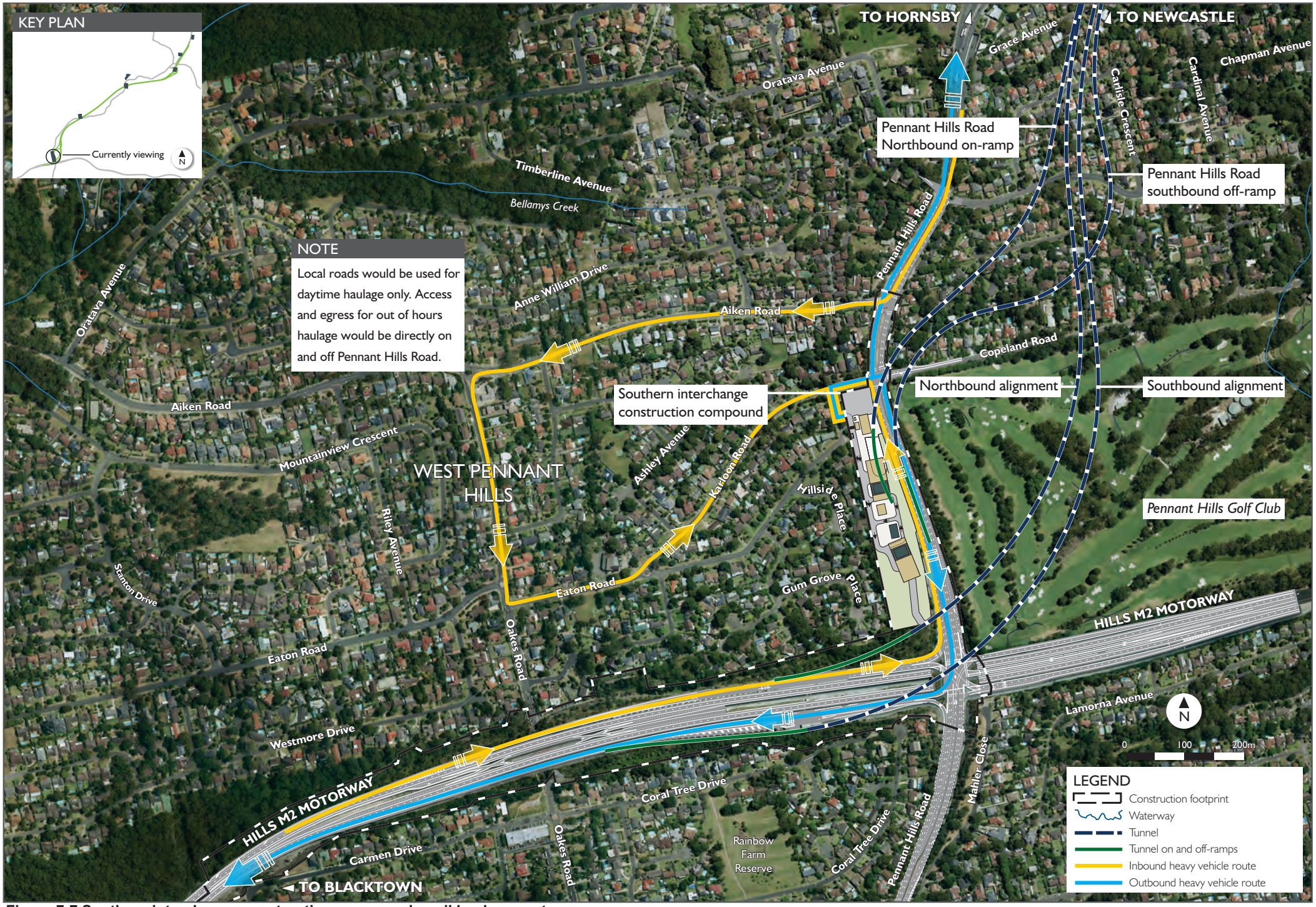

Figure 7-7 Southern interchange construction compound spoil haulage routes

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Figure 7-8 Wilson Road construction compound spoil haulage routes

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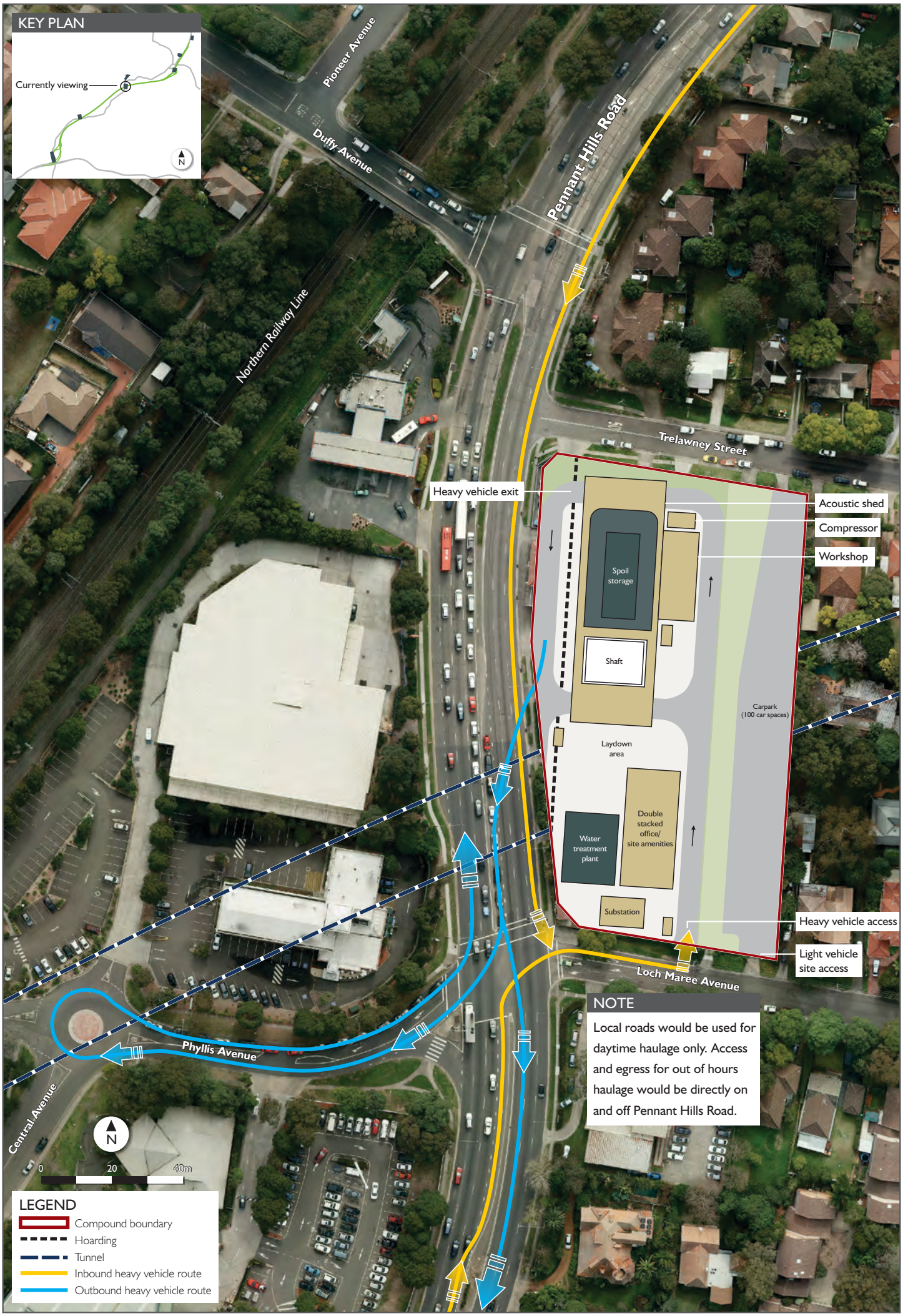

