Nine Network Australia Pty Ltd
19-Aug-2013

Nine Network Australia (NNA) Willoughby site redevelopment

Transport and Accessibility Impact Assessment for PPR

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Client: Nine Network Australia Pty Ltd

ABN: 88008685407

Prepared by

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

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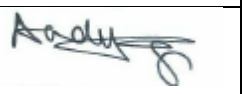
B	19-Aug-2013	Final report	Andy Yung Principal Transport Planner	

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Appendix B

SIDRA Intersection Outputs A

1.0 Introduction

1.1 Background

AECOM was commissioned by Nine Network Australia Pty Ltd (NNA) to prepare a Transport and Accessibility Impact Assessment in support of an Environment Assessment (EA) of the Concept Plan prepared for the redevelopment of the site at 6-30 Artarmon Road, Willoughby. The project site in relation to its regional context is shown in **Figure 1**.

Figure 1 Location of the project site

Source: AECOM 2012

A traffic report with the original Concept Plan proposing approximately 585 dwelling units has been submitted to Department of Planning & Infrastructure (DPI) in March 2013 to support a major project application (MP10_0198). During the assessment of the major project application, DPI has commissioned Arup to prepare an independent transport assessment of the proposed development, in consultation with Willoughby Council.

As a result of reviewing of submissions and on-going consultation with DPI and relevant stakeholder, a Preferred Project Report (PPR) is prepared seeking approval for a maximum of 450 residential dwellings. This revised traffic report that supports the PPR has been prepared to incorporate:

- Background traffic data that have recently been released that will have implications to the assessment such as 2011 census data and journey-to-work data, trip generation rates produced by RMS etc.
- Assessment and modelling to reflect a development yield of up to 450 dwellings (to support PPR).
- Assessment and modelling of weekend peak hour (as a result of concerns of weekend traffic conditions raised in submissions).
- Address of the proponent and AECOM's view of recommendations made in the independent transport assessment.

1.2 Report structure

The report is structured as follows:

- **Section 2** summarises the existing conditions in the area surrounding the site, including travel patterns and behaviour, public transport, cyclist and pedestrian facilities as well as the existing performance of the road network.
- **Section 3** gives details of the development proposal including vehicular access and parking arrangements.
- **Section 4** provides a traffic impact assessment of the site on the existing road network. This includes the trip generation exercise and intersection performance testing using the SIDRA modelling software.
- **Section 5** provides a summary and conclusions of the report.

2.0 Existing Conditions

2.1 Site description

The project site is located in the Inner North Sub-Region of the Sydney Metropolitan area, as defined by the Metropolitan Strategy 2031 as the area between the northern harbour foreshore, Chatswood and Macquarie Park. Approximately 8km to the north of the Sydney CBD, the site is located in the centre of the Willoughby Local Government Area (LGA). At a local level, the site is located within close proximity to the Chatswood CBD (2km) and Artarmon train station (1km) on the North Shore line of the CityRail network. Services provide frequent connection to the CBD and Chatswood.

The site is bounded to the north by Artarmon Road and Richmond Avenue to the west with existing residential areas located to the east and south. Scott Street is currently owned by Council, but the parking areas on both side of Scott Street are owned by the Nine Network. The extent of the site is highlighted by the red dotted line in **Figure 2**.

Figure 2 Site boundary

Source: AECOM, 2012

The site is located within 15 minute walking distance to Artarmon train station and Willoughby Road is a key bus corridor providing frequent bus services between Chatswood, North Sydney and the CBD. The M40 bus service provides an express bus service for local residents along Willoughby Road to Chatswood and the CBD. 2011 census data showed that the site has good public transport mode share, over 35 per cent of journey-to-work trips from Willoughby area were made by public transport.

2.1.1 Site access

The main site access is through the security gate at Artarmon Road, at approximately 30m east of Edward Street. Another main access to the car park is located at Scott Street. An emergency access is located at Richmond Avenue, at approximately 90m south of Artarmon Road.

2.1.2 On-site parking provision

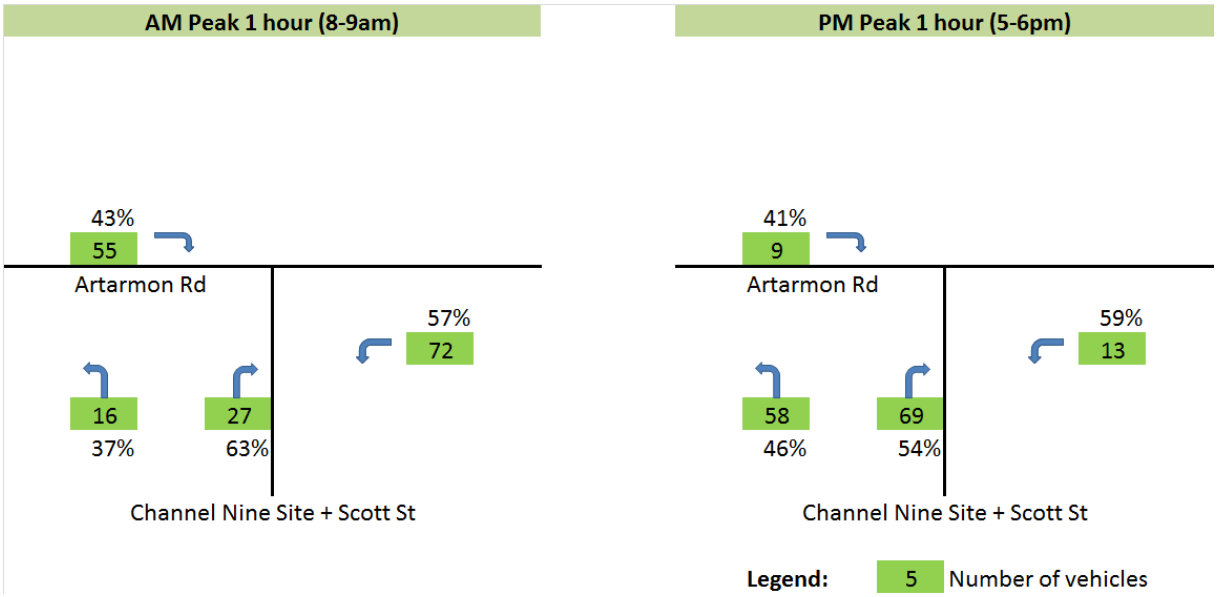
There are 356 parking spaces provided on site at present, including the 90 degree angled parking spaces on Scott Street. The on-street parking spaces on Scott Street are currently reserved by Nine Network Australia Pty Ltd and are not for general public parking.

2.1.3 Existing trip generation from site

At present, the staff levels at the existing Channel Nine TV station are around 650 people and up to 900 people for the large broadcasting events. Channel Nine currently operates a shuttle bus service between the site and Artarmon Station throughout the day, with approximately 150 staff using the shuttle service every day.

A traffic survey was undertaken on 11 October 2012 at the main Artarmon Road access and Scott Street to determine total traffic volumes being generated by the site during the (7am to 9am) and evening (4pm to 6pm) peak hours. As shown in **Figure 3**, the existing site currently generates 170 and 149 vehicle movements during the morning and evening peak hours respectively. Approximately 60 per cent of the traffic generated by the site use Willoughby Road to access the wider road network. The survey indicated that no heavy commercial vehicles visited the site during the peak periods.

Figure 3 Trip generated by the existing site (October 2012)



During the site visit undertaken in October 2012, some employees were observed to park their cars on Artarmon Road and Richmond Avenue. These vehicular movements were not captured in the traffic surveys at the main access points to determine the existing trip generation.

Additional traffic surveys undertaken in June 2013 as part of the independent transport assessment demonstrated that the existing Channel Nine site generates 198 and 176 vehicle movements during the morning and evening peak hours respectively, slightly more traffic movements than those recorded by AECOM in October 2012. This is regarded as an upper range of the existing site generation in the traffic assessment.

However, it is noted that activity during the Saturday peak hour is significantly lower than the weekday peak hours – generating approximately 25 vehicle movements. The proponent confirmed the weekend site traffic generation surveyed by Arup is representative of typical weekend condition for the site.

2.2 Road network

The site has good access to Sydney's motorway and arterial road network. Willoughby Road is classified as a sub-arterial road, while other surrounding streets such as Artarmon Road and Edward Street are classified as collector and local roads. The proposed site is also located close to the Warringah Freeway, which provides good connectivity to Sydney Central Business District (CBD).

2.2.1 Willoughby Road

Willoughby Road is an urban sub-arterial road providing a link between Willoughby and Crows Nest. It is connected to the Warringah Freeway near the Naremburn shops, providing direct access to Sydney CBD and areas to the south, east and west of the CBD. It is also used as a major road connecting North Sydney and Chatswood as an alternative route of Pacific Highway.

Willoughby Road between Mowbray Road and Warringah Freeway is a state road under the care and management of the RMS. The road has a posted speed limit of 60km/h through the section in Willoughby, and 50km/h in the areas through Crows Nest at the south of Warringah Freeway off ramp.

Willoughby Road is generally a four- lane road with on-street parking permitted on both sides of the road. Clearways operate in peak periods in the direction of peak traffic flow between Mowbray Road and Warringah Freeway. No parking is permitted on the section between Artarmon Road and Warringah Freeway.

2.2.2 Artarmon Road

Artarmon Road is generally a four-lane collector road with a 50km/h speed limit which runs from Willoughby Road in the east to Elizabeth Street in Artarmon to the west. It provides connectivity to Artarmon village and railway station. There is a three ton load limit restriction for the vehicles using this road. Unrestricted on-street parking is permitted on both sides of the road in the vicinity of the site. Artarmon Road is very steep between Willoughby Road and Edward Street and becomes relatively flat west of Edward Street. Footpaths are provided on both sides of Artarmon Road.

2.2.3 Edward Street

Edward Street is a local road with one travel lane and a parking lane in each direction with a speed limit of 50km/h. It provides a local connection between Artarmon Road and Willoughby Road with connectivity to other local residential streets. With right turn ban from Willoughby Road to Artarmon Road during the morning peak period, Edward Street provides an alternative route access to Artarmon Road from Willoughby Road. Short-term two hour limit on-street parking (local resident excepted) is permitted on both sides of the road.

2.2.4 Richmond Avenue

Richmond Avenue is a local cul-de-sac with one travel lane and a parking lane in each direction. It provides access to the existing residents in the area and also provides an emergency access to the existing site. Unrestricted on-street parking is permitted on the eastern side of the street and short-term two hour limit on-street parking is permitted on the western sides of the street.

2.2.5 Scott Street

Scott Street is also a local cul-de-sac road with two lanes and a speed limit of 50km/h. It runs along the eastside of the proposed site and connects to Artarmon Road. On-street parking is reserved for the Channel Nine employees.

2.2.6 Willoughby Road / Artarmon Road / Small Street intersection

The Willoughby Road / Artarmon Road / Small Street intersection is a signalised four-way intersection. Artarmon Road is the western approach which provides access to the project site as well as the local residential area in Willoughby. The eastern approach to the intersection is Small Street which links to Hallstrom Park, Bicentennial Reserve and Willoughby Leisure Centre.

