SCT Consulting

DOUBLE BAY TRANSPORT STUDY

Prepared for Woollahra Municipal Council

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Quality Assurance

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Executive Summary

Background and Introduction

SCT Consulting has been engaged by Woollahra Municipal Council (WMC) to undertake a transport study to support a review of existing planning controls for the Double Bay Town Centre. The objectives of the study include a need to:

– Obtain an understanding of the existing parking, traffic and transport conditions within the Double Bay Town Centre;

– Identify the potential parking, traffic and transport implications from additional mixed residential and non-residential development in selective parts of the Double Bay Town Centre;

– Identify what additional development the Double Bay Town Centre can accommodate before key intersections and road network cease to function efficiently;

– Identify strategies, policies and network improvement measures can mitigate those implications; and

– Identify measures to encourage active and public transport usage in association with people living, visiting and working in the Double Bay Town Centre.

Existing Conditions

The Double Bay Town Centre benefits from strong accessibility to the surrounding public transport system. The Double Bay Ferry Wharf is located on the northern extent of the town centre, Edgecliff Station is within walking distance from the town centre and high frequency buses are available along New South Head Road.

There are two ferry services per hour during the AM and PM peak hour periods on the F7 Eastern Suburbs Ferry line, providing access to Circular Quay, Rose Bay and Watsons Bay. Bus and train services provide access to surrounding sub-regional centres and to the City throughout the day. Trains travel to Edgecliff Station with a frequency of more than 16 services per hour on the T4 Eastern Suburbs and Illawarra Line during the AM and PM peak periods. Bus services provide accessibility to the City, Barangaroo, Bondi Junction Vaucluse, and Watsons Bay. Customer patronage of bus services was gathered for the month of August 2016 and August 2017 for comparative purposes. The results of this analysis indicate an increase in the number of passengers boarding and alighting at Double Bay in 2017 when compared to 2016. During the AM and PM peak hour, a total of six inbound bus services were identified as exceeding seating capacity, however, given the number of services to the area there is spare capacity on the bus network within the town centre.

Bay Street and Cross Street are identified as key bicycle routes on the WMC “Cycling in Waverley and Woollahra cycle map”. These routes are marked as part of the on-road cycle network and traverse the town centre through low traffic volume corridors. Town centre bicycle routes connect to the wider network via New South Head Road to the west, Manning Road and Bellevue Road to the south-east, and via William Street to the north east.

Pedestrian footpaths and facilities are provided through wide paved footpaths on both sides of the carriageway and raised zebra crossings throughout the town centre. On New South Head Road signalised pedestrian crossings are provided at intersections with Manning Road, Knox Street, Kiaora Road and Bellevue Road, providing safe crossing locations and access to the surrounding facilities and public transport network.

Within the town centre, there are low traffic volumes and no notable causes for traffic delay or congestion. On New South Head Road congestion and high traffic volumes were identified during AM and PM peak hour periods in the peak direction of travel. During the AM peak hour, westbound queues and congestion originating at New South Head Road / Ocean Street extend into and impact the operational performance of New South Head Road / Manning Road.

The intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road is also identified as a pinch point within the corridor, with queuing of 200m observed along Bellevue Road during the AM peak. During the PM peak, safety and operational efficiency concerns were noted on the dual right turn movement from New South Head Road (W leg) to Kiaora Road (SW leg) and Bellevue Road (S leg).

Potential Growth

As a result of the outcomes of the Double Bay Economic Feasibility Study (July 2015) WMC officers have undertaken a review of the existing planning controls for the Double Bay Town Centre. This review investigated a series of site-specific uplifts to both height and floor space ratio controls to facilitate more viable mixed use development.

WMC staff prepared a hypothetical development scenario based on the proposed amendment to the development controls. When compared to the current built form, the proposed amendments could facilitate:

– An uplift of 1,196 parking spaces and 2,936 people across a potential expansion of residential, commercial and retail land uses.

Under the potential scenario construction of the full development would be completed by 2027, while approximately 50 per cent of the potential development would be delivered within a five-year period to 2022.

Trip Generation and Traffic Impacts

Overall the potential development supports best practice transit oriented development principles, by providing increased residential and employment density in proximity to existing transport infrastructure.

Internally the proposal encourages sustainable transport use with a permeable layout providing easy access to public transport and existing pedestrian and bicycle facilities. The town centre site has access to the public transport system via train, bus and ferry travelling immediately adjacent to the town centre and providing connections to surrounding sub-regional centres and to the City throughout the day. Existing services have sufficient capacity to meet the number of additional public transport trips due to the potential development.

At full development, the potential development could generate up to 493 vehicle trips during the AM peak, 754 vehicle trips during the PM peak and 571 trips during the Saturday peak period. Vehicle access to and from the potential development will be via existing service roads throughout the town centre.

Modelling analysis indicates that under 2022 forecast demands, which includes 50 per cent of the potential development, the majority of intersections within the network operate at an acceptable level of performance and within capacity under all periods. In 2022, the pinch point on the network will be the intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road, which operates slightly over capacity during the AM and Saturday peak period. Saturated movements are the turning movements at the intersection, however, overall the intersection operates at LoS D, which is an acceptable measure of delay.

By 2027, modelling indicates that the intersection of New South Head Road with Cross Street / Bellevue Road / Kiaora Road operates over capacity during the AM, PM and Saturday peak periods and is unable to meet the forecast traffic demand associated with background traffic growth and full development yield. All other intersections operate at LoS A to LoS C, and satisfactorily cater for forecast travel demands associated with full development.

As a means to identify strategies to mitigate adverse implications of the potential development on the surrounding network performance, two sensitivity tests were assessed as follows:

– Target mode shift of vehicle trips to sustainable modes of transport such as active transport (walking / cycling) and public transport; and

– Network modifications and internal trip redistribution.

The proposed sensitivity tests successfully mitigated identified impacts and resulted in all intersections operating within capacity.

Recommended Traffic and Transport Strategies

To mitigate adverse impacts associated with the increased level of trip generation associated with the potential development of the Double Bay Town Centre, the following series of strategies / policies have been identified for consideration:

– Provide additional car share (Go Get) spaces on street within WMC as well as in dedicated parking spaces within new developments and WMC car parks. WMC may also investigate the use of car share schemes in conjunction with certain residences not being eligible for access to residential parking permit schemes;

– Evaluate existing parking controls within the Woollahra Development Control Plan (2015) as well as considering pricing mechanisms to encourage reassignment of mode choice;

– Monitor public transport patronage to determine the needs of residents and evaluate the success of public transport improvements;

- Lobby Transport for NSW for additional services to the Double Bay Ferry Wharf to increase the attractiveness of the mode as a viable alternative to rail and bus connections to the Sydney CBD;
- Introduce a Travel Demand Management Program within Double Bay businesses;
- Consider expanding the current residential parking permit scheme beyond existing limits; and
- Introducing programs like walking groups promoted by the Heart Foundation and walk to school programs to help encourage a modal shift from private vehicles to walking and cycling.

In addition, there are several network improvements options available to WMC to ensure that traffic efficiency is improved within the Town Centre and an increased number of trips by active transport is supported, such as:

- Investigate a timing ban, for the right turn movement from New South Head Road to Kiaora Road. This will improve the efficiency of the New South Head Road approach and the overall intersection performance of New South Head Road / Cross Street / Bellevue Road / Kiaora Road;
- Removal, or investigate a timing ban, for the right turn movement from New South Head Road to Knox Street. This will improve the efficiency of New South Head Road and vehicles with an alternate route path to vehicles available via William Street;
- Removal, or investigate a timing ban, for the right turn movement from Bellevue Road to New South Head Road as a means to improve overall intersection performance of New South Head Road / Cross Street / Bellevue Road / Kiaora Road;
- Formalise Line Marking (Knox Street) to improve lane discipline and reduce the occurrence of vehicles queuing in the centre lane and reducing available storage space;
- Removal of two kerbside parking spaces on Knox Street during the AM peak will facilitate greater access to the left turn lane and provide greater efficiency for the operation of the New South Head Road / Knox Street intersection;
- Keep clear pavement markings are proposed at the intersection of Ocean Avenue / Cooper Street to prevent cars from queuing into the intersection footprint and preventing the right turn movement from Ocean Avenue to Cooper Street;
- Provide separated bicycle infrastructure along Ocean Avenue and Cooper Street to improve rider safety ; and
- Investigate opportunities to improve pedestrian amenity and crossing opportunities along key walking routes.

Conclusion

The Double Bay Transport Study has centred on the assessment of two potential development scenarios, two sensitivity tests and the identification of associated impacts for the Double Bay Town Centre. The assessment has found that:

- Existing public transport servicing the Double Bay Town Centre has sufficient capacity to meet increased travel demand associated with the area's potential growth and expansion;
- Existing active transport infrastructure within and around the Double Bay Town Centre is suitable to cater for the increase in population caused by potential growth within the centre, however, further steps can be taken to increase active transport as a viable mode; and
- The Double Bay Town Centre will be able to successfully cater for the proposed expansion through the application of various strategies / policies, as noted above.

1.0 Introduction

1.1 Background

As a result of the Double Bay Place Plan being adopted by WMC in December 2014 the following actions were requested:

– Commission an economic study to examine the opportunities for an additional residential population accommodated in Double Bay in smaller apartments with car share

– Report the outcome of that study to WMC and amend planning controls (LEP and DCP) as required to encourage new moderate scale housing.

The outcomes of the Double Bay Economic Feasibility Study (July 2015) have resulted in WMC officers undertaking a review of the existing planning controls for the Double Bay Town Centre. This review investigated a series of precinct specific uplifts to both height and floor space ratio controls to facilitate more viable mixed use development.

The review has been undertaken in alignment with the nine-point liveability framework in the Greater Sydney Commission's Draft Central District Plan (2016). Specific reference in the document is made regarding the need to have healthy, connected communities through the use of public transport, walking and cycling.

Based on the outcome of the above-mentioned documentation the Double Bay Town Centre study area is defined within **Figure 1**–1.

Figure 1–1 Double Bay Transport Study Area

Source: SCT Consulting; 2020

1.2 Objectives

At the completion of the study the following objectives will have been achieved:

– Obtain an understanding of the existing traffic and transport conditions within the Double Bay Town Centre;

– Identify the potential traffic and transport implications from additional mixed residential and non-residential development in selective parts of the Double Bay Town Centre;

– Identify measures to mitigate those implications;

– Identify what additional development the Double Bay Town Centre can accommodate before the intersections and road network cease to function efficiently; and

– Identify measures to encourage increased liveability (connectivity) in association with people living in, visiting and working in the Double Bay Town Centre.

1.3 Report Structure

This report has been structured into the following sections:

– **Section 2** documents the site observations taken of the traffic and transport performance of the study area;

– **Section 3** provides an overview of existing transport demographics within the study area;

– **Section 4** provides an overview of existing intersection operational conditions for the Double Bay Town Centre;

– **Section 5** outlines the hypothetical development yield, trip generation and associated intersection performance results;

– **Section 6** outlines the impact on the study area when sensitivity testing of the potential development yield is applied;

– **Section 7** outlines various strategies/policies and mitigation measures to accommodate the potential growth of trips within the study area of the Double Bay Town Centre;

– **Appendix A** provides intersection performance results for base network operation and potential future year development scenarios;

– **Appendix B** provides a summary of mid-block traffic survey data;

– **Appendix C** provides a summary of the network flow diagrams;

– **Appendix D** provides a summary of intersection performance results for the two sensitivity tests;

2.0 Site Observations

To gain an understanding of the existing operational conditions, and identify existing issues within the study area, multiple site visits were undertaken on Wednesday 30th August 2017, Thursday 31st August 2017 and Saturday 2nd September 2017. Key observations recorded during this time are noted below with the location of key intersections highlighted in **Figure 1**–1.

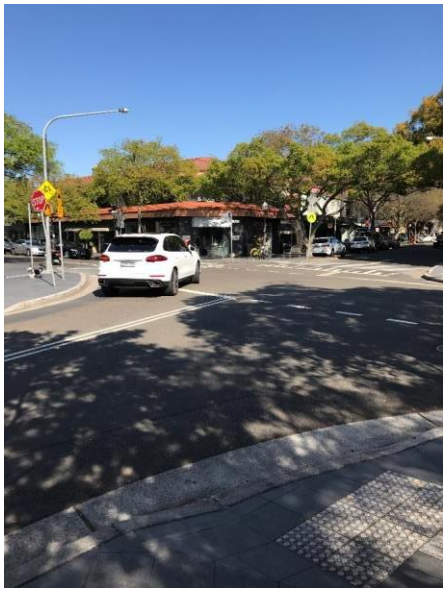
2.1 Cross Street / Bay Street

During the AM, PM and Saturday peak periods no notable congestion issues were observed at the intersection of Cross Street / Bay Street. Two wombat crossings and two uncontrolled crossings are available at the intersection with pram ramps located on both sides of the crossing. An illustration of the observed on-site traffic conditions is provided in **Figure 2**–1, **Figure 2**–2 and **Figure 2**–3**.**

Figure 2–1 Cross Street / Bay Street (AM Peak)

Figure 2–2 Cross Street / Bay Street (PM Peak)

Figure 2–3 Cross Street / Bay Street (Saturday Peak)



Source: SCT Consulting; 2020

2.2 William Street / Bay Street

During the AM, PM and Saturday peak periods no notable congestion issues were observed at the intersection of William Street / Bay Street. Two wombat crossings and two uncontrolled crossings are available at the intersection with pram ramps located on both sides of the crossing. An illustration of the observed on-site traffic conditions is provided in **Figure 2**–4, **Figure 2**–5 and **Figure 2**–6.

Figure 2–4 William Street / Bay Street (AM Peak)

Figure 2–5 William Street / Bay Street (AM Peak)

Figure 2–6 William Street / Bay Street (AM Peak)

Source: SCT Consulting; 2020

2.3 Ocean Avenue / Greenoaks Avenue

During the AM, PM and Saturday peak periods no notable congestion issues were observed at the intersection of Ocean Avenue / Greenoaks Avenue. However, vehicles turning right from Ocean Avenue to Cooper Street at the nearby Ocean Avenue / Cooper Street intersection were observed to cause occasional delay to the northbound through movement on Ocean Avenue. This is due to southbound vehicles on Ocean Avenue queuing through the intersection of Ocean Avenue / Cooper Street and preventing the abovementioned right turn movement. Pedestrians are given some visibility while crossing Greenoaks Avenue via a pedestrian island as well as north of the intersection along Ocean Avenue where there is also a pedestrian island. Both crossings have a pram ramps located on either side. An illustration of the observed on-site traffic conditions is provided in **Figure 2**–7, **Figure 2**–8 and **Figure 2**–9.

Figure 2–7 Ocean Avenue / Greenoaks Avenue (AM Peak)

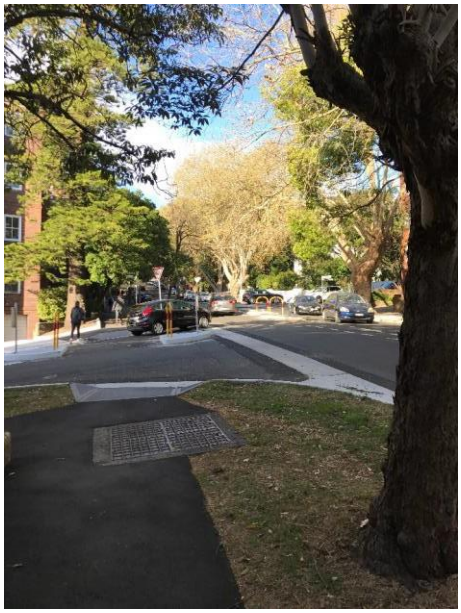


Figure 2–8 Ocean Avenue / Greenoaks Avenue (PM Peak)

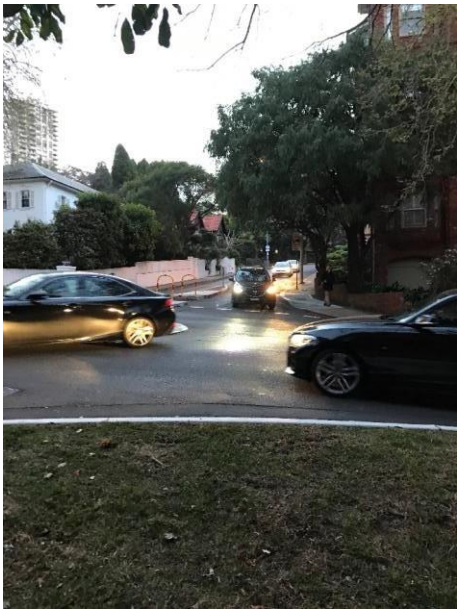


Figure 2–9 Ocean Avenue / Greenoaks Avenue (Sat Peak)

Source: SCT Consulting; 2020

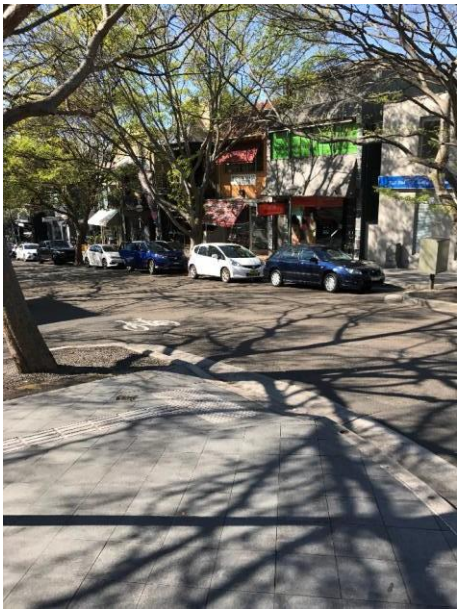
2.4 New South Head Road / Bay Street

During the PM and Saturday peak periods no notable congestion issues were observed at the intersection of New South Head Road / Bay Street. However, during the AM peak period congestion was noted for the westbound (citybound) movement. This is due to the signalised intersection of New South Head Road / Ocean Street which restricts the through movement on New South Head Road due to the available green time. Pedestrians cross Bay Street using an uncontrolled crossing with kerb extensions on either side to give pedestrians more visibility as they cross the road. Pram ramps are provided on both sides of the crossing, Pedestrians cannot cross New South Head Road at this intersection An illustration of the observed on-site traffic conditions is provided in **Figure 2**–10**, Figure 2**–11 and **Figure 2**–12**.**

Figure 2–10 NSH Road / Bay Street (AM Peak)

Figure 2–11 NSH Road / Bay Street (PM Peak)

Figure 2–12 NSH Road / Bay Street (Sat Peak)



Source: SCT Consulting; 2020

2.5 New South Head Road / Manning Road

During the PM and Saturday peak periods the queue for the right turn movement from New South Head Road to Manning Road was observed to extend beyond the provided storage bay. This impedes the eastbound through movement on New South Head Road and induces localised congestion, particularly during the PM peak.

During the AM peak period congestion was noted for the westbound (citybound) movement. This is due to the signalised intersection of New South Head Road / Ocean Street which restricts the through movement on New South Head Road due to the available green time. The signalised through movement recorded a minimum of 15 seconds dead green time per cycle based on-site observations and a reduction in free flow capacity. An illustration of the observed on-site traffic conditions is provided in **Figure 2**–13, **Figure 2**–14 and **Figure 2**–15.

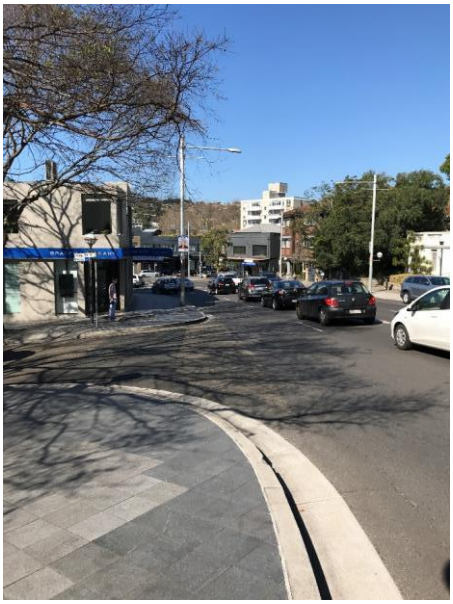
Manning Road experienced moderate levels of congestion in the AM peak for the left turn movement to New South Head Road (citybound direction of travel). As noted above this is due to the queue which extends from the intersection of New South Head Road / Ocean Street, restricting the capacity of the intersection.

Pedestrians cross Manning Road and New South Head Road using signalised crossings available at all approaches. Pram ramps are provided on both sides of all crossings,

Figure 2–13 NSH Road / Manning Road (AM Peak)

Figure 2–14 NSH Road / Manning Road (PM Peak)

Figure 2–15 NSH Road / Manning Road (Sat Peak)



Source: SCT Consulting; 2020

2.6 New South Head Road / Knox Street

In isolation, the intersection of New South Head Road / Knox Street would experience minimal delays due to the two phase signal operation. However, the intersection is impacted upon by queuing caused due to the reduced throughput at the intersection of New South Head Road / Manning Road. In the AM peak, whilst parking is removed in the kerbside lane, delays are most prominent due to the westbound peak direction of travel.

During the PM peak period queuing was also observed due to the reduction in through lane capacity from three to two. This factor, when combined with the introduction of parking in the kerbside lane, was noted as the reason for the observed delays.

The right turn movement from New South Head Road to Knox Street is currently permitted from the centremost through lane. This was observed, in all peak periods, to result in vehicles stopping and restricting the throughput of vehicles with flow on impacts at the intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road. Vehicles were also observed to make late and sudden lane changing manoeuvres upon encountering a stopped vehicle, resulting in an increased risk of a traffic accident.

Lastly, vehicles were unable to access the kerbside lane on Knox Street to turn left onto New South Head Road due to the following two factors:

– Inadequate line marking resulting in vehicles queuing over the centreline and reducing the available lane width

– The queue for right turning vehicles extending beyond the start of parking spaces (AM peak only)

Pedestrians cross Knox Street and New South Head Road using signalised crossings available on all approaches. Pram ramps are provided on both sides of all crossings,

An illustration of the observed on-site traffic conditions is provided in **Figure 2**–16, **Figure 2**–17 and **Figure 2**–18.

Figure 2–16 NSH Road / Knox Street (AM Peak)

Figure 2–17 NSH Road / Knox Street (PM Peak)

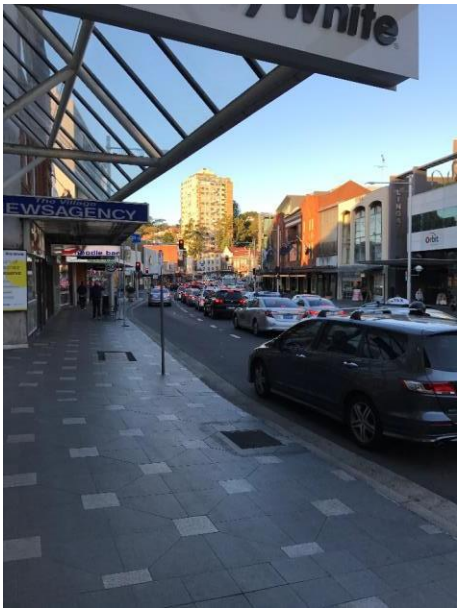


Figure 2–18 NSH Road / Knox Street (Sat Peak)

Source: SCT Consulting; 2020

2.7 New South Head Road / Cross Street / Bellevue Road / Kiaora Road

The intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road is characterised by five approach / departure legs. Site observations, in the AM, PM and Saturday peak periods noted that this impacts upon the operational efficiency of the intersection due to the additional phasing for all movements with associated intergreen delay.

Of all the intersections observed within the study area this location was the poorest performing across the AM, PM and Saturday peak periods.

In the AM peak queuing was observed to extend for over 200m along Bellevue Road for the left turn movement to New South Head Road. The queue blocked the single lane of traffic and prevented vehicles from accessing the centre lane on the approach to the signalised intersection. This resulted in dangerous driving from motorists who were observed to drive on the wrong side of the road to overtake queued vehicles.

In the PM peak safety and operational efficiency concerns were noted due to the dual right turn movement from New South Head Road (W leg) to Kiaora Road (SW leg) and Bellevue Road (S leg). This impacts the intersection as follows:

– Vehicles turning right in Kiaora Road are delayed due to the spacing from the New South Head Road (E leg) stop line. Note that in the PM peak these vehicles were observed to turn right through queued vehicles and, on one occasion, a near miss occurred with a vehicle travelling in the kerbside lane was unable to see the turning vehicle.

– No dedicated right turn movement is provided to vehicles turning right to Bellevue Road (S leg). This results in vehicles only achieving this movement during the phase intergreen. In the event that a vehicle is turning right in to Kiaora Road (SE leg) this movement is unable to occur and the vehicle must wait until the intergreen at the end of the next cycle.

Pedestrians cross Kiaora Road, Cross Street, Bellevue Road and New South Head Road using signalised crossings available on all approaches. Pram ramps are provided on both sides of all crossings.

An illustration of the observed on-site traffic conditions is provided in **Figure 2**–19, **Figure 2**–20 and **Figure 2**–21.

Figure 2–19 NSH Road / Cross Street / Bellevue Road / Kiaora Road (AM Peak)

Figure 2–20 NSH Road / Cross Street / Bellevue Road / Kiaora Road (PM Peak)

Figure 2–21 NSH Road / Cross Street / Bellevue Road / Kiaora Road (Sat Peak)

Source: SCT Consulting; 2020

3.0 Existing Transport Demographics

Section 3 provides an overview of existing transport demographics, excluding road network performance, which is discussed in **Section 4**.

3.1 Journey to Work Data

Analysis of Journey to Work Data (Travel Zones 535, 536, 537 and 541) from the 2011 Census[1] is provided in **Table 3-1**. The data indicates that the Double Bay Town Centre contains a high proportion (54 per cent) of individuals who utilise public and active transport to access their place of employment. The highest percentage of mode share is based on the Vehicle (Driver) category which accounts for 37 per cent of total trips.

Contrastingly, only 30 per cent of people utilise public transport to commute to the Double Bay Town Centre. Vehicle (Driver) as a proportion of overall mode share increases to 63 per cent. This statistic is noteworthy when compared against the geographic location of employees (**Table 3-2**) which shows that 54 per cent of people who work in the Double Bay Town Centre live in proximity within the Eastern Suburbs.

A total of 78 per cent of Double Bay Town Centre residents journey to work trips are to the inner city of Sydney or Eastern Suburbs (North) areas. This concentration of residential and employment land uses encourages a higher proportion of walking trips as a mode, reported as 12 per cent. Should these trends continue, or be enhanced in the future, greater focus and investment on active transport as a key travel mode could be realised. An increased proportion of individuals working from home also has the potential to disrupt traditional travel patterns.

Table 3-1 Journey to Work Mode Data – Double Bay Town Centre

Mode	From Double Bay Town Centre		To Double Bay Town Centre	
	Value	Percentage	Value	Percentage
Vehicle (Driver)	604	37%	1,737	63%
Vehicle (Passenger)	67	4%	108	4%
Train	552	34%	435	16%
Bus	68	4%	110	4%
Walked only	192	12%	262	10%
Ferry / Tram	67	4%	-	-
Other	50	3%	53	2%
Mode not stated	26	2%	31	1%
Total	**1,881**	**100%**	**3,142**	**100%**

Source: http://visual.bts.nsw.gov.au/jtwdynamic/; 2017, modified by SCT Consulting; 2020

[1] 2016 data not available at time of publication

Table 3-2 Journey to Work Origin / Destination Data (Top 5) – Double Bay Town Centre

Origin / Destination	From Double Bay Town Centre (Destination)		To Double Bay Town Centre (Origin)	
	Value	Percentage	Value	Percentage
Sydney (Inner City)	953	51%	309	10%
Eastern Suburbs (North)	513	27%	1,341	43%
North Sydney – Mosman	99	5%	-	-
Eastern Suburbs (South)	40	2%	342	11%
Chatswood – Lane Cove	40	2%	-	-
Kogarah – Rockdale	-	-	87	3%
Strathfield – Burwood - Ashfield	-	-	86	3%
Total	**1,645**	**87%**	**2,165**	**70%**

Source: http://visual.bts.nsw.gov.au/jtwdynamic/; 2017, modified by SCT Consulting; 2020

3.2 Household Travel Survey

Double Bay Town Centre sits within the statistical area “Eastern Suburbs (North)” as defined by the Australian Bureau of Statistics within the 2015/2016 Household Travel Survey.