Figure 7-9 Trelawney Street construction compound spoil haulage routes

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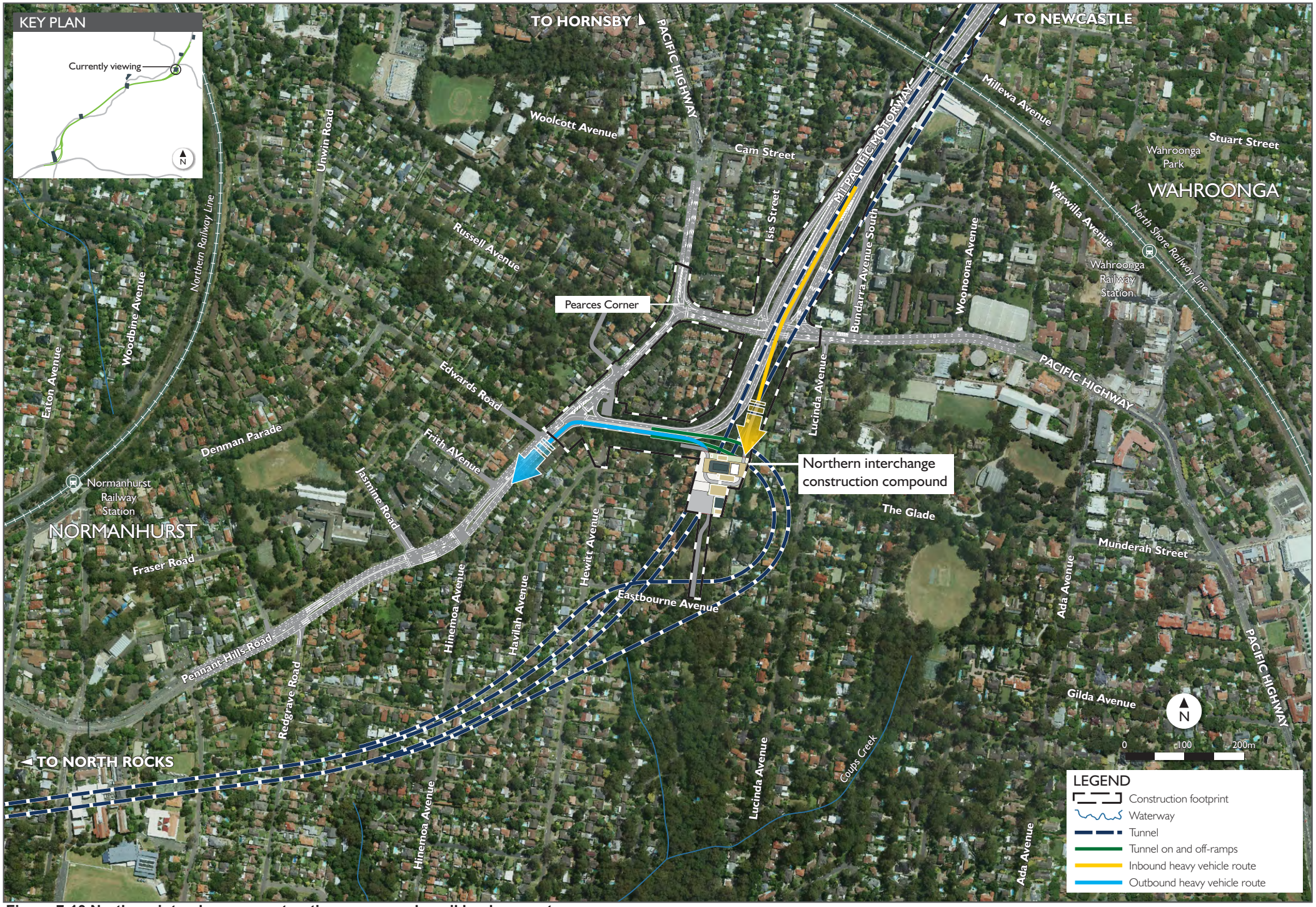

Figure 7-10 Northern interchange construction compound spoil haulage routes

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Construction traffic generated by the project has been considered in two broad categories:

- Construction traffic generated along the Hills M2 Motorway corridor associated with integration works. Traffic from these works would be relatively low compared with total construction traffic generated by the project. In most cases this would involve direct access and egress to and from the Hills M2 Motorway and would be scheduled outside of peak periods (including at night as a consequence of out of hours construction works).
- Construction traffic generated along the Pennant Hills Road corridor which, given the volume of traffic and the need to conduct continuous tunnelling activities, would be scheduled 24 hours per day, seven days per week, subject to traffic management requirements and local amenity considerations.

The volume of construction traffic is indicative and based on the preferred tender design. Whilst the exact numbers would be subject to change based on detailed design and refinements of construction methods, the project would to aim to result in a similar level of intersection performance to that predicted within this assessment.

Access requirements for surrounding local roads

The use of local roads for heavy vehicle access would be minimised as far as feasible and reasonable. However, the use of some local roads is unavoidable in order to practically undertake some construction activities, including:

- Establishing construction compounds.
- Localised specific construction activities such as noise barrier removal and construction, building demolition, utility relocation or protection, and some drainage works.
- Demobilisation and rehabilitation of construction compounds.

