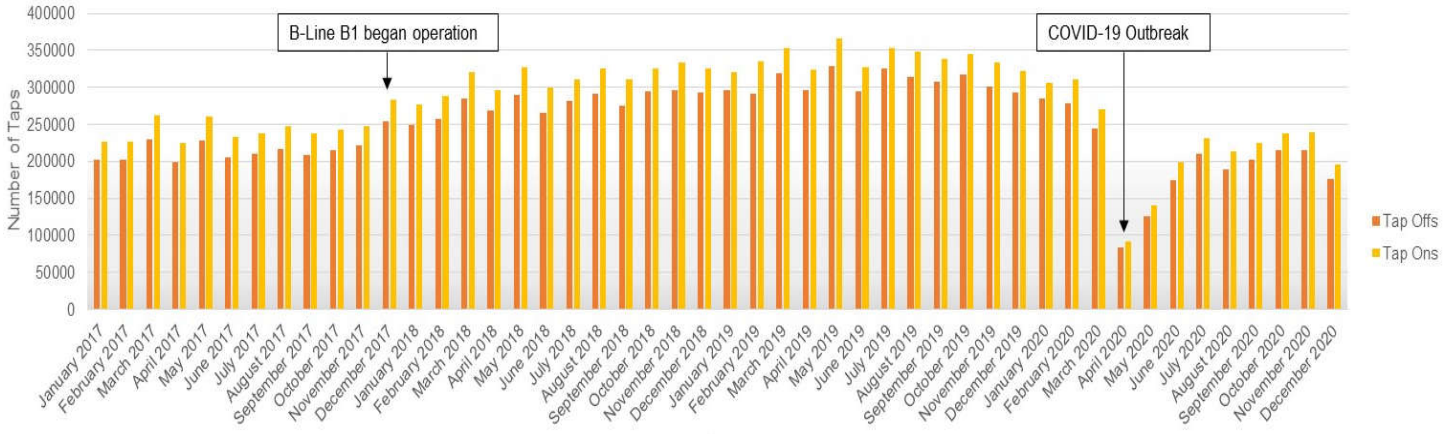


Figure 3.16: Opal Data - Total Tap Ons and Tap Offs

The total volume of 'tap ons' and 'tap offs' in each year is shown in Table 3.2. There was an increase of around 1,500,000 taps between 2017 to 2018, and an increase of around 700,000 taps between 2018 and 2019. The 2020 data was affected by COVID-19 impacts. There is insufficient permanent behaviour change evidence at this time to suggest if bus usage growth patterns evident before the pandemic will continue post-pandemic or if there have been permanent shifts in travel behaviours that would lead to long term reductions in expected bus patronage.

Table 3.2: Annual Tap-On and Tap-Off Volumes

Year	Tap-On	Tap-Off	Total
2017	2,929,767	2,592,214	5,521,981
2018	3,739,826	3,349,202	7,089,028
2019	4,070,431	3,686,008	7,756,439
2020[1]	2,660,614	2,397,349	5,057,963

[1] *Covid-19 affected*

The relative growth in bus patronage levels from January 2017 is shown in Figure 3.17.

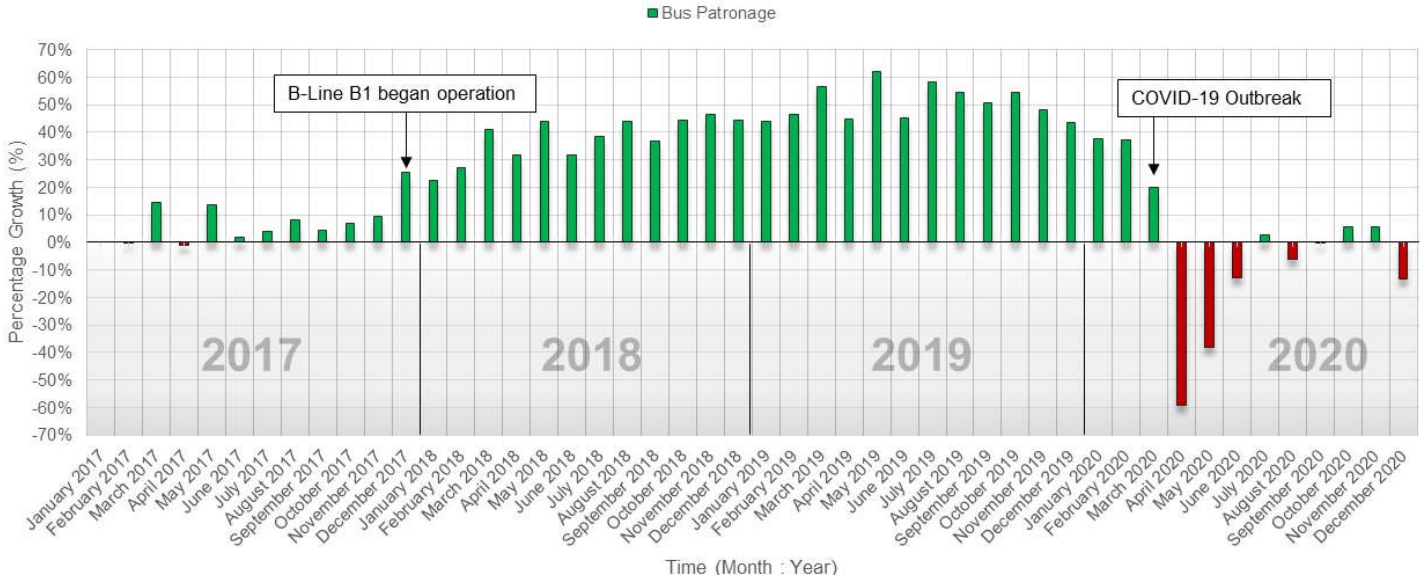


Figure 3.17: Bus Patronage Growth from January 2017

The pattern of growth shows that for the most part, there is a consistent level of 'background' growth in bus patronage each month. The sharp increase in bus patronage levels that is shown towards the end of 2017. is due to the commencement of the B-Line B1 in November 2017.

To estimate the patronage growth solely due to the introduction of the B1 service, the data was analysed to isolate the B-Line growth compared to background (usual) growth. It was assumed that the majority of the B-Line-specific growth occurred in 2018, with growth patterns expected to have stabilised to usual patters by 2019. The one-year growth by month from 2017 to 2018 was compared between these year periods, as shown in Table 3.3. For clarification, the percentages shown refer to the increase from (for example) August 2017 to August 2018.

Table 3.3: Bus Stop Growth (1-year growth by month)

Month	2017 - 2018	2018 - 2019	2019 - 2020
January	+23%	+17%	-4%
February	+27%	+15%	-6%
March	+23%	+11%	-24%
April	+33%	+10%	-72%
May	+27%	+13%	-62%
June	+29%	+10%	-40%
July	+33%	+14%	-35%
August	+33%	+7%	-39%
September	+31%	+10%	-34%
October	+35%	+7%	-32%
November	+34%	+1%	-29%
December	+15%	0%	-40%
YEAR TOTAL	+28%	+9%	-35%

The comparison of one-year growth calculated per month shows that:

- From 2017 to 2018, there was an average growth of 28% across the year (max 35%)
- From 2018 to 2019, there was an average growth of 9% across the year (max 17%).

The 2018 to 2019 growth at 9% is reflective of the aforementioned 7% average increase in bus patronage from beginning 2017 to end 2017. Therefore, given that the growth in the year period following the commencement of B-Line services is around 28%, then it can be estimated that the start of the B1 bus service resulted in increased bus patronage levels of around **20%**.

Based on a series of assumptions, this would mean:

- Approximately 1.1 million new “tap ons” plus “tap offs” each month due to the introduction of the B-Line equating to approximately 550,000 taps per direction per month.
- Assuming an even distribution through a 30-day month, this is around 18,400 taps per direction per day.
- Assuming that 20% of this occurs during the AM+PM peak hours, this is around 1,800 taps per direction per hour
- With the B-Line bus capacity of 86 seats and standing room for 15 people, this would require around 18 buses an hour in each direction to cater for the demand. This is equivalent to a bus frequency of around 1 bus every 3 minutes and assumes that the buses are empty before arriving in the study area.

It is understood that this is approximately reflective of the existing B1 frequency during peak hours, which reinforces that the assumed 20% of total patronage growth is a reasonable representation of the B-Line effects.

3.2.6 On Demand Services

The Northern Beaches currently has On Demand services operated by Keolis Downer, referred to as ‘Keoride’. Keoride services are public transport ride share services operated via passenger cars which provide what is referred to as ‘first and last mile connections’ which aim to reduce Park and Ride demand for short connection trips.

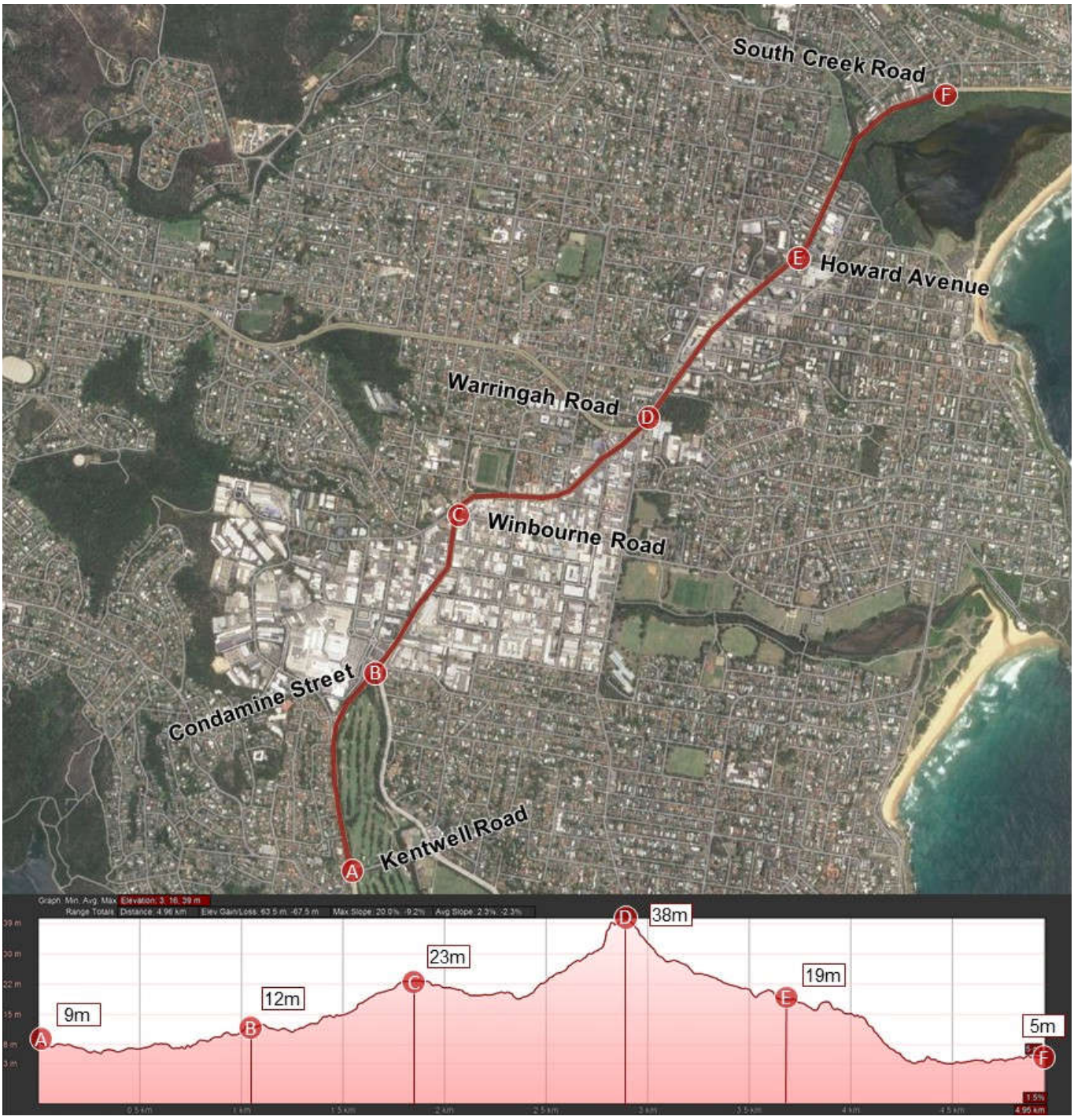
Keoride only operates in the suburbs north of the study area, including Mona Vale, Warriewood, Narrabeen and Newport.

3.3 Active Transport

3.3.1 Walking

Pittwater Road has a highly connected network of footpaths on both sides of the corridor with a reasonable number of crossing opportunities, mostly at traffic signals. Pittwater Road is predominately fronted by residential and commercial land uses.

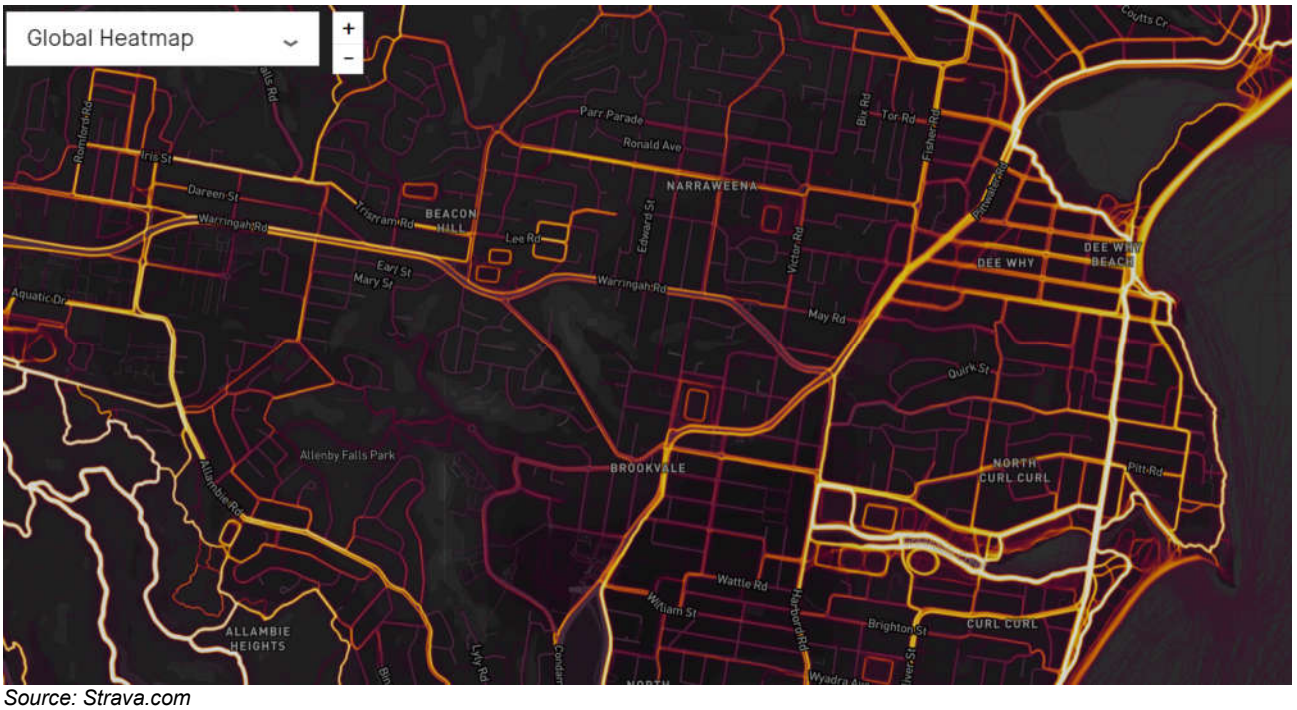
The elevation profile along the Pittwater Road corridor is shown in Figure 3.18. While some sharp changes in gradient are present along parts of the Pittwater Road corridor, the average gradient is not very steep with an average slope of 2.3%. From south to north, the corridor grades upwards and peaks at Point D (elevation 38m), at a position just north of Pittwater Road / Warringah Road / Harbord Road, before gradually grading downwards through the Dee Why Town Centre.



Source: Google Earth

Figure 3.18: Pittwater Road Corridor Elevation Profile

Output for the study area from Strava's global heatmap for walking is shown in Figure 3.19. This data indicates that the Dee Why Town Centre has the densest concentration of recorded pedestrian activity, with relatively lighter levels around Warringah Mall and Beacon Hill. Local roads such as Fisher Road, McIntosh Road, Willandra Road and Winbourne Road are used by pedestrians to a moderate level, reflective of the services, schools, and recreational parks along these streets.

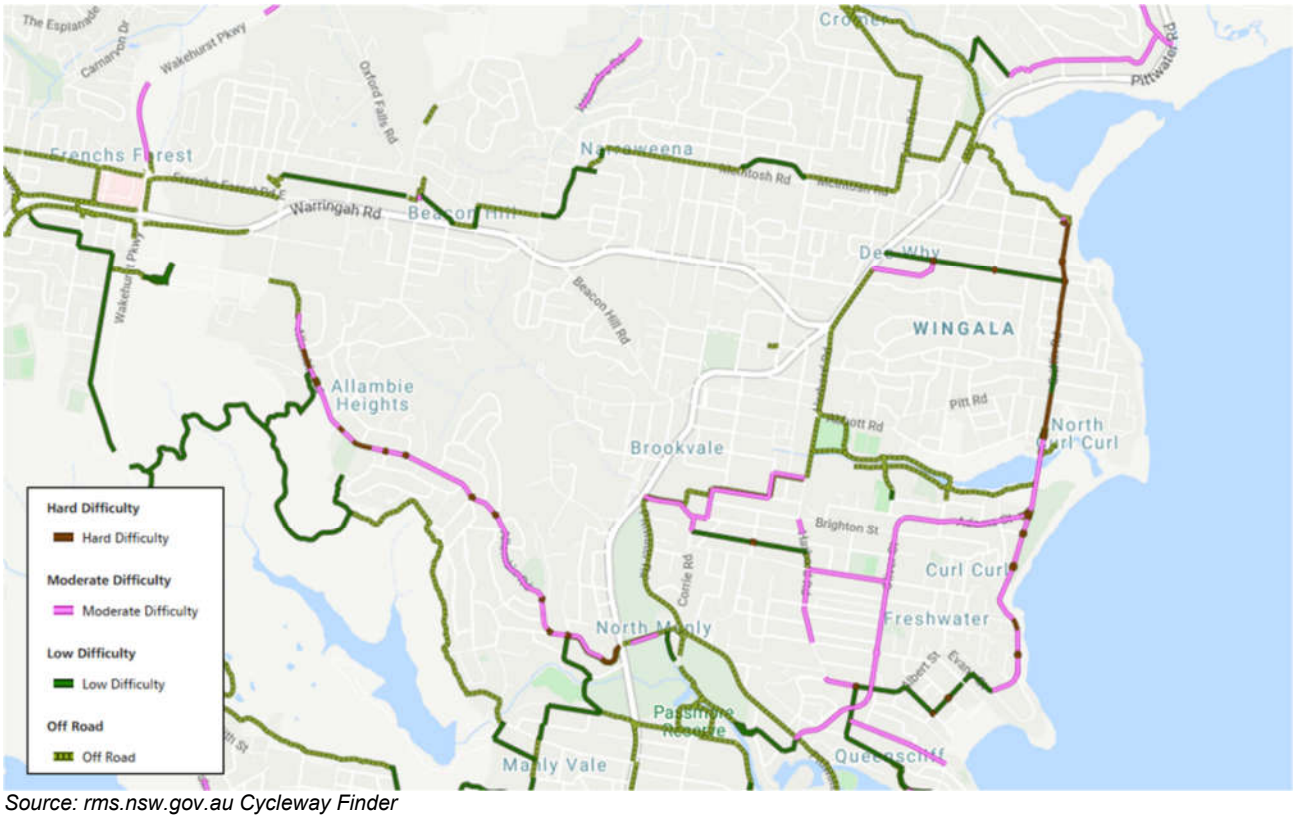


Source: Strava.com

Figure 3.19: Walking Activity

3.3.2 Cycling

The cycling network within the study area is shown in Figure 3.20, divided between on-road and off-road cycling routes of varying difficulty levels.



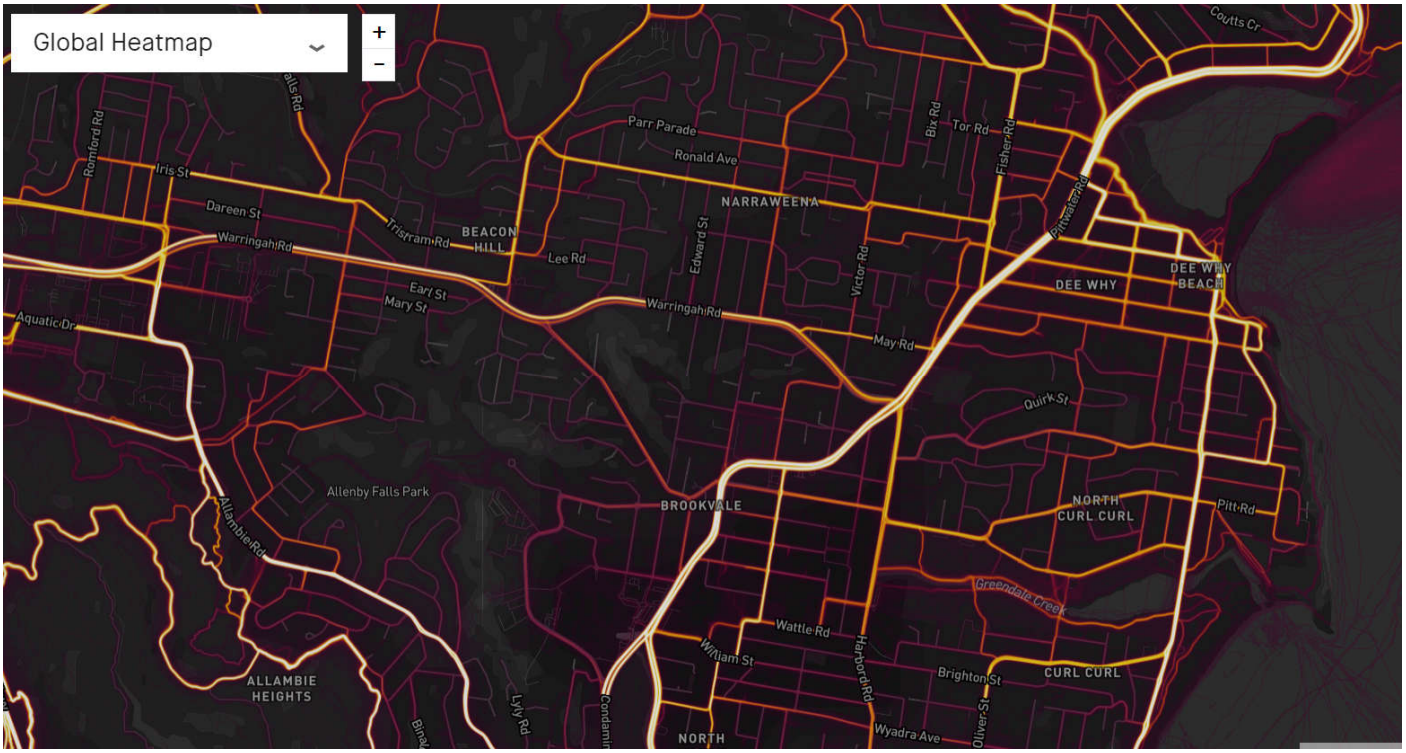
Source: rms.nsw.gov.au Cycleway Finder

Figure 3.20: Cycling Network

The cycling network in the Brookvale Dee Why area encourages the diversion of vulnerable cyclists away from the main Pittwater Road corridor, as well as away from the Warringah Road east-west corridor. Off-road shared paths are provided on a number of other roads, including along Harbord Road and Pittwater Road south of Condamine Street. Connections to and through the western side of the Pittwater Road corridor are limited, with the only westbound links being along Allambie Road and along McIntosh Road. The study area is considered to be well connected and suitable for current demands but is acknowledged to have a large area around Beacon Hill Road which is not particularly cycling-friendly.

Outputs from Strava's global heatmap for cycling in the study area are shown in Figure 3.21. This data shows that despite the lack of dedicated infrastructure south of Warringah Road, cycling along the Pittwater Road corridor is relatively popular showing relatively high usage through the Brookvale and Dee Why Town Centres. It should be recognised however that the data is likely to be biased towards sports cyclists who have a bias in using major through routes over local roads.

While the council-nominated route via Harbord Road and local streets are shown to be used, parallel alternatives such as Mitchell Road also demonstrate relatively high usage. Furthermore, reasonable levels of cycling activity are shown along Warringah Road which has no current provision for cyclists.



Source: strava.com

Figure 3.21: Cycling Activity

3.4 Road Network Description

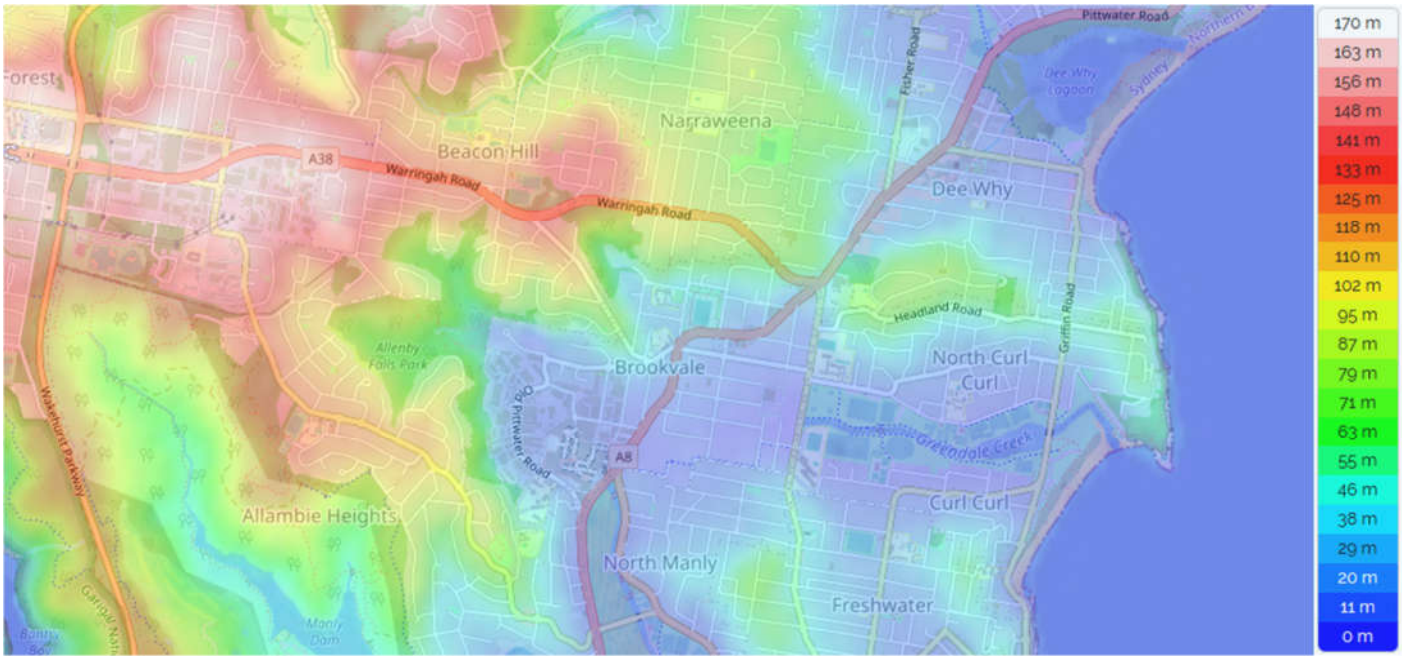
3.4.1 Overview

The study area road network is structured around the two main movement corridors: Pittwater Road and Warringah Road. These roads, as well as the supporting road system between and around them, are described in the sub-sections below.

3.4.2 Topography

The study area is characterised by a steep topographic rise around Beacon Hill and Narraweena, relative to the eastern suburbs near the coast. While the main Pittwater Road corridor remains relatively consistent in terms of height above sea level, Warringah Road, Beacon Hill Road and Allambie Road all show steeper gradients in the rise up to Frenchs Forest. The gradient of these roads present challenges to the safe and efficient operation of cars, trucks, buses and bicycles, reflected in the lower speed limit for trucks and buses on Warringah Road as they travel steep gradients.

The topography of the region is shown in Figure 3.22.



Source: Topographic-map.com

Figure 3.22: Study Area Topography

3.4.3 Pittwater Road

Pittwater Road is the primary north-south arterial road in the study area and has a posted speed limit of 60 km/h. There are over 30 intersections along the corridor through Brookvale and Dee Why. Pittwater Road is, for the most part, a six lane two-way road, with two travel lanes and a bus lane in each direction. The northbound bus lane with its clearway condition is activated in the AM peak and the southbound bus lane is activated in the PM peak. During the off-peak periods when the bus lanes are inactive, there is time-limited kerbside parking in these lanes. Pittwater Road transitions into Condamine Street south of Warringah Mall as a continuation of the larger movement corridor.

Pittwater Road serves a multi-function role in the road network, facilitating regional through movements between the Northern Beaches and the lower North Shore, as well as 'local' trips between Dee Why and Brookvale. Furthermore, it provides the 'backbone' of the B-Line services to and from the Sydney CBD. A typical cross-section of Pittwater Road is shown in Figure 3.23.

Source: Google Street View

Figure 3.23: Typical Cross-section of Pittwater Road (Northbound)

3.4.4 Warringah Road

Warringah Road is an east-west major arterial road with a posted speed limit of 60 km/h to 70km/h, connecting Pittwater Road to the suburbs to the west of the study area, including Frenchs Forest, Forestville, Belrose, Roseville, and Chatswood. Warringah Road is primarily a six lane, two-way road with three travel lanes each way. The section to the east of Beacon Hill Road has unrestricted parking in the kerbside lane, while the section to the west has 6:00 AM to 7:00 PM clearway conditions on weekdays. A typical cross-section of Warringah Road is shown in Figure 3.24.

Source: Google Street View

Figure 3.24: Typical Cross-section of Warringah Road (Eastbound)

3.4.5 Harbord Road

Harbord Road is a north-south sub-arterial road with a posted speed limit of 60 km/h, connecting to the major movement corridors in the network. Harbord Road is generally a four lane, two-way road with two travel lanes each way. There are sections of kerbside parking along the road, particularly to the south of Abbott Road. To the south of Miles Street, Harbord Road transitions into a two lane, two-way road as it passes through the residential catchment.

A typical cross-section of Harbord Road is shown in Figure 3.25.

Source: Google Street View

Figure 3.25: Typical Cross-section of Harbord Road (Northbound)

3.4.6 Beacon Hill Road

Beacon Hill Road is a north-south collector road with a posted speed limit of 50 km/h. It joins Old Pittwater Road to the south and Warringah Road to the north, enhancing the interconnectivity between the major corridors in the network. Beacon Hill Road functions as a bypass of the core Pittwater Road / Warringah Road intersection for drivers travelling between Brookvale, Beacon Hill, and Frenchs Forest.

A typical cross-section of Beacon Hill Road is shown in Figure 3.26.

Source: Google Street View

Figure 3.26: Typical Cross-section of Beacon Hill Road (Southbound)

3.4.7 Mitchell Road

Mitchell Road is a north-south collector road within the Brookvale Industrial precinct. It is signposted at 50 km/h. Mitchell Road is typically two lanes, two-way, with unrestricted kerbside parking on both sides of the road. Mitchell Road connects Pittwater Road and Wattle Road facilitating movement between its industrial lots and Pittwater Road. Mitchell Road is also a bicycle route and includes bicycle awareness zone markings.

A typical cross-section of Mitchell Road is shown in Figure 3.27.

Source: Google Street View

Figure 3.27: Typical Cross-section of Mitchell Road (Southbound)

3.4.8 Winbourne Road

Winbourne Road is an east-west local road. Winbourne Road connects Pittwater Road and Harbord Road. It provides for traffic movements through the industrial precinct as well as providing access to a number of industrial lots. Winbourne Road is two lanes, two-way, with kerbside parking on both sides of the road which is time-restricted to the west of Mitchell Road and unrestricted to the east of it. The road has inconsistent speed signage, signposted as 50 km/h for most of its eastbound direction and 60 km/h westbound.

A typical cross section of Winbourne Road is shown in Figure 3.28.

Source: Google Street View

Figure 3.28: Typical Cross-section of Winbourne Road (Southbound)

3.5 Traffic Data

3.5.1 Intersection Counts

Intersection counts were undertaken by Traffic Data & Control (TDC) at 44 intersections within the study area with 43 of these locations surveyed on Thursday 7th February 2019. Due to a later expansion of the study area to include the Old Pittwater Road industrial corridor around Warringah Mall, an additional intersection count was undertaken on Thursday 30th May 2019. This count was for the signalised intersection of Old Pittwater Road and Warringah Mall Access.

The time periods for traffic surveys were:

- Weekday AM Peak: 0600-1000
- Weekday PM Peak: 1500-1900.

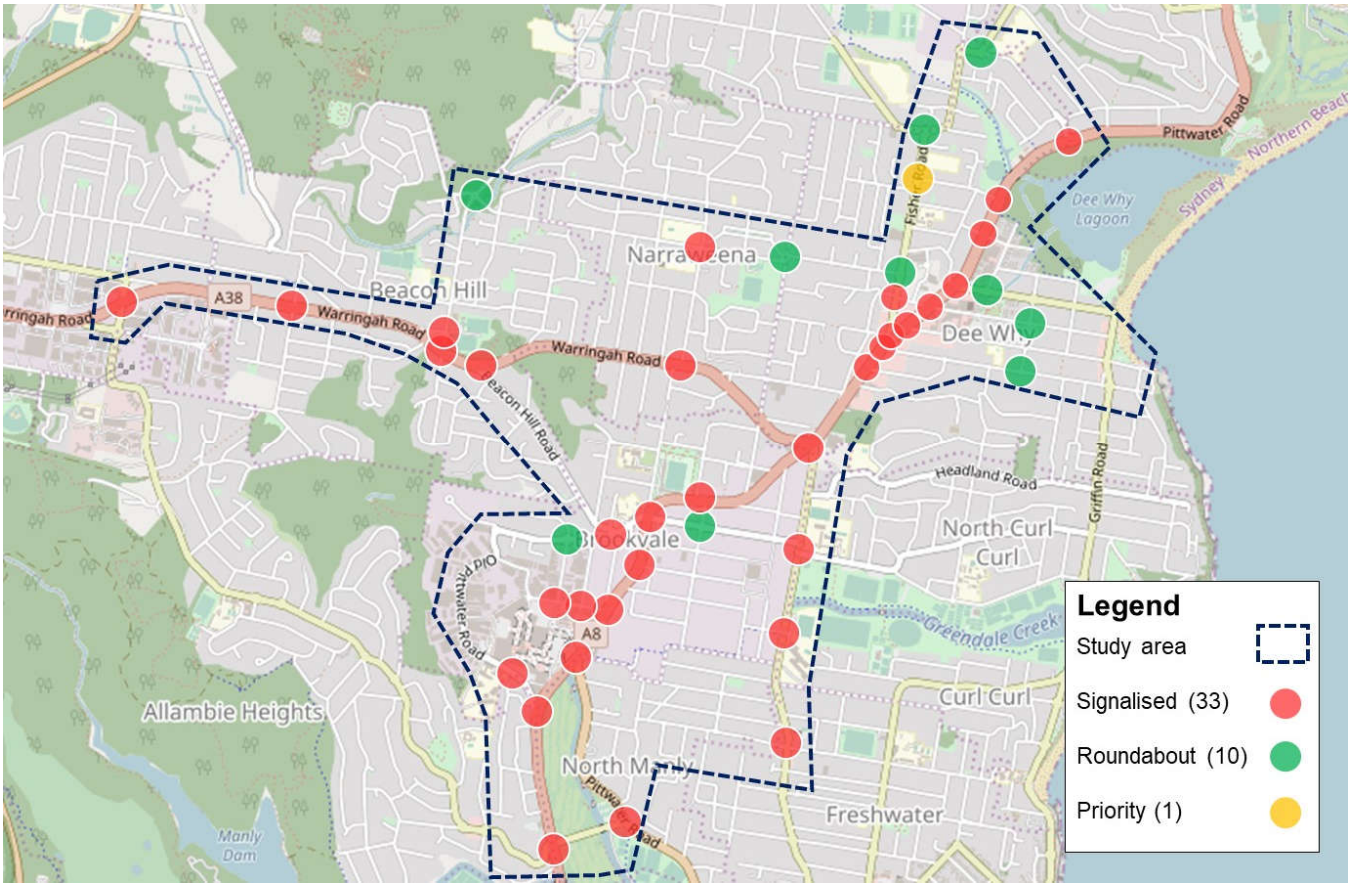
The intersection count data was used for matrix estimation / calibration of the 2019 Base AIMSUN model. Table 3.4 shows each intersection ID, intersection name and control type for the surveyed intersections.

Table 3.4: Intersection Count Locations

ID	Intersection Name	Control Type
1	Pittwater Road / South Creek Road	Signalised
2	Pittwater Road / Lismore Avenue	Signalised
3	Pittwater Road / Hawkesbury Avenue	Signalised
4	Pittwater Road / Dee Why Parade / Kingsway	Signalised
5	Pittwater Road / Howard Avenue / St David Avenue	Signalised
6	Pittwater Road / Oaks Avenue	Signalised
7	Pittwater Road / Fisher Road	Signalised
8	Pittwater Road / Pacific Parade	Signalised
9	Pittwater Road / Sturdee Parade	Signalised
10	Pittwater Road / Warringah Road / Harbord Road	Signalised
11	Pittwater Road / Mitchell Road / Pine Avenue	Signalised
12	Pittwater Road / Winbourne Road / Old Pittwater Road	Signalised
13	Pittwater Road / Sydenham Road	Signalised
14	Pittwater Road / Cross Street / Brookvale Depot	Signalised
15	Pittwater Road / Condamine Street	Signalised
16	Condamine Street / Old Pittwater Road	Signalised
17	Condamine Street / Kentwell Road	Signalised
18	Pittwater Road / Kentwell Road	Signalised
19	Old Pittwater Road / Beacon Hill Road / Roger Street	Signalised
20	Old Pittwater Road / Green Street / Brookvale Avenue	Roundabout
21	Cross Street / Dale Street	Signalised
22	Green Street / Cross Street	Signalised
23	Mitchell Road / Winbourne Road	Roundabout
24	Harbord Road / Abbott Road / Winbourne Road	Signalised
25	Harbord Road / Miles Street	Signalised
26	Harbord Road / Wyadra Avenue	Signalised
27	Warringah Road / Alfred Street	Signalised
28	Warringah Road / Beacon Hill Road	Signalised
29	Warringah Road / Willandra Road	Signalised
30	Warringah Road / Allambie Road	Signalised

ID	Intersection Name	Control Type
31	Willandra Road / McIntosh Road	Roundabout
32	McIntosh Road / Victor Road / Alamein Avenue	Roundabout
33	Fisher Road / St David Avenue / Lewis Street	Signalised
34	Fisher Road / McIntosh Road	Roundabout
35	Fisher Road / Lismore Avenue	Priority
36	Fisher Road / Campbell Avenue / Lynwood Avenue	Roundabout
37	S Creek Road / Parkes Road	Roundabout
38	Pacific Parade / Avon Road	Roundabout
39	Howard Avenue / Avon Road	Roundabout
40	Dee Why Parade / Clarence Avenue	Roundabout
41	Warringah Road / Government Road / Ellis Road	Signalised
42	Willandra Road / Cornish Avenue	Signalised
43	McIntosh Road / Alfred Street	Signalised
44	Old Pittwater Road / Warringah Mall Access	Signalised

The surveyed intersections are shown in Figure 3.29.



