Traffic and transport

1.1 Methodology

The traffic and transport assessment was provided by Roads and Maritime Services and considered the impacts with and without the proposal on the intersection average delays and queue lengths for the base year (2016) and future year (2026).

To assist in the assessment of the intersection performance, traffic modelling was undertaken. Traffic models are used to estimate the number of trips that would be made on a transportation system as a result of change in the road network (for example, the introduction of a new or upgraded road) or a change in travel demand (for example, the impact of a local development).

For this project, traffic models were developed using SIDRA software. The analysis used traffic data and intersection data collected through traffic surveys and validated and calibrated with site observations and SCATS data. The traffic survey was undertaken by Matrix in September 2016.

SIDRA analysis modelled intersection enhancements resulting from the proposal in terms of improvements to average delays, queue lengths and Level of Service (LOS) for 2016 and 2026, with and without the proposal.

Overall intersection performance is reported as an estimate of the average delay that all vehicles encounter at a particular intersection; the detailed measure is commonly expressed qualitatively as Level of Service which categorises the average delay into bands A to F, with LoS A representing the best operation and LoS F representing the worst operation. The banded categories are defined in Table 1.

Table 1 Level of Service

Level of service (LoS)	Average delay per vehicle in seconds
	Signalised Movements
A	< 14.5
B	14.5 to 28.5
C	28.5 to 42.5
D	42.5 to 56.5
E	56.5 to 70.5
F	> 70.5

As part of assessment, two modelling scenarios were considered:

- 2016 represents the base year, with and without the proposal
- 2026 provides a 10 year comparison from the modelled base year, with and without the proposal.

1.2 Existing Environment

NorthConnex is a nine kilometre tunnel that will link the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at West Pennant Hills, as shown in Figure 1, removing around 5,000 trucks off Pennant Hills Road each day. The nine kilometre tunnel motorway includes interchanges to the north and south to accommodate connections at either end of the project. When complete in 2019, it will link Sydney's north to the Orbital network.

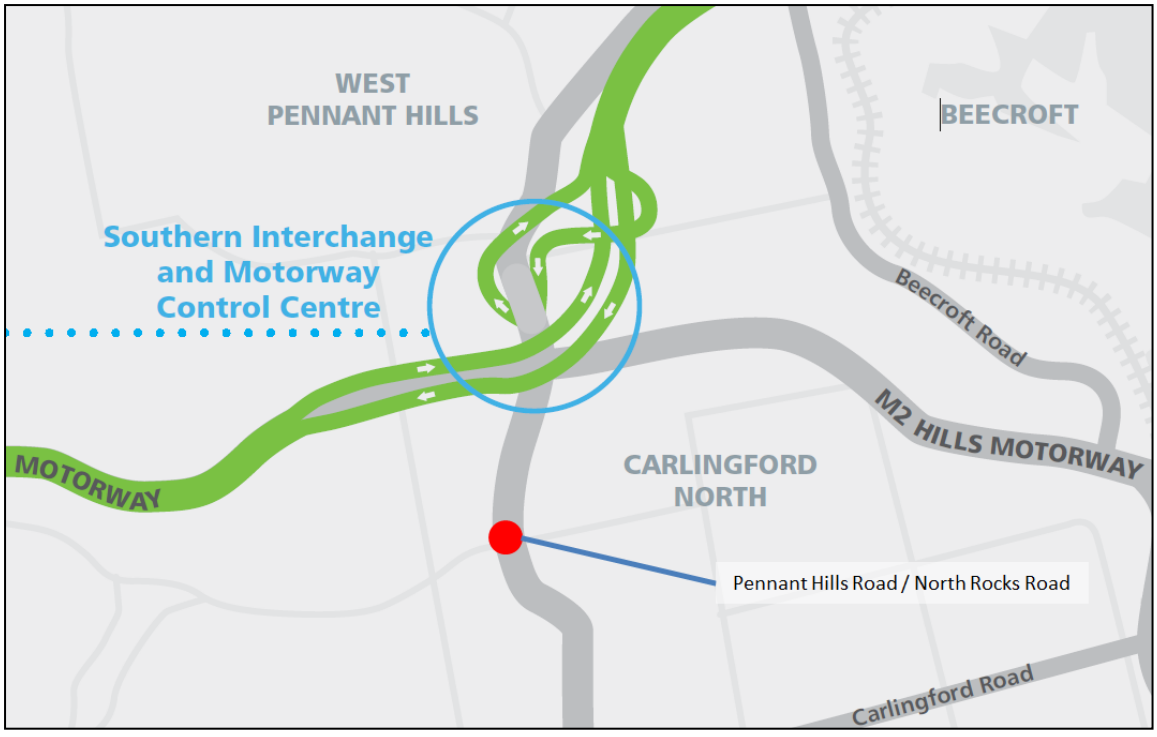
The southern interchange will provide connections between the tunnel, Hills M2 Motorway and Pennant Hills Road. The northbound on-ramp and southbound off-ramp joining Pennant Hills Road would be located south of Copeland Road approximately one kilometre north of the Pennant Hills Road / North Rocks Road intersection.