Table 7-15 identifies the local roads which are likely to require heavy vehicle access, and the anticipated average traffic volume and duration of use. There may be periods during construction where the vehicle numbers on individual roads are higher than that identified in **Table 7-15** in order to conduct discreet construction activities. As these vehicle movements would occur throughout the day, they are not expected to impact on the performance of the local road network.

Table 7-15 does not include the use of local roads in order to regularly access and egress each construction compound such as heavy vehicles to support tunnelling works and buses for the transfer of workers to and from each compound. These roads and associated movements are identified in **Table 5-19**.

The use of these local roads would be further reviewed as part of the development of the traffic management plans during the detailed design phase of the project.

Table 7-15 Access requirements on local roads

Access route	Suburb	Anticipated purpose	Anticipated average vehicle numbers per day	Anticipated duration
Windsor Road compound (C1)				
Torr Street	Baulkham Hills	Site establishment	10	3 months
		Site restoration and demobilisation	10	3 months
Darling Mills Creek compound (C2)				
Ventura Road	Northmead	Delivery of large equipment	2	1 month
		Removal of large equipment	2	1 month
Barclay Road compound (C3)				
Barclay Road and Perry Street	North Rocks	Site establishment	10	3 months
		Site restoration and demobilisation	10	3 months
Yale Close compound (C4)				
Barclay Road, Baden Powell Place and Duncan Place	North Rocks	Site establishment	10	3 months
		Site restoration and demobilisation	10	3 months
Wilson Road compound (C6)				
Boundary Road, Victoria Road and Wilson Road	Pennant Hills	Site establishment	10	3-6 months
		Landscaping and demobilisation	10	9-12 months
Trelawney Street compound (C7)				
Loch Maree Avenue	Thornleigh	Site establishment	15	3-6 months
		Landscaping and demobilisation	10	9-12 months
Trelawney Street	Thornleigh	Site establishment	15	3-6 months
		Landscaping and demobilisation	10	9-12 months
Pioneer Avenue compound (C8)				
Combination of access routes using Duffy Avenue, Pioneer Avenue, Chilvers Road, Dartford Road, Sefton Road and Lymoore Avenue	Thornleigh	Site establishment	70	3-6 months
		Site restoration and demobilisation	15	3 months

Access route	Suburb	Anticipated purpose	Anticipated average vehicle numbers per day	Anticipated duration
Northern interchange compound (C9)				
The Comenarra Parkway, Fox Valley Road, Lucinda Avenue and Eastbourne Avenue	Wahroonga	Site establishment	20	4-6 months
		Rehabilitation and demobilisation	20	3-6 months
Hinemoa Avenue, Bristol Avenue, Edgecombe Avenue, Hewitt Avenue, Havilah Avenue and Eastbourne Avenue	Wahroonga	Site establishment	20	4-6 months
		Rehabilitation and demobilisation	20	3-6 months
Bareena Avenue compound (C10)				
Myra Street, Ingram Road, Edgeworth David Avenue, Woonona Avenue North and Bareena Avenue (west of M1 Pacific Motorway)	Wahroonga	Site establishment, building demolitions, utility works, noise wall works	15	2-4 months
Junction Road compound (C11)				
Myra Street, Ingram Road, Edgeworth David Avenue, Junction Road and Coonanbarra Road	Wahroonga	Site establishment	15	3-6 months
		Rehabilitation and demobilisation	15	3-6 months
Access to Coral Tree Drive Switching Station				
Coral Tree Drive, Oakes Road and Jenkins Road	Carlingford	Switching Station construction	15	15 months
Access to construction works at Aaron Place				
Aaron Place	Wahroonga	Noise wall works, utility works and road widening	15	12-18 months
Access to construction works east of the M1 Pacific Motorway				
Combination of Edgeworth David Avenue, Junction Road, Coonanbarra Road, Lochville Street, Burns Road, Grosvenor Street and Cleveland Street	Wahroonga	Building demolition, utility works, noise wall works and civil works	25	18-24 months
Redleaf Avenue, Alexandria Parade Millewa Avenue	Wahroonga	Building demolition, utility works, noise wall works and civil works	10	2-4 months
Access to construction works west of the M1 Pacific Motorway				
Combination of Ingram Road, Alexandria Parade, Myra Avenue, Oleander Avenue, Highlands Avenue, Fern Avenue, Bundarra Avenue North, Benson Close, Woonona Avenue North Lochville Street and Douglas Avenue	Wahroonga	Building demolition, utility works, noise wall works and civil works	10	2-4 months

Construction traffic along the Hills M2 Motorway corridor

Construction traffic movements predicted for the Hills M2 Motorway integration works are presented in **Table 7-16**. Construction traffic would generally be via the Hills M2 Motorway with the exception of:

- Traffic to and from the Windsor Road compound (C1) would be via Torr Street and Windsor Road.
- There would be some limited movements to and from the access track at the end of Ventura Road associated with the Darling Mills Creek compound (C2). This would involve the delivery of drill rigs and large excavation equipment.
- Traffic to and from the Barclay Road compound (C3) would be via Perry Street and Barclay Road.

Construction traffic associated with the Hills M2 Motorway integration works would also occur at night to:

- Minimise disruption to the operation of the Hills M2 Motorway.
- Avoid peak traffic periods on the motorway where feasible and reasonable to do so.

Due to relatively low predicted traffic volumes for the Windsor Road (C1), Darling Mills Creek (C2) and Yale Close compounds (C4) from the local road network, impacts on the local road network are anticipated to be negligible and as such have not been assessed through a modelling based framework. Construction traffic from the Barclay Road compound (C3) and for integration works along the Hills M2 Motorway have been included in the traffic modelling and assessment for the project. Access to Darling Mills Creek compound (C2) and Yale Close compound (C4) directly from the Hills M2 Motorway are included in the movements off the relevant sections of the Hills M2 Motorway.

Table 7-16 Indicative construction traffic - Hills M2 Motorway integration works

Location	Details	Daily vehicles (heavy)	Daily vehicles (light)
Barclay Road to Windsor Road interchange westbound	Access would be directly from the Hills M2 Motorway. Up to 180 of these movements (heavy and light vehicles) would occur at night.	40	300
Barclay Road compound (C3)	Access would be via the intersection of Barclay Road and Perry Street.	25	26
Pennant Hills Road interchange to Barclay Road westbound	Access would be directly from the Hills M2 Motorway. Up to 180 of these movements (heavy and light vehicles) would occur at night.	50	360

In line with observations during construction of the Hills M2 Motorway Upgrade project it is possible that motorists may use alternative routes during construction of the Hills M2 Motorway integration works in response to lower speed limits and lane closures during construction. This is expected to occur mainly during the off peak periods, including at night.