Basemap Source: OpenStreetMap

Figure 3.29: Intersection Count Locations

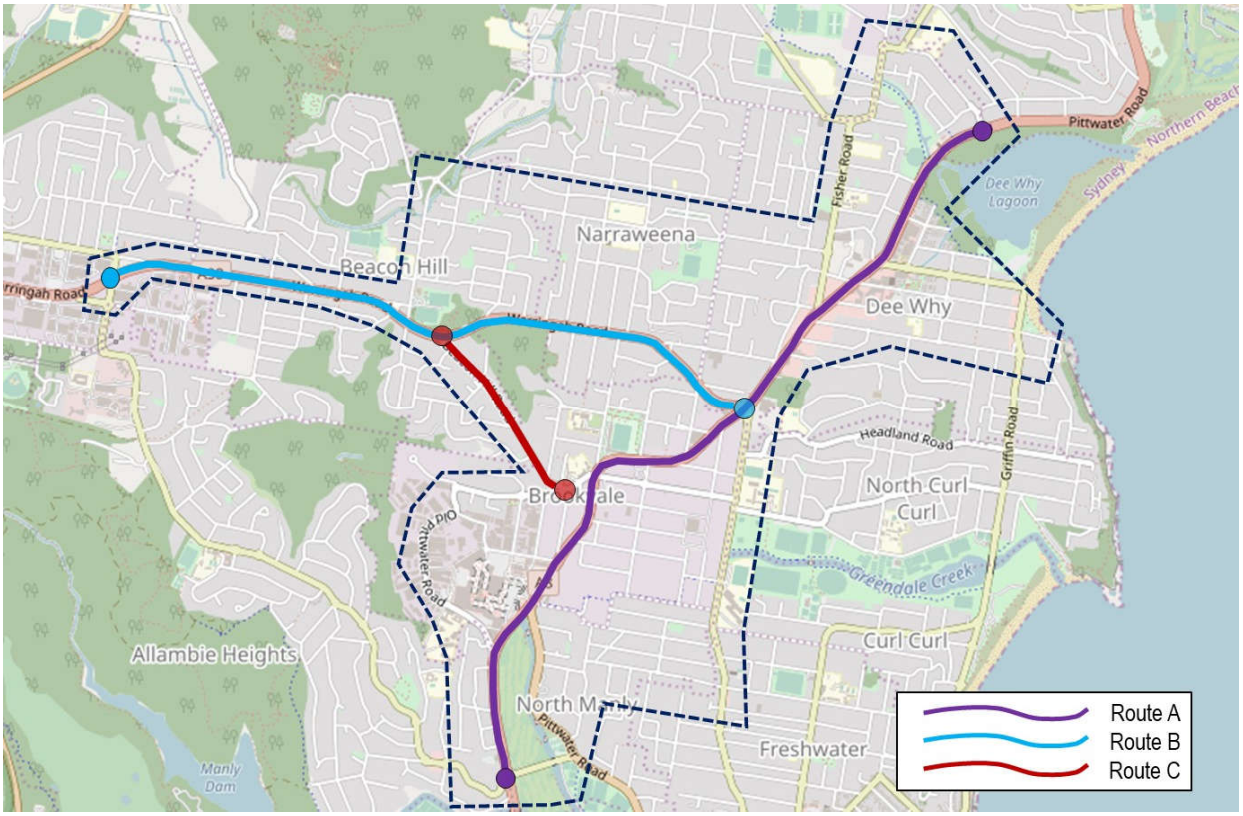
3.5.2 Traffic Signals Data

The SCATS traffic signal data was provided by TfNSW for the 33 traffic signals within the study area. The data was recorded for 24-hours (12:00:00 AM to 11:59:59 PM) on Thursday 7th February 2019. For the same reasons as the traffic surveys, the SCATS data for the Old Pittwater Road / Warringah Mall Access was collected at a later date (on Thursday 30th June 2019).

3.5.3 Travel Time Surveys

Travel times were used for AIMSUN model validations purposes and were collected for the following routes within the study area, and as shown in Figure 3.30:

- **Route A:** Pittwater Road between South Creek Road and Kentwell Road
- **Route B:** Warringah Road between Pittwater Road and Allambie Road
- **Route C:** Beacon Hill Road between Old Pittwater Road and Warringah Road.



Basemap Source: OpenStreetMap

Figure 3.30: Travel Time Survey Routes

The Route A and Route B travel time surveys were undertaken by TDC on the same date as the intersection counts (on 7th February 2019). The Route C travel time surveys were undertaken by Bitzios Consulting at a later date (on 12th February 2020) in response to increasing the coverage of the AIMSUN model validation. The survey used GPS devices to record the location of the vehicle every second on each route and the 'Floating Car' survey method was adopted for multi-lane route segments.

3.5.4 Queue Length Data

Back-of-queue length surveys were undertaken at each of the side streets to Pittwater Road and to Condamine Street as detailed in Table 3.5. The queue lengths at these side streets were used to validate queue lengths from the AIMSUN and SIDRA models.

The queues along Pittwater Road itself were not included in the survey. In peak periods, these queues often run into each other and are highly dependent on the dynamic signal changes that occur in each cycle. This data is too variable to be useful for model validation purposes.

Table 3.5: Back of Queue Survey Intersections

ID	Intersection Name
1	Pittwater Road / South Creek Road
2	Pittwater Road / Lismore Avenue
3	Pittwater Road / Hawkesbury Avenue
4	Pittwater Road / Dee Why Parade / Kingsway
5	Pittwater Road / Howard Avenue / St David Avenue
6	Pittwater Road / Oaks Avenue
7	Pittwater Road / Fisher Road
8	Pittwater Road / Pacific Parade
9	Pittwater Road / Sturdee Parade
10	Pittwater Road / Warringah Road / Harbord Road
11	Pittwater Road / Mitchell Road / Pine Avenue
12	Pittwater Road / Winbourne Road / Old Pittwater Road
13	Pittwater Road / Sydenham Road
14	Pittwater Road / Cross Street / Brookvale Depot
15	Pittwater Road / Condamine Street
16	Condamine Street / Old Pittwater Road
18	Pittwater Road / Kentwell Road

The locations of the back of queue surveys are illustrated in Figure 3.31.

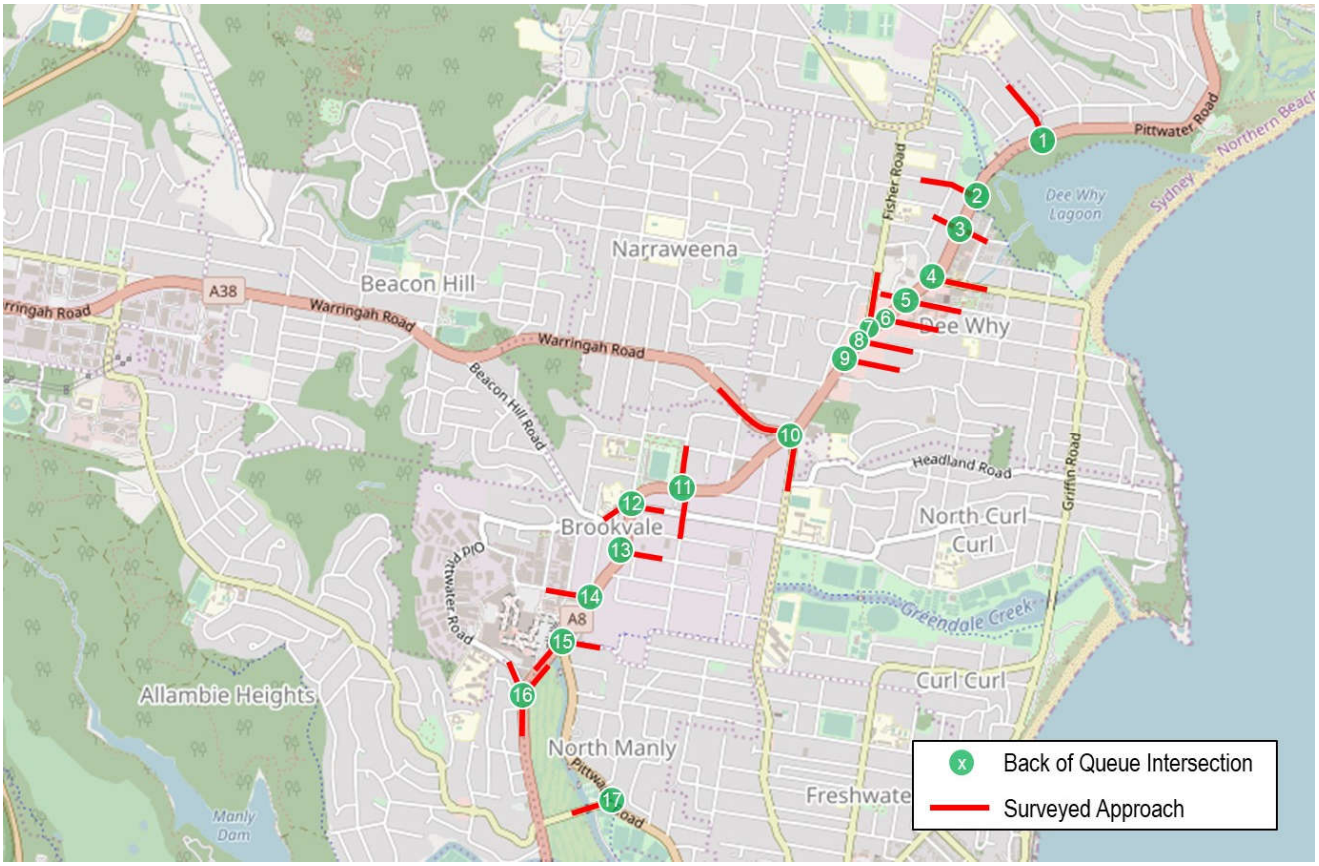


Figure 3.31: Back of Queue Survey Locations

3.6 Crash Data Analysis

The crash statistics within the study area were obtained from TfNSW for 2015-2019. A total of 527 crashes were recorded during the 5-year period, resulting in a total of 371 casualties. A summary of the crash locations, severity, type, and trends is presented in the section below.

Figure 3.32: Crash Location Map

Table 3.6: Crash Severity

Crash Severity	Count	Percentage
Non-casualty (towaway)	156	29.6%
Minor/Other Injury	134	25.4%
Moderate Injury	117	22.2%
Serious Injury	116	22.0%
Fatal	4	0.8%
Total	**527**	**100%**

A total of four fatalities were recorded within the study area between 2015 and 2019, three of which were pedestrians. The number of crashes along Pittwater Road is generally higher than the surrounding roads, which is expected given that Pittwater Road has the highest traffic volumes in the study area.

Table 3.7: Crashes by Type

Crash Type	RUM Codes	Count	Percentage
Pedestrian	1 to 9	54	10.2%
At Intersection	10 to 29	134	25.4%
Rear End	30, 31 and 32	125	23.7%
Side Swipe or Lane Change	33 to 37	63	12.0%
U-Turn	40 and 41	6	1.1%
Parking	42 to 49	49	9.3%
Overtaking	50 to 59	3	0.6%
On Path	60 to 69	7	1.3%
Off Path, on Straight	70 to 79	61	11.6%
Off Path, on Curve	80 to 89	23	4.4%
Other	90 to 99	2	0.4%

As shown in Table 3.7 approximately 10% of reported crashes involved pedestrians. The largest proportion of crashes involved movements at intersections, closely followed by rear end crashes on approaches to intersections.

Table 3.8: Historical Crash Trends

Year	Crashes	Injuries	Fatalities	Injury / Fatality %
2015	131	90	0	69%
2016	97	72	2	76%
2017	89	66	1	75%
2018	91	66	1	74%
2019	119	73	0	61%

As shown in Table 3.8, there does not seem to be a clear trend in reported crashes or injuries.

3.7 Existing Traffic Conditions and Pinch Points

3.7.1 Summary

Overall, the traffic network between Brookvale and Dee Why within the study area was mostly free flowing in 2019, with continuous traffic movement for the majority of the morning and afternoon peak periods.

However, during the busiest part of each peak hour, there were some key locations which showed severe congestion, leading to long delays, queues, and slow-moving traffic. These areas are discussed in more detail in the following subsection.

3.7.2 Key Pinch Points

A summary of key pinch points is mapped in Figure 3.33.

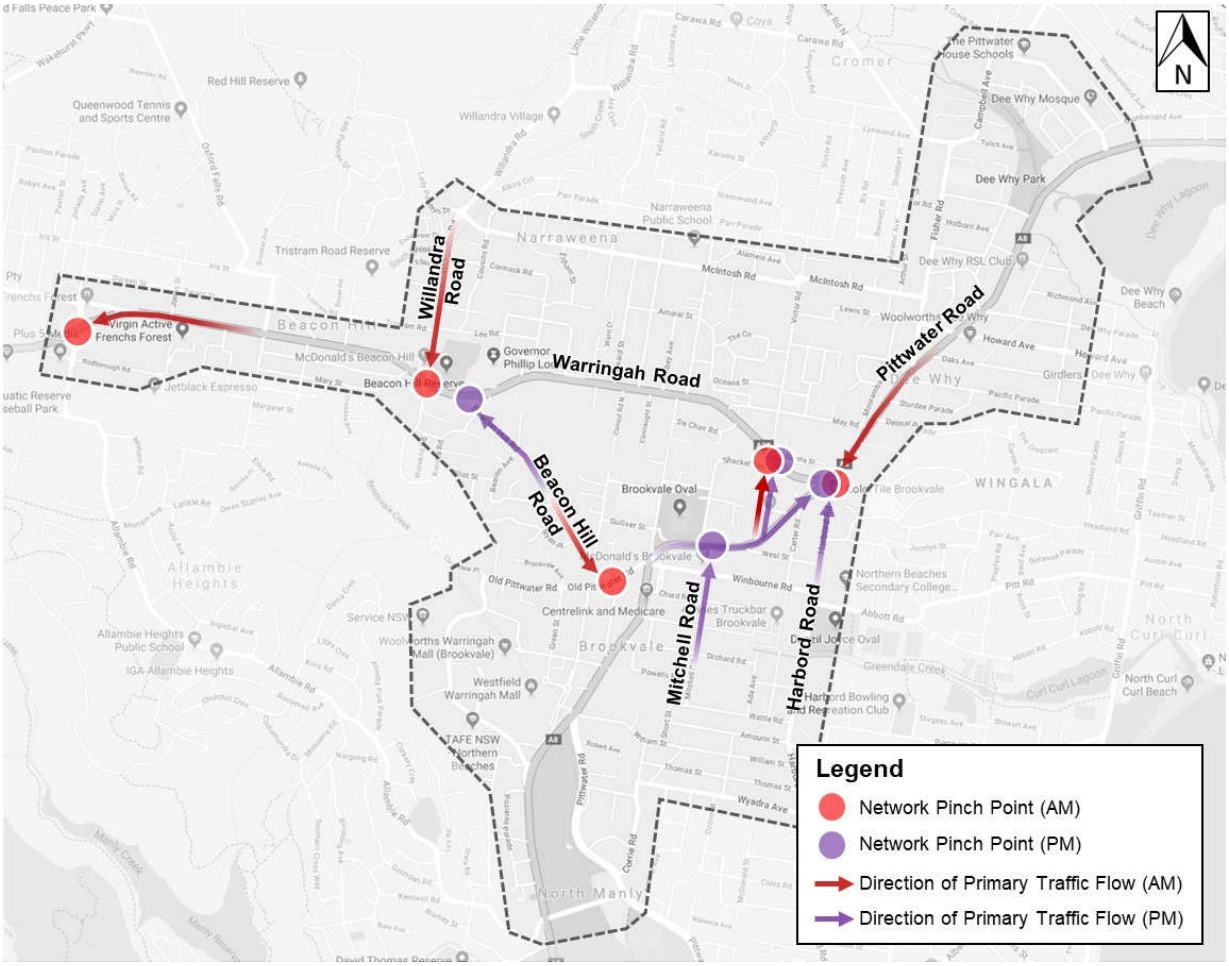


Figure 3.33: Key Pinch Points

AM Peak Pinch Points

As shown in Figure 3.34, some queueing is observed in the southbound direction along the corridor, propagating primarily from the Pittwater Road / Warringah Road / Harbord Road intersection. This results in some queue 'pushback' effects on intersections through the Dee Why Town Centre, slowing down the movement of southbound traffic along Pittwater Road.

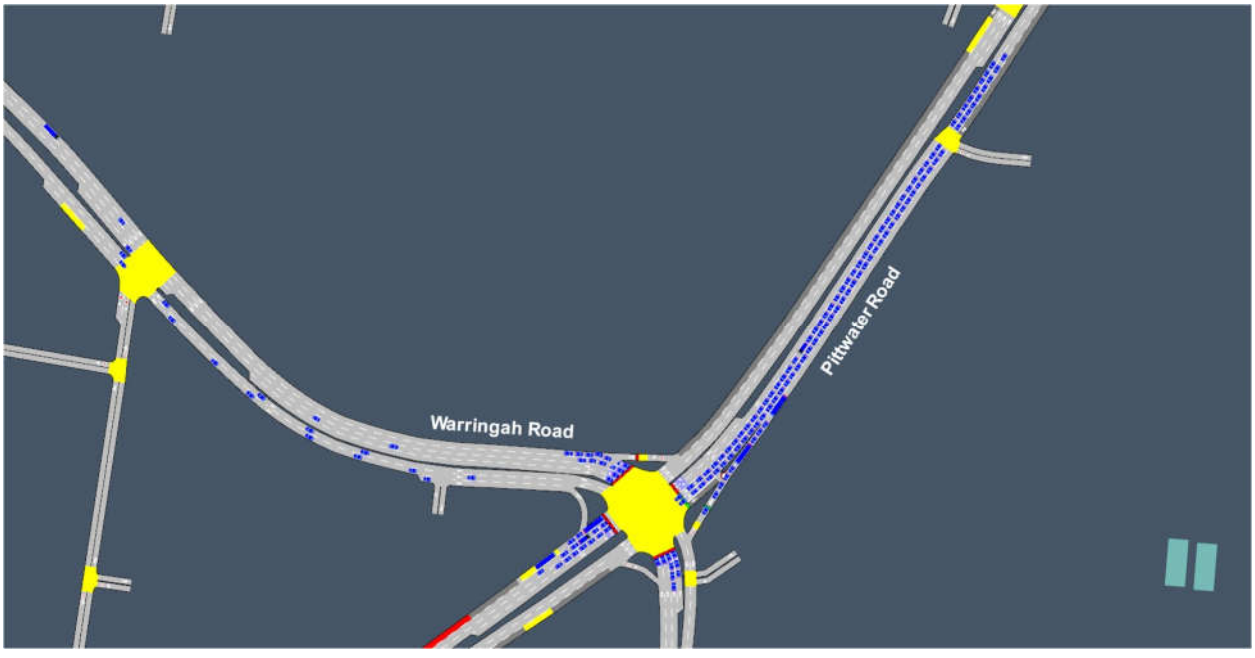


Figure 3.34: Southbound Queues at Pittwater Road / Warringah Road / Harbord Road

As shown in Figure 3.35, Willandra Road carries a heavy flow of traffic in the southbound direction, with a slow dissipation of queues despite the relatively long side road phase time at its signalised intersection with Warringah Road. This is one of the study area's key pinch points. Willandra Road not only carries local traffic from Beacon Hill and Narraweena, but also connects further north to Cromer and Wheeler Heights. As it is the primary collector servicing the surrounding region it demonstrates a 'bottleneck' effect for traffic accessing Warringah Road.

Figure 3.35: Southbound Queues at Warringah Road / Willandra Road

As shown in Figure 3.36, towards the western end of the study area, there are significant delays for traffic travelling in a westbound direction due to downstream queues extending back from the Wakehurst Parkway traffic signals. During the busiest period between 7:00 AM and 9:00 AM this results in a large amount of wasted green time along Warringah Road at the Warringah Road / Allambie Road traffic signal and a slow-moving queue across all three through travel lanes, constricting the flow of westbound traffic on Warringah Road.

Figure 3.36: Westbound Queues at Warringah Road / Allambie Road

Beacon Hill Road is one of the main 'short cut' connections between Pittwater Road and Warringah Road, bypassing one of the busiest sections of Pittwater Road. A substantial volume of traffic uses Beacon Hill Road, especially in the southbound direction in the morning peak (see Figure 3.37). As the majority of Beacon Hill Road has only one lane of traffic in each direction due to the kerbside parking lane, delays and queues from the Beacon Hill Road / Old Pittwater Road can impact long sections of the road.

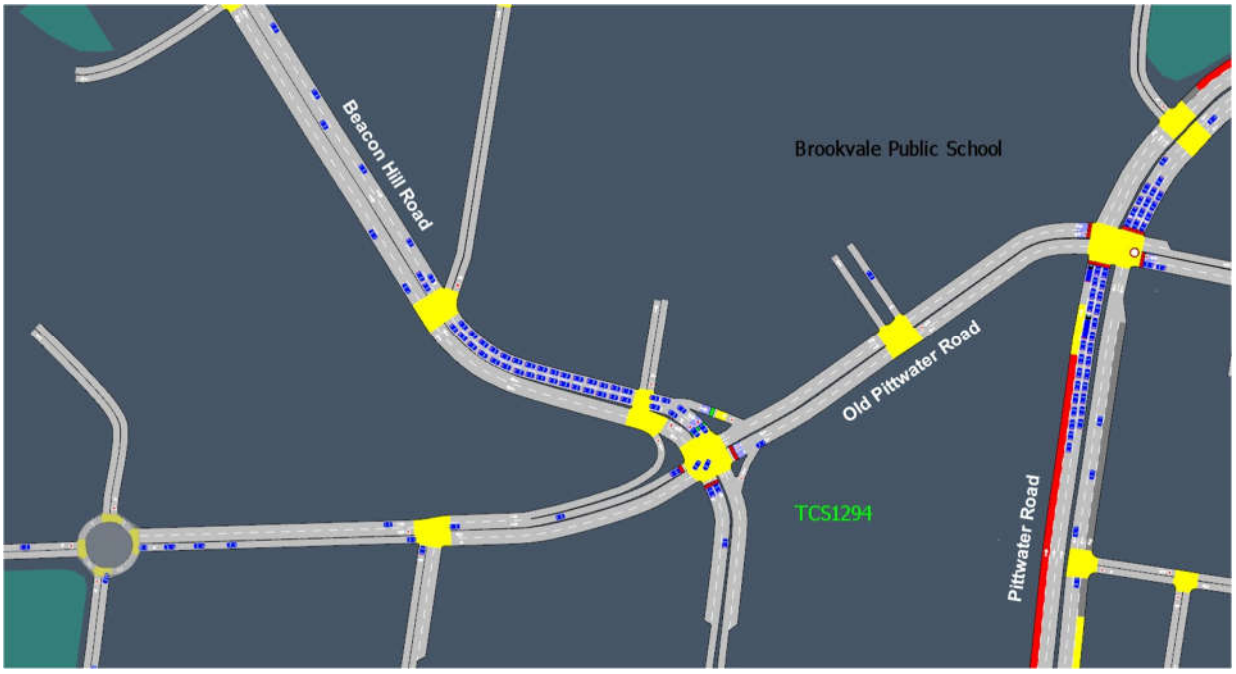


Figure 3.37: Southbound Queues at Beacon Hill Road / Old Pittwater Road

PM Peak Pinch Points

As shown in Figure 3.38, significant queueing is observed in the northbound direction along the corridor, primarily resulting from the Pittwater Road / Warringah Road / Harbord Road intersection. Queues extend over 500m at times with slow-moving traffic on Pittwater Road between Mitchell Road and Warringah Road.

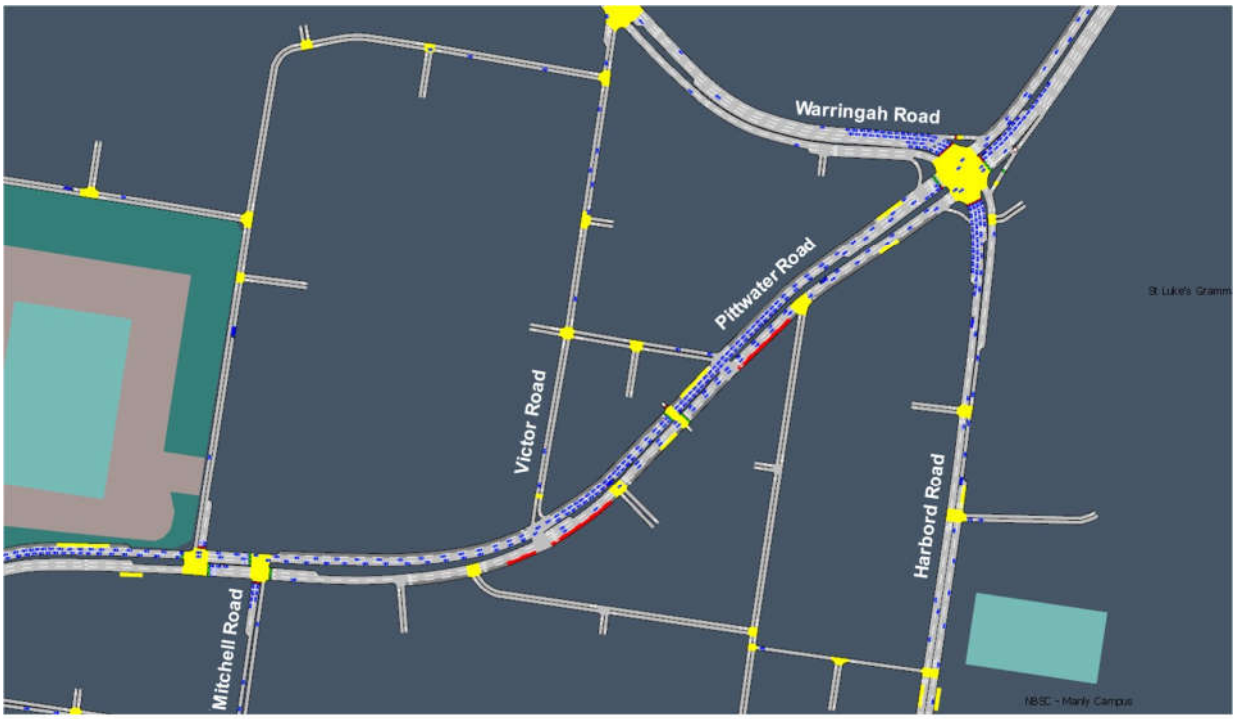


Figure 3.38: Eastbound Queues at Pittwater Road / Warringah Road / Harbord Road

As shown in Figure 3.39, queueing is also observed in the northbound direction on Harbord Road on approach to its intersection with Warringah Road. While there are four approach lanes at the intersection, two lanes are short lanes, with only two lanes available to service the heavy northbound flow.

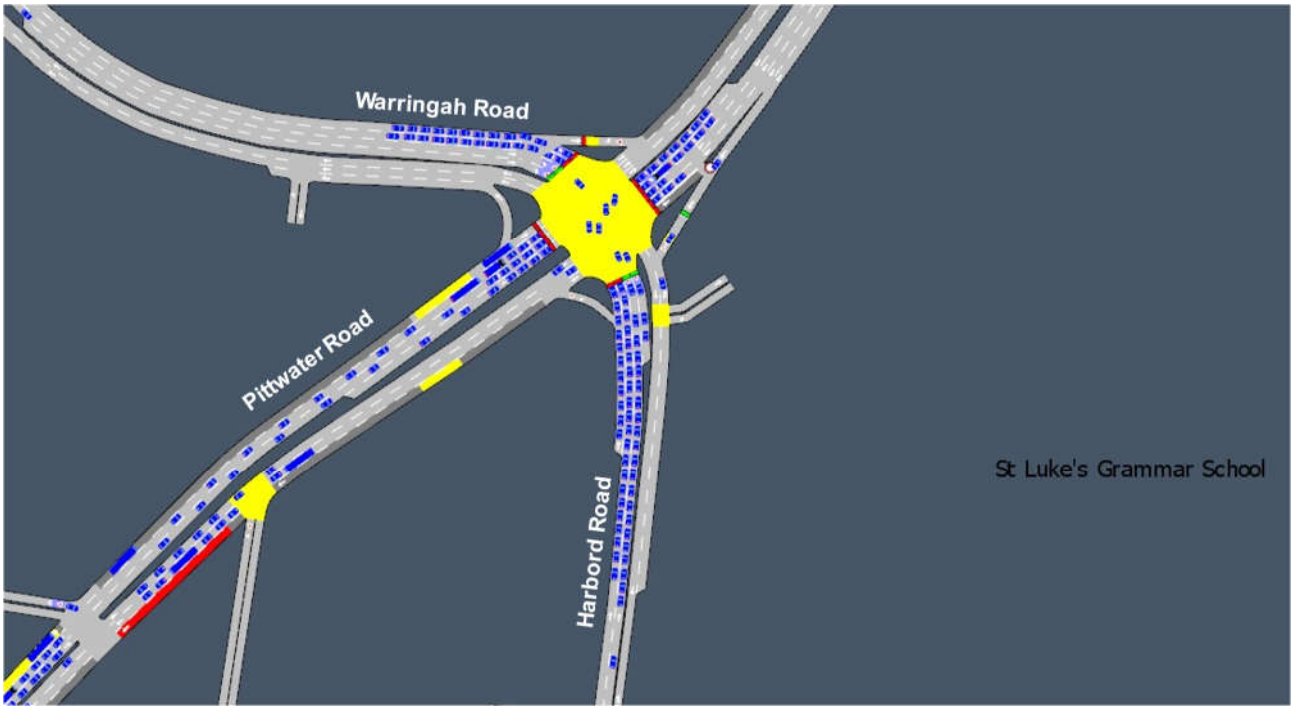


Figure 3.39: Northbound Queues at Pittwater Road / Warringah Road / Harbord Road

As shown in Figure 3.40, Mitchell Road experiences heavy northbound traffic, as one of the only exit points from the Brookvale industrial area. This creates a pinch point in the afternoon peak. This, in combination with the high traffic flow along Winbourne Road, results in the single-lane roundabouts on Mitchell Road often having queues through them.

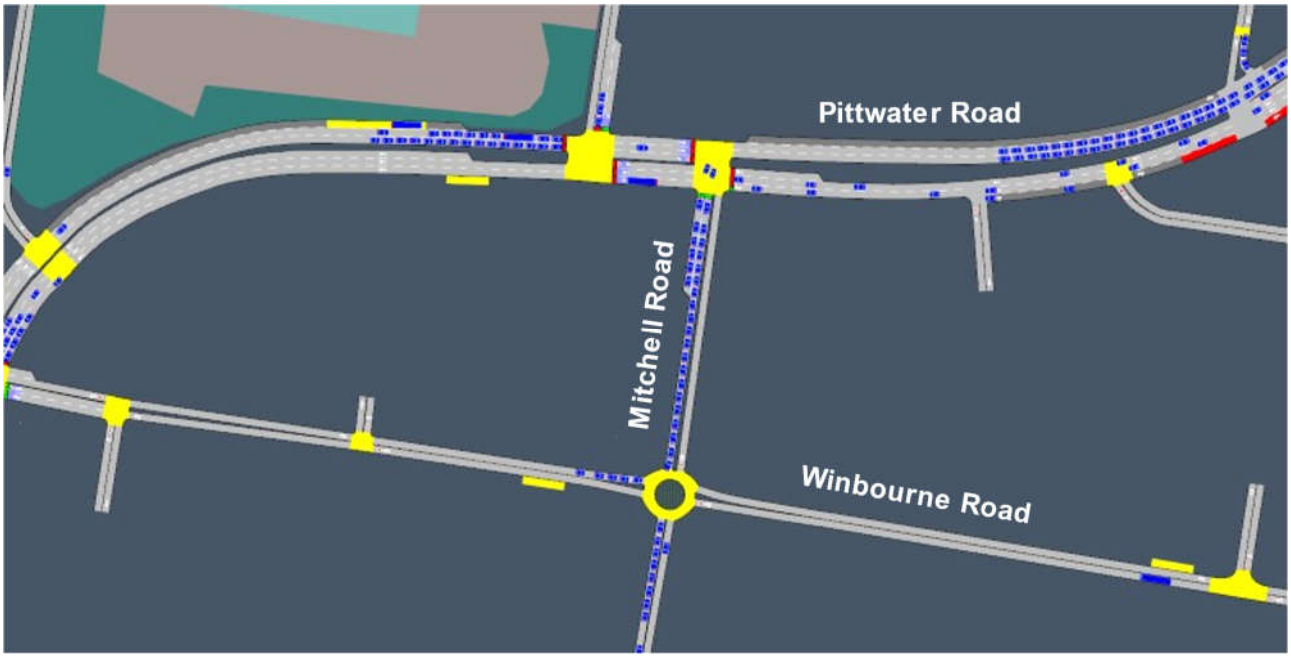


Figure 3.40: Northbound Queues at Pittwater Road / Mitchell Road

As shown in Figure 3.41, Beacon Hill Road is congested in the afternoon peak. Vehicles travelling in the northbound direction experience substantial delays at times due to its single lane northbound despite the provision of a slip lane and long green phase time for left turning vehicles onto Warringah Road. These vehicles often queue into, and block, right-turning traffic.

Figure 3.41: Northbound Queues at Warringah Road / Beacon Hill Road

Other Issues

Victor Road is commonly used as a 'rat-run' between Pittwater Road and Warringah Road, to bypass the busy Pittwater Road / Warringah Road / Harbord Road traffic signals. This is particularly the case during the afternoon peak, where the northbound movement on Pittwater Road is slow. For drivers with destinations to the north-west, Victor Road allows them to bypass the slow-moving queue.

3.7.3 SIDRA Intersection Modelling

Intersection modelling was undertaken using SIDRA Intersection 8 to assess the current operational performance levels of the 30 key intersections. The existing geometric layout for each intersection was modelled, based on latest satellite imagery and the models were calibrated to back of queue data.

It is noted that the Pittwater Road corridor has time-of-day bus lanes as follows:

- Southbound Bus lane active between 6:00AM and 10:00AM, Monday to Friday
- Northbound Bus lane active between 3:00PM and 7:00PM, Monday to Friday.

To accommodate the time-sensitive bus lanes, separate layouts were prepared for the weekday AM, weekday PM and weekend assessments. For active bus lane periods, buses were assigned to the designated lane and other vehicle classes were excluded, except for allowing for left hand turns. When the bus lane was not active, the geometry was adjusted to reflect the lane removal or provision of short turning lanes with parking.

A summary of the SIDRA modelling outputs is presented in Table 3.9.

Table 3.9: Existing Conditions (2019) SIDRA Outputs

ID	Intersection	AM Peak			PM Peak		
		DoS	Average Delay (s)	LoS	DoS	Average Delay (s)	LoS
101	Pittwater Road / South Creek Road	0.84	18	B	0.81	15	B
102	Pittwater Road / Lismore Road	0.70	12	A	0.99	14	A
103	Pittwater Road / Hawkesbury Avenue	0.71	17	B	0.77	17	B
104	Pittwater Road / Dee Why Parade	0.50	10	A	0.55	10	A
105	Pittwater Road / Howard Avenue	0.66	17	B	0.69	18	B
106	Pittwater Road / Oaks Avenue	0.49	4	A	0.55	5	A
107	Pittwater Road / Fisher Road	0.64	13	A	0.62	13	A
108	Pittwater Road / Pacific Parade	0.70	6	A	0.62	6	A
109	Pittwater Road / Sturdee Parade	0.91	20	B	0.95	18	B
110	Pittwater Road / Warringah Road	0.99	60	E	over capacity	90	F
111	Pittwater Road / Mitchell Road	0.72	12	A	over capacity	39	C
112	Pittwater Road / Pine Avenue	0.90	8	A	0.87	12	A
113	Pittwater Road / Old Pittwater Road	0.89	27	B	0.89	27	B
114	Pittwater Road / Sydenham Road	over capacity	28	B	1.02	18	B
115	Pittwater Road / Cross Street	0.79	22	B	over capacity	6	D
116	Pittwater Road / Condamine Street	1.02	32	C	0.99	30	C
117	Condamine Street / Old Pittwater Road	0.76	18	B	0.94	38	C
118	Condamine Street / Kentwell Road	over capacity	67	E	over capacity	86	F
119	Pittwater Road / Kentwell Road	0.65	17	B	0.80	22	B
120	Old Pittwater Road / Beacon Hill Road	over capacity	379	F	over capacity	136	F
122	Cross Street / Dale Street	0.45	14	A	0.52	13	A
123	Cross Street / Green Street	0.57	16	B	over capacity	183	F
125	Harbord Road / Winbourne Road	over capacity	230	F	over capacity	175	F
126	Harbord Road / Abbott Road	over capacity	265	F	0.94	36	C
129	Warringah Road / Alfred Street	over capacity	48	D	1.03	23	B
130	Warringah Road / Beacon Hill Road	0.99	50	D	1.05	49	D
131	Warringah Road / Willandra Road	over capacity	62	E	over capacity	65	E
132	Warringah Road / Allambie Road	over capacity	94	D	over capacity	76	F
135	Fisher Road / St David Avenue	0.75	15	B	0.96	18	B
143	Warringah Road / Government Road	over capacity	66	E	over capacity	73	F

Notes: An intersection can show a Dos >1 and still have its average delays reflect a LoS of A to D depending on the scale of the traffic volume on the approaches that have Dos >1.

3.8 Known Projects Influencing the Study Area

A number of projects / upgrades have been identified that have been introduced after the development of the base model in 2019. These projects / upgrades have been added into the 2026 and 2036 models and are:

- No Right Turn restriction from Pittwater Road into Delmar Parade between 6:00 AM and 10:00 AM weekdays
- No Right Turn restriction from Old Pittwater Road to Pittwater Road
- No Right Turn restriction from Pittwater Road into Victor Road between 3:00 PM and 7:00 PM weekdays
- The Dee Why Town Centre High Pedestrian Activity Area (HPAA) speed zone changes.

The traffic management projects like No Right Turn restrictions and lowered speed limits in the Dee Why town centre has relatively localised effects on the traffic network. It is understood that these changes have primarily been implemented for safety reasons.

The proposed restriction of the right turn from Old Pittwater Road to Pittwater Road causes some local re-routing of vehicles through Dale Street and Cross Street to access Pittwater Road. This was seen to place additional pressure on the already busy Cross Street approach to Pittwater Road, which is currently heavily used by vehicles exiting Warringah Mall.