The tunnel portals provide accessibility for both northbound and southbound vehicles to and from Pennant Hills Road. North Rocks Road is a potential major east-west traffic distributor for traffic accessing Pennant Hills Road and the NorthConnex tunnel.

Recent site inspections conducted during the morning (AM) and afternoon (PM) peaks identified a noticeable pinch point for through traffic in both directions on Pennant Hills Road, between North Rocks and Murray Farm Roads. This is primarily attributed to lane geometry, where a 220m length of the northbound carriageway between the two intersections is reduced from three to two lanes.

A similar reduction from three to two lanes for the southbound carriageway occurs immediately north of Murray Farm Road. Intermediate access to service stations, community facilities and schools also exacerbate the issue.

Figure 1 NorthConnex Southern Interchange



Source: Roads and Maritime; 2016

1.2.1.1 Traffic Volumes (2016)

The 2016 traffic volumes are presented in **Figure 2** and **Figure 3**. The volumes suggest that southbound direction along Pennant Hills Road is the peak direction during the AM peak hour, and the northbound direction along Pennant Hills Road is the peak direction during the PM peak hour.

Figure 2: 2016 AM Peak Traffic Volumes

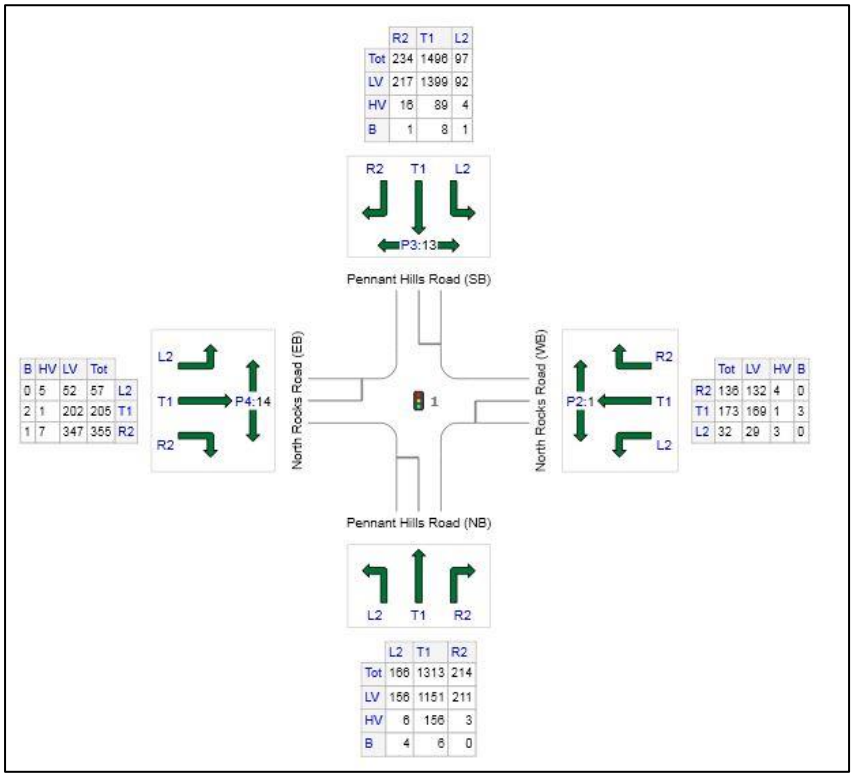
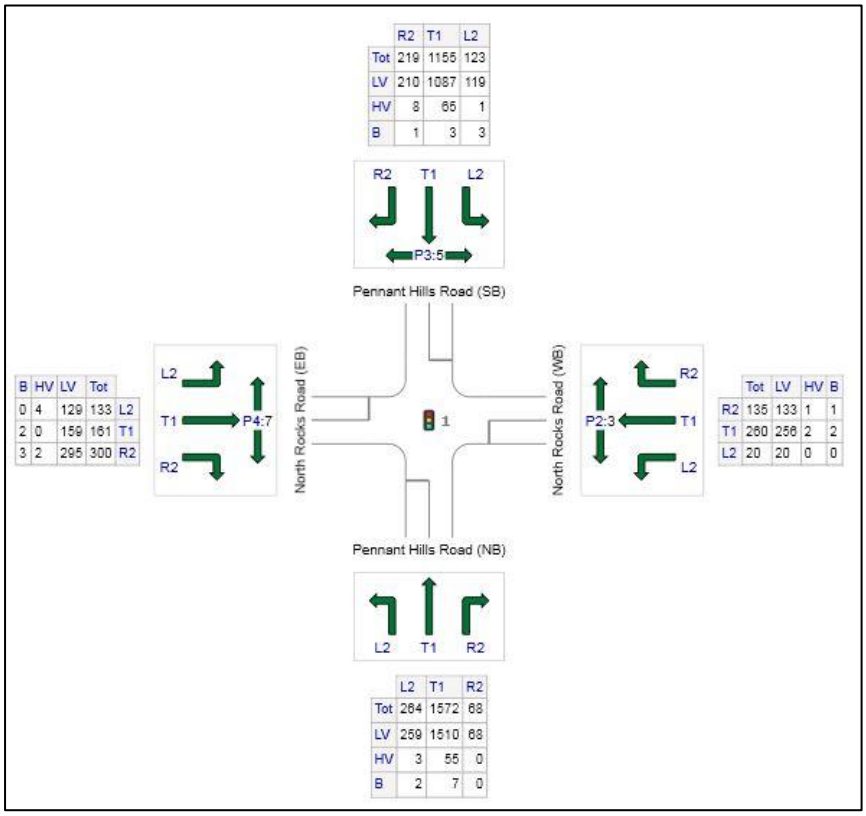