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

Analysis of the 2015/2016 Household Travel Survey, which is reflective of travel characteristics of residents throughout an average weekday, indicates that over 50 per cent of trips made by residents of statistical area "Eastern Suburbs (North)" are likely to be associated with shopping, personal, business and social and recreational activities. Trips of this nature are likely to account for a high proportion of trips that are made on a Saturday peak.

On this basis, the Household Travel Survey for “Eastern Suburbs (North)” is considered reflective of the trips likely to be made in Double Bay during the Saturday peak period and reflect typical travel characteristic and mode choice associated with these trips.

Table 3-3 and **Table 3-4** provides a summary of the purpose of travel and overall mode choice by residents of Eastern Suburbs (North) associated with these trip purposes compared against the Sydney average and the districts of Manly, Parramatta and Penrith.

There is a relatively consistent comparison regarding trip purpose between Eastern Suburbs (North) and Sydney. The main differences and within the social / recreation trip purpose which is higher in the Eastern Suburbs (North) area, compared to Sydney, with an overall percentage of total trips of 26 versus 22. The Eastern Suburbs (North) area also makes fewer education trips, five per cent, compared to Sydney at eight per cent.

When compared to the Manly, Parramatta and Penrith districts the primary differences noted are that the Eastern Suburbs (North) district has a greater percentage of social / recreational trips and a reduction in trips which are to serve a passenger.

Regarding mode share the Eastern Suburbs (North) area has a higher proportion of walk trips, 30 per cent, compared to Sydney with 17 per cent. This is attributable to the higher density of the eastern suburbs and associated urban design outcomes and is also reflected in the lower proportion of trips recorded in the Eastern Suburbs for the Vehicle (Driver) and Vehicle (Passenger) categories. This is also evidenced when comparing mode share within Manly, Parramatta and Penrith. The greater the density, as shown with Manly and Parramatta, the greater the proportion of walking trips and trips by public transport.

Table 3-3 Household Travel Survey – Residents within Eastern Suburbs (North) and Sydney: Trip purpose

Travel by purpose	Eastern Suburbs (North)	Sydney	Manly	Parramatta	Penrith
Commute	11%	11%	12%	13%	14%
Work related business	9%	8%	5%	5%	13%
Education / childcare	5%	8%	6%	9%	10%
Shopping	13%	14%	13%	13%	11%
Personal business	3%	4%	5%	3%	4%
Change mode of travel	14%	14%	15%	17%	8%
Social / recreation	26%	22%	23%	17%	18%
Serve passenger	14%	17%	18%	19%	19%
Other	5%	3%	3%	4%	2%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/statistical-area-level-3, accessed 30/10/2018

Table 3-4 Household Travel Survey – Residents within Eastern Suburbs (North) and Sydney: Mode Choice

Mode	Eastern Suburbs (North)	Sydney	Manly	Parramatta	Penrith
Vehicle (Driver)	41%	48%	39%	42%	57%
Vehicle (Passenger)	13%	21%	20%	20%	24%
Train	6%	6%	3%	7%	3%
Bus	5%	6%	6%	7%	5%
Walk only	30%	17%	25%	23%	9%
Other	4%	2%	8%	1%	1%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: https://www.transport.nsw.gov.au/performance-and-analytics/passenger-travel/surveys/household-travel-survey/statistical-area-level-3, accessed 30/10/2018

3.3 Public Transport[2]

3.3.1 Ferry

3.3.1.1 Services

The Double Bay Ferry Wharf is located on the northern extent of the study area and on the F7 Eastern Suburbs Ferry line. A summary of services to and from the wharf is provided in **Table 3-5**. The current peak hour frequency of two services per hour is challenging to attract significant patronage increases due to the competing high frequency modes of bus and rail. A greater number of services has the potential to increase demand as customers will be able to use the ferry on a 'turn up and go' basis as opposed to using a timetable or high frequency bus services on New South Head Road.

Table 3-5 Double Bay Ferry Wharf Services (Monday to Friday)

Time Period	Inbound (To Circular Quay)	Outbound (From Circular Quay)
Before 7AM	6:48AM	-
7AM – 9AM	7:18AM | 7:48AM | 8:18AM | 8:48AM	7:14AM | 7:44AM | 8:14AM | 8:44AM
9AM – 4PM	9:51AM | 10:51AM |11:21AM | 11:51AM	9:32AM | 3:22PM
4-6PM	5:49PM	4:19PM | 4:51PM | 5:46PM
After 6PM	6:19PM | 6:49PM 7:19PM	6:16PM | 6:46PM | 7:16PM | 8:06PM | 9:06PM | 10:06PM^ | 11:06PM^

^ Friday only

Source: Transport for NSW; 2018

3.3.1.2 Patronage

Customer patronage of ferry services utilising the Double Bay Ferry Wharf was gathered for the month of August 2016 and August 2017 for comparative purposes. The results of this analysis, provided for Tuesday, Wednesday and Thursdays only, is provided in **Table 3-6**. Overall, trips originating from the Double Bay Ferry Wharf were observed to increase for the month of August, across the 12 month period, by a total of 117. For destination trips to Double Bay a total of 161 fewer people was recorded. These results should be considered in line with the additional ferry services that were provided across this time period. Further, the change in timetables on 26 November 2017 which alters the stopping pattern of ferries accessing the Double Bay wharf is not reflected in the below dataset. It is recommended that this information be reviewed again in August 2018 to determine the impact of these changes.

Table 3-6 Double Bay Ferry Wharf Patronage (August 2016 vs August 2017)

Time Period	Inbound (To Circular Quay)			Outbound (From Circular Quay)		
	August 2016	August 2017	Difference	August 2016	August 2017	Difference
6 - 6:59	136	143	7	-	-	-
7 - 7:59	807	752	-55	50	28	-22
8 - 8:59	918	918	0	32	57	25
9 - 9:59	115	165	50	42	39	-3
10 - 10:59	111	101	-10	21	18	-3
11 - 11:59	201	181	-20	67	58	-9
12 - 12:59	5	4	-1	1	1	0

[2] Service, patronage and capacity figures are reflective of timetable prior to revision on 26 November 2017

Time Period	Inbound (To Circular Quay)			Outbound (From Circular Quay)		
	August 2016	August 2017	Difference	August 2016	August 2017	Difference
13 - 13:59	69	40	-29	111	92	-19
14 - 14:59	30	34	4	79	79	0
15 - 15:59	28	36	8	103	157	54
16 - 16:59	36	72	36	315	255	-60
17 - 17:59	104	65	-39	333	333	0
18 - 18:59	52	45	-7	600	511	-89
19 - 19:59	19	14	-5	167	144	-23
20 - 20:59	3	6	3	79	69	-10
21 - 21:59	1	1	0	47	45	-2
Total	**2,635**	**2,752**	**117**	**2,047**	**1,886**	**-161**

Source: Transport for NSW; 2017

3.3.1.3 Capacity

Capacity figures for ferries operating to and from Double Bay were unable to be obtained for the purposes of this study.

3.3.2 Bus

3.3.2.1 Services

The Double Bay Transport study area contains four bus stops, as shown in **Figure 1**–1 and **Table 3-7** which provides a summary of bus stops and associated services.

Table 3-7 Double Bay Town Centre: Bus Stops and Services

Stop ID	Location	Services
202819	New South Head Road (EB), near Knox Street	• Route 323: City <> Dover Heights • Route 324: City <> Watsons Bay • Route 325: City <> Watsons Bay • Route 326: City <> Bondi Junction
202833	New South Head Road (WB), opposite Knox Street	• Route 323: City <> Dover Heights • Route 324: City <> Watsons Bay • Route 325: City <> Watsons Bay • Route 326: City <> Bondi Junction
202812	Manning Road (NB), near New South Head Road	• Route 327: City <> Bondi Junction
202813	Manning Road (SB), near New South Head Road	• Route 327: City <> Bondi Junction

Source: SCT Consulting; 2020

During peak hour periods, bus stops adjacent to the town centre are offered a high frequency of services with Double Bay being well connected to surrounding areas and Edgecliff Station.

During the AM peak period, there are approximately 15 and 11 services travelling to and from Edgecliff, respectively. During the PM peak, 11 services travel towards Edgecliff whilst 13 services travel in the eastbound direction. There has been minimal change in the number of bus services to the area between 2016 and 2017, with only one additional service offered in the outbound direction during the day.

The number of buses per hour that service the bus stops adjacent to the Double Bay Town Centre are summarised in **Table 3-8**.

Table 3-8 Bus Services per hour (1st week of August 2016 vs 1st week of August 2017)

Time Period	Inbound (To Edgecliff)		Outbound (From Edgecliff)	
	2016	2017	2016	2017
Before 7AM	3	3	4	4
7AM – 9AM	15	15	11	11
9AM – 3PM	6	6	6	7
3-7PM	11	11	13	13
After 7PM	4	4	4	4

Source: Transport for NSW; 2017, modified by SCT Consulting; 2020

3.3.2.2 Patronage

Analysis of Opal Data indicates that there was an increase in the number of passengers boarding and alighting at Double Bay in 2017, when compared to 2016. In 2017, a total of 161 additional passengers boarded, equivalent to a seven per cent increase to 2016 passengers. There was a 15 per cent increase in the number of passengers alighting in 2017, equivalent to 187 passengers.

A comparison of 2016 and 2016 bus patronage is summarised in **Table 3-9**.

Table 3-9 Bus Service Patronage (1st week of August 2016 vs 1st week of August 2017)

Stop ID	Tap On			Tap Off		
	2016	2017	Difference	2016	2017	Difference
202812						
All day	33	29	-4	69	86	17
7-8AM	4	2	-2	11	9	-2
8-9AM	3	10	7	9	25	16
4-5PM	6	2	-4	7	2	-5
5-6PM	7	1	-6	2	12	10
202813						
All day	70	100	30	16	34	18
7-8AM	-	1	1	1	-	-1
8-9AM	4	5	1	1	10	9
4-5PM	13	15	2	-	4	4
5-6PM	16	26	10	8	2	-6
202819						
All day	393	430	37	827	937	90

Stop ID	Tap On			Tap Off		
	2016	2017	Difference	2016	2017	Difference
7-8AM	15	19	4	85	108	23
8-9AM	11	11	-	84	137	53
4-5PM	47	61	14	52	63	11
5-6PM	40	45	5	94	105	11
202833						
All day	1,712	1,810	98	355	377	22
7-8AM	126	125	-1	10	20	10
8-9AM	235	219	-16	46	47	1
4-5PM	114	156	42	20	26	6
5-6PM	193	183	-10	23	28	5
Total	**2,208**	**2,369**	**161**	**1,247**	**1,434**	**187**

Source: Transport for NSW; 2017

3.3.2.3 Capacity

Opal Data information (tap on / tap off) provided by Transport for NSW for the 2nd week of August 2016 and August 2017, indicates that during peak periods, a total of six inbound bus services per hour exceed seating capacity (45 seats), with two of these also exceeding standing capacity (59 passengers). This trend was evident in both 2016 and 2017. The number of service exceeding seating and standing capacity is summarised in **Table 3-10**. Compared against the number of services per hour to the area (**Table 3-8**), the analysis indicates that the majority of services are not over capacity and there is spare capacity on the network at this location. This is evidenced within **Table 3-11** which highlights the average spare capacity on services throughout a standard weekday in both 2016 and 2017.

Table 3-10 Number of services over seating (and standing) capacity per period per day (August 2016 vs August 2017)

Time Period	Inbound (To Edgecliff)		Outbound (From Edgecliff)	
	2016	2017	2016	2017
Before 7AM	0	0	2 (1)	3 (1)
7AM – 9AM	6 (2)	6 (2)	1	2
9AM – 3PM	1	4 (4)	2 (1)	0
3-7PM	6 (1)	7 (1)	1	3 (1)
After 7PM	1	1	0	0

Source: Transport for NSW; 2017

Table 3-11 Average Spare Capacity (August 2016 vs August 2017)

Time Period	Inbound (To Edgecliff)		Outbound (From Edgecliff)	
	2016	2017	2016	2017
Before 7AM	48	48	39	37
7AM – 9AM	36	35	39	37
9AM – 3PM	40	37	45	45
3-7PM	38	37	45	43
After 7PM	47	46	48	47

Source: Transport for NSW; 2017

3.3.2.4 Average Speed

In relation to bus service performance the average bus speed through the Double Bay Town Centre is summarised in **Table 3-12**. The data indicates that there has been an increase in the average bus travel speed in 2017, when compared against equivalent time periods in 2016. This increase could be representative of an improvement in the prevailing road network conditions and / or greater passenger uptake of Opal which results in a reduction in bus dwell times. The attractiveness of public transport as a mode is therefore improved and, if communicated to travellers accessing/egressing Double Bay, can support further attitudinal changes towards public transport.

The most significant improvement is observed between 6am and 8am for the inbound (westbound) direction, with an average increase of 4km/h in travel speed for trips toward Edgecliff. In the eastbound (outbound) direction, the average bus speed increased by 5km/h in 2017 between 3pm and 4pm, when compared against 2016 bus speeds for the same time period.

Table 3-12 Average Speed (August 2016 vs August 2017)

Time Period	Inbound (To Edgecliff)			Outbound (From Edgecliff)		
	2016	2017	Difference	2016	2017	Difference
06:00 to 07:00	18	22	4	21	24	3
07:00 to 08:00	15	19	4	18	20	2
08:00 to 09:00	13	15	2	18	19	1
09:00 to 10:00	12	15	3	19	19	0
15:00 to 16:00	10	12	2	14	19	5
16:00 to 17:00	9	12	3	16	18	2
17:00 to 18:00	12	13	1	15	18	3
18:00 to 19:00	15	15	0	16	20	4

Source: Transport for NSW; 2017

3.3.3 Train

3.3.3.1 Services

Edgecliff Station is located to the south-west of the study area, approximately 400m and five minutes walking distance from the town centre. Edgecliff Station is on the T4 Eastern Suburbs and Illawarra Line and on the South Coast Line, these train lines provide direct access to Bondi Junction, the City, Sutherland and to Wollongong, whilst also interconnecting to the wider Sydney Train network.

Trains travel to/from this station with a frequency of 18 services, in each direction of travel, during the AM peak hour period. Sixteen outbound (to Bondi Junction) trains and 17 inbound (to Central) trains service the station in the PM peak hour. There are approximately seven train services per hour on Saturdays.

3.3.3.2 Patronage

Patronage figures for the current rail line have not been provided to inform this study however, an overall summation of patronage, regarding the maximum capacity of the line is discussed below in **Section 3.3.3.3**.

3.3.3.3 Capacity

Capacity, assessed in the form of peak loading, has been obtained from Transport for NSW for the time period of March 2016 on the T4 - Eastern Suburbs and Illawarra Line in the peak direction of travel. Capacity is assessed against the following two measures:

– 100% load: A seat is available for each passenger

– 135% load: The benchmark beyond which passengers experience crowding and dwell times that can impact on on-time running.

During the AM peak the peak direction of travel is from Waterfall, Hurstville and Cronulla towards the city. Of the 30 trains that operate between 7-9AM, based on their arrive time at Central Station, only one train exceeds the 135 per cent threshold and five trains exceed the 100 per cent threshold as measured at Kings Cross Station. This indicates a large degree of spare capacity to operate future growth for individuals travelling to Edgecliff Station.

In the PM peak, peak load measurements were undertaken at Martin Place Station for the T4 line. During the 4-6PM time period a total of 31 trains were recorded, based on the departure time from Central Station within this time period. Only one train was recorded as exceeding the 100 per cent threshold with no trains exceeding the 135 per cent threshold. As was noted in the AM peak this provides sufficient capacity to cater for potential growth in the Double Bay Town Centre.

3.4 Cycling Usage

An overview of key cycling routes, as well as dedicated walking paths, within and around the study area is provided in **Figure 3**–1.

Figure 3–1 Key Cycling routes

Source: WMC; 2007, modified by SCT Consulting; 2020

Bay Street and Cross Street are identified as key bicycle routes on the WMC 'Cycling in Waverley and Woollahra Cycle Map'. These routes are marked as part of the on-road cycle network and traverse the town centre through low traffic volume corridors. Town centre bicycle routes connect to the wider network via New South Head Road to the west, Manning Road and Bellevue Road to the south-east and via William Street to the north east. No dedicated cycle routes are shown along New South Head Road within the Double Bay Town Centre, as identified in the Woollahra Bicycle Strategy (2009).

3.4.1.1 Existing Cycling Conditions

Cycling to and from Double Bay is currently observed to be difficult and potentially unsafe due to a lack of dedicated cycling infrastructure and topographical constraints. Multiple roads with steep grades make it difficult for cyclists to ride uphill with limited protection for cyclists.

Ocean Avenue between Cooper Street and New South Head Road and William Street between Sherbrooke Avenue and New South Head Road in particular, have very steep gradients making them a challenging environment for cyclists.

Sydney's Cycling Future released by TfNSW in 2013 classified Sydney's cycleway network into six and grouped them into three customer preference categories (shown in **Figure 3–2**).

Figure 3–2 Sydney's Cycling future – facilities classification

Facility Type	Preference
 Off road separated bicycle path (separated from pedestrians)	
 On road separated bicycle path (physically separated from vehicles/ pedestrians)	
 Mixed traffic lane on quiet local street	
 Road shoulder	
 Bicycle logo beside a parked car	
 Mixed traffic lane on busy street	

Facility Type Preference Ranking	
	>75% feel quite or very safe and comfortable
	As many feel safe and comfortable as unsafe and uncomfortable
	>75% feel quite or very unsafe and uncomfortable

Source: TfNSW, 2013, modified by SCT Consulting; 2020

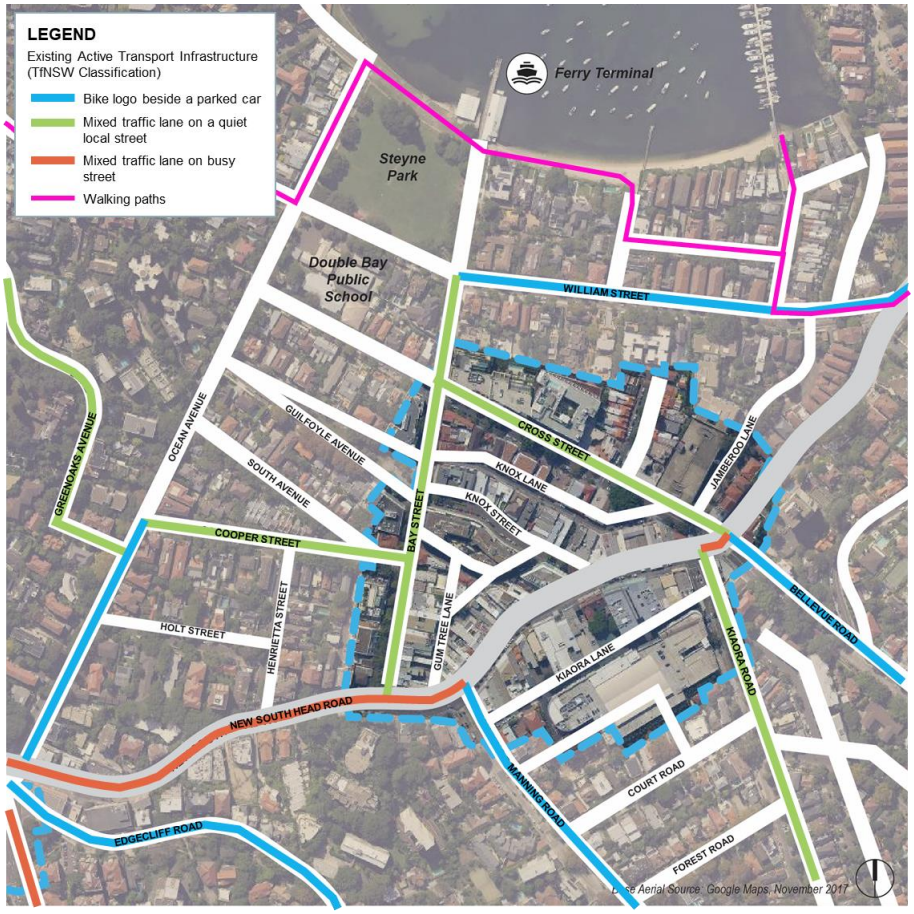
The Double Bay study area comprises of three cycleway classifications:

- "Mixed traffic lane on busy street" where the designated cycleway is located on a major arterial road such as New South Head Road;
- "Bicycle logo beside a parked car" where the designated cycleway is located on a major council road such as Ocean Avenue or where painted cycleways are located next to a parked car such as Bellevue Road; and
- "Mixed traffic lane on a quiet local street" where the designated cycleway is located on a minor council road such as Cooper Street.

There are currently no cycleways within the Double Bay study area where ">75% feel quite or very safe and comfortable".

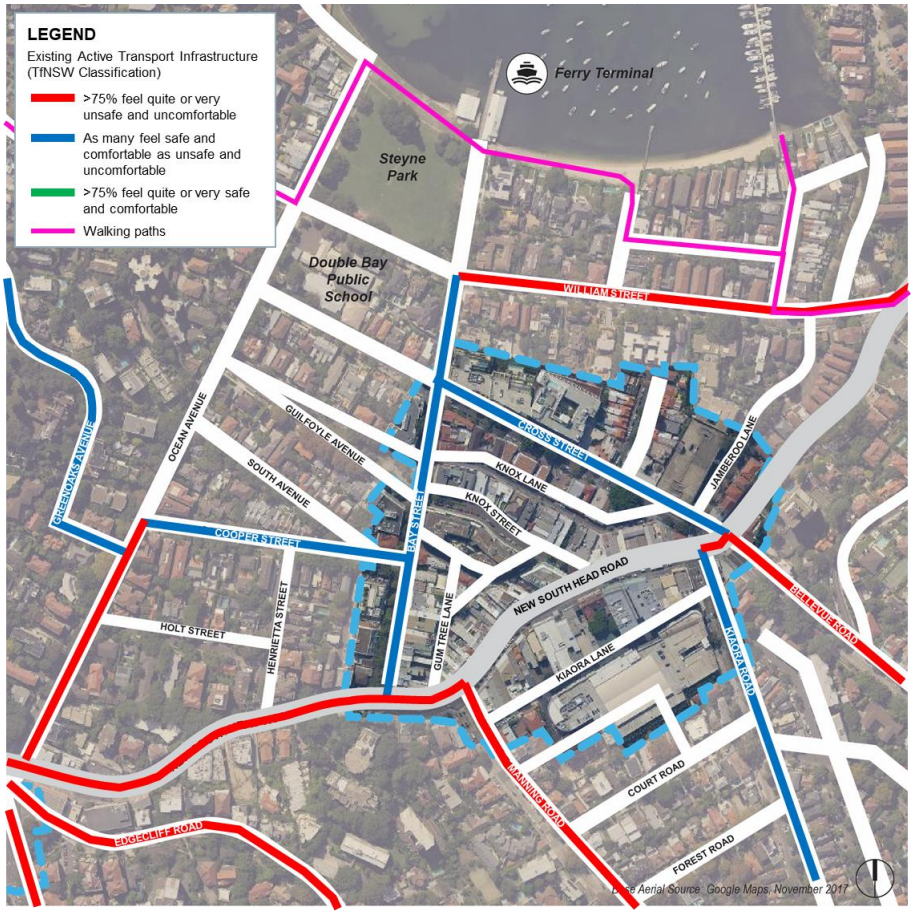
A summary of active transport facilities in the Double Bay and their preference rankings are shown in **Figure 3–3** and **Figure 3–4** respectively.

Figure 3–3 Existing active transport facility types using TfNSW Classifications



Source: WMC; 2007, modified by SCT Consulting; 2020

Figure 3–4 Existing active transport facility type preference ranking using TfNSW Classifications



Source: WMC; 2007, modified by SCT Consulting; 2020

3.4.1.2 Cyclist volumes

To provide an estimate of current ridership volumes within the Double Bay Town Centre data was obtained from Strava for the time period July 2015 to June 2017. Whilst only representing a subset of the cycling population the series profile that is provided across the multiple routes within the study area highlights a key travel pattern of this subset of cyclists. **Figure 3–5**, which highlights the utilised routes visually, indicates that New South Head Road is the most frequently used route for cyclists within the Double Bay Town Centre for this subset. All remaining roads within the study area recorded a low patronage range total of between 1 and 1,718 cyclists over the two year period.

Cyclist counts at key intersections within the Double Bay area (surveyed in August 2017) indicated that New South Head Road, Ocean Avenue and William Street were the most frequently used roads for cyclists within the Double Bay Area as shown in **Figure 3–5**. Cyclist counts at the intersection of Ocean Avenue and Greenoaks Avenue indicated a northbound desire line from Ocean Avenue to William Street were the highest instead of WMC's route designation of Bay Street to William Street.

Additionally, cycle counts showed that cyclists were more willing to cycle downhill in the Double Bay area where the volume of cyclists travelling downhill along New South Head Road, Ocean Avenue and William Street were significantly higher when compared to the cyclist volumes of those travelling uphill.

Figure 3–5 Cycle counts

Source: Strava; 2017, modified by SCT Consulting; 2020

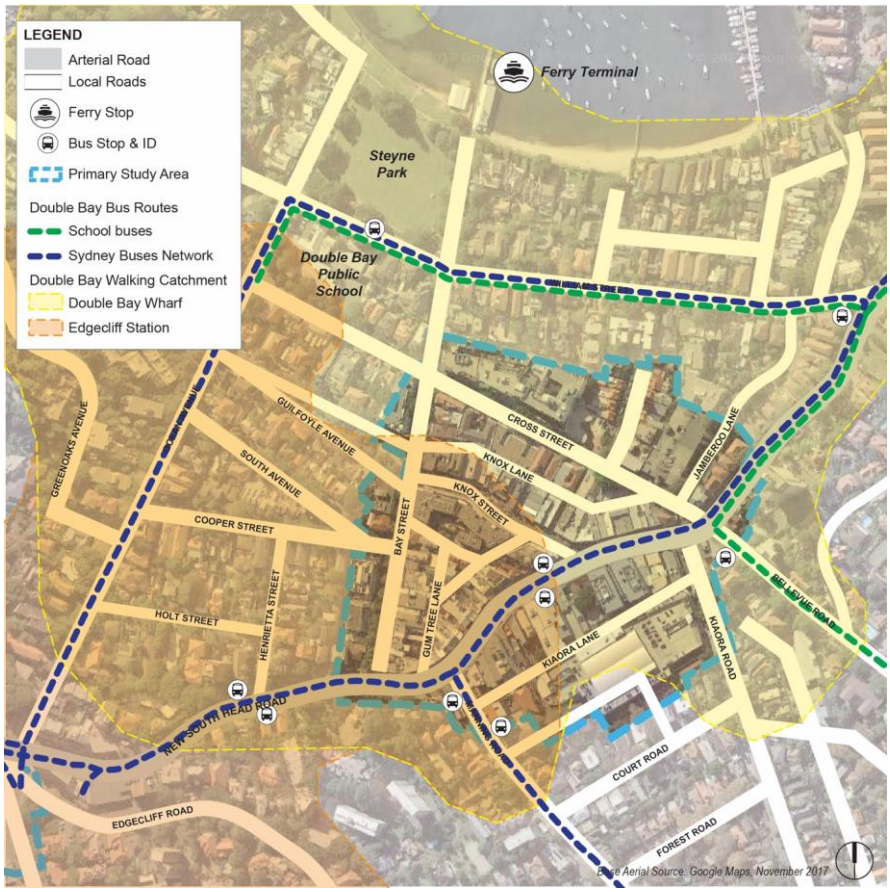
3.5 Walking

Walking is a very accessible travel model for residents living in the Double Bay study area. The Department of Infrastructure and Transport notes that generally people are prepared to walk approximately 800m to a high frequency, direct public transport service such as trains and ferries. For indirect or local services such as buses, people are willing to walk about 400m[3].

In relation to the Double Bay study area, almost all residents live within an 800m walking catchment to either Edgecliff Train Station or Double Bay Ferry Wharf as shown in **Figure 3–6**. For buses, most residents live within a 400m walking catchment to at least one bus stop located along New South Head Road, the primary road for buses travelling into Sydney CBD. Similarly, key destinations (as shown in **Figure 3–7**) such as Double Bay Town Centre and Double Bay Primary School are accessible within an 800m catchment for all residents living within the Double Bay study area.

Double Bay Town Centre is an attractive destination with high pedestrian activity along streets like Cross Street, Knox Street and Transvaal Avenue. It's appeal as a local destination combined with Double Bay's high quality walking environment makes it easy to encourage residents to walk instead of drive.