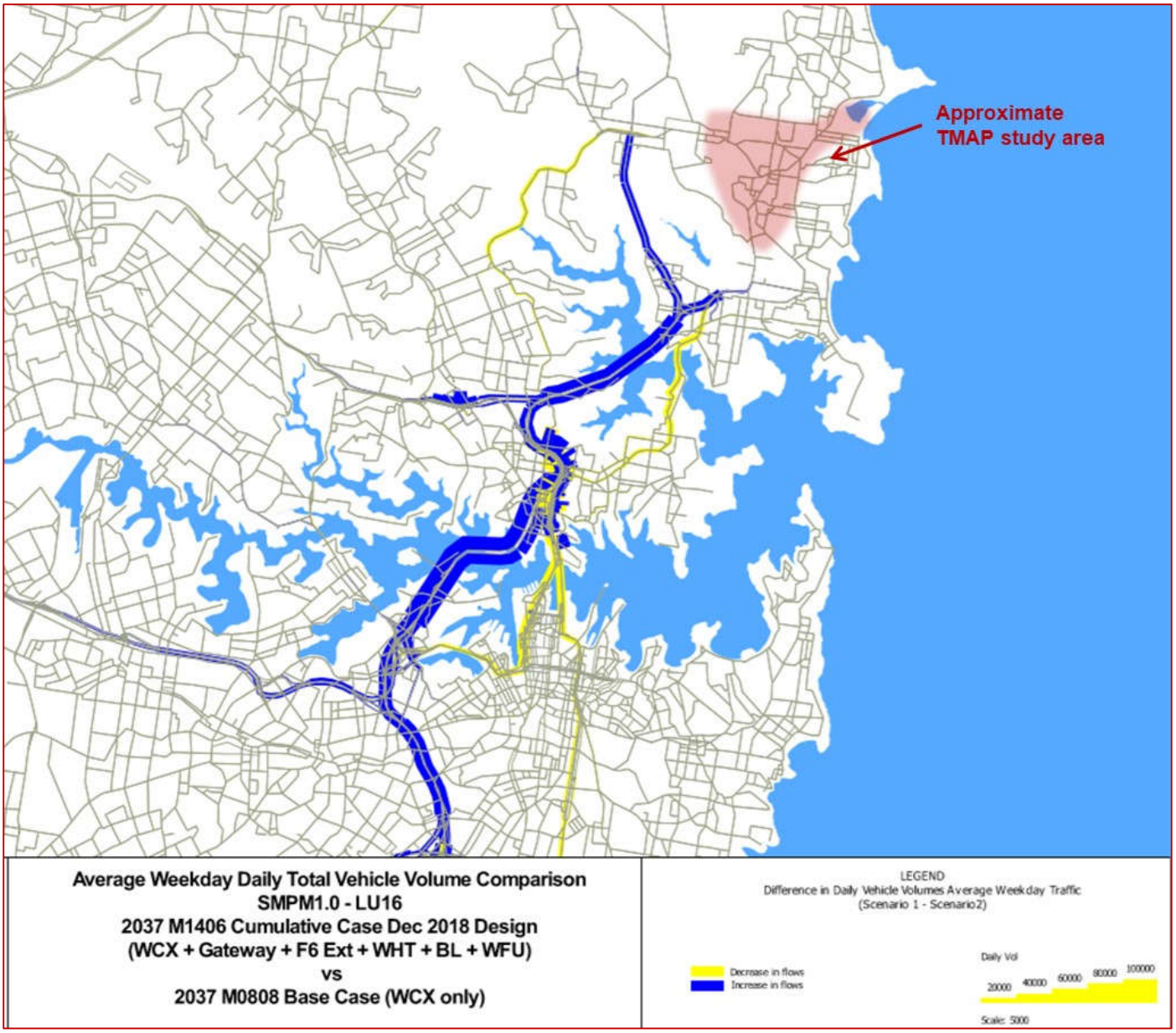
While outside the study area, the Northern Beaches Hospital upgrade works and the proposed Beaches Link project also influence traffic in the study area in the future.

The Northern Beaches Hospital road upgrades are to the west of the modelled area for this study. As shown in Figure 3.36, existing observations indicated that westbound queues pushed back from the Wakehurst Parkway traffic signals into the modelled area, affecting the westbound discharge of vehicles through the Warringah Road / Allambie Road traffic signals. With the new Warringah Road underpass facilitating free flow through movements at Wakehurst Parkway, it is assumed that this queue-back into the modelled area will be resolved.

The Beaches Link is a proposed tunnel between North Sydney and the Northern Beaches, providing a second connection as a new alternative to Spit Bridge. Beaches Link will tie into Wakehurst Parkway to the west of the study area. As referenced in the Beach Link EIS (December 2020), Beaches Link is expected to reduce pressure on key roads such as Pittwater Road and Condamine Street within the study area. The Beaches Link Project is expected to (from its EIS):

- Reduce travel times from Brookvale to the Sydney CBD by up to 27 minutes
- Reduce Dee Why to Sydney Airport by up to 41 minutes
- Ensure that over 15 per cent more Northern Beaches residents will be within a 45 minute commute to work
- Provide the benefit of better access to Greater Sydney for Northern Beaches businesses.

Strategic modelling outputs published in the EIS shows that the primary influence of Beaches Link on Pittwater Road through the study area would be expected involve a shift of some traffic from Pittwater Road to Warringah Road - Beaches Link; although this does not appear to be significant based on the volume difference plots in the EIS (see Figure 3.42).



Source: Adapted from Beaches Link and Gore Hill Freeway Connection EIS

Figure 3.42: Beaches Link Effects on the Study Area

4. MOVEMENT AND PLACE ASSESSMENT

This section describes the 'preliminary' Movement-Place assessment which has been completed based on the Government Architect NSW's Practitioner's Guide to Movement and Place (PGMP) to provide input into the consideration of pinch point upgrade options and more broadly provide insight into the considerations for the road network upgrades strategy components of the TMAP.

4.1 Context

4.1.1 Framework and Scope

The PGMP was released by the NSW Government in March 2020. It defined the approach to Movement and Place assessment as:

Movement and Place is a cross-disciplinary, 'place-based' approach to the planning, design, delivery, and operation of transport networks. It recognises the network of public spaces formed by roads and streets and the spaces they adjoin and impact.

The 'core process' for Movement and Place assessment involves 6 steps, which are:

- **Step 1:** Establish the project scope, vision, objectives, and evaluation criteria
- **Step 2:** Understand place
- **Step 3:** Understand movement
- **Step 4:** Overlay and discuss conflicts, issues, and opportunities
- **Step 5:** Develop options
- **Step 6:** Choose the preferred option.

This part of the study is not a 'complete' Movement and Place assessment in accordance with the PGMP. Such a study would require its own study team, governance arrangements, a review of the broader social, cultural, and environmental context, understanding the micro-level planning intent for each area, establishing the case for change, and gathering broader information related to social, cultural, environmental, and economic factors influencing each sub-area.

The key considerations for this TMAP are understanding the influences of the proposed locations of land use development and proposed road infrastructure upgrades on Movement and Place in existing areas, and in proposed redevelopment areas. That is, only Steps 1-4 are relevant for consideration in the TMAP and further investigations would be required at each location to develop options and to choose preferred treatments should they be identified as being required.

4.1.2 Classifying Street Environments

The PGMP uses a road and street environment classification system with four main categories:

- **Main roads:** Main roads are high-capacity roads which typically feature higher speed limits and primarily service long distance trips for people and goods. These usually include key movement corridors including motorways, freight corridors and major public transport routes
- **Main streets:** Main streets attract both high volumes of both vehicular and pedestrian traffic and are typically bustling urban activity centres. As the interface between different types of traffic, main streets must find a balance in streetscape design to accommodate both pedestrians and vehicles
- **Local streets:** Local streets are typically a low-speed road environment characterised primarily by the quiet, neighbourhood streets servicing the local residential community. A majority of the road network is comprised of local streets
- **Civic spaces:** Civic spaces are characterised by slow movement areas with high pedestrian activity generators, with limited access or connectivity for through traffic. These are often found in town and city centres and are typically envisaged to be pedestrian or shared priority areas.

These categories and their position in the Movement-Place framework are shown in Figure 4.1.

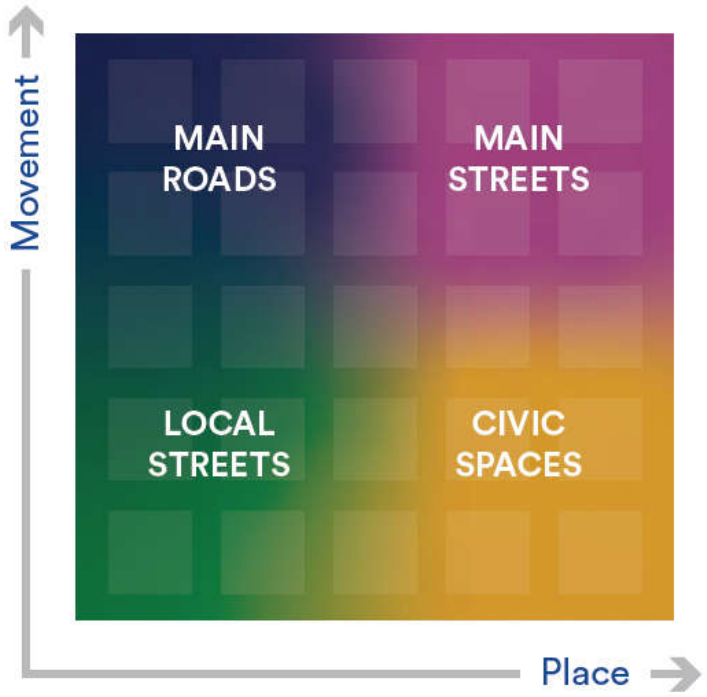


Figure 4.1: Movement-Place Street Classification Framework

4.2 Preliminary Assessment

4.2.1 Step 1: Scope, Strategic Vision and Objectives

As identified above, the scope of the investigation is geographically limited to the study area. The depth of the scope of the Movement and Place assessment is limited to identifying potential opportunity and conflict areas associated with the proposed redevelopment locations and proposed road network upgrades.

Council has undertaken or is currently preparing a number of strategies to explore the opportunities available for the spatial distribution of new housing as well as commercial and retail growth. These plans and strategies include:

- The Dee Why Town Centre Masterplan
- Northern Beaches Local Housing Strategy
- Northern Beaches Employment Study
- Brookvale Structure Plan.

The strategic vision for the study area will ultimately be drawn from these studies in combination with the TMAP produced for this study.

From a review of these studies and the work undertaken in this study, the key objectives for the study area include:

- Maximise the “Main Road” function of the Pittwater Road and Warringah Road corridors
- Catering for the “Main Street” and “Civic Space” environments in the Dee Why centre and the emerging “Civic Space” environment near the Brookvale bus interchange
- Allowing for future “Civic Spaces” to be created in the proposed redevelopment areas in Brookvale, north and north-east of Westfield Shopping Centre
- Protecting “Local Streets” as much as possible from the growing demand for through traffic movements and identifying those “Local Streets” that are most appropriate to shift closer towards “Main Roads” as a consequence of travel demand growth in the study area.

4.2.2 Step 2: Understanding Place

For the preliminary assessment purposes of the TMAP investigations, a simplified place categorisation system has been defined, generally aligned with the approach used in the Practitioners Guide, as follows:

Place Intensity Category	Activity, Physical Form and Meaning Description (adapted from PGMP Figure 22: Measures of Place Intensity)
High	Existing or future (2036) high population and / or employment density with high street activity within the area (e.g. shopping precincts/plazas, public transport waiting areas)
Medium	Existing or future (2036) medium population and / or employment density with moderate street activity through the area (e.g. emerging fringe business areas, urban renewal-medium density areas)
Low	Low existing or future (2036) population and / or employment density with minimal street activity through the area (e.g. low-density residential streets or limited access road sections)

The categorisation of each place area within the general study area is presented in Figure 4.2.

Figure 4.2: Future Categorisation, Place

The Dee Why Centre will continue to be a place of high intensity and mixed activity due to the B-Line stops and mixed-use development fronting Pittwater Road. The proposed development at the Westfield site in Brookvale will also increase trip diversity and intensity in this area, particularly orientated at the B-Line stop on Pittwater Road. Council's planning includes redevelopment of the northern Brookvale area which will also see greater trip intensification and diversity either side of Pittwater Road.

4.2.3 Step 3: Understanding Movement

Movement in relation to a place is considered in terms of trips through, to / from and within that place. The primary transport networks which are present in an area are:

- Public transport
- Private traffic (both light and heavy vehicles)
- Active transport (walking and cycling).

For the purpose of this assessment, a simplified movement categorisation system has been defined, generally aligned with the approach used in the Practitioners Guide. Active transport has not been included in this assessment because of its localised nature and its predominant usage of local streets in the study area.

The expected significance of movement through the study area for each motorised transport type as follows:

Movement Type in the Study Area	Functional typology in the study area		
	Through Function	To / From Function	Within Function
Public Transport	Major	Medium	Minor
Private Vehicles: Roads	Major	Medium	Minor
Private Vehicles: Streets	Minor	Major	Medium
Freight (Trucks)	Major	Medium	Minor

Active transport occurs along all movement corridors to varying degrees at varying times of the day/night.

The categorisation of each movement type within the general study area is presented in Figure 4.3.

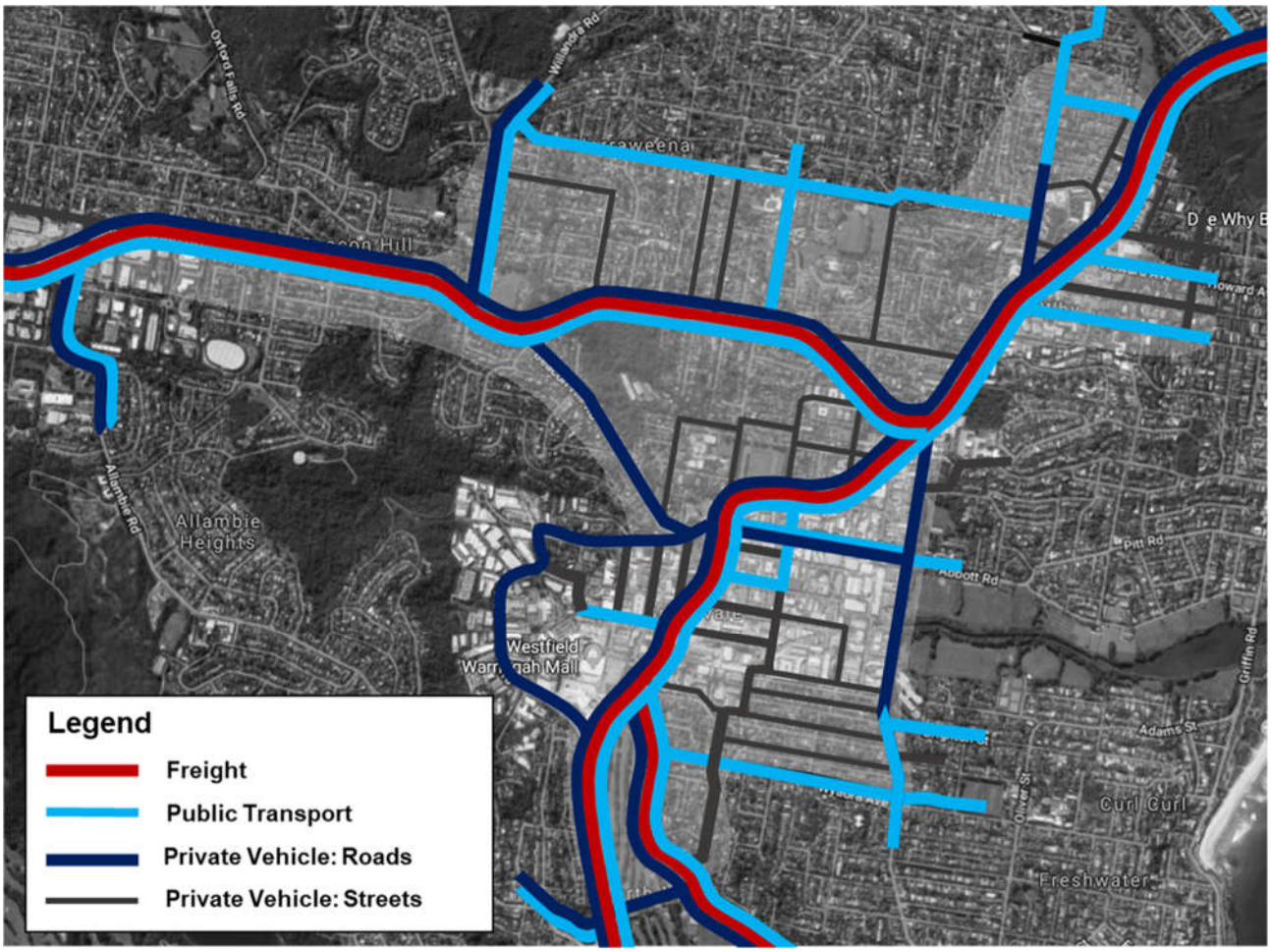


Figure 4.3: Future Categorisation, Movement

Key changes between 2019 and 2036 include greater through movement and more trip destination intensity in the Mitchell Road-Short Street-Corrie Road corridor associated with proposed redevelopment of the general industrial area in Brookvale as well as more trips destined to / from the area south of Old Pittwater Road, west of Pittwater Road and north of Westfield Shopping Centre.

4.2.4 Step 4: Conflicts, Issues and Opportunities

The overlay of the Step 2 and Step 3 mapping provides a "high level" comparison of the conflicts, issues, and opportunities across the study area. Key areas where Movement and Place outcomes may be in conflict and need to be carefully managed are shown in Figure 4.4.

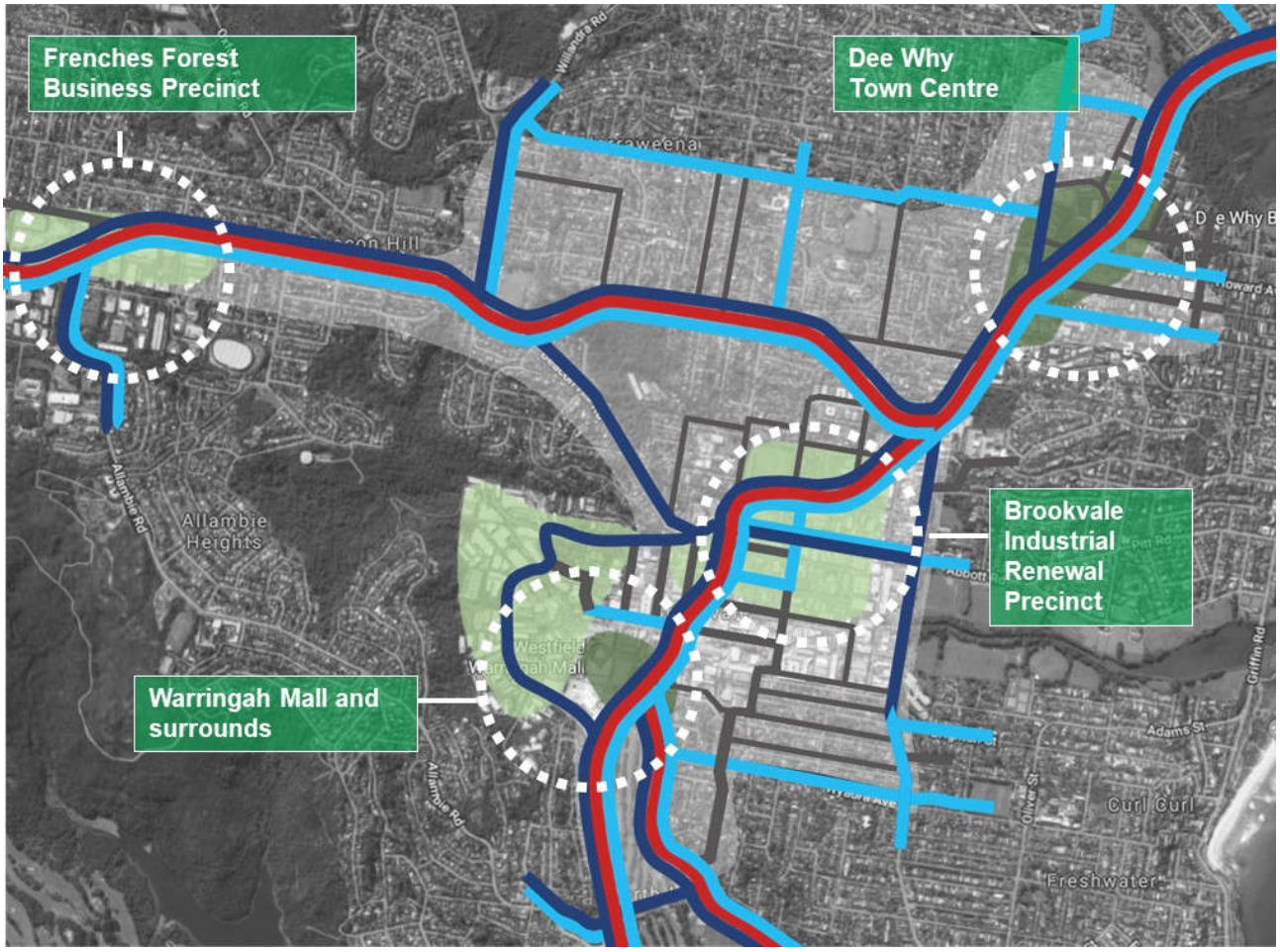


Figure 4.4: Movement and Place Overlay - Key Conflict Areas

The overarching considerations in addressing the identified conflict areas include:

- Where main roads intersect, it is likely that larger-scale upgrades will be necessary to accommodate future traffic
- The majority of the proposed traffic capacity upgrades will be located on main roads
- Where Main Roads intersect with Local Streets, there will be the need for some localised improvements to enable the slower, lower volume traffic on the minor streets to interface safely with the faster, higher volume traffic on the major roads
- Main Streets are emerging locations for traffic and pedestrian interface management and the street cross section needs careful consideration as the street evolves to maximise safety and amenity
- Civic Spaces will require more and wider pedestrian paths, pedestrian-friendly crossing facilities, open gathering areas, park space, a greater density of intersections etc.

The four main areas where Movement and Place conflicts are greatest are investigated below.

Warringah Mall and Surrounds

There is a mix of through pedestrian movement in the streets surrounding Warringah Mall and pedestrian dwelling activity at the B-Line bus stops along Pittwater Road in front of the mall. This activity is likely to increase in the future with more people using public transport, redevelopment of the areas to the north of the shopping centre and potential development on the shopping centre site itself.

Pittwater Road is heavily trafficked in this area by all motorised movement types, private vehicles, heavy trucks, and public transport. There is a clear current and growing conflict between Movement and Place objectives in this area.

A reimagining of the space is complicated by the importance of the Pittwater Road corridor's through movement function; any measures to improve the pedestrian environment through or within the area should not result in a decrease in the operational performance of the main road. Furthermore, the high volume, high speed road environment is in direct conflict with the potential to make the B-Line stop area a pleasant and safe place to wait and move around.

One opportunity considered further on this study is remove these conflicts by forming a new civic space via a grade separation of the pedestrian (Place) space from the through traffic space at the B-Line stop fronting Westfield Shopping Centre.

Brookvale Industrial Precinct Renewal Area

The Brookvale Industrial precinct is located on the eastern side of Pittwater Road in close proximity to Brookvale Oval. Mitchell Road forms the spine of this area, carrying both pedestrian and vehicular traffic through the area and onto the Pittwater Road corridor. Some retail in the area as well as the Brookvale McDonald's generate moderate pedestrian activity, along with the bus stops along Winbourne Road.

Council's plans for the area have included commercial and residential redevelopment of the B5 zoned land along Pittwater Road, as well as new community-orientated facilities such as parks, community centres, libraries, etc. Further planning has also considered retention of general industrial uses. In either case, any redevelopment creates opportunities to sensitively plan places and movement corridors within the area. For example, it is likely that Michell Road's movement function will increase at the expense of its Place function but providing opportunities to increase the Place function of east-west streets and new "between street" connections.

Dee Why Town Centre

The Dee Why Town Centre Masterplan works have recently revitalised the street environment. These works have included: the new Walter Gors Park, Redman Road Plaza, cycling infrastructure Spaces" within this "Main Street" environment have been created without impacting the importance of the through movement function on Pittwater Road.

Extension of the Place function of the area to the eastern side of Pittwater Road will add further conflict with through traffic movements and preserving side street accessibility will be a key challenge as the redevelopment of the centre is completed.

Frenchs Forest Business Precinct

The business precinct in Frenchs Forest to the east of the Northern Beaches Hospital is one of the key precincts of expected employment growth. The Warringah Road movement corridor interfaces with minor roads like Allambie Road in this area. It is inevitable that 'Movement" functions will continue to dominate this area but localised opportunities to enhance 'Place' are likely to arise south of Warringah Road, such as along Rodborough Road. Street design and intersection type selection are key considerations in this transition and 'to / from' and 'within' pedestrian and cyclist movements increase in importance.

4.2.5 Road Categorisation Scheme

The overlay of the movement map and place map has informed the creation of the road categorisation scheme in Figure 4.5 in accordance with the Movement and Place street environment classification scheme.

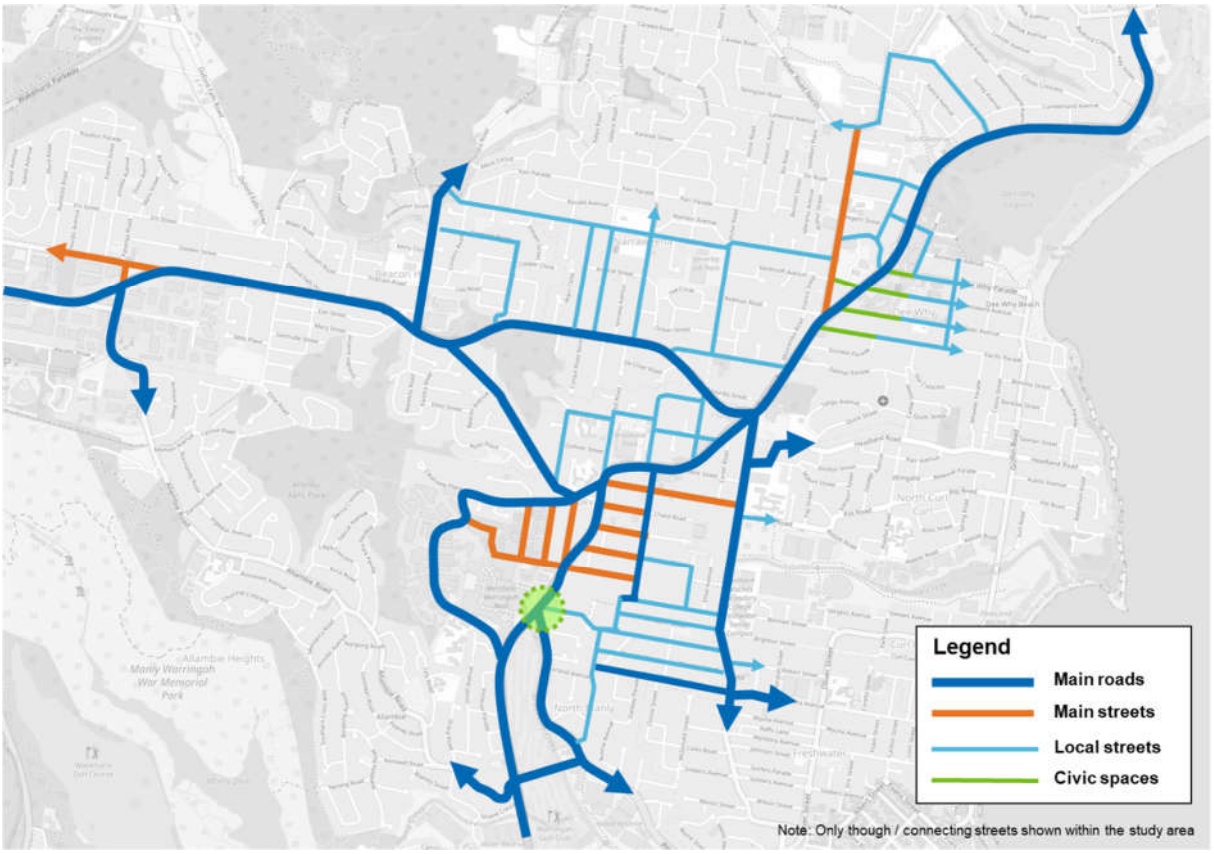


Figure 4.5: Movement and Place Categorisation

The key features of this movement-place road categorisation plan include:

- ***Main Roads*** reflect the high proportion of through vehicles that they carry. Through movement capacity and safety are the primary considerations on these roads
- There are a number of 'districts' with ***Main Streets***, including the proposed industrial redevelopment area in Brookvale (east of Pittwater Road), the combined retail / commercial redevelopment area north of Warringah Mall, and evolving areas like Fisher Road near Dee Why Town Centre. These Main Street 'districts' are characterised by a moderate level of traffic with diverse pedestrian activity generators nearby including shops, bus stops and employment areas. The conflicts between traffic and pedestrians need to be carefully managed.
- ***Local Streets*** are mostly characterised by residential areas where most of the traffic on the street should be destined to residences in close proximity of the street. They should have relatively low levels of traffic and low pedestrian movement volumes
- ***Civic Spaces*** are the locations with high levels of pedestrian accessibility and amenity, where people move in a variety of directions for a variety of purposes and often dwell in the area. These areas specifically favour active transport over vehicular traffic. Two locations were defined as strong candidates for this designation:
  - **Dee Why Town Centre**: which already features a 40km/h High Pedestrian Activity Area east of Pittwater Road, characterised by numerous marked pedestrian crossings, cafes, local shops, and local parks
  - **Warringah Mall B-Line Stop:** The movement corridors of Pittwater Road and Condamine Street intersect near the heavily pedestrianised B-Line stops in front of Warringah Mall. There is a clear conflict here leading to consideration of the need to for physically separating these two different functions.

5. TRANSPORT MODELLING PROCESS

This section describes the strategic, simulation and intersection models prepared and used for this study.

5.1 Overview

Traffic and transport modelling was undertaken to provide a set of decision tools to assist with:

- Understanding the key pinch points in the network and their sensitivities to increasing traffic demand
- Informing decisions regarding the additional development traffic that the network can absorb, with practical upgrades
- Selecting and optimising network upgrade options to maximise traffic and transport performance
- Understanding the level of travel demand management measures, public transport modal shift and active transport modal shift needed to support future development.

Following the creation of the base years models, two 'stages' of modelling were undertaken, namely:

- **Stage 1**: Using the STM and SIDRA modelling to understand the likely potential maximum development levels that could be absorbed by the network with "pragmatic" intersection upgrades
- **Stage 2**: Using the STM to model the preferred land use scenario and then AIMSUN microsimulation modelling to test local upgrade options and select preferred improvement options to provide a reasonable level of service across the network in the future (with the proposed development levels from Stage 1).

More generally, the process involved three 'levels' of modelling:

- Strategic modelling using the TfNSW Transport Performance and Analytics (TPA) Strategic Travel Model (STM)
- Microsimulation modelling using new models created in AIMSUN for this project
- Individual intersection modelling using new models created in SIDRA for this project.

A comparison of the strategic and microsimulation model is illustrated in Figure 5.1.

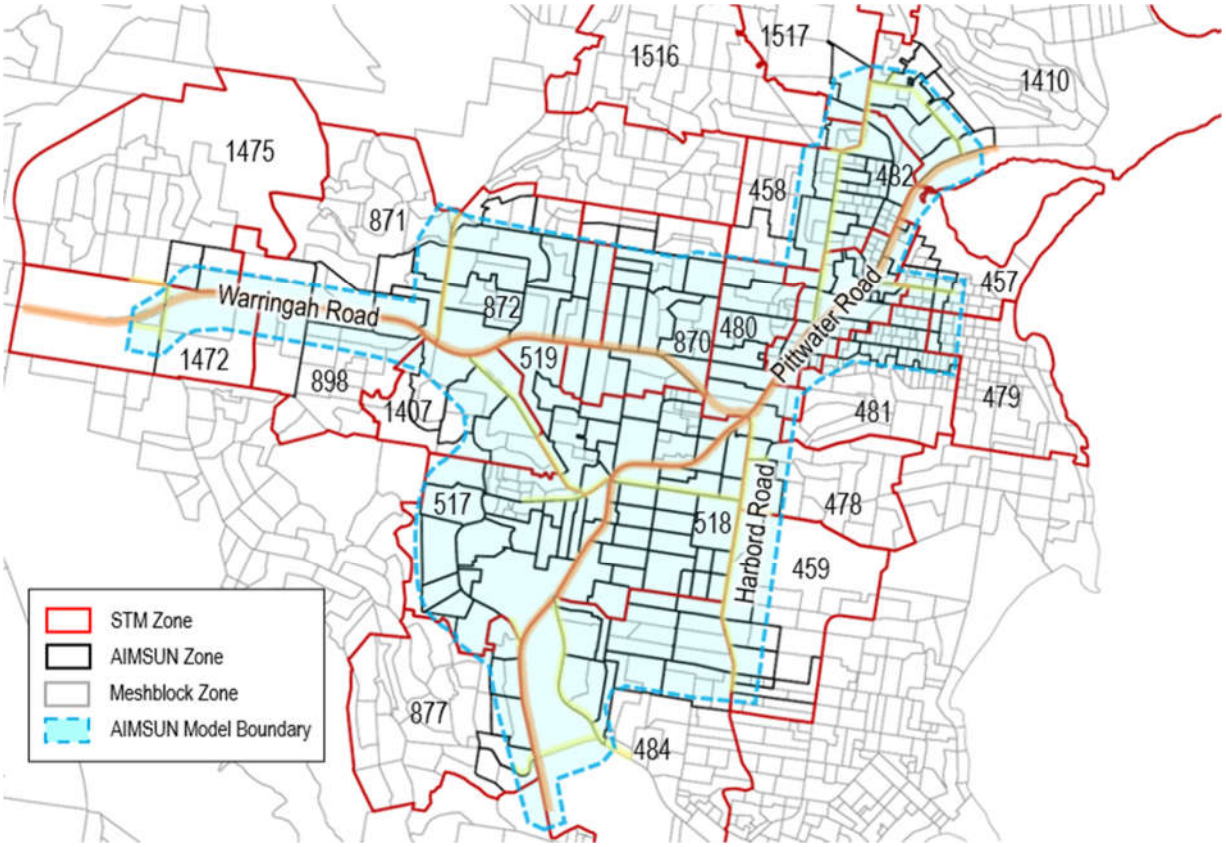


Figure 5.1: STM and AIMSUN Model Boundary and Zones

The modelling process used is detailed in Figure 5.2.

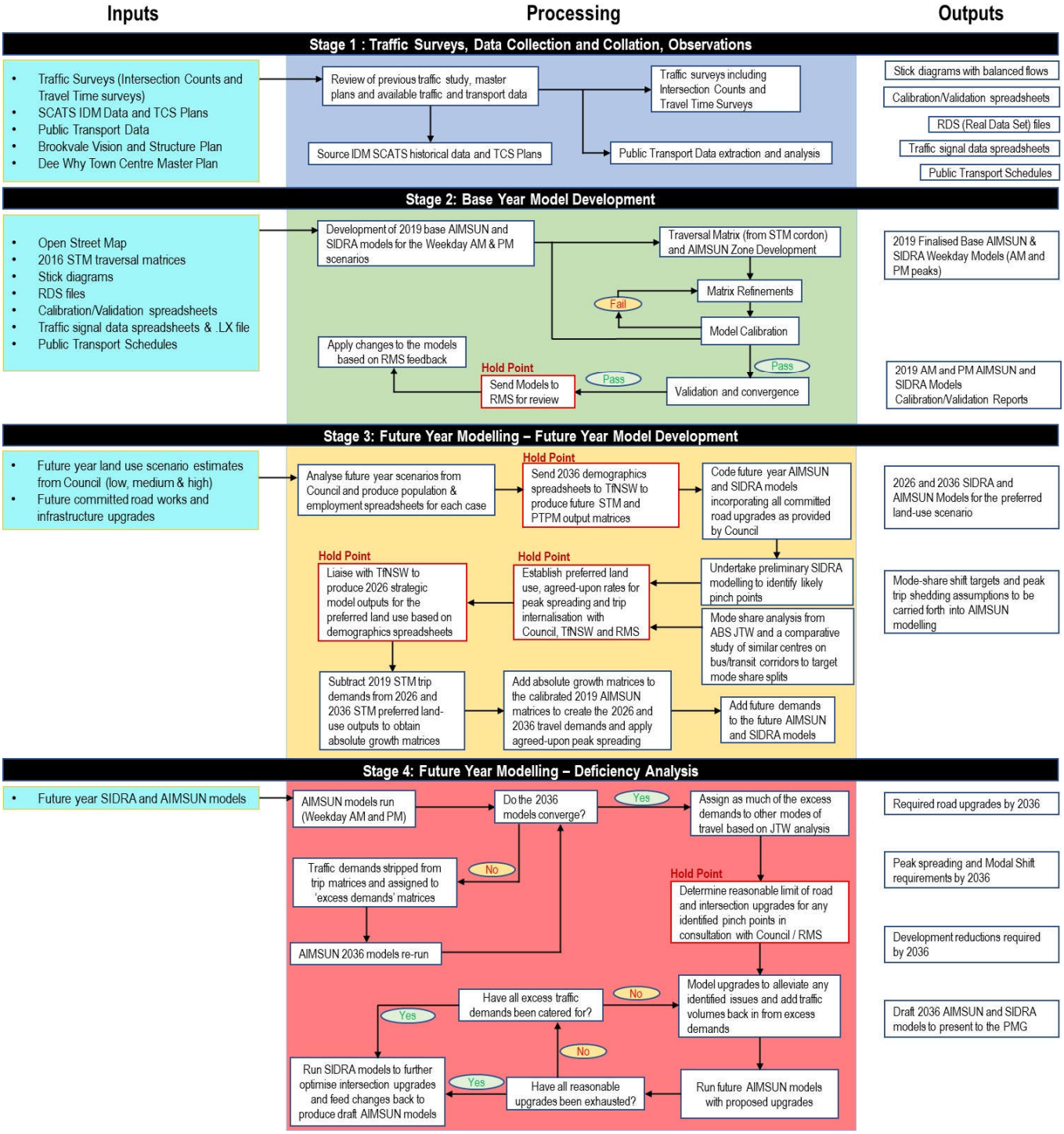


Figure 5.2: Modelling Process

5.2 Models Development

5.2.1 Strategic Models

The strategic modelling was undertaken by TPA with demographic inputs for the study area provided by Bitzios Consulting. The version of the STM was discussed and agreed with Roads and Maritime (now TfNSW) given the changing status of a number of motorway projects and proposals during the course of this study between 2018 and 2020.

The strategic modelling provided by TPA was used for the following purposes:

- To provide year 2016 'pattern' traffic demands for disaggregation and input into the creation of year 2019 'prior' traffic demands for the estimation of AM peak and PM peak demands in AIMSUN
- To run various land use scenarios with demographic input options within the study area to understand the effects of different land use options and inform, with SIDRA modelling, the preferred land use scenario for more detailed modelling
- For the preferred land use scenario to provide year 2016 to 2036 traffic demand growth matrices to disaggregate and add to the year 2019 calibrated / validated AIMSUN matrices to create year 2036 traffic demands (and similarly for 2026).

5.2.2 Microsimulation Modelling in AIMSUN

The process for developing the 2019 Base AIMSUN model involved:

- Coding the model based on the network characteristics identified from open-source data and verified via site observations and the latest Nearmap satellite imagery. Signalised intersection data was obtained from TfNSW
- Creating a model zone system from the Sydney Strategic Transport Model (STM) zoning system and splitting these zones to ABS meshblock zone sizes
- 'Cordoning' the STM to extract initial 'prior' traffic demands for further refinement via 'furnessing' using the total traffic volumes at zone production and attraction locations, both internal to the study area and at the edges of the model, where traffic count data was available
- Calibrating the traffic demands in the model to observed intersection counts spread across the study area using 'Matrix Estimation'
- Validating the 2019 Base AIMSUN Model to travel time survey data and back of queue data.

A calibration and validation report was prepared and endorsed by TfNSW. Year 2036 and year 2026 AIMSUN models were subsequently created for the preferred future land use scenario, taken from the traffic growth matrices from the STM. Year 2036 and 2026 'do minimum' networks were also established based on known or committed road network changes within the study area. The future year AIMSUN models were used to test options and inform the selection of preferred road upgrades at key pinch point locations in 2036 and 2026.

The extents of the AIMSUN network are shown in Figure 5.3.

Figure 5.3: AIMSUN Network Extent

5.2.3 SIDRA Intersection Modelling

SIDRA intersection models were created for the 2019 AM and PM peak one hours for 30 key traffic signal sites. The SIDRA models were calibrated to reflect observed local traffic conditions, including back-of-queue validation on the minor roads.

These models were used for the year 2036 assessment to determine the expected levels of traffic demand which could be catered for by the road network with 'reasonable' intersection upgrades. This work informed the selection of the preferred land use scenario in Stage 1 for detailed assessment in Stage 2 using AIMSUN microsimulation modelling.