The network performance modelling for the Barclay Road / Perry Street intersection associated with the Barclay Road compound (C2) indicate that the existing level of service would be maintained during construction. There may be some minor increases in average delay. However this in expected be no more than 0.3 second per vehicle.

Construction traffic along the Pennant Hills Road corridor

Anticipated volumes of heavy and light vehicles at construction ancillary facilities along Pennant Hills Road are presented in **Table 7-17**.

Table 7-17 Indicative construction vehicle volumes at construction ancillary facilities

No.	Site	Access / egress arrangements	AM peak (vehicles / hour)	PM peak (vehicles / hour)	Daily vehicles
Heavy vehicles					
C5	Southern interchange compound	Eaton Road	25	28	740
C6	Wilson Road compound	Left in / left out Pennant Hills Road	23	26	600
C7	Trelawney Street compound	Left in Loch Maree Avenue Left out Pennant Hills Road	23	26	570
C8	Pioneer Avenue compound	Lymoore Avenue Pioneer Avenue (secondary)	4	4	24
C9	Northern Interchange compound	Left in / left out M1 Pacific Motorway	26	29	720
C10	Bareena Avenue compound	Left in / left out M1 Pacific Motorway	3	4	20
C11	Junction Road compound	Coonanbarra Road / Carrington Road	0	0	1
Total			104	117	2,675
Light vehicles					
C5	Southern interchange compound	Eaton Road	12	12	165
C6	Wilson Road compound	Wilson Road	8	8	100
C7	Trelawney Street compound	Loch Maree Avenue	8	8	100
C8	Pioneer Avenue compound	Lymoore Avenue Pioneer Avenue (secondary)	98	98	650
C9	Northern interchange compound	Eastbourne Avenue	10	10	100
C10	Bareena Avenue compound	Woonona Avenue North	3	3	25
C11	Junction Road compound	Coonanbarra Road / Carrington Road	16	16	100
Total			155	155	1,240

As shown in **Table 7-17**, the highest volumes of both heavy and light construction vehicles are expected to originate from the southern interchange compound (C5), northern interchange compound (C9), and both the Wilson Road (C6) and Trelawney Street compounds (C7).

Due the fact that there is no right turn provision from Pennant Hills Road to Eaton Road, construction vehicles approaching from the north would access the southern interchange compound (C5) from Eaton Road via Aiken, Oakes and Karloon Roads. Construction vehicles approaching from the south would access the southern interchange compound (C5) from Eaton Road via Pennant Hills Road. Construction vehicles leaving the site would re-join Pennant Hills Road at the signalised intersection with Copeland Road and Eaton Road. This compound is anticipated to attract significant additional heavy vehicle trips to the surrounding local road network. Local widening works on Eaton Road and Karloon Road are proposed to accommodate heavy vehicle movements at the southern interchange compound.

Access and egress to and from the southbound carriageway of the M1 Pacific Motorway would be constructed to accommodate construction vehicle access to the northern interchange compound (C9). Construction traffic impacts associated with this compound are anticipated to be largely limited to existing approved heavy vehicle routes (Pennant Hills Road and the M1 Pacific Motorway). The volume of light vehicle trips associated with the northern interchange compound (C9) is not expected to be significant. Light vehicles would use local roads in order to access the compound from Eastbourne Avenue.

Heavy vehicles egressing the northern interchange compound and travelling north would be required to travel south along Pennant Hills Road until a suitable location to perform a u-turn (likely to be at either Phyllis Avenue or Beecroft Road). Heavy vehicles approaching the site from the south would travel north along the M1 Pacific Motorway from the Pacific Highway on-ramp, then exit at the Ku-ring-gai Chase Road interchange to perform a u-turn and travel south on the M1 Pacific Motorway to the site access point.

Heavy vehicle access to and egress from the Wilson Road compound (C6) would be provided directly from Pennant Hills Road between Beecroft Road North and South, via a left in / left out priority intersection with Pennant hills Road northbound. Light vehicles accessing the site would use local road in order to access the compound from Wilson Road. Traffic impacts resulting from heavy vehicle routes at this compound are expected to be limited to Beecroft Road and Pennant Hills Road.

Construction heavy vehicle access to the Trelawney Street compound (C7) would be from Loch Maree Avenue, with egress being left out onto Pennant Hills Road. After entering Pennant Hills Road, northbound vehicles would be required to immediately turn right into Phyllis Avenue and conduct a u-turn at the Phyllis Avenue / Central Avenue roundabout before proceeding northbound on Pennant Hills Road. Light vehicles would access and egress the site to and from Loch Maree Avenue at the separate access point to the heavy vehicles.

It is anticipated that the Trelawney Street compound would attract significant additional heavy vehicle movements to the local network, particularly at the intersections of Pennant Hills Road with Loch Maree Avenue, Trelawney Street and Phyllis Avenue. Difficulties may arise for construction vehicles attempting to cross three lanes of Pennant Hills Road in a short distance to turn right into Phyllis Avenue. In addition, further assessment may be required to determine whether the existing geometry of the Phyllis Avenue / Central Avenue roundabout can accommodate the anticipated heavy vehicle u-turn manoeuvre.

The egress arrangements at the Trelawney Street compound would be reviewed as part of the development of the traffic management plans.

Primary access and egress to and from Bareena Avenue compound (C10) for construction works, particularly the tunnel portal (ie the cut and cover tunnel) and road works would be provided from the M1 Pacific Motorway. The majority of building works at the compound would require access from Woonona Avenue North. As Woonona Avenue North is primarily a residential street, disruption to residents would require management during construction.

Construction traffic volumes associated with the Junction Road compound (C11) are not anticipated to be sufficient to significantly affect the performance of the local road network.

A central construction workforce parking area would be provided, from which workers would be transported to various worksites by bus. The parking area would be located within the Pioneer Avenue compound (C8), with a capacity of around 600 vehicles. Around 50 additional car spaces would be provided at the Junction Road compound (C11). The transfer of employees to and from worksites has been conservatively assumed to occur during peak hours and has been included as part of this assessment.

Road safety

As the volume of traffic generated by construction is expected to be relatively low compared to existing traffic volumes on Pennant Hills Road, the Pacific Highway, the Hills M2 Motorway and the M1 Pacific Motorway, the effects of this short-term increase are not expected to significantly impact road safety in the project area. Although total construction traffic volumes are relatively low, the proportion of heavy vehicles within this total (about two thirds of total construction traffic) is relatively high. When compared to existing traffic volumes, total construction traffic would be the equivalent of:

- Around five per cent of total daily traffic on Pennant Hills Road in the study area.
- Around nine per cent of total daily traffic on the Pacific Highway in the study area.
- Less than four per cent of total daily traffic on the Hills M2 Motorway in the study area.