This intersection has two lanes on each approach and does not have auxiliary turning bay facility on both Willoughby Road approaches. Short turning lanes are provided at Artarmon Road and Small Street approaches by restricting on-street parking on the approaches to the intersection. At present, there is no exclusive right turning phase provided on both Willoughby Road approaches. No right turn is permitted from Willoughby Road to Artarmon Road during the morning peak (6-10am) and from Willoughby Road to Small Street during the afternoon peak (3-7pm). Signalised pedestrian crossing facilities are provided at all approaches except the southern approach.

2.3 Traffic volumes

2.3.1 Daily traffic counts

Historic traffic data was obtained from RMS to establish background traffic growth in the vicinity of the site. The Average Annual Daily Traffic (AADT) data from selected RMS count survey location in the area surrounding the site are presented in **Table 1**, with the location of the traffic count stations shown in **Figure 4**.

Table 1 Daily traffic volume

Station	Location	2006 AADT	2007 AADT	2008 AADT	2009 ADT	2010 ADT
33.098	Willoughby Road – South of Artarmon Road	35,034	33,463	32,747	32,494	30,236

Note:

AADT (Annual Average Daily Traffic was calculated on 365 days of data)

ADT (Average Daily Traffic was calculated based on the number of days available for that year. 2009 (Average Available Days = 329) 2010 (Average Available Days = 142)

Source: RMS 2012

Figure 4 Traffic count location

Source: AECOM 2012

The data indicates that traffic on Willoughby Road in the vicinity of the site has gradually declined between 2006 and 2010. For the purpose of any future year analysis, traffic growth is assumed to be at zero per cent rather than a negative growth as a worst case.

2.3.2 Intersection traffic counts

Classified turning movement counts were undertaken by Austraffic Pty Ltd during the morning (7am to 9am) and evening (4pm to 6pm) peak periods on 11 October, 2012 at the following intersections:

- Willoughby Road / Artarmon Road (I-1)
- Willoughby Road / Garland Road (I-2)

These intersections are considered to be critical in the movement to and from the site, as they are the main intersections connecting to the arterial road (Willoughby Road and Warringah Freeway). The selection of the key intersections for this assessment is consistent with Willoughby City Council's traffic assessment of the development of Willoughby Leisure Centre Expansion, which is located near the site on Small Street.

The turning movement counts revealed that the AM and PM peak hours for the survey date were 8am to 9am and 5pm to 6pm respectively. There were 23 cars recorded making the illegal right turn from Willoughby Road (south approach) to Small Street (east approach) during the evening peak one hour.

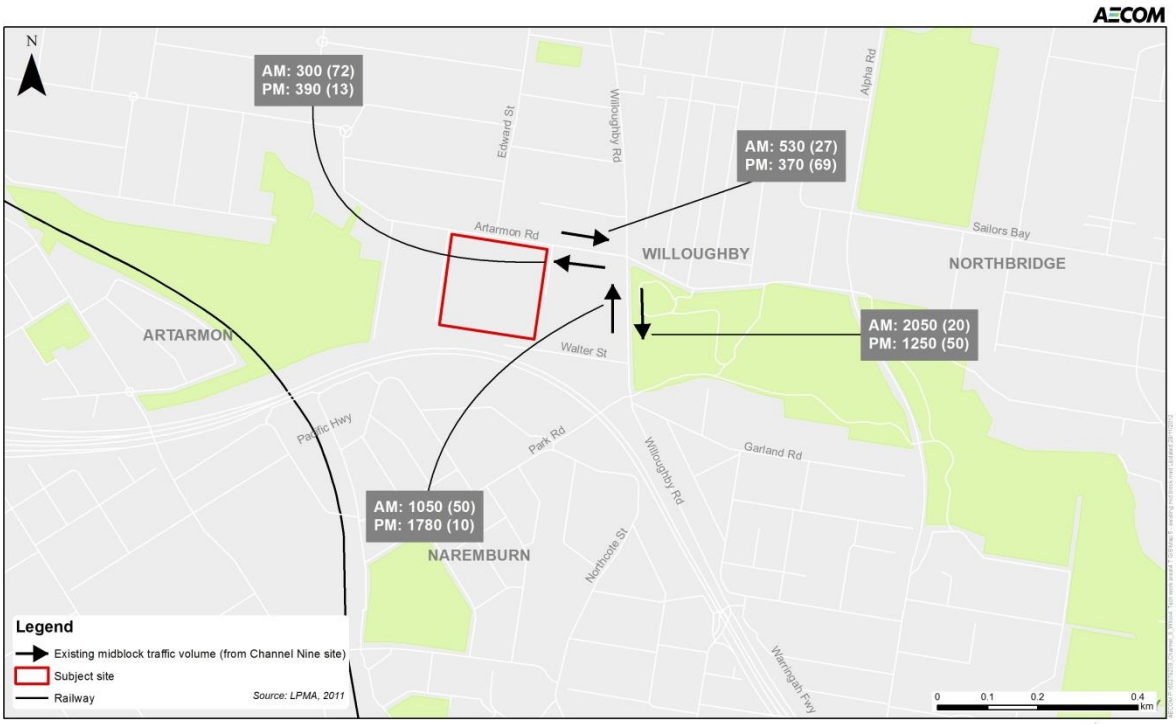
Based on the intersection surveys undertaken, a summary of peak hour midblock traffic counts on the local road network at locations surrounding the site is shown in **Table 2**. **Figure 5** shows the total peak hour traffic on the Artarmon Road and Willoughby Road approaches as well as the component of traffic generated by the existing operation of Channel Nine (as shown in brackets).

Table 2 Peak hour traffic volume

Midblock location	Direction	AM peak hour (veh/hr)	PM peak hour (veh/hr)
Willoughby Road, South of Artarmon Road	NB	1,050	1,780
	SB	2,050	1,250
	Total Peak Hour Traffic	**3,100**	**3,030**
Artarmon Road, West of Willoughby Road	EB	530	370
	WB	300	390
	Total Peak Hour Traffic	**830**	**760**

Source: AECOM 2012

Figure 5 Midblock traffic volumes in the vicinity of the site



Source: AECOM 2012

*Additional traffic surveys undertaken in June 2013 as part of the independent transport assessment demonstrated that the weekday survey day (Thursday) and peak time periods aligned with surveys undertaken by AECOM in October 2012. A comparison of survey results are provided in **Table 3**. This confirms that the data and the analysis undertaken by AECOM is representative of the existing traffic conditions. Therefore the weekday peak hour data collected by AECOM are used for the revised traffic assessment.*

However, as a comparison it is noted that the Saturday survey data collected by Arup are up to 15% higher than those collected by the local residents back in May 2013 and by GTA consultants in 2012 (for the Leisure Centre Traffic Study).

Table 3 Comparison of survey results at Artarmon Road and Willoughby Road (Oct 2012 and June 2013)

Road section	Two-way peak hour traffic flow (veh/hr)					
	AM peak hour (8-9am)		PM peak hour (5-6pm)		Saturday peak hour (11am-12pm)	
	Oct 2012	Jun 2013	Oct 2012	Jun 2013	Oct 2012	Jun 2013
Artarmon Road, west of Willoughby Road	830	843	760	834	-	859
Willoughby Road, south of Artarmon Road	3,100	3,116	3,030	2,972	-	2,810
Willoughby Road, north of Artarmon Road	2,380	2,354	2,470	2,363	-	2,109

Source: AECOM 2012 and Arup 2013

Additional data has been collected and assessed for the site access and Richmond Road intersections with Artarmon Road by the independent transport assessment. The independent transport assessment confirmed that the proposed development will have negligible impacts to these two intersections along Artarmon Road and will continue to operate satisfactorily as a priority intersection. Therefore, no further assessment has been undertaken to these intersections as part of the revised traffic assessment to support the PPR. However, the revised traffic assessment has included an assessment of existing and future traffic conditions of a typical weekend peak period using traffic data collected by the independent transport assessment collected in June 2013.

2.4 Existing intersection performance

Intersection performances have been evaluated using *SIDRA Intersection 5.1*, a computer based modelling package designed for calculating isolated intersection performance.

The main performance indicators for SIDRA 5.1 include:

- Degree of Saturations (DoS) – a measure of the ratio between traffic volumes and capacity of the intersection is used to measure the performance of isolated intersections. As DoS approaches 1.0, both queue length and delays increase. Satisfactory operations usually occur with a DoS range between 0.7-0.8 or below.
- Average Delay – duration, in seconds, of the average vehicle waiting at an intersection.
- Level of Service (LoS) – a measure of the overall performance of the intersection (this is explained further in **Table 4**.

Table 4 Level of Service criteria for intersections

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

Source: RMS, 2002

The existing performance of the key intersections has been assessed and the results are presented in **Table 5** for the AM and PM peak hours. The table summarises intersection performance based on the 2012 traffic flows for the weekday morning and evening peak hours and 2013 traffic data for the weekend peak hour. SIDRA detail results are contained in **Appendix B**.

Table 5 Intersection performance – existing 2012 weekday and 2013 weekend

Location	Demand Flow (veh/h)	Level of Service	Degree of Saturation	Ave Delay (sec)	95% Back of Queue (m)
AM Peak					
Willoughby Road / Artarmon Road / Small Street	3,271	B	0.86	23	191
PM Peak					
Willoughby Road / Artarmon Road / Small Street	3,278	B	0.80	19.5	209
Saturday Peak					
Willoughby Road / Artarmon Road / Small Street	3,298	D	1.04	42.8	341

Source: AECOM 2013

The results indicate that in the existing AM and PM peak hour, both intersections in the vicinity of the proposed site operate satisfactorily at LoS B or better during weekday peak hours. The model results show that the queues on Willoughby Road would not queue back to the previous intersections.

On Saturday peak hour, the intersection operates at LoS D with a degree of saturation of 1.04. This indicates that the intersection is operating at capacity with overflow queues start to become a problem. The over-saturation of this intersection mainly relates to right turning vehicles from Willoughby Road into Small Street restricting the flow and capacity of northbound traffic along Willoughby Road.

2.5 Travel behaviour

2.5.1 Journey to work data

Travel characteristics for NSW residents travelling to work are gathered from the journey-to-work data extracted from the Australian Bureau of Statistics (ABS) 2011 census data. Journey to work data (JTW) includes details of the origin and destination of trips, together with characteristics of the journey such as mode of travel. The project site is located within the Willoughby LGA and Travel Zone (TZ) 1853. JTW data from and to the project site travel zone has been analysed and is summarised in the tables below.

Table 6 shows the mode share of trips travelling to and from the project site travel zone and **Table 7** shows the origins and destinations of trips to and from the project site travel zone.

Table 6 Journey to work mode split

Mode	Site area as origin (TZ 1853) *	Site area as destination (TZ 1853)
Total JTW Trips	1,074	1,270
Vehicle Driver	50%	80%
Vehicle Passenger	4%	3%
Bus	29%	4%
Train	7%	8%
Walked only	7%	3%
Other Modes	3%	2%

Note: * 15% of employees are either worked at home or did not go to work on the day of the 2011 Census.

Source: ABS Census Data 2011

The data indicates a high number of residents living in the travel zone utilise non-car modes of travel, accounting for just under half of all trips. This reflects the relatively good public transport availability close to the site. The census data also shows that a high proportion of trips from the travel zone are made by bus (29%), reflected that the site's proximity to the major bus corridor along Willoughby Road, with high frequency bus services to the City and major town centre such as Chatswood, has a significant influence in encouraging use of public transport in the study area. On the other hand, over 80% of all trips into the area are made by private vehicle. This is probably because of high availability of on-street parking on site.