Figure 3: 2016 PM Peak Traffic Volumes



1.2.1.2 Roads and Maritime Historical Data

The most recent average daily traffic (ADT) data for Pennant Hills Road was collected in 2017. The data was obtained from one permanent mid-block counting station (74090)

located along Pennant Hills Road (Cumberland Highway) approximately 2.4km north of M2 Motorway and provide ADT data in both directions.

Table 2 shows the historical growth experienced at the counting station.

Table 2 Pennant Hill Road historical daily traffic count

Station	Location	Direction	Two-way traffic volumes					
			2013	2014	2015	2016	2017	% Total Growth
74090	Pennant Hill Road, 2.4km north of M2 Motorway	Northbound	26,687	22,233	27,500	30,458	30,137	13%
		Southbound	31,323	31,397	32,002	32,225	32,339	3%

Source: Roads and Maritime 2017

1.2.1.3 Existing Intersection performance

A 2016 Base Case scenario was developed to quantify existing performance of the intersection and formed the basis for comparison of the existing (2016) and future (2026) year assessment of the proposal.

Existing intersection performance was assessed by considering the estimated average vehicle delays, average queue lengths and Level of Service (LoS) during the AM and PM peak hours. Table 3 summarises the existing AM and PM weekday peak performance of the intersection for the base year (2016).

Table 3: 2016 SIDRA Outputs

Approach		Existing Scenario (2016)			
		DoS	Delays (s)	LoS	Avg Queues (Veh)
AM	Northbound	1.01	53	D	69
	Southbound	0.91	57	E	66
	Eastbound	0.99	135	F	33
	Westbound	1.01	138	F	18
	Intersection	**1.01**	**72**	**E**	-
PM	Northbound	1.00	72	F	113
	Southbound	0.91	42	D	38
	Eastbound	0.97	116	F	29
	Westbound	0.89	83	F	16
	Intersection	**1.00**	**69**	**E**	

The base case assessment indicates:

- The intersection operates with a LoS E and average delays of 72 and 69 seconds during the AM and PM peak hours respectively.
- Northbound movements experience average delays of 53 and 72 seconds and average queues of 69 and 113 vehicles during the AM and PM peak hours respectively.
- Southbound movements experience average delays of 57 and 42 seconds and average queues of 66 and 38 vehicles during the AM and PM peak hours respectively.

- Eastbound movements experience average delays of 135 and 116 seconds and average queues of 33 and 29 vehicles during the AM and PM peak hours respectively.
- Westbound movements experience average delays of 138 and 83 seconds and average queues of 18 and 16 vehicles during the AM and PM peak hours respectively.

1.2.1.4 Pedestrian movements

The following existing pedestrian facilities exist:

- Northern crossing on Pennant Hills Road
- Eastern and western crossings on North Rocks Road
- Zebra crossing on the left turn slip lane from North Rocks Road west to Pennant Hills Road north.

No new pedestrian crossings are proposed as part of the intersection upgrade.