Figure 3–6 Walking Catchment to Edgecliff Station and Double Bay Ferry Wharf



Source: SCT Consulting; 2020

[3] Walking, Riding and Access to Public Transport, Department of Infrastructure and Transport

Figure 3–7 Points of interest in Double Bay

Source: SCT Consulting; 2020

3.5.1.1 Existing Walking Conditions

Walking conditions within the Double Bay area are generally pleasant with wide footpaths on either side of almost all local roads and large street trees providing pedestrians with protection from the weather.

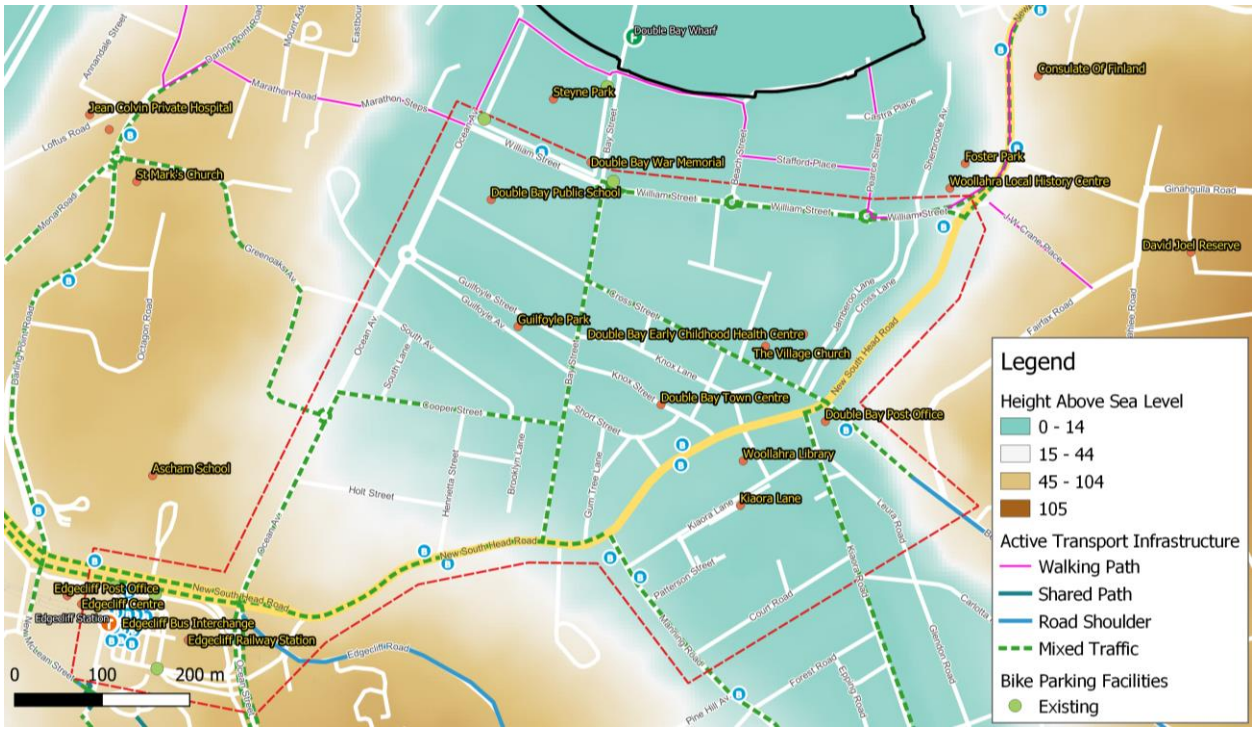
All crossing opportunities identified as a key walking route in Double Bay (refer to **Figure 3–8**) have kerb ramps installed on both sides of crossing opportunities.

In relation to topography, the Double Bay area is mostly flat where the profile of the area varies between 0 to 14 meters above sea level (see **Figure 3–9**). The area outside Double Bay however is quite high with profiles ranging from 14 to 104 meters above sea level. This difference in height between Double Bay and its surrounding areas creates steep roads and footpaths making it difficult for surrounding residents to access Double Bay Town Centre by walking.

Figure 3–8 Key Walking Routes in Double Bay

Source: SCT Consulting; 2020

Figure 3–9 Double Bay Topography



Source: SCT Consulting; 2020

3.6 Car Share Usage

Within the overall Double Bay Transport Study area, shown in **Figure 1**–1, there are a total of five locations (six vehicles) where residents have access to GoGet car share vehicles, shown in **Table 3-13**. A total of 440 GoGet members currently are within 250m of at least one of these locations.

Data was obtained for the month of March 2016 and 2017 to determine underlying trends in car share usage within the precinct. Results indicated that car share usage has declined within the Double Bay Town Centre precinct over the past 12 months across overall bookings, hours booked and average trip hour metrics. This dataset is not considered large enough to form a representative sample and draw conclusions relating to car share usage in Double Bay. Further, the Holt Street pod is considered an outlier given the significant difference in usage between 2016 and 2017 as well as when compared to other pods locations.

Table 3-13 Go Get Car Share Usage (March 2016 vs March 2017)

Bay Location	Number of bookings		Hours Booked		Average Trip Hours	
	March 2016	March 2017	March 2016	March 2017	March 2016	March 2017
Cross Street Car Park	31	42	502.5	190	16.2	4.5
Holt Street	29	25	189.5	108.5	6.5	4.3
Ocean Avenue	27	15	138.5	128.5	5.1	8.6
South Avenue	29	27	130	178	4.5	6.6
William Street	25	21	192	73.5	7.7	3.5
Total	**165**	**138**	**1253.5**	**719.5**	**44.2**	**32.6**

Source: GoGet Car Share; 2017

3.6.1 Benefits of Car Share

Benefits realisation of car share schemes, with respect to the City of Sydney Local Government Area, is documented within the Committee for Sydney document 'Carsharing: Sydney Snapshot' as follows:

– Each car share vehicle removes 10 private vehicles from the road network. Within the Double Bay area research indicates that approximately 70 per cent of these vehicles would be parked on street. These factors can be considered in the application of ratios for car spaces within new dwellings.

– A reduction in vehicle kilometres travelled by approximately 2,000km per year for each user with corresponding increases in walking, riding a bicycle or using public transport. This has flow on impacts to the health of residents.

– Each car space in a multi-storey car park can cost between $30,000 - $70,000 to construct with apartment prices increasing in cost by $50,000 - $140,000 when a car space is provided. These cost savings are passed on to developers and unit owners alike.

– The current benefit that each car share vehicle provides is estimated at $59,673. This takes into consideration factors such as congestion, environmental factors such as emissions, opportunity cost of not owning a car space, management fees and community value of space.

These statistics support the notion of using car share schemes, such as Go Get, to achieve reductions in private vehicle ownership. They also allow for action to be taken regarding parking provision and a review of existing parking controls.

3.7 Future Growth Patterns

Future patterns of growth are not possible to accurately predict based on the increasing emergence of technology in aiding workplace productivity and the ability of staff to work remotely and the unknown workplace location of these individuals. However, factors such as attitudinal changes to public transport, increased public transport frequencies during peak times, and future employment growth within the WMC local area all have the potential to further improve the public and active transport mix for journey to work trips. This would reduce the impact of private vehicles on the local road network relative to existing usage rates.

Furthermore, the changing pattern of car ownership in future years has the potential to change both people's travel behaviour and the need for parking within residential buildings, commercial dwellings. Research indicates that as many as 200,000 Australians are currently using car share schemes with this potentially increasing to 1.5m in the next 10 years.

4.0 Existing Intersection Operational Conditions

4.1 Geometric Layout and Operational Performance

Section 4 provides a detailed overview of the existing geometrical and operational performance characteristics of the following key intersections within the study area:

– Cross Street / Bay Street

– William Street / Bay Street

– Ocean Avenue / Greenoaks Avenue

– New South Head Road / Bay Street

– New South Head Road / Manning Road Street

– New South Head Road / Knox Street

– New South Head Road / Cross Street / Bellevue Road / Kiaora Road

The following time periods were identified as the peak hour within the surveyed AM, PM and Saturday data sets:

– AM peak (7:45AM – 8:45AM)

– PM peak (5:30PM – 6:30PM)

– Saturday peak (11:45AM – 12:45PM)

Detailed intersection approach volumes for all assessed sites as well as midblock tube count summaries for Manning Street, Kiaora Road and Bellevue Road are provided in **Appendix A** and **Appendix B**, respectively. Detailed SIDRA results for each scenario are also provided in **Appendix A**.

Operational performance is typically measured through an assessment of the throughput of vehicles across a traffic network, with average delay per vehicle used to assess the performance of an individual intersection. This is consistent with Roads and Maritime Service best practice and is industry standard for the assessment of intersection performance. The average delay per vehicle measure is linked to a Level of Service (LoS) index which characterises the intersection's operational performance. **Table 4–1** provides a summary of the LoS performance bands.

Table 4-1 Level of Service Index

Level of Service	Average Delay per Vehicles (sec/h)	Traffic Signals / Roundabout	Give Way / Stop Signs
A	Less than 14.5	Good operation	Good operation
B	14.5 to 28.4	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	28.5 to 42.4	Satisfactory	Satisfactory, but incident study required
D	42.5 to 56.4	Operating near capacity	Near capacity and incident study required
E	56.5 to 70.4	At capacity, at signals incidents will cause excessive delays. Roundabouts require other control method.	At capacity, requires other control method
F	70.5 or greater	At capacity, at signals incidents will cause excessive delays. Roundabouts require other control method.	At capacity, requires other control method

Source: Guide to Traffic Generating Developments; Roads and Maritime Services; 2002

Degree of saturation is used to measure the capacity of an intersection. This is determined from the ratio of the volume of vehicles which pass through an intersection against the capacity provided by green time, if applicable, andnumber of traffic lanes available. i.e. vehicle / capacity = DoS. DoS has been used as the measure to define network capacity for this study and to determine whether the road network can cater for any potential development.

All sites assessed as part of the Double Bay Transport Study have been modelled in the software package SIDRA 7.

4.1.1 4.1.1 Cross Street / Bay Street

4.1.1.1 Geometric Layout

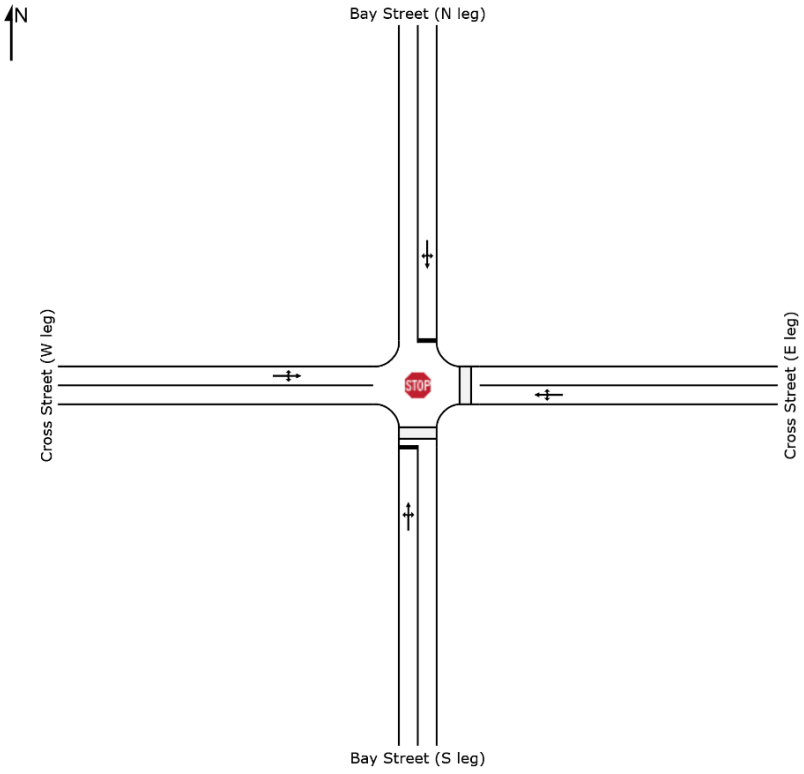
Cross Street / Bay Street is a priority controlled intersection, located at the northern extent of the Double Bay Town Centre, characterised by single lanes on approach and departure. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-2** and **Figure 4**–1.

Table 4-2 Cross Street / Bay Street: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
Bay Street (S leg)	50	-	-	-
Cross Street (E leg)	50	-	-	-
Bay Street (N leg)	50	-	-	-
Cross Street (W leg)	50	-	-	-

Source: SCT Consulting; 2020

Figure 4–1 Cross Street / Bay Street: Geometric Layout



Source: SCT Consulting; 2020

4.1.1.2 Intersection Performance

A summary of the existing operational performance of the Cross Street / Bay Street intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-3**. Modelling results indicate that the intersection operates with a large degree of spare capacity in both the AM, PM and Saturday peak hour periods, recording LoS A at all times. The largest DoS recorded in any period was 0.18 (Saturday peak hour period).

Table 4-3 Cross Street / Bay Street: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	813	0.17	9.2	A	4
PM Peak Hour Period	718	0.17	8.5	A	4
Saturday Peak Hour Period	745	0.18	8.7	A	4

Source: SCT Consulting; 2020

4.1.2 William Street / Bay Street

4.1.2.1 Geometric Layout

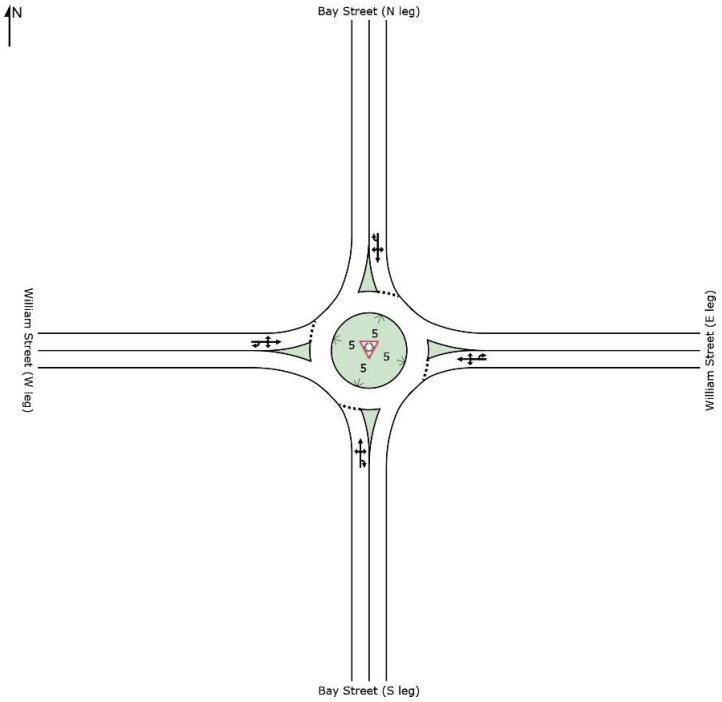
William Street / Bay Street is a roundabout priority controlled intersection, located at the northern extent of the Double Bay Town Centre. The site borders Steyne Park to the north and is characterised by single lanes on approach and departure. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-4** and **Figure 4**–2**.**

Table 4-4 William Street / Bay Street: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
Bay Street (S leg)	50	-	-	-
William Street (E leg)	50	-	-	-
Bay Street (N leg)	50	-	-	-
William Street (W leg)	50	-	-	-

Source: SCT Consulting; 2020

Figure 4–2 William Street / Bay Street: Geometric Layout



Source: SCT Consulting; 2020

4.1.2.2 Intersection Performance

A summary of the existing operational performance of the William Street / Bay Street intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-5**. Modelling results indicate that the intersection operates with a large degree of spare capacity in both the AM, PM and Saturday peak hour periods, recording LoS A at all times. The largest DoS recorded in any period was 0.35. This was noted in the AM and Saturday peak hour periods.

Table 4-5 William Street / Bay Street: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	1,026	0.35	7.7	A	17
PM Peak Hour Period	779	0.34	7.9	A	16
Saturday Peak Hour Period	883	0.35	8.1	A	16

Source: SCT Consulting; 2020

4.1.3 Ocean Avenue / Greenoaks Avenue

4.1.3.1 Geometric Layout

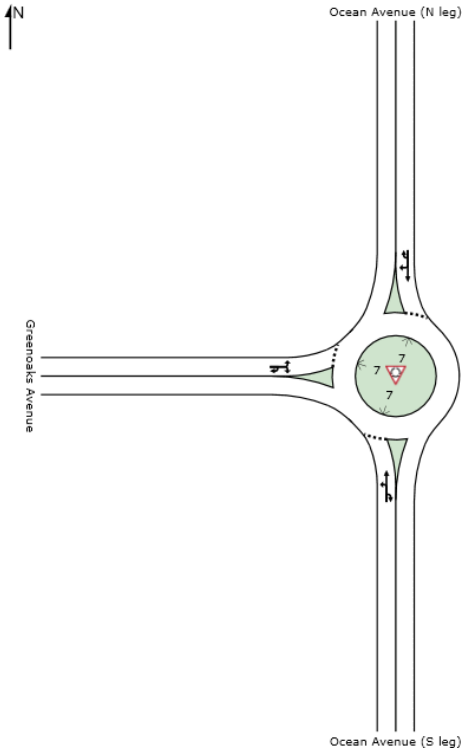
Ocean Avenue / Greenoaks Avenue is a roundabout priority controlled intersection, located at the western extent of the Double Bay Town Centre. The site is characterised by single lanes on approach and departure. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-6** and **Figure 4**–3.

Table 4-6 Ocean Avenue / Greenoaks Avenue: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
Ocean Avenue (S leg)	50	-	-	-
Ocean Avenue (N leg)	50	-	-	-
Greenoaks Avenue (W leg)	50	-	-	-

Source: SCT Consulting; 2020

Figure 4–3 Ocean Avenue / Greenoaks Avenue: Geometric Layout



Source: SCT Consulting; 2020

4.1.3.2 Intersection Performance

A summary of the existing operational performance of the Ocean Avenue / Greenoaks Avenue intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-7**. Modelling results indicate that the intersection operates with a large degree of spare capacity in both the AM, PM and Saturday peak hour periods, recording LoS A at all times. The largest DoS recorded in any period was 0.67. This was noted in the AM peak hour period.

Table 4-7 Ocean Avenue / Greenoaks Avenue: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	1,804	0.67	12.3	A	52
PM Peak Hour Period	1,334	0.50	8.0	A	27
Saturday Peak Hour Period	1,484	0.57	7.4	A	33

Source: SCT Consulting; 2020

4.1.4 New South Head Road / Bay Street

4.1.4.1 Geometric Layout

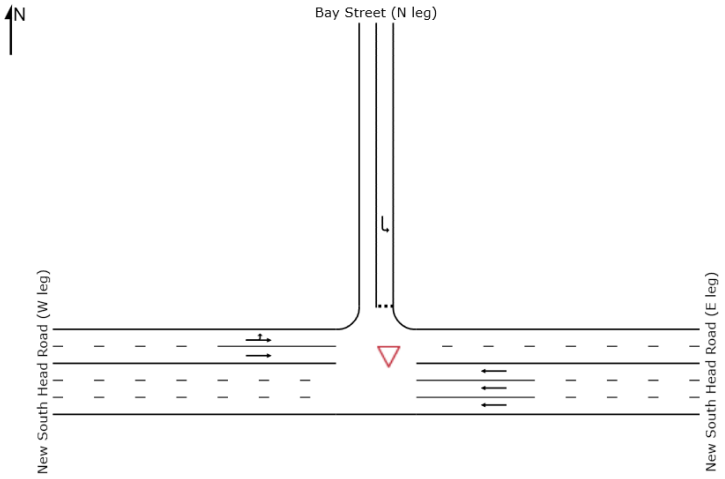
New South Head Road / Bay Street is a signalised intersection, located at the southern extent of the Double Bay Town Centre. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-8** and **Table 4-4.**

Table 4-8 New South Head Road / Bay Street: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
New South Head Road (E leg)	60	Right	-	-
Bay Street (N leg)	50	Right	-	-
New South Head Road (W leg)	60	-	-	-

Source: SCT Consulting; 2020

Figure 4–4 New South Head Road | Bay Street: Geometric Layout



Source: SCT Consulting; 2020

4.1.4.2 Intersection Performance

A summary of the existing operational performance of the New South Head Road / Bay Road intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-9**. Modelling results indicate that the intersection operates with a large degree of spare capacity in both the AM, PM and Saturday peak hour periods, recording LoS A at all times. The largest DoS recorded in any period was 0.55. This was noted in the Saturday peak hour period.

Table 4-9 New South Head Road / Bay Street: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	3,280	0.38	6.3	A	2
PM Peak Hour Period	3,198	0.44	0.4	A	9.3
Saturday Peak Hour Period	3,509	0.55	13.5	A	17.0

Source: SCT Consulting; 2020

4.1.5 New South Head Road / Manning Road

4.1.5.1 Geometric Layout

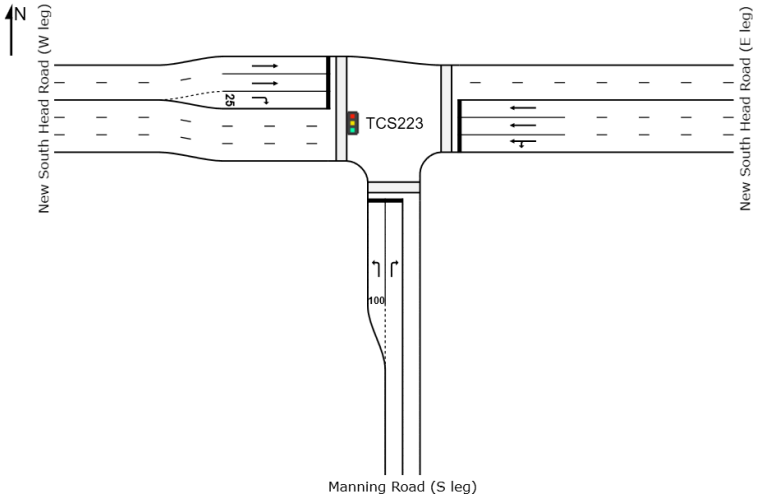
New South Head Road / Manning Road is a signalised intersection, located at the southern extent of the Double Bay Town Centre. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-10** and **Figure 4**–5.

Table 4-10 New South Head Road / Manning Road: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
Manning Road (S leg)	50	-	Left	100
New South Head Road (E leg)	60	-	-	-
New South Head Road (W leg)	60	-	Right	25

Source: SCT Consulting; 2020

Figure 4–5 New South Head Road / Manning Road: Geometric Layout



Source: SCT Consulting; 2020

4.1.5.2 Intersection Performance

A summary of the existing operational performance of the New South Head Road / Manning Road intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-11**. Modelling results indicate that the intersection operates with at least 10 and 20 per cent spare capacity in the AM and PM peak hour periods respectively. The intersection operates at LoS A at all times. The largest DoS recorded in any period was 0.88. This was noted in the AM peak hour period.

Table 4-11 New South Head Road / Manning Road: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	3,383	0.88	35.4	C	229
PM Peak Hour Period	3,316	0.81	12.7	A	106
Saturday Peak Hour Period	3,144	0.74	11.7	A	106

Source: SCT Consulting; 2020

4.1.6 New South Head Road / Knox Street

4.1.6.1 Geometric Layout

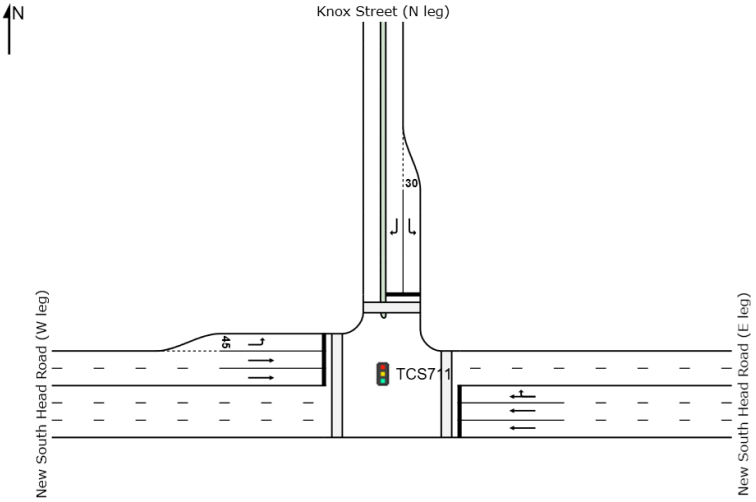
New South Head Road / Knox Street is a signalised intersection, located at the eastern extent of the Double Bay Town Centre. The site is characterised is the intersect of arterial and local road networks. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-12** and **Figure 4–6.**

Table 4-12 New South Head Road / Knox Street: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
New South Head Road (E leg)	60	-	-	-
Knox Street (N leg)	50	-	Left	30
New South Head Road (W leg)	60	-	Left	45

Source: SCT Consulting; 2020

Figure 4–6 New South Head Road / Knox Street: Geometric Layout



Source: SCT Consulting; 2020

4.1.6.2 Intersection Performance

A summary of the existing operational performance of the New South Head Road / Knox Street intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-13**. Modelling results indicate that the intersection operates at practical capacity during the AM peak period, with DoS 0.92 and LoS B. There is a large degree of spare capacity in the PM and Saturday peak hour periods, recording LoS A.

Table 4-13 New South Head Road / Knox Street: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	2,924	0.92	15.3	B	111
PM Peak Hour Period	2,853	0.77	5.3	A	45
Saturday Peak Hour Period	2,404	0.41	5.4	A	43

Source: SCT Consulting; 2020

4.1.7 New South Head Road / Cross Street / Bellevue Road / Kiaora Road

4.1.7.1 Geometric Layout

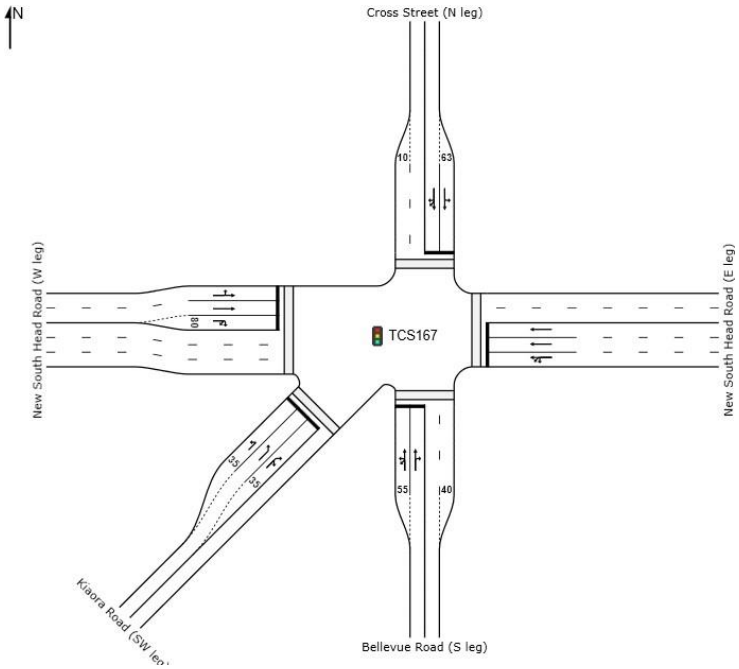
New South Head Road / Cross Street / Bellevue Road / Kiaora Road is a signalised intersection to the, located at the eastern extent of the Double Bay Town Centre. The site is characterised by five approaches which restrict the overall operating capacity of the intersection. An overview of the geometric layout and characteristics of the intersection is provided in **Table 4-14** and **Figure 4**–7.

Table 4-14 Ocean Avenue / Greenoaks Avenue: Geometric Layout Key Features

Approach	Speed Limit	Banned Movements	Turn Bay	
			Movement	Length
Bellevue Road (S leg)	50	-	Left	55
New South Head Road (E leg)	60	Right	-	-
Cross Street (N leg)	50	-	Left	63
New South Head Road (W leg)	60	-	Right	80
Kiaora Road (SW leg)	50	-	Left | Right	35 | 35

Source: SCT Consulting; 2020

Figure 4–7 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: Geometric Layout



Source: SCT Consulting; 2020

4.1.7.2 Intersection Performance

A summary of the existing operational performance of the New South Head Road / Cross Street / Bellevue Road / Kiaora Road intersection, for the AM, PM and Saturday peak periods, is provided in **Table 4-15**. Modelling results indicate that the intersection operates with acceptable overall performance, with LoS C during all periods. During the AM peak the highest DoS occurs on Bellevue Road at 0.99, and is associated with the left turn movement. During the PM and Saturday peak the most saturated movement is the right turn movement on New South Head Road (W leg), operating at DoS 0.98 and 0.96 respectively.