AIMSUN and SIDRA modelling calibration and validation reports were produced and approved by TfNSW in early 2019.

6. STAGE 1: LAND USE SCENARIO ASSESSMENT

This section summarises the modelling and assessment completed to determine the preferred land use scenario. Further details are provided in Working Paper #3 Land Use Testing and Mode Share.

6.1 Land Use Scenarios

The population and jobs growth in the STM was reviewed for the study area and compared with land use forecasts provided by NBC. These included low, medium, and high population and employment growth scenarios for a realisation year of 2036. A summary is provided in Table 6.1.

Table 6.1: Summary of Population and Employment Growth by Scenario

Scenario	Population Growth (2016-2036)	Employment Growth (2016-2036)
Low Growth	3,700	3,000
Medium Growth	9,940	4,170
High Growth	17,300	6,000
Initial STM data	2,875	5,200

In general, NBC's population projections were higher than what was contained in the STM, and NBC's employment projections were similar to the STM for the medium and high growth scenarios.

6.2 Scenario Modelling Outcomes

Preliminary intersection modelling was undertaken in SIDRA to analyse the impacts of the forecast traffic growth of the three land use scenarios provided by NBC.

The key findings of the SIDRA modelling are summarised as follows:

- Warringah Road to the west is a traffic 'throttle' for traffic exiting and entering the study area
- Growth scenario impacts are far greater through Brookvale than through Dee Why due to two effects:
  - The scenarios tested had far more growth allocated to Brookvale than to Dee Why
  - Dee Why, in general, appears to have more spare traffic capacity than Brookvale does
- For the medium growth scenario, some Brookvale intersections were revealed to be 10% - 65% over capacity in 2036 (with one outlier at 189%), although upgrades were identified to mitigate these impacts
- For the high growth scenario, some Dee Why intersections show some queue propagation between adjacent intersections but these queues generally clear in a single signal cycle.

Based on the preliminary modelling, the preferred 2036 Land Use scenario for subsequent detailed AIMSUN modelling, determined in consultation with the study's Project Management Group, was:

- **Medium** scenario employment and population growth in Brookvale
- **High** scenario employment and population growth through Dee Why.

The growth areas for Brookvale were divided up into a number of 'zones' while Dee Why was considered in aggregate. A summary of population and employment growth that was tested and then recommended for Stage 2 is shown in Figure 6.1.

Brookvale Population

Key Site	Area	Low	Med	High
A. Brookvale Oval	4.16ha	0	200	450
B. Town Centre	6.38ha	500	1200	1800
C. Bus Depot	4.33ha (2.9 depot only)	0	750	1500
D. Warringah Mall	17.51ha (17.06 mall only)	0	400	800
E. Southern R2 East	6.56ha	300	600	1200
F. Southern R2 West	3.22ha	0	300	600
Total		**800**	**3450**	**6350**

Brookvale Employment

Precinct	Low	Med	High
Warringah Mall (Key Site D)	750	1125	1800
Town Centre (Key Site B)	450	700	1100
Bus Depot (Key Site C)	0	25	50
IN1 Industrial East	200	250	400
IN1 Industrial West	300	400	650
Total	**1,700jobs**	**2,500 jobs**	**4,000 jobs**
	50,000sqm	**70,000sqm**	**112,000sqm**

Dee Why TC	L	M	H
Population (persons)	930	2000	3778
Employment (jobs)	500	750	1000

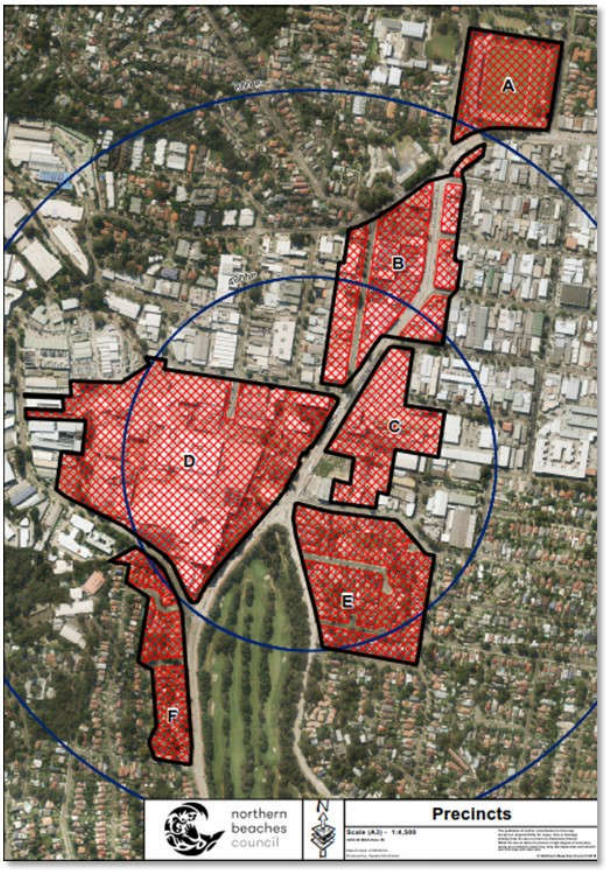


Figure 6.1: Preferred 2036 Land Use Scenario

The 2026 population and employment projections were advised by Council to be a proportion of the growth expected by 2036. Given that development is occurring at different rates across the study area, the following percentage assumptions were adopted:

- Dee Why: 2018-2026 growth is 40% of 2018 to 2036 growth
- Brookvale and surrounds: 2018-2026 growth is 35% of 2018 to 2036 growth.

These ratios were used to calculate the year 2026 traffic demands.

6.3 Land Use Breakdown by Travel Zone

The blended land use forecasts with Medium growth in Brookvale and High growth in Dee Why were provided to TfNSW for input into the STM. TfNSW then provided the cordon traffic matrices for use in calculating traffic growth to add to the Aimsun base year traffic matrices for use in future year modelling. Figure 6.2 presents the population and employment growth assumptions by Travel Zone.

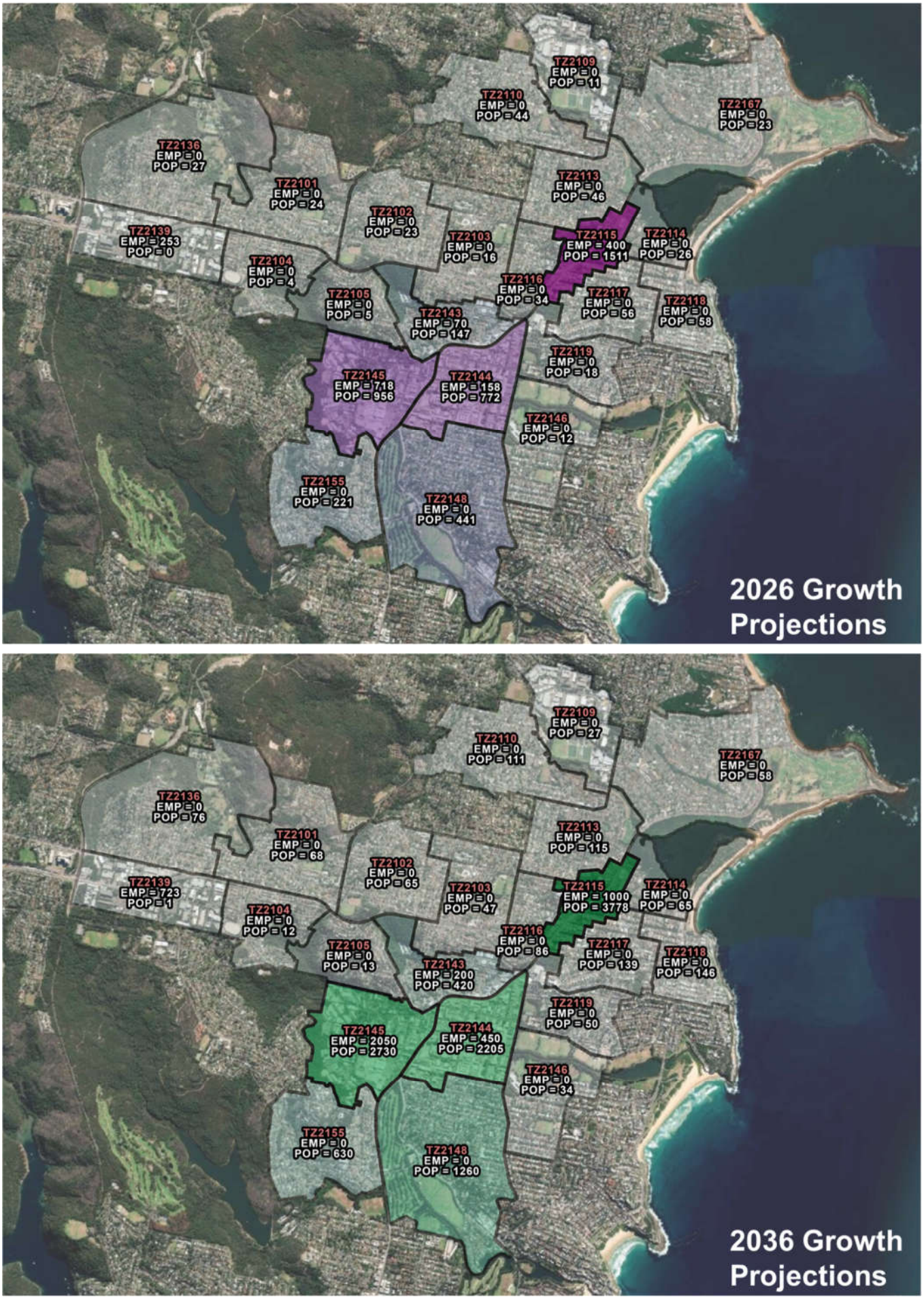


Figure 6.2: **Population and Employment Growth from 2018**

The population and employment growth from 2018 by Travel Zone are presented in Table 6.2.

Table 6.2: Growth Projections by Travel Zone

Travel Zone	Growth 2018-2026		Growth 2018-2036	
	Population	Employment	Population	Employment
2,101	24	0	68	0
2,102	23	0	65	0
2,103	16	0	47	0
2,104	4	0	12	0
2,105	5	0	13	0
2,109	11	0	27	0
2,110	44	0	111	0
2,113	46	0	115	0
2,114	26	0	65	0
2,115	1,511	400	3,778	1,000
2,116	34	0	86	0
2,117	56	0	139	0
2,118	58	0	146	0
2,119	18	0	50	0
2,136	27	0	76	0
2,139	0	253	1	723
2,143	147	70	420	200
2,144	772	158	2,205	450
2,145	956	718	2,730	2,050
2,146	12	0	34	0
2,148	441	0	1,260	0
2,155	221	0	630	0
2,167	23	0	58	0
TOTAL	**+4,474 persons**	**+1,598 jobs**	**+12,136 persons**	**+4,423 jobs**

7. STAGE 2: NETWORK UPGRADES MODELLING

This section describes the deficiency analysis modelling, options development and options assessment using the AIMSUN microsimulation model created for this study. Further details are provided in Working Paper #4 Deficiencies and Options.

7.1 Overview

The assessment of the base 2019 AIMSUN network revealed a number of key deficiencies with the existing road network (as described earlier in Section 3.7.2). Furthermore, the Movement and Place assessment revealed a number of areas where the conflicts between movement and place was prominent.

To determine how these issues would change by 2026 and 2036 year 'future 'Do Minimum' microsimulation models were established for 2026 and 2036.

The growth in traffic demands between 2019 and 2026 and between 2019 and 2036 were determined from the STM which was run with the demographics in the study area reflective of the medium scenario in Brookvale and the high scenario in Dee Why. Whilst not described in detail by TfNSW, it is understood that the network used in the STM included Beaches Link and the proposed B-Line improvements (in 2026 and in 2036) but did not include bus lanes and any associated changes being contemplated for Warringah Road.

7.2 2026 and 2036 Do Minimum AIMSUN Models

The process for developing the future Do Minimum AIMSUN models involved:

- Sending the updated land use assumptions to TfNSW for input into the STM to produce traffic demand matrices for 2026 and 2036
- Adding confirmed road upgrades to the 2019 Base AIMSUN network for both 2026 and 2036 scenarios
- Adding the 2026 and 2036 traffic growth to the 2019 AIMSUN base demands.

The traffic demand changes between 2019, 2026 and 2036 are summarised in Table 7.1.

Table 7.1: Do Minimum Modal Splits and Traffic Demands

	Study Area	2019		2026 Do Minimum		2036 Do Minimum	
		0600-1000	1500-1900	0600-1000	1500-1900	0600-1000	1500-1900
Private vehicle modal share (AM)	TO	81%		79%		78%	
	FROM	73%		72%		70%	
	WITHIN	63%		61%		59%	
Traffic demands	TO	12,594	9,546	12,859	10,075	14,148	11,497
	FROM	8,992	13,090	9,570	13,435	10,729	14,887
	WITHIN	4,953	5,908	5,027	5,933	5,202	6,186
	THROUGH	14,808	16,564	15,854	17,370	16,780	18,266
	TOTAL	41,347	45,107	43,311	46,814	46,860	50,837

Overall, peak period traffic demand was estimated to increase by 13% between 2019 and 2036.

7.3 Deficiencies Analysis

7.3.1 General

The AIMSUN microsimulation modelling of the 2036 traffic demands on the 2036 Do Minimum network identified that severe traffic congestion would occur. A number of congestion pinch points would impede traffic flow along the major road corridors which would result in very long queues along Pittwater Road, Warringah Road, and side streets. The full extent of congestion in the network could not be presented as the modelled traffic network resulted in circular queuing ('gridlock') during the simulation runs which did not allow all of the forecast demand to be loaded into the network.

7.3.2 2036 Network Statistics

The key network statistics from the 2036 Do Minimum modelling are compared to the year 2019 model results in Table 7.2.

Table 7.2: Network Performance Statistics (2036 Do Minimum)

Scenario	2019		2036 Do Minimum	
Attribute	AM	PM	AM	PM
Traffic assignment period	0600-1000	1500-1900	0600-1000	1500-1900
VHT	7,024	8,459	5,940[1]	6,796[1]
VKT	183,632	229,796	141,877[1]	137,654[1]
Completed trips	73,965	86,630	60,002	57,575
Commenced but incomplete trips	1,334	1,600	**11,185**	**12,260**
Unreleased trips	0	0	**13,691**	**29,227**
Average network speed (km/h)	30	29	27	24

VHT: Vehicle-Hours travelled for (completed + commenced trips)
VKT: Vehicle-kilometres Travelled (completed + commenced trips)
[1] No correction applied for incomplete or unreleased trips

The 2036 Do Minimum results indicate a substantial number of both unreleased trips and incomplete trips in the network at the end of the simulation. Due to this, all other statistics show a reduction relative to the 2019 base scenario, with lower VHT, VKT and average network speed.

7.3.3 2036 Corridor Performance and Pinch Points

During the AM peak hours, the Dee Why road network is heavily saturated with traffic, whilst the Brookvale area is functioning reasonably well, most likely being 'protected' by traffic being held up further to the north.

During the PM peak hours, the reverse condition applies. The Brookvale area shows signs of heavy congestion while the Dee Why region is not overly congested as traffic is held up in Brookvale. This is indicative of the significant tidal flow patterns, with heavy southbound traffic during the morning period and heavy northbound traffic in the afternoon period.

Considering these 'blockage' issues, further observations have been made from the model in regard to the operations of the traffic network along the Pittwater Road corridor and surrounding streets as follows:

AM Peak Period

- Heavy southbound flow along Pittwater Road is constrained by the signals at Warringah Road, resulting in a 'shockwave' queue that propagates back through the Dee Why Town Centre and saturates upstream traffic signals
- Traffic on minor side roads in the Dee Why Town Centre are prevented from turning onto the Pittwater Road corridor during green signal phases due to extensive queues occupying the available road space

- Vehicles were observed to bypass Pittwater Road southbound by 'rat-running' through local streets like Victor Road and May Road, to turn right onto Warringah Road at the priority intersection of Warringah Road / May Road
- Southbound flow on Willandra Road substantially exceeds the capacity of the traffic signals at Warringah Road / Willandra Road, with two-lane queues extending over 750m to the McIntosh Road / Willandra Road roundabout
- Eastbound right turning vehicles exceed the turning bay capacity at the Warringah Road / Allambie Road traffic signals, spilling into the through traffic lanes
- Westbound traffic on Abbott Road is observed to have suboptimal characteristics due to the unique road layout, leading to some congestion outside of the model boundary
- The Brookvale centre experiences relatively uncongested traffic flow, with no notable queueing.

PM Peak Period

- Heavy northbound flow along Pittwater Road and Condamine Street is the primary cause of network congestion and is constrained by the signals at Warringah Road, generating queues to the south over one kilometre long and affecting all intersecting minor roads
- Mitchell Road becomes oversaturated with vehicles departing the Brookvale industrial area, with queues extending through the roundabouts at Winbourne Road, Chard Road, Sydenham Road and Orchard Road
- Northbound traffic on Harbord Road is delayed at two locations: at the traffic signals at Abbott Road / Winbourne Road and Pittwater Road / Warringah Road due to:
  - At Abbott Road / Winbourne Road, increased right turning demand in combination with short signal phasing obstructs through traffic due to the lack of provision of right turn bay
  - The single lane capacity on Harbord Road south of Abbott Road, vehicles are queued for a long distance alongside the NBSC Freshwater Campus
  - At Pittwater Road / Warringah Road, increased right turning demand in combination with short turning bay and oversaturated traffic signals cause extended delays and queueing
- Beacon Hill Road northbound traffic is slow-moving, with a 'crawling queue' originating from the traffic signals at Warringah Road due to the left-turn slip lane and its single lane capacity
- Northbound traffic on Condamine Street at the southern boundary of the model is restrained by the Condamine Street / Kentwell Street traffic signals. Queues extend outside of the model, with a substantial number of unreleased trips indicating potential impacts to Manly Vale to the south.

The locations of key pinch points are mapped in Figure 7.1.

The differences between peak hour travel times within the 2036 Do Minimum compared to 2019 are summarised as follows (noting the limitations due to unreleased and incomplete trips):

- During the AM peak, northbound travel times for both private vehicles and buses remain consistent with 2019, with a negligible increase in the future 2036 scenario
- During the AM peak, southbound travel times along Pittwater Road show significant increases of around 8 minutes for general traffic and 1.5 minutes for buses
- During the PM peak, southbound travel times for both general traffic and buses remain relatively consistent, with a minor increase in delays around Mitchell Road
- During the PM peak, northbound travel times along Pittwater Road show extremely high delays, with an increase in travel time of around 13 minutes for general traffic and 5 minutes for buses
- Bus travel times include the assumption that buses will stop at all bus stops along their route. These effects are visible in the counter-peak direction in each peak (i.e. northbound in AM and southbound in PM), where bus travel times are longer than relatively free-flowing traffic. In the peak direction of traffic, bus travel times are shorter primarily due to the bus lanes.

It is noted that due to the traffic gridlock in the future year model, especially in the 2036 PM peak, travel times may not be sensitively represented due to blockages within the primary corridor.

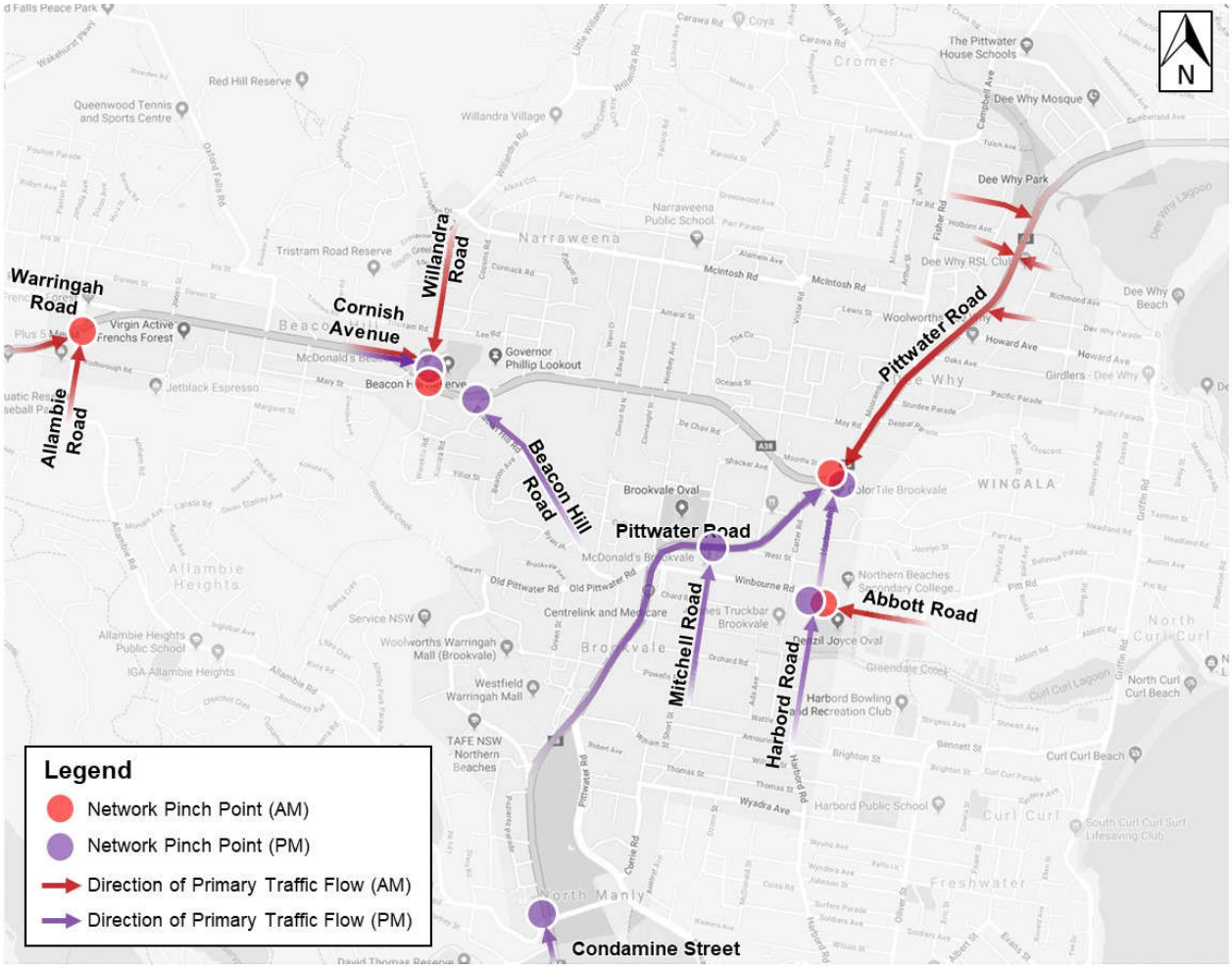


Figure 7.1: Key Pinch Points, 2036

7.3.4 2026 Network Statistics

The 2026 models were observed to have fewer delays and fewer congested locations compared to the 2036 models. The road network functions relatively smoothly in the AM peak period, with the exception of some southbound congestion through the Dee Why Town Centre during the busiest part of the peak. The 2026 PM peak models showed signs of northbound congestion which ultimately resulted in gridlock towards the end of the modelled 4-hour period.

The key network statistics from the 2026 Do Minimum modelling are compared to the year 2019 model results in Table 7.3.

Table 7.3: Network Performance Statistics (2026 Do Minimum)

Scenario	2019		2036 Do Minimum		2026 Do Minimum	
Attribute	AM	PM	AM	PM	AM	PM
Traffic assignment period	0600-1000	1500-1900	0600-1000	1500-1900	0600-1000	1500-1900
VHT	7,024	8,459	5,940[1]	6,796[1]	6,949	8,575[1]
VKT	183,632	229,796	141,877[1]	137,654[1]	181,489	187,059[1]
Completed trips	73,965	86,630	60,002	57,575	76,881	76,399
Commenced but incomplete trips	1,334	1,600	**11,185**	**12,260**	1,477	**8,404**
Unreleased vehicles	0	0	**13,691**	**29,227**	69	**6,826**
Average network speed (km/h)	30	29	27	24	29	26

VHT: Vehicle-Hours travelled for (completed + commenced trips)
VKT: Vehicle-kilometres Travelled (completed + commenced trips)
[1] *No correction applied for incomplete or unreleased trips*

7.3.5 2026 Corridor Performance and Pinch Points

Overall, the Brookvale and Dee Why study area traffic network functions without excessive congestion in the 2026 scenario. The key difference to 2019 is a worsening of traffic conditions along Pittwater Road (particularly in the PM peak) due to the heavier flows, with queues pushing back through multiple intersections from Pittwater Road / Warringah Road / Harbord Road.

The network performance is however significantly better than in 2036. The following observations have been made regarding the operations of the traffic network along the Pittwater Road corridor and surrounding streets in 2026.

AM Peak Period

- Southbound traffic through the Dee Why Town Centre during the AM peak period is heavy, with queues causing some congestion on side roads. However, it is observed that impacts to local roads dissipate by around 9:00 - 9:30 AM
- Willandra Road southbound is beginning to show signs of heavy congestion, with queues extending back to around Beacon Hill Public School. However, it is observed that the queues do not extend back to the roundabout like they do in 2036
- Allambie Road is observed to have northbound queues at Warringah Road, extending through the Rodborough Road roundabout which causes blockage issues with vehicles on the east and west approaches. This issue is similar to what occurs in 2036
- Westbound traffic on Abbott Road is congested with queues extending beyond the model boundary. While there are two right turning lanes present, the staggered nature of the intersection with Winbourne Road and limited capacity on Harbord Road between the two streets means that the right turning vehicles from Abbott Road seeking to access Winbourne Road (which is a large proportion of them) will opt to only turn from the short left turning lane.

PM Peak Period

- Northbound traffic on Pittwater Road is heavily congested in 2026, constrained by the Pittwater Road / Warringah Road / Harbord Road traffic signals. While queues are observed to take time to build in this peak, they eventually extend through to the Brookvale centre, with the effects felt over one kilometre away from the pinch point
- Due to this, the follow-on congestion present in the 2036 modelling is also shown in the 2026 modellings, most notably for northbound traffic on Mitchell Road and on Harbord Road
- Northbound traffic at the southern boundary of the model is also held up by the Condamine Street / Kentwell Street traffic signals. Queues extend outside of the model, with a substantial number of unreleased trips indicating potential impacts to Manly Vale to the south. However, it is likely that this impact is influenced by the fixed arrival rate of traffic entering the model area on Pittwater Road which is a limitation of the model's edge conditions
- Slow travel speeds are observed on Beacon Hill Road northbound with long queues generated exacerbating 2019 queue lengths.

A summary of key pinch points in 2026 is mapped in Figure 7.2.

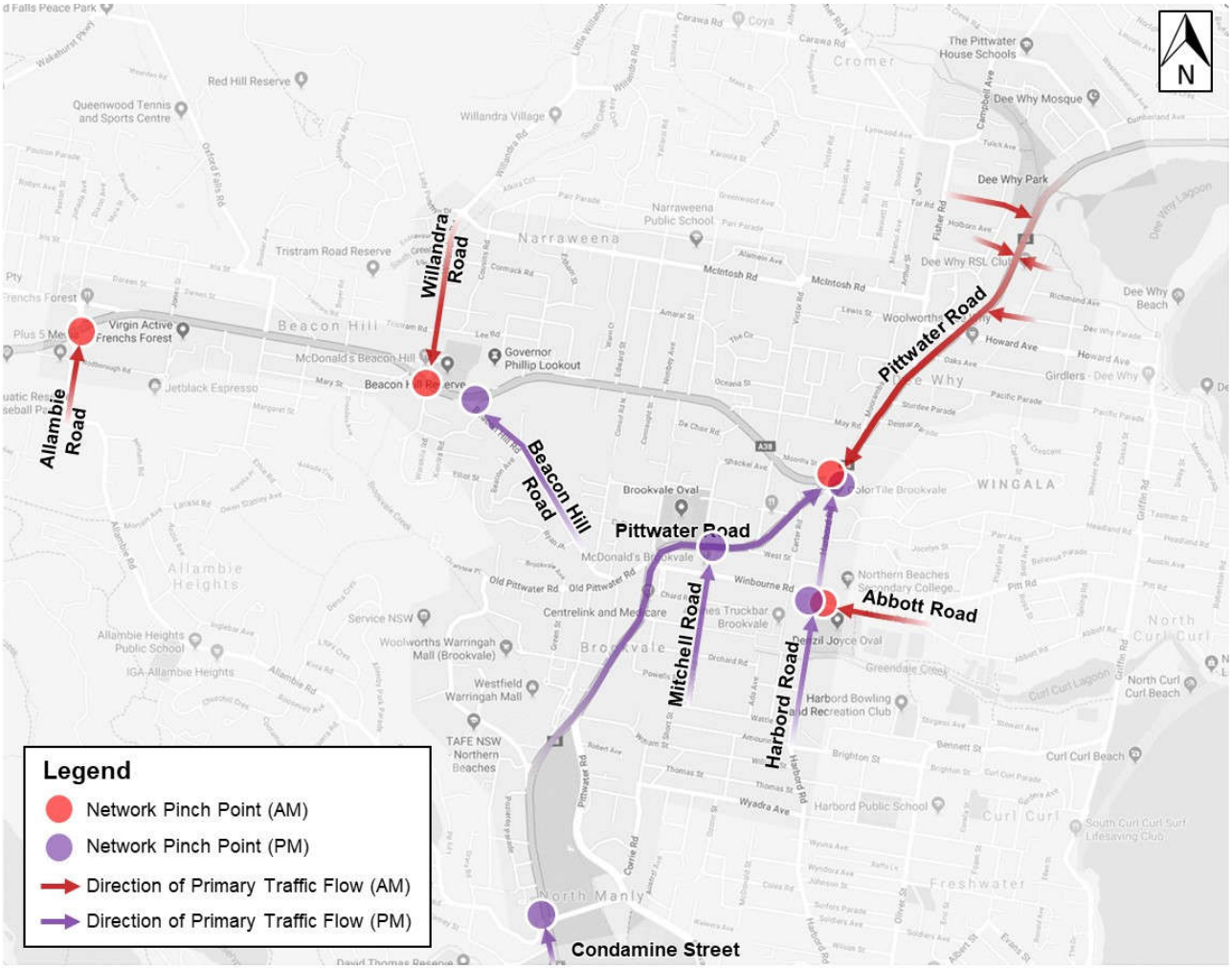


Figure 7.2: Key Pinch Points, 2026

The differences between peak hour travel times within the 2026 Do Minimum models and 2019 models are summarised as follows:

- During the AM peak, northbound travel times for both general traffic and buses remain consistent with 2019, with only very minor differences in the future 2026 scenario
- During the AM peak, southbound travel times along Pittwater Road show delays compared to 2019, with an increase of around 5 minutes for general traffic and 1 minute for buses
- During the PM peak, southbound travel times for both general traffic and buses remain consistent with 2019, with only a very minor difference in the future 2026 scenario
- During the PM peak, northbound travel times along Pittwater Road show an increase of around 8 minutes for general traffic and 3 minutes for buses compared to 2019.

7.4 Options Development, Modelling and Evaluation

7.4.1 Options Development

Options were developed for reducing the impact of each pinch point within the network, and following consultation with the PMG, a final list of options to test using the AIMSUN models was agreed upon. This list is summarised in Table 7.4.

Table 7.4: Summary of Congestion Issues and Options to Test

Issue	Critical Peak Period	Options
Pittwater Road / Warringah Road / Harbord Road Northbound congestion on Pittwater Road stemming from the key intersection	PM	**Option 1.01:** Upgrade the Pittwater Road / Warringah Road / Harbord Road intersection with an overpass / underpass road arrangement to allow for grade-separation of the major flows: N-S on Pittwater Road and E-W on Warringah Road / Harbord Road.
Pittwater Road / Warringah Road / Harbord Road Southbound congestion on Pittwater Road stemming from the key intersection	AM	**Option 1.01:** Upgrade the Pittwater Road / Warringah Road / Harbord Road intersection with an overpass / underpass road arrangement to allow for grade-separation of the major flows: N-S on Pittwater Road and E-W on Warringah Road / Harbord Road.
Warringah Road / Allambie Road Right turn queues from Warringah Road into Allambie Road exceeding the turning bay capacity	AM	**Option 3.01:** Extension of the median-side right turn bay for additional right turn capacity and to minimise spillage of queues into through traffic lanes **Option 3.02:** Right turn flyover from west to south.
Warringah Road / Willandra Road Southbound congestion on Willandra Road with very long queues and delays	AM	**Option 4.01:** Extend the Willandra Road to Warringah Road left turn lane to the Cornish Avenue traffic signals via a realignment of Willandra Road traffic lanes between Warringah Road and Cornish Avenue. This may require either narrowing of the adjacent northbound lane (subject to turn path assessment) or earthworks to widen the southbound side of the road into the Beacon Hill Reserve boundary (subject to environmental constraints). **Option 4.02:** Convert Willandra Road to one-way southbound between Cornish Avenue and Warringah Road. This treatment would also prevent right, left and through movements into Willandra Road north. With the exception of the right turn, these are low volume movements, but banning the turn will impact existing school bus services. **Option 4.03:** Consider road hierarchies in the area to 'upgrade' another north-south road to collector level to shift some of the through traffic demand and alleviate traffic pressure on Willandra Road. Potential candidates include Alfred Street or Daines Parade via Tristram Road. Ellis Road is also a strong option but would require additional connectivity via Tristram Road.
Willandra Road / Cornish Avenue Eastbound congestion on Cornish Avenue turning onto Willandra Road, queueing back to Warringah Road	AM / PM	**Option 5.01:** Remove the kerb build-out on the corner of Cornish Avenue and Willandra Road to allow for an additional lane at the traffic signals. To accompany this, implement peak period kerbside parking restrictions on the north side of Cornish Avenue. This will allow for lane re-allocation, to provide more capacity for left and right turn movements **Option 5.02:** Modify the Cornish Avenue lane allocation by extending the right turn lane at Willandra Road and converting the westbound left turn lane to a shared through and left turn lane. Turn paths for access into the service station would need to be checked

Issue	Critical Peak Period	Options
Pittwater Road / Warringah Road / Harbord Road Northbound congestion on Harbord Road stemming from the key intersection	PM	**Option 6.01:** Extend the existing inner right turn bay at the traffic signals.
Harbord Road / Abbott Road Westbound congestion on Abbott Road during the AM peak Northbound congestion on Harbord Road during the PM peak	AM / PM	**Option 7.01:** Introduce kerbside parking restrictions during the afternoon peak period to increase northbound capacity along Harbord Road and minimise through vehicles from being obstructed by right turning vehicles at the traffic signals. **Option 7.02:** Upgrade the intersection to remove the staggered configuration with Abbott Road and Winbourne Road to create a larger 4-way intersection with right turn protection. This option has significant property implications and is unlikely to be possible. **Option 7.03**: Installation of new short northbound left turning lane on Harbord Road between Winbourne Road and Abbott Road.
Pittwater Road / Mitchell Road Northbound congestion on Mitchell Road caused by capacity constraints of Pittwater Road	PM	**Option 8.01:** Convert the existing one-lane roundabout at Winbourne Road and Mitchell Road to a two-lane roundabout to increase capacity and mitigate the effects of queues propagating through the roundabout. **Option 8.02:** Provide additional right-turn opportunities onto Pittwater Road from the Brookvale industrial zone. In line with the proposed signals at Chard Road and Orchard Road. **Option 8.03:** Adjust signal phasing at the Pittwater Road / Pine Avenue / Mitchell Road signalised intersection to have an early cut-off for the eastbound through movement. This should allow some free capacity each cycle for right turning vehicles from Mitchell Road. This will impact northbound delays on Pittwater Road but at least provides an opportunity for Mitchell Road traffic to exit the area. **Option 8.04:** Re-align the Pine Avenue and Mitchell Road intersections with Pittwater Road to form a conventional 4-way signalised intersection. This will involve adjustments to the Pine Avenue approach and retain Mitchell Road at the existing alignment and will be based on B-Line concept design provided by TfNSW.
Warringah Road / Beacon Hill Road Northbound congestion on Beacon Hill Road with long, slow-moving queues	PM	**Option 9.01:** Install an additional left turn lane at the Warringah Road / Beacon Hill Road traffic signals, either via an additional left slip lane or adjustment to intersection layout. **Option 9.02:** Extend the timed 'No Stopping' zone on the western side of Beacon Hill Road as far south as Beacon Avenue to allow for additional capacity during the PM peak. **Option 9.03:** Restrict westbound traffic on Warringah Road to two-lane approach to facilitate a free-flowing left slip lane out of Beacon Hill Road.
Warringah Road / Allambie Road Northbound congestion on Allambie Road extending to the Rodborough Road roundabout	AM	**Option 10.01:** Adjust lane allocation at the Warringah Road / Allambie Road traffic signals to allow two through traffic lanes. This should greatly increase through capacity and is not expected to excessively impact right turns due to the recent right turn short bay added at this location. **Option 10.02:** Upgrade the Allambie Road / Rodborough Road roundabout's northbound departure to two traffic lanes. **Option 10.03:** Upgrade the Allambie Road / Rodborough Road roundabout to traffic signals.

7.4.2 Options Testing Processes, Considerations and Outcomes

In congested conditions, relieving a network pinch point will result in the release of more traffic into downstream locations. This is not additional traffic demand in the network but reflects less time spent at the pinch point intersection with traffic arriving at the next intersection(s) sooner and in higher volumes per unit of time.

An incremental modelling approach was required where the most congested / critical pinch point relief options were upgraded first, with subsequent downstream effects incrementally assessed and upgrade options applied.

Where there were multiple proposed options at each of the pinch point locations identified in Table 7.4, the modelling approach first considered the lowest cost option in terms of infrastructure works. These options included introducing peak period parking restrictions to extend lane capacities at intersections, re-arrangement of lane allocations, re-phasing signals, line marking changes etc. Following implementation of an option at a specific pinch point location, the model was re-run to determine the degree of improvement locally as well as any wider network benefits or implications. If the traffic issues were still present, this process was iteratively repeated for the other options, scaling up to major upgrades such as additional traffic lanes, road re-alignments or grade separations.

The selection preferred of upgrade strategies is detailed in Section 8.

The performance of the upgraded road network shows significant improvements compared to the corresponding Do Minimum scenario. There is a substantial reduction in network congestion, with the excessive queueing from the network 'pinch points' being successfully mitigated through the suite of upgrade measures. There are still signs of residual localised queueing at key points in the network, but these no longer spread through the network with cascading follow-on impacts to other intersections. Most importantly, all of the future traffic demand is able to be released into the network, with the majority of the trips passing smoothly through the network within the modelled peak periods.

7.4.3 Preferred Option Network Statistics

The network performance statistics of the preferred option are summarised in Table 7.5, compared with that of the 2019 Existing and 2036 Do Minimum scenarios.

Table 7.5: Network Performance Statistics (2036 Upgraded)

Scenario	2019		2036 Do Minimum		2036 Upgraded Network	
Attribute	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
Traffic assignment period	0600-1000	1500-1900	0600-1000	1500-1900	0600-1000	1500-1900
VHT	7,024	8,459	5,940[1]	6,796[1]	7,207	8,909
VKT	183,632	229,796	141,877[1]	137,654[1]	199,430	248,623
Completed trips	73,965	86,630	60,002	57,575	83,293	97,120
Commenced but incomplete trips	1,334	1,600	**11,185**	**12,260**	1,568	1,699
Unreleased vehicles	0	0	**13,691**	**29,227**	1	0
Average network speed (km/h)	30	29	27	24	30	29

VHT: Vehicle-Hours travelled for (completed + commenced trips)
VKT: Vehicle-Kilometres Travelled (completed + commenced trips)
[1] No correction applied for incomplete or unreleased trips

8. PREFERRED STRATEGIES AND UPGRADES

This section summarises the outcomes of the traffic modelling and stakeholder discussions culminating in the preferred option in each location. Further details are provided in Working Paper #5 Interventions and Road Network Strategy.