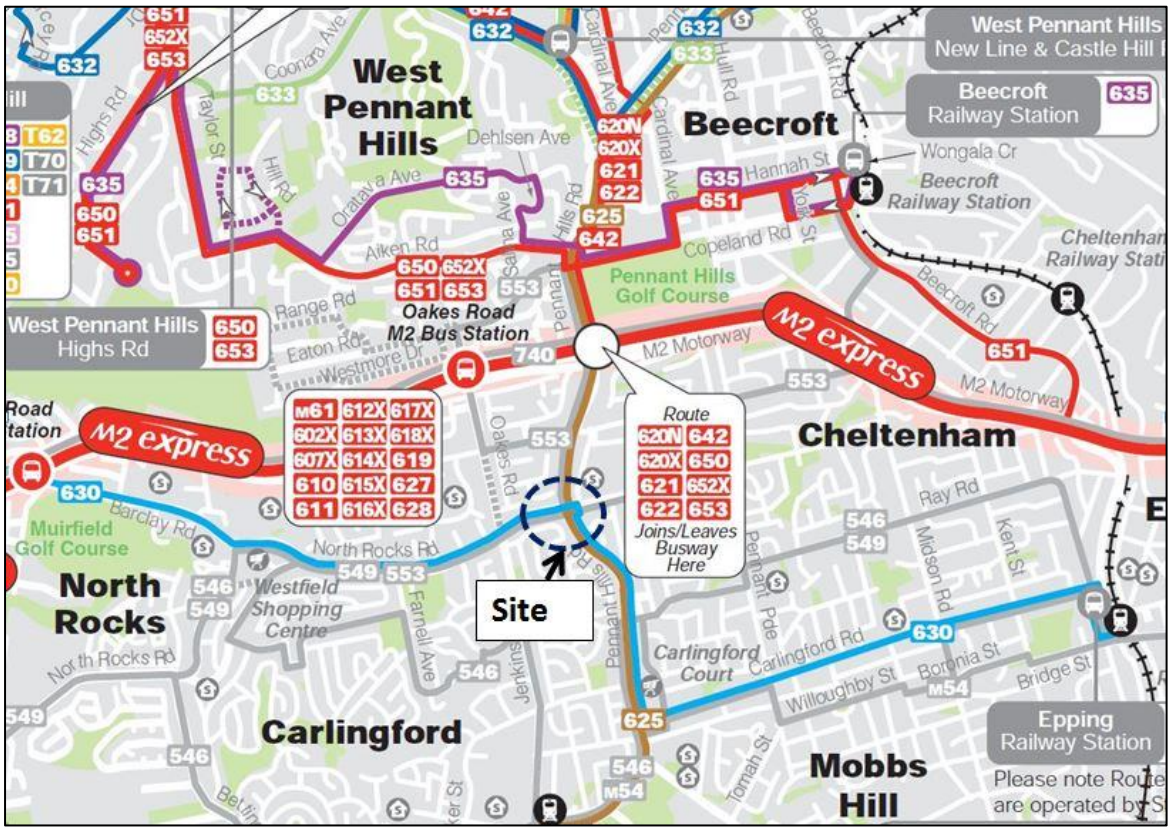
1.2.1.5 Parking

'No Stopping' and 'No Parking' zones are provided along both directions of Pennant Hills Road and North Rocks Road at the vicinity of the intersection. In addition, clearways are in operation along Pennant Hill Road during the hours of 6am to 10am and 3pm to 7pm Monday to Friday.

1.2.1.6 Public transport

Four bus routes namely 549, 553, 625 and 630 travel through the intersection as shown in Figure 4. No changes to the current bus services are proposed as part of the intersection upgrade.

Figure 4: Bus Services at the intersection



1.2.1.7 Property Access

Properties along Pennant Hills Road between North Rocks Road and North Murray farms can be accessed by right turn traffic crossing the BB line in the existing conditions.

The proposal includes adding an additional lane on the northbound direction on that segment and a new raised median will be provided to increase the safety along that section of the Road. The new median will restrict the access to the properties on in this area of the road from the opposing side which would require the use of alternative routes to access those properties as shown in Figure 5 and Figure 6.

Figure 5: Alternative property access routes (Pennant Hills Southbound)