The 2011 journey to work mode share data has shown an increase of up to 4% of non-car modes of travel (compared to 2006) made by residents living in this travel zone. This shows the trend of non-car mode travel in this area.

Table 7 Journey to work origins / destinations

Site Area Travel Zone (TZ 1853)			
Destination*	Proportion	Origins	Proportion
Sydney Inner City	33%	Chatswood - Lane Cove	21%
Chatswood – Lane Cove	27%	Warringah	10%
North Sydney - Mosman	13%	North Sydney - Mosman	8%
Ryde – Hunters Hill	5%	Sydney Inner City	7%
Warringah	3%	Ku-ring-gai	5%
Botany	3%	Eastern Suburbs - North	4%
Ku-ring-gai	3%	Ryde - Hunters Hill	4%
Eastern Suburbs – North	2%	Eastern Suburbs - South	3%
Eastern Suburbs – South	1%	Pittwater	3%
No fixed address	3%	Baulkham Hills	2%
Others	7%	Others	32%

Source: ABS Census Data 2011

The JTW data shows that the majority of trips leaving the site area travel zone are self-contained within the Chatswood and Lane Cove area (27%), or travelling to Sydney (33%). A high proportion of trips to Chatswood and Lane Cove area were either made by walking, cycling (21%) or public transport (8%).

A high proportion of trips coming to the site area travel zone to work also originate within the Chatswood / Lane Cove area (21%) and a high proportion of trips originate from Warringah (10%) and North Sydney (8%).

2.6 Public transport network

2.6.1 Bus services

A number of frequent bus services operate along Willoughby Road, which is within 350m from the western end of the site near Richmond Avenue and within 150m from the eastern end of the site near Scott Street. These bus services provide direct connection to the CBD, Chatswood and also Bondi Junction. Two bus stops are located in the just north of Artarmon Road on Willoughby Road. The bus routes which operate on this corridor are illustrated in **Figure 6**, and include:

- Route 257 Chatswood – Balmoral Beach via Crows Nest and Neutral Bay
- Route 272 North Willoughby – City
- Route 273 Chatswood – City via North Sydney
- Route M40 Chatswood – Bondi Junction via City.

Figure 6 Bus services in the vicinity of the site

Source: Sydney Buses, 2012

The number and frequency of bus services in the area are shown in **Table 8**.

Table 8 Frequency of bus services on Willoughby Road corridor

Bus Service	Route	Weekdays			Weekend
		AM Peak (0700-0900)	Off Peak	PM Peak (1600-1800)	
257	Chatswood - Balmoral Beach via Crows Nest and Neutral Bay	20 minutes 6 services	30 minutes	20 minutes 7 services	30 minutes 4 services
272	North Willoughby - City	6 minutes 20 services	No service	13 minutes 9 services	No service
273	Chatswood - City via North Sydney	9 minutes 14 services	10 minutes	7 minutes 17 services	15-60 minutes 2-8 services
M40	Chatswood - Bondi Junction via City	10 minutes 12 services	15 minutes	10 minutes 12 services	20 minutes 6 services

Source: Sydneybuses.info, 2013

During the site visit in October 2012, it was observed that most bus seats were occupied during the AM peak period.

2.6.2 Shuttle bus services

Willoughby Council currently operates a number of community shuttle bus services in the local area providing free transport options to local residents to key destinations such as Chatswood. One of the shuttle services operates between Northbridge and Chatswood via Artarmon Station and the existing site along Artarmon Road. This service only operates on Wednesdays and Fridays at every 45 minutes from 10:15am to 2:45pm.

2.6.3 Rail services

The project site is approximately 1.2 km to both Artarmon and St Leonards Stations, which takes approximately 15 minutes walking time.

Figure 7 shows that both stations are serviced by the North Shore and Northern lines which provide extensive services to the City and other major areas such as Hornsby, Macquarie Park, Epping and Chatswood, encouraging commuters to use public transport as a viable alternative to private motor vehicle transport. The number and frequency of railway services operating during peak hours is high and is shown in **Table 9**.

Figure 7 Existing rail network

Source: Cityrail, October 2012

Table 9 Rail services at Artarmon / St Leonards station

Key Destination	AM Peak (0700-0900)	PM Peak (1600-1800)
To City	3-7 minutes 30 services	3-9 minutes 30 services
From City	3-6 minutes 30 services	3-7 minutes 26 services
To Hornsby via Macquarie Park	15 minutes 7 services	15 minutes 8 services
From Hornsby via Macquarie Park	15 minutes 7 services	15 minutes 8 services
To Hornsby via Gordon	3-9 minutes 23 services	3-12 minutes 22 services
From Hornsby via Gordon	3-9 minutes 23 services	3-9 minutes 22 services

Source: Cityrail, October 2012

With the site being less than 2.5km away from the station, it is within a reasonable cycling distance for commuters. A total of 12 bike lockers and a number of bike racks are available at Artarmon and St Leonards Station. Kiss and ride facilities are also provided at both stations.

Figure 8 Bicycle parking facilities at Artarmon Station

Source: AECOM, 2012

2.7 Pedestrian routes and facilities

Footpaths are provided on both side of Artarmon Road and Richmond Avenue. There is also an extensive footpath network in the surrounding area, which allows easy and safe access for pedestrian to nearby shopping areas on Willoughby Road, parks, bus stops and train stations. Pedestrian crossing points are located at Willoughby Road / Artarmon Road signalised intersection.

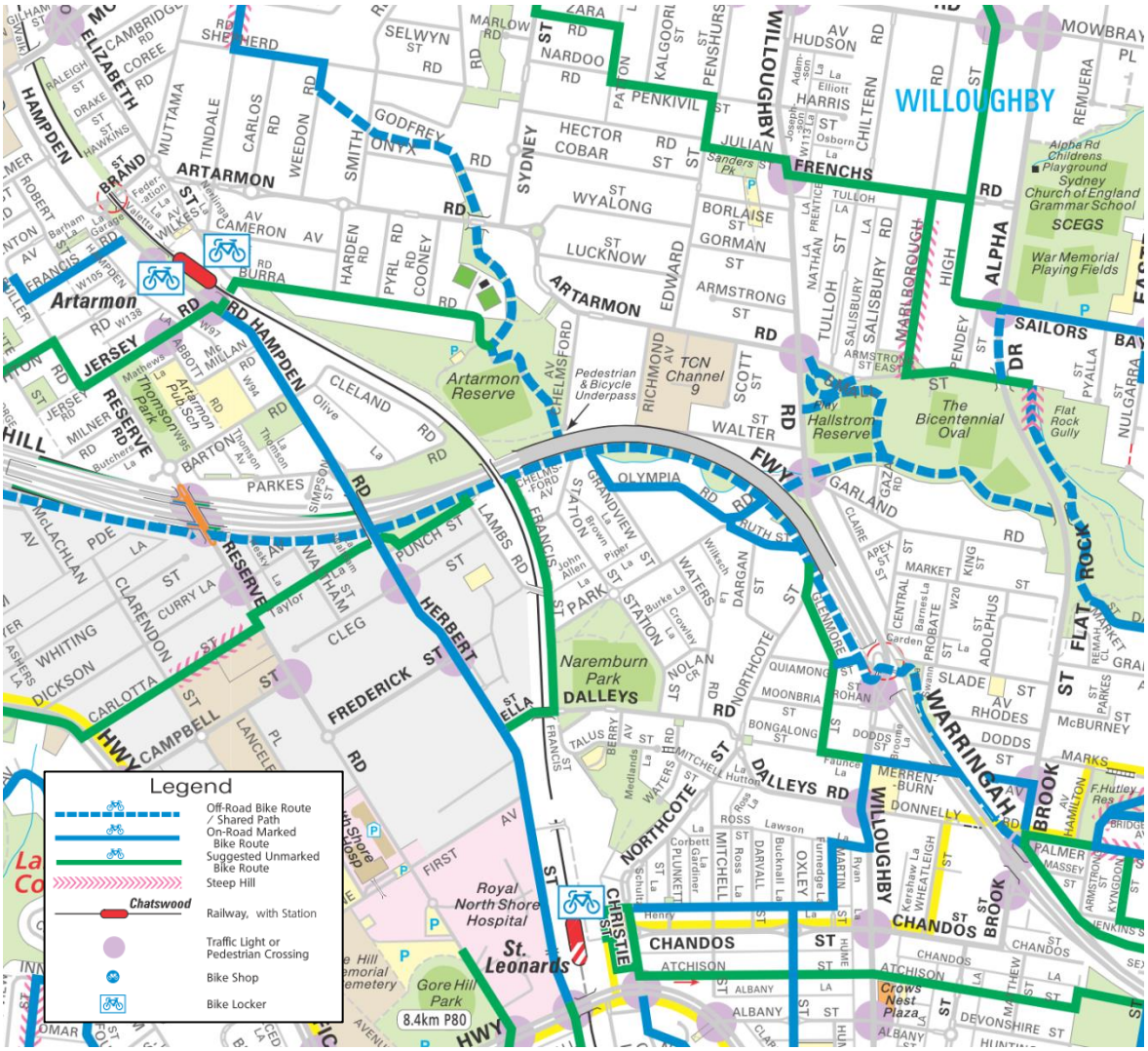
A pedestrian refuge is provided on Artarmon Road at the east of Richmond Avenue.

2.8 Cycling routes and facilities

There are no dedicated cycle facilities along Artarmon Road and Willoughby Road. However, there are a number of on- road and off-road cycle routes in the surrounding area providing connections between key destinations including schools, parks and reserves, train stations, etc.

Off-road cycle routes are available on the Gore Hill Freeway and part of the Warringah Freeway, as well as in the nearby Artarmon Reserve and Hallstrom Park which link with a wider network of cycling routes. On road cycling options include Herbert Street connecting to St Leonards Station, although traffic is heavier on these routes. An extract of Willoughby and Artarmon bicycle route map is shown in **Figure 9**.

Figure 9 Willoughby and Artarmon cycle route map



Source: Willoughby City Council

2.9 Crash analysis

A crash analysis has been undertaken using historical crash data provided by the RMS for a five year period from 2007 to 2011. The crash data was provided along Artarmon Road between Willoughby Road and Richmond Avenue.

Between 2007 and 2011, a total of 15 crashes have been recorded along this section of Artarmon Road, including six crashes involving injury-related crashes and nine tow away crashes. No fatality crash has been recorded during this period. **Table 10** shows the crash statistics for this period and **Table 11** summarises annual crash incidents by casualty from 2007 to 2011.

Table 10 Crash statistics for Artarmon Road between Willoughby Road and Richmond Avenue, 2007-2011

Location	Total crashes	Fatal crashes	Injury crashes	Non-casualty crashes
Artarmon Road, between Willoughby Road and Richmond Avenue	15	0	6	9

Source: AECOM, based on RMS Crash Report 2007-2011

Table 11 Historical trend of crashes by casualty 2007-2011

	2007	2008	2009	2010	2011	Total
Crashes	5	2	2	2	4	15
Casualties	6	1	3	2	0	12

Source: AECOM, based on RMS Crash Report 2007-2011

There has been less than five crashes occurred each year over the last five years, with only two crashes recorded each year between 2008 and 2010. A total of 12 injuries were reported from 2007 to 2011, with no injuries recorded in 2011. Of these 15 recorded crashes, there were:

- Twelve reported crashes at or within 10m approach to the Willoughby Road / Artarmon Road / Small Street intersection.
- One reported crash at Artarmon Road / Scott Street intersection. This crash involved a pedestrian.
- One reported crash at Artarmon Road / Edward Street. There was no casualty for this crash.
- One reported crash at Artarmon Road / Richmond Avenue. There was no casualty for this crash.