Table 4-15 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: Intersection Performance

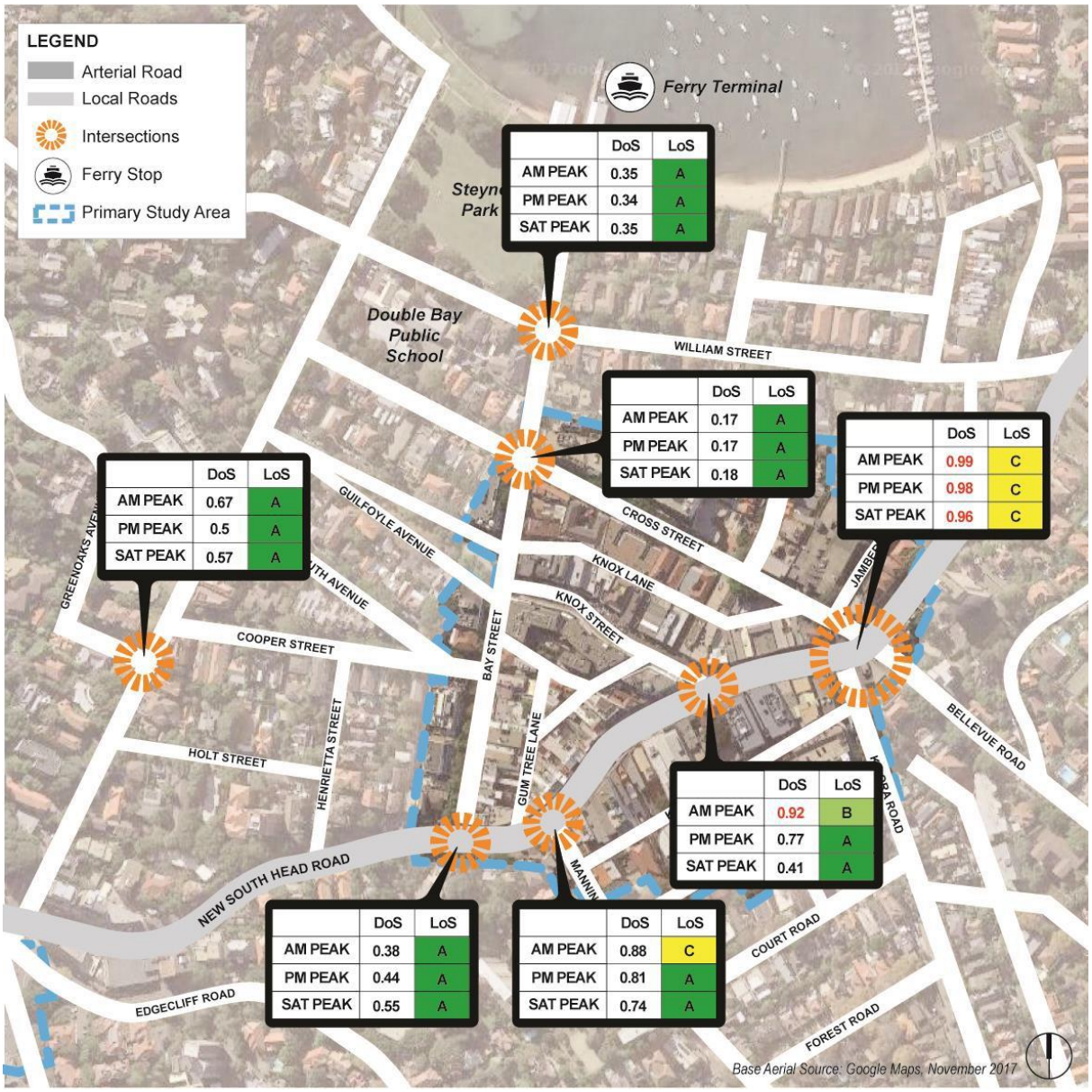
Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	3,771	0.99	38.4	C	195
PM Peak Hour Period	3,475	0.98	32.2	C	137
Saturday Peak Hour Period	3,523	0.96	33.9	C	201

Source: SCT Consulting; 2020

4.2 Existing Intersection Performance Summary

A summary of DoS and LoS across the Double Bay Transport Study area is provided in **Figure 4**–8.

Figure 4–8 Existing Intersection Performance Summary



Source: SCT Consulting; 2020

5.0 Potential Development

5.1 Scenarios

In order to ascertain the impact of the potential additional development yield on the Double Bay Town Centre the following scenarios were assessed:

– Scenario 1

- Five year plan which centred on the assessment of the following peak periods:
  - AM peak hour
  - PM peak hour
  - Saturday peak hour

  A breakdown of the developments that could potentially occur within five years is provided in **Table 5-1** below. The assessment year for Scenario 1 is 2022.

– Scenario 2

- 10 year plan which centred on the assessment of the following peak periods:
  - AM peak hour
  - PM peak hour
  - Saturday peak hour

  A breakdown of the developments that could potentially occur within the next 10 years is provided in **Table 5-1** below. The assessment year for Scenario 2 is 2027.

5.2 Background traffic

Analysis of the Woollahra Local Government Area (LGA) Journey to Work data between 2006 and 2011 indicates that there was an increase in approximately 0.7 per cent in vehicle trips (Car (Driver) over the five year period. This is equivalent to approximately 0.15 per cent growth in vehicle trips per annum.

A background growth rate of 0.15 per cent per annum has been adopted for vehicle trips along New South Head Road, as per historical trends indicated from the Journey to Work data for the Woollahra LGA. A summary of key Journey to Work trips is provided in **Table 5–1**.

Table 5-1 Woollahra LGA Journey to Work Analysis (2006-2011)

Main Method of Travel	2011			2006			Change ('06 to '11)	
	Number	%	Sydney %	Number	%	Sydney %	trips	% per annum
Train	3,829	14.6	13.8	3,156	12.7	12.3	+673	3.94%
Bus	2,466	9.4	5.8	2,221	8.9	5.4	+245	2.11%
Tram or Ferry	597	2.3	0.4	571	2.3	0.4	+26	0.89%
Taxi	293	1.1	0.3	370	1.5	0.3	-77	-4.56%
Car (Driver)	10,434	39.7	53.8	10,358	41.6	53.7	+76	**0.15%**
Car (Passenger)	1,042	4.0	4.5	1,127	4.5	5.3	-85	-1.56%
Truck	56	0.2	1.1	48	0.2	1.3	+8	3.13%
Motorbike	302	1.1	0.6	177	0.7	0.5	+125	11.28%
Bicycle	332	1.3	0.8	167	0.7	0.6	+165	14.73%
Walked only	2,266	8.6	4.1	2,123	8.5	4.2	+143	1.31%

Source: http://profile.id.com.au/; 2017, modified by SCT Consulting 2018

5.3 Development Yield

Figure 5–1 and **Table 5-2** provide an overview of the hypothetical development scenario for potential development and includes locations, yield, car parking provision, and associated population growth associated with the residential, commercial and retail land uses. At completion, the potential expansion of the Double Bay Town Centre could result in an uplift of 1,196 parking spaces and 2,936 people across all three land uses.

The development potential is based on the total future development compared to the existing development as a baseline.

Figure 5–1 Double Bay Town Centre Potential Development Schematic

Source: WMC; 2017

Table 5-2 Double Bay Town Centre Potential Development Yield

Site / Land Use		Residential		Commercial		Retail	
		Future	Uplift	Future	Uplift	Future	Uplift
Site 1 Knox Street North	GFA (m^2)	7,331		3,405		2,837	
	People	147	147	170	90	95	11
	Parking	95	95	51	18	56	56
Site 2 Cross Street south west	GFA (m^2)	10,037		4,589		4,589	
	People	201	201	229	184	153	40
	Parking	130	130	69	50	91	91
Site 3 Transvaal and Cross Street	GFA (m^2)	2,454		943		943	
	People	49	49	47	47	31	6
	Parking	32	32	14	14	19	19
Site 4 New South Head Road north east	GFA (m^2)	5,093		2,596		2,596	
	People	102	102	130	94	87	3
	Parking	66	66	39	24	51	51
Site 5 New South Head Road north west	GFA (m^2)	8,760		4,047		4,047	
	People	175	168	202	143	135	4
	Parking	114	111	61	37	80	80
Site 6 New South Head Road south	GFA (m^2)			25,843		7,038	
	People	0	0	1292	1157	235	19
	Parking	0	0	388	313	139	139
Site 7 Post Office	GFA (m^2)	738		330		295	
	People	15	15	17	17	10	0
	Parking	10	10	5	5	6	6
Site 8 Bay Street east and west	GFA (m^2)	5,502		2,700		2700	
	People	110	106	135	115	90	57
	Parking	72	70	41	23	53	53
Site 9 New South Head Road south west	GFA (m^2)	750	300	0	0	200	
	People	15	15			7	7
	Parking	10	10			4	4
Total	People	813	802	2,223	1848	842	146
	Parking	529	524	667	483	500	500

Source: WMC; 2017

For the purposes of the hypothetical development scenario it was estimated that construction for the full development will be completed by 2027, while 50 per cent of the potential development will be delivered within a five-year period by 2022. **Table 5-3** provides a summary of the 50 per cent staged development yield for the year 2022 that is assumed for the purpose of analysis.

Table 5-3 Double Bay Town Centre, 2022 Potential Development Yield (50%)

Site / Land Use		Residential		Commercial		Retail	
		2022	Uplift	2022	Uplift	2022	Uplift
Site 2 Cross Street south west	GFA (m^2)	5,219		3,212		2,753	
	People	104	**104**	161	**129**	92	**24**
	Parking	68	**68**	48	**35**	55	**55**
Site 3 Transvaal and Cross Street	GFA (m^2)	1,227		566		472	
	People	25	**25**	28	**28**	16	**3**
	Parking	16	**16**	8	**8**	9	**9**
Site 4 New South Head Road north east	GFA (m^2)	1,019		1,038		779	
	People	20	**20**	52	**38**	26	**1**
	Parking	13	**13**	16	**10**	15	**15**
Site 5 New South Head Road north west	GFA (m^2)	8,760		4,047		4,047	
	People	175	**168**	202	**143**	135	**4**
	Parking	114	**111**	61	**37**	80	**80**
Site 6 New South Head Road south	GFA (m^2)	-		11,629		1,760	
	People	-	**-**	581	**521**	59	**5**
	Parking	-	**-**	174	**141**	35	**35**
Site 8 Bay Street east and west	GFA (m^2)	3301		1,890		1,620	
	People	66	**64**	95	**81**	54	**34**
	Parking	43	**42**	28	**16**	32	**32**
Site 9 New South Head Road south west	GFA (m^2)	750	**300**	-	**-**	200	
	People	15	**15**	-	**-**	7	**7**
	Parking	10	**10**	-	**-**	4	**4**
Total	People	**406**	**396**	**1,119**	**940**	**388**	**77**
	Parking	**264**	**259**	**336**	**246**	**230**	**230**

Source: WMC; 2017

5.4 Development Trip Generation

As described in **Section 5.2**, the potential development compromises residential, retail and commercial land uses.

The average trip rate for medium density residential flat buildings within Sydney urban areas, as published by the Roads and Maritime Services, is identified as 0.4 – 0.5 trips per dwelling within the AM and PM peak hour periods respectively. On this basis, the potential development would expect to generate up to 262 trips in the AM and PM peak hour. The ratio of inbound to outbound trips in the AM peak is assumed to be 10:90, conversely PM peak inbound to outbound ratio is assumed to be 90:10.

At full development it is assumed that the Double Bay Town Centre will include approximately 44,450sqm GFA of commercial development i.e. existing + potential yield. The Roads and Maritime Guide to Traffic Generating Developments – updated traffic survey (TDT 2013/04a) indicates the Sydney average trip rate for large scale commercial precincts is 0.52 trips / 100 sqm and 0.56 trips / 100 sqm during the AM and PM peak hour respectively. Applied to the Double Bay Town Centre the commercial development will generate 231 trips / hour during the AM peak and 249 trips during the PM peak hour.

Whilst the total potential uplift in retail, based on the growth scenario, is in the order of 4,100 sqm, the existing Double Bay Town Centre includes approximately 21,000sqm of retail space. The average trip rate for retail precincts, with a total floor area in the area in the range of 20,000 and 30,000 sqm, is 5.9 trips / 100sqm and 7.5 trips / 100 sqm during the PM peak and Saturday peak respectively. On this basis the total retail trips generated will be 243 trips / hour and 309 trips / hour in the Thursday PM peak hour and Saturday peak hour.

The total trip generation associated with the potential development is summarised in **Table 5-4** with network flow schematics provided in **Appendix C**.

Table 5-4 Double Bay Town Centre Potential Development Trip Generation

Site / Land Use	Residential		Commercial		Retail		Total	
	2022 50% Dev	2027 Full Dev.	2022 50% Dev	2027 Full Dev	2022 50% Dev	2027 Full Dev	2022 50% Dev	2027 Full Dev
AM Peak								
Site 1	0	48	0	18	-	-	0	65
Site 2	34	65	17	24	-	-	51	89
Site 3	8	16	3	5	-	-	11	21
Site 4	7	33	5	14	-	-	12	47
Site 5	55	55	21	21	-	-	76	76
Site 6	0	0	60	134	-	-	60	134
Site 7	0	5	0	2	-	-	0	7
Site 8	21	35	10	14	-	-	31	49
Site 9	5	5	0	0	-	-	5	5
Total	**130**	**262**	**116**	**231**	**-**	**-**	**246**	**493**
PM Peak								
Site 1	0	48	0	19	0	19	0	85
Site 2	34	65	18	26	42	71	94	162
Site 3	8	16	3	5	6	11	17	33
Site 4	7	33	6	15	1	4	14	52
Site 5	55	55	23	23	7	7	85	85
Site 6	0	0	65	145	8	33	73	178
Site 7	0	5	0	2	0	0	0	6

Site / Land Use	Residential		Commercial		Retail		Total	
	2022 50% Dev	2027 Full Dev.	2022 50% Dev	2027 Full Dev	2022 50% Dev	2027 Full Dev	2022 50% Dev	2027 Full Dev
Site 8	21	35	11	15	61	101	92	151
Site 9	5	5	0	0	-3	-3	2	2
Total	**130**	**262**	**125**	**249**	**122**	**243**	**377**	**754**
Saturday Peak								
Site 1	0	48	-	-	0	24	0	71
Site 2	34	65	-	-	54	90	88	155
Site 3	8	16	-	-	7	14	15	30
Site 4	7	33	-	-	2	6	8	39
Site 5	55	55	-	-	9	9	64	64
Site 6	0	0	-	-	10	42	10	42
Site 7	0	5	-	-	0	0	0	4
Site 8	21	35	-	-	77	128	98	163
Site 9	5	5	-	-	-4	-4	1	1
Total	**130**	**262**	**-**	**-**	**155**	**309**	**285**	**571**

Source: SCT Consulting; 2020

5.5 Intersection Performance Results

Intersection operational analysis for key intersections within the Double Bay Town Centre is provided below following the introduction of the potential abovementioned development proposal in 2022 and 2027. Detailed outputs of the below intersection performance results are provided in **Appendix A**.

5.5.1 Cross Street / Bay Street

Modelling analysis indicates that the intersection of Cross Street / Bay Street will operate with sufficient levels of spare capacity in 2022 and 2027, for both the AM, PM and Saturday peak periods, following completion of the potential development within the Double Bay Town Centre. Results, provided in **Table 5-5**, indicate that a LoS of A is forecast in all peak periods with DoS values no higher than 0.26. The 0.26 DoS value was recorded for the PM peak period in 2027.

Table 5-5 Cross Street / Bay Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	865	906	0.19	0.20	9.5	9.8	A	A	4	5
PM Peak Hour Period	813	912	0.22	0.26	9.0	9.5	A	A	5	6
Saturday Peak Hour Period	847	931	0.22	0.25	9.2	9.7	A	A	5	6

Source: SCT Consulting; 2020

5.5.2 William Street / Bay Street

Modelling analysis indicates that the intersection of William Street / Bay Street will operate with sufficient levels of spare capacity in 2022 and 2027, for both the AM, PM and Saturday peak periods, following completion of the

potential development within the Double Bay Town Centre. Results, provided in **Table 5-6**, indicate that a LoS of A is forecast in all peak periods with DoS values no higher than 0.35. The 0.35 DoS value was recorded for the AM peak and Saturday peak hour periods in both 2022 and 2027.

Table 5-6 William Street / Bay Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	1,028	1,028	0.35	0.35	7.7	7.7	A	A	17	17
PM Peak Hour Period	791	800	0.34	0.34	7.9	7.9	A	A	16	16
Saturday Peak Hour Period	897	906	0.35	0.35	8.1	5.3	A	A	16	16

Source: SCT Consulting; 2020

5.5.3 Ocean Avenue / Greenoaks Avenue

Modelling analysis indicates that the intersection of Ocean Avenue / Greenoaks Avenue will operate with sufficient levels of spare capacity in 2022 and 2027, for both the AM, PM and Saturday peak periods, following completion of the potential development within the Double Bay Town Centre. Results, provided in **Table 5-7**, indicate that a LoS of A is forecast in all peak periods with DoS values no higher than 0.74. The 0.74 DoS value was recorded for the AM peak period in 2027.

Table 5-7 Ocean Avenue / Greenoaks Avenue: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	1,887	1,991	0.70	0.74	13.7	15.5	A	A	59	66
PM Peak Hour Period	1,440	1,539	0.54	0.59	9.1	10.3	A	A	31	36
Saturday Peak Hour Period	1,609	1,739	0.62	0.67	9.8	11.2	A	A	41	50

Source: SCT Consulting; 2020

5.5.4 New South Head Road / Bay Street

Modelling analysis indicates that the intersection of New South Head Road / Bay Street will operate with sufficient capacity in 2022 and 2027, for all peak hour periods. The Bay Street approach experiences the maximum delay at the intersection, however, this is equivalent to a LoS A during the AM and PM peak hour period. During the 2022 Saturday peak hour, the intersection operates at LoS B, this increased delay is associated with queuing from downstream intersections, however is still considered acceptable. Modelling results are summarised in **Table 5-8**.

Table 5-8 New South Head Road / Bay Street: 2022 and 2017 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	3,448	3,489	0.43	0.40	7.4	6.6	A	A	3	42
PM Peak Hour Period	3,427	3,452	0.47	0.47	10.3	10.3	A	A	97	106
Saturday Peak Hour Period	3,649	3,775	0.60	0.48	18.1	10.0	B	A	21	24

Source: SCT Consulting; 2020

5.5.5 New South Head Road / Manning Road

Modelling analysis indicates that the intersection of New South Head Road / Manning Road will operate at capacity in the 2022 AM peak period, with a DoS of 0.98 associated with the westbound (citybound) movement on New South Road. Similar operational performance is indicated in the 2027 AM peak, with the westbound movement operating at capacity. Modelling results for 2027 PM peak indicate that by 2027 the eastbound right turn movement into Manning Road operates at capacity, with DoS 0.98. During the Saturday peak the intersection with spare capacity (DoS <0.82) and LoS A during both 2022 and 2027.

Results, provided in **Table 5-9**, indicate that a LoS C is forecast during the 2022 and 2027 AM peak, while the intersection operates at LoS B and LoS A in the PM peak and Saturday peak respectively, under both 2022 and 2027 demands.

Table 5-9 New South Head Road / Manning Road: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	3,546	3,702	0.98	0.98	35.8	37.6	C	C	229	229
PM Peak Hour Period	3,478	3,660	0.89	0.98	15.7	19.5	B	B	106	106
Saturday Peak Hour Period	3,244	3,349	0.78	0.81	12.2	12.7	A	A	106	106

Source: SCT Consulting; 2020

5.5.6 New South Head Road / Knox Street

Modelling analysis indicates that the intersection of New South Head Road / Knox Street will operate over capacity in the 2022 AM peak period, with a DoS of 1.00 associated with the citybound New South Head Road movement. By 2027 modelling results demonstrate that the intersection will exceed capacity and is unable to support forecast background traffic growth and the full yield of the potential development within the Double Bay Town Centre.

Results, provided in **Table 5-10**, indicate that a LoS of C and LoS D is forecast in the 2022 and 2027 AM peak hour periods. During the PM and Saturday peak, the intersection operates with spare capacity and LoS A under forecast 2022 and 2027 demands.

Table 5-10 New South Head Road / Knox Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	3,038	3,139	1.00	1.32	39.0	54.1	C	D	134	203
PM Peak Hour Period	3,037	3,222	0.79	0.81	5.5	6.5	A	A	59	74
Saturday Peak Hour Period	2,500	2,612	0.54	0.70	6.2	7.0	A	A	57	71

Source: SCT Consulting; 2020

5.5.7 New South Head Road / Cross Street / Bellevue Road / Kiaora Road

Modelling analysis indicates that the intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road will operate over capacity in the 2022 AM with a DoS of 1.06 and Saturday peak period with a DoS 1.04. These movements which exceed capacity are predominantly turning movements. Overall the intersection performs satisfactorily from a LoS perspective, at LoS D during the 2022 AM peak and at LoS C during the PM and Saturday peak.

By 2027 modelling results demonstrate that the intersection will exceed capacity and is unable to support the forecast background growth together with the full yield of the potential development within the Double Bay Town Centre. The intersection operates at DoS 1.29 in the 2027 AM peak, associated with the right turn movement from Cross Street (N leg) into New South Head Road (W leg). During the 2027 PM and Saturday periods the intersection operates at DoS 1.10 and DoS 1.15 respectively. Oversaturated movements are again predominantly associated with turning manoeuvres.

Results, provided in **Table 5-11**, indicate that a LoS D and LoS E is forecast in 2022 and 2027 AM peak periods respectively. During the 2022 PM peak and 2022 Saturday peak periods, the intersection operates at LoS C.

Table 5-11 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: 2022 and 2017 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	2022	2027	2022	2027	2022	2027	2022	2027	2022	2027
AM Peak Hour Period	3,840	3,920	1.06	1.29	46.5	58.1	D	E	230	273
PM Peak Hour Period	3,625	3,811	0.99	1.10	33.3	42.2	C	C	149	173
Saturday Peak Hour Period	3,618	3,728	1.04	1.15	37.9	45.8	C	D	203	208

Source: SCT Consulting; 2020

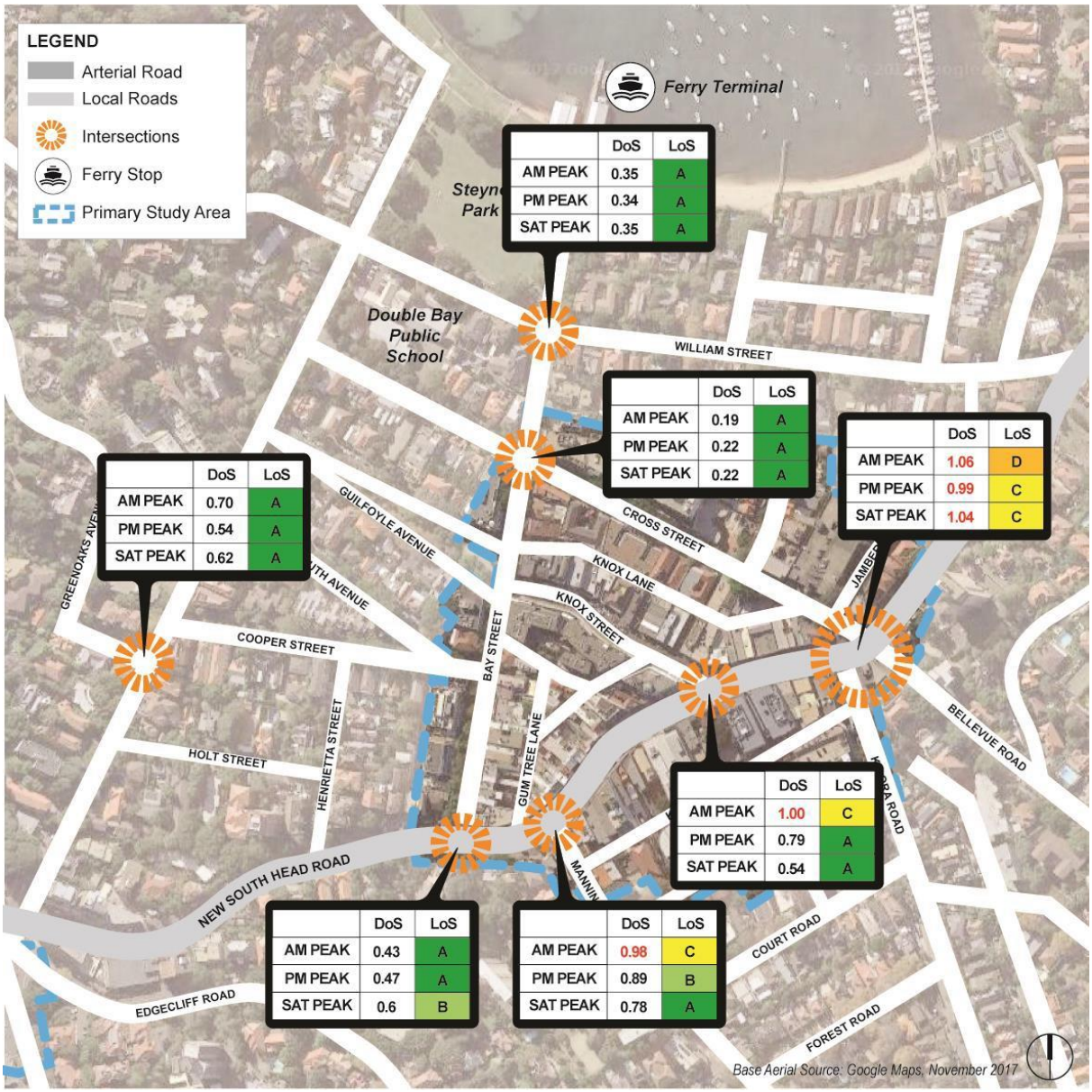
5.6 Intersection Performance Summary

A summary of the overall intersection LoS and DoS across the 2022 and 2027 AM peak, PM peak and Saturday periods is provided in **Figure 5**–2 and **Figure 5**–3.

The analysis indicates that under 2022 forecast demands, which include 50 per cent of the potential development, the majority of intersections within the network operate at an acceptable level of performance and within capacity under all periods. In 2022, the pinch point on the network will be the intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road, which operates just over capacity during the AM and Saturday peak period. Saturated movements are the turning movements at the intersection, however, overall the intersection operates at LoS D.

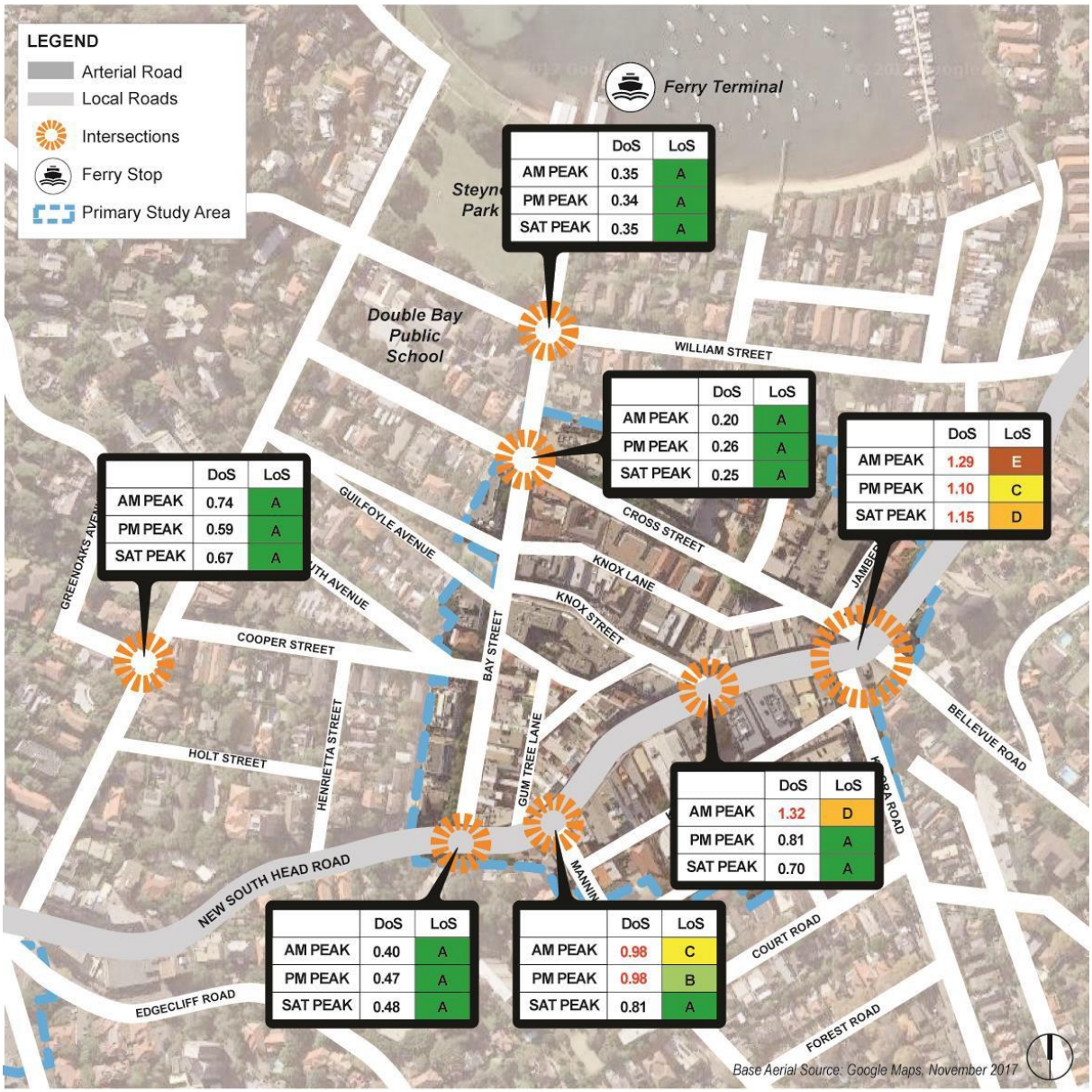
By 2027, the intersection of New South Head Road with Cross Street / Bellevue Road / Kiaora Road operates over capacity during the AM, PM and Saturday peak periods and is unable to meet the forecast traffic demand associated with background traffic growth and the potential full development yield. The intersection of New South Head Road / Knox Street also operates over capacity with DoS 1.15 during the AM peak. All other intersections operate at LoS A to LoS C, and satisfactorily cater for forecast travel demands associated with the potential full development.