As the volume of traffic generated by construction is expected to be relatively low compared to existing traffic, the effects of this short-term increase on the existing road network is not expected to significantly impact road safety in the project area. In addition, any foreseen impacts to road safety for all users during construction would be mitigated through the provision of tailored traffic management plans and measures, as detailed in **Section 7.1.5**.

The presence of construction compounds would also result in an interface between heavy vehicles and pedestrians. Traffic management plans would involve measures to managed this interface and provide safe pedestrian movements around construction sites.

Network performance

During the main construction works, a length of the eastbound off-ramp at the Hills M2 Motorway / Pennant Hills Road interchange is planned to be reduced from two lanes to one lane, before it flares to the existing five lanes at the off-ramp stop line. This does not affect the operation of the Hills M2 Motorway / Pennant Hills Road interchange.

Mid-block traffic volume / capacity ratios and intersection performance have been assessed under the 'with construction' scenario to determine the impact of construction traffic on Pennant Hills Road in 2016. As spoil disposal locations are currently under investigation, a sensitivity test has been undertaken assessing the impacts of all construction vehicles using a northern disposal site (accessed via the M1 Pacific Motorway), and all construction vehicles using a southern / western disposal site (accessed via the Hills M2 Motorway). In reality, it is possible that spoil would be disposed of at sites to the north and the south / west of construction areas, and the assessment of spoil traffic impacts is therefore conservative.

Mid-block traffic volume / capacity ratios for the 2016 'with construction' northbound spoil disposal scenario are presented in **Table 7-18**.

Table 7-18 Mid-block traffic volumes and LoS (2016) with construction (northbound spoil disposal)

Location	Direction	Mid-block capacity	Light vehicles	Heavy vehicles	V/C	LoS
AM peak						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	1,370	160	0.65	D
	Southbound	2,800	1,940	110	0.81	D
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	2,200	360	0.77	D
	Southbound	4,200	2,980	260	0.87	E
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,420	290	0.78	D
	Southbound	4,200	2,060	220	0.64	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,220	340	1.00	F
	Southbound	4,200	3,040	240	0.89	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,000	320	0.70	D
	Southbound	4,200	2,090	320	0.72	D
PM peak						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	1,840	60	0.72	D
	Southbound	2,800	1,720	120	0.74	D
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	3,380	210	0.95	E
	Southbound	4,200	2,670	320	0.86	E
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,360	500	0.65	D
	Southbound	4,200	2,130	290	0.71	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,430	210	0.96	E
	Southbound	4,200	2,630	360	0.87	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,710	230	0.80	D
	Southbound	4,200	2,670	370	0.70	D

Table 7-19 provides a summary of intersection performance results at key locations along Pennant Hills Road under forecast 2016 volumes for both the 'with construction' and 'without construction' northbound spoil disposal scenarios.

Table 7-19 Intersection performance (2016) with construction and without construction (northbound spoil disposal)

Peak	2016 without construction				2016 with construction			
	Light vehicles	Heavy vehicles	Average delay (s)	LoS	Light vehicles	Heavy vehicles	Average delay (s)	LoS
Pennant Hills Road / North Rocks Road								
AM peak	4,290	290	79.6	F	4,290	290	94.2	F
PM peak	4,680	190	>100	F	4,680	190	>100	F
Hills M2 Motorway / Pennant Hills Road interchange								
AM peak	5,590	620	45.0	D	5,610	620	44.7	D
PM peak	5,900	490	>100	F	5,930	490	>100	F
Pennant Hills Road / Copeland Road								
AM peak	5,500	590	>100	F	5,530	620	>100	F
PM peak	5,830	480	68.6	E	5,870	510	58.8	E
Pennant Hills Road / Aiken Road								
AM peak	5,140	570	37.2	C	5,180	620	23.7	B
PM peak	6,170	480	24.5	B	6,220	530	42.6	D
Pennant Hills Road / Castle Hill Road								
AM peak	4,790	560	12.9	A	4,830	630	13.4	A
PM peak	5,850	450	26.1	B	5,900	520	26.8	B
Pennant Hills Road / Beecroft Road (South)								
AM peak	5,240	480	60.4	E	5,310	590	78.4	F
PM peak	5,570	410	>100	F	5,630	520	>100	F
Pennant Hills Road / Beecroft Road (North)								
AM peak	6,260	500	68.6	E	6,330	640	>100	F
PM peak	5,940	420	12.5	A	6,030	560	14.0	A
Pennant Hills Road / Boundary Road								
AM peak	6,240	560	51.2	D	6,310	700	38.7	C
PM peak	6,490	480	34.5	C	6,580	620	35.6	C

Peak	2016 without construction				2016 with construction			
	Light vehicles	Heavy vehicles	Average delay (s)	LoS	Light vehicles	Heavy vehicles	Average delay (s)	LoS
Pennant Hills Road / Yarrara Road								
AM peak	5,620	560	39.5	C	5,690	700	49.0	D
PM peak	5,910	480	44.6	D	6,000	620	59.5	E
Pennant Hills Road / Comenarra Parkway								
AM peak	4,650	620	77.5	F	4,720	760	92.0	F
PM peak	5,320	470	>100	F	5,210	610	>100	F
Pennant Hills Road / Phyllis Avenue / Loch Maree Avenue								
AM peak	3,940	620	21.8	B	4,030	830	>100	F
PM peak	4,660	480	39.8	C	4,770	690	66.8	E
Pennant Hills Road / Duffy Road								
AM peak	3,530	590	>100	F	3,620	770	>100	F
PM peak	4,870	410	86.5	F	4,950	590	>100	F
Pennant Hills Road / Dartford Road								
AM peak	3,350	570	>100	F	3,460	730	>100	F
PM peak	4,550	400	35.2	C	4,670	560	66.5	E
M1 Pacific Motorway / Pennant Hills Road								
AM peak	4,110	510	28.4	B	4,180	700	33.1	C
PM peak	4,580	400	36.6	C	4,660	590	>100	F
Pennant Hills Road / Pacific Highway								
AM peak	2,940	190	77.6	F	2,990	320	78.2	F
PM peak	3,370	120	45.7	D	3,420	250	47.1	D
M1 Pacific Motorway / Pacific Highway interchange								
AM peak	4,520	260	43.7	D	4,530	390	72.3	F
PM peak	5,010	140	65.4	E	5,020	270	>100	F

Results presented in **Table 7-19** show that under the 2016 'without construction' scenario, key intersections along Pennant Hills Road would be at or approaching capacity and experiencing high levels of delay during AM and PM peak periods. These intersections are susceptible to large increases in average delay with only small increases in demand. Hence, when viewing results for the 'with construction' scenario it is should be noted that background growth rates alone (irrespective of project traffic contributions) account for a significant part of the deterioration in road network performance.