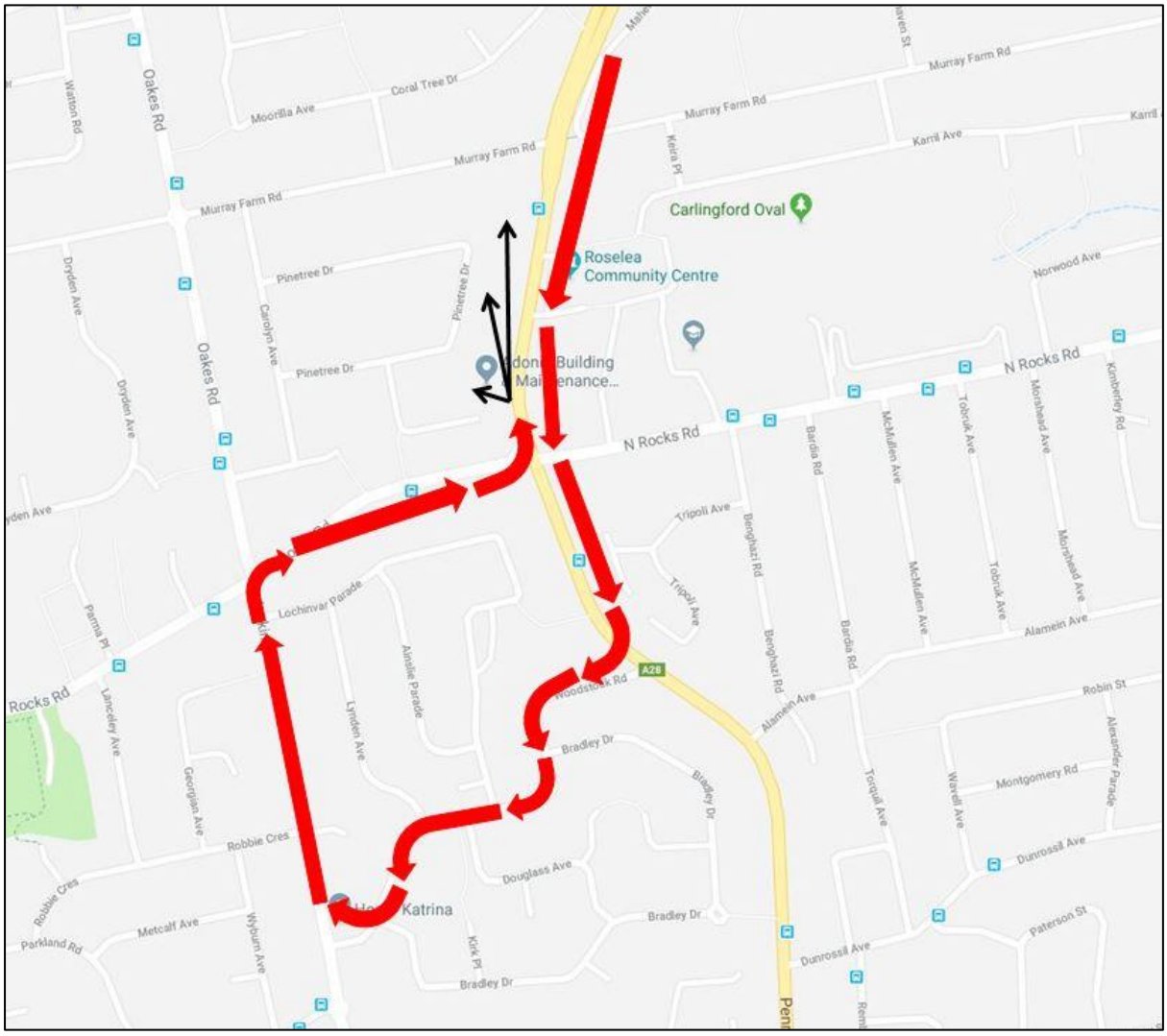
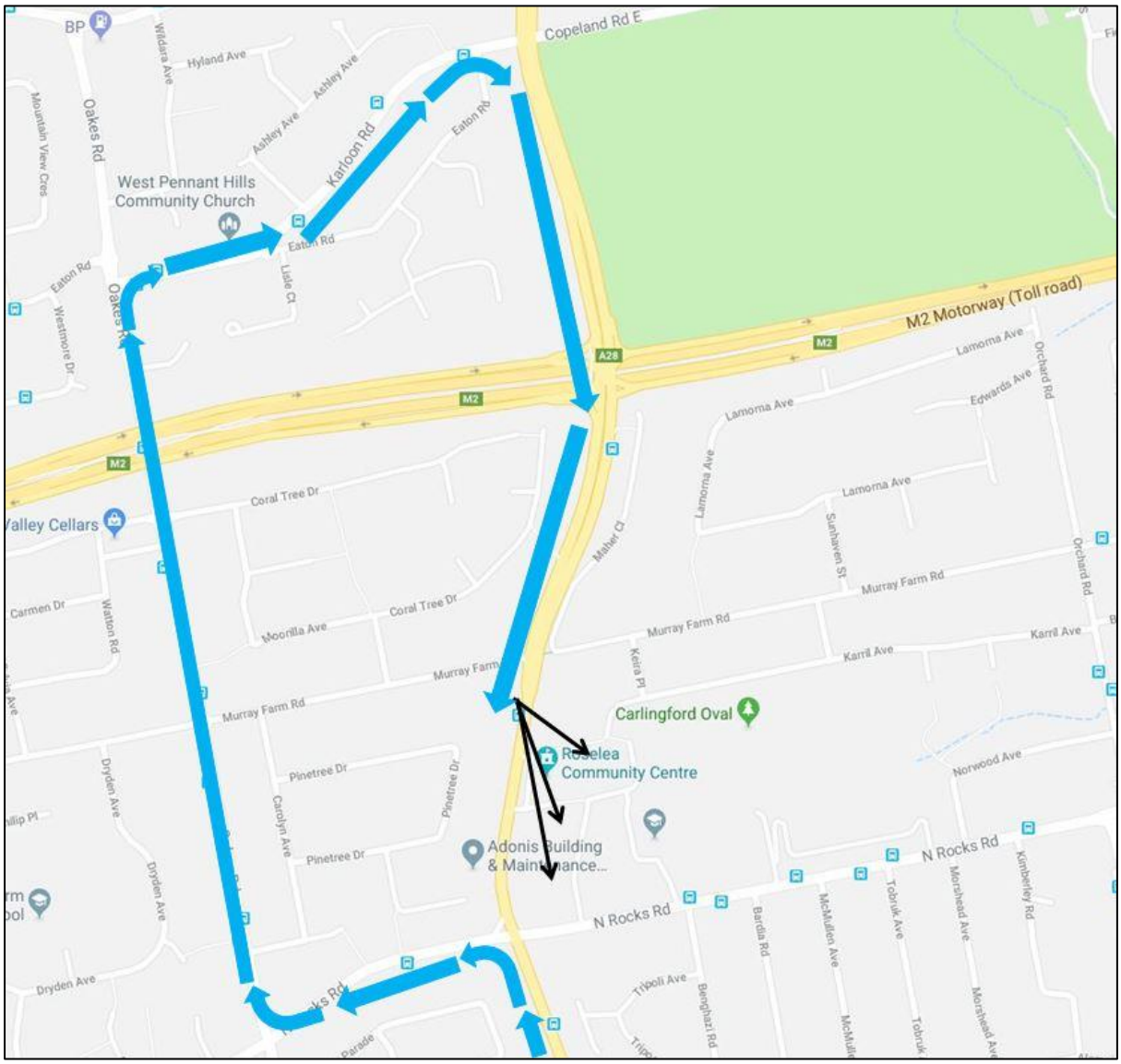