Figure 5–2 Double Bay Town Centre Intersection Performance: Scenario 1 (2022)



Source: SCT Consulting; 2020

Figure 5–3 Double Bay Town Centre Intersection Performance: 2027 Full Development (Scenario 2)



Source: SCT Consulting; 2020

5.7 Public Transport, Walking and Parking Impact Summary

An analysis of Journey to Work and Household Travel Survey data has been undertaken to estimate the number of trips that are likely to be generated from the potential development of Double Bay Town Centre.

For the purpose of analysis, it has been assumed that the modal split data from the 2011 Census[4] Journey to Work Data provides a suitable reflection of the proportion of trips being undertaken by all travel modes during the weekday AM and PM peak hour periods, where a high proportion of trips during this timeframe are associated with journey to work trips.

For the Saturday peak hour period, Household Travel Survey proportional mode split has been used. It is acknowledged that Household Travel Survey provides the information surrounding trips made by residents on an average weekday, however, analysis of Household Travel Survey information indicates that over 50 per cent trips made by residents of statistical area "Eastern Suburbs (North)" are likely to be associated with shopping, personal business and social and recreational activities. On this basis, the Household Travel Survey is considered reflective of

[4] 2016 data not available at time of publication

the trips likely to be made during the Saturday peak period and reflect typical travel characteristic and mode choice associated with these trips.

5.7.1 Public Transport

Journey to Work travel mode data indicates that during the peak hour period public transport trips accounts for approximately 42 per cent outbound trips and 20 per cent of inbound trips. Train trips account for 34 per cent and 16 per cent of these trips respectively, whilst bus trips account for four per cent of inbound and outbound trips. Ferry trips account for four per cent of inbound trips.

Household travel data indicates that approximately six per cent of all trips are undertaken by train, while five per cent of all trips throughout the day are undertaken by bus. Ferry trips are not recorded.

On this basis **Table 5-12**, provides a summary of the number of additional train, bus and ferry trips that are likely to be generated by the potential development of Double Bay Town Centre. The peak number of trips for train are during the AM and PM peak hours in the outbound and inbound directions respectively. At full development this accounts for 238 trips in the AM peak and 351 trips in the PM peak.

At full development this equates to approximately 13 passengers per train trip in the outbound direction of travel within the AM peak and 21 additional passengers for the inbound direction of travel during the PM peak. As detailed in **Section 3.3.3** the Sydney Train Network has capacity to cater for the potential increase in travel demand.

Similarly, there are over 11 bus services per hour in the peak travel demand direction during AM and PM peak hour periods, at full development this would equate little over four additional passengers per bus service. As the majority of services are not at full capacity (refer **Section 3.3.2**), it is anticipated that the bus network can cater for this increase in demand.

Ferry growth, based on the current low proportion of usage, is anticipated to grow by approximately 30 trips in the AM peak and 40 trips in the PM peak. This is in an inbound and outbound direction of travel, respectively. The current 30 minute frequency of ferry services during peak periods prevents the mode from being a viable alternative to high frequency buses which connect residents to Edgecliff Station.

Table 5-12 Public Transport Trip Generation

Mode	AM Peak[5]		PM Peak[6]		Saturday Peak[7]	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
2022 Partial Development						
Train	30	118	175	47	21	21
Bus	7	14	21	12	17	17
Ferry	-	14	21	-	-	-
2027 Full Development						
Train	59	238	351	94	42	42
Bus	15	28	41	24	35	35
Ferry	-	28	41	-	-	-

Source: SCT Consulting; 2020

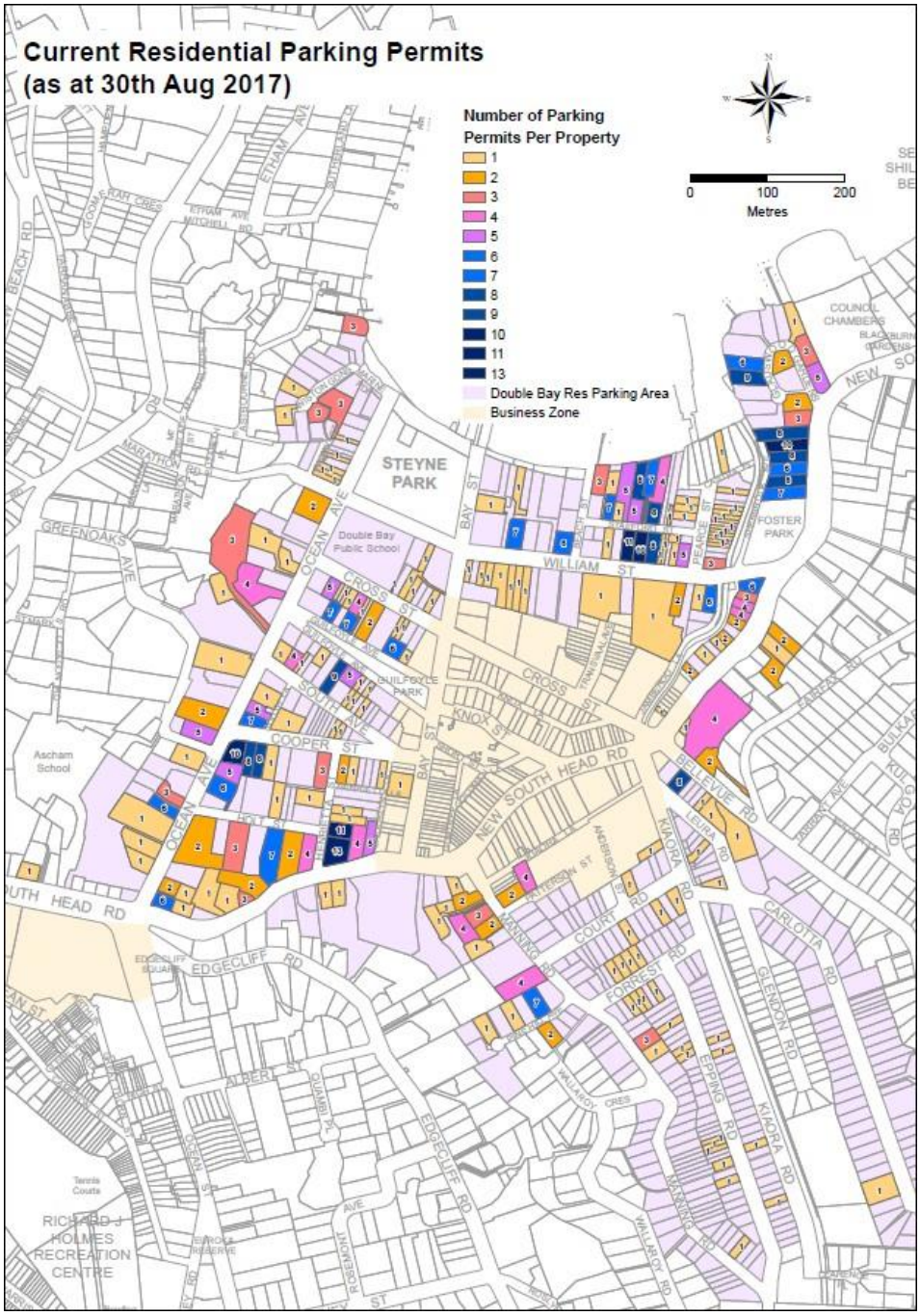
5.7.2 Parking

Potential developments may increase the parking capacity of the Town Centre, however this would likely be offset by the additional parking demands generated by the new developments which may impact on the surrounding road network. It is recommended that the impact of the potential development on the surrounding street network be monitored at regular intervals, in line with the development expansion, to ascertain the level of car parking occupancy

[5] Based on Journey to Work Data(2011)
[6] Based on Journey to Work Data(2011)
[7] Based on Household Travel Survey Data (2015/16)

which cannot be quantified at this stage. This may potentially lead to an extension of parking provision if required. An illustration of WMC's residential parking permit scheme, which may require extension, is provided in **Figure 5**–4.

Figure 5–4 WMC Current Residential Parking Permit Scheme



Source: WMC; 2017

5.7.3 Walking

Journey to Work travel mode data indicates that during the peak hour period “walked only” trips accounts for approximately 12 per cent outbound trips and 10 per cent of inbound trips. This is a significant representation of active transport and a reflection of the density of Double Bay and proximity to surrounding employment land uses. In addition to this, residents and visitors to Double Bay Town Centre also walk in order to access public transport trips, such as the bus stops on North South Head Road, Edgecliff Station located approximately 400m to the south east and to the Double Bay Ferry Wharf located on the northern edge of the study area. Under the potential future development of the Double Bay Town Centre, and based on current Journey to Work data, it is forecast that an additional 121, 183 and 417 walking trips would be realised in the AM, PM and Saturday peak hour respectively. The current Double Bay Town Centre street network has sufficient capacity to cater for this increase in demand. The broader question, of how pedestrian amenity is fostered and increased within the Double Bay Town Centre, is discussed within **Section 7**.

5.7.4 Cycling

WMC have identified cycling as a key component of active transport travel that is to be improved as a mode share through targeted infrastructure improvements. Treatments proposed for WMC to achieve this aim to:

– Cater to existing cycling desire lines in the Double Bay area such as Ocean Avenue and William Street;

– Improve safety outcomes;

– Generate increased demand for active transport leading into the local centres and key public transport hubs of Edgecliff Train Station and Double Bay Ferry Wharf; and,

– Cater for the emergence of new technologies such as electric bikes and electric scooters. These will make climbing steep hills easier which could result in greater active transport demand.

In order to deliver a successful cycleway infrastructure, the following cycleway constraints should be considered:

5.7.4.1 Existing Road Widths

City of Sydney’s Cycle Strategy and Action Plan 2007-2017 indicate that the minimum road requirement to install a separated bi-directional cycleway is 12.8m (see **Figure 5–5**). A one-way separated cycleway (assuming 1.2m bike path and 1m clearance*) would therefore require a minimum road with of 12.4m.

Roads in the study area with a minimum road width of 12.4m which could be considered for installing separated cycleways include:

– Cooper Street (road width: 13m)

– Ocean Avenue (road width: 12.8m)

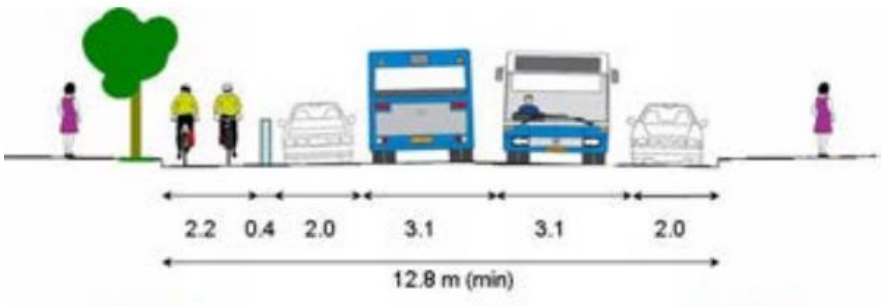
– William Street (road width: 12.8m)

– Cross Street (road width: 12.7m)

– Kiaora Road (road width: 12.5m)

– Knox Street (road width: 12.4m)

Figure 5–5 Typical cross-section of a separated bidirectional cycleway



Source: City of Sydney, 2017

5.7.4.2 Roundabouts

The Cycling Aspects of Austroads Guides (2017) notes that at large single-lane or multilane roundabouts where speeds are higher (eg >20km/hr), consideration should be given to separate treatments such as an off-road bicycle path around the roundabout with uncontrolled cyclist / pedestrian movement across each approach leg . Such treatments will likely require additional treatments to the intersection which could be costly due to potential land acquisition requirements.

Roundabouts located along Ocean Avenue and William Street will need to be considered when investigating separated cycleway options in Double Bay.

5.7.4.3 Crown Lines

Installing separated cycleways along an existing road could affect the location of the crown centreline. A crown line that is not at the centre of the carriageway should be reviewed for safety implications of a vehicles wheel path straddling both sides of the crown.

6.0 Sensitivity Testing

6.1 Overview

In **Section 5.6**, the intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road was identified as the key pinch point within the network during the 2022 AM and Saturday peak, and 2027 AM, PM and Saturday peak periods. The intersection of New South Head Road / Knox Street was also identified as operating over capacity during the 2027 AM peak hour full development scenario.

To identify the impact of strategies to mitigate adverse implications of the potential development on the surrounding network performance (i.e. To achieve a DoS of 1.00 or less) two sensitivity tests were assessed as follows:

- Sensitivity Test 1
  - Target mode shift of trips from private vehicles (Refer to **Section 6.1.1**)
- Sensitivity Test 2
  - Network modifications and trip redistribution (Refer to **Section 6.1.2**)

Detailed intersection performance outputs of the above sensitivity tests are provided in **Appendix D**.

6.1.1 Sensitivity Test 1 – Modal Shift

Given the capacity constraints in the network, the aim of Sensitivity Test 1 was to identify the reduction in the number of development generated vehicle trips required, to maintain satisfactory network performance. This was based on the assumption that no network modifications would be delivered as part of the potential development. The assessment was undertaken for the following peak periods:

- 2022 and 2027 AM peak hour
- 2022 PM peak hour
- 2022 and 2027 Saturday peak hour

6.1.1.1 Trip Reduction

Table 6-1 and **Table 6-2** provide a summary of the number of vehicle trips required to transfer to sustainable transport modes to enable the network to operate within its available capacity under forecast 2022 and 2027 development scenarios. For example, 2022 AM peak hour modelling analysis shows that at the intersection of New South Head Road / Cross Street WMC should aim to redistribute four outbound residential private vehicle trips to public or active transport to allow the intersection to operate within capacity. This is based on modelling analysis and includes trips associated with the potential increase in development. Site 2 has been identified as the site most likely to impact on intersection operation.

Table 6-1 Sensitivity Test 1 – modal shift, target reduction in vehicle trips (2022)

Peak Period / Approach	Movement	Reduction in Trips	Site	Trip reduction
AM Peak Hour Period (2022)				
Cross Street (N leg)	southbound right turn	-4 veh/h	Site 2	- 4 outbound residential trips
Bellevue Road (S leg)	northbound left turn	-5 veh/h	Site 5, 6, 8	- 5 inbound commercial trips
Saturday Peak Hour Period (2022)				
Cross Street (N leg)	southbound right turn	-2 veh/h	Site 2	- 2 outbound residential trips
NSH Road (SW leg)	eastbound left turn into Bellevue Rd	-4 veh/h	Site 8	- 4 outbound retail trips

Source: SCT Consulting; 2020

Table 6-2 Sensitivity Test 1 – modal shift, target reduction in vehicle trips (2027)

Peak Period / Approach	Movement	Reduction in Trips	Site	Trip Reduction
AM Peak Hour Period (2027)				
NSH Road (SW leg)	eastbound left turn into Bellevue Rd	-2 veh/h	Site 1	- 2 outbound residential trips
Cross Street (N leg)	southbound right turn	-10 veh/h	Site 2 Site 3	8 outbound residential trips 2 outbound residential trips
Bellevue Road (S leg)	northbound left turn	-12 veh/h	Site 6 Site 1, 5, 8	9 inbound commercial trips 3 inbound commercial trips
Knox Street (N leg)	southbound right turn	-39 veh/h	Site 4 Site 5	15 outbound residential trips 24 outbound residential trips
PM Peak Hour Period (2027)				
NSH Road (SW leg)	eastbound left turn into Bellevue Rd	-18 veh/h	Site 8 Site 1, 4, 5 Site 1, 4, 5,8	9 outbound retail trips 2 outbound retail trips 7 outbound commercial trips
Kiaora Road (S leg)	northbound right turn	-3 veh / h	Site 6	- 3 outbound commercial trips
Saturday Peak Hour Period (2027)				
Cross Street (N leg)	southbound right turn	-11 veh/h	Site 2, 3 Site 2, 3	8 outbound residential trips 3 outbound retail trips
NSH Road (SW leg)	eastbound left turn into Bellevue Rd	-18 veh/h	Site 8 Site 1, 5 Site 1, 4, 5, 8	11 outbound retail trips 3 outbound retail trips 5 outbound residential trips

Source: SCT Consulting; 2020

6.1.1.1 Intersection Performance

Modelling analysis indicates that achieving the proposed vehicle trip reductions results in the intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road operating at capacity in the 2022 and 2027 peak periods, at LoS C. The intersection of New South Head Road / Knox Street also satisfactorily operates at LoS C in the 2027 AM peak hour period.

The operational performance for critical intersections on the network in association with sustainable modal shift, achieving the proposed target reductions above, is summarised in **Table 6-3** and **Table 6-4** overleaf. A discussion of potential strategies to achieve the trip reductions discussed above is provided in **Section 7**.

Table 6-3 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
AM Peak Hour Period	3,833	3,894	0.99	1.00	40.7	41.9	C	C	213	212
Year	**2027**		**2027**		**2027**		**2027**		**2027**	
PM Peak Hour Period	3,789		1.00		37.2		C		166	
Year	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Saturday Peak Hour Period	3,612	3,698	1.00	1.00	36.1	36.8	C	C	203	208

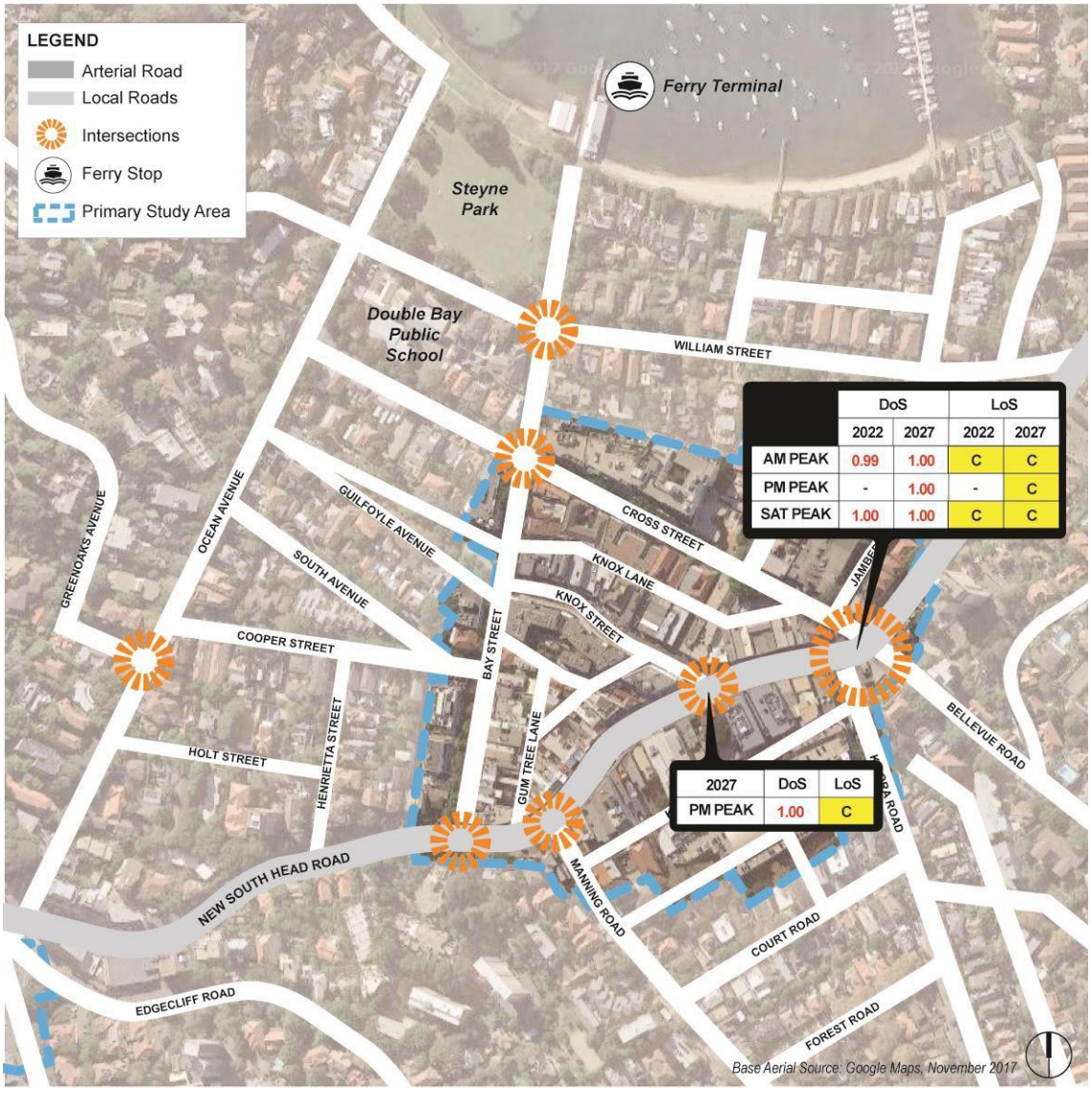
Source: SCT Consulting; 2020

Table 6-4 New South Head Road / Knox Street: 2027 Intersection Performance (Sensitivity Test 1 – modal shift)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	3,078	1.00	36.7	C	134

Source: SCT Consulting; 2020

Figure 6–1 Sensitivity Test 1: Intersection Performance Summary



Source: SCT Consulting; 2020

6.1.2 Sensitivity Test 2 – Network modifications and trip redistribution

An assessment was undertaken to review the performance implications associated with the closure of the right turn movement from New South Head Road (W leg) into Kiaora Road during the periods where the intersection was previously identified as exceeding capacity (**Section 5.3.6**).

– 2022 and 2027 AM peak hour

– 2027 PM peak hour

– 2022 and 2027 Saturday peak hour

As part of this closure, the right turn movement trips were redirected to Manning Road (S leg) within the network model. This measure provides an option to WMC should they wish to proceed with the potential development and not adopt the alternative strategic policy measures, discussed in **Section 7.0**. These provide an alternate way in which to achieve desired development levels without closing the abovementioned right turn movement.

In addition to the above, Sensitivity Test 2 considers the redistribution of trips associated with saturated movements. Trip redistribution was considered for the 2027 AM peak only, for the right turn movement from Knox Street into New South Head Road, previously identified as exceeding capacity (**Section 5.5.6**). These trips exceed the available capacity of the right turn movement and are associated predominantly with residential trips, traveling westbound and by users familiar with the network.

In Sensitivity Test 2, it was assumed that during the 2027 AM peak hour, 39 of the 160 right turning vehicles utilise the alternative route of Knox Street – Bay Street – Cross Street – Ocean Avenue to re-join New South Head Road and continue their journey westbound. This alternative route has sufficient capacity to cater for the diverted trips.

A summary of the resulting intersection performance for network pinch points is provided in **Table 6-5** and **Table 6-6** with a graphical representation provided in **Figure 6**–2.

Modelling analysis indicates that with the potential closure of the right turn movement from New South Head Road (W leg) into Kiaora Road and internal redistribution of trips, the network has sufficient capacity to cater for the potential development. The intersection of New South Head Road / Cross Street / Bellevue Road / Kiaora Road will operate at capacity in the 2022 and 2027 AM, PM and Saturday peak periods, with a DoS greater than 0.9. The intersection performs satisfactorily during the PM peak and Saturday peak at LoS C. During the 2022 AM peak hour, the intersection operates at LoS D. By 2027, modelling results indicate that the intersection will operate at LoS E during the AM peak.

Under Sensitivity Test 2 the intersection of New South Head Road / Knox Street operates at LoS C and at capacity during the 2027 AM peak hour period.

Table 6-5 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
AM Peak Hour Period	3,809	3,920	0.97	0.98	43.0	59.8	D	E	243	346
Year (Scenario)	**2027**		**2027**		**2027**		**2027**		**2027**	
PM Peak Hour Period	3,744		0.92		32.5		C		134	
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Saturday Peak Hour Period	3,558	3,667	0.96	0.98	33.5	35.5	C	C	207	222

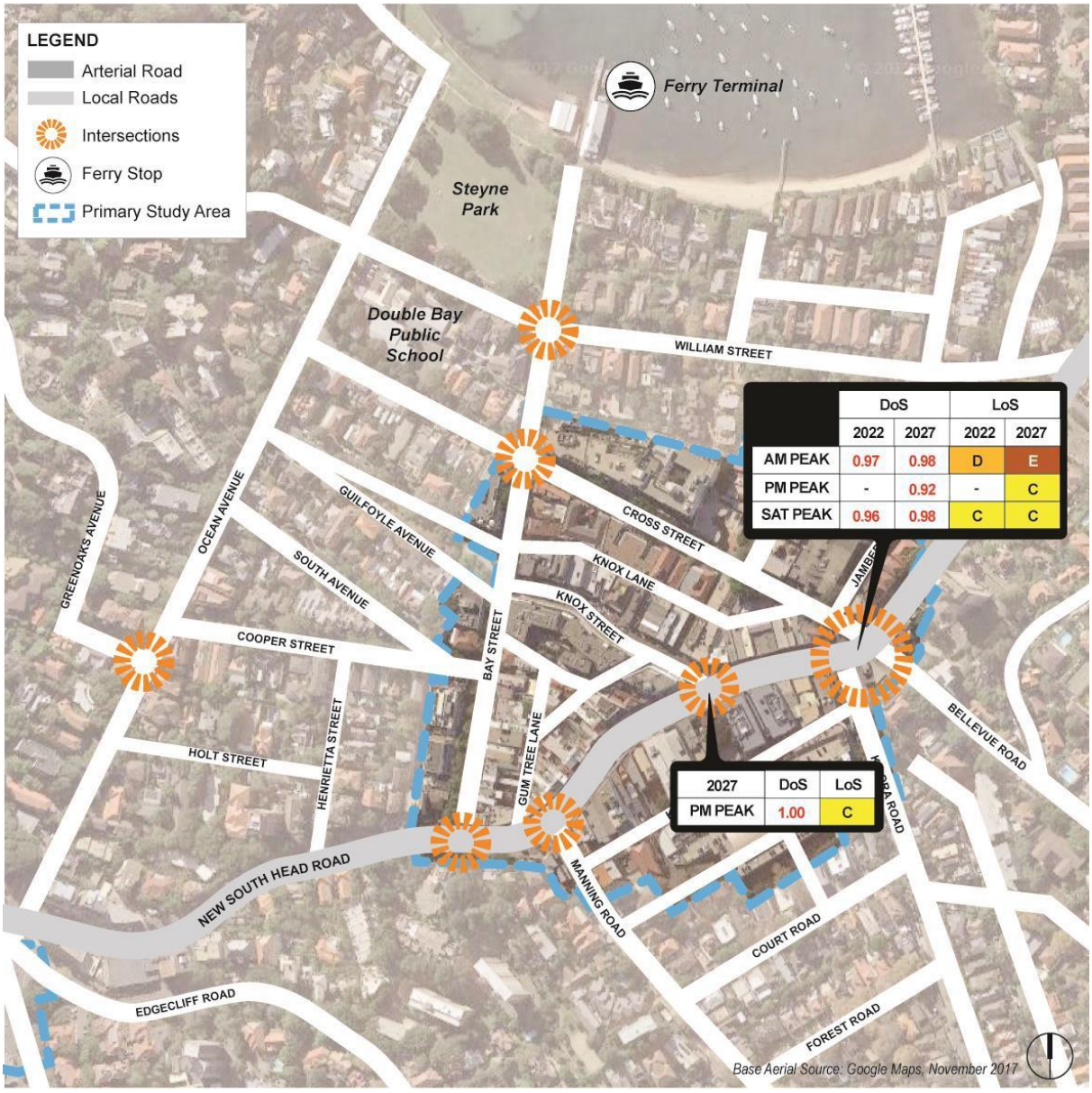
Source: SCT Consulting; 2020

Table 6-6 New South Head Road / Knox Street: 2027 Intersection Performance (Sensitivity Test 2)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period	3,063	1.00	40.1	C	134

Source: SCT Consulting; 2020

Figure 6–2 Sensitivity Test 2: Intersection Performance Summary



Source: SCT Consulting; 2020

7.0 Potential Traffic and Transport Solutions

7.1 Strategic Policy

Regardless of the level of development which is pursued within the Double Bay Town Centre, the resultant impact on the network will be an increased level of trip generation. Dependant on the mode split of this increase, the increased trip generation may impact on the operation of the Double Bay Town Centre and is an important consideration in the place and precinct outcomes for the area. Based on the analysis undertaken to develop the Double Bay Transport Study the following strategic policy direction / solutions are recommended for WMC to drive a successful outcome for the potential development:

– Provide additional car share (Go Get) spaces on street within WMC as well as dedicated parking provision within new developments and WMC car parks

  - Currently there are 271 Go Get members within the Double Bay postcode area. Go Get has room to expand as the current car provision rate is less than the desired target of 30 members per vehicle. The Go Get 2016 member survey of Double Bay members identified that 62.5 per cent owned one or more cars before joining Go Get, now 62.5 per cent do not own a car with 37.5 per cent owning only one car. Furthermore, 72.65 per cent of people indicated that if they were looking to buy or rent an apartment the availability of a car share vehicle would result in them favouring those apartments over others (29.25 per cent) or consider it somewhat favourable (43.4 per cent). These statistics demonstrate the benefit of car share vehicles in lowering car ownership rates. When coupled with new developments car share reduces the need for individuals to purchase a vehicle and, as highlighted in Section 3.5, provides significant benefits to the area in which they operate. City of Sydney Council statistics indicate that one car share vehicle can remove up to 10 local vehicles that would compete for on street parking. As such, advocating the allocation of one car space for shared vehicles to offset 10 off-street parking spaces could be considered for future developments.