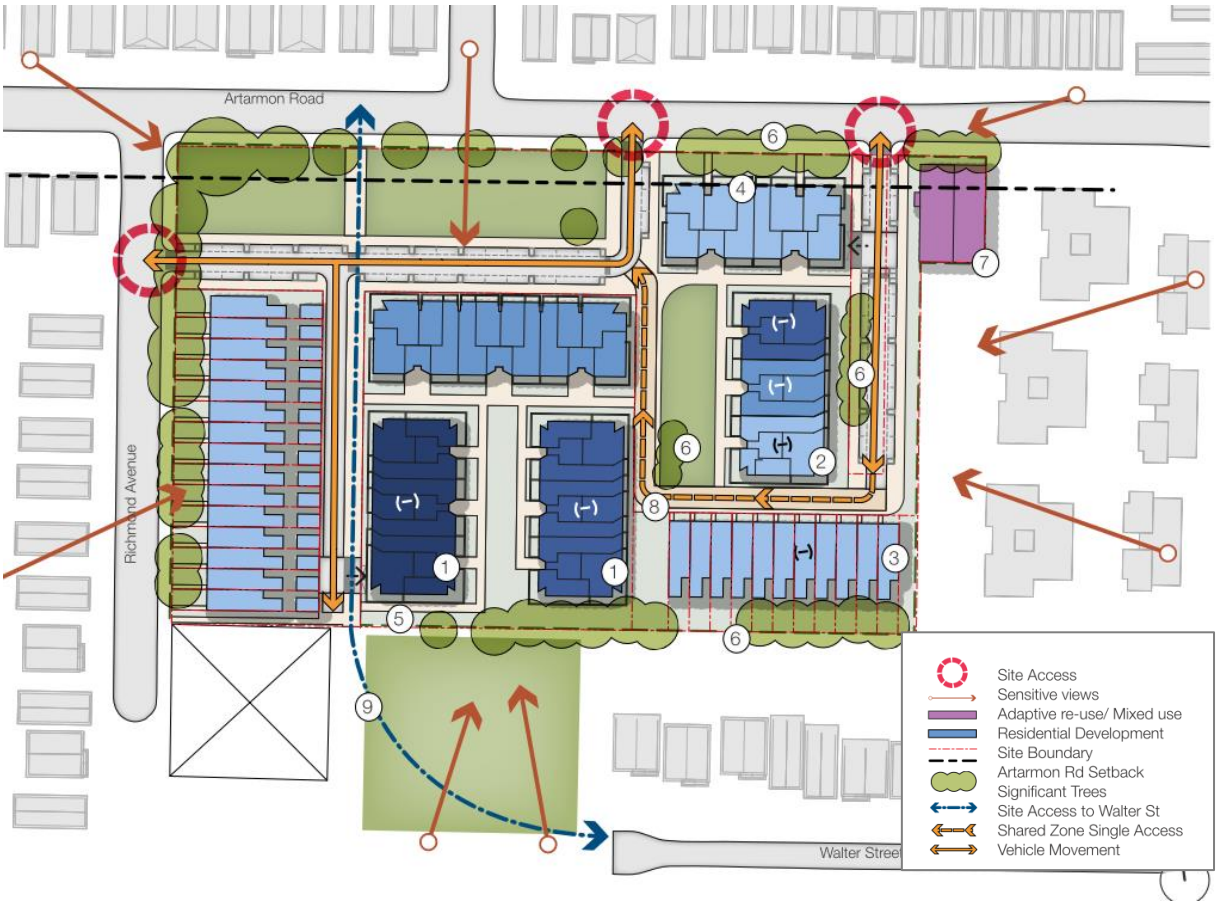
3.0 Proposed Development

3.1 Introduction

Nine Network Australia Pty Ltd has prepared an Environment Assessment (EA) of a Concept Plan for the redevelopment of the site at 6-30 Artarmon Road, Willoughby. The Concept Plan proposes a residential development with approximately 585 dwelling with a small scale retail component serving a local catchment within walking distance.

As a result of reviewing of submissions and on-going consultation with DPI and relevant stakeholder, a Preferred Project Report (PPR) is prepared seeking approval for a maximum of 450 residential dwellings. The preferred concept plan is shown in **Figure 10**.

Figure 10 Preferred concept plan



Source: SJB, 2013

3.2 Vehicular access

Three accesses to the site are proposed at Artarmon Road, Scott Street and Richmond Avenue. The access at Scott Street is an existing access which provides reasonable sight distance to both east and west traffic approaches from Artarmon Road.

The proposed access at Artarmon Road is located at approximately 20m east of the existing Nine Network main site access which provides better sight distance than the existing access. In order to satisfy sight distance requirements, a raised pedestrian crossing to the west of Edward Street is proposed to reduce vehicle speeds along Artarmon Road approach this proposed site access. This will also improve pedestrian safety crossing Artarmon Road. Based on the forecast traffic turning volumes, a priority controlled intersection is proposed for the site access at Artarmon Road.

The proposed access at Richmond Avenue is located at approximately 40m south of Artarmon Road. Due to the lower approach speed for the vehicles turning from Artarmon Road, this access provides reasonable sight lines between conflicting traffic streams on approach to the intersection.

An internal road network will connect the proposed accesses at Richmond Avenue and Artarmon Road, providing direct access to underground car parks of individual buildings. A one way shared zone connects Scott Street to the new internal road towards the west, providing street frontages to all developments. On-street parking will also be provided along the internal road network to provide parking opportunities for visitors in addition to those provided in the off-street car parks. The width and turning path of the internal road will be designed to allow access by refuse collection vehicles.

3.3 Parking provision

Off-street parking will be provided in a multi-level basement car parking areas, in accordance with Willoughby Council DCP. Based on the Willoughby DCP rates for residential flats within railway precincts and located on major public transport corridors, in this case Willoughby Road, the overall proposed development will require approximately 426 resident parking spaces and 105 visitor spaces, a total of 531 parking spaces. Given the proximity to Willoughby Road as a major bus corridor, this level of parking to be provided on site can be supported to reduce the dependent on private car use.

Comparing to Willoughby Council DCP, the RMS Guide to Traffic Generating Developments (2002) mentioned in **Section 2.1.8** suggests a lower parking rates for the high density development which requires 268 parking spaces for residents and 60 spaces for visitors, a total of 328 parking spaces. Opportunities also exist with consultation with Willoughby Council to count the on-street parking spaces created along the internal road network as part of the requirements for visitor parking space.

However during the community consultation, local residents have expressed their concerns that there is a general shortage of on-street car parking spaces surrounding the site at present. To minimise the potential impact to local residents, Willoughby Council DCP parking rates are currently used to reflect the specific parking situation on the subject site, which have been reduced given the site's proximity to a major bus corridor.

A small proportion of these off-street parking spaces can also be converted to car share spaces to provide further incentives to residents of not owning a car, but has the flexibility of using a car when required if the destinations are not accessible by public transport.

Loading areas for removalist van and waste collection vehicles are required to be provided for all residential developments in excess of 12 units. The concept plan provides loading docks to cater for 10m vehicles in the basement car park. This is considered to be adequate as the maximum length of the waste collection vehicle operating in Willoughby LGA is 9.9m.

The service vehicles and general light vehicles are proposed to use the same access to the basement car park which is considered to be acceptable because the frequency of service vehicle access to the site is expected to be low for residential development. Such arrangements have been found in other existing high density residential developments in Willoughby LGA. The concept plan also proposes to use a turntable in the loading dock thus all vehicles are to enter and leave the site in a forward direction as required in Part 2 of Australian Standard (AS2890), and will minimise the conflicts with other general light vehicles accessing the car park.

3.4 Pedestrian and Cyclist Facilities

The design of the internal road network and internal footpaths will provide good connectivity to surrounding pedestrian and cyclist networks. In order to encourage sustainable transport choices, the proposed development will include end-of-trip cycle facilities on site in accordance with the Willoughby Council DCP. Applying the DCP rate, 42 bicycle lockers and 35 bicycle rail / racks will be provided as part of the proposed development.

As mentioned in Section 3.2, a raised pedestrian crossing to the west of Edward Street is proposed on Artarmon Road. This would facilitate an additional safe crossing opportunity for residents to the northern side of Artarmon Road which connects to the signalised pedestrian crossing on the northern approach of the Willoughby Road / Artarmon Road intersection, where local residents would be using to access the citybound bus stop on Willoughby Road.

The close proximity to shops, parks and recreational facilities and bus stops will encourage walking and cycling as an alternative to private car transport, which will in turn serve to reduce trip generation from the proposal and traffic impacts on the surrounding area.

3.5 Public Transport Facilities

The site has very good accessibility to existing public transport services and facilities. Bus services and stops at Willoughby Road can be easily accessed within walking distance in less than a five-minute walk. Bus stops at Willoughby Road provide frequent services to Chatswood, Sydney CBD and Mosman, with services up to every 5 minutes during peak times. These services could be further improved in future, if justified by future population increase along this corridor.

Artarmon Station is a 15-minute walk and St Leonards Station is within cycling distance to the proposed development. These stations provide regular and frequent services on the North Shore Line and the Northern Line to major employment areas in Chatswood, Macquarie Park, Hornsby, Epping and Sydney.

4.0 Traffic Impact Assessment

This section of the report assesses the likely traffic impacts of the proposed redevelopment on the local road network and recommends mitigation measures to alleviate any impacts if required.

The revised traffic assessment has considered the impacts of the proposed development (up to 450 dwellings) during typical weekday AM and PM peak hour (based on 2012 traffic data collected by AECOM) as well as Saturday peak hour (based on 2013 traffic data collected by the independent transport assessment). The cumulative impacts of trips expected to be generated by the expanded Willoughby Leisure Centre have also been considered as part of the weekend peak traffic impact assessment.

4.1 Trip generation

The original traffic assessment has used a weekday peak hour trip rate of 0.24 trips / unit, according to the RMS Guide to Traffic Generating Developments (2002), to determine the number of vehicle trips the development will generate.

The trip rate was considered appropriate at the time of preparing the original traffic assessment given the location of the proposed development with high accessibility to public and active transport alternatives. This trip rate was also validated by a traffic survey that was undertaken on the same day as the other intersection surveys in 2012 to determine the number of vehicle movements generated by the existing high-rise residential building development at Castle Vale.

The 2012 survey results indicate that a total of 62 and 73 vehicle trips were generated during the AM Peak and PM Peak periods respectively. By using the RMS trip rates, it is estimated that there could be up to 20 vehicular movements generated by the child care centre during each of the peak hours. After excluding these vehicular trips, the residential land use would generate approximately 42 trips in the morning peak and 53 trips in the evening peak. For the 160 residential units on site, the trip generation rates would range between 0.26 and 0.33 trips per unit.