Figure 6: Alternative property access routes (Pennant Hills Northbound)



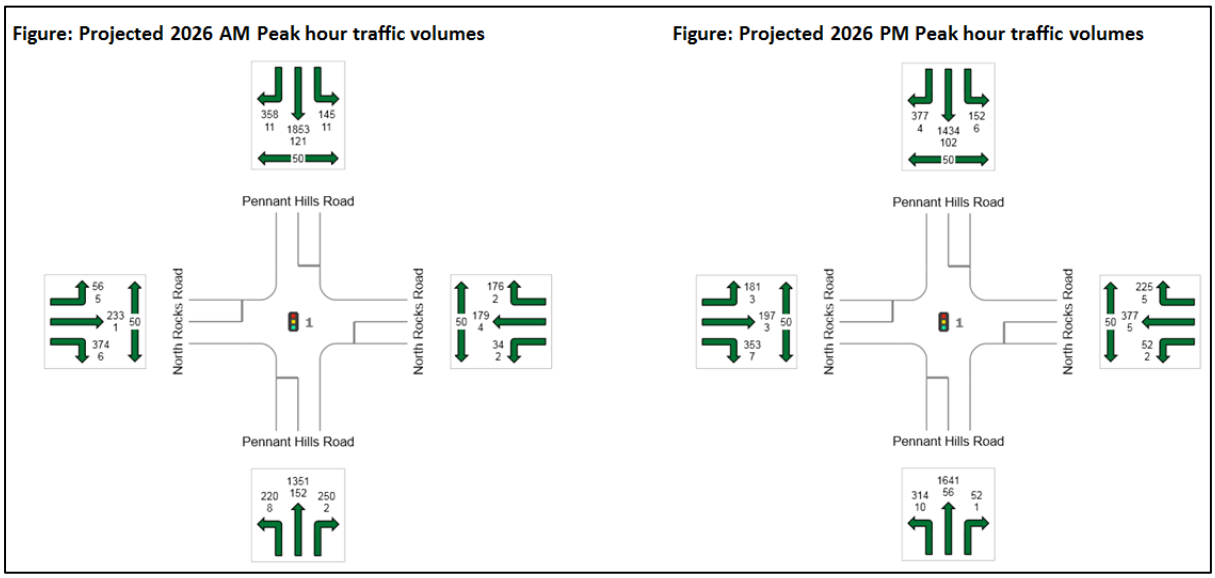
1.2.1.8 Future Traffic Growth

The proposal was assessed for the 2016 base year and 2026 future year, which incorporates anticipated levels of background traffic growth. To facilitate the future year assessment, the Sydney Strategic Traffic Forecasting Model (STFM) was used to calculate the growth factors from 2016 to 2026.

The STFM outputs are based on the latest available planning data for Sydney and incorporate factors such as future travel behaviour changes and vehicle travel pattern changes in response to infrastructure upgrades. The STFM outputs were considered the best available source of strategic traffic information for the assessment.

The projected 2026 peak hour traffic volumes are presented in Figure 7.

Figure 7: Projected 2026 peak hour volumes



1.2.1.9 Future Intersection performance

Similar to 2016 assessment, the intersection performance was assessed by considering the estimated average vehicle delays, average queue lengths and Level of Service (LoS) during the AM and PM peak periods. Table 4 summarises the estimated AM and PM weekday peak performance of the intersection for the base year (2026).