    WMC may also investigate the use of car share schemes in conjunction with certain residences not being eligible for access to residential parking permit schemes.

– Evaluate existing parking controls

  - Current maximum parking provision rates and parking multipliers within Part E ‘General Controls for all Development’ of the Woollahra Development Control Plan (2015) should be evaluated in view of considering a reduction, particularly for residential uses.
  - Consider the inclusion of mandatory car share space(s) within developments above a determined threshold. The inclusion of car share spaces under this threshold could be promoted through a reduction in overall parking spaces required for the development.
  - The price of parking within the town centre, both on and off street parking facilities, should be considered as a monetary strategy to induce mode shift away from private vehicles. WMC may choose to use funds gathered from this to subsidise forms of public transport / invest in new active transport infrastructure.

– Monitor public transport patronage

  - Data sources regarding public transport patronage are increasing thanks to advances in technology and the establishment of the Opal ticketing system. Through regular monitoring of public transport conditions WMC will be able to make informed decisions about the success of strategies and have informed discussions with Transport for NSW regarding transport needs within their LGA.

– Lobby Transport for NSW for additional services to Double Bay Ferry Wharf

  - The current service frequency for the ferry mode of travel to access the Sydney CBD from Double Bay is limited to two peak hour services. The lack of frequency limits the success of the ferry as a viable alternative mode for residents It is recommended that WMC lobby for further services to increase the attractiveness and patronage of the mode.

– Introduce Travel Demand Management[8] Program within Double Bay businesses

  - As shown in Section 3.1, 63 per cent of employees who live in proximity to the study area currently drive to their place of employment within the Double Bay Town Centre. This is based on an established pattern of

[8] Travel demand management is the application of strategies and policies to reduce travel demand, or to redistribute demand in time or mode used.

travel behaviour. A Travel Demand Management7 program, with the aim of reducing peak period travel patterns and reliance on private vehicles, has the potential to educate these individuals on alternate modes of travel to their destination and, pending employee acceptability of the proposed scheme, may encourage greater flexibility in working hours to spread the demand placed on the arterial and local road network.

– Consider expanding the current residential parking permit scheme

  - Continue to evaluate the parking demand for the Double Bay Town Centre during the area's expansion. Potentially expand the current residential parking permit scheme depending on assessed parking impacts.

– Encourage modal shift towards walking and cycling in the Double Bay area

  - Pleasant walking environments and good walking catchments to public transport and key destinations within Double Bay create an opportunity for WMC to promote walking and cycling. Introducing programs such as walking groups promoted by the Heart Foundation and walk to school programs could help encourage a modal shift from private vehicles to walking and cycling;
  - Review speed limits within the study area to improve pedestrian safety and personal security; and
  - Provide street tree planting along sections of road where there are fewer trees to give pedestrians weather protection along key walking routes.

The above strategic policies will support WMC in enhancing the transport capacity of the Double Bay Town Centre and control the level of private vehicle traffic generation of future developments. These policies will support the desired reduction in private vehicle traffic generation highlighted in Section 6.

7.2 Infrastructure Modifications

In addition to the above strategic policy directions various short to medium term road and active transport infrastructure upgrades are proposed to benefit the Double Bay Town Centre road network operation. These are outlined in Error! Reference source not found. and **Figure 7**–4 respectively and are for further consideration and assessment by WMC. Road infrastructure modifications are listed by priority, which has been determined by the anticipated level of impact on the road network of the Double Bay Town Centre.

7.2.1 Road Infrastructure

– ID1: Right turn movement ban (Kiaora Road)

  - As modelled in Scenario 4 it is proposed to remove, or investigate a timing ban, for the right turn movement from New South Head Road to Kiaora Road. This will improve the efficiency of the New South Head Road approach and the overall intersection performance of New South Head Road / Cross Street / Bellevue Road / Kiaora Road. This option provides an alternate measure should strategic policy direction recommendations, outlined in **Section 7.1**, not be pursued.

– ID2: Right turn movement ban (Knox Street)

  - Remove, or investigate a timing ban, for the right turn movement from New South Head Road to Knox Street. This will improve the efficiency of New South Head Road and vehicles with an alternate route path to vehicles available via William Street. Note that with the proposed trip reduction strategies and policies this may not be required in future years with the potential development increase within the Double Bay Town Centre.

– ID3: Right turn movement ban (Bellevue Road)

  - Removal, or investigate a timing ban, for the right turn movement from Bellevue Road to New South Head Road. This will improve the efficiency of the Bellevue Road approach and the overall intersection performance of New South Head Road / Cross Street / Bellevue Road / Kiaora Road. Note that with the proposed trip reduction strategies and policies this may not be required in future years with the potential development increase within the Double Bay Town Centre.

– ID4: Formalise Line Marking (Knox Street)

  - Currently the two lane approach, on Knox Street, to the intersection of New South Head Road / Knox Street is unmarked. Marking the lanes and designating vehicles travel path will remove the occurrence of vehicles queuing in the centre lane and reducing available storage space.

– ID5: Knox Street Kerbside Parking

  - Removal of two kerbside parking spaces on Knox Street during the AM peak will facilitate greater access to the left turn lane and provide greater efficiency for the operation of the New South Head Road / Knox Street intersection.

– ID6: Keep Clear Pavement Markings

  - Keep clear pavement markings are proposed at the intersection of Ocean Avenue / Cooper Street to prevent cars from queuing into the intersection footprint and preventing the right turn movement from Ocean Avenue to Cooper Street.

Figure 7–1 Double Bay Transport Study: Solution Development (Road Infrastructure)

Source: SCT Consulting; 2020

7.2.2 Cycling Infrastructure

Enhance safety and ridership potential through enhanced cycling infrastructure within, and surrounding, the Double Bay Town Centre by:

– ID7: Providing a separated bicycle path along Ocean Avenue and Cooper Street

- Providing a separated bike path along Ocean Avenue (**Figure 7–2**) and Cooper Street (**Figure 7–3**) will aim to encourage cycling for locals who are interested or enthused about cycling but feel safer being physically separated from cars.

Temporary bike lanes could be considered to trail cycling demand in the area before committing to more permanent infrastructure.

Figure 7–2 Separated cycleway options for Ocean Avenue

Source: SCT Consulting; 2020

Figure 7–3 Separated cycleway options for Cooper Street

Source: SCT Consulting; 2020

– ID8: Refresh and improve signage and linemarking at intersections of local roads

  - Refreshing and improving signage and linemarking along William Street and Ocean Avenue, particularly at roundabouts will improve driver awareness of cyclists in the area.

– ID9: Provide a dedicated bike parking facility at Guilfoyle Park

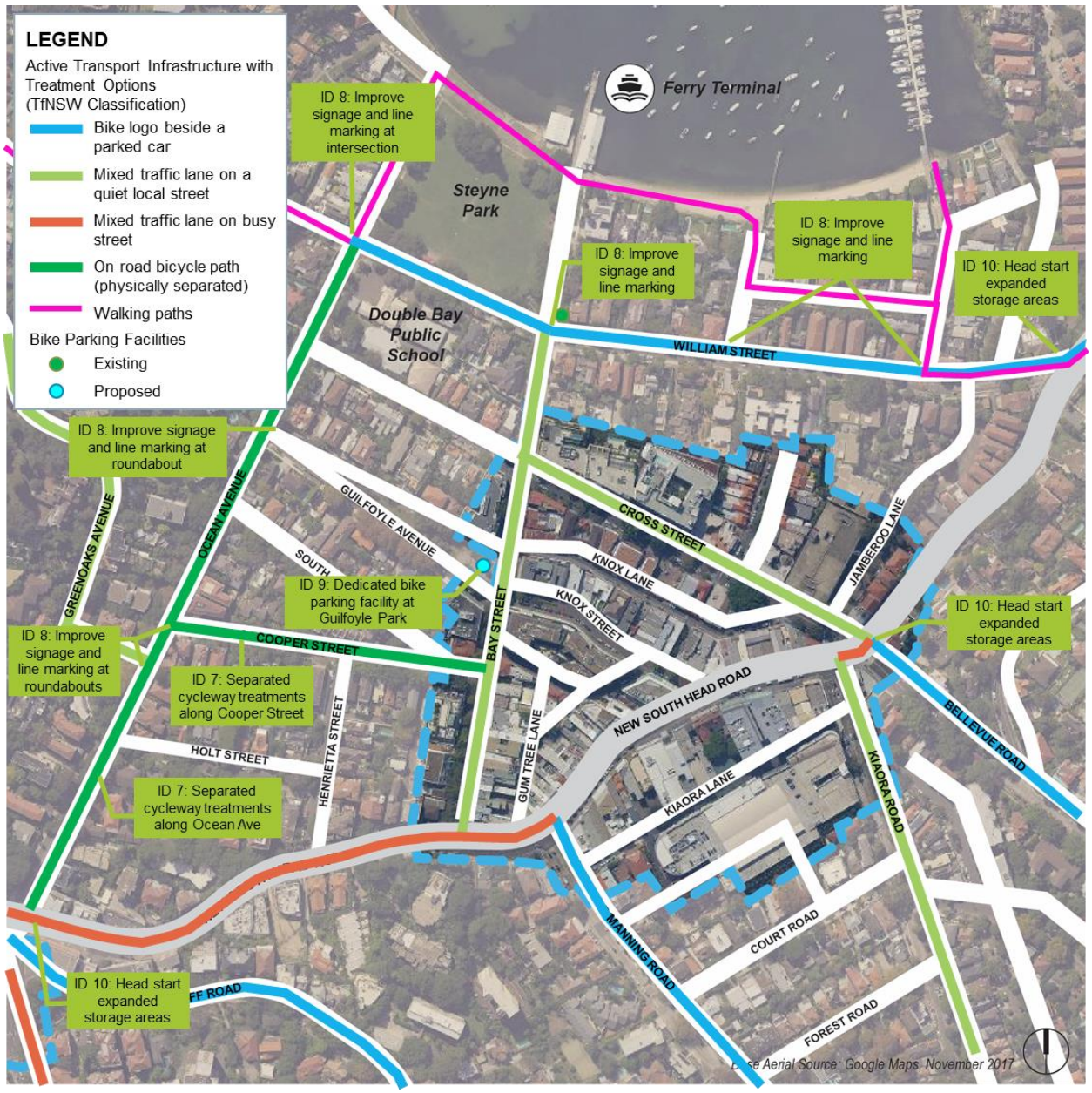
  - In addition to improving cycling infrastructure within the Double Bay study area, the convenience of a dedicated bike parking facility at Guilfoyle Park will help to encourage more cycling trips into Double Bay Town Centre.

– ID10: Provide head start and expanded storage areas intersections along New South Head Road

  - Head start and expanded storage areas at the intersections of New South Head/ Ocean Street, New South Head Road / Cross Street and New South Head Road / William Street would position cyclists in a highly visible location while they are waiting to proceed through the intersection and thereby improving safety.

A summary of cycling infrastructure improvement options is summarised in **Figure 7–4.**

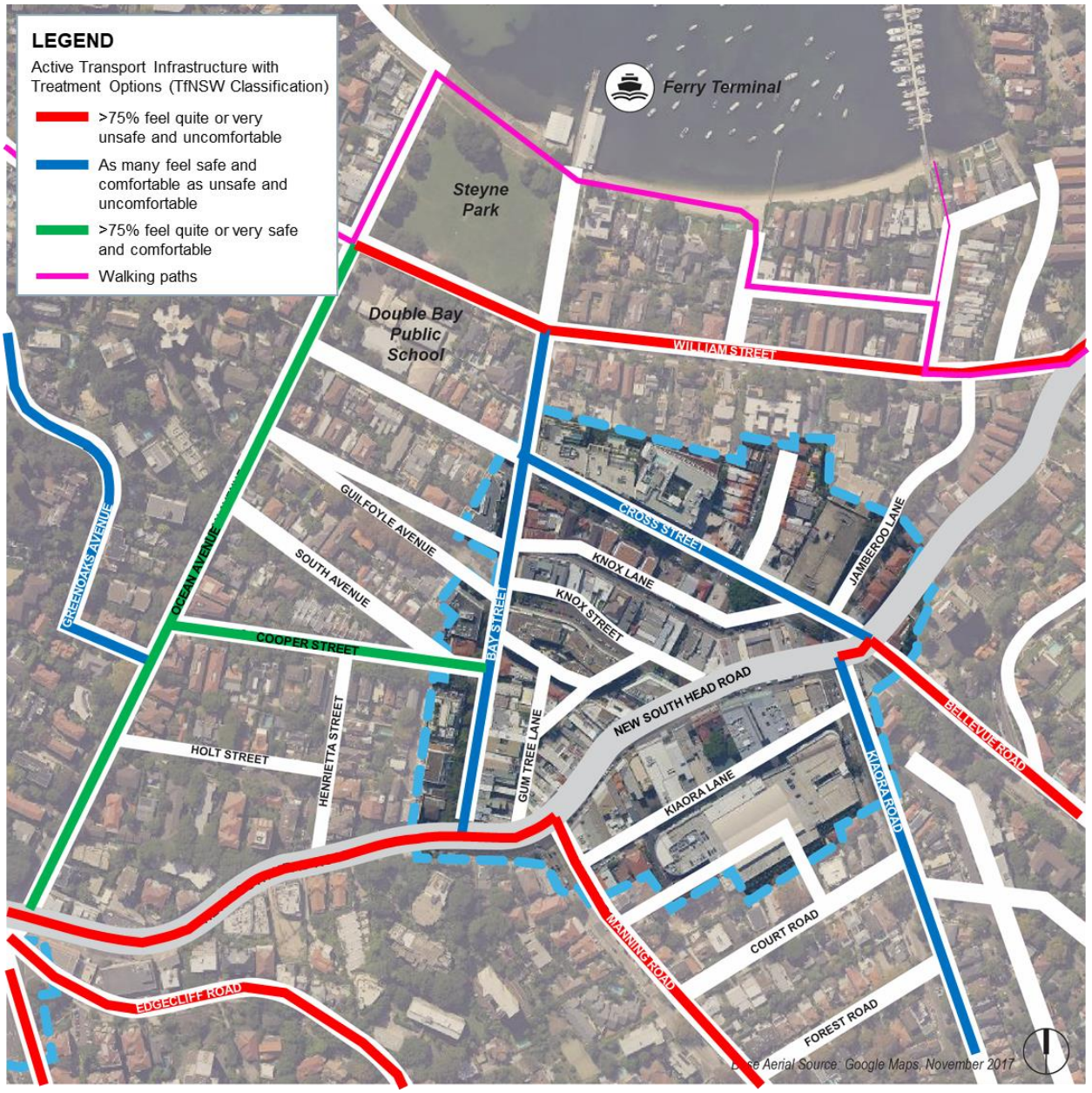
Figure 7–4 Double Bay Transport Study: Solution Development (Cycling Infrastructure)



Source: SCT Consulting; 2020

Based on the TfNSW's (2013) Sydney Cycling Futures, installation of the above treatment types would result in a facility preference change from >75% of people feeling quite or very unsafe and uncomfortable to >75% feeling very safe and comfortable along Ocean Avenue and Cooper Street. A summary of TfNSW cycling infrastructure preference rankings is shown in **Figure 7–5**.

Figure 7–5 Active transport facility type - preference ranking using TfNSW Classifications following potential cycling infrastructure upgrades



Source: SCT Consulting; 2020

7.2.3 Walking Infrastructure

Enhance safety and walking potential through enhanced walking infrastructure within, and surrounding, the Double Bay Town Centre by:

– ID11: Improve pedestrian amenity along key walking routes

  - Improve pedestrian amenity along key walking routes through enhanced wayfinding for pedestrians and cyclists and speed limit reviews.

– ID12: Enhance pedestrian crossing infrastructure along key walking routes

  - Enhancing pedestrian crossing infrastructure along key walking routes (pending warrants assessment) could make pedestrians feel safer and encourage more people to walk instead of drive.

A summary of walking infrastructure improvement options is summarised in **Figure 7–6.**

Figure 7–6 Double Bay Transport Study: Solution Development (Cycling Infrastructure)

Source: SCT Consulting; 2020

8.0 Summary and Next Steps

8.1 Summary

The Double Bay Transport Study has centered on the assessment of two potential development scenarios for the Double Bay Town Centre, two sensitivity tests and the identification of associated impacts. The assessment has found that:

– Existing public transport servicing the Double Bay Town Centre has sufficient capacity to meet increased travel demand associated with the potential full development scheme.

– Existing active transport infrastructure within and around Double Bay is suitable to cater for the increase in trip generation resulting from the potential Double Bay Town Centre expansion. However, greater emphasis, through policy and infrastructure, can be made to support an increase in active transport as a travel mode.

– The road network responds favourably to the potential increase in development with results indicating a minor exceedance of capacity based on existing patterns of travel behaviour. Various policies and strategic directions are available for WMC to mitigate this impact and cater for the anticipated increased level of trip generation. It is recommended that WMC consider implementing these policies / strategies which include:

  - Providing additional Go Get (car share) parking spaces
  - Evaluating existing parking controls
  - Monitoring public transport
  - Lobby Transport for NSW for additional ferry services
  - Introducing travel demand management programs within Double Bay
  - Expanding the current residential parking permit scheme
  - Encouraging a modal shift from driving in private vehicles to walking and cycling to key destinations like Double Bay town centre and Double Bay Public School.

In addition, modifications to permitted turning movements at critical intersections can also be made to further enhance network performance. These modifications, such as turn restrictions, may not be required depending on the success of the proposed trip reduction strategies / policies. Any potential adverse impacts may also be naturally addressed through localised trip diversions.

8.2 Next Steps

Following review of the Double Bay Transport Study documentation the following next steps are recommended for action by WMC:

– Progress and implement the various strategic policies / solutions identified within **Section 7** to foster reduced private vehicle trip generation within the Double Bay Town Centre improve traffic and transport operating conditions within the Double Bay Town Centre.

– Evaluate, through the strategic design stage of project development (where applicable), the installation of physical infrastructure / turn restrictions as outlined in **Section 7**.

APPENDIX A

Intersection Performance Summaries

Table A1 Cross Street / Bay Street: Intersection Performance (2017)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
Bay Street (S leg)	134	0.16	9.2	A	4
Cross Street (E leg)	328	0.17	2.5	A	3
Bay Street (N leg)	132	0.13	8.6	A	3
Cross Street (W leg)	219	0.11	1.3	A	1
Total	**813**	**0.17**	**9.2**	**A**	**4**
PM Peak Hour Period					
Bay Street (S leg)	165	0.17	8.5	A	4
Cross Street (E leg)	241	0.12	2.7	A	3
Bay Street (N leg)	131	0.11	8.1	A	3
Cross Street (W leg)	181	0.10	1.0	A	1
Total	**718**	**0.17**	**8.5**	**A**	**4**
Saturday Peak Hour Period					
Bay Street (S leg)	166	0.18	8.7	A	4
Cross Street (E leg)	261	0.14	2.6	A	3
Bay Street (N leg)	140	0.12	8.2	A	3
Cross Street (W leg)	178	0.10	0.6	A	1
Total	**745**	**0.18**	**8.7**	**A**	**4**

Source: SCT Consulting; 2020

Table A2 William Street / Bay Street: Intersection Performance (2016)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
Bay Street (S leg)	121	0.14	7.7	A	5
William Street (E leg)	465	0.35	4.5	A	17
Bay Street (N leg)	32	0.04	7.7	A	1
William Street (W leg)	408	0.32	4.5	A	15
Total	**1,026**	**0.35**	**7.7**	**A**	**17**
PM Peak Hour Period					
Bay Street (S leg)	128	0.12	6.7	A	4
William Street (E leg)	207	0.16	4.7	A	6
Bay Street (N leg)	32	0.04	7.9	A	1
William Street (W leg)	412	0.34	4.8	A	16

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
Total	**779**	**0.34**	**7.9**	**A**	**16**
Saturday Peak Hour Period					
Bay Street (S leg)	125	0.12	7.0	A	4
William Street (E leg)	288	0.22	4.6	A	9
Bay Street (N leg)	51	0.06	8.1	A	2
William Street (W leg)	419	0.35	4.8	A	16
Total	**883**	**0.35**	**8.1**	**A**	**16**

Source: SCT Consulting; 2020

Table A3 Ocean Avenue / Greenoaks Avenue: Intersection Performance (2016)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
Ocean Avenue (S leg)	449	0.63	12.3	A	44
Ocean Avenue (N leg)	757	0.62	7.2	A	46
Greenoaks Avenue (W leg)	598	0.67	9.7	A	52
Total	**1,804**	**0.67**	**12.3**	**A**	**52**
PM Peak Hour Period					
Ocean Avenue (S leg)	471	0.48	6.4	A	24
Ocean Avenue (N leg)	428	0.34	6.2	A	17
Greenoaks Avenue (W leg)	435	0.50	8.0	A	27
Total	**1,334**	**0.50**	**8.0**	**A**	**27**
Saturday Peak Hour Period					
Ocean Avenue (S leg)	531	0.57	7.5	A	33
Ocean Avenue (N leg)	512	0.40	6.2	A	23
Greenoaks Avenue (W leg)	442	0.53	8.7	A	31
Total	**1,484**	**0.57**	**7.4**	**A**	**33**

Source: SCT Consulting; 2020

Table A4 New South Head Road / Bay Street: Intersection Performance (2016)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
New South Head Road (E leg)	2,176	0.38	0	A	0
Bay Street (N leg)	65	0.08	6.3	A	2
New South Head Road (W leg)	1,039	0.31	0.3	A	0
Total	**3,280**	**0.38**	**6.3**	**A**	**2**
PM Peak Hour Period					

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
New South Head Road (E leg)	1,413	0.37	0	A	0
Bay Street (N leg)	79	0.24	9.2	A	3.1
New South Head Road (W leg)	1,706	0.44	0.2	A	9.3
Total	**3,198**	**0.44**	**0.4**	**A**	**9.3**
Saturday Peak Hour Period					
New South Head Road (E leg)	1,761	0.46	0	A	0
Bay Street (N leg)	84	0.36	13.5	A	4.9
New South Head Road (W leg)	1,664	0.55	0.3	A	17.0
Total	**3,509**	**0.55**	**13.5**	**A**	**17.0**

Source: SCT Consulting; 2020

Table A5 New South Head Road / Manning Road: Intersection Performance (2016)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
Manning Road (S leg)	426	0.60	**48.7**	D	124
New South Head Road (E leg)	1,920	0.88	45.7	D	229
New South Head Road (W leg)	1,037	0.51	10.8	A	75
Total	**3,383**	**0.88**	**35.4**	**C**	**229**
PM Peak Hour Period					
Manning Road (S leg)	363	0.46	40.1	C	76
New South Head Road (E leg)	1,260	0.56	3.3	A	32
New South Head Road (W leg)	1,693	0.81	13.9	A	106
Total	**3,316**	**0.81**	**12.7**	**A**	**106**
Saturday Peak Hour Period					
Manning Road (S leg)	373	0.49	40.5	C	86
New South Head Road (E leg)	1,565	0.62	2.7	A	36
New South Head Road (W leg)	1,206	0.74	14.4	A	106
Total	**3,144**	**0.74**	**11.7**	**A**	**106**

Source: SCT Consulting; 2020

Table A6 New South Head Road / Knox Street: Intersection Performance

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
New South Head Road (E leg)	1,892	0.92	19.6	B	111
Knox Street (N leg)	117	0.73	60.3	E	37
New South Head Road (W leg)	916	0.34	0.9	A	5

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
Total	**2,924**	**0.92**	**15.3**	**B**	**111**
PM Peak Hour Period					
New South Head Road (E leg)	1,159	0.52	0.7	A	10
Knox Street (N leg)	212	0.49	51.2	D	45
New South Head Road (W leg)	1,482	0.77	2.3	A	45
Total	**2,853**	**0.77**	**5.3**	**A**	**45**
Saturday Peak Hour Period					
New South Head Road (E leg)	1,156	0.39	1.5	A	7
Knox Street (N leg)	200	0.41	52.2	D	43
New South Head Road (W leg)	1,048	0.36	0.8	A	6
Total	2,404	**0.41**	**5.4**	**A**	**43**

Source: SCT Consulting; 2020

Table A7 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: Intersection Performance (2016)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
AM Peak Hour Period					
Bellevue Road (S leg)	500	0.99	83.2	F	187
New South Head Road (E leg)	1,732	0.72	30.2	C	195
Cross Street (N leg)	178	0.94	58.3	E	41
New South Head Road (W leg)	848	0.87	14.2	A	52
Kiaora Road (SW leg)	513	0.83	55.4	D	93
AM Peak Hour Period	**3,771**	**0.99**	**38.4**	**C**	**195**
PM Peak Hour Period					
Bellevue Road (S leg)	309	0.59	48.7	D	71
New South Head Road (E leg)	1,078	0.54	26.4	B	124
Cross Street (N leg)	284	0.72	50.9	D	66
New South Head Road (W leg)	1,366	0.98	17.9	B	134
Kiaora Road (SW leg)	438	0.95	66.9	E	137
PM Peak Hour Period	**3,475**	**0.98**	**32.2**	**C**	**137**
Saturday Peak Hour Period					
Bellevue Road (S leg)	386	0.81	53.9	D	102
New South Head Road (E leg)	1,424	0.74	29.2	C	201
Cross Street (N leg)	256	0.94	66.3	E	72
New South Head Road (W leg)	1,041	0.96	15.4	B	78
Kiaora Road (SW leg)	416	0.87	58.0	E	108
Total	**3,523**	**0.96**	**33.9**	**C**	**201**