Construction traffic would include up to an additional 300 vehicles per hour moving northbound / southbound on Pennant Hills Road, the majority of which would be transporting spoil northbound on the M1 Pacific Motorway (PCU factor applied). As the north-south movement receives priority, some intersections are shown to absorb the increase in traffic volumes, continuing to operate at an acceptable level with only moderate increases in average delay.

However, in addition to those intersections already forecast to operate beyond capacity without construction traffic, modelling results indicate that the 'with construction' northbound spoil disposal scenario would see the following intersections deteriorate to level of service F as a result of construction traffic:

- Pennant Hills Road / Beecroft Road (South) (AM Peak - LoS E to LoS F).
- Pennant Hills Road / Beecroft Road (North) (AM Peak - LoS E to LoS F).
- Pennant Hills Road / Phyllis Avenue (AM Peak - LoS B to LoS F).
- Pennant Hills Road / Pacific Highway (PM Peak - LoS D to LoS F).
- M1 Pacific Motorway / Pacific Highway interchange (PM Peak - LoS E to LoS F).

The significant deterioration in performance at the intersection of Pennant Hills Road and Phyllis Avenue is the result of an increase in right turn movements from Pennant Hills Road onto Phyllis Avenue associated with the Trelawney Street compound (C7). The above intersection performance results represent a worst case scenario based on peak construction traffic movements and would not be representative of the level of service for the duration of the construction period.

At some intersections, stable or minor improvements in performance are forecast with the addition of construction traffic. These improvements are the result of upstream intersections operating over capacity. An example of this is the Pennant Hills Road / Boundary Road intersection which shows an improvement in level of service during the AM peak with the introduction of construction traffic. Once capacity has been reached, upstream intersections behave as bottlenecks, reducing traffic flow to downstream intersections. This effect suggests why some isolated intersections show marginally improved performance with the addition of construction traffic.

Mid-block traffic volume / capacity ratios for the 2016 'with construction' southbound spoil disposal scenario are presented in **Table 7-20**.

Table 7-20 Mid-block traffic volumes and LoS (2016) with construction (southbound spoil disposal)

Location	Direction	Mid-block capacity	Light vehicles	Heavy vehicles	V/C	LoS
AM peak						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	1,370	160	0.65	D
	Southbound	2,800	1,940	110	0.81	D
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	2,200	380	0.79	D
	Southbound	4,200	2,980	280	0.89	E
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,420	320	0.80	D
	Southbound	4,200	2,060	250	0.66	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,220	340	1.00	F
	Southbound	4,200	3,040	240	0.89	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,000	300	0.68	D
	Southbound	4,200	2,090	290	0.70	D
PM peak						
Pennant Hills Road, North Rocks Road to Hills M2 Motorway	Northbound	2,800	1,840	60	0.72	D
	Southbound	2,800	1,720	120	0.74	D
Pennant Hills Road, Hills M2 Motorway to Castle Hill Road	Northbound	4,200	3,380	240	0.97	E
	Southbound	4,200	2,670	370	0.87	E
Pennant Hills Road, Castle Hill Road to Beecroft Road	Northbound	4,200	2,360	520	0.67	D
	Southbound	4,200	2,130	310	0.72	D
Pennant Hills Road, Beecroft Road to Comenarra Parkway	Northbound	4,200	3,430	210	0.96	E
	Southbound	4,200	2,630	350	0.87	E
Pennant Hills Road, Comenarra Parkway to Pacific Highway	Northbound	4,200	2,710	200	0.78	D
	Southbound	4,200	2,670	340	0.68	D

Results presented in **Table 7-20** demonstrate that with the addition of construction traffic to background growth rates, anticipated impacts to mid-block performance under the southbound spoil disposal scenario are similar to those anticipated under the northbound spoil disposal scenario. Several sections of Pennant Hills Road are forecast to approach theoretical design capacity in 2016 under the 'with construction' southbound spoil disposal scenario, with volume / capacity ratios in excess of 0.90.

Under both the northbound and southbound spoil disposal scenarios, access and egress to and from construction areas along the Hills M2 Motorway during construction of the Hills M2 Motorway integration works would not impact on the mid-block operational performance of the road network.

Table 7-21 provides a summary of intersection performance results at key locations along Pennant Hills Road under forecast 2016 volumes for both the 'with construction' and 'without construction' southbound spoil disposal scenarios.

Table 7-21 Intersection performance (2016) with construction and without construction (southbound spoil disposal)

Peak	2016 without construction				2016 with construction			
	Light vehicles	Heavy vehicles	Average delay (s)	LoS	Light vehicles	Heavy vehicles	Average delay (s)	LoS
Pennant Hills Road / North Rocks Road								
AM peak	4,290	290	79.6	F	4,290	290	96.2	F
PM peak	4,680	190	>100	F	4,680	190	>100	F
Hills M2 Motorway / Pennant Hills Road interchange								
AM peak	5,590	620	45.0	D	5,610	780	49.5	D
PM peak	5,900	490	>100	F	5,930	650	>100	F
Pennant Hills Road / Copeland Road								
AM peak	5,500	590	>100	F	5,530	750	>100	F
PM peak	5,830	480	68.6	E	5,870	640	63.4	E
Pennant Hills Road / Aiken Road								
AM peak	5,140	570	37.2	C	5,180	720	29.3	C
PM peak	6,170	480	24.5	B	6,220	630	31.0	C
Pennant Hills Road / Castle Hill Road								
AM peak	4,790	560	12.9	A	4,830	690	13.9	A
PM peak	5,850	450	26.1	B	5,900	580	27.6	B
Pennant Hills Road / Beecroft Road (South)								
AM peak	5,240	480	60.4	E	5,300	620	78.4	F
PM peak	5,570	410	>100	F	6,630	550	>100	F
Pennant Hills Road / Beecroft Road (North)								
AM peak	6,260	500	68.6	E	6,330	630	>100	F
PM peak	5,940	420	12.5	A	6,030	550	16.8	B
Pennant Hills Road / Boundary Road								
AM peak	6,240	560	51.2	D	6,310	670	38.7	C
PM peak	6,490	480	34.5	C	6,580	590	33.5	C