8.1 Road Network Upgrades Summary

Options which have been tested and discarded are not discussed but have been discarded on the basis that they do not adequately address the capacity issues at that location. Table 8.1 summarises the preferred upgrades with more specific details about each item provided in subsequent sections.

Table 8.1: Preferred Upgrades by Pinch Point Location

Location	Preferred Upgrade	Further Considerations
Pittwater Road / Warringah Road / Harbord Road	Option 1.01 Installation of grade-separated interchange between Pittwater Road and Warringah Road.	This is a major, high-cost upgrade which will be subject to further concept development and options analysis to minimise land take and construction costs in achieving the traffic capacity improvement outcomes. The upgrade concept provided in this report should therefore be considered as a starting point for more detailed investigations. *Note: development-capacity sensitivity testing has been undertaken for the Brookvale Centre without this project given its potential implementation uncertainties (see Section 9.3)*
Warringah Road / Allambie Road	Option 3.01 Extension of the right turn bay from Warringah Road to Allambie Road by around 35m.	Additionally, a minor increase to the signal phase time (main diamond phase from Warringah Road) would be required by 2036.
Warringah Road / Willandra Road	Option 4.01 Extension of the short southbound left turning lane on Willandra Road from Warringah Road to Cornish Avenue by reducing the adjacent northbound carriageway from two lanes to one lane.	Swept path analysis was also undertaken to demonstrate that buses could still turn into and out of Willandra Road in the single lane northbound section.
Willandra Road / Cornish Avenue	Option 5.02 Lane reconfiguration to extend the right turn bay from Cornish Avenue to Willandra Road by reducing the westbound direction to one lane.	Swept path analysis was also undertaken to demonstrate that fuel tankers / delivery trucks could still; access the service station.
Harbord Road / Abbott Road	Option 7.01 Installation of a peak period clearway (parking restrictions) along the southern side of Abbott Road and Option 7.03 Installation of a new northbound left turn lane on Harbord Road between Abbott Road and Winbourne Road .	The existing property setback on the western side of Harbord Road allows for the additional lane with no property impacts.
Pittwater Road / Mitchell Road	No action taken.	Traffic issues at this location are resolved by implementation of **Option 1.01.** This option allowed northbound traffic from Mitchell Road to enter Pittwater Road freely and hence reduce its queueing.

Location	Preferred Upgrade	Further Considerations
Warringah Road / Beacon Hill Road	Option 9.01 Beacon Hill Road left slip lane changing to two signalised left turn lanes.	Increased capacity for the dominant left-turn movement reduces delays and queues at the Beacon Hill Road approach. Signals assist with weave to Willandra Road right turn pocket.
Warringah Road / Allambie Road	Option 10.02 Upgrade Allambie Road / Rodborough Road roundabout to allow two northbound circulating lanes through the roundabout or Option 10.03 Upgrade Allambie Road / Rodborough Road roundabout to traffic signals.	**Option 10.02** facilitates greater northbound queue storage capacity through the Rodborough Road roundabout, which allows greater queue dissipation via the Warringah Road signals. **Option 10.03**, the conversion of the Rodborough Road / Allambie Road roundabout to traffic signals, has been retained for further consideration given the operational and safety benefits to all users.

In addition to the pinch point-specific upgrades detailed above, there were a number of other changes that were made to the 2036 road network in the AIMSUN model. These changes were identified as being necessary on the bases of:

- Improving local accessibility and / or traffic safety
- Previous TMAS recommendations primarily associated with local traffic
- Consequential issues due to the release of traffic associated with the pinch point upgrades from Table 8.1
- Committed' road upgrade projects.

These additional measures are described in Table 8.2.

Table 8.2: Other Network Changes by Location

Location	Upgrade	Further Considerations
Pittwater Road / Victor Road *Local accessibility and safety improvements*	▪ Signalise Pittwater Road / Victor Road ▪ Ban Right Turn from Federal Parade onto Pittwater Road ▪ Remove the signalised mid-block pedestrian crossing between Victor Road and Federal Parade.	Federal Parade to Pittwater Road Right Turn ban and removal of the signalised mid-block pedestrian crossing will be introduced in conjunction with Victor Road traffic signals, to direct drivers to the protected right turn at the new signals and away from the right turn from Federal Parade due to its safety concerns.
Pittwater Road / Delmar Parade *Traffic Safety*	▪ Ban Right Turn from Pittwater Road to Delmar Parade (AM peak only).	Traffic safety measure. Already being considered by TfNSW.
Pittwater Road / Old Pittwater Road / Winbourne Road *Traffic safety*	▪ Ban Right Turn from Old Pittwater Road onto Pittwater Road (currently a filtered movement).	Traffic safety measure already being considered by TfNSW.

Location	Upgrade	Further Considerations
Pittwater Road / Cross Street / Powells Road *Local accessibility improvements*	▪ Construct road link from Pittwater to Powells Road through the bus depot site. ▪ Change Cross Street approach lane allocation to dedicated left, left-through-right and dedicated right ▪ Maintain No Right Turn from Pittwater Road to Powells Road extension (AM peak only).	Requires major changes to the traffic signal design. Maintaining the No Right Turn restriction is necessary to prevent filling of the right turn bay during the morning peak. Sydenham Road currently caters for this demand into the Industrial area and has sufficient capacity in 2036. The Powells Road link dissects the existing bus depot and will have impacts on the space within the depot. TfNSW is not supportive of this link unless existing depot operations can be maintained. Further investigations and discussions are required between NBC and TfNSW to resolve these issues. *Note: development-capacity sensitivity testing has been undertaken for the Brookvale Centre without this project given its potential implementation uncertainties (see Section 9.3)*
Harbord Road (north of Headland Road) *Traffic safety and capacity*	Implement AM and PM peak hour parking restrictions (clearways) on the eastern side of Harbord Road north of Headland Road (around 80m long).	This short section of parking reduces northbound traffic from two lane flow to single lane flow, generating local turbulence. Also, any right turn movements into driveways on the western side of Harbord Road in this section block through traffic.
Pittwater Road Parking restrictions to extend continuity of bus lanes	Implement AM and PM peak hour parking restrictions on both sides of the Pittwater Road corridor. Convert timed morning / afternoon bus lanes to full-time bus lanes.	To capitalise on expected / desired increases in bus patronage.
Dee Why Town Centre Speed Limit reduction *Road user safety*	Change speed limit in Dee Why Town Centre to 40 km/h to reflect recent implementation of High Pedestrian Activity Area.	Zone is located east of Pittwater Road. Previous speed limit was 50 km/h. Formal HPAA scheme required.
Condamine Street *Traffic capacity*	Upgrade Condamine Street NB from three lanes to four lanes from model boundary to the Old Pittwater Road left turn lane.	It was determined that there is insufficient existing road capacity to accommodate the future incoming traffic flow at the southern boundary. This project has significant impacts that may need further, more detailed consideration
Harbord Road / Brighton Street *Traffic safety and capacity*	Signalise Harbord Road / Brighton Street / Amourin Street.	Increased traffic released onto Harbord Road at upstream intersections impacts the ability of Brighton Street traffic to turn out.

Figure 8.1 shows the study area with annotated locations of each proposed upgrade. The staging of upgrades for implementation by 2026 and by 2036 is detailed in Section 9.0.

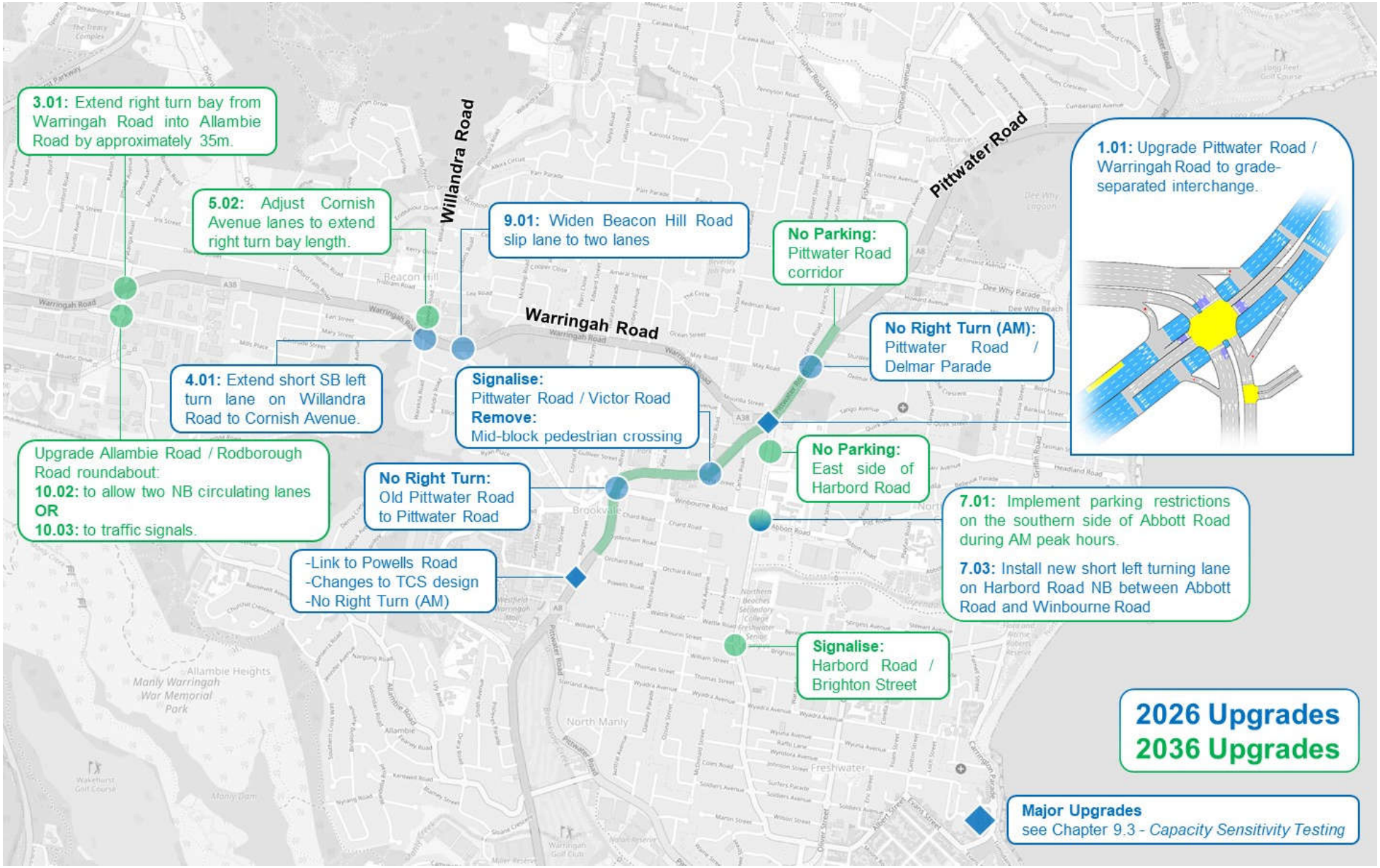


Figure 8.1: Summary of Proposed 2036 Network Upgrades

8.2 Road Capacity Upgrade Descriptions

8.2.1 Pittwater Road / Warringah Road / Harbord Road Grade Separated Intersection

Pittwater Road / Warringah Road / Harbord Road currently functions as the key intersection in the study area. As the connection between two major movement corridors, the performance of this intersection is critical on the overall network extending deep into Brookvale and into Dee Why. Due to very high traffic volumes and turning movements from all approaches, this intersection is one of the major identified pinch points in the existing network. Its congested condition is exacerbated by future growth proposed in the area, and growth in through traffic, with queues propagating back into both the Brookvale and Dee Why centres.

The proposed upgrade at this intersection is **Option 1.01**, which is grade-separation. The preferred configuration was advised by Council to be Warringah Road-Harbord Road running over Pittwater Road with the traffic signals elevated to this upper level. This configuration will retain Pittwater Road at its current alignment with the north-south through movements on Pittwater Road being uncontrolled. Figure 8.2 shows this configuration.

Figure 8.2: Pittwater Road / Warringah Road / Harbord Road Upgrade Proposal

The proposed configuration had the following effects on traffic:

- The separation of Pittwater Road north-south through traffic from the traffic signals greatly reduces Do Minimum congestion in this area in both the AM and PM peak periods
- Due to 'freeing up' of green time at the traffic signals due to the removal of the major Pittwater Road through traffic phase, the re-allocated phase times greatly reduces queues on Harbord Road
- On the southern Harbord Road approach, a single right-turning lane was sufficient in meeting the turning demand, simplifying the single lane merge requirements onto Pittwater Road northbound.

8.2.2 Warringah Road / Allambie Road

Warringah Road / Allambie Road does not currently (in 2019) have significant local congestion, with the exception of downstream congestion at Wakehurst Parkway causing westbound delays during the AM peak. However, the future 2036 traffic demands result in increasing demand on the right turn from Warringah Road into Allambie Road during the AM peak primarily due to the expected employment growth in the Frenchs Forest Business Centre along Rodborough Road. These vehicles were observed to queue back and exceed the capacity of the right turn pockets, affecting eastbound through traffic on Warringah Road.

The proposed upgrade at this intersection is **Option 3.01**, which is an extension of the median-side right turn bay from the existing 180m long to 215m long. This was also accompanied by some minor adjustments to phase times at the traffic signals in 2036. Some additional green time was allocated to the diamond right turn phase on Warringah Road to meet future demands.

Figure 8.3 shows the preferred configuration.

Figure 8.3: Warringah Road / Allambie Road Upgrade Proposal

The tested configuration had the following effects on traffic:

- With the additional capacity, right turning queues were better contained within the turning bay
- It was observed that in the busiest parts of the AM peak (around 7:30 AM to 8:00 AM and 8:30 AM to 9:00 AM), some right turning vehicles still overflowed the bay slightly however the effects were not prolonged and did not significantly affect eastbound through traffic flow.

While there will still be some minor residual right turn pocket 'queue-out' impacts, the next upgrade (Option 3.02, a right turn flyover) is a significant step in complexity and cost, the scale of which is not justified by the extent of the minor residual impacts under Option 3.01.

8.2.3 Warringah Road / Willandra Road

The Willandra Road southbound approach to the Warringah Road / Willandra Road intersection involves heavy traffic flows, especially during the AM peak. By 2036, the modelling has shown queues increasing to over 750m long, back through the Willandra Road / McIntosh Road roundabout. The majority of these vehicles are turning right onto Warringah Road, travelling towards the west. The existing intersection includes:

- A short left turn lane on the north approach (around 20m long), with capacity for only 3-4 vehicles
- A low volume left turn movements from Warringah Road to Willandra Road, as Cornish Avenue provides an earlier and more efficient turning opportunity
- A rock retaining wall next to the footpath on the eastern side of Willandra Road, adjacent to Beacon Hill Reserve meaning that widening the approach to the east is difficult.

The build-up of southbound queues at this location is caused in part by the inability of left turning vehicles to reach the short left turn lane as they are caught behind the heavier right turn queues. This effectively restricts the approach to operating as two lanes despite it having three lanes.

The proposed upgrade at this intersection is **Option 4.01**, which is an extension of the short southbound left turning lane on Willandra Road from around 20m long to 70 metres long, so that it can be more easily accessed. The left turn lane would be the full length of Willandra Road between Cornish Avenue and Warringah Road. To provide this lane and given the difficulty in widening Willandra Road to the east, one of the two northbound lanes could be converted to a southbound lane. The northbound flows in this location are relatively small and are able to be serviced by a single lane. The lane designation on the northbound approach (south side of the intersection) would need to be modified accordingly as shown in Figure 8.4.

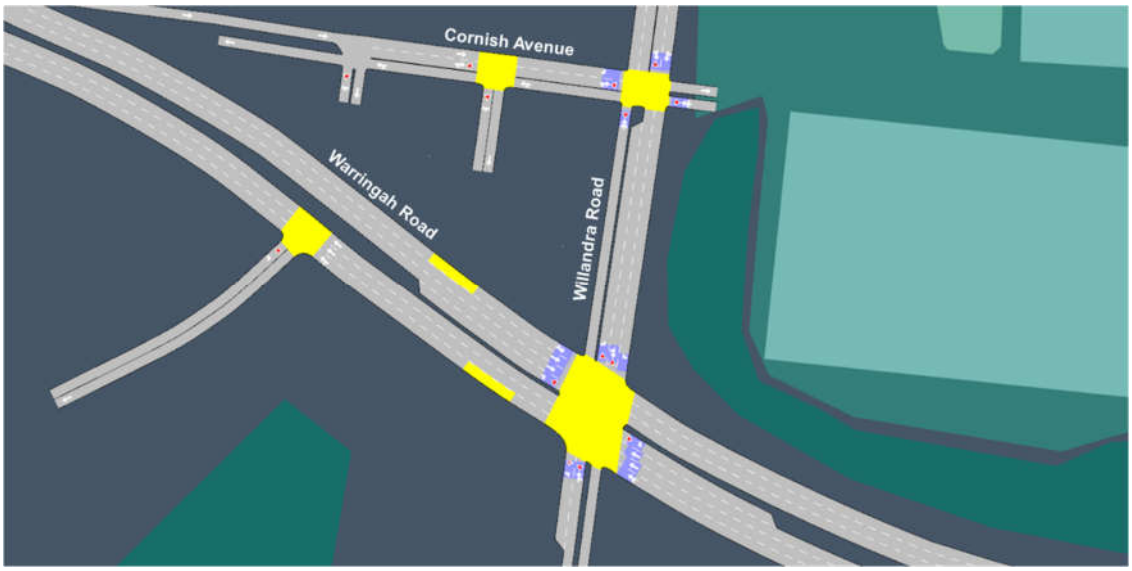


Figure 8.4: Warringah Road / Willandra Road Upgrade Proposal

The tested configuration has the following effects on traffic:

- During the AM peak, southbound queues are significantly reduced to around Tristram Road (maximum of 200m). The kerbside lane remains clear for left-turning vehicles.
- During the PM peak, southbound queues rarely extend through the Cornish Avenue signals and the southbound kerbside lane remains clear for left-turning vehicles.

The upgrade also allows for the future potential to re-allocate the southbound lane designations to provide a third right turn (shared) lane to help service the dominant right turn demand if required.

8.2.4 Willandra Road / Cornish Avenue

Cornish Avenue currently serves, in part, as a bypass of the Warringah Road / Willandra Road intersection, allowing vehicles to 'slip' onto Willandra Road via the Willandra Road / Cornish Avenue traffic signals. Site observations have revealed that almost all drivers coming from the west seeking access to Willandra Road will use Cornish Avenue in this way. By 2036, the increase in traffic demands in the area cause Cornish Avenue to be at capacity during the busiest parts of the AM and PM peak periods. Queues extend back along the entire length of Cornish Avenue and spill out onto Warringah Road, affecting the otherwise unimpeded eastbound traffic stream and introducing safety issues.

This is partly caused by insufficient queue storage capacity on Cornish Avenue. On-street parking limits storage capacity to a single left turn lane and a very short right turn pocket (around 20m long). With traffic departing the Caltex and McDonald's via Cornish Avenue, the right pocket in Cornish Avenue at Willandra Road often queues out of the bay and blocks left turning traffic.

The proposed upgrade at this intersection is **Option 5.02**, which is a re-allocation of the road space within Cornish Avenue to provide one westbound lane and two eastbound lanes between Willandra Road and the Caltex driveway. The extension of the right turning lane from around 20m to around 80m allows for significantly increased queueing capacity, limiting the blockage effects.

Figure 8.5 shows the proposed configuration.

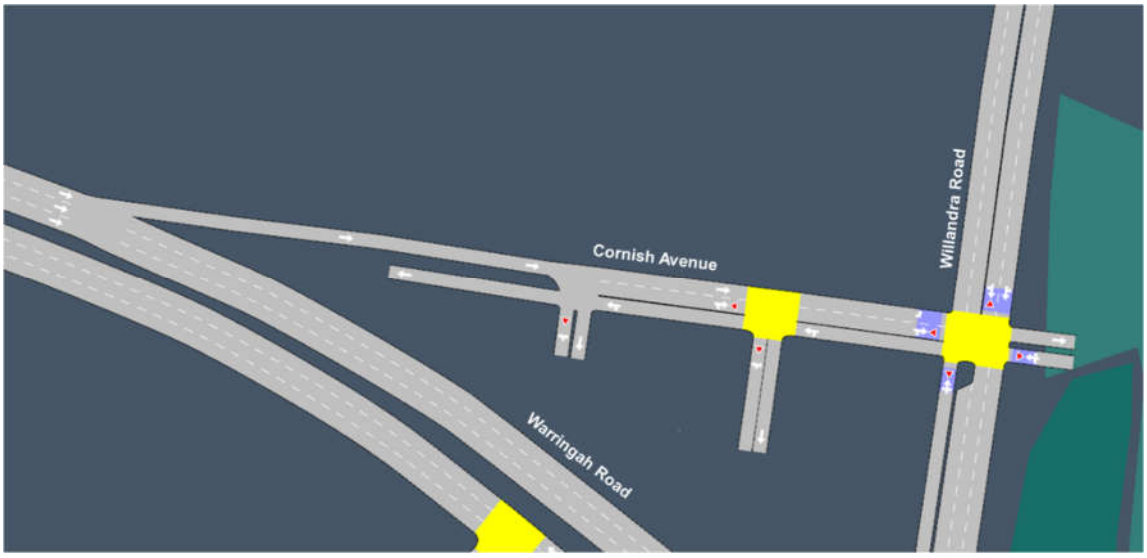


Figure 8.5: Cornish Avenue Upgrade Proposal

The tested configuration had the following effects on traffic:

- Eastbound queues along Cornish Avenue were observed to be moderately reduced
- Right turning queues rarely exceeded the extended turning pocket length and therefore did not block left turning traffic as often
- Queues no longer extend back into Warringah Road eastbound.

As a part of this improvement, it was necessary to consider any impacts to service station delivery vehicles. Council has advised that delivery vehicles access the site via the driveway on Warringah Road and depart via Cornish Avenue.

A swept path analysis was run for a 19m semi-trailer which found it was capable of performing the (now) “sharper” right-turn manoeuvre into the extended right turn bay but would encroach upon the adjacent kerbside travel lane. The manoeuvre is shown in Figure 8.6. This type of encroachment is not significant given the infrequency of this movement, particularly at peak times.

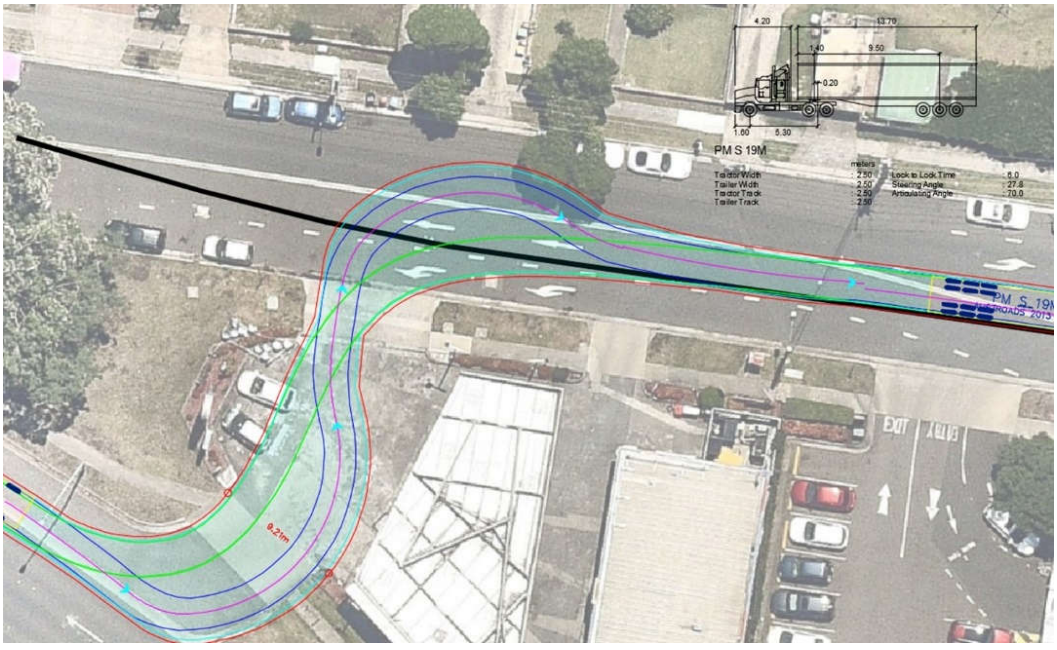


Figure 8.6: Cornish Avenue Semi-Trailer Turn Path Analysis

8.2.5 Harbord Road / Abbott Road

Harbord Road / Abbott Road currently functions as part of the staggered traffic signals with Winbourne Road. Under the 2036 future year demands, the following two traffic issues were identified at this location:

- During the AM peak, westbound traffic on Abbott Road queued back to the edge of the model, blocking traffic from being released into the network. This was caused by right turners who sought to immediately turn left into Winbourne Road and would only use the short kerbside right turn lane.
- During the PM peak, northbound traffic on Harbord Road queued back a significant distance. This was caused by queues for right turns into Abbott Road blocking through traffic in this 50m long two-lane section.

The proposed upgrades at this location are **Option 7.01** and **Option 7.03**. These upgrades include:

- The extension of the length of parking restrictions along the southern side of Abbott Road during the morning peak (7:00 AM to 9:00 AM) from the existing 30m to 70m
- The provision of a 30m long left turn pocket on Harbord Road between Abbott Road and Winbourne Road. The new lane arrangements on the southern approach to the Winbourne Road stop line would be left, through-left and through to cater for increasing left turn movements and minimise trap lane inefficiencies.

Figure 8.7 shows the proposed configuration.

Figure 8.7: Harbord Road / Abbott Road Upgrade Proposal

The tested configuration has the following effects on traffic:

- During the AM peak, westbound queues were heavily reduced on Abbott Road, with minimal observations of unreleased demand into the model during the busiest part of the peak period
- During the PM peak, northbound queues were no longer observed to be heavily affected by the build-up of right turning vehicles into Abbott Road. This may be due in part to the downstream increase in road capacity.

8.2.6 Pittwater Road / Mitchell Road

The previously identified pinch point at this location was resolved by other upgrades. No upgrades were found to be necessary at this location.

8.2.7 Warringah Road / Beacon Hill Road

Warringah Road / Beacon Hill Road is currently a three-leg intersection which services a substantial volume of traffic. There are left turn slip lanes from both Warringah Road westbound onto Beacon Hill Road and from Beacon Hill Road northbound onto Warringah Road. The latter is controlled by signals to minimise priority yielding before joining the fast-moving Warringah Road traffic. During the PM peak, the heavy flow of left turning traffic out of Beacon Hill Road causes very long queues extending back far enough to also block off access to the right turn lane.

The following design options were tested at this location:

- Option 9.03: Restriction of westbound movement on Warringah Road to two through lanes to allow a low-angle continuous left turn out of Beacon Hill Road
- Option 9.01: Re-alignment of Beacon Hill Road left slip lane to provide a standard approach with left and left-right lane allocations
- Option 9.01 (alternative): Widening of Beacon Hill Road signalised left slip lane to two lanes.

The following findings are noted for each respective option:

- Option 9.03: The provision of a low-angle continuous left turn slip lane out of Beacon Hill Road greatly reduced delays and queueing along Beacon Hill Road. However, it was achieved at the cost of reducing westbound capacity on Warringah Road to two lanes, which was not supported by TfNSW given that Warringah Road was the primary movement corridor. Furthermore, it was noted that this upgrade would 'slip' drivers into the left-most lane on Warringah Road resulting in higher speed weaving movements across multiple lanes, as some drivers seek to access the right-turn bay for turns into Willandra Road within a distance of only 50m
- Option 9.01: The re-alignment of Beacon Hill Road to a standard signalised approach with one left turn lane and one left-right turn lane was shown to reduce delays and queueing along Beacon Hill Road using a significantly smaller intersection footprint. However, the modelling showed a high occurrence of right turning vehicles blocking left-turners. During Phase B, this often resulted in only a single lane free to discharge left turning vehicles onto Warringah Road. This configuration introduced capacity and movement flexibility risks to the intersection
- Option 9.01 (alternative): The widening of the Beacon Hill Road to provide two left turn slip lanes was similar in nature to the previous option to re-align Beacon Hill Road, but it retained a short storage area for right turning vehicles. While there were still instances of right turning vehicles overflowing their pocket (particularly in the PM peak), there was an overall improved usage of the green time for these movements.

The proposed upgrade at this intersection is **Option 9.01 (alternative)**, which is a widening of the Beacon Hill Road left slip lane to create two lanes. This will require adjustment to the existing slip lane angle and corner island to accommodate the second lane, as well as potential need for a strip of property acquisition, subject to more detailed design investigations. This option retains a short, separate right turn storage bay. Figure 8.8 shows the proposed configuration.

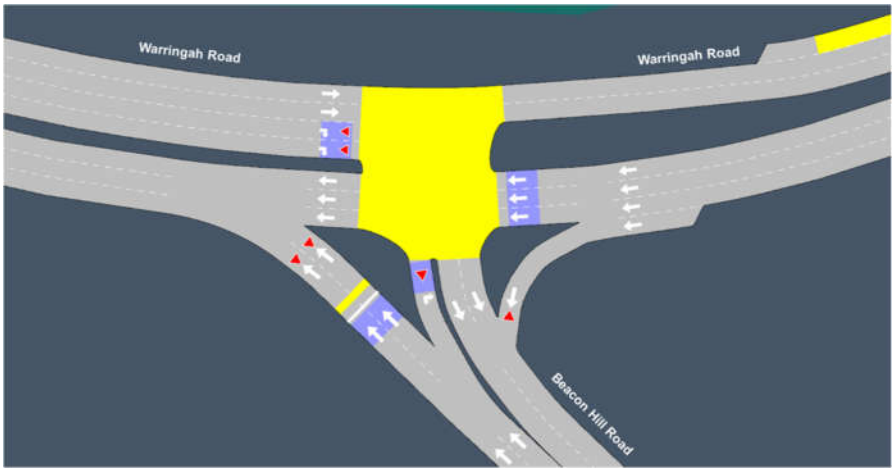


Figure 8.8: Warringah Road / Beacon Hill Road Upgrade Proposal

The tested configuration had the following effects on traffic:

- Left turning queues on Beacon Hill Road northbound were significantly reduced due to the increased capacity and throughput at the signals
- Right turn queues sometimes exceeded the three vehicles storage bay, blocking left turning vehicles. The phase sequence at the intersection allowed these blocked vehicles to clear during the following phase with a green light for both left and right turning vehicles
- Weaving movements for traffic travelling between the Beacon Hill Road and Willandra Road were managed better by allowing these drivers to turn directly into the middle lane on Warringah Road.

8.2.8 Allambie Road / Rodborough Road

Roundabout Upgrade Option

Allambie Road / Rodborough Road is a four-leg roundabout approximately 130m south of Warringah Road. The roundabout has two circulating lanes in the southbound direction, and one circulating lane in the northbound direction. It serves as the main access to the Frenchs Forest Business Centre to the east on Rodborough Road. Northbound queues propagating back from the Warringah Road traffic signals and through the roundabout, block movements from the other approaches and causing localised congestion issues. This is exacerbated by the growth in traffic by 2036, particularly during the PM peak.

One of the proposed upgrades at this intersection is **Option 10.02**, which is an upgrade of the Allambie Road / Rodborough Road roundabout to allow two northbound circulating lanes. This allows greater northbound storage capacity, and also allows minor road traffic greater opportunities to enter the roundabout. Figure 8.9 shows the preferred intersection configuration.

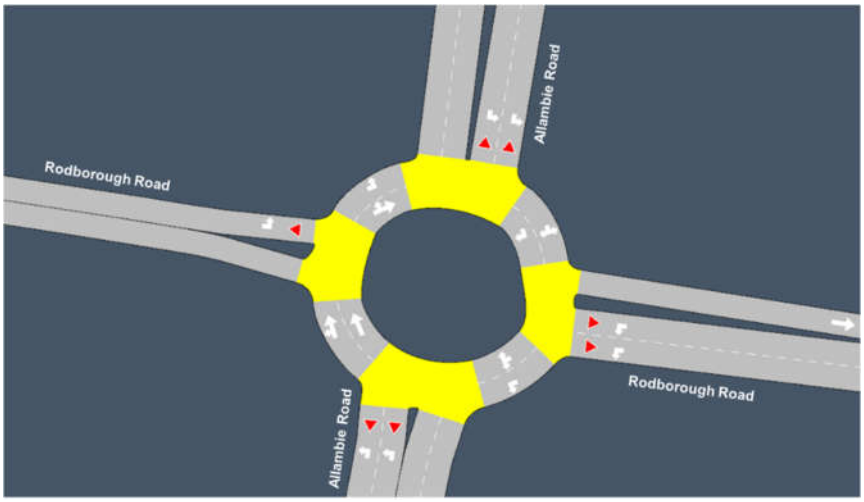


Figure 8.9: Allambie Road / Rodborough Road Upgrade Proposal

The tested configuration had the following effects on traffic:

- Minor improvements on the discharge of northbound traffic on Allambie Road through the roundabout
- Better distribution of vehicles between the through traffic and right-turning traffic lanes at the Warringah Road traffic signals and hence more efficient queue storage.

Intersection Signalisation Option

TfNSW has previously advised that it would not support signalising this intersection due to its proximity to the signals at Allambie Road / Warringah Road. However, there are significant traffic, cyclist, and pedestrian safety benefits with signalising this intersection and there are strong grounds to reconsider signalising this option. These include:

- Major developments such as the proposed Bunnings on the north-east corner of the intersection and the master planned development at 185-189 Allambie Road which will add traffic and pedestrians to the intersection
- The visual separation to the Allambie Road / Warringah Road signals and the extremely low probability of 'see through' effects being an issue at this location. In any case, the intersection separation is on the threshold of the 130m minimum spacing criteria usually used by TfNSW (see Figure 8.10).
- The operational benefits of controlling (via signal coordination and progression) the dissipation of platooned arrivals from the heavy Allambie Road / Warringah Road right turn which cannot be controlled under the roundabout configuration and introduces the risk of queues back to Warringah Road
- The operational benefits of 'metering' flows towards the Allambie Road / Warringah Road signals using the subject intersection and overall better management of queues which will otherwise block the roundabout at peak times
- The safety benefits of protecting pedestrian and cyclist crossing movements using the new signals.

Source: Google Streetview

Figure 8.10: Approaching Rodborough Road (Warringah Road signals in the background)

On the basis of the above, an option of signalising the intersection has also been prepared, as **Option 10.03.** The preliminary intersection layout is depicted in Figure 8.11.

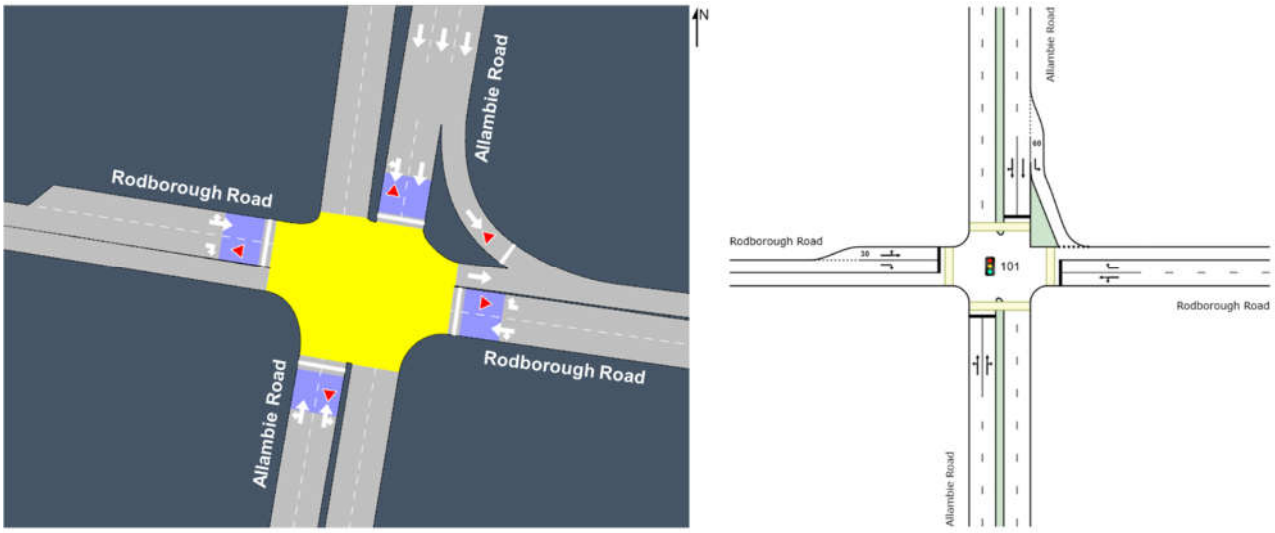


Figure 8.11: Allambie Road / Rodborough Road Traffic Signals – Concept Layout

The proposed layout for the Allambie Road / Rodborough Road traffic signals includes the following:

- Two lanes on each approach, with two through lanes permitted on Allambie Road approaches
- A short high-angle slip lane from Allambie Road (N) to Rodborough Road (E), around 60m long
- Signalised pedestrian crossings on all approaches.

The adopted signal phasing is shown below in Figure 8.12, with a preliminary cycle length of 80s.

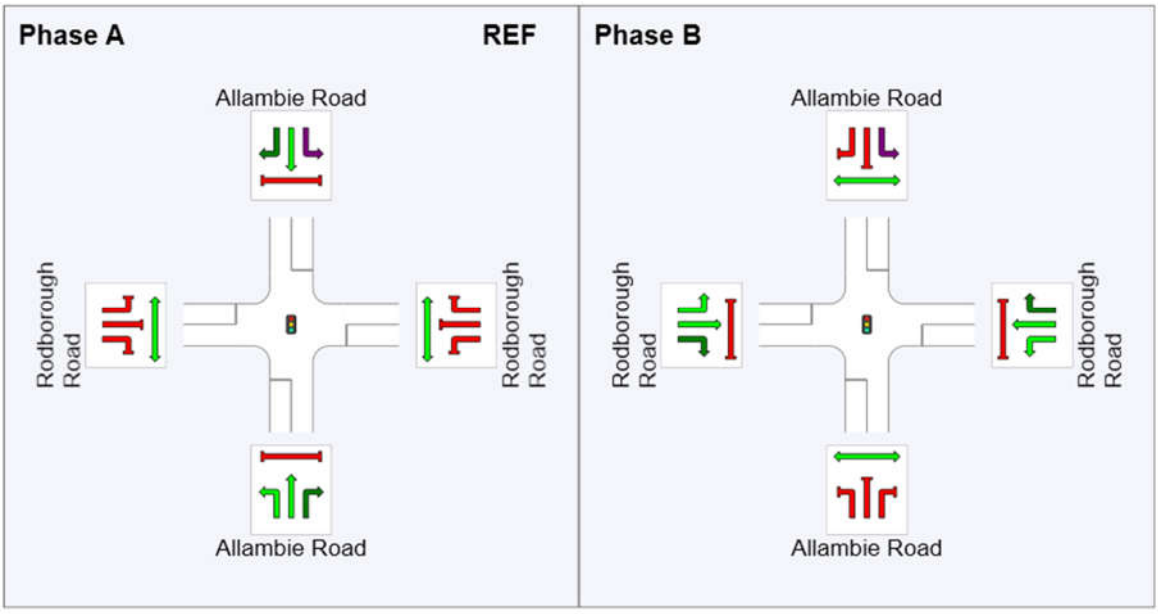


Figure 8.12: Allambie Road / Rodborough Road Traffic Signals – Phase Sequence

For modelling purposes, the traffic signals (Option 10.03) have been implemented in the modelling to demonstrate the projected effects on traffic flow near Allambie Road. The tested configuration had the following effects on traffic:

- Overall satisfactory performance of the traffic signals, with minimal queueing and delays
- Northbound queues rarely propagated back from Warringah Road through the new signals
- The ability to effectively coordinate the heavy right flows from Warringah Road (W) through the new signals so as to minimise the risk of queueing back from the new signals into Warringah Road.