These trip generation rates for Castle Vale have been confirmed through similar surveys undertaken in 2013 by the independent transport assessment. However, it is believed that the Castle Vale development would have more conservative car-based travel behaviour compared to the Channel Nine redevelopment, given the development is much older.

Recently, a technical direction (TDT 2013/04) was released by the RMS which updated the traffic survey rates from the 2002 publication. The RMS's supplementary guide advises the following traffic generation rates (revised from 2012 surveys) for high density developments:

- 0.07 - 0.32 vehicle trips / dwelling (average 0.19) AM peak hour
- 0.06 - 0.41 vehicle trips / dwelling (average 0.15) PM peak hour
- 0.18 - 0.32 vehicle trips / dwelling (average 0.24) Saturday peak hour

These rates are also validated by the independent transport assessment by undertaking additional peak hour traffic surveys at the 260 Penshurst Street residential development, which are considered to be comparable to the proposed Channel Nine redevelopment, as high density residential development and located adjacent to a bus corridor but away from a railway station in the Willoughby Council area. The 2013 surveyed trip generation rates by the independent transport assessment are summarised in **Table 12**.

Table 12 2013 surveyed high density residential trip generation rates

Site	No. of units	Peak hour traffic (veh/hr)			Peak hour trip generation (trips / dwelling)		
		AM peak	PM peak	Sat peak	AM peak	PM peak	Sat peak
Castle Vale	161	41	52	36	0.25	0.32	0.22
260 Penshurst St	43	8	8	n/a	0.19	0.19	n/a

Source: Arup, 2013

The independent transport assessment acknowledged that the rate of 0.32 trips / dwelling is conservative and that a weekday peak hour rate of 0.19 trips / dwelling is more appropriate for proposed development at the Channel Nine site.

For trip generation rates on a Saturday peak hour, the independent transport assessment has adopted the average RMS rate instead of the site specific survey rate for Castle Vale development. Proven by the weekday peak hour rate, the rate surveyed for the Castle Vale development tends to be more car-based than a new development. It is also acknowledged by the independent transport assessment that Saturday travel is more discretionary compared with weekday travel, where people generally do not have to arrive at their destination at a fixed time. Therefore residents have greater scope on Saturdays to delay their journeys to avoid traffic congestion at busy intersections. Without any other surveyed information, it is proposed the rate of 0.22 trips / dwelling to be used for the weekend assessment.

Assuming weekday trip rate of 0.19 per dwelling and weekend trip rate of 0.22 per dwelling for up to 450 dwellings, the traffic generation during the AM, PM and Saturday peak hours are summarised in **Table 13**.

Table 13 Forecast site trip generation

Peak hour	Existing generation	Forecast generation	Net increase in traffic generation
Weekday AM	170 - 198	86	(-84) to (-112)
Weekday PM	149 - 176	86	(-63) to (-90)
Saturday	24	99	+75

Source: AECOM, 2013

As shown in **Table 13**, the traffic generation of the proposed developments will be fewer than the existing traffic flows generated by the current operation of Nine Network during the weekday peak hour. However, it is acknowledged that the direction of travel of the existing trips will be different to the future trips because of the change in land use type. This will be future explained in the following section of the report.

For a Saturday peak hour, there could be an increase of up to 75 trips to be generated by the proposed development.

For the proposed residential land use, it is also assumed that 10 per cent of trips will enter the site in the AM peak and 90 per cent will leave the site, with the reverse occurring in the PM peak. Weekend trips for the residential site have been split evenly between those entering and departing the site.

4.2 Trip distribution

Since the trip distribution patterns (travel direction of peak hour trips) are different between the existing use of the site (employment) and the proposed use of the site (residential). In order to determine the net increase in trips in each travel direction, trip distribution for the vehicular movements for the current and future uses of the site have been determined using existing (2011) JTW patterns to and from the site area travel zone and the traffic turning volume survey undertaken for the existing project site respectively.

As stated in the existing trip generation survey, approximately 60 per cent of the traffic generated by the site use Willoughby Road to access the wider road network, whereas 40 per cent would use Artarmon Road to and from the north and west of the site.

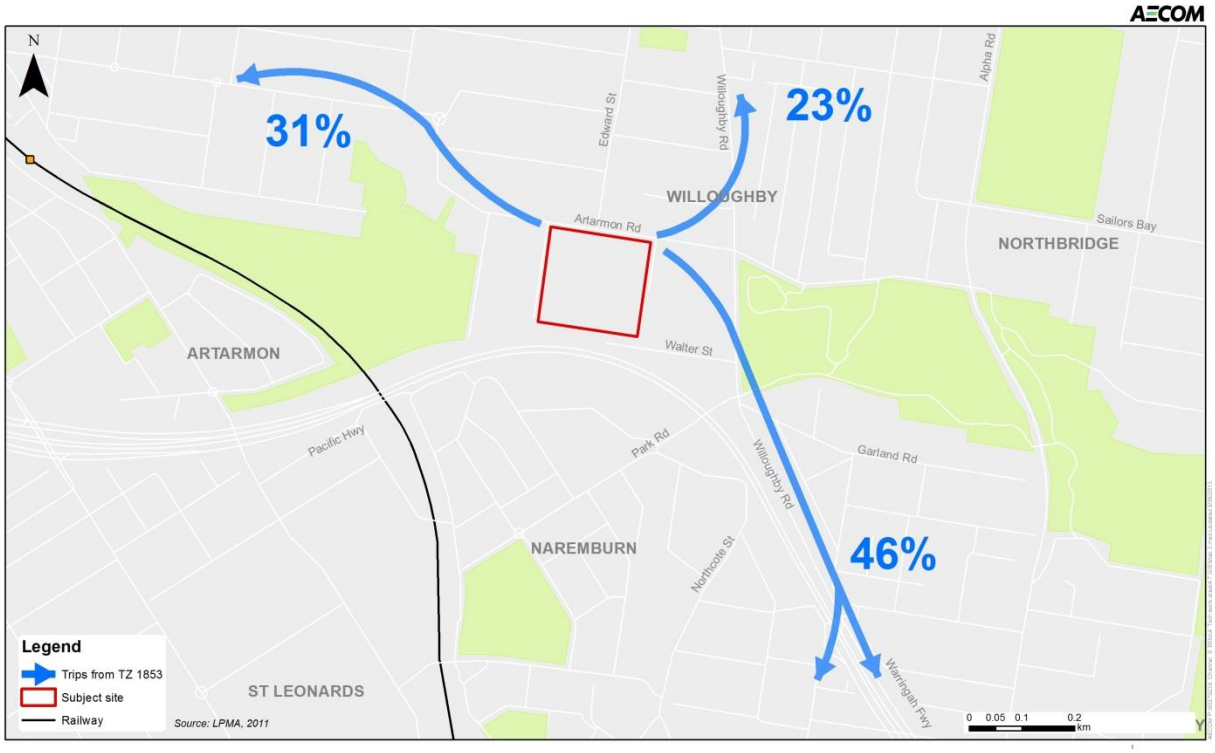
Table 14 and **Figure 11** show the expected travel directions of future residential trips for the AM peak hour. It has been assumed that the reverse travel pattern will occur for the PM peak hour.

Table 14 Distribution of proposed trips – AM peak hour

Direction	Strategic road link	In	Out
South, South East	Via Willoughby Road / Warringah Freeway	40%	46%
North, West	Via Artarmon Road	36%	31%
North East	Via Willoughby Road	24%	23%

Source: Journey to Work, 2011

Figure 11 Distribution of proposed outgoing trips – AM peak hour



Source: Journey to Work, 2011

4.3 Forecast Traffic Flow

Typically, a traffic impact assessment is undertaken for a future design year of 10year post opening / completion of the development. In this case, the development could be completed in 2016 and therefore the assessment should be undertaken for 2026.

However, as historical traffic data on Willoughby Road corridor shows a negative average annual growth rate in **Section 2.3.1**, as a worst case, the assessment has assumed there will be zero growth on Willoughby Road.

Therefore forecast traffic flow along Artarmon Road and Willoughby Road has been estimated by using the existing 2012 traffic flows as background traffic, with the removal of existing traffic generated by the existing operations of Channel Nine before the additional of the proposed residential development traffic.

This approach to traffic modelling was acknowledged and a zero per cent background traffic growth on the surrounding road network has been adopted in the independent transport assessment.

Trips have also been distributed on to the road network according to the existing road network restrictions, i.e. right turn movement banned from Willoughby Road into Artarmon Road during AM Peak.

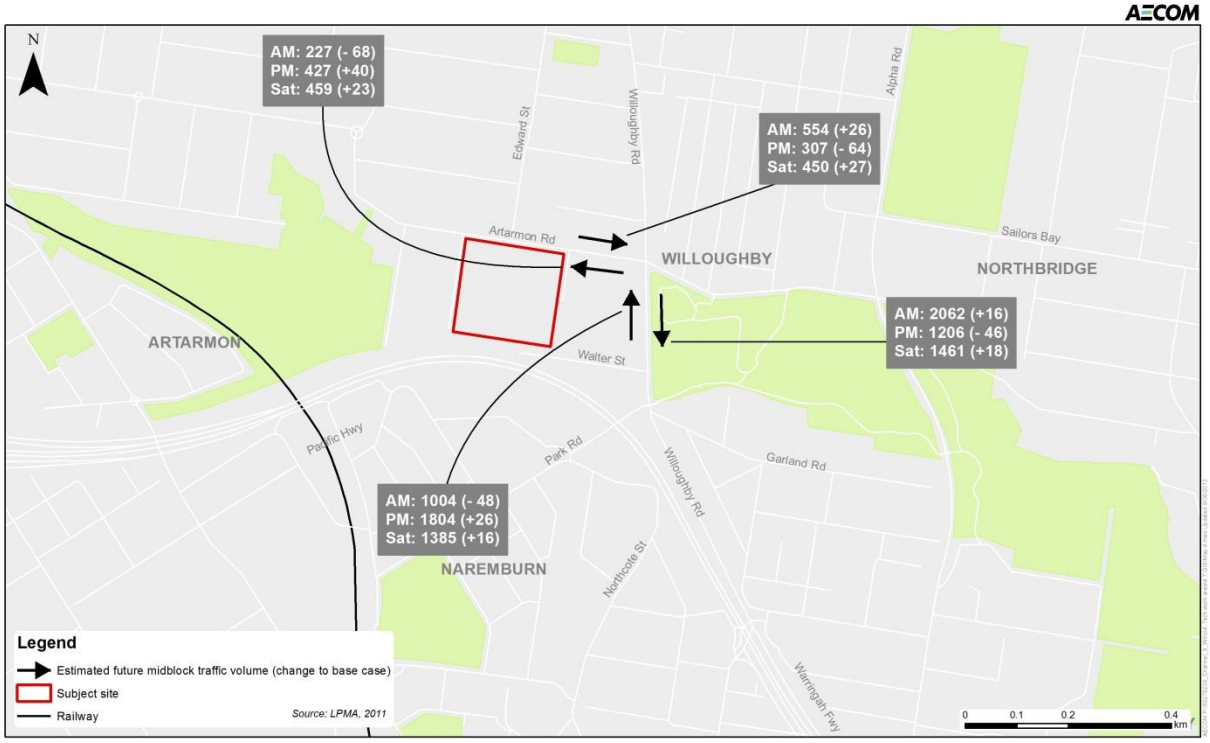
Table 15 and **Figure 12** show the midblock traffic volumes at locations in the vicinity of the subject site, with the residential development generated traffic present on the local road network (and the removal of existing operations traffic). It is evident that the total net increase of traffic as a result of the change of use of the proposed development is negligible across the network.