Peak	2016 without construction				2016 with construction			
	Light vehicles	Heavy vehicles	Average delay (s)	LoS	Light vehicles	Heavy vehicles	Average delay (s)	LoS
Pennant Hills Road / Yarrara Road								
AM peak	5,620	560	39.5	C	5,690	670	48.7	D
PM peak	5,910	480	44.6	D	6,000	590	58.9	E
Pennant Hills Road / Comenarra Parkway								
AM peak	4,650	620	77.5	F	4,720	730	>100	F
PM peak	5,320	470	>100	F	5,410	580	>100	F
Pennant Hills Road / Phyllis Avenue / Loch Maree Avenue								
AM peak	3,940	620	21.8	B	4,030	750	23.3	B
PM peak	4,660	480	39.8	C	4,770	610	50.4	D
Pennant Hills Road / Duffy Road								
AM peak	3,530	590	>100	F	3,620	680	>100	F
PM peak	4,870	410	86.5	F	4,980	500	88.3	F
Pennant Hills Road / Dartford Road								
AM peak	3,350	570	>100	F	3,470	640	>100	F
PM peak	4,550	400	35.2	C	4,690	470	51.8	D
M1 Pacific Motorway / Pennant Hills Road								
AM peak	4,110	510	28.4	B	4,180	670	32.2	C
PM peak	4,580	400	36.6	C	4,660	560	76.4	F
Pennant Hills Road / Pacific Highway								
AM peak	2,940	190	77.6	F	2,990	300	77.1	F
PM peak	3,370	120	45.7	D	3,420	240	44.9	D
M1 Pacific Motorway / Pacific Highway interchange								
AM peak	4,520	260	43.7	D	4,530	270	72.4	F
PM peak	5,010	140	65.4	E	5,020	250	66.7	E

Results presented in **Table 7-21** show that under the 2016 'without construction' scenario, the majority of the Pennant Hills Road corridor is forecast to operate at or approaching practical capacity during the AM and PM peak periods.

Under the southbound spoil disposal scenario, the majority of the additional 300 construction vehicles per hour moving northbound / southbound on Pennant Hills Road would be transporting spoil southbound / westbound on the Hills M2 Motorway (PCU factor applied). As the north-south movement receives priority, some intersections are shown to absorb the increase in traffic volumes, continuing to operate at an acceptable level with only moderate increases in average delay.

However, in addition to those intersections already forecast to operate beyond capacity without construction traffic, modelling results indicate that the 'with construction' southbound spoil disposal scenario would see the following intersections deteriorate to level of service F as a result of construction traffic:

- Pennant Hills Road / Beecroft Road (South) (AM Peak - LoS E to LoS F).
- Pennant Hills Road / Beecroft Road (North) (AM Peak - LoS E to LoS F).
- Pennant Hills Road / M1 Pacific Motorway (PM Peak – LoS D to LoS F)
- M1 Pacific Motorway / Pacific Highway interchange (AM Peak - LoS D to LoS F).

The above intersection performance results represent a worst case scenario based on peak construction traffic movements and would not be representative of the level of service for the duration of the construction period.

Traffic delays and disruptions

Construction traffic along both the Hills M2 Motorway and the M1 Pacific Motorway may result in traffic delays and disruptions.

During construction of the integration and tie-in works, the existing lane capacity would generally be maintained, ie two general traffic lanes westbound on the Hills M2 Motorway and three general traffic lanes in each direction on the M1 Pacific Motorway. Road works may require temporary road closures, and these would be carried out in accordance with approvals by Roads and Maritime or other road authorities, as relevant, which are likely to stipulate that these works occur outside of peak traffic periods.

Reduced speed limits would also be required around construction areas. This may result in some minor increases to travel times under free flowing conditions, however this is not likely to affect peak period traffic when travel speeds are already lower.

Public transport, pedestrians and cyclists

An increase in heavy vehicles on the existing road network during the construction period would potentially result in increased delays at intersections along the project corridor and in surrounding areas. Heavy vehicle volumes would be likely to increase along Pennant Hills Road and surrounding major roads.

Under the ‘with construction’ scenario, the following impacts to bus services would be anticipated:

- The temporary closure of individual bus stops such as the bus stop on the northbound carriageway of Pennant Hills Road between the Hills M2 Motorway and Eaton Road. Consultation would be undertaken with bus service providers to identify appropriate alternative arrangements where bus stops are impacted.
- An increase in bus service travel times due to slower travel speeds and increased intersection delays.
- Longer travel times to and from bus stops by supplementary travel modes (eg car passenger, walking to / from bus stop, etc.) due to an increase in traffic volumes, slower travel speeds and increased intersection delays.

During construction of the Hills M2 Motorway integration works, the existing westbound bus lane would be utilised by general traffic to maintain two lane capacity along the motorway. Westbound buses would be required to use the general traffic lanes during the construction period. Westbound buses, which currently use the bus lane, would experience increased travel times due to travelling in general traffic at reduced speeds.

Rail services in the vicinity of the project and surrounding areas are not expected to be affected by construction of the project.

Under the ‘with construction’ scenario, cyclists may experience increased delays at intersections for on-road cyclists due to an increase in traffic volumes along the corridor. Cyclists may be diverted through or around construction sites and / or be required to dismount at certain locations in order to ensure their safety is not impacted by construction of the project.

Additionally, there would be no cyclist access to certain sections of the Hills M2 Motorway and the M1 Pacific Motorway during construction works. During the construction period, alternative cycle routes would be established. The alternative cycle route for the Hills M2 Motorway is likely to be consistent with the route recently utilised during the construction of the Hills M2 Motorway Upgrade project. The alternative cycle route for the M1 Pacific Motorway would be likely to use the Old Pacific Highway to Berowra.

Pedestrian access to the bushwalking track underneath the Darling Mills Creek viaduct (Murri-Yanna track) would be closed during the construction period to ensure the safety of the public. Despite this, options would be investigated to erect safety fencing and open the walking track on weekends or at other times when works are not actively occurring in the area. During times of closure, alternative routes would be identified and signage would be erected to alert the community to changes in access arrangements.

Emergency vehicles

Pennant Hills Road, the Hills M2 Motorway, the M1 Pacific Motorway and the surrounding local road network are currently used by emergency services travelling to and from call-outs. Construction of the project may require temporary traffic diversions, road occupation, temporary road closures and alternative property access arrangements. The construction traffic management plan(s) (TMP) for the project would be developed in consultation with relevant emergency services, ensuring that procedures are in place to maintain safe, priority access for emergency vehicles through construction zones. In addition, local emergency services would be periodically updated on the staging and progress of construction works. Further information on mitigation of impacts to emergency services is provided in **Section 7.1.5**.