Source: SCT Consulting; 2020

Table A8 Cross Street / Bay Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bay Street (S leg)	147	157	0.18	0.20	9.5	9.8	A	A	4	5
Cross Street (E leg)	358	384	0.19	0.20	2.3	2.2	A	A	3	3
Bay Street (N leg)	134	135	0.13	0.13	8.7	8.8	A	A	3	3
Cross Street (W leg)	226	231	0.12	0.12	1.3	1.3	A	A	1	1
Total	**865**	**906**	**0.19**	**0.20**	**9.5**	**9.8**	**A**	**A**	**4**	**5**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bay Street (S leg)	193	220	0.22	0.26	9.0	9.5	A	A	5	6
Cross Street (E leg)	272	308	0.14	0.16	2.5	2.5	A	A	3	3
Bay Street (N leg)	142	152	0.12	0.13	8.3	8.5	A	A	3	3
Cross Street (W leg)	206	232	0.11	0.12	1.0	1.0	A	A	1	1
Total	**813**	**912**	**0.22**	**0.26**	**9.0**	**9.5**	**A**	**A**	**5**	**6**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bay Street (S leg)	184	201	0.22	0.25	9.2	9.7	A	A	5	6
Cross Street (E leg)	309	346	0.16	0.18	2.5	2.4	A	A	3	3
Bay Street (N leg)	154	163	0.13	0.14	8.4	8.6	A	A	3	4
Cross Street (W leg)	200	220	0.10	0.12	0.5	0.6	A	A	0	0
Total	**847**	**931**	**0.22**	**0.25**	**9.2**	**9.7**	**A**	**A**	**5**	**6**

Source: SCT Consulting; 2020

Table A9 William Street / Bay Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bay Street (S leg)	121	121	0.14	0.14	7.7	7.7	A	A	5	5
William Street (E leg)	467	468	0.35	0.35	4.5	4.5	A	A	17	17
Bay Street (N leg)	32	32	0.04	0.04	7.7	7.7	A	A	1	1
William Street (W leg)	408	408	0.32	0.32	4.5	4.5	A	A	15	15
Total	**1,028**	**1,028**	**0.35**	**0.35**	**7.7**	**7.7**	**A**	**A**	**17**	**17**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bay Street (S leg)	128	128	0.12	0.12	6.7	6.7	A	A	4	4
William Street (E leg)	219	228	0.17	0.18	4.8	4.8	A	A	7	7
Bay Street (N leg)	32	32	0.04	0.04	7.9	7.9	A	A	1	1
William Street (W leg)	412	412	0.34	0.34	4.8	4.8	A	A	16	16
Total	**791**	**800**	**0.34**	**0.34**	**7.9**	**7.9**	**A**	**A**	**16**	**16**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bay Street (S leg)	125	125	0.12	0.12	7.0	7.0	A	A	4	5
William Street (E leg)	302	312	0.23	0.24	4.7	4.7	A	A	10	10
Bay Street (N leg)	51	51	0.06	0.06	8.1	8.1	A	A	2	2
William Street (W leg)	419	419	0.35	0.35	4.8	4.8	A	A	16	16
Total	**897**	**906**	**0.35**	**0.35**	**8.1**	**5.3**	**A**	**A**	**16**	**16**

Source: SCT Consulting; 2020

Table A10 Ocean Avenue / Greenoaks Avenue: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Ocean Avenue (S leg)	485	518	0.68	0.74	13.7	15.5	A	A	54	65
Ocean Avenue (N leg)	804	875	0.66	0.72	7.2	7.3	A	A	52	63
Greenoaks Avenue (W leg)	598	598	0.70	0.73	11.0	12.4	A	A	59	66
Total	**1,887**	**1,991**	**0.70**	**0.74**	**13.7**	**15.5**	**A**	**A**	**59**	**66**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Ocean Avenue (S leg)	526	580	0.54	0.59	6.7	7.4	A	A	29	36
Ocean Avenue (N leg)	479	524	0.37	0.41	6.2	6.1	A	A	20	23
Greenoaks Avenue (W leg)	435	435	0.53	0.56	9.1	10.3	A	A	31	35
Total	**1,440**	**1,539**	**0.54**	**0.59**	**9.1**	**10.3**	**A**	**A**	**31**	**36**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Ocean Avenue (S leg)	572	612	0.62	0.67	8.5	9.6	A	A	41	50
Ocean Avenue (N leg)	582	658	0.45	0.50	6.2	6.2	A	A	28	34
Greenoaks Avenue (W leg)	456	469	0.57	0.62	9.8	11.2	A	A	36	43
Total	**1,609**	**1,739**	**0.62**	**0.67**	**9.8**	**11.2**	**A**	**A**	**41**	**50**

Source: SCT Consulting; 2020

Table A11 New South Head Road / Bay Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
NSH Road (E leg)	2,245	2,278	0.39	0.40	0.0	0.0	A	A	0	0
Bay Street (N leg)	87	87	0.13	0.11	7.4	6.6	A	A	3	3
NSH Road (W leg)	1,116	1,124	0.43	0.34	0.4	0.3	A	A	0	42
Total	**3,448**	**3,489**	**0.43**	**0.40**	**7.4**	**6.6**	**A**	**A**	**3**	**42**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
NSH Road (E leg)	1,513	1,523	0.39	0.40	0.0	0.0	A	A	0	0
Bay Street (N leg)	105	105	0.32	0.33	10.3	10.3	A	A	5	5
NSH Road (W leg)	1,809	1,823	0.47	0.47	0.4	0.4	A	A	97	106
Total	**3,427**	**3,452**	**0.47**	**0.47**	**10.3**	**10.3**	**A**	**A**	**97**	**106**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
NSH Road (E leg)	1,813	1,859	0.47	0.48	0.0	0.0	A	A	0	0
Bay Street (N leg)	107	119	0.53	0.34	18.1	10.0	B	A	8	5
NSH Road (W leg)	1,729	1,797	0.60	0.47	0.4	0.4	A	A	21	24
Total	**3,649**	**3,775**	**0.60**	**0.48**	**18.1**	**10.0**	**B**	**A**	**21**	**24**

Source: SCT Consulting; 2020

Table A12 New South Head Road / Manning Road: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Manning Road (S leg)	437	442	0.79	0.80	52.2	52.9	D	D	135	138
NSH Road (E leg)	2,011	2,084	0.98	0.98	44.1	44.3	D	D	229	229
NSH Road (W leg)	1,099	1,176	0.78	0.91	14.0	20.1	A	B	92	106
Total	**3,546**	**3,702**	**0.98**	**0.98**	**35.8**	**37.6**	**C**	**C**	**229**	**229**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Manning Road (S leg)	374	383	0.50	0.53	40.5	40.9	C	C	77	77
NSH Road (E leg)	1,369	1,489	0.61	0.68	3.5	4.0	A	A	40	56
NSH Road (W leg)	1,735	1,787	0.89	0.98	20.0	27.8	B	B	106	106
Total	**3,478**	**3,660**	**0.89**	**0.98**	**15.7**	**19.5**	**B**	**B**	**106**	**106**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Manning Road (S leg)	383	392	0.45	0.46	40.9	41.1	C	C	88	88
NSH Road (E leg)	1,623	1,685	0.64	0.66	2.7	2.8	A	A	40	44
NSH Road (W leg)	1,238	1,273	0.78	0.81	15.8	17.0	B	B	106	106
Total	**3,244**	**3,349**	**0.78**	**0.81**	**12.2**	**12.7**	**A**	**A**	**106**	**106**

Source: SCT Consulting; 2020

Table A13 New South Head Road / Knox Street: 2022 and 2027 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
NSH Road (E leg)	1,931	1,975	1.00	1.00	52.9	54.1	D	D	134	134
Knox Street (N leg)	177	216	0.97	1.32	87.3	287.4	F	F	80	203
NSH Road (W leg)	931	948	0.37	0.37	1.0	0.9	A	A	6	6
Total	**3,038**	**3,139**	**1.00**	**1.32**	**39.0**	**54.1**	**C**	**D**	**134**	**203**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
NSH Road (E leg)	1,268	1,374	0.58	0.65	0.8	0.9	A	A	13	17
Knox Street (N leg)	251	283	0.65	0.80	52.6	56.3	D	D	59	74
NSH Road (W leg)	1,518	1,565	0.79	0.81	1.6	2.4	A	A	25	33
Total	**3,037**	**3,222**	**0.79**	**0.81**	**5.5**	**6.5**	**A**	**A**	**59**	**74**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
NSH Road (E leg)	1,181	1,220	0.41	0.43	1.6	1.6	A	A	7	8
Knox Street (N leg)	239	277	0.54	0.70	53.2	54.9	D	D	57	71
NSH Road (W leg)	1,080	1,115	0.42	0.50	0.9	0.9	A	A	8	11
Total	**2,500**	**2,612**	**0.54**	**0.70**	**6.2**	**7.0**	**A**	**A**	**57**	**71**

Source: SCT Consulting; 2020

Table A14 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: 2022 and 2017 Intersection Performance

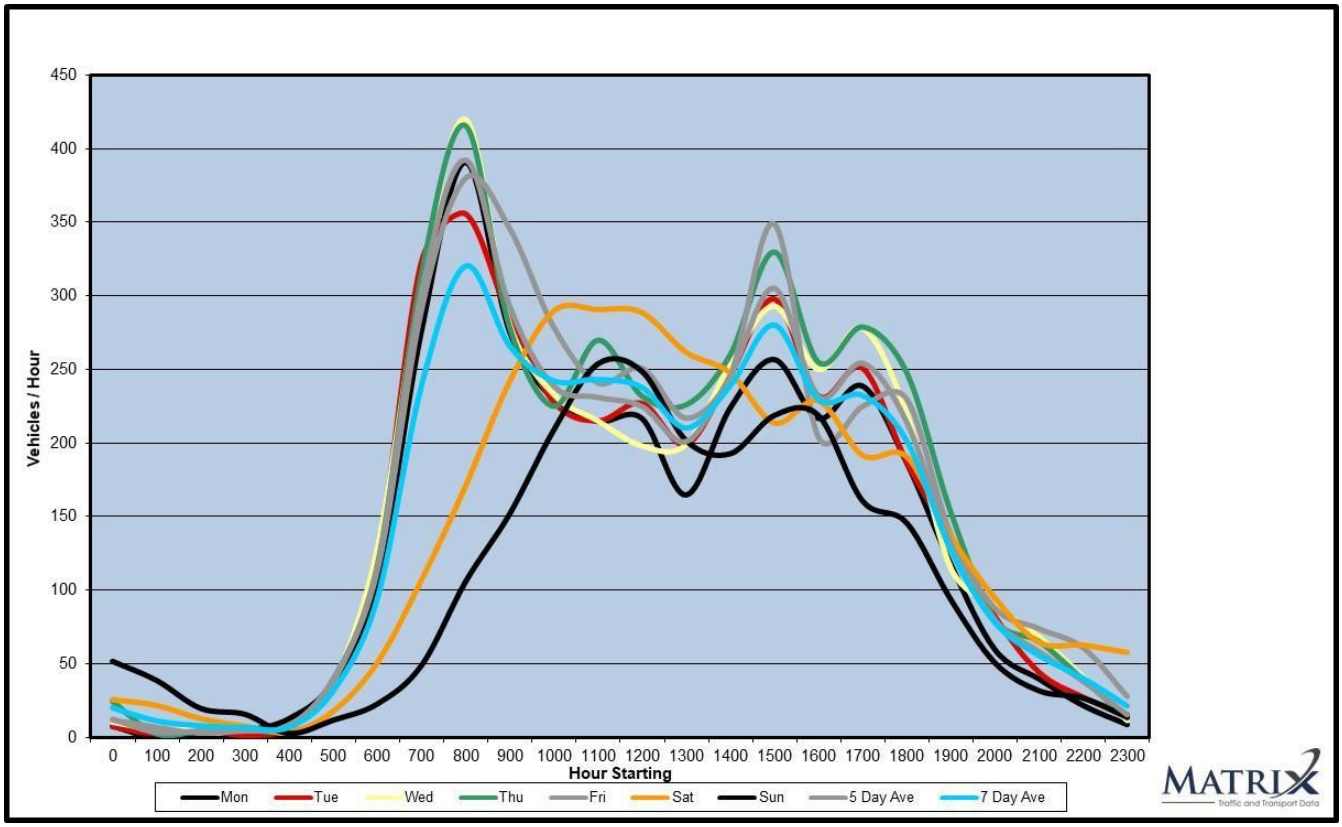
Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	510	522	1.04	1.10	98.1	126.1	F	F	227	273
NSH Road (E leg)	1,749	1,769	0.83	0.87	36.9	42.7	C	D	230	254
Cross Street (N leg)	192	202	1.06	1.29	76.5	140.6	F	F	44	78
NSH Road (W leg)	867	888	1.01	1.08	20.8	27.2	B	B	72	89
Kiaora Road (SW leg)	521	538	0.88	0.91	59.7	62.7	E	E	99	105
Total	**3,840**	**3,920**	**1.06**	**1.29**	**46.5**	**58.1**	**D**	E	**230**	**273**
PM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	328	346	0.65	0.66	50.3	49.9	D	D	74	77
NSH Road (E leg)	1,091	1,105	0.53	0.56	24.4	26.0	B	B	121	128
Cross Street (N leg)	304	320	0.87	0.90	55.4	55.9	D	D	71	75
NSH Road (W leg)	1,400	1,451	0.99	1.10	17.9	33.0	B	C	134	134
Kiaora Road (SW leg)	502	589	0.98	1.01	71.4	82.9	F	F	149	173
Total	**3,625**	**3,811**	**0.99**	**1.10**	**33.3**	**42.2**	**C**	**C**	**149**	**173**
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	405	425	0.84	0.89	55.5	59.5	D	E	107	118
NSH Road (E leg)	1,438	1,456	0.74	0.76	28.9	29.0	C	C	203	208
Cross Street (N leg)	277	294	1.03	1.15	89.1	134.4	F	F	98	135
NSH Road (W leg)	1,074	1,113	1.04	1.14	22.1	33.2	B	C	105	134
Kiaora Road (SW leg)	424	441	0.88	0.90	58.6	60.3	E	E	110	115
Total	**3,618**	**3,728**	**1.04**	**1.15**	**37.9**	**45.8**	**C**	**D**	**203**	**208**

Source: SCT Consulting; 2020

APPENDIX B

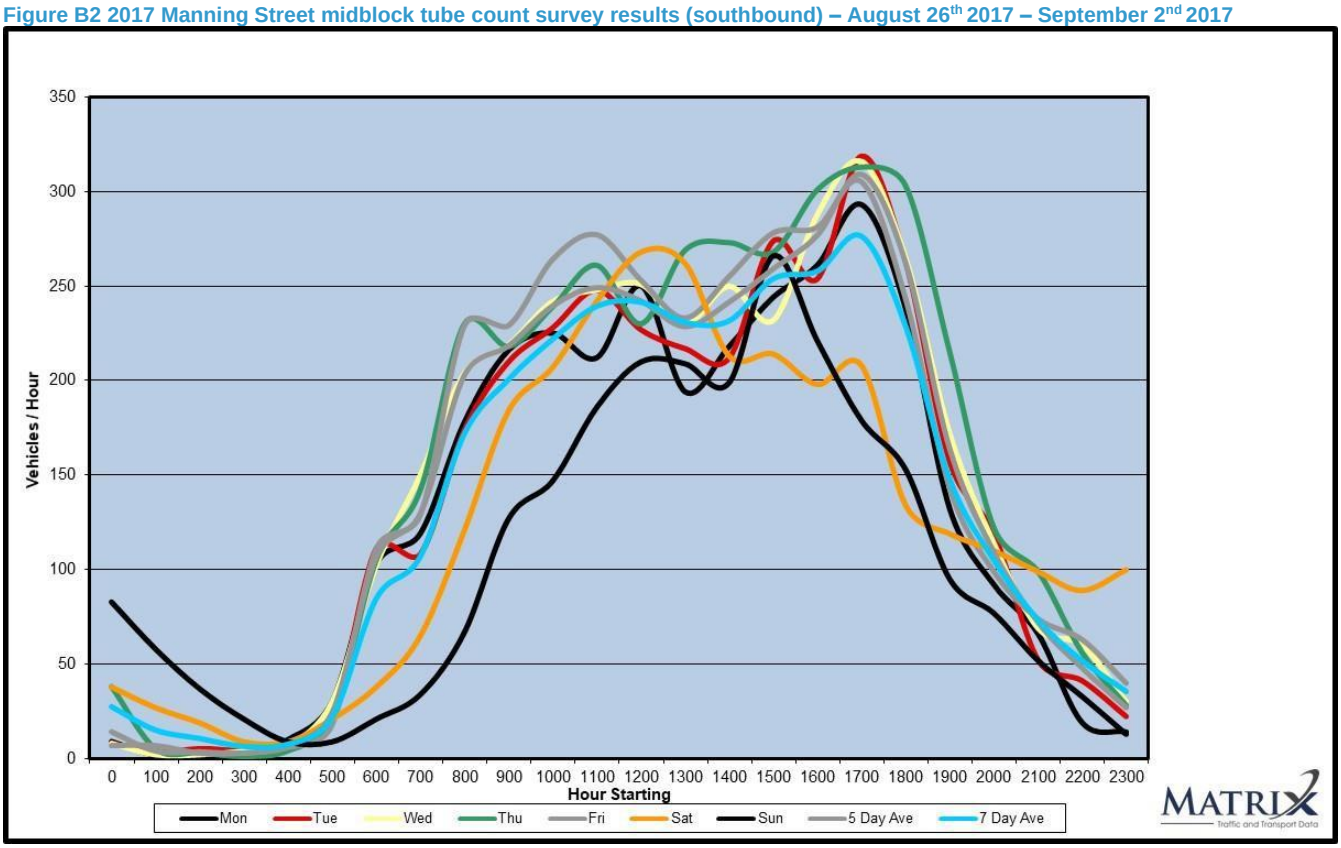
Mid-block Traffic Survey Results

Figure B1 2017 Manning Street midblock tube count survey results (northbound) – August 26th 2017 – September 2nd 2017



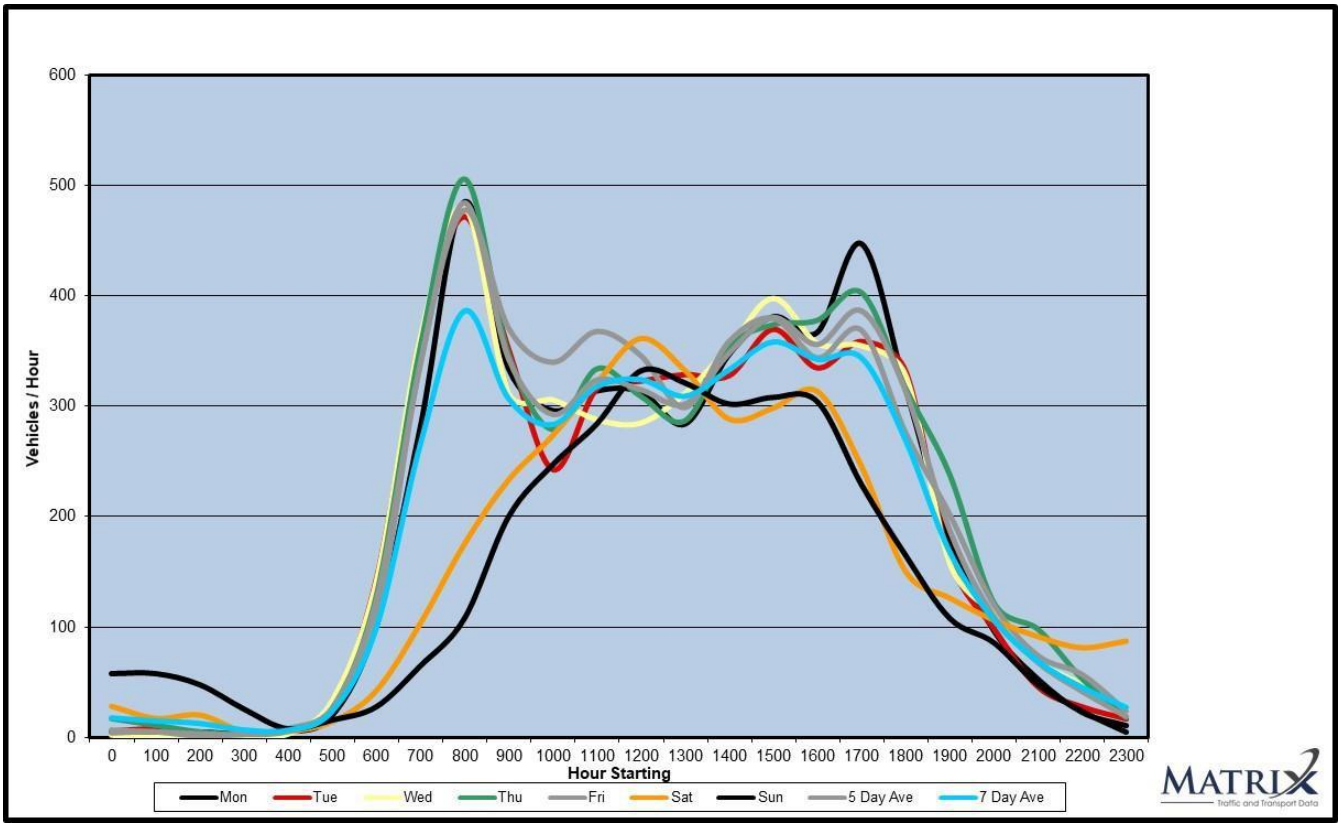
Source: Matrix; 2017

Figure B2 2017 Manning Street midblock tube count survey results (southbound) – August 26th 2017 – September 2nd 2017



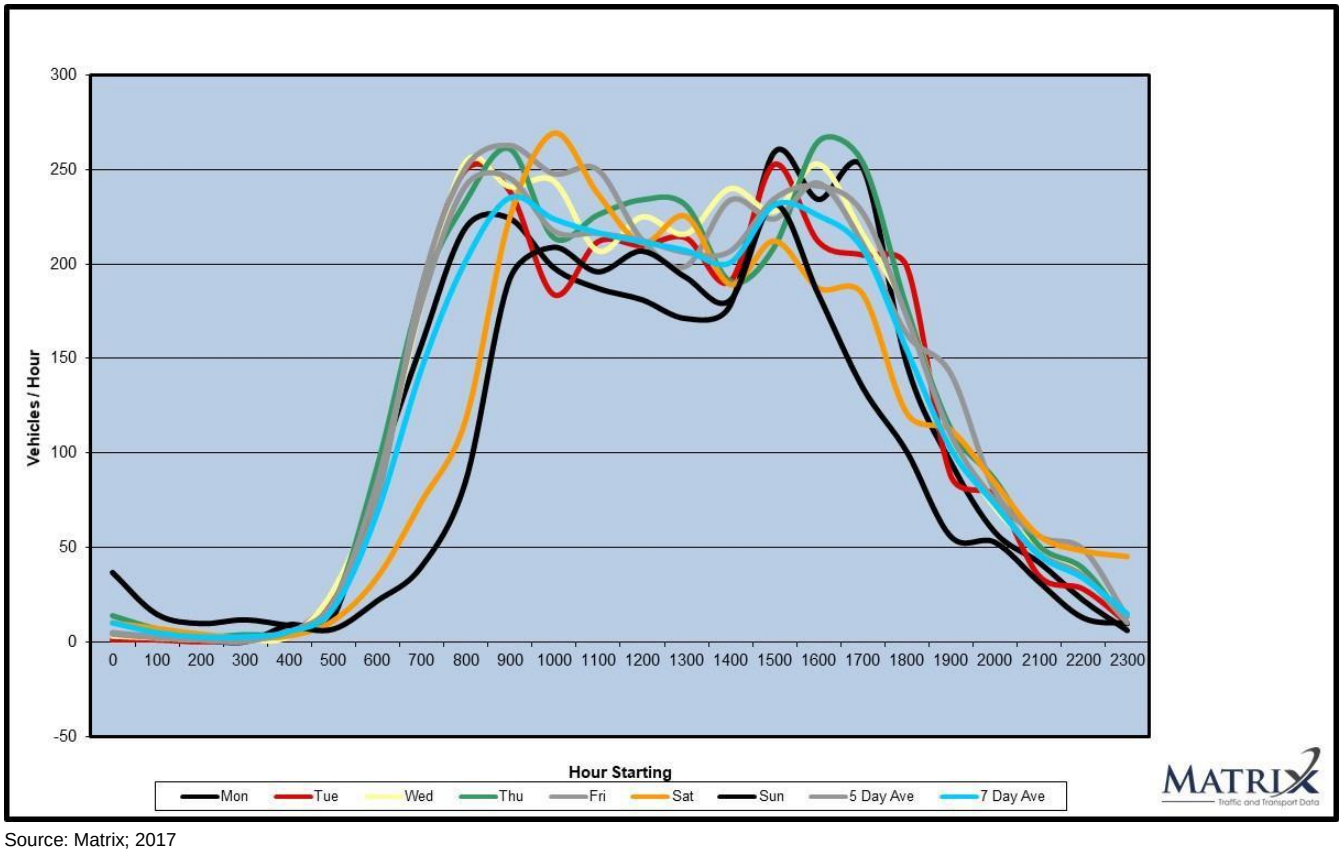
Source: Matrix; 2017

Figure B3 2017 Kiaora Road midblock tube count survey results (northbound) – August 26th 2017 – September 2nd 2017



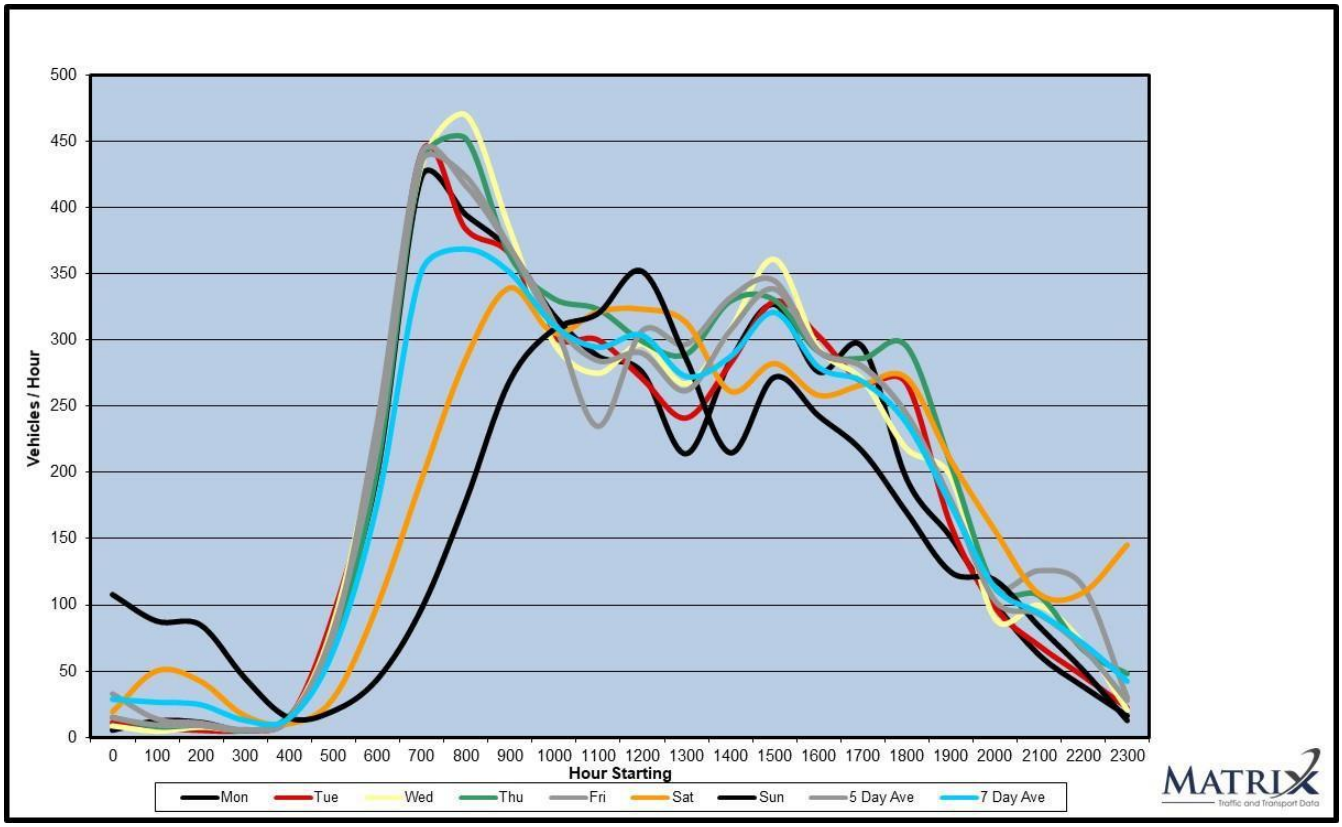
Source: Matrix; 2017

Figure B4 2017 Kiaora Road midblock tube count survey results (southbound) – August 26th 2017 – September 2nd 2017