Table 4: 2026 SIDRA Outputs

Approach		Future No Build Scenario (2026)			
		DoS	Delays (s)	LoS	Avg Queues (Veh)
AM	Northbound	1.14	161	F	166
	Southbound	1.23	423	F	252
	Eastbound	1.08	217	F	50
	Westbound	1.17	361	F	38
	Intersection	**1.23**	**300**	**F**	-
PM	Northbound	1.11	156	F	193
	Southbound	1.55	268	F	92
	Eastbound	1.21	436	F	81
	Westbound	1.45	805	F	108
	Intersection	**1.55**	**313**	**F**	-

The assessment for the future 2026 scenario indicates that:

- Average delays of 300 and 313 seconds with LoS F are estimated at the intersection during the AM and PM peak hours under the existing layout.
- Average delays of 161 and 156 seconds are estimated for northbound movements with estimated average queues of 166 and 193 vehicles during the AM and PM peak hours respectively.
- Average delays of 423 and 268 seconds are estimated for southbound movements with estimated average queues of 252 and 92 vehicles during the AM and PM peak hours respectively.

- Average delays of 217 and 436 seconds are estimated for eastbound movements with estimated average queues of 50 and 81 vehicles during the AM and PM peak hours respectively.
- Average delays of 361 and 805 seconds are estimated for westbound movements with estimated average queues of 38 and 108 vehicles during the AM and PM peak hours respectively.

Overall this intersection has insufficient capacity to cater for the projected traffic demands, creating significant delays for traffic and negatively impacts the safety of the intersection. The detail of the SIDRA analysis is provided in the attachment of this memo.

1.3 Proposal

Based on the base year (2016) and future design year (2026) traffic demands, the intersection will not be able to perform adequately with excessive delays and queuing. The proposed improvements for the intersection include:

Pennant Hills Road North Approach:

- Providing a left turn slip lane with a high entry angle
- Changing the acceleration lane on the departure side to a lane and merge
- Constructing a new median that will extend to Murray Farm Road.

Pennant Hills Road South Approach:

- Changing the configuration of the kerbside lane to a shared through and left lane instead of exclusive left turn.

North Rocks Road East Approach:

- Changing the configuration of the outer lane from shared through and right to dedicated right turn
- Extending the length of the kerbside lane to 60 metres and changing the configuration to a shared through and left.

1.4 Intersection Performance under the improved layout

SIDRA assessment was done to predict the change in average delays, average queue lengths and LoS at the intersection during peak hours if the improvement measures are implemented. A comparative assessment between the performances of the intersection for 2016 and 2026 in both with and without proposal scenarios is summarised in Table 5 and **Table 6**.

The base and future assessments were based on the existing cycle length and phase times at the intersection to assess the impacts of the improvements without any delay improvements that might occur as a result of any cycle length or phase time optimisation. As a result, the actual delays are likely to be different from the modelled estimated delays.

Table 5: Base Year (2016) Assessment (With and Without Proposal)

Approach		Without Proposal (2016)				With Proposal (2016)			
		DoS	Delays (s)	LoS	Avg Queues (Veh)	DoS	Delays (s)	LoS	Avg Queues (Veh)
AM	Northbound	1.01	53	D	69	0.84	36	D	27
	Southbound	0.91	57	E	66	0.89	47	D	53
	Eastbound	0.99	135	F	33	0.99	131	F	33
	Westbound	1.01	138	F	18	0.86	80	F	11
	Intersection	**1.01**	**72**	**E**	-	**0.98**	**59**	**E**	**59**
PM	Northbound	1.01	72	F	113	0.75	31	C	41
	Southbound	0.91	42	D	38	0.91	38	D	31
	Eastbound	0.97	116	F	29	0.97	114	F	29
	Westbound	0.89	83	F	16	0.61	71	E	10
	Intersection	**1.01**	**69**	**E**		**0.97**	**48**	**D**	**-**

The analysis suggests that:

- The proposed improvements reduce the average delays for northbound movements by 17 and 41 seconds during the AM and PM peak hours respectively.
- The proposed layout improves the LoS for Northbound movements from F to C in the PM peak. The improvements also reduce the average queues for those movements from 69 to 27 vehicles in the AM peak and from 113 vehicles to 41 vehicles in the PM peak.
- The proposed improvements reduce the average delays for southbound movements by 10 and 4 seconds during the AM and PM peak hours respectively.
- The proposed layout improves the LoS for southbound movements from E to D in the AM peak. The improvements also reduce the average queues for those movements from 66 to 53 vehicles in the AM peak and from 38 to 31 vehicles in the PM peak.
- The proposed improvements reduce the average delays for westbound movements by 58 and 12 seconds during the AM and PM peak hours respectively and improve the LoS for those movements from F to E in the PM peak.
- The proposed improvements reduce the average queues for westbound movements from 18 to 11 vehicles in the AM peak and from 16 to 10 vehicles in the PM peak
- The proposed improvements reduce the overall average delays at the intersection by 13 and 21 seconds during the AM and PM peak hours respectively and improve the LoS of the intersection from E to D during the PM peak.