8.3 Safety and Access Upgrades

8.3.1 Pittwater Road / Victor Road

Pittwater Road / Victor Road currently functions as a priority STOP-controlled intersection. Right turns into Pittwater Road can be made via a 25m right turn pocket however these movements are challenging at peak times across three lanes with some queued and some moving northbound traffic (including buses) in Pittwater Road. Right turns from Victor Road into Pittwater Road are prohibited.

The proposed upgrade at this intersection is signalising the intersection, allowing all movements, and providing pedestrian facilities. The length of the turning bay is subject to detailed design of the intersection but for the purposes of modelling the right turn bay was provided as 22m long to cater for the turning demand. This upgrade may require some minor realignment of the traffic lanes, which should be able to be accommodated within the existing road reserve due to the wide bus lane at this location. Figure 8.13 shows the preferred intersection configuration.

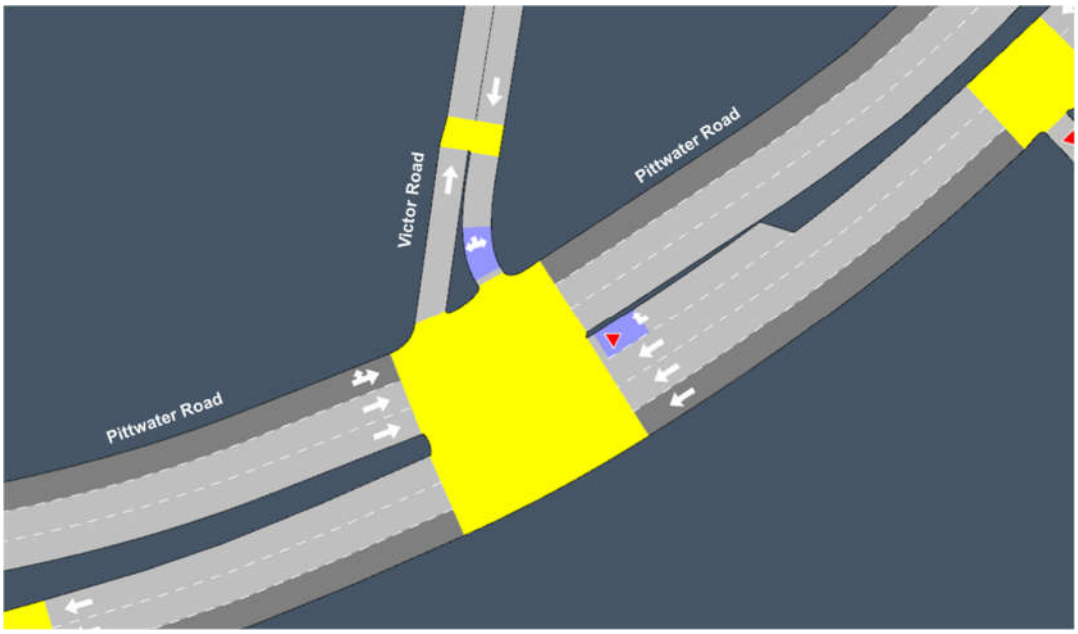


Figure 8.13: Pittwater Road / Victor Road Traffic Signals Intersection Layout

The phase sequence of the signals was modelled as shown in Figure 8.14, with a trailing right turn into Victor Road. The phase sequence is in line with similar T-intersections in Brookvale, but with no allowance of a filtered right turn into Victor Road due to safety concerns. Pedestrian protection effects were incorporated in the signal coding for the north and east approaches.

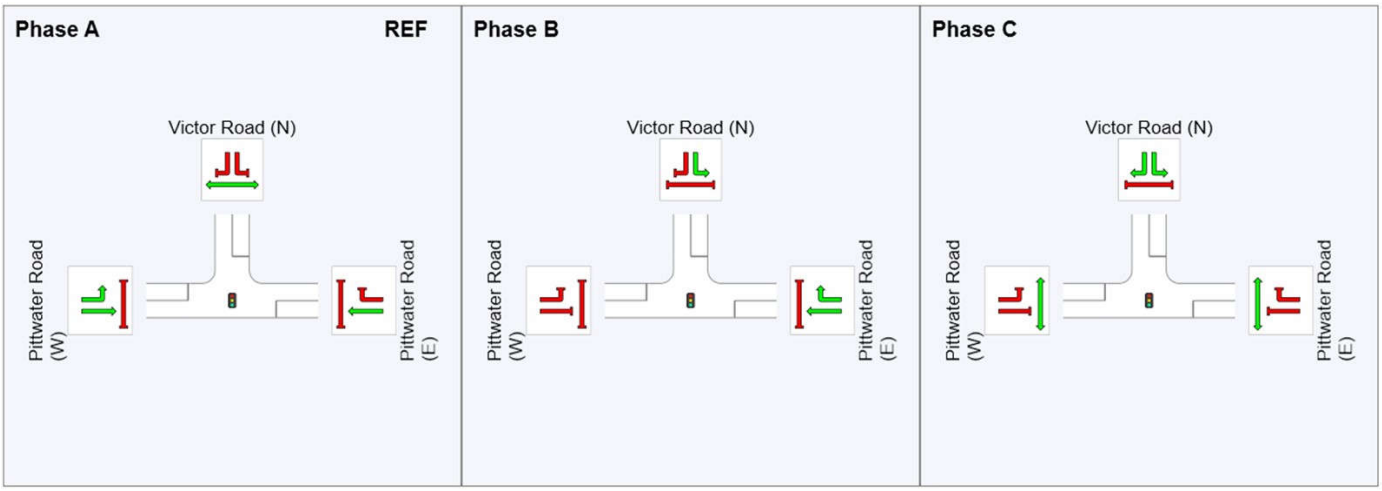


Figure 8.14: Pittwater Road / Victor Road - Signal Phasing

8.3.2 Mid-block Pedestrian Crossing between Victor Road and Federal Parade

There is an existing mid-block pedestrian crossing, situated on Pittwater Road between Victor Road and Federal Parade. The facility caters for pedestrian traffic crossing Pittwater Road and is heavily utilised at times due to pedestrian desire line between the Manly Leagues Club and bus stop on Pittwater Road. The proposed signalisation of the Victor Road intersection which is 100m south of the existing pedestrian signals includes pedestrian crossings on all approaches. The warrants for traffic signals in the Traffic Signal Design guidelines requires a minimum 130m spacing between mid-block pedestrian crossings and signalised intersections.

The removal of the mid-block pedestrian crossing is recommended as part of the Victor Road intersection signals if they are taken up. It is recognised that this will result in small offset of the pedestrian crossing facility from the existing pedestrian desire lines. This could be partially mitigated by:

- Relocation of the Pittwater Road bus stops around 75m south to be closer to Victor Road
- Installation of protective fencing to discourage crossing away from the signals.

The bus stop relocation has been included in the future year modelling.

8.3.3 Pittwater Road / Cross Street / Powells Road Extension

Pittwater Road / Cross Street currently functions as a four-way intersection, with the eastern approach being the access point for the Brookvale Bus Depot. At this location, Pittwater Road divides the main Brookvale strategic centre between the retail / commercial zone north of Warringah Mall and the Brookvale Industrial (redevelopment) zone east of Pittwater Road. Due to the density of premises on both sides of the arterial corridor, there is a high level of activity between the two areas. At present, this is constrained by the road network, which limits the routing of these trips via Orchard Road and Sydenham Road, resulting in heavy right turn traffic demands across Pittwater Road southbound as a consequence.

Council and TfNSW have previously contemplated the extension of Powells Road westwards through the bus depot and to its intersection with Cross Street and Pittwater Road. This link facilitates better connectivity between the two activity sectors, with beneficial effects on the accessibility and functionality of the centre as a whole. The new connection centralises traffic movements at the Pittwater Road / Cross Street / Powells Road intersection, reducing turning demands at nearby smaller intersections.

State Transit Authority (STA) has advised that the retainment of the Brookvale Bus Depot at the existing site and at a similar capacity is essential to maintain operations in the region. As the extension of Powells Road will bisect the depot site, there are challenges with how the site and its accesses will be integrated with the new road connection as well as the potential nett loss of some bus parking area. Some reconfigurations of the site layout will be necessary, with facilities on both sides of Powells Road connected via a four-way intersection with Powells Road. This is likely to result in loss of on-site bus parking availability.

A concept of how this might be configured is shown in Figure 8.15.

Figure 8.15: Powells Road Extension and Bus Depot Reconfiguration Concept

The design of this intersection is a key consideration in the connection of this new road link. Pittwater Road / Cross Street currently services heavy traffic volumes, primarily due to Cross Street providing access to sites such as Warringah Mall's car parking and the Brookvale ALDI. In future year traffic demand forecasts, these issues are exacerbated due to:

- Growth of Warringah Mall traffic and the redevelopment of the surrounding area as a commercial precinct
- The proposed right turn ban from Old Pittwater Road to Pittwater Road at TCS0731. Redirected vehicles are likely to 'trickle down' to Cross Street via Dale Street or Green Street to continue on Pittwater Road southbound
- Increased through movements on Pittwater Road.

The Pittwater Road / Cross Street intersection was shown to operate close to its capacity in the 2036 PM Do Minimum case, despite having only a very low volume of traffic on the eastern approach from the bus depot. To reduce vehicle delays and to cater for the additional right turn demands with the Powells Road extension, the lane markings on Cross Street were modified from two dedicated left turn lanes and a through-right lane to a dedicated left turn lane, a left-through-right lane, and a dedicated right turn lane, as shown in Figure 8.16. This arrangement better distributed queues across the three lanes, allowing for greater utilisation of the available storage capacity.

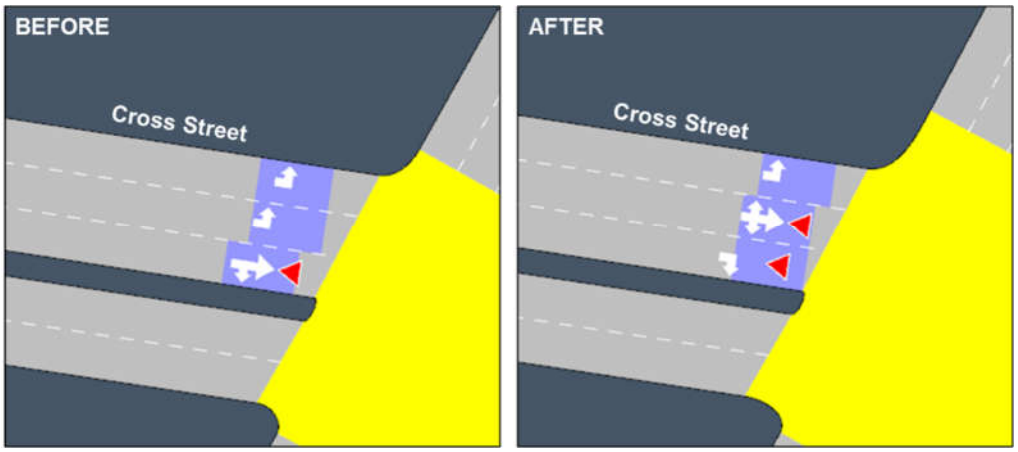


Figure 8.16: Cross Street – Proposed Change in Lane Allocations

The Powells Road connection was initially tested with a single approach and departure lane. Preliminary testing indicated that the new Powells Road would attract around 200 vehicles in each direction during peak hours and that a single approach lane was insufficient. The approach was widened to two lanes comprising of a short kerbside lane as through-left lane and a 'full length' through-right lane, as shown in Figure 8.17.

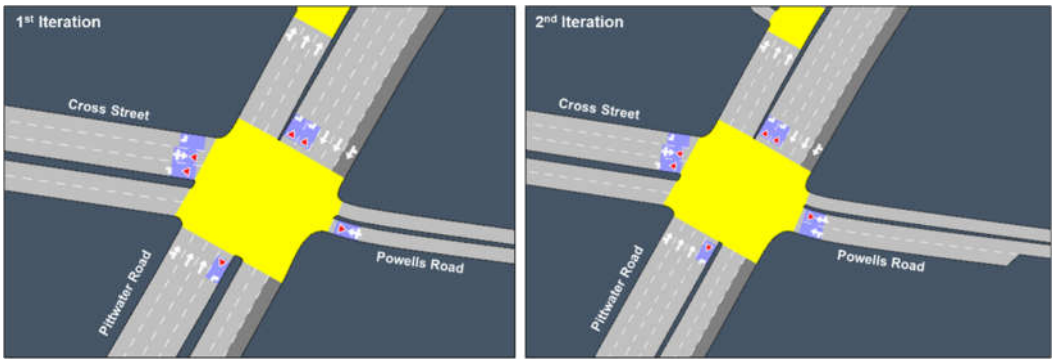


Figure 8.17: Proposed Powells Road Link – Approach Lanes

The existing single diamond overlap signal phasing at the intersection was initially retained. However, during simulation modelling, it was found that the increased flow through Powells Road had significant impacts on vehicles turning right from Cross Street onto Pittwater Road with excessive delays to filtering vehicles. This resulted in severe congestion along Cross Street and affected the ability of vehicles to depart from Warringah Mall.

The signal phasing was adjusted to separate Cross Street and Powells Road phases into independent signal phases, as shown below in Figure 8.18.

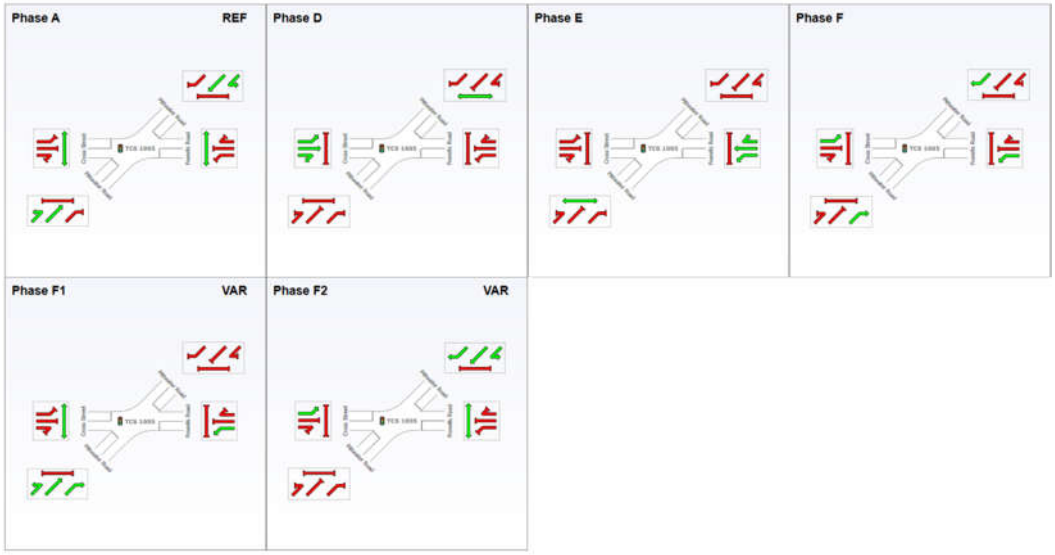


Figure 8.18: Proposed Powells Road Extension / Pittwater Road – Signal Phasing

Further testing then showed significant northbound delays during the AM peak period. The key issue was excessive queuing for the right-turn from Pittwater Road into the Powells Road extension, with vehicles queueing out of the existing turning bay and blocking through traffic caused by a shift of turning demand from the existing right-turn at Sydenham Road to the earlier turn at the new Powells Road extension. Different measures were tested to attempt to reduce the detrimental effects of this change in routing, including:

- Increased signal timing for the diamond right turn on Pittwater Road
- Extension of the right turn bay
- Additional right turning bay (for a total of two turning lanes).

These measures were found to not be suitable for the following reasons:

- Due to the heavy traffic flows on all approaches, any changes to signal timing resulted in adverse effects on the other approaches
- Due to the length of queues, the extension of the south to east right turn bay did not result in a notable improvement in queue-spillage impacts at this location
- An additional right turn bay from south to east improved the clearance of right turn queues and mitigated the congestion issues however it required the addition of a second departure lane on Powells Road, and road widening on Pittwater Road. These works would have substantial impacts and costs.

Given the above, the preferred option was determined to be a restriction of the right turn from Pittwater Road to the Powells Road extension during the AM peak hours (7:00 AM to 9:00 AM), with buses expected to allow access to the depot.

As a part of this scheme, a new signalised pedestrian crossing spanning the southern approach on Pittwater Road is proposed to increase crossing opportunities for pedestrians. The effects of pedestrian protection have been incorporated in the modelled signal coding.

Taking all the above into account, Figure 8.19 shows the preferred configuration.

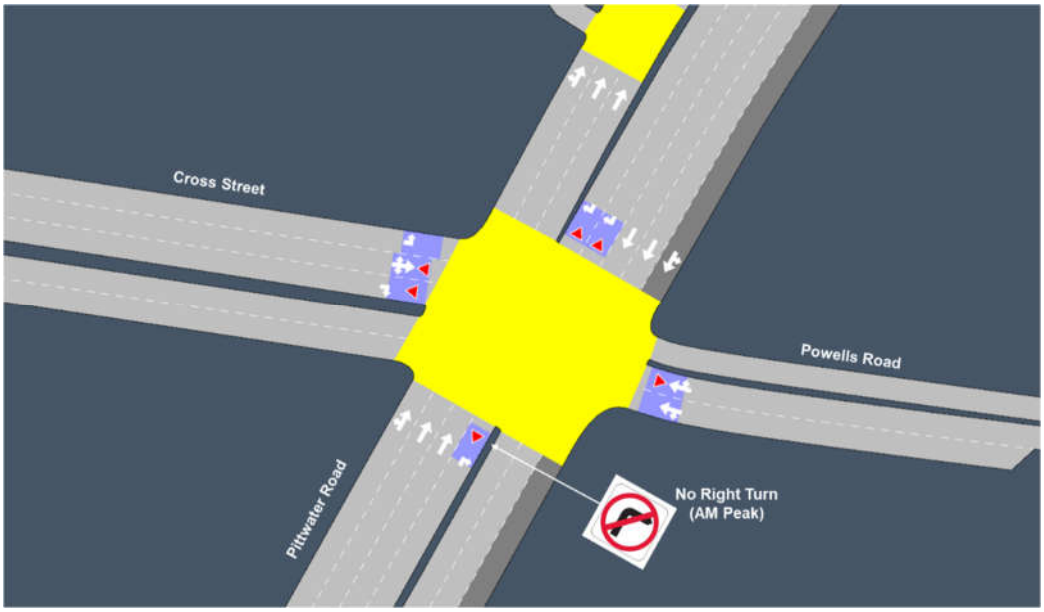


Figure 8.19: Cross Street / Pittwater Road / Powells Road Upgrade Proposal

The primary purpose of the link to Powells Road is to improve the local accessibility of traffic, pedestrians and cyclists travelling between the commercial district in the west and the industrial renewal precinct, in the east. The secondary role of this connection is to reduce the pressure on right turns across Pittwater Road at other locations.

An alternative arrangement for the Pittwater Road / Cross Street / Powells Road intersection was considered during the option testing phase, featuring double diamond overlap (DDO) signal phasing. With dedicated right turn phases, different lane allocations were necessary on Cross Street and Powells Road to prevent shared lanes from blocking right turn traffic. The tested arrangements were:

- Cross Street approach: through-left, right, right
- Powells Road approach: through-left, right.

The results from this testing demonstrated that the intersection would perform at a similar level to the preferred configuration, with comparable delays and LoS. However, there were significant increases to queue lengths on the Cross Street approach which had wider network implications such as making it more difficult for vehicles to leave Warringah Mall and long queues southbound on Dale Street. For these reasons, this option was not considered further.

The ultimate layout at this intersection will need to further consider the long-term needs of the bus depot site in consultation with TfNSW / STA.

8.3.4 Pittwater Road / Delmar Parade

Pittwater Road / Delmar Parade currently functions as a priority intersection with right turn access to and from Pittwater Road. There is an 80m northbound right turn pocket on Pittwater Road. High traffic flows along Pittwater Road, different lane speeds, queues at times, and poor sight distance due to larger vehicles influence traffic safety concerns at this intersection for the right turn movements out of Delmar Parade and right turns into Delmar Parade. These movements must cross multiple lanes of traffic and there is a history of right versus through vehicle crashes.

The upgrade of the Pittwater Road / Delmar Parade intersection to traffic signals is inhibited by its proximity to the Pittwater Road / Sturdee Parade traffic signals. TfNSW Network and Safety Section (NSS) has recently installed a part-time 'No Right Turn' restriction for turns from Pittwater Road into Delmar Parade during the weekday AM peak period between 6:00 AM and 10:00 AM.

For modelling purposes, this restriction was enforced in the model in AM peak hours (between 6:00 AM and 10:00 AM), with no other changes to the intersection.

8.3.5 Pittwater Road / Old Pittwater Road / Winbourne Road

TfNSW has advised that it is considering banning the right turn movement from Old Pittwater Road to Pittwater Road at the Pittwater Road / Old Pittwater Road / Winbourne Road traffic signals. This measure aims to mitigate the risk of right-through crashes due to the existing filter right turn movement. This measure has been supported by NBC and has been included in the future year models.

It is understood that further investigation and consultation will be undertaken by NBC for this restriction, particularly given that the redirected vehicles are expected to route through and impact local streets like Dale Street and Green Street.

8.3.6 Harbord Road (north of Headland Road)

Currently there is a short section of road with unrestricted kerbside parking on Harbord Road immediately north of Headland Road. Parked vehicles in this location cause a localised 'pinching' of traffic flow as southbound vehicles merge to form one lane. With future increases in peak period traffic plus a faster rate of arrival due or the nearby the grade-separated signals at Pittwater Road / Warringah Road, this southbound merge caused extensive queueing in the future year models.

Peak period kerbside parking restrictions have been recommended to be implemented along this section, as identified in Figure 8.20.

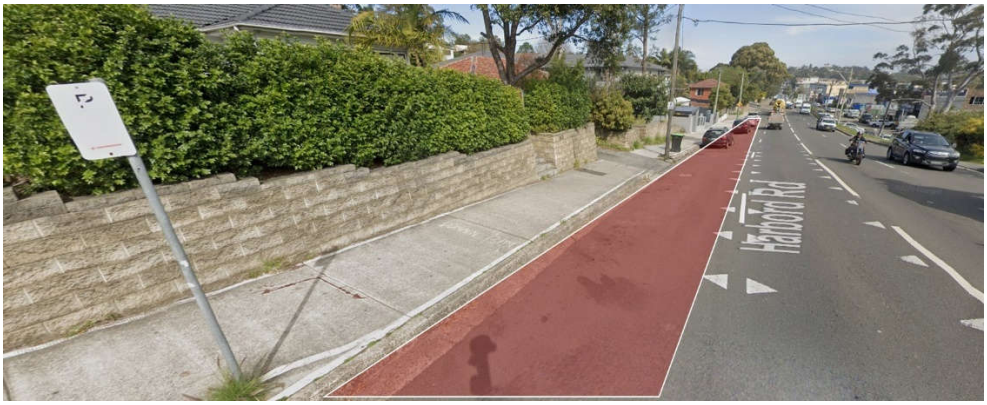


Figure 8.20: Harbord Road – Proposed Kerbside Parking Restrictions

When run through the models, this clearway alleviated the congestion effects at this location.

8.3.7 Pittwater Road Bus Lanes

The Pittwater Road corridor has sections of 'tidal' peak period bus lanes: southbound in the AM peak and northbound in the PM peak reverting to parking lanes outside of these periods. Some sections include 24-hour bus lanes.

With the evolution of the B-Line and increased patronage, a reasonable assumption taken into the future year modelling was that all bus lanes along both sides of Pittwater Road would be 24-hour bus lanes with no kerbside parking.

It is acknowledged that this would result in impacts to the parking supply along Pittwater Road, with potential effects on local businesses. A detailed investigation into parking supply and management strategies can be further considered as re-development occurs and the bus priority measures are implemented.

8.3.8 Dee Why Town Centre HPAA

The speed limit within parts of the Dee Why Town Centre have been reduced from 50km/h to 40km/h in the modelling to reflect the recently implemented High Pedestrian Activity Area (HPAA). The HPAA was not included in the 2019 Base Model. All future modelling scenarios included the 40km/h speed limit on the relevant road sections shown in Figure 8.21.

Figure 8.21: Dee Why Town Centre Section Speeds

8.3.9 Condamine Street Widening

Condamine Street south of Old Pittwater Road is the primary route into and out of Brookvale from / to the south.

During the modelling of 2026 traffic demand, an emerging pinch point at the Condamine Street / Kentwell Road traffic signals was identified during the PM peak. Northbound queues were observed to extend from this location southwards to the southern extent of the model resulting in a number of vehicles waiting to enter the modelled area at the end of the modelled period. This was expected to be untenable in 2036 given that it would result in queues extending back through to the Manly Vale town centre to the south.

Adjustments to signal timing were insufficient to alleviate this issue. Also, discussion with NBC revealed that there was no support for any measure that would impact the bus lanes.

The measure used to allow a release of this constrained traffic flow was the widening of Condamine Street to three northbound traffic lanes, plus retaining its northbound bus lane. The widening was implemented from the model boundary around 370m south of Kentwell Road to Pozieres Parade.

Through discussions with TfNSW, it is understood that such a widening is unlikely to be implemented in the future, given the implications on property. However, it has been included in the modelling to ensure that the forecast traffic demand can be released into the network in the PM peak.

This ensures that intersection upgrades assessed within the model area account for the 'potential' traffic demand irrespective of if the upstream supply is constrained or not. In doing so, the proposed strategy can be future-proofed against any future resolution of upstream traffic constraints.

This assumption could be revisited closer to the implementation of each specific upgrade project recommended as part of this study to identify if any reduction in the scale of the recommended upgrades is reasonable and considering any potential implications of further planning of the Beaches Link project.

8.3.10 Harbord Road / Brighton Street / Amourin Street

The Harbord Road / Brighton Street intersection is a priority STOP intersection. Harbord Road has a steep downhill gradient northbound and concerns have been raised at this intersection regarding road safety, particularly in light of limited sight distance when turning out of Brighton Street.

With the increase in Harbord Road traffic in the future significant delays to Brighton Street traffic were identified in the modelling, particularly during the AM peak period with queues extending outside of the model boundary.

These delays would also be a significant safety issue by encouraging shorter than normal gap acceptance by Brighton Street turning traffic.

Traffic signals have been proposed at the Harbord Road / Brighton Street intersection in the configuration shown in Figure 8.22. The design of this upgrade would need to specifically consider stopping sight distance influences on Harbord Road northbound and the need for warning signals on approach.

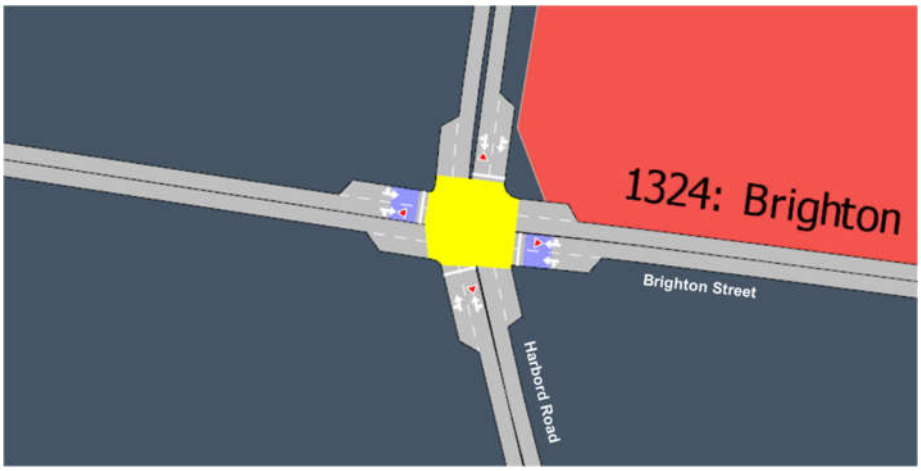


Figure 8.22: Brighton Street – Traffic Signals Layout

The warrants for traffic signals per the Traffic Signal Design Guidelines – Section 2 are outlined in Table 8.3.

Table 8.3: Traffic Signal Warrants – Brighton Street

Type of Warrant	Requirement	Time	Satisfies?
Traffic Demand	Major Road flow exceeds 600 veh/hr in each direction Minor Road flow exceeds 200 veh/hr in one direction	For four separate one-hour periods in an average day	No (Met for three separate one-hour periods in modelled hours)
Continuous Traffic	Major Road flow exceeds 900 veh/hr in each direction Minor Road flow exceeds 100 veh/hr in one direction Delays caused by speed on major road or limited sight distance No nearby traffic signal for minor road traffic	For four separate one-hour periods in an average day	No
Pedestrian Safety	Major Road flow exceeds 600 veh/hr in each direction Major Road pedestrian crossing flow exceeds 150 ped/hr	For four separate one-hour periods in an average day	No
Pedestrian Safety – high speed road	Major Road flow exceeds 450 veh/hr in each direction Major Road pedestrian crossing flow exceeds 150 ped/hr 85th percentile speed on Major Road exceeds 75km/h	For four separate one-hour periods in an average day	No
Crashes	Intersection has been the site of three or more reported tow-away or casualty traffic accidents over a three-year period, where the accidents could have been prevented by signals Traffic flows are at least 80% of the appropriate flow warrants	-	Yes Six crashes recorded between 2014 and 2017, of which half were associated with a right-turn crash code) (Flows meet at least 80% of the Traffic Demand warrant requirements).

The justification of this intersection is the exacerbation of an existing crash risk due to growth in through traffic in the future.

8.4 Brookvale Centre Future Planning

8.4.1 Existing Context

The Brookvale centre encompasses the area around Warringah Mall, including Cross Street to the north and the Brookvale B-Line bus stops to the south as shown in shown in Figure 8.23. The majority of the current pedestrian activity in the area is associated with the Westfield site.

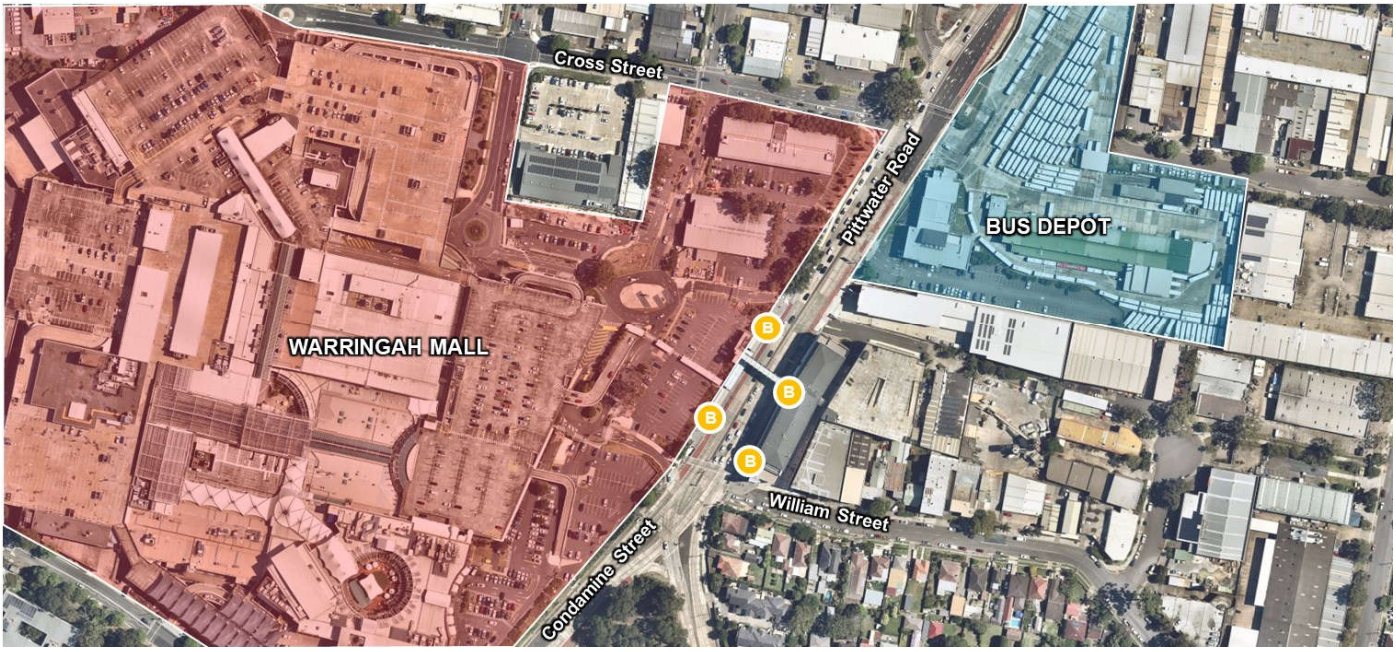


Figure 8.23: Existing Brookvale Centre

At the Pittwater Road / Condamine Street / William Street traffic signals, there is a signalised pedestrian crossing on the northern approach to the intersection, spanning Pittwater Road. This crossing previously functioned as an important pedestrian link between the commercial/retail sector to the west and the industrial sector to the east. Recently, the crossing has been gated to direct pedestrians to the newly installed pedestrian bridge near this location. It is understood that the at-grade pedestrian crossing only operates in the event of lift failure at the bridge.

8.4.2 Planning for a Future Urban Centre

The Movement and Place assessment presented in Section 4 identified the potential to establish a 'Place' for people in this area. As the B-Line usage increases over time and the Westfield site continues to develop, the density and diversity of pedestrian and vehicular movements at this location are expected to increase significantly.

Whilst the existing arrangement is functional given existing demands, there is the opportunity to revitalise the area. To achieve this, pedestrian activity needs to be drawn out of Warringah Mall and returned to the street and surrounds. One-way to achieve this is to integrate the Westfield development proposals with the heavily used B-Line bus stops. However, heavy through and turning traffic volumes in the area are a significant impediment to achieving this improved 'place' around the B-Line stops.

One means to achieve an improved place around the bus stops is a grade-separated integrated pedestrian plaza and bus interchange, separated from the flow of traffic on the Pittwater Road corridor. This concourse could be located both above-ground and below-ground. In this way, the bus lane approaches to the intersection can be repurposed and made more accessible for pedestrians. The major B-Line bus stops could be relocated into the new interchange, with increased capacity for both pedestrian and vehicle storage. The new bus hub could also be supported by ancillary pedestrian spaces, including opportunities for new retail shopping at the street level.

One potential concept of this arrangement is shown in Figure 8.24.

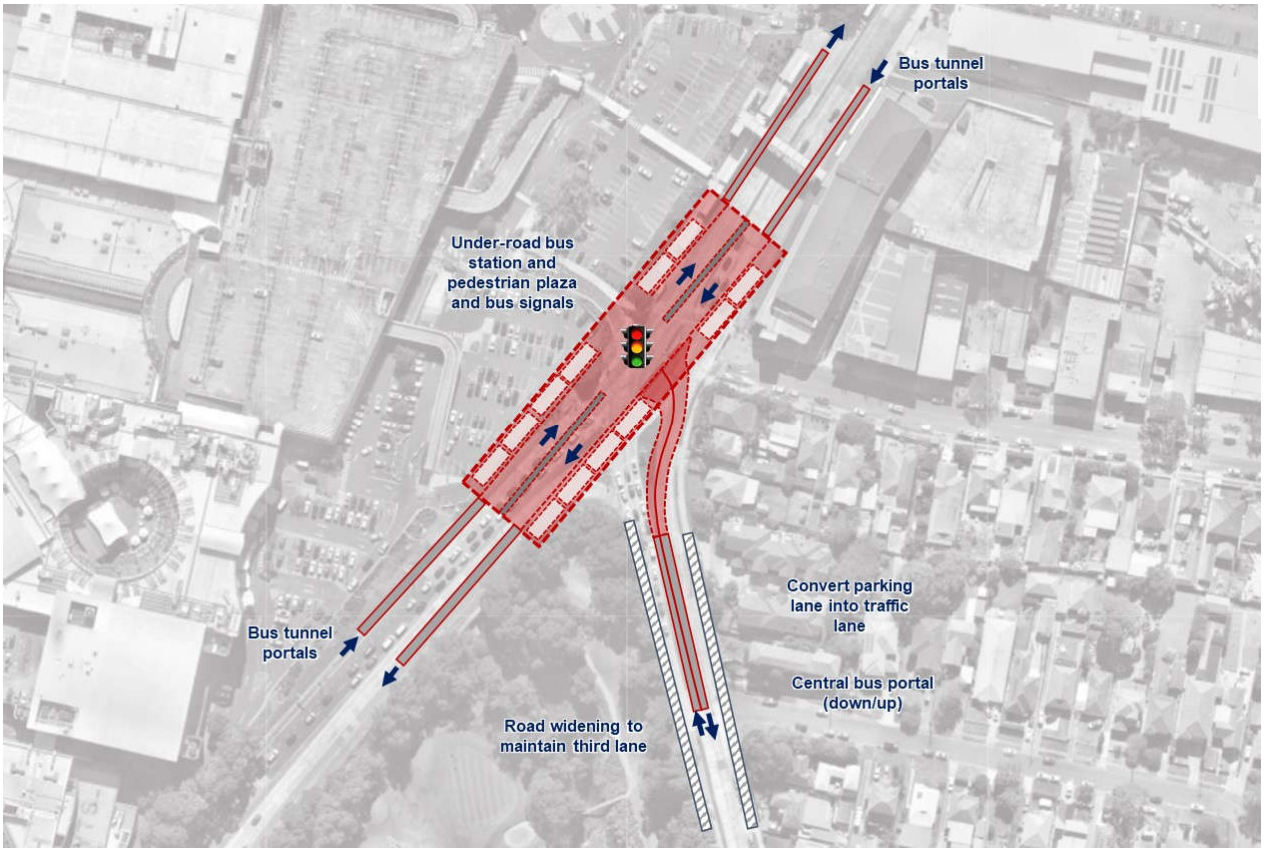


Figure 8.24: Separated Pedestrian/Bus Plaza Proposal Concept

The scheme has been modelled and has demonstrated minimal improvements to the overall capacity of the road network with its primary benefits and purpose being around improved pedestrian safety and accessibility and sense of place.

The project's expense, given the need for grade-separation, would have to be weighed up against the public realm improvements that would be gained and would be reliant on complementarity with the redevelopment plans being considered by Westfield. The concept could be considered in further discussions with the relevant stakeholders (Westfield, STA, TfNSW).

8.5 Travel Demand Management Considerations

A travel demand management strategy seeks to reduce the number of cars on the road network by shifting people to alternative modes of travel and encouraging trip linking and trip suppression where reasonable to do so (e.g. work from home).

Future medium to large scale development applications should be required to present Green Travel Plans (GTP) as part of development consent, encouraging developers to consider pedestrians, cyclists, and public transport access measures, including ongoing consultation and evaluation.

Given the trips originating or ending within the study only comprise a small proportion of the total trips within study area (i.e. the large majority of trips are passing through the study area), the impact of reducing travel demand within Dee Why and Brookvale will only have a minor impact on future traffic conditions. Modal shifts would have to occur along the entire Pittwater Road corridor north of the study area to result in a significant reduction of traffic through the study area.

8.6 Public Transport Improvements

8.6.1 Changes to the Public Transportation Network

The 2016 public transport mode share was 26% for commuters travelling from the study area and 13% for commuters travelling to the study area.