Table 15: Midblock traffic volumes with development traffic

Midblock location	Direction	AM peak hour			PM peak hour			Saturday peak hour		
		Base	With Dev	Diff	Base	With Dev	Diff	Base	With Dev	Diff
Willoughby Road, South of Artarmon Road	NB	1,052	1,004	-48	1,778	1,804	26	1,369	1,385	16
	SB	2,046	2,062	16	1,252	1,206	-46	1,443	1,461	18
	Total	**3,098**	**3,065**	**-33**	**3,030**	**3,010**	**-20**	**2,812**	**2,846**	**34**
Artarmon Road, West of Willoughby Road	EB	528	554	26	371	307	-64	432	450	27
	WB	295	227	-68	387	427	40	436	459	23
	Total	**823**	**780**	**-43**	**758**	**734**	**-24**	**859**	**909**	**50**

Source: AECOM, 2013

Figure 12 Midblock traffic volumes with development traffic



Source: AECOM, 2013

During the peak hours, the increase of traffic on the Willoughby Road (main arterial roads) is generally less than two per cent of existing traffic volumes in one direction. It should also be noted that there is a decrease in traffic in the opposite direction due to the change of the current employment land use to the proposed residential land use.

The highest increase in traffic is expected at Artarmon Road, on the approach to Willoughby Road. An increase of under 40 veh/hr is expected in the eastbound direction during the AM peak and in the westbound direction during the PM peak. However, the total volume at Artarmon is still within the capacity of a collector road.

4.4 Intersection assessment

The key intersections in the vicinity of the proposed development have been remodelled in SIDRA 5.1 in the AM, PM and Saturday peak hour. The intersection performance results for Willoughby Road / Artarmon Road during the AM, PM and Saturday peak hour are shown in **Table 16** and the detail results are contained in **Appendix B**.

Table 16: Intersection performance of Willoughby Road / Artarmon Road – with development

Scenario	Demand Flow (veh/h)	Level of Service*	Deg of Satn (v/c)	Ave Delay (sec)	95% Back of Queue (m)
AM Peak					
Base	3,271	B	0.86	23.0	191
With development	3,229	B	0.82	24.4	235
PM Peak					
Base	3,278	B	0.80	19.5	209
With development	3,254	B	0.81	20.3	226
Saturday Peak					
Base	3,298	D	1.04	42.8	341
With development	3,351	D	1.10	52.6	364
With development (with right turn ban)	3,332	C	1.01	37.7	354

Source: AECOM 2013

The SIDRA model outputs from **Table 16** were compared to determine the likely changes in traffic performance in the key intersections after the proposed development in place. There is no substantial change in the modelled overall intersection performance during the weekday peak hours, in fact there are alight improvements of performance during the AM peak hour as a result of the reduction in traffic flows. The intersections all continue to perform within capacity during the weekday peak hours.

During Saturday peak hour, where the intersection is currently functioning above its operational capacity, the additional trips generated by the proposed development have very minor impacts to the performance of the intersection. The assessment has considered the worst case assuming that the trip distribution pattern is same as the weekday. In reality, due to its existing operational constraints, the development traffic would choose to make the trip at a different time and along a different route to avoid the congestion.

As acknowledged by the independent transport assessment, one of the main contributing factors to the operational constraint of this intersection is that all movements are permissible on the weekends. Therefore, an additional modelling scenario has been undertaken to test the impacts of banning the southbound right turn movement from Willoughby Road into Artarmon Road. The SIDRA modelling shows that the intersection will perform at acceptable LoS C with slightly improved intersection performance compared to existing conditions. Therefore, no upgrades are required except banning the right turn allowed from Willoughby Road into Artarmon Road, to cater for the likely proposed development traffic on a Saturday peak.

The banning of this movement should have negligible impacts to the surrounding road network as there are only 11 movements recorded during the Saturday peak hour.

4.5 Cumulative impacts

Willoughby City Council is planning to expand the existing Willoughby Leisure Centre located at Small Street, Willoughby. A traffic and parking study has been prepared by GTA Consultants for Council in May 2012 to consider the impacts and mitigation measures as a result of the expansion during the peak time on a Saturday at the intersection of Willoughby Road / Small Street. A package of measures and infrastructure upgrades have been recommended including the construction of a left turn slip lane from Small Street into Willoughby Road in the

short-term and an addition of a northbound right turn bay from Willoughby Road into Small Street in the longer-term. However, it is not clear if funding is secured for these proposed works.

The cumulative impacts of the proposed residential development with the existing operations and future expansion of the leisure centre has been considered. An additional 59 peak hour trips forecast for the expanded Willoughby Leisure Centre have been included in the weekend traffic assessment to understand the cumulative impacts of both development to the intersection of Willoughby Road / Artarmon Road. It should be noted that of the 59 forecast additional trips generated during the Saturday peak hour by the expanded centre, only 31 trips will access the centre via the intersection of Willoughby Road / Artarmon Road, according to the GTA traffic report.

The intersection performance results for Willoughby Road / Artarmon Road during the Saturday peak hour for different scenarios are shown in **Table 17**.

Table 17: Weekend Intersection performance of Willoughby Road / Artarmon Road – cumulative impacts with Willoughby Leisure Centre

Scenario	Demand Flow (veh/h)	Level of Service*	Deg of Satn (v/c)	Ave Delay (sec)	95% Back of Queue (m)
Base	3,298	D	1.04	42.8	341
With development	3,351	D	1.10	52.6	364
With development (with right turn ban)	3,332	C	1.01	37.7	354
With development and expanded Willoughby Leisure Centre (with right turn ban)	3,365	C	1.04	42.0	375

Source: AECOM 2013

SIDRA analysis shows that the intersection will perform at acceptable LoS C with delays and degree of saturation of intersection no worse than existing conditions. Therefore, no upgrades are required except banning the right turn allowed from Willoughby Road into Artarmon Road, to cater for the likely traffic generated by the expanded leisure centre and Channel 9 redevelopment on a Saturday peak.

4.6 Impacts to on-street parking

Some of the existing Nine Network employees were observed to park their vehicles on Artarmon Road and Richmond Avenue. With the relocation of the Nine Network operations, it is anticipated that the on-street parking spaces that are currently occupied by existing employees would become available.

The proposed development will also provide sufficient on-site car park according to Council's DCP. The Willoughby Council's DCP also indicates that they will not issue Resident Parking Permits to residents of the new multi-unit developments. Therefore, future residents and visitors are expected to park on-site and not the local streets in the surrounding area. Willoughby City Council may review the on-street parking scheme in the area after the development is in place.

4.7 Impacts to public transport

Based on the average dwelling occupancy for high rise unit blocks in Willoughby LGA of 2.1 people / dwelling, the proposed development will have a potential population of 945 residents. Assuming 15% of these do not go to work or work at home (according to 2011 Journey to work data) and 50% of residents travel in the peak hour (according to latest Bureau of Transport Statistics 2010/11 HTS Summary report – Figure 3.9.2), approximately 400 person trips in the AM and PM peak hours are forecast.

Given the 2011 journey to work mode share data has shown an increase of up to 5% of non-car modes of travel (compared to 2006) made by residents living in this travel zone. It is suggested that this trend will continue and there could be an additional shift of 5% to 10% to bus travel given the restrained parking environment and accessibility to good public transport services in the vicinity of the proposed development.

With a potential up to 40% bus mode split, the proposed development could generate up to 160 additional peak hour bus trips. In site visits undertaken by AECOM in 2012 during the morning peak, most buses on Willoughby Road at the Artarmon Road stop have capacity to cater for additional passengers.

Given the development will not be occupied for a number of years and the responsibility for bus timetabling lies in outside the direct control of the proponent, it is suggested that discussions with TfNSW be initiated prior to the occupation of the development to confirm how additional bus services can service the additional development.

5.0 Travel Demand Management

5.1 Introduction

Travel Demand Management (TDM) strategies involve the application of policies, objectives, measures and targets to influence travel behaviour, to encourage uptake of sustainable forms of transport, i.e. non-car modes, wherever possible and to reduce the need to travel and hence reduce overall transport and travel demand and the impacts of new development.

5.2 Proposed sustainable travel measures

The measures include a range of different types of initiatives which together reinforce the principles and objectives of the sustainable travel strategy.

The measures support delivery of the high level transport and travel demand management objectives and support the wider principles discussed. This is how the precinct planning process will deliver a sustainable precinct, in which travel by car is not the only option for residents and visitors to make the journeys they wish to make.

5.2.1 Household Information Packs (HIPs) for each household

Each household in the proposed development would be provided with a household information pack (HIP) which would be a sustainable travel kit. This would incorporate public transport leaflets, route maps and timetables (including direction to the 131500 travel information line and website and bus, train and fare information), pedestrian and cycle network maps including leisure maps, and information on sustainable community initiatives, such as Bicycle User Groups, Car Sharing Schemes, and other local community projects to reduce travel or encourage uptake of sustainable modes.

5.2.2 Car sharing scheme

At present, car sharing scheme (GoGet) has a network connecting to Chatswood Interchange, Artarmon Station, Royal North Shore Hospital and Crows Nest. The extension of providing car share parking spaces on site using an established provider (such as GoGet) for the proposed residential development should be considered. This would reduce residents need to own and operate their own vehicle, safe in the knowledge that there can get access to a vehicle if they require one.

5.2.3 Public transport measures

The public transport service improvements could encourage more people to reduce the car usage. It includes the improvements of:

- Bus network coverage
- Frequency of bus services
- Quality of bus stops.

5.2.4 Bicycle measures

The following measures could encourage bicycle use and promote bicycle rides and initiatives.

- Dedicated, high quality cycle routes
- Bicycle facilities such bicycle parking
- Encourage local Bicycle User Group (BUG)
- Promotion of bicycle initiatives – NSW bicycle week, cycle to work day

5.2.5 Pedestrian Measures

A highly permeable and safe pedestrian network throughout the development will encourage and facilitate pedestrian accessibility.

6.0 Summary and Conclusions

A traffic report with the original Concept Plan proposing approximately 585 dwelling units has been submitted to Department of Planning & Infrastructure (DPI) in March 2013 to support a major project application (MP10_0198). During the assessment of the major project application, DPI has commissioned Arup to an independent transport assessment of the proposed development, in consultation with Willoughby Council.

As a result of reviewing of submissions and on-going consultation with DPI and relevant stakeholder, a Preferred Project Report (PPR) is prepared seeking approval for a maximum of 450 residential dwellings. This revised traffic report that supports the PPR.

The site has very good accessibility to existing public transport services and facilities. Bus services and stops at Willoughby Road can be easily accessed within walking distance in less than a five-minute walk. Bus stops at Willoughby Road provide frequent services to Chatswood, Sydney CBD and Mosman, with services up to every 5 minutes during peak times. These services could be further improved in future, if justified by future population increase along this corridor.

Artarmon Station is a 15-minute walk and St Leonards Station is within cycling distance to the proposed development. These stations provide regular and frequent services on the North Shore Line and the Northern Line to major employment areas in Chatswood, Macquarie Park, Hornsby, Epping and Sydney.