Table 6: Future Year (2026) Assessment

Approach		Without Proposal (2026)				With Proposal (2026)			
		DoS	Delays (s)	LoS	Avg Queues (Veh)	DoS	Delays (s)	LoS	Avg Queues (Veh)
AM	Northbound	1.14	161	F	166	1.06	51	D	39
	Southbound	1.23	423	F	252	1.20	361	F	31
	Eastbound	1.08	217	F	50	1.08	224	F	50
	Westbound	1.17	361	F	38	1.12	177	F	31
	Intersection	**1.23**	**300**	**F**	-	**1.20**	**220**	**F**	**-**
PM	Northbound	1.11	156	F	193	0.87	41	D	66
	Southbound	1.55	268	F	92	1.55	243	F	71
	Eastbound	1.21	436	F	81	1.21	439	F	80
	Westbound	1.45	805	F	108	1.05	156	F	31
	Intersection	**1.55**	**313**	**F**	-	**1.55**	**183**	**F**	

The analysis suggests that:

- The proposed improvements reduce the estimated average delays for northbound movements by 110 and 115 seconds during the AM and PM peak hours respectively.
- The proposed layout improves the estimated LoS for northbound movements from F to D in the AM and PM peak hours. The improvements also reduce the estimated average queues for those movements from 166 to 39 vehicles in the AM peak and from 193 vehicles to 66 vehicles in the PM peak.
- The proposed improvements reduce the estimated average delays for southbound movements by 62 and 25 seconds during AM and PM peak hours respectively.
- The proposed improvements reduce the estimated average queues for southbound movements from 252 to 31 vehicles in the AM peak and from 92 to 71 vehicles in the PM peak.
- The proposed improvements reduce the estimated average delays for westbound movements by 184 and 649 seconds during the AM and PM peak hours respectively.
- The proposed improvements reduce the estimated average queues for westbound movements from 108 to 31 vehicles in the PM peak.
- The proposed improvements reduce the estimated overall average delays at the intersection by approximately 80 and 130 seconds during the AM and PM peak hours respectively.

1.5 Safeguards and management measures

Impact	Environmental safeguards	Responsibility	Timing
Traffic and transport	A Traffic Management Plan (TMP) will be prepared and implemented as part of the CEMP. The TMP will be prepared in accordance with the Roads and Maritime Traffic Control at Work Sites Manual (RTA, 2010) and QA Specification G10 Control of Traffic (Roads and Maritime, 2008). The TMP will include: • confirmation of haulage routes. • measures to maintain access to local roads and properties. • site specific traffic control measures (including signage) to manage and regulate traffic movement. • measures to maintain pedestrian and cyclist access. • requirements and methods to consult and inform the local community of impacts on the local road network. • access to construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads. • a response plan for any construction traffic incident. • consideration of other developments that may be under construction to minimise traffic conflict and congestion that may occur due to the cumulative increase in construction vehicle traffic. • monitoring, review and amendment mechanisms.	Contractor	Detailed design / Pre-construction
Traffic congestion and safety	Traffic control will be provided in accordance with the approved construction TMP to manage traffic movements (vehicular, cycle and pedestrian) during construction.	Contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
Traffic and transport	VMS boards will be set up to inform motorists, cyclists and pedestrians of the work and changed traffic conditions during construction.	Contractor	Pre-construction / construction
Public transport	Access to bus stop locations would be maintained during construction. Temporary changes to bus stops will be undertaken in consultation with bus service provider.	Contractor	Pre-construction / construction
Public transport	Updates on the location of temporary bus stops would be provided to the community.	Roads and Maritime and Construction Contractor	Pre-Construction and Construction
Pedestrian and cyclist access	Traffic controllers will manage the work area and will assist pedestrians and cyclist and maintain access along the work location. Additionally, signage outlining pedestrian and cyclist diversion routes would be displayed during construction (where required).	Contractor	Construction
Property access	Access to affected residential properties would be maintained during construction and temporary property access would be provided to residences where required. The management of property access would be considered by the construction contractor and detailed in the traffic management plan.	Construction Contractor	Pre-Construction and Construction
Property access	Roads and Maritime will continue to consult with all properties that will have altered access following construction of the Proposal.	Roads and Maritime	Detailed design

Impact	Environmental safeguards	Responsibility	Timing
Property access	Residents and businesses will be notified of any specific impacts to property access and arrangements required during construction.	Roads and Maritime	Detailed design