However, the bus network has undergone several changes since the Census in 2016. Most significantly, the B-Line service was introduced in November 2017, leading to increased capacity and reduced travel times between major Northern Beaches bus stops and the CBD. Free commuter car parks have also been constructed near B-Line bus stops. It is expected that the increased convenience of buses would have encouraged more people to use buses to travel to work since 2016.

Bus Opal Assignment Model statistics showed that buses routes running through the study area can experience moderate delays, but the delays generally originate from outside of the study area.

B-Line facilities have recently been upgraded in Brookvale and in Dee Why. Improvements include:

- Stop upgrades on Pittwater Road at Brookvale
- A new pedestrian bridge over Pittwater Road near the stops
- 250 bays of Park and Ride as part of the Community Health Centre in Brookvale with free parking using an Opal card
- A new inbound lane and bus stop in Dee Why
- 121 commuter parking bays as part of the Dee Why PCYC.

TfNSW announced in October 2020 a rationalisation of bus services within the Northern Beaches and Lower North Shore to create a new all-day frequent bus network. A number of select routes in the Northern Beaches are now operating at a 10-minute frequency every day of the week, including the new Route 160X between Dee Why and Chatswood and the modified Route 199 between Palm Beach and Manly. Local bus routes will also be changed to reduce route duplications and to encourage transfers to B-Line services.

8.6.2 Further Bus Infrastructure Initiatives

While the existing B-Line greatly increases public transport capacity on north-south, increasing demand for east-west bus movement is a key consideration of the future transport network in the Northern Beaches. T proposed 160X bus service between Dee Why and Chatswood will cater for some of this demand for east-west travel. Also, TfNSW if undertaking planning for a new B-Line 'B2' service between Dee Why and Chatswood. Early planning suggests that this service would likely operate primarily via Warringah Road.

To be competitive with private vehicles and as a rapid transit service, a new B-Line route would need to be supported by upgrades along the route such as dedicated bus lanes and high capacity stops.

Preliminary plans shows that bus lanes to be installed within the existing road reserve of Warringah Road. Warringah Road is currently a six-lane road, with three lanes in each direction. To the east of Beacon Hill Road, there is existing unrestricted parking in the kerbside lanes, frequently interspersed with bus zones. To the west of Beacon Hill Road, there are daytime clearways during both weekdays and weekends.

During the option modelling stage of the TMAP, east-west bus lanes along Warringah Road were tested by converting the existing kerbside travel / parking lane into a bus lane, as shown in Figure 8.25.

Figure 8.25: Bus Lanes along Warringah Road

The simulation runs found that:

- Traffic performance along Warringah Road was severely impacted, especially in the eastbound direction to the west of Beacon Hill Road. The reduction in intersection capacity for general traffic resulted in significant delays
- Key pinch points included the traffic signals at Warringah Road / Willandra Road and Warringah Road / Ellis Road / Government Road, with queues pushing back over 500m and into upstream intersections.

Initial testing of east-west bus lanes along Warringah Road with a 'hypothetical' widened road reserve showed that there could be savings of up to 60 seconds in travel time for buses in each direction across the 3.5km section of Warringah Road within the study area. This amounts to a reduction in travel time of around 10%.

The time saved by implementing these bus lanes will have to be weighed up against the additional cost for road widening. Additional bus priority measures could also be investigated to minimise the degree of widening that would be required, as part of optimising the design.

8.6.3 Further On-Demand Service Initiatives

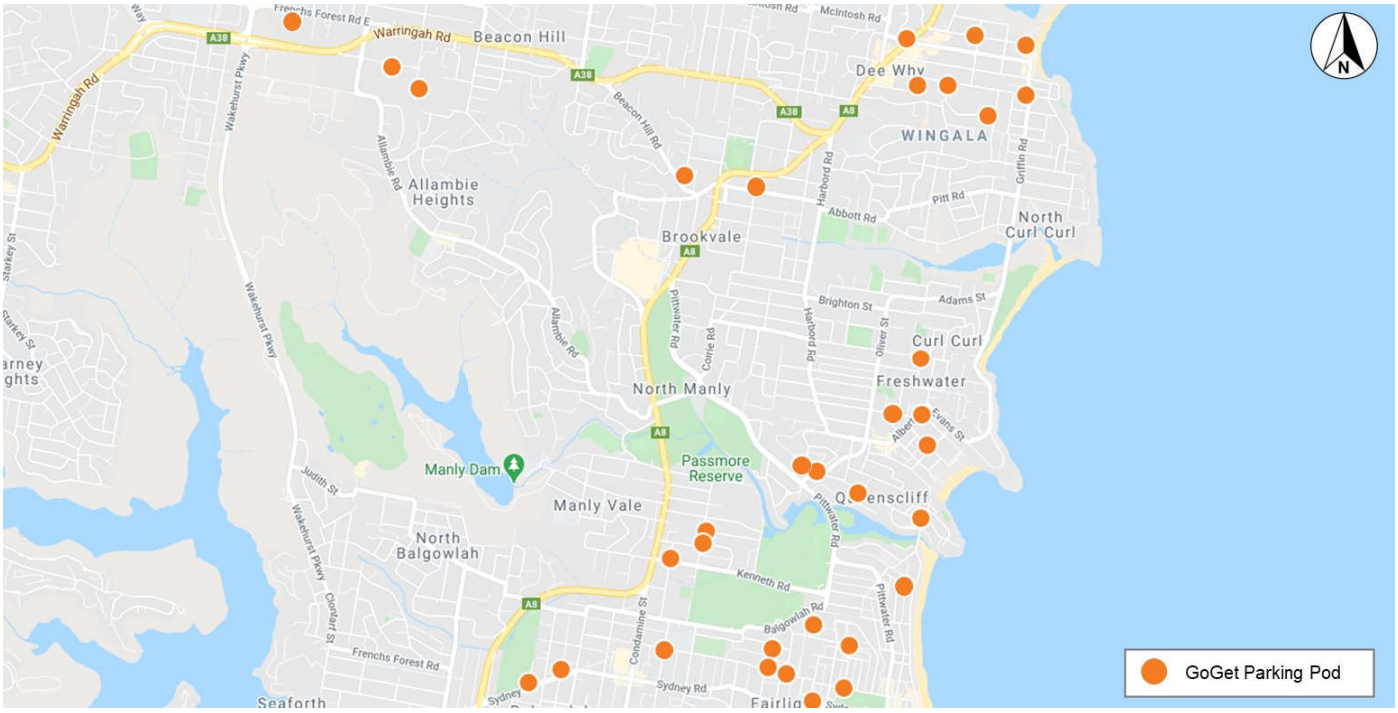
The existing on-demand Keoride service currently operates north of the study area, in the suburbs around Narrabeen, Warriewood and Mona Vale. There is an opportunity to expand the scope of these services (or provide new similar services) to cover the Dee Why and Brookvale areas as they redevelop. The intention would be to provide the growing local residential populations in these areas with on-demand connections to the major B-Line bus stops in each suburb.

The expected benefits of these initiatives would be reduced demand for Park and Ride as well as supporting a shift towards public transport more broadly.

8.6.4 Further Car Share Initiatives

A review of popular car share providers like GoGet revealed that while there are a number of carshare pods near Dee Why Beach and in the coastal areas of Freshwater, Queenscliff and Fairlight, there are limited vehicles parked across the study area, with a lack of these vehicles in Brookvale, as shown in Figure 8.26. As the Brookvale area redevelops with expected increases in population, the demand for car share facilities will increase, and should be encouraged through development initiatives.

For example, the integration of car share as a part of major new developments in the study area could encourage reduced car ownership when moving into the area.



Source: GoGet

Figure 8.26: GoGet Parking Pods in the Northern Beaches

8.7 Active Transport Improvements

8.7.1 Walking

The redevelopment of parts of Brookvale and the ongoing development in Dee Why are catalysts for increasing local trips by walking. The share of trips made by walking is intrinsically related to, and limited by, the mix and proximity of residents and activity generating uses.

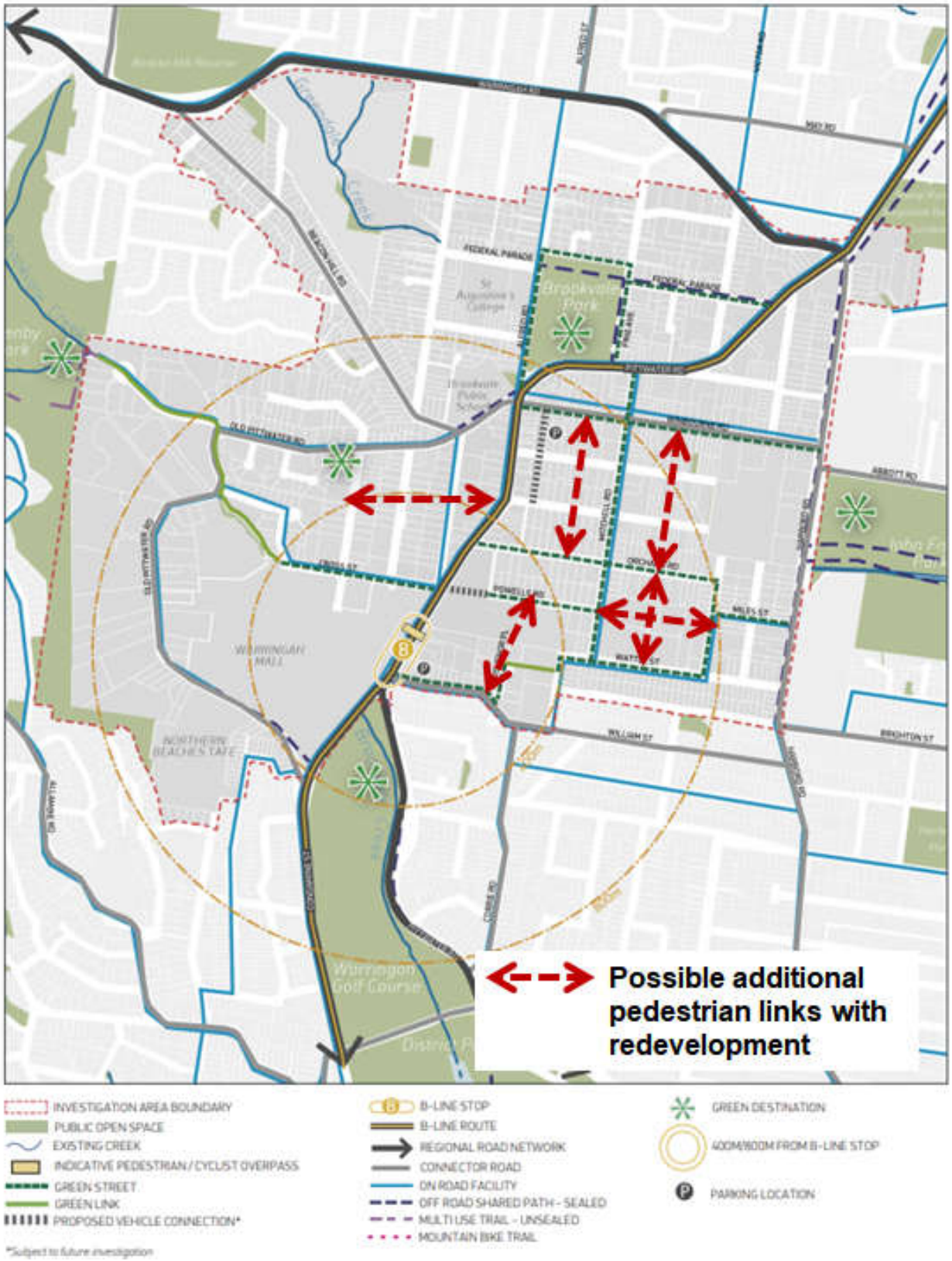
Northern Beaches Council has adopted the Northern Beaches Walking Plan in 2019, which identified the existing issues with the network and future goals for it, in consultation with the Community. The strategy proposed actions which addressed the issues and goals. The Northern Beaches Walking plan covers a range of topics, including the five key 'directions':

- Connecting the network
- Delivering the network
- Making walking safe
- Creating walking neighbourhoods
- Encourage walking.

The footpath networks surrounding Brookvale and Dee Why are well connected, with few missing links. Improvements to the footpath network should prioritise connecting residences, public transport stops and the town centres, as well as maintaining the safety of the existing network, particularly in redevelopment areas.

Recommended actions include:

- Reduction of speed limits in high pedestrian activity locations, pending a detailed speed review. While the main movement corridors should be preserved with respect to their regional significance, the implementation of new 40km/h HPAA on the side roads would create more walking-friendly environments. The recent Dee Why Town Centre HPAA is a good example of this. Potential locations for this would be around Warringah Mall and within the Brookvale redevelopment (industrial) precinct.
- Reduction of speed limits in residential areas, pending a detailed speed review. There are a number of 40km/h Local Traffic Areas (LTA) within the study area, including areas within North Manly and Beacon Hill. There is an opportunity to expand these areas, as well as create new ones such as within local streets around Brookvale Oval.
- Enhancement of footpaths and pedestrian amenity near transport hubs and nodes. The B-Line bus stops at Brookvale and Dee Why are prime examples, having been upgraded with wider footpaths and waiting areas. These types of upgrades should be considered for other bus stops along Pittwater Road. Improving / widening footpaths and waiting areas for stops along the B-Line supports its reinforcement as a modern, high quality public transport system adding to the entire customer experience. Other key bus stops in the study area, that are well-positioned to attract residential patronage with improved footpaths and waiting areas include those on Frenchs Forest Road East and along McIntosh Road.
- Much of the proposed network around Brookvale has limited permeability due to the large street blocks. A key strategy in the redevelopment of the area would be far greater pedestrian permeability through smaller block sizes and / or pedestrian linkages through sites. Figure 8.27 shows potential locations in Brookvale where pedestrian linkages could be considered as part of redevelopment
- Similar to Brookvale, the Dee Why area, particularly east of Pittwater Road includes long blocks with limited pedestrian connections. With redevelopment opportunities less likely further east of Pittwater Road, new north-south pedestrian links would be less likely to achieve with redevelopment.



Base Map Source: Brookvale Structure Plan (2017)

Figure 8.27: Possible new Pedestrian Links with Redevelopment in Brookvale

8.7.2 Cycling

The Northern Beaches Bike Plan (Bike Plan) sets out a number of directions and actions which aim to encourage the community to choose cycling as a transport option. The directions include:

- Expanding, improving, and maintaining the safe cycling network
- Improving and maintaining the road cycling network
- Providing and maintaining end-of-trip facilities
- Promoting and encouraging cycling.

The Bike Plan notes that community engagement revealed that one of the biggest obstacles to cycling was the perceived lack of safe and connected cycle paths, with the vast majority of the cycling-able population falling into an 'interested but concerned' category.

Several cycling routes currently run through the study area, but the routes are poorly connected with many missing links. To encourage increased bicycle usage, bicycle network upgrades should aim to connect the main residential areas around Dee Why to employment areas in Brookvale and Frenchs Forest. Options should be provided for both on-road and off-road cycle paths to cater for all levels of experience and confidence.

An analysis of 2016 JTW data shows that cycling contributes to only a very low percentage of the short-length commuter trips within the study area. The percentage of cycling trips to the Brookvale - Freshwater area for work from a selection of origins to the north and west is shown in Figure 8.28.

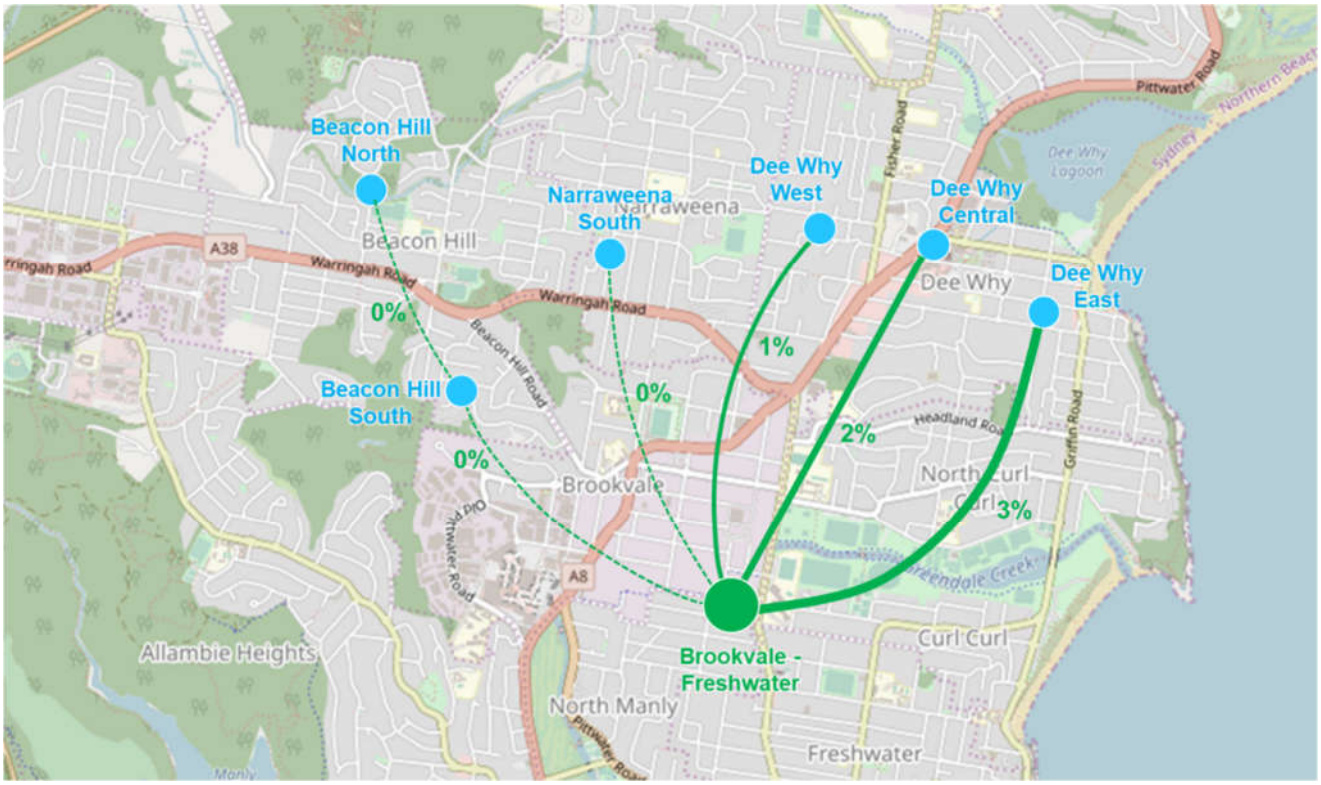
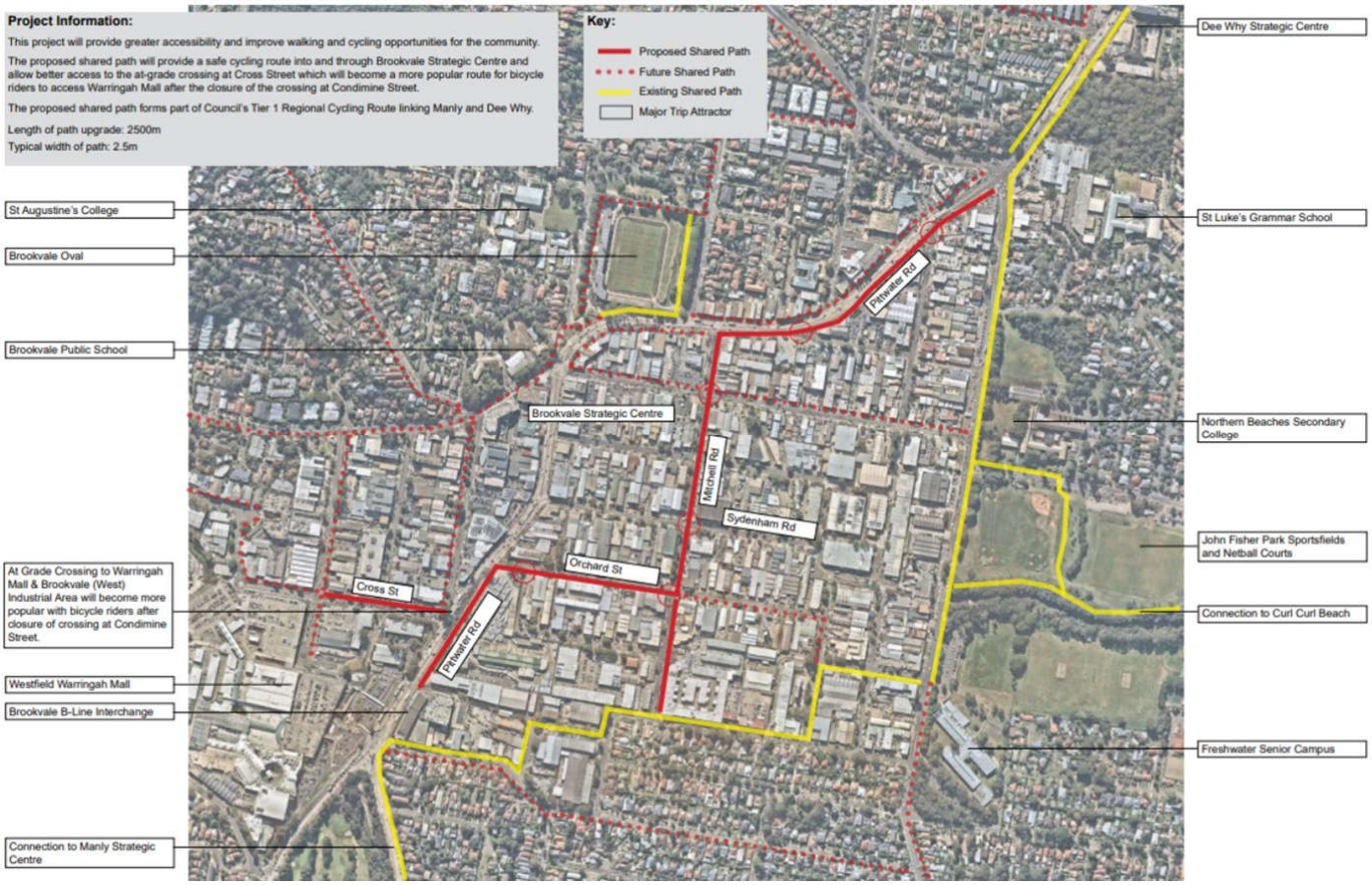


Figure 8.28: Short Length Trips – Sample of Cycling JTW Modal Share

As redevelopment occurs in Brookvale, opportunities to introduce off road shared path links, possibly aligned with proposed new links shown in Figure 8.27 should be explored. In Dee Why the focus should be on widening existing paths were possible to provide for shared paths, particularly on east-west routes.

It is understood that NBC has recently completed community consultation for a proposed extension of the Shared Path network between Brookvale and Dee Why. The backbone of the network is a new Shared Path on the east side of Pittwater Road starting south of Warringah Road, which continues to Cross Street via Mitchell Road and Orchard Road. Reconfiguration of Mitchell Road and its intersections as the area redevelops could be used to better facilitate the safety of this path.

The Brookvale Shared Path Proposal is shown in Figure 8.29.



Source: Proposed Path Upgrade Brookvale to Dee Why (Northern Beaches Council)

Figure 8.29: Northern Beaches Council - Brookvale Shared Path Proposal

It is also noted that further Shared Paths are considered for future implementation, including along Beacon Hill Road. Given the low cycling utilisation from the north-west region of the study area, a connection between this region and the main Brookvale commercial / industrial redevelopment area is important to encouraging new cycling activity. It is acknowledged that there are significant topographical constraints. To address this, other innovative solutions may need to be considered, such as an alternative dedicated off-road cycling route across Brookvale Creek through Allenby Park, or facilitating the increased uptake of electronic bicycles (e-bikes).

Recommended actions include:

- Improvement of local and district-wide cycling connectivity between the main activity centres. The Brookvale Shared Path Proposal is a good start and provides a valuable connection. The next consideration should be for the nearby north-west regions of Beacon Hill and Narraweena. Any proposed facility should be safe and comfortable for cyclists, and preferably separated from traffic. Adverse grades could potentially be bypassed via a new 'scenic' off-road bicycle facility through Allenby Park
- Provision of convenient and secure end of trip facilities at B-Line and any key bus stops. Aligned with the strategy for increasing walking, the enhancement of key bus stops around the network can encourage a local boost to cycling activity for bus access
- Provision of shared crossing facilities at traffic signals along major bicycle routes. This is particularly relevant in areas where there are closely spaced intersections, such as Dee Why Town Centre, which would otherwise be very disruptive to cyclists.

8.8 Parking Strategy

8.8.1 On-Street Parking

In Dee Why, with the extension of clearways proposed as part of B-Line upgrades, the shift in parking demand from Pittwater Road could have significant effects in Dee Why's side streets and require a review of timed parking restrictions in those streets. This may require the existing 2P restrictions on side streets off Pittwater Road to be extended deeper into the residential areas which have not been redeveloped.

In Brookvale, on-street parking management approaches will need to dynamically respond to the make-up of each development area and the nature of the uses. For example, residential developments may need 'spare' on-street parking primarily outside of business hours, while retail and commercial uses may result in heavily occupied areas, conflicting with residual light industrial uses which are synonymous with heavily relying on the supply of on-street parking. The transition of Brookvale's industrial area into mixed use areas will need to be carefully monitored, particularly when construction zones exacerbate expected conflicts.

8.8.2 Off Street Parking

The B-Line provides an opportunity to reduce off street parking rates for residential development closer to it (e.g. within 400m of a B-Line stop), but this would need to be carefully balanced with the local on-street parking timing policy. Retail, commercial and industrial uses are less likely to have the modal shares influenced by the B-Line and sufficient off street parking in line with the DCP's should be considered for these uses, unless the density of surrounding residential development suggest reliance on a significant 'walk-up' catchment to these retail and commercial uses.

The existing parking supply along Pittwater Road between Condamine Street and South Creek Road is shown in Figure 8.30. The removal of these parking spaces as part of further B-Line implementation is likely to result in a shift in this parking demand onto side streets which is a key consideration as redevelopment of the proposed Town Centre evolves.

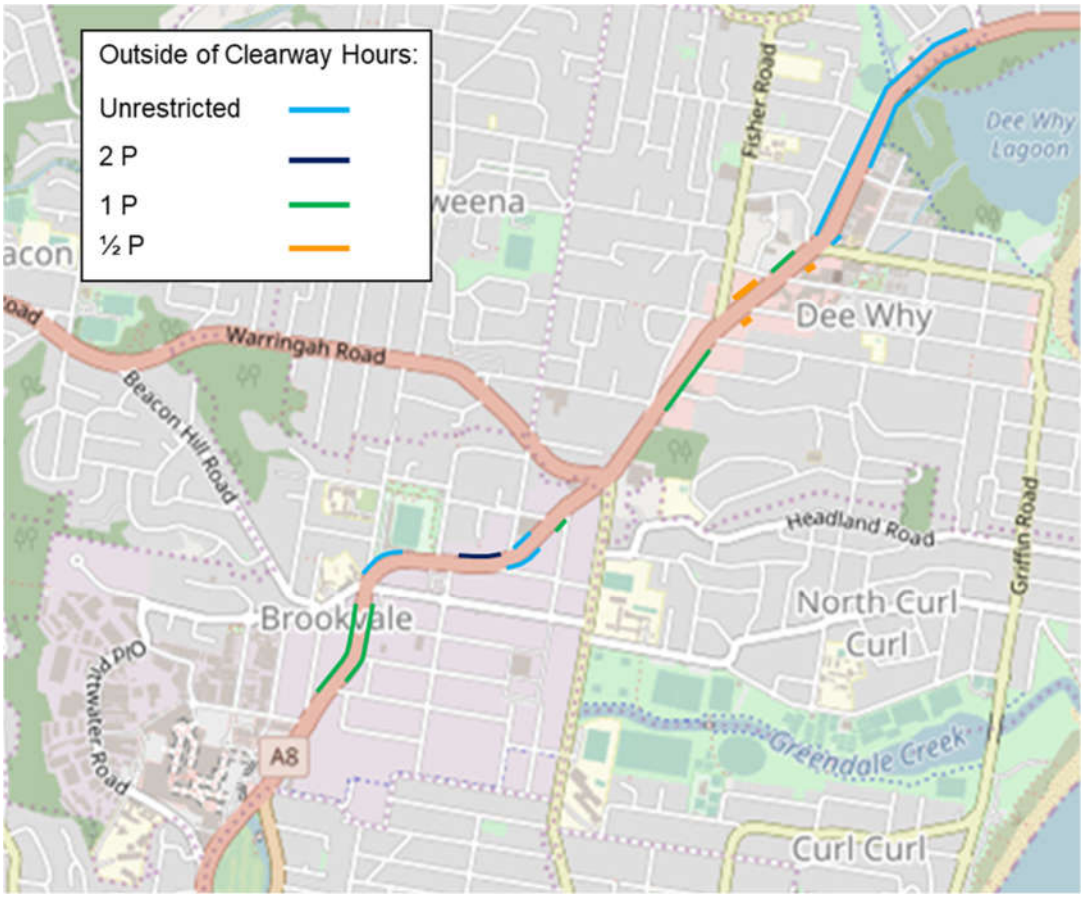


Figure 8.30: Pittwater Road On-Street Parking

8.8.3 Park and Ride Facilities

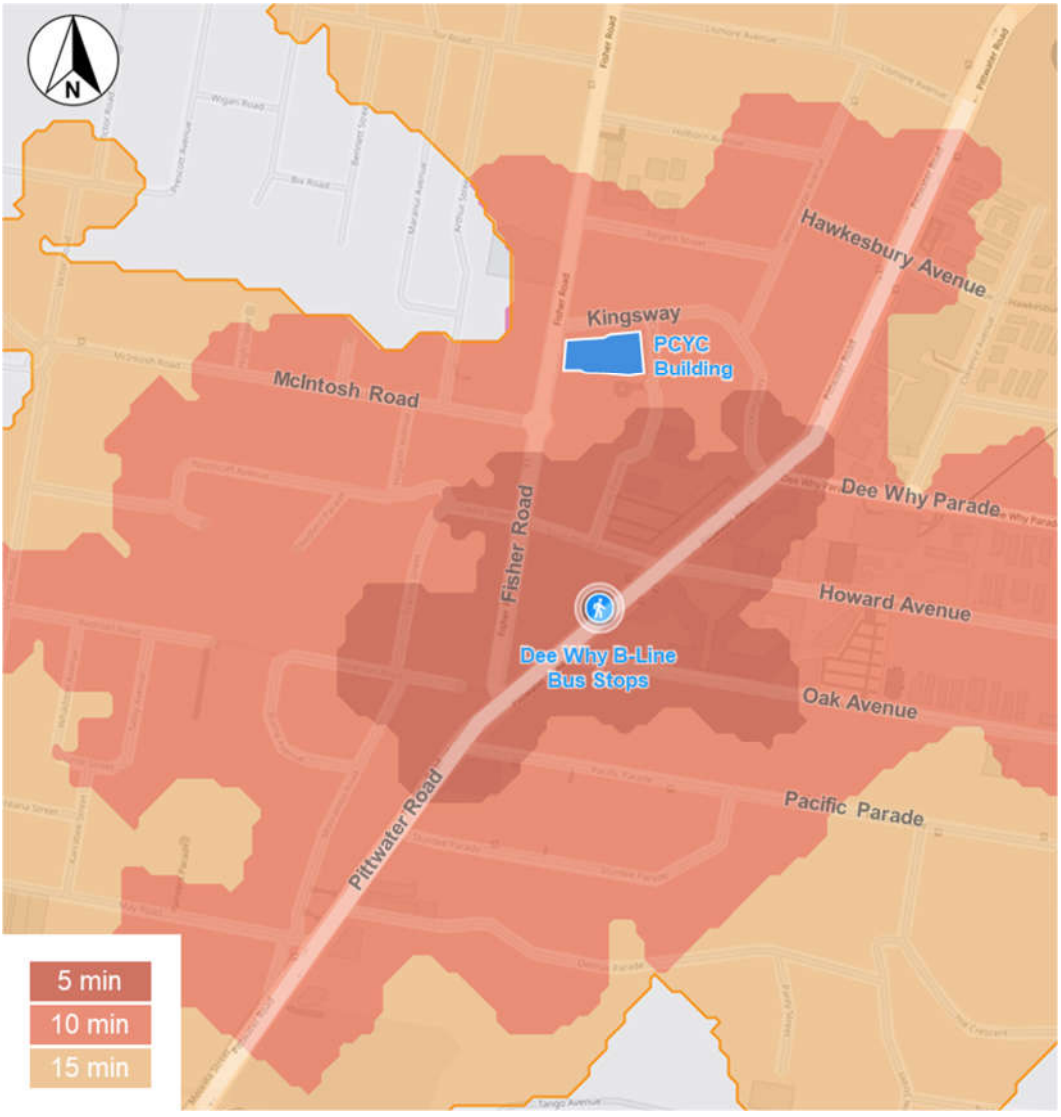
There are a total of six (6) public car parks designated for commuter use by TfNSW within the Northern Beaches; ancillary to the B-Line bus stops. Of these, two (2) are located within the study area at:

- Brookvale, on the corner of Pittwater Road and William Street opposite Warringah Mall
- Dee Why, on Level 3 of the PCYC Building on the corner of Kingsway and Civic Parade.

Both of these facilities include around 200 – 250 car parking spaces for commuters and offer free parking if the trip is linked onto an Opal card service.

These facilities currently operate at or near capacity, with some resulting overflow onto the surrounding residential streets. As bus patronage continues to grow, particularly if a new high-capacity B-Line service begins operation, then additional commuter parking capacity is likely to be required to maximise the potential usage of the new services.

Figure 8.31 shows the 5-min, 10-min and 15-min walking catchments from the Dee Why B-Line bus stops.

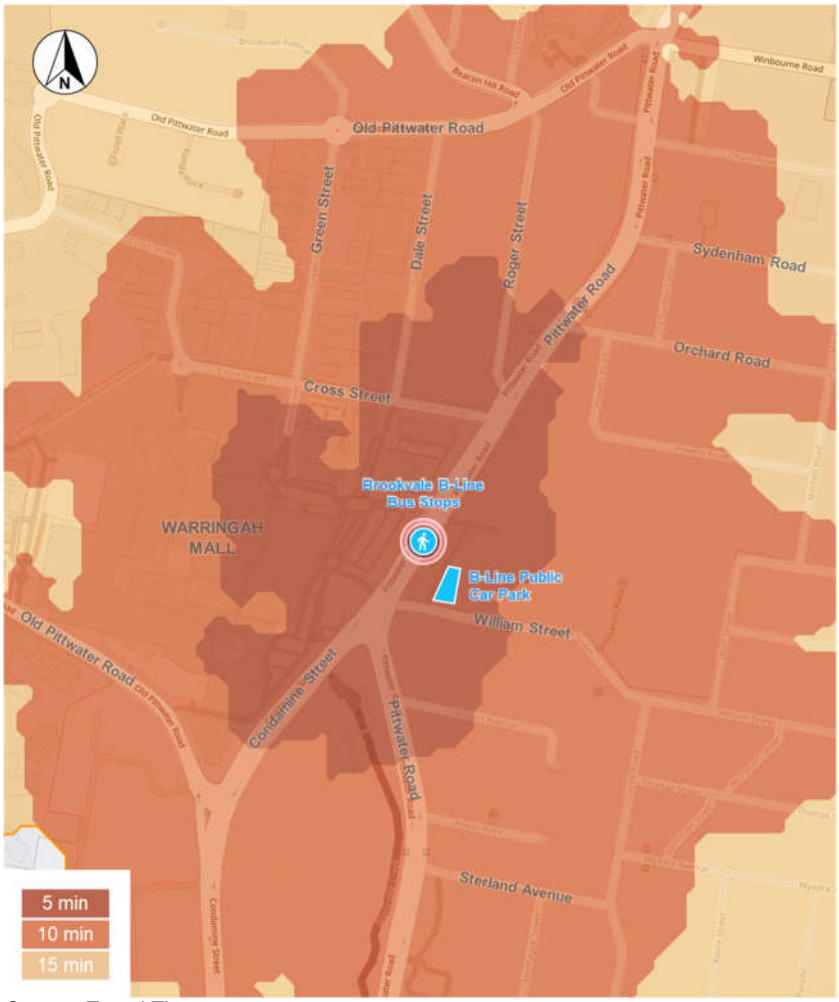


Source: Travel Time

Figure 8.31: Dee Why – Walking Catchments from B-Line Bus Stops

It is noted that the existing parking facility located in the PCYC building on the Kingsway is located outside of the area within a 5-minute walking distance. Ideally, any new Park and Ride facilities should be within the 5-minute catchment, with potential opportunities on streets like St David Avenue, Fisher Road or Oaks Avenue.

Figure 8.32 shows the 5-min, 10-min and 15-min walking catchments from the Brookvale B-Line bus stops



Source: Travel Time

Figure 8.32: Brookvale – Walking Catchments from B-Line Bus Stops

The existing commuter car park on William Street is located within the 5-minute walking catchment and has direct pedestrian connections to its associated B-Line stops. Adding parking to this site (if possible) would be an ideal future strategy for increasing Park and Ride capacity. Alternatively, additional capacity could be considered at nearby locations such as on Cross Street, Dale Street or as a part of the Warringah Mall area.

It is noted that initiatives that encourage other modes of travel such as active transport improvements or expanded on-demand services may mitigate some of the needs and impacts of growth in Park and Ride demand.

8.8.4 Parking Strategy Actions

A selection of the recommended actions to address parking issues across the study area include:

- Adoption of lower parking rates than the LGA-wide rates for residential development within 400m of B-Line bus stops. This can be achieved via site specific or town centre DCPs
- Implementation or extension of timed parking restrictions on side streets near the B-Line bus stops
- Provision of new commuter car parking areas. Both the major B-Line stops within the study area now have a commuter car park, but these facilities fill quickly, and there will be increased demand pressure when the B-Line is further upgraded. Additional or expanded sites may need to be considered, preferably located within a 5-minute walk from the central bus hub
- Provision of dedicated car share parking and drop-off areas in areas which have recently been redeveloped (e.g. in Dee Why) or as redevelopment occurs (e.g. in Brookvale). This could also be incorporated into the new commuter car parks as they are developed.

9. UPGRADE STAGING CONSIDERATIONS

9.1 Process for Determining Staging Needs

The suite of preferred strategies and upgrades were initially determined based on year 2036 demands.

To determine the extent of upgrades required by 2026, the suite of upgrades was progressively 'stripped back' in the AIMSUN model under close observation, to ensure that the observed network pinch points did not re-emerge.

A number of the upgrades described in Section 8.3 were implemented for traffic safety reasons or as improvements to local network accessibility. These upgrades were retained in the 2026 upgrades suite, as their need was identified as being 'short term' and are not subject to road capacity and performance.

Capacity-related upgrades described in Section 8.2 were iteratively removed from the network, starting from the most minor upgrades until it was able to be determined what capacity-based upgrades were needed by 2026 and what upgrades were needed between 2026 and 2036.

9.2 Outcomes

The capacity-based upgrades which were determined as necessary by 2026 were:

- **Option 1.01:** Pittwater Road / Warringah Road / Harbord Road interchange
- **Option 4.01:** Willandra Road upgrades
- **Option 7.03:** New short left turn lane on Harbord Road northbound north of Abbott Road
- **Option 9.01:** Beacon Hill Road / Warringah Road intersection upgrade.

The upgrades required by 2026 are shown in Figure 9.1.

The upgrades which were found to be 'removable' from the 2026 network without significant consequence to the network traffic operations are listed as follows. That is, the 2026 and 2036 upgrades required between 2026 and 2036 were identified as:

- **Option 3.01:** Extension of the right turn bay from Warringah Road to Allambie Road
- **Option 5.02:** Cornish Avenue lane adjustments
- **Option 7.01**: Extended parking restrictions on the southern side of Abbott Road
- **Option 10.03**: Allambie Road / Rodborough Road traffic signals
- Peak period parking restrictions along the eastern side of Harbord Road
- Peak period parking restrictions on both sides of Pittwater Road
- Traffic signals at Harbord Road / Brighton Street.