The Concept Plan proposes a residential development with a maximum of 450 dwelling units. The vehicular accesses to the development will be via Artarmon Road and Richmond Avenue, connected by an internal road network providing direct access to underground parking areas.

Based on the Willoughby City Council's DCP, a total of 532 parking spaces should be provided on-site, including 426 resident parking spaces and 105 visitor spaces. 42 bicycle lockers and 35 bicycle rail / racks will also be provided on-site to encourage non-private car use by future residents and visitors.

With the relocation of the existing operations of the Nine Network at the Willoughby site and the proposed development of the preferred Concept Plan, it is anticipated that there is a net reduction in vehicular trips during the weekday peak hours, based on the RMS trip generation rate for high density dwellings. Even considering the different peak hour travel direction between the existing and future uses, the net vehicular impacts of the proposed development is considered negligible.

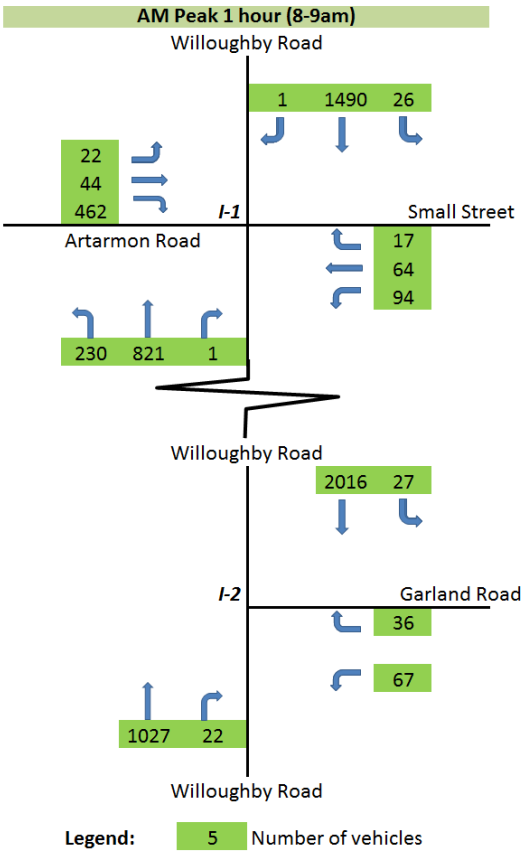
During Saturday peak hour, where the intersection is currently functioning above its operational capacity, the additional trips generated by the proposed development have very minor impacts to the performance of the intersection. To improve the performance of the intersection, it is recommended that the right turn movement from Willoughby Road to Artarmon be banned on the weekend. The SIDRA modelling shows that the intersection will perform at acceptable LoS C with slightly improved intersection performance compared to existing conditions, with the right turn ban. The banning of this movement should have negligible impacts to the surrounding road network as there are only 11 movements recorded during the Saturday peak hour.

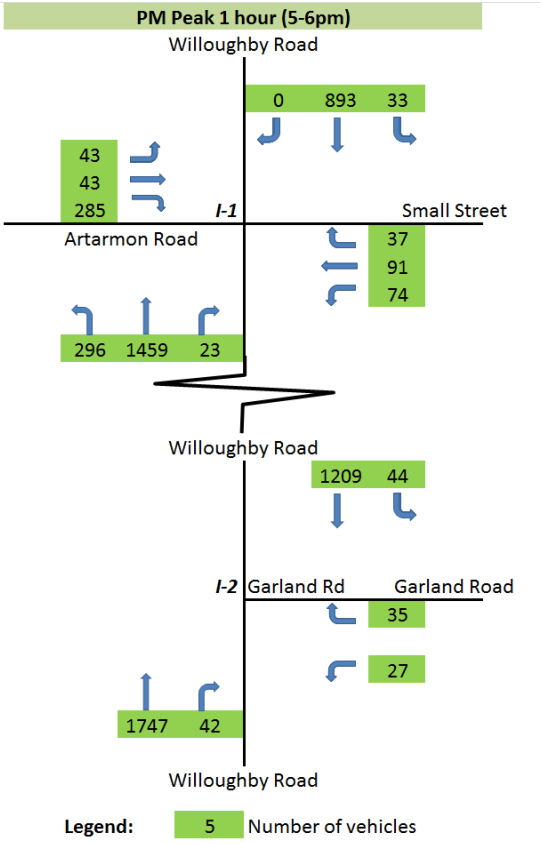
Intersection modelling also confirmed that no upgrades are required except banning the right turn allowed from Willoughby Road into Artarmon Road, to cater for the likely traffic generated by the expanded leisure centre and Channel 9 redevelopment on a Saturday peak.

Appendix A

Existing Intersection Traffic Counts

2012 Thursday Observed Traffic Flows





Appendix B

SIDRA Intersection Outputs

MOVEMENT SUMMARY

Site: Existing - AM Peak

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 115 seconds (User-Given Phase Times)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	230	0.4	0.463	17.9	LOS B	11.3	81.1	0.47	0.90	39.9
2	T	821	5.8	0.515	10.2	LOS A	11.7	85.8	0.44	0.40	45.1
3	R	1	0.0	0.515	17.4	LOS B	11.7	85.8	0.42	1.07	41.0
Approach		1052	4.7	0.515	11.9	LOS A	11.7	85.8	0.44	0.51	43.9
East: Small St (E)											
4	L	94	4.3	0.750	69.7	LOS E	5.7	41.1	1.00	0.87	19.4
5	T	64	0.0	0.603	59.6	LOS E	4.7	32.9	1.00	0.79	19.7
6	R	17	0.0	0.603	66.9	LOS E	4.7	32.9	1.00	0.79	20.3
Approach		175	2.3	0.750	65.7	LOS E	5.7	41.1	1.00	0.84	19.6
North: Willoughby Rd (N)											
7	L	26	3.8	0.614	18.0	LOS B	16.2	116.7	0.47	1.04	40.7
8	T	1490	3.1	0.768	11.6	LOS A	26.6	191.0	0.55	0.51	43.6
Approach		1516	3.1	0.768	11.8	LOS A	26.6	191.0	0.55	0.52	43.6
West: Artarmon Rd (W)											
10	L	22	0.0	0.858	63.2	LOS E	12.4	86.9	0.95	0.98	20.7
11	T	44	0.0	0.858	56.1	LOS D	12.4	86.9	0.95	0.95	20.1
12	R	462	0.4	0.858	63.7	LOS E	19.4	136.5	0.99	0.96	20.5
Approach		528	0.4	0.858	63.0	LOS E	19.4	136.5	0.98	0.96	20.5
All Vehicles		3271	3.1	0.858	23.0	LOS B	26.6	191.0	0.61	0.60	35.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	13.6	LOS B	0.1	0.1	0.49	0.49
P5	Across N approach	53	45.2	LOS E	0.2	0.2	0.89	0.89
P7	Across W approach	53	15.1	LOS B	0.1	0.1	0.51	0.51
All Pedestrians		159	24.7	LOS C			0.63	0.63

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Existing - PM Peak

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 117 seconds (User-Given Phase Times)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	296	0.0	0.796	19.0	LOS B	29.5	209.3	0.61	0.96	39.7
2	T	1459	2.3	0.796	10.7	LOS A	29.5	209.3	0.59	0.56	44.0
3	R	23	0.0	0.796	17.4	LOS B	24.4	173.9	0.57	1.03	41.5
Approach		1778	1.9	0.796	12.1	LOS A	29.5	209.3	0.59	0.63	43.2
East: Small St (E)											
4	L	74	1.4	0.476	64.8	LOS E	4.3	30.2	0.99	0.77	20.3
5	T	91	0.0	0.774	61.9	LOS E	7.7	54.1	1.00	0.90	19.2
6	R	37	0.0	0.774	69.2	LOS E	7.7	54.1	1.00	0.90	19.8
Approach		202	0.5	0.774	64.3	LOS E	7.7	54.1	1.00	0.85	19.7
North: Willoughby Rd (N)											
7	L	33	0.0	0.350	13.1	LOS A	5.7	40.5	0.26	1.05	43.9
8	T	893	2.8	0.437	6.0	LOS A	7.6	54.2	0.27	0.24	50.3
9	R	1	0.0	0.437	13.7	LOS A	7.6	54.2	0.29	1.11	43.7
Approach		927	2.7	0.437	6.2	LOS A	7.6	54.2	0.27	0.27	50.1
West: Artarmon Rd (W)											
10	L	43	0.0	0.778	63.8	LOS E	10.2	71.1	1.00	0.91	20.6
11	T	43	0.0	0.778	56.7	LOS E	10.2	71.1	1.00	0.91	20.0
12	R	285	0.0	0.778	64.2	LOS E	11.7	82.1	1.00	0.90	20.4
Approach		371	0.0	0.778	63.3	LOS E	11.7	82.1	1.00	0.90	20.4
All Vehicles		3278	1.8	0.796	19.5	LOS B	29.5	209.3	0.57	0.57	37.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	11.1	LOS B	0.1	0.1	0.44	0.44
P5	Across N approach	53	52.7	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	12.5	LOS B	0.1	0.1	0.46	0.46
All Pedestrians		159	25.4	LOS C			0.62	0.62

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Existing - Sat

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 110 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	366	0.0	0.778	18.5	LOS B	26.7	188.3	0.61	0.94	39.8
2	T	998	1.5	1.037	52.9	LOS D	48.2	341.4	0.78	0.97	23.5
3	R	77	0.0	1.037	114.9	LOS F	48.2	341.4	1.00	1.46	14.2
Approach		1441	1.0	1.037	47.5	LOS D	48.2	341.4	0.75	0.99	25.2
East: Small St (E)											
4	L	132	0.0	0.978	90.8	LOS F	9.3	65.3	1.00	1.14	16.3
5	T	81	0.0	1.018	104.5	LOS F	11.3	78.9	1.00	1.26	13.7
6	R	55	0.0	1.018	111.8	LOS F	11.3	78.9	1.00	1.26	14.2
Approach		274	0.0	1.018	100.5	LOS F	11.3	78.9	1.00	1.20	15.0
North: Willoughby Rd (N)											
7	L	71	0.0	0.736	23.4	LOS B	6.0	42.6	0.68	0.93	37.0
8	T	1056	1.2	0.736	13.6	LOS A	22.4	158.3	0.63	0.57	41.6
9	R	12	0.0	0.736	20.0	LOS B	22.4	158.3	0.61	1.02	39.6
Approach		1138	1.1	0.736	14.3	LOS A	22.4	158.3	0.63	0.60	41.3
West: Artarmon Rd (W)											
10	L	29	0.0	0.878	67.3	LOS E	12.5	87.3	1.00	1.04	20.0
11	T	93	0.0	0.878	60.1	LOS E	12.5	87.3	1.00	1.04	19.4
12	R	323	0.0	0.878	67.6	LOS E	14.4	100.8	1.00	1.00	19.8
Approach		445	0.0	0.878	66.0	LOS E	14.4	100.8	1.00	1.01	19.8
All Vehicles		3298	0.8	1.037	42.8	LOS D	48.2	341.4	0.76	0.87	26.3

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	10.9	LOS B	0.1	0.1	0.45	0.45
P5	Across N approach	53	49.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	12.3	LOS B	0.1	0.1	0.47	0.47
All Pedestrians		159	24.1	LOS C			0.62	0.62