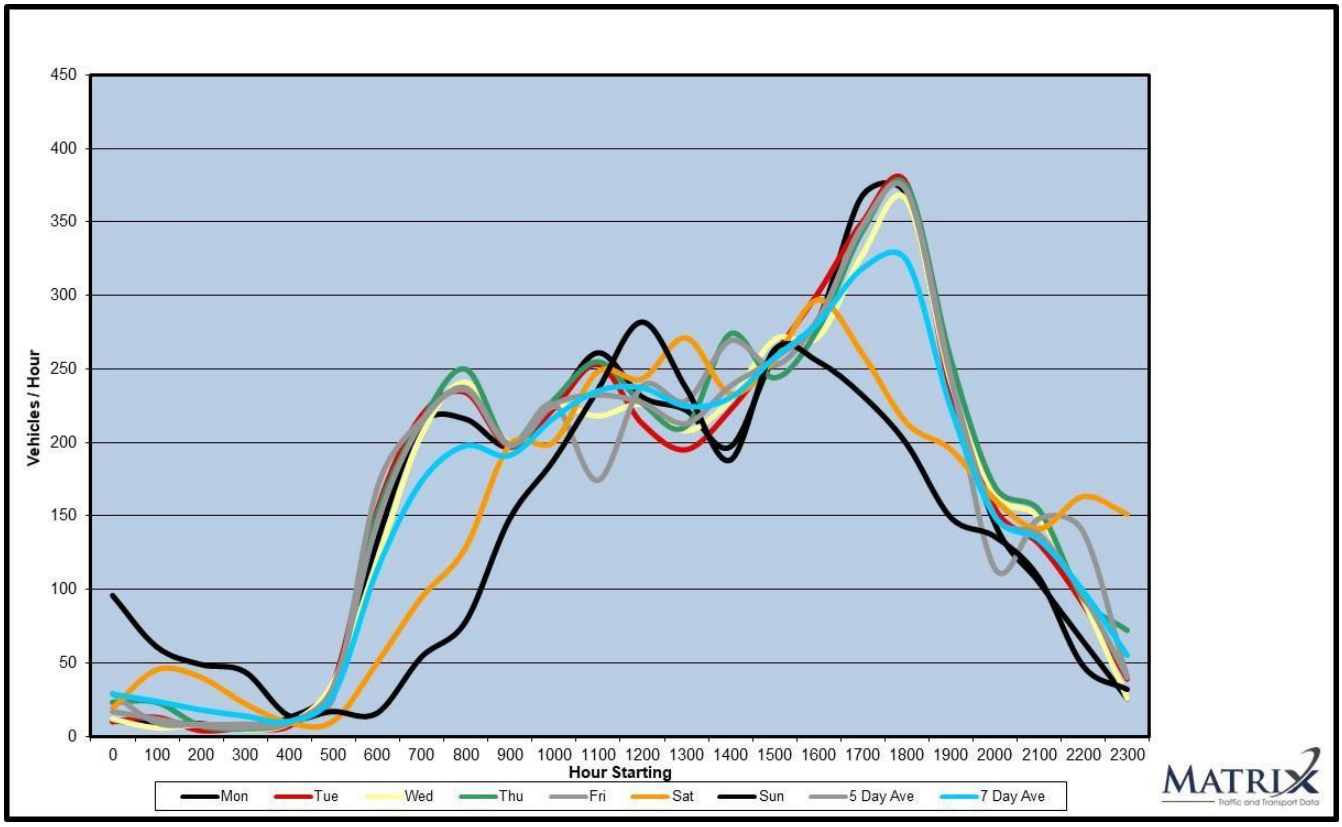
Source: Matrix; 2017

Figure B5 2017 Bellevue Road midblock tube count survey results (northbound) – August 26th 2017 – September 2nd 2017



Source: Matrix; 2017

Figure B6 2017 Bellevue Road midblock tube count survey results (southbound) – August 26th 2017 – September 2nd 2017

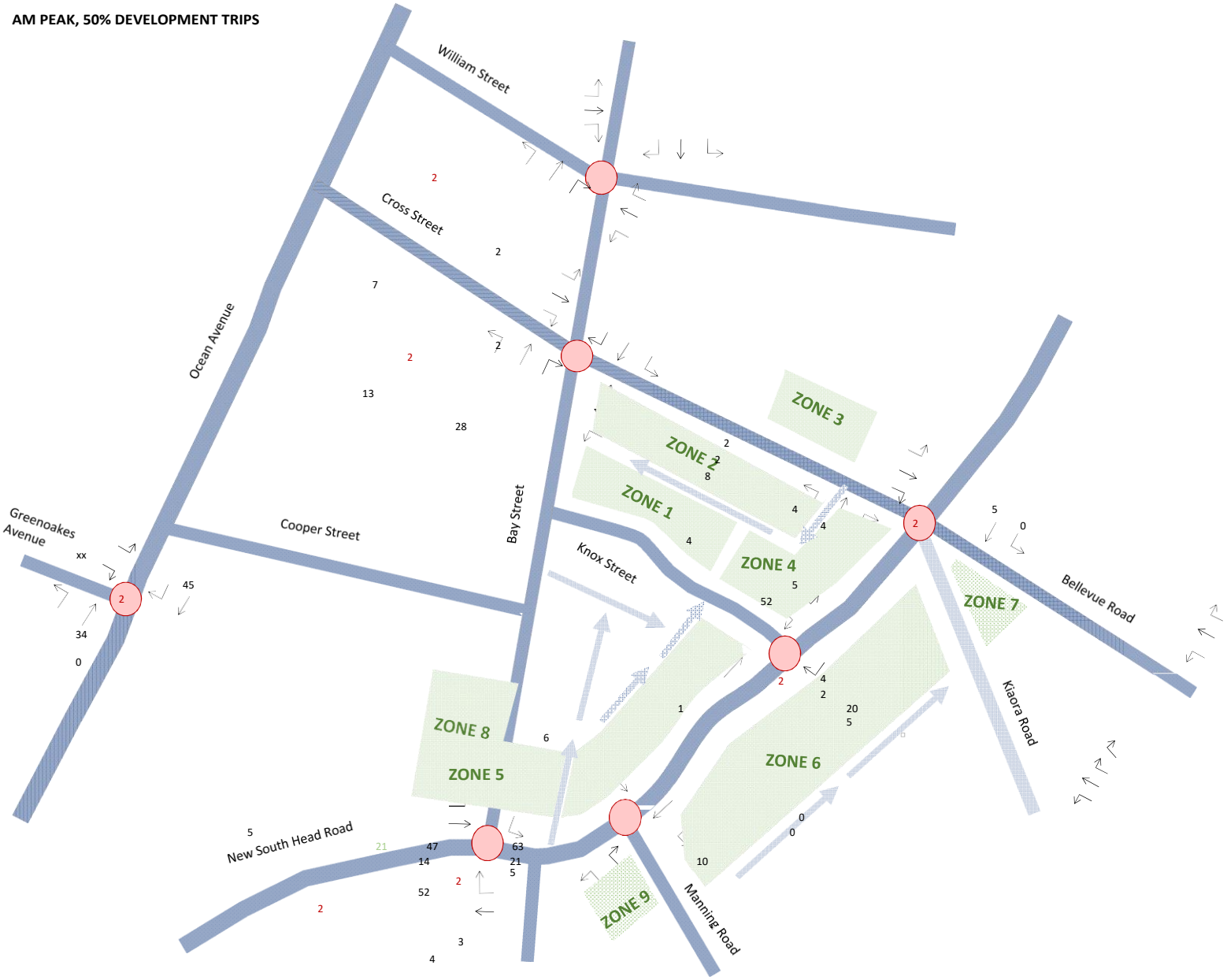


Source: Matrix; 2017

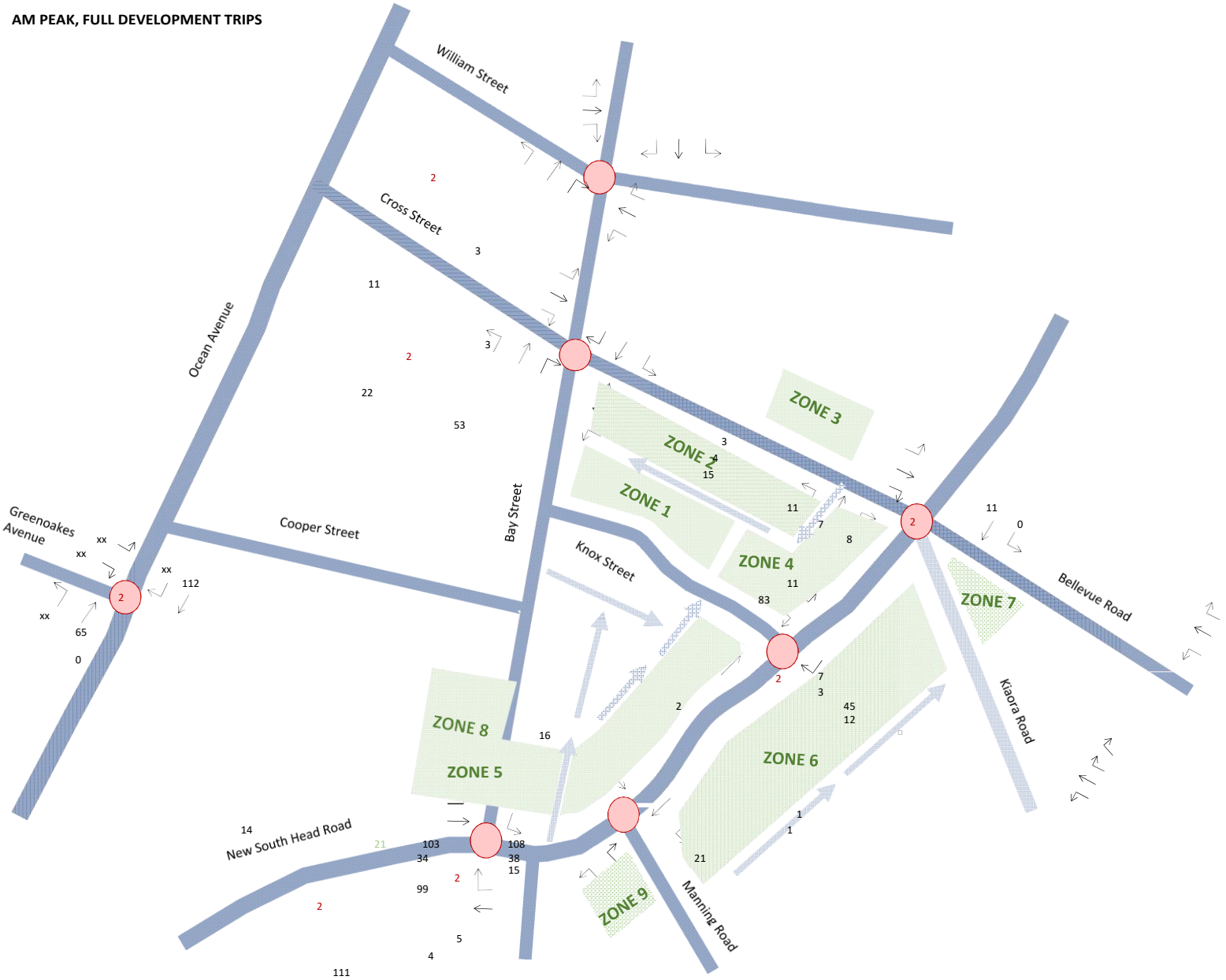
APPENDIX C

Network Flow Diagrams

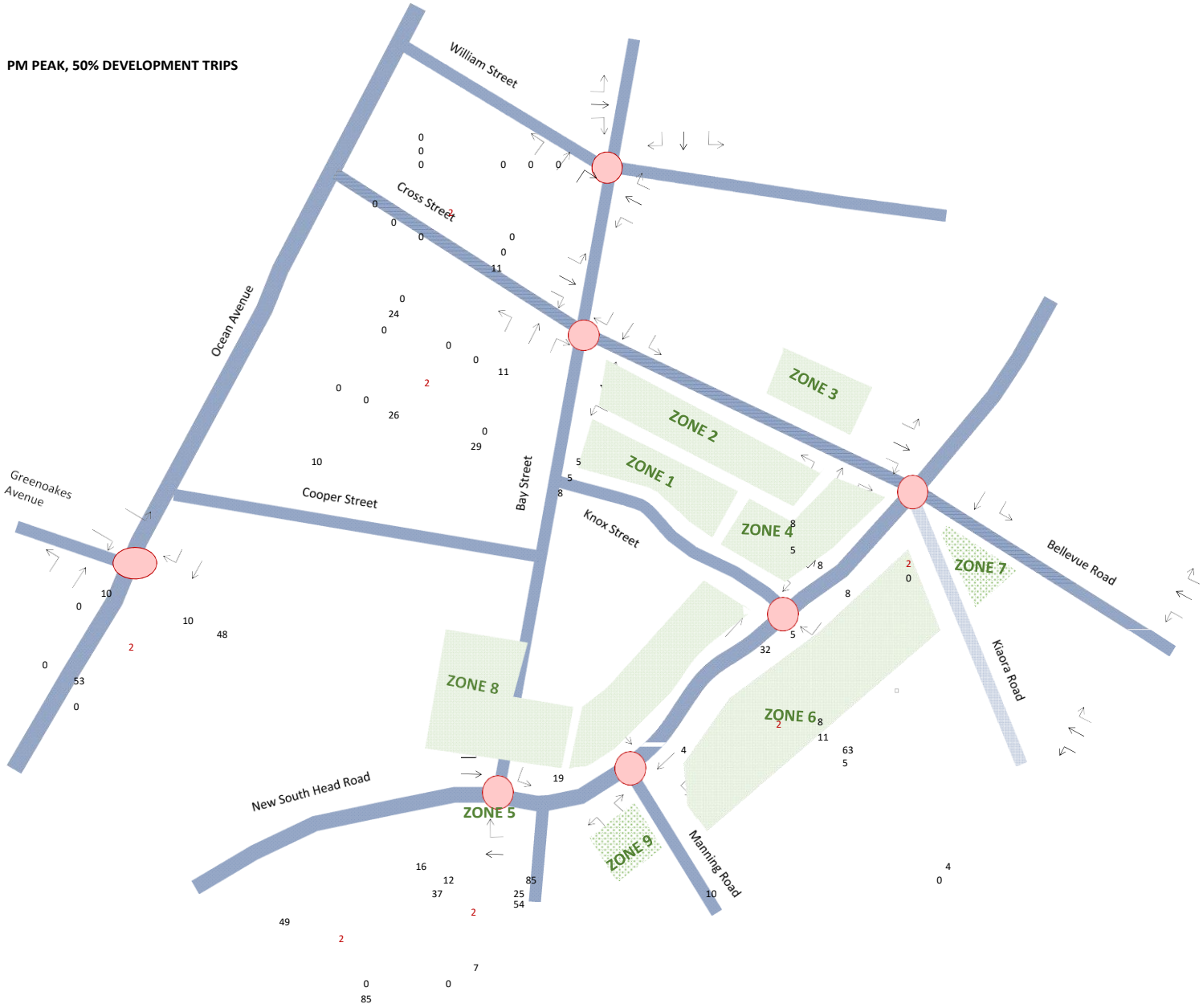
AM PEAK, 50% DEVELOPMENT TRIPS

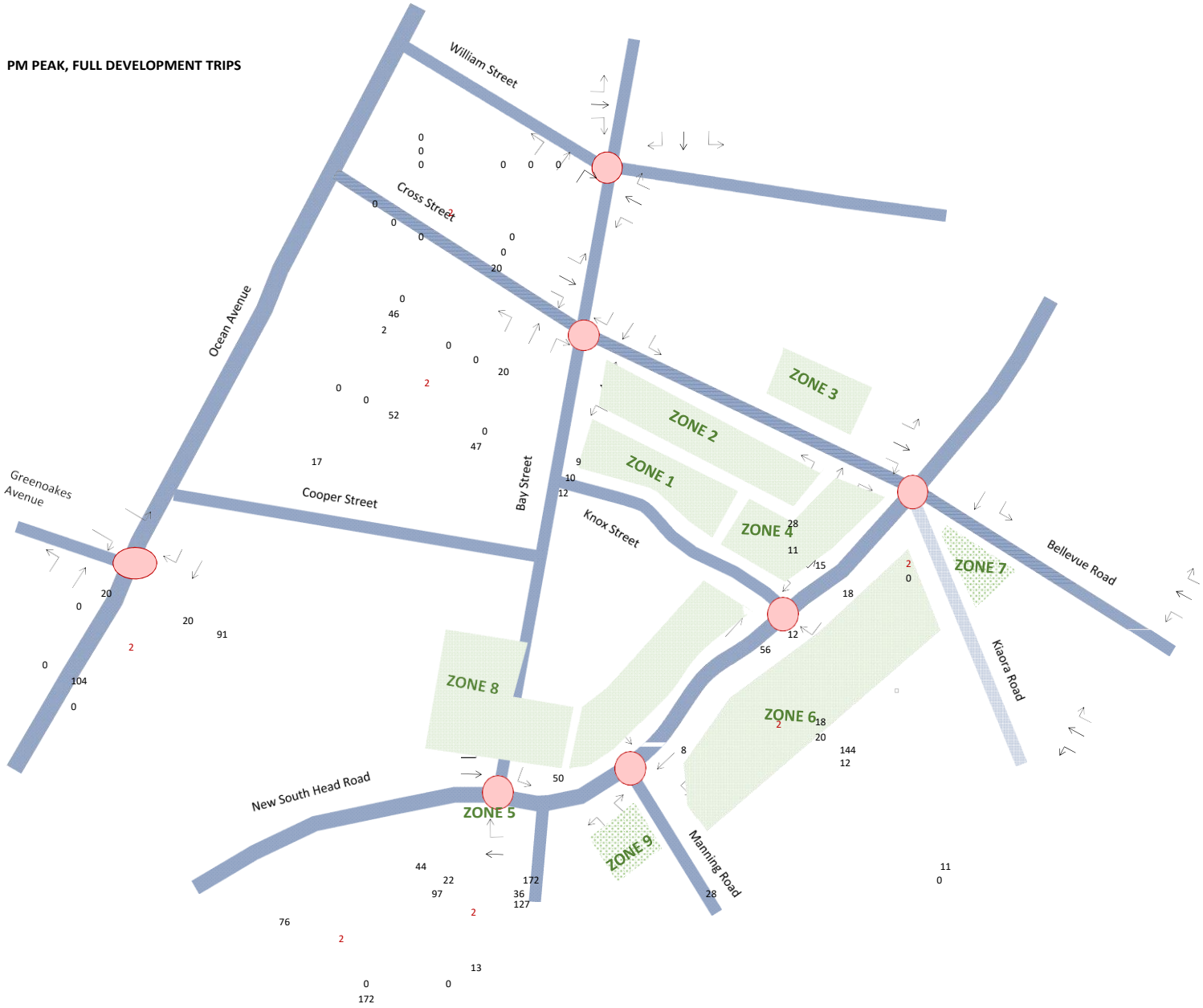


AM PEAK, FULL DEVELOPMENT TRIPS



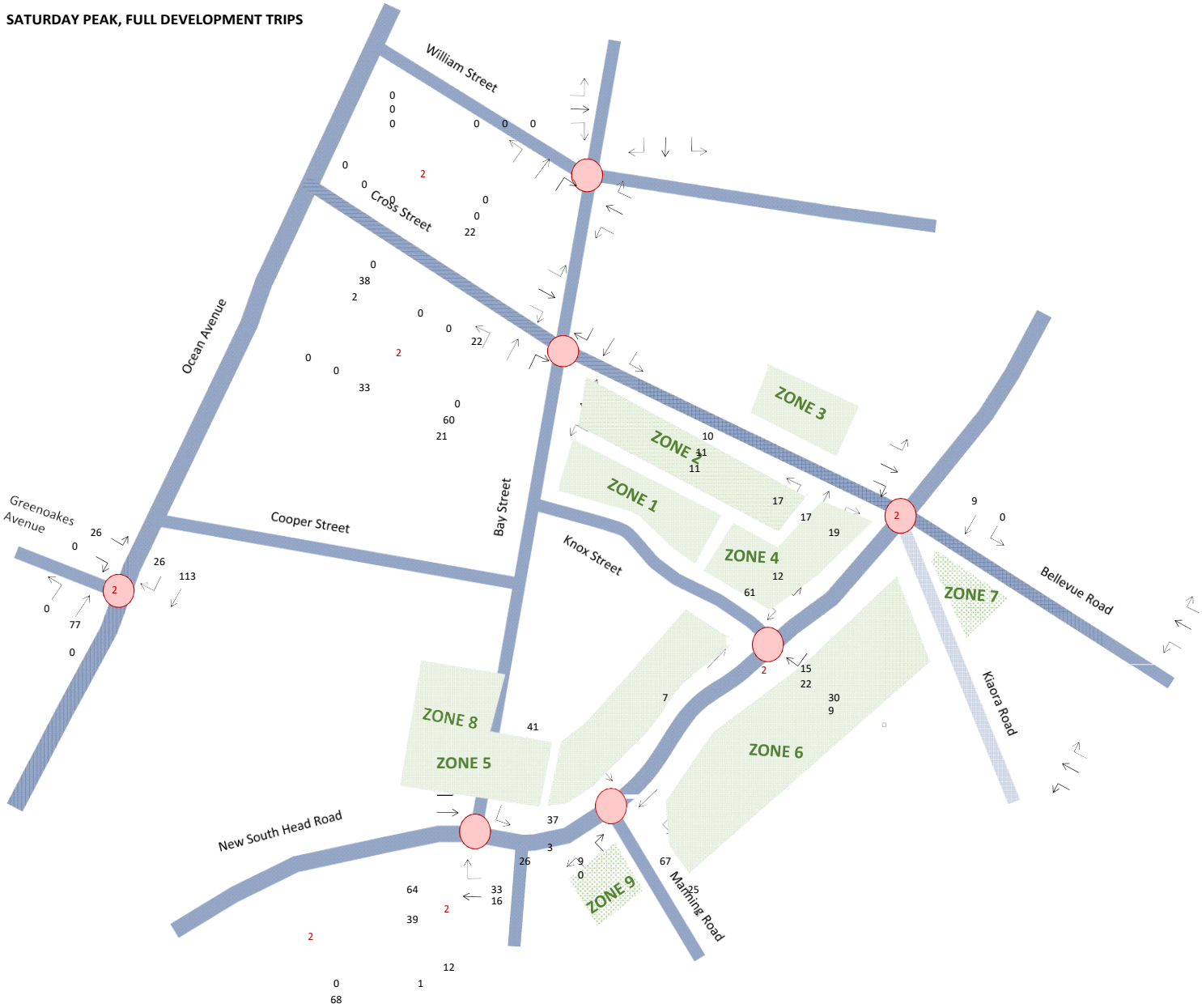
PM PEAK, 50% DEVELOPMENT TRIPS




PM PEAK, FULL DEVELOPMENT TRIPS
William Street
Cross Street
Ocean Avenue
Greenoakes Avenue
Cooper Street
Bay Street
Knox Street
Bellevue Road
Kiaora Road
New South Head Road
Manning Road
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
ZONE 6
ZONE 7
ZONE 8
ZONE 9


SATURDAY PEAK, 50% DEVELOPMENT TRIPS
William Street
Cross Street
Ocean Avenue
Greenoakes Avenue
Cooper Street
Bay Street
Knox Street
Bellevue Road
Kiaora Road
New South Head Road
Manning Road
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
ZONE 6
ZONE 7
ZONE 8
ZONE 9

SATURDAY PEAK, FULL DEVELOPMENT TRIPS



APPENDIX D

Sensitivity Test Intersection Performance

Table D1 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: 2022 and 2017 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	505	509	0.98	0.99	79.1	81.3	F	F	185	190
NSH Road (E leg)	1749	1,769	0.78	0.78	32.8	31.4	C	C	213	212
Cross Street (N leg)	190	192	0.93	0.95	56.6	57.7	E	E	43	44
NSH Road (W leg)	867	886	0.99	1.00	19.8	20.1	B	B	70	74
Kiaora Road (SW leg)	521	538	0.88	0.96	59.3	68.9	E	E	99	117
Total	**3833**	**3,894**	**0.99**	**1.00**	**40.7**	**41.9**	**C**	**C**	**213**	**212**

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
PM Peak Hour Period					
Year	**2027**	**2027**	**2027**	**2027**	**2027**
Bellevue Road (S leg)	346	0.70	51.5	D	79
NSH Road (E leg)	1,105	0.54	25.2	B	126
Cross Street (N leg)	320	0.98	64.6	E	76
NSH Road (W leg)	1,432	1.00	19.2	B	134
Kiaora Road (SW leg)	586	1.00	80.2	F	166
Total	**3,789**	**1.00**	**37.2**	**C**	**166**

Saturday Peak Hour Period										
Year	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	405	425	0.84	0.85	55.5	55.3	D	D	107	111
NSH Road (E leg)	1,438	1,456	0.74	0.76	28.9	29.0	C	C	203	208
Cross Street (N leg)	275	282	1.00	0.98	81.0	74.1	F	F	90	89
NSH Road (W leg)	1,069	1,094	1.00	1.00	18.1	18.1	B	B	90	91
Kiaora Road (SW leg)	424	441	0.88	0.95	58.6	67.5	E	E	110	126
Total	**3,612**	**3,698**	**1.00**	**1.00**	**36.1**	**36.8**	**C**	**C**	**203**	**208**

Source: SCT Consulting; 2020

Table D2 New South Head Road / Knox Street: 2027 Intersection Performance (Sensitivity Test 1 – modal shift)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
2027 AM Peak Hour Period					
NSH Road (E leg)	1,955	0.99	48.5	D	134
Knox Street (N leg)	175	1.00	99.1	F	82
NSH Road (W leg)	948	0.37	1.0	A	6
Total	**3,078**	**1.00**	**36.7**	**C**	**134**

Source: SCT Consulting; 2020

Table D3 New South Head Road / Cross Street / Bellevue Road / Kiaora Road: 2022 and 2017 Intersection Performance

Peak Period / Approach	Vehicles		DoS		Average Delay (sec)		LoS		95th percentile back of queue (m)	
AM Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	510	522	0.97	0.92	74.4	61.6	F	E	182	166
NSH Road (E leg)	1,749	1,769	0.85	0.98	41.2	79.1	C	F	243	346
Cross Street (N leg)	192	202	0.87	0.76	52.7	48.3	D	D	43	41
NSH Road (W leg)	837	858	0.77	0.93	15.1	20.0	B	B	56	73
Kiaora Road (SW leg)	521	538	0.88	0.91	59.5	62.4	E	E	99	105
Total	**3,809**	**3,920**	**0.97**	**0.98**	**43.0**	**59.8**	**D**	E	**243**	**346**
PM Peak Hour Period										
Year (Scenario)	**2027**		**2027**		**2027**		**2027**		**2027**	
Bellevue Road (S leg)	346		0.66		49.9		D		77	
NSH Road (E leg)	1,105		0.59		28.5		C		134	
Cross Street (N leg)	320		0.90		55.9		D		75	
NSH Road (W leg)	1,384		0.85		14.1		A		91	
Kiaora Road (SW leg)	589		0.92		60.1		E		133	
Total	**3,744**		**0.92**		**32.5**		**C**		**134**	
Saturday Peak Hour Period										
Year (Scenario)	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**	**2022**	**2027**
Bellevue Road (S leg)	405	425	0.80	0.81	52.7	52.2	D	D	102	106
NSH Road (E leg)	1,438	1,456	0.76	0.79	29.9	32.2	C	C	207	222
Cross Street (N leg)	277	294	0.96	0.98	70.2	75.1	E	F	83	93
NSH Road (W leg)	1,014	1,052	0.67	0.76	10.3	11.9	A	A	48	55
Kiaora Road (SW leg)	424	441	0.88	0.90	59.1	60.3	E	E	111	115
Total	**3,558**	**3,667**	**0.96**	**0.98**	**33.5**	**35.5**	**C**	**C**	**207**	**222**

Source: SCT Consulting; 2020

Table D4 New South Head Road / Knox Street: 2027 Intersection Performance (diverted trips)

Peak Period / Approach	Vehicles	DoS	Average Delay (sec)	LoS	95th percentile back of queue (m)
2027 AM Peak Hour Period					
NSH Road (E leg)	1,975	1.00	52.9	D	134
Knox Street (N leg)	175	1.00	99.1	F	82
NSH Road (W leg)	914	0.35	1.0	A	5
Total	**3,063**	**1.00**	**40.1**	**C**	**134**

Source: SCT Consulting; 2020

SCT Consulting