NBC also identified the need to nominate specific years to each action / upgrade. This has been estimated in the recommended action plan in Section 10.2. It should be noted that these estimates are based on model observations only and the interactions between development levels and upgrade needs is complex. That is, it is difficult to nominate precise years for implementation when the specific location, scale and type of each development is not able to be disaggregated with any certainty.

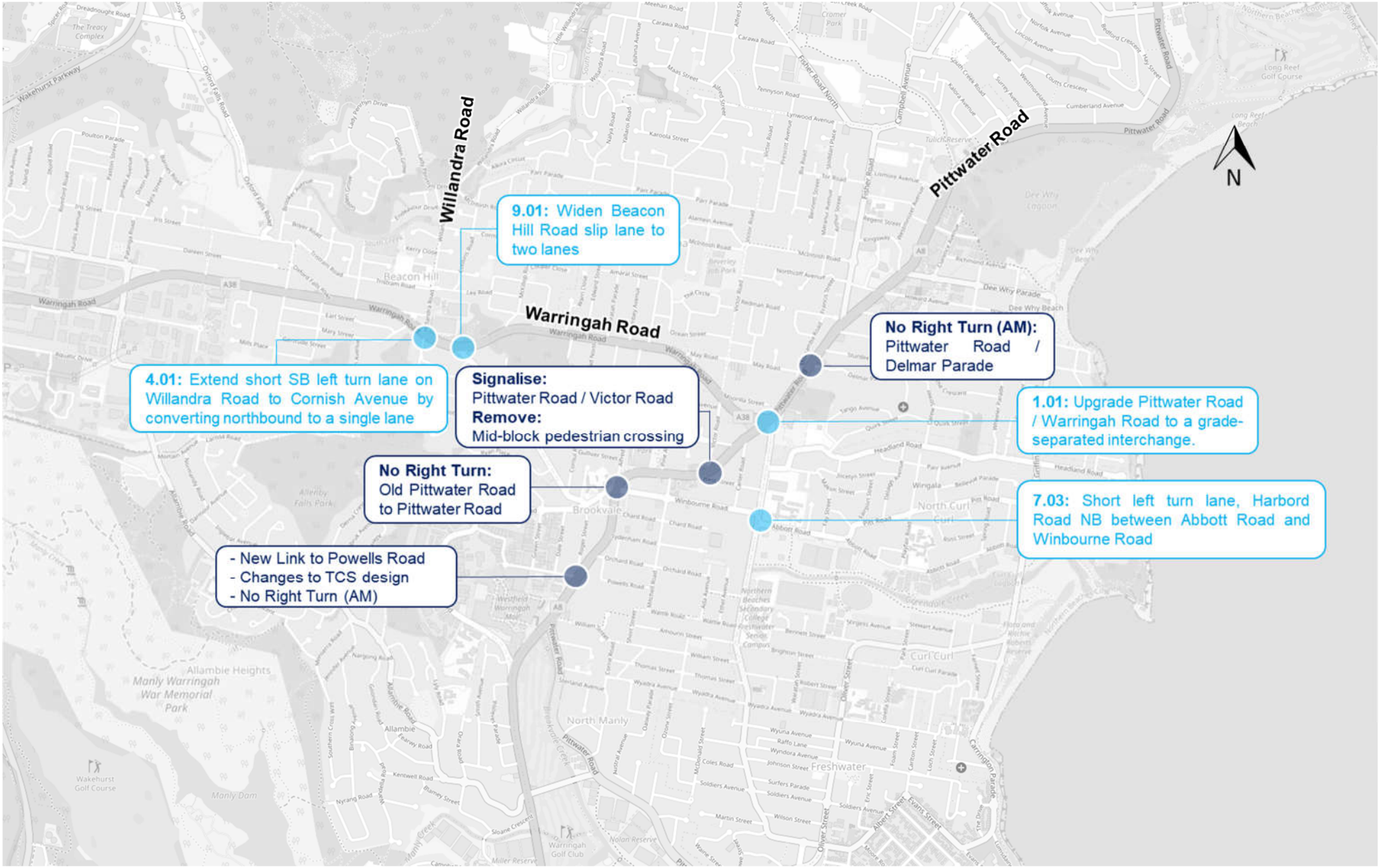


Figure 9.1: **Network Capacity Upgrades Required by 2026**

9.3 Capacity Sensitivity Testing

9.3.1 Overview

NBC is progressing the Brookvale Structure Plan, which guides the "*strategic land use planning framework for Brookvale for the next 20 years*". As a part of the plan, the dwelling and employment targets will be defined as an outcome of the traffic network capacity determined by this TMAP.

NBC requested network capacity testing based on the suite of upgrades nominated in this TMAP by 2026 and 2036, with the exception of two projects which may be challenging to implement, namely:

- Pittwater Road / Warringah Road / Harbord Road Interchange
- Powells Road Extension.

These projects have been excluded as there is uncertainty as to the realisation and timing of both of these upgrades. The Pittwater Road / Warringah Road / Harbord Road Interchange in particular is the most significant upgrade project within the study area and the performance of this existing intersection is a key determinant of the performance of the entire study area network and a key consideration for setting dwelling and employment limits for the Brookvale Structure Plan. However, due to the significance of these projects and their impact to State-level infrastructure, they are dependent on other stakeholders and cannot be ratified by Council alone.

Removing these upgrades was expected to significantly reduce the capacity of the entire study area network and hence the population and employment growth capacity of the Brookvale Structure Plan area.

9.3.2 2026 and 2036 Demographic Projections

As described in Section 6, an initial capacity assessment was undertaken using strategic model forecasts and SIDRA intersection analysis to determine the population and employment scenarios to use for detailed modelling. The purpose of the detailed modelling in AIMSUN was to establish the suite of network upgrades which accommodated the input levels of population and employment growth across the entire study area by 2026 and by 2036, as shown in Table 6.2.

The Brookvale Structure Plan Area generally includes the Warringah Mall, Brookvale Oval and the industrial precinct. The Travel Zones (TZ) in the TfNSW strategic transport models that cover this area are highlighted in Figure 9.2. These are:

- TZ 2105: The residential catchment west of Beacon Hill Road
- TZ 2143: The mixed-use catchment around Brookvale Oval
- TZ 2144: The industrial precinct between Pittwater Road and Harbord Road
- TZ 2145: The commercial precinct around Warringah Mall.

Table 9.1 shows the specific population and employment growth forecasts for each of these TZs.

Table 9.1: Brookvale Structure Plan Input Population and Employment Growth Forecasts

Travel Zone	Population Growth by 2026	Employment Growth by 2026	Population Growth by 2036	Employment Growth by 2036
2105	5	0	13	0
2143	147	70	420	200
2144	772	158	2205	450
2145	956	718	2730	2050
2148	*441*	*0*	*1260*	*0*
2155	*221*	*0*	*630*	*0*
TOTAL Modelled	**+2,542 persons**	**+946 jobs**	**+7,258 persons**	**+2,700 jobs**

Zones 2148 and 2155 are also shown because these areas were originally considered in the 'growth budget' for the structure plan area but are unlikely to realise any growth

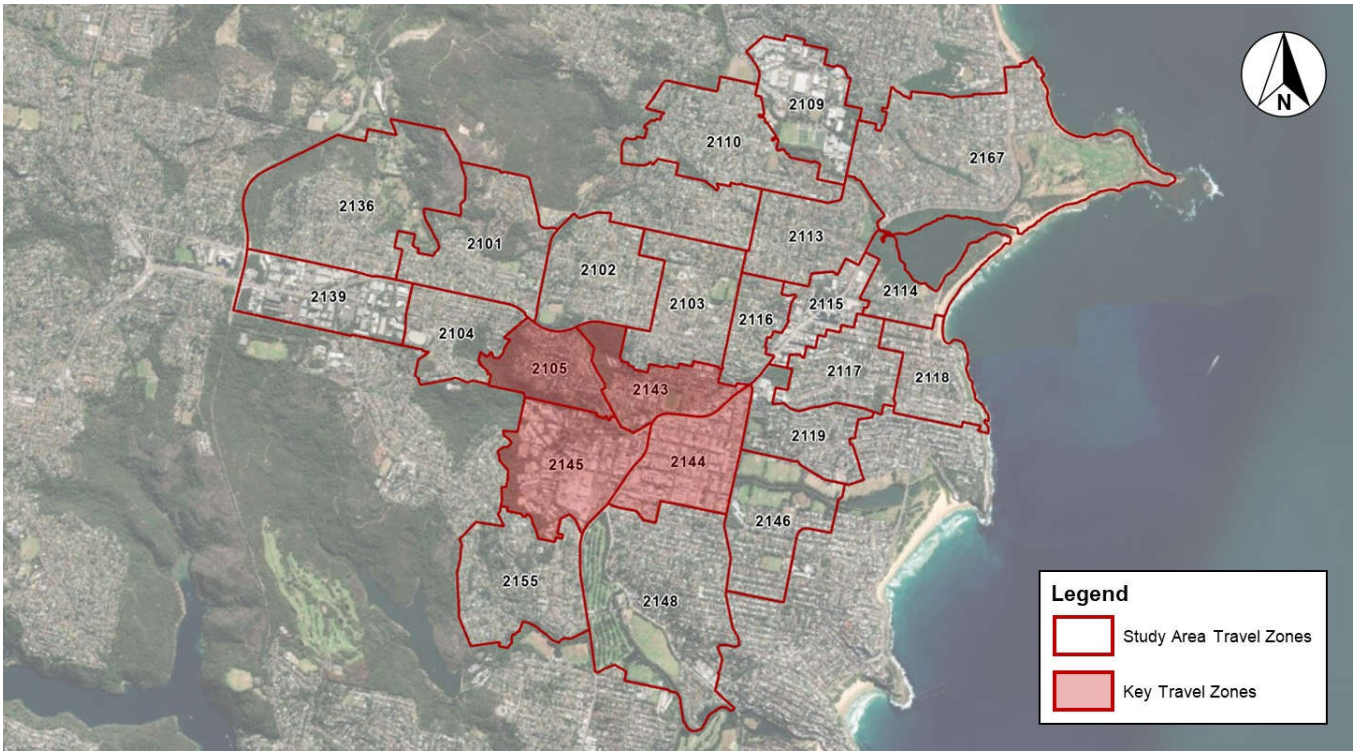


Figure 9.2: TMAP Study Area Travel Zone Map

9.3.3 Road Network Upgrade Scenarios

Two upgrade scenarios are defined for the capacity testing undertaken in this section. These are described as the:

- 2026 Limited Upgrades Scenario
- 2036 Limited Upgrades Scenario.

These upgrade scenarios are based on the recommended upgrades for the design years in Section 9.2, with the exception of the two 'major' upgrades (Pittwater Road / Warringah Road / Harbord Road interchange and Powells Road extensions) in all scenarios. It is acknowledged that these projects may be challenging to implement and will likely take many years to fully evaluate.

9.3.4 Methodology

The Brookvale Structure Plan area growth capacity testing was completed using the AIMSUN microsimulation model for the entire study area. The model's performance does not specifically discriminate between the traffic congestion issues caused by traffic generated by the Brookvale Structure Plan area and traffic generated by other zones in the study area or by external zones. The capacity assessment therefore has to be based on the proportion of the total traffic demand that the entire network could accommodate based on the demand from all zones with that proportion.

Once the proportion was identified, then it was used to recommend what reductions in population and employment forecasts would be required in the zones relevant to the Brookvale Structure Plan area due to the removal of the two challenging upgrades.

9.3.5 Defining Network Capacity

For the purpose of this analysis, the modelled road network was defined as being **at-capacity** if any of the following conditions was met:

- Convergence failure of the Dynamic User Equilibrium (DUE) model run
- 'Gridlock' in the Stochastic Route Choice microsimulation run
- High volumes of unreleased vehicles in the Stochastic Route Choice microsimulation run.

DUE Convergence Criterion

The AIMSUN model uses a multi-resolution approach, progressing from a Static Macroscopic assignment to a Dynamic Mesoscopic assignment to a Dynamic Microscopic simulation. The Mesoscopic model targets user equilibrium of the traffic route choice between all origins and all destinations based on iterations of delay calculations and traffic assignment, re-calculation of delay and re-assignment of traffic. If equilibrium is not achieved within a reasonable number of model iterations, then the model is considered to be unstable. This typically occurs in a highly congested networks where there are significant delays and route choice can become unrealistic.

Gridlock Criterion

The term 'gridlock' in the context of simulation modelling refers to continuous queues of vehicles extending through a number of intersections, causing cyclical blockages and preventing traffic flow from all directions in the network. In reality, gridlock is rare because of how drivers adapt to these situations.

However, in microsimulation modelling with AIMSUN, in congested road network conditions, long queues will often propagate through upstream intersections in the model. When gridlock occurs, most commonly seen at roundabouts, vehicles will become locked in place until the end of simulation, causing a significant, unrealistic blockage to the network. Gridlocked networks are usually considered to be unstable and not suitable for extraction of meaningful results.

Unreleased Vehicles Criterion

Even though a network may converge and not gridlock, this does not mean that there is not excessive congestion. "Unreleased vehicles" is traffic demand that cannot get into the network usually due to excessive congestion within the network. For the purpose of this assessment, the unreleased vehicles threshold was set at of 1% of the peak hour traffic demand.

9.3.6 Traffic Demands

The 2026 traffic demands that were calculated in Section 7 were adopted as a starting point for the analysis to test whether:

- The road network with the 2026 Limited Upgrades Scenario would be capable of supporting the traffic demand associated with the original 2026 demographic growth
- The road network with the 2036 Limited Upgrades Scenario was capable of supporting any additional growth on top of what was able to be accommodated with the 2026 Limited Upgrades.

The AIMSUN model was initially run with 100% of the traffic demand. In the case that the network was found to breach its capacity threshold, the Growth Demand between 2018 and 2026 was 'stripped back' in 10% increments across the entire traffic demand matrix.

This process is outlined in Figure 9.3.

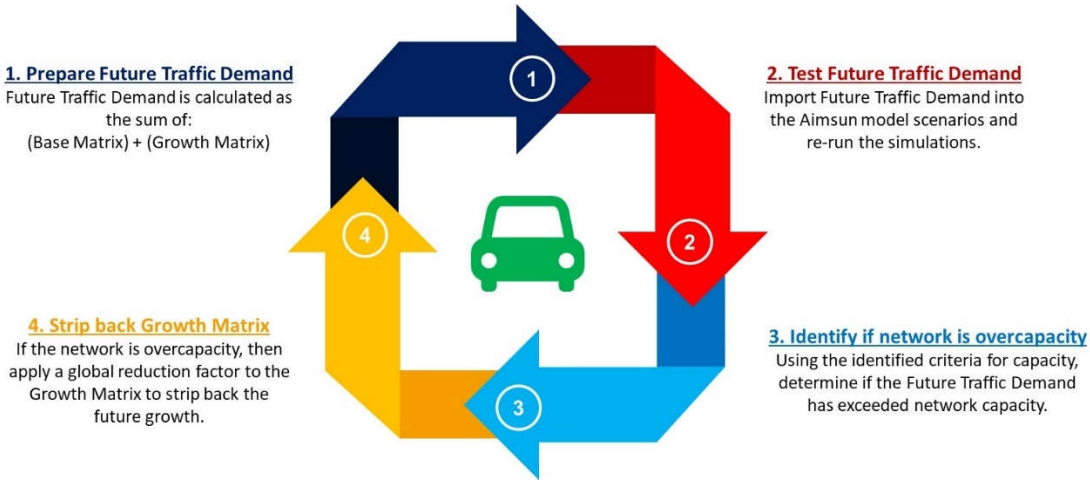


Figure 9.3: Iterative process for developing the Future Traffic Demands

Once a stable network was observed, then the associated percentage reduction was documented as the acceptable traffic level and that percentage was applied to the input demographics for the Brookvale Structure Plan area.

There are limitations with this methodology, primarily in that the reduction factor was applied globally to the Growth Demand between 2018 and 2026**,** representative of a 'stripping back' of planned future growth. However, this results in an identical reduction of future growth in other sections of the network like the Dee Why Town Centre or external-to-external through traffic along Pittwater Road. This growth is not associated with or controlled by the development of the Brookvale Structure Plan area.

9.3.7 Outcomes

The stability outcomes from the modelled network upgrade suite and traffic demand combinations are summarised in Table 9.2. The modelled found that with the:

- 2026 Limited Upgrades Scenario, the network was able to support **80% of the 2026 Growth Demand**
- 2036 Limited Upgrades Scenario, the network was able to support **85% of the 2026 Growth Demand**.

Table 9.2: Modelled Scenarios

Scenario	Description	DUE Convergence	Gridlocks	Unreleased Vehicles
2026 Limited Upgrades				
2026 100%	2018 Base + 100% of the 2026 Growth	☑	☒	☒
2026 90%	2018 Base + 90% of the 2026 Growth	☑	☒	☒
2026 80%	2018 Base + 80% of the 2026 Growth	☑	☑	☑
2036 Limited Upgrades				
2026 100%	2018 Base + 100% of the 2026 Growth	☑	☒	☒
2026 90%	2018 Base + 90% of the 2026 Growth	☑	☒	☒
2026 85%	2018 Base + 85% of the 2026 Growth	☑	☑	☑

Higher percentages of the growth demand resulted in network instability, primarily caused by gridlock issues through the local streets around Old Pittwater Road during the PM peak. Relative to the 2026 Limited Upgrades, the 2036 Limited Upgrades showed a nominal increase of 5% of the 2026 growth demand. This is not an unexpected result, given that the 2036 Limited Upgrades items are primarily localised improvements mostly for safety or accessibility reasons rather than the wider road network capacity and did not address the fundamental capacity limitation at the Pittwater Road / Warringah Road / Harbord Road intersection which dominate considerations in the study area.

9.3.8 Achievable Population and Employment Growth

Based on the capacity testing undertaken, the achievable growth in population and employment across the four key zones in the Brookvale Structure Plan area is summarised in Table 9.3.

Table 9.3: Achievable Population and Employment Growth – Brookvale Structure Plan TZ

Travel Zone	With 2026 Limited Upgrades		With 2036 Limited Upgrades	
	Population Growth (persons)	Employment Growth (jobs)	Population Growth (persons)	Employment Growth (jobs)
2105	4	0	4	0
2143	118	56	126	60
2144	618	126	662	135
2145	765	574	819	615
Total	**+1,503 persons**	**+757 jobs**	**+1,610 persons**	**+810 jobs**

Note: Individual TZ growth volumes rounded to the nearest whole number.

9.3.9 Ultimate Population and Employment Growth

The ultimate road network, inclusive of the two removed upgrades (Pittwater Road / Warringah Road Interchange and Powells Road Link), was capable of accommodating the full 2036 traffic demands. These demands accounted for the following additional growth:

- Population: +3,758 persons
- Employment: +1,890 jobs.

These volumes are *in addition to* the aforementioned achievable growth limits with the 2036 Limited Upgrades Scenario presented in Table 9.3.

9.4 Concentration of Population and Employment Growth

9.4.1 Overview

It is recognised that the current projection 'splits' across each of the Brookvale Structure Plan zones are estimates only, with actual growth subject to the specifics of future development in each area.

As shown in as shown in Table 9.1, zones 2155 and 2148 to the south of the structure plan area also have a level of growth under the scenarios input to the TMAP. These areas (also shown in Figure 9.4) do not have development uplift plans and it would be reasonable to relocate the growth potential assumed in these zones to the Brookvale Structure Plan area zones.

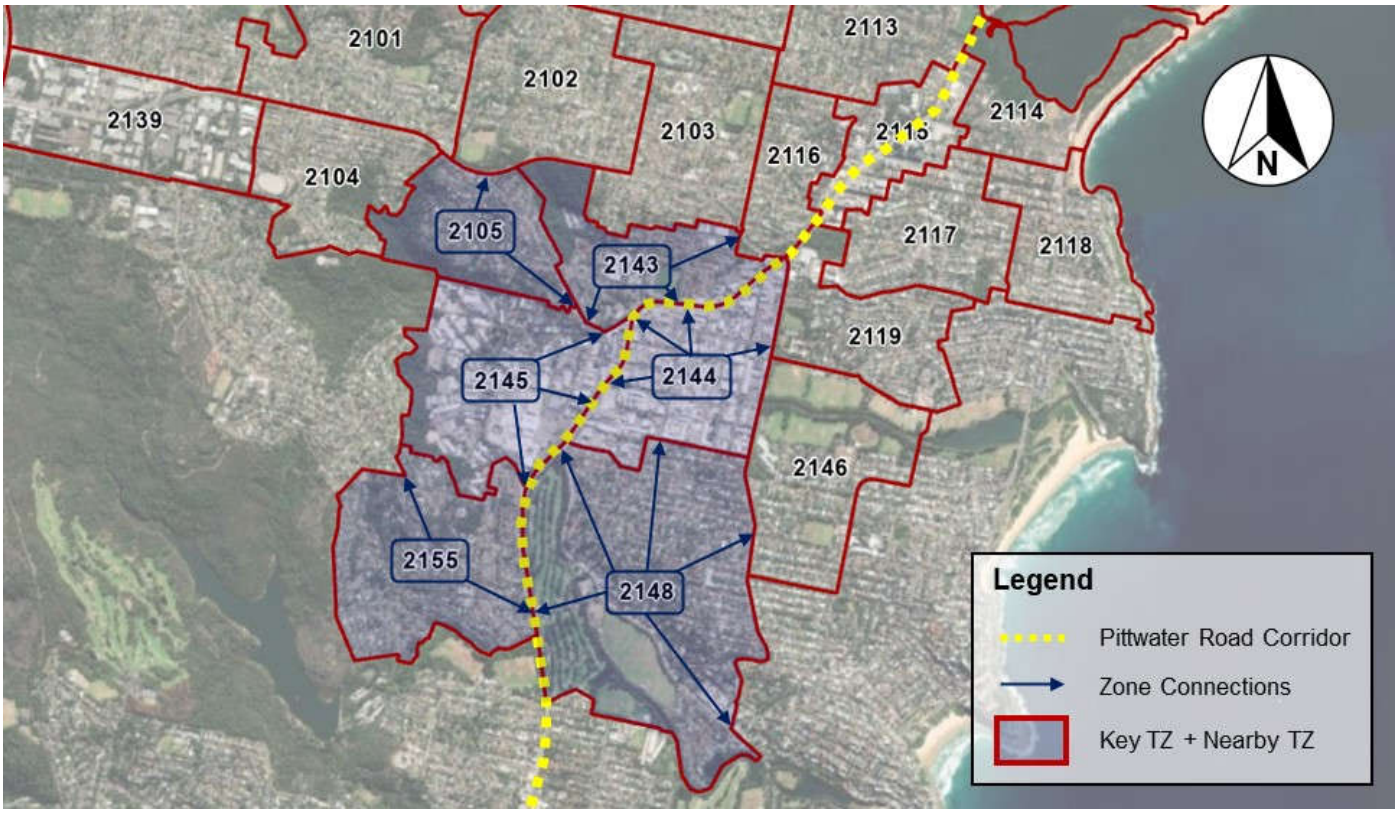


Figure 9.4: Travel Zone Connections

In terms of the modelling and assessment implications of such a relocation of demographic growth, both zones 2155 and 2148 have a direct connection to the Pittwater Road corridor and would similarly influence the capacity limitations of the network as would be the case if their demographics were 'shifted' into the structure plan area. This allows the total population and employment growth limits for the six zones to be considered as an aggregate growth budget for the entire Brookvale Structure Plan area, as presented below.

9.4.2 Aggregate Growth 'Budget'

The total Brookvale Structure Plan area growth budget by 2026 and 2036 after implementing the respective sets of limited upgrades for each year is summarised in Table 9.4.

Table 9.4: Achievable Population and Employment Growth - Aggregate

Travel Zone	Total Growth by 2026		Total Growth by 2036	
	Population (persons)	Employment (jobs)	Population (persons)	Employment (jobs)
2105	5	0	13	0
2143	147	70	420	200
2144	772	158	2,205	450
2145	956	718	2,730	2,050
2148	441	0	1,260	0
2155	221	0	630	0
Total with all upgrades	**+2,542**	**+946**	**+7,258**	**+2,700**
With 2026 Limited Upgrades	**+2,034**	**+757**	**-**	**-**
With 2036 Limited Upgrades	**-**	**-**	**+2,177**	**+810**

9.4.3 Local Constraints

Given that the major capacity constraint within the network is caused by the Pittwater Road / Warringah Road intersection, once the Brookvale Structure Plan area population and employment increases, the same effect on *broader network capacity* is expected regardless of the specific distribution of growth amongst the zones in the structure plan area.

However, relocating the growth from zones 2155 and 2148 into the Brookvale Structure Plan area will potentially generate greater *localised impacts* that need consideration as part of future development planning. Some of these considerations are presented in the following sections:

9.4.4 Travel Zone 2144 – Brookvale Industrial Precinct

A concentration of the future growth within TZ 2144, the zone corresponding to the existing Brookvale industrial precinct would have its greatest effects during the PM peak, due to conflicts.

Key potential issue areas include:

- **Pittwater Road / Mitchell Road**
  - As the backbone of the precinct's traffic network, any growth within TZ 2144 will likely affect with Mitchell Road. Mitchell Road provides the most direct access to Pittwater Road, but is interspersed with roundabouts every 100m or so.
  - There are existing capacity issues along Mitchell Road, stemming back from the signals at Pittwater Road, even prior to any concentration of growth in the area. Further development may lead to an exacerbation of queues, extending through a number of roundabouts at intersections with Winbourne Road, Chard Road, Sydenham Road and Orchard Road.
  - It is noted that Mitchell Road north of Winbourne Road has parking restrictions for additional road capacity during the PM peak.
  - Potential options for Mitchell Road to support the increase in traffic volumes could involve maintaining four-lanes in peak periods via extension of parking restrictions which could take the form of peak period clearways
  - Other considerations as development occurs include in more demand for, and potential reductions in, on street parking supply, bicycle route implications, and local upgrade needs to the local roundabouts on Mitchell Road due to the increase to the number of approach lanes and to better cater for the increased active transport activity expected in these areas.

- **Pittwater Road / Sydenham Road**
  - There would be additional traffic on Sydenham Road travelling towards Pittwater Road, as one of the few signal-controlled accesses from the existing precinct onto the arterial movement corridor.
  - Due to the signal control and existing parking restrictions, the left turn lane is limited in length with only enough capacity for around 2-3 queued vehicles. With increasing local traffic, more left turners would be blocked by more right turners on this approach.
  - Potential options mitigate these impacts include the implementation of peak hour parking restrictions on Sydenham Road between Pittwater Road and Charlton Lane.

9.4.5 Travel Zone 2145 – Warringah Mall and surrounds

TZ 214 is the zone corresponding to the area generally surrounding Warringah Mall and bound by the Old Pittwater Road loop. More locally-generated traffic in this area would be expected to cause increase traffic demands at intersections with Pittwater Road. These include Old Pittwater Road (opposite Winbourne Road), Cross Street, and Old Pittwater Road (to Condamine Street). Issues and mitigation options include:

- **Old Pittwater Road / Pittwater Road / Winbourne Road signals**
  - The west approach to this intersection would see longer delays and longer queues, exacerbating existing delays caused by significant queueing back from Pittwater Road which would result in additional underuse of signal green time from the side roads.
  - There is only around 150m distance between this intersection and the upstream intersection at Old Pittwater Road / Beacon Hill Road / Roger Street. While this section is two-lane, the majority of eastbound traffic aims to turn left onto Pittwater Road in the afternoon, rather than using Winbourne Road. This results in an unbalanced single-lane queue which push back to the upstream intersection and impact its performance.
  - Potential options to mitigate the increase in left-turn demand from Old Pittwater Road to Pittwater Road include allowing for a slip-lane or similar however such an upgrade is likely to involve property acquisition and the need to consider pedestrian safety, especially due to the adjacent Brookvale Public School site. Redevelopment opportunities in this area may allow some of these options / needs to be incorporated.
- **Old Pittwater Road / Beacon Hill Road / Roger Street signals**
  - More local traffic increasing queues back from the traffic signals to the east of this intersection may significantly affect the performance of this intersection.
  - Mitigating these issues will require improvements to eastbound traffic flow but without compromising the efficiency of the movements to/from Beacon Hill Road. Potential improvements at the intersection could include an additional eastbound traffic lane as it is currently a single lane approach with two departure lanes, whilst retaining the left slip lane onto Beacon Hill Road.
- **Old Pittwater Road / Green Street / Brookvale Avenue roundabout**
  - The performance at this roundabout is affected by the performance of the two traffic signals to the east. Increased localised traffic to the south and west of the roundabout will increase the volume of traffic from these areas and towards Pittwater Road.
  - The roundabout is like to reach its capacity as a consequence, particularly if the single-lane queues extend back from the signals at Beacon Hill Road.
  - Potential improvements which could be considered to upgrade the roundabout for this increased local traffic demand include widening to provide an additional circulating lane and extensions to parking restrictions on approach to the roundabout.
- **Cross Street / Dale Street**
  - Southbound flows along Dale Street have increased in the 'with upgrades' case already due to the proposed right turn ban from Old Pittwater Road to Pittwater Road. A concentration of growth in this area would result in more traffic along Dale Street.
  - This will likely result in longer queues on Dale Street southbound, particularly for its left turn into Cross Street. If this queue exceeds around 35m, it will queue into the through lane and block through traffic.
  - Potential mitigation measures could include an extension of the two-lane northern approach to the Cross Street / Dale Street signals via an extension of parking restrictions in the area, which could be applied in peak periods only.

10. Conclusions and Recommendations

10.1 Conclusions

The Brookvale Structure Plan, coupled with the Dee Why Master Plan have been assessed, along with opportunities provided by B-Line improvements and the Beaches Link proposal, to determine the potential maximum development levels which can be accommodated in each centre with reasonable levels of upgrades to transport infrastructure and services. This analysis found that the 'medium' development scenario of 3,450 dwellings and 2,500 jobs in Brookvale and the 'high' development scenario of 3,778 persons and 1,000 jobs in Dee Why were preferred. The road network in Brookvale had limited residual capacity for growth while more 'spare capacity' was demonstrated to exist in Dee Why in 2019.

The modelling of 2036 conditions based on this growth revealed that the Warringah Road / Pittwater Road / Harbord Road intersection was the traffic capacity 'linchpin' for the study area and needed to be grade separated. A number of other capacity pinch point upgrades were also identified by 2036, mostly south of Warringah Road or along Warringah Road west of Pittwater Road. Most of these upgrades were identified as needed after 2026, except for a few key upgrades such as the Warringah Road / Pittwater Road / Harbord Road intersection. A suite of safety and local accessibility upgrades were also identified as being required to better manage turning conflicts at intersections which worsen with more through traffic and with more local traffic generation particularly in the redevelopment areas within Brookvale.

Sensitivity analysis was also undertaken to determine the maximum development possible in the Brookvale Structure Plan area if the Pittwater Road / Warringah Road / Harbord Road interchange and the Powells Road Extension projects were not included due to their implementation uncertainties. The modelling determined that an additional 810 jobs and 1037 dwellings could be accommodated in the area of the Brookvale Structure Plan if these two projects were not constructed, but all other recommended projects were.

There have been recent upgrades along Pittwater Road within the study area at the two B-Line bus stops and there has also been a recent rationalisation of bus routes in the Northern Beaches area. Further initiatives should be considered to continue evolving the Northern Beaches public transport network, including new east-west express bus routes supported by infrastructure improvements. There is also potential to expand on-demand services like Keoride into the Brookvale and Dee Why areas as well as encouraging greater coverage of car share opportunities into redevelopment areas.

In addition to the development of major transport options, there are also key opportunities for localised improvements to infrastructure such as footpaths and bus stop facilities near non B-Line bus stops along Pittwater Road, Warringah Road and elsewhere in the study area. With the planned redevelopment in Brookvale, opportunities exist to create a more permeable network of walking / cycling links on either side of Pittwater Road and the creation of more shared paths should be a key priority given the emerging cycling usage opportunities in the area.

Parking demand will also change with redevelopment of Brookvale and opportunities exist to restrain residential development parking near the B-Line. This can be supported by the provision of expanded free commuter car parking facilities within convenient walking distance of the major bus hubs in the study area. There is little opportunity to significantly reduce retail, commercial or industrial parking rates in this area compared to the current DCP. In Dee Why, on-street parking impacts are likely to require the extension of '2P' zones further into existing residential streets.

Overall, traffic capacity and safety have been identified as the central issues for consideration in this TMAP. To respond to proposed redevelopment in Brookvale and Dee Why, a number of upgrades will need to be progressively implemented so that existing levels of service are not significantly reduced.

10.2 Recommended Action Plan and Staging

The recommended TMAP actions and their timing are presented in Table 10.1 and shown in Figure 10.1

Table 10.1: Action Plan

ID	Item Description	Agency	Timing
Road Network			
RN1	Pittwater Road / Warringah Road / Harbord Road grade separated intersection.	NBC / TfNSW	Design: Immediate. Construction: When possible.
RN2	Warringah Road / Allambie Road turn bay extension.	NBC / TfNSW	2030
RN3	Warringah Road / Willandra Road reconfiguration.	NBC / TfNSW	2026
RN4	Willandra Road / Cornish Avenue reconfiguration.	NBC / TfNSW	2026
RN5	Harbord Road / Abbott Road / Winbourne Road upgrades.	NBC / TfNSW	2024
RN6	Warringah Road / Beacon Hill Road turn bay duplication.	NBC / TfNSW	Design: Immediate. Construction: When possible
RN7	Allambie Road / Rodborough Road intersection upgrade.	NBC / TfNSW	2030
RN8	Pittwater Road / Victor Road signalisation.	NBC / TfNSW	2024
RN9	Mid-block pedestrian crossing removal between Victor Road and Federal Parade.	NBC / TfNSW	With item RN8.
RN10	Pittwater Road / Cross Street / Powells Road Extension.	NBC / TfNSW	2028
RN11	Pittwater Road / Delmar Parade AM right turn ban.	NBC / TfNSW	2022
RN12	Pittwater Road / Old Pittwater Road / Winbourne Road right turn ban.	NBC / TfNSW	2022
RN13	Harbord Road parking clearway.	NBC / TfNSW	2024
RN14	Pittwater Road bus lane parking clearway.	NBC	TfNSW – dependent.
RN17	Harbord Road / Brighton Street / Amourin Street signalisation.	NBC / TfNSW	2034
Public Transport			
PT1	Review Bus Stop infrastructure along major bus routes and ensure they are compliant with DDA standards and have high quality stop facilities and access paths.	TfNSW	2024
Active Transport (Walking and Cycling)			
AT-W1	Investigate and implement HPAA schemes as Brookvale Town Centre evolves.	NBC / TfNSW	As development occurs.
AT-W2	Review potential reduction of speed limits in residential local traffic areas such as North Manly and Beacon Hill.	NBC / TfNSW	2022
AT-W3	Improvements to pedestrian crossing facilities and increase network permeability as redevelopment occurs.	NBC / TfNSW	As development occurs.
AT-C1	Improvement of local and regional cycling connectivity at / between the main activity centres.	NBC	2022 - 2030
AT-C2	Provision of secure end of trip facilities at major bus stops.	NBC	2022 - 2024
AT-C3	Provision of shared crossing facilities at intersections and traffic signals along major bicycle routes.	NBC / TfNSW	2022 - 2030
Parking			
P-1	Adoption of lower residential parking rates around B-Line stops.	NBC	Immediate.
P-2	Implementation of extension of timed parking restrictions on side streets near the B-Line stops.	NBC / TfNSW	As required.
P-3	Provision of dedicated car share parking and drop-off areas in or near multi-unit redevelopments.	NBC	As development occurs.
P-4	Provision of new or expanded B-Line commuter car parking areas.	NBC	2028 - 2030
P-5	Review and reduce permitted parking times in sections closest to the Brookvale and Dee Why Centres.	NBC	Short Term.

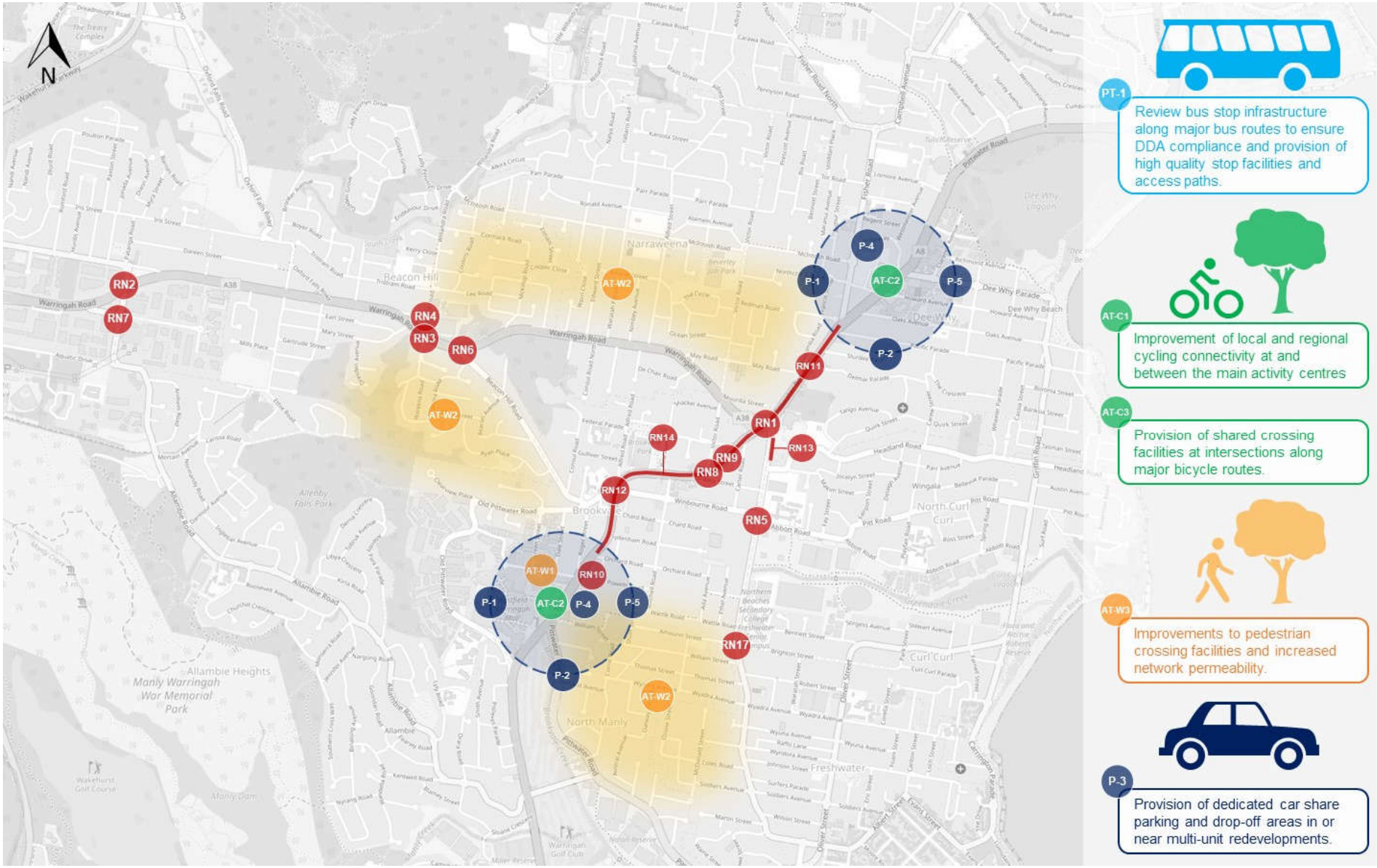


Figure 10.1: Locations of the Recommended Actions