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Future - AM Peak - Dev

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 115 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	182	0.5	0.471	20.4	LOS B	12.0	86.8	0.52	0.92	38.3
2	T	821	5.8	0.524	12.8	LOS A	13.0	95.7	0.50	0.45	42.6
3	R	1	0.0	0.524	20.2	LOS B	13.0	95.7	0.49	1.05	39.1
Approach		1004	4.9	0.524	14.2	LOS A	13.0	95.7	0.50	0.54	41.8
East: Small St (E)											
4	L	94	4.3	0.750	69.7	LOS E	5.7	41.1	1.00	0.87	19.4
5	T	44	0.0	0.456	58.5	LOS E	3.5	24.3	1.00	0.75	19.9
6	R	17	0.0	0.456	65.8	LOS E	3.5	24.3	1.00	0.75	20.5
Approach		155	2.6	0.750	66.1	LOS E	5.7	41.1	1.00	0.83	19.7
North: Willoughby Rd (N)											
7	L	26	3.8	0.654	21.2	LOS B	19.5	140.4	0.57	1.02	38.7
8	T	1490	3.1	0.818	15.5	LOS B	32.4	232.6	0.66	0.61	40.2
Approach		1516	3.1	0.818	15.6	LOS B	32.4	232.6	0.66	0.62	40.2
West: Artarmon Rd (W)											
10	L	32	0.0	0.802	54.9	LOS D	11.0	77.4	0.91	0.92	22.5
11	T	44	0.0	0.802	47.7	LOS D	11.0	77.4	0.91	0.86	22.0
12	R	478	0.4	0.802	55.9	LOS D	19.8	139.1	0.98	0.91	22.2
Approach		554	0.4	0.802	55.2	LOS D	19.8	139.1	0.97	0.91	22.2
All Vehicles		3229	3.2	0.818	24.4	LOS B	32.4	232.6	0.68	0.65	34.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	15.7	LOS B	0.1	0.1	0.52	0.52
P5	Across N approach	53	41.8	LOS E	0.1	0.1	0.85	0.85
P7	Across W approach	53	17.3	LOS B	0.1	0.1	0.55	0.55
All Pedestrians		159	24.9	LOS C			0.64	0.64

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Future - PM Peak - Dev

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 117 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	322	0.0	0.814	19.3	LOS B	31.5	223.8	0.64	0.95	39.4
2	T	1459	2.3	0.814	12.4	LOS A	31.5	223.8	0.64	0.61	42.3
3	R	23	0.0	0.814	20.3	LOS B	28.4	202.6	0.65	1.01	39.6
Approach		1804	1.9	0.814	13.7	LOS A	31.5	223.8	0.64	0.68	41.8
East: Small St (E)											
4	L	74	1.4	0.471	64.8	LOS E	4.2	29.9	0.99	0.77	20.3
5	T	91	0.0	0.779	62.1	LOS E	7.8	54.6	1.00	0.90	19.2
6	R	37	0.0	0.779	69.4	LOS E	7.8	54.6	1.00	0.90	19.8
Approach		202	0.5	0.779	64.4	LOS E	7.8	54.6	1.00	0.85	19.7
North: Willoughby Rd (N)											
7	L	33	0.0	0.420	13.4	LOS A	7.3	52.3	0.28	1.06	43.8
8	T	893	2.8	0.525	10.4	LOS A	12.4	88.7	0.40	0.36	45.2
9	R	14	0.0	0.525	22.8	LOS B	12.4	88.7	0.54	1.01	37.4
Approach		940	2.7	0.525	10.7	LOS A	12.4	88.7	0.40	0.39	45.0
West: Artarmon Rd (W)											
10	L	26	0.0	0.646	59.9	LOS E	8.0	55.8	0.98	0.82	21.4
11	T	43	0.0	0.646	52.7	LOS D	8.0	55.8	0.98	0.81	20.8
12	R	239	0.0	0.646	60.4	LOS E	9.2	64.3	0.99	0.82	21.2
Approach		308	0.0	0.646	59.3	LOS E	9.2	64.3	0.99	0.82	21.2
All Vehicles		3254	1.8	0.814	20.3	LOS B	31.5	223.8	0.63	0.62	36.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	11.1	LOS B	0.1	0.1	0.44	0.44
P5	Across N approach	53	52.7	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	12.5	LOS B	0.1	0.1	0.46	0.46
All Pedestrians		159	25.4	LOS C			0.62	0.62

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Future - Sat - Dev

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 110 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	383	0.0	0.827	19.5	LOS B	31.6	223.0	0.67	0.95	39.2
2	T	998	1.5	1.103	70.5	LOS F	51.5	364.0	0.80	1.05	19.7
3	R	77	0.0	1.103	168.4	LOS F	51.5	364.0	1.00	1.66	10.4
Approach		1458	1.0	1.103	62.3	LOS E	51.5	364.0	0.77	1.06	21.4
East: Small St (E)											
4	L	132	0.0	0.978	90.8	LOS F	9.3	65.3	1.00	1.14	16.3
5	T	81	0.0	1.018	104.5	LOS F	11.3	78.9	1.00	1.26	13.7
6	R	55	0.0	1.018	111.8	LOS F	11.3	78.9	1.00	1.26	14.2
Approach		274	0.0	1.018	100.5	LOS F	11.3	78.9	1.00	1.20	15.0
North: Willoughby Rd (N)											
7	L	71	0.0	0.808	29.0	LOS C	8.1	57.1	0.77	0.96	33.9
8	T	1056	1.2	0.808	21.3	LOS B	29.2	206.7	0.79	0.74	35.9
9	R	19	0.0	0.808	28.7	LOS C	29.2	206.7	0.80	0.98	34.5
Approach		1145	1.1	0.808	21.9	LOS B	29.2	206.7	0.79	0.75	35.8
West: Artarmon Rd (W)											
10	L	39	0.0	0.934	64.8	LOS E	12.8	89.8	1.00	0.94	20.5
11	T	93	0.0	0.934	57.6	LOS E	12.8	89.8	1.00	0.94	19.9
12	R	342	0.0	0.934	74.0	LOS F	16.7	117.2	1.00	1.03	18.7
Approach		474	0.0	0.934	70.0	LOS E	16.7	117.2	1.00	1.01	19.1
All Vehicles		3351	0.8	1.103	52.6	LOS D	51.5	364.0	0.83	0.96	23.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	10.9	LOS B	0.1	0.1	0.45	0.45
P5	Across N approach	53	49.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	12.3	LOS B	0.1	0.1	0.47	0.47
All Pedestrians		159	24.1	LOS C			0.62	0.62

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Future - Sat - Dev - Right Turn Ban

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 110 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	383	0.0	0.757	19.0	LOS B	25.7	180.9	0.61	0.93	39.4
2	T	998	1.5	1.010	47.1	LOS D	50.0	354.2	0.80	0.98	25.0
3	R	77	0.0	1.010	91.9	LOS F	50.0	354.2	1.00	1.37	16.9
Approach		1458	1.0	1.010	42.1	LOS C	50.0	354.2	0.76	0.99	26.8
East: Small St (E)											
4	L	138	0.0	0.908	75.1	LOS F	8.7	60.9	1.00	1.04	18.5
5	T	81	0.0	0.868	63.6	LOS E	8.2	57.6	1.00	1.00	18.9
6	R	55	0.0	0.868	70.9	LOS F	8.2	57.6	1.00	1.00	19.5
Approach		274	0.0	0.908	70.9	LOS F	8.7	60.9	1.00	1.02	18.8
North: Willoughby Rd (N)											
7	L	71	0.0	0.673	20.7	LOS B	4.9	34.6	0.61	0.91	38.6
8	T	1056	1.2	0.673	9.6	LOS A	17.4	122.9	0.49	0.44	45.6
Approach		1126	1.1	0.673	10.3	LOS A	17.4	122.9	0.50	0.47	45.1
West: Artarmon Rd (W)											
10	L	39	0.0	0.934	64.8	LOS E	12.8	89.8	1.00	0.94	20.5
11	T	93	0.0	0.934	57.6	LOS E	12.8	89.8	1.00	0.94	19.9
12	R	342	0.0	0.934	74.0	LOS F	16.7	117.2	1.00	1.03	18.7
Approach		474	0.0	0.934	70.0	LOS E	16.7	117.2	1.00	1.01	19.1
All Vehicles		3332	0.8	1.010	37.7	LOS C	50.0	354.2	0.73	0.82	28.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	11.4	LOS B	0.1	0.1	0.45	0.45
P5	Across N approach	53	49.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	12.8	LOS B	0.1	0.1	0.48	0.48
All Pedestrians		159	24.4	LOS C			0.63	0.63

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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MOVEMENT SUMMARY

Site: Future - Sat - LC+Dev - Right Turn T Ban

Willoughby Road / Artarmon Road

Signals - Fixed Time Cycle Time = 110 seconds (User-Given Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue		Prop. Queued	Effective Stop Rate	Average Speed
							Vehicles	Distance			
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Willoughby Rd (S)											
1	L	383	0.0	0.782	19.3	LOS B	27.6	194.8	0.63	0.94	39.2
2	T	998	1.5	1.043	56.1	LOS D	53.0	375.0	0.80	1.03	22.7
3	R	83	0.0	1.043	115.7	LOS F	53.0	375.0	1.00	1.50	14.1
Approach		1464	1.0	1.043	49.9	LOS D	53.0	375.0	0.77	1.03	24.5
East: Small St (E)											
4	L	143	0.0	0.940	79.4	LOS F	9.3	65.3	1.00	1.06	17.9
5	T	85	0.0	0.945	74.4	LOS F	9.8	68.7	1.00	1.12	17.2
6	R	61	0.0	0.945	81.7	LOS F	9.8	68.7	1.00	1.12	17.7
Approach		291	0.0	0.945	79.4	LOS F	9.8	68.7	1.00	1.09	17.6
North: Willoughby Rd (N)											
7	L	77	0.0	0.679	20.9	LOS B	5.0	35.0	0.62	0.90	38.5
8	T	1056	1.2	0.679	9.6	LOS A	17.7	125.4	0.49	0.44	45.5
Approach		1133	1.1	0.679	10.4	LOS A	17.7	125.4	0.50	0.48	45.0
West: Artarmon Rd (W)											
10	L	39	0.0	0.942	64.0	LOS E	12.8	89.8	1.00	0.92	20.7
11	T	97	0.0	0.942	56.8	LOS E	12.8	89.8	1.00	0.92	20.0
12	R	342	0.0	0.942	75.4	LOS F	17.2	120.2	1.00	1.04	18.5
Approach		478	0.0	0.942	70.7	LOS F	17.2	120.2	1.00	1.00	18.9
All Vehicles		3365	0.8	1.043	42.0	LOS C	53.0	375.0	0.73	0.84	26.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model used.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow	Average Delay	Level of Service	Average Back of Queue		Prop. Queued	Effective Stop Rate
					Pedestrian	Distance		
		ped/h	sec		ped	m		per ped
P3	Across E approach	53	11.4	LOS B	0.1	0.1	0.45	0.45
P5	Across N approach	53	49.2	LOS E	0.2	0.2	0.95	0.95
P7	Across W approach	53	12.8	LOS B	0.1	0.1	0.48	0.48
All Pedestrians		159	24.4	LOS C			0.63	0.63

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

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