Cumulative construction impacts

It is anticipated that construction of the project would be completed by the end of 2018. Based on this appreciation of construction timeframes, it is likely that construction of the project would occur concurrently with other major infrastructure projects in the region, namely:

- North West Rail Link.
- Epping to Thornleigh Third Track Project (ETTT).
- WestConnex – Stages 1 and 2.

As such, depending on the location of surface construction sites and haulage routes, there is potential for cumulative traffic impacts to arise from construction of these projects. These potential cumulative traffic impacts are summarised in **Table 7-22**.

Table 7-22 Potential cumulative construction traffic impacts

Project	Construction timeframe	Potential cumulative impact
North West Rail Link	• Excavation of Cheltenham and Epping tunnel shafts programmed for completion by mid-2015. • Major spoil removal activity for Cherrybrook Station site programmed for late 2014 to late 2015, with some minor station excavation activity programmed from late 2015 to early 2016[1].	While some station excavation activity at Cherrybrook is programmed from late 2015 to early 2016 this is not expected to be significant, with only six truck movements per hour (ie in and out) anticipated at this site. In the event that these vehicles were to also utilise Pennant Hills Road, these additional heavy vehicle movements above those required for the NorthConnex project not be significant. On this basis, the potential for significant cumulative impacts is negligible
Epping to Thornleigh Third Track project	Major civil works such as earthworks, spoil removal and structures are programmed for completion by the end of 2014, with highest heavy vehicle numbers occurring during the earthworks program[2].	While there is potential for overlap with the peak NorthConnex construction period during late 2015 and early 2016, it is unlikely to align with Epping to Thornleigh Third Track project peak period. The cumulative impacts are likely to relate to station works with an average of about six truck movements per hour (ie in and out) predicted for each of the three station sites (Cheltenham, Beecroft and

Project	Construction timeframe	Potential cumulative impact
		Pennant Hills), as well as installation of track, signalling and communications and overhead wires. It is therefore considered that while there may some cumulative impacts, these are likely to be short-term (2015-2016) and minor due to the relatively low heavy vehicle numbers currently predicted for the Epping to Thornleigh Third Track project.
WestConnex	• Stage 1 (M4 Motorway Widening and M4 East Motorway components): – Early 2015 to early 2017 for M4 Motorway Widening. – Mid-2016 to early 2019 for M4 East Motorway. • Stage 2 (M5 East Airport Link component): design and construction between mid-2016 and early 2020. • Stage 3 (M4 South component): detailed design and construction work between late 2018 and mid-2023[3].	There is potential for Stages 1 and 2 of WestConnex to overlap with the peak NorthConnex construction period between mid-2015 and early 2017. Limited information is currently available regarding the location of construction sites for the WestConnex project. However, due to the geographic location of WestConnex, it is considered unlikely that there would be an overlap of construction heavy vehicle routes between the two projects. As such there is unlikely to be a significant cumulative impact in the vicinity of the project.

[1] Thiess John Holland Dragados Joint Venture, 2013.

[2] Epping to Thornleigh Third Track Alliance, 2013.

[3] Roads and Maritime, 2014.

Construction traffic management

Appropriate controls would be implemented during the construction phase in order to reduce and manage the potential impacts associated with construction traffic. This would include:

- Scheduling of works and traffic movements outside of peak period where feasible and reasonable.
- Minimising road closures, especially during peak traffic periods.
- Maintaining property access or providing an alternative access in consultation with the property owner.

Traffic Management Plans and Traffic Control Plans would be developed in order to detail the site specific construction vehicle arrangements as well as the safe movement of motorists, cyclists and pedestrians around the construction sites. Additional measures would be considered during the development of Traffic Management Plans such as:

- The use of temporary traffic lights at heavy vehicle egress points.
- Siting heavy vehicle egress point where there are downhill grades where feasible and reasonable.
- Stipulating certain emissions standards (such as Euro 3) from heavy vehicles used as part of the project.
- The use of trucks with greater capacity to reduce the overall number of heavy vehicle movements.

Additional construction traffic mitigation measures are provided in **Section 7.1.5**.

Operation

As discussed in **Section 7.1.2**, Pennant Hills Road currently operates as an arterial link between the Hills M2 Motorway and the M1 Pacific Motorway, carrying large volumes of traffic comprising a high proportion of heavy vehicles. Congestion is experienced during peak periods and most key intersections along Pennant Hills Road are currently operating beyond practical capacity (refer to **Section 7.1.2**). If no alterations are made, deterioration of network performance, peak hour travel time and speed along Pennant Hills Road is predicted under forecast traffic volumes for 2019 and 2029. Due to its connecting role within the National Road Network, such deterioration in performance has adverse, undesirable implications for inter-regional traffic movements and freight efficiency.

Once operational, the project would provide an alternative route for travel between the M1 Pacific Motorway and the Hills M2 Motorway. In line with project objectives (refer to **Section 3.4**), the provision of this alternative route would assist with, the reduction of traffic congestion along Pennant Hills Road and the surrounding road network, improving performance, shortening travel times for road users and provide opportunities for improved public transport. Of particular importance is the provision of a high standard motorway alternative for freight vehicles. By encouraging the transfer of freight traffic underground, the project would contribute towards reducing the number of heavy vehicles that currently travel on Pennant Hills Road. In turn, improvements in travel conditions and local amenity are predicted for all road users including motorists, cyclists and pedestrians.

Light vehicles using the tunnels exhibit peak hour travel patterns, with the main movement being north bound in the PM peak and south bound in the AM peak. Northbound light vehicle numbers in the PM peak are anticipated to be around 900 per hour at opening, growing to 1,250 per hour by 2029. Southbound light vehicle numbers in the AM peak are anticipated to be around 830 per hour at opening, growing to 1,180 per hour by 2029. Heavy vehicles do not exhibit the same peak hour travel patterns. In 2019, there would be around 210 to 350 vehicles per hour in each direction, growing to 240 to 410 vehicles per hour in 2029.

The predicted origin and destination of AWDT traffic volumes in and out of the southern portal of the tunnel are presented in **Table 7-23**. These are broadly similar to the existing origin and destination pattern for Pennant Hills Road without the project.

Table 7-23 Origin and destination of 2019 and 2029 tunnel AWDT volumes

NorthConnex Tunnel	Two-way AWDT 2019 (vehicles per day)	Two-way AWDT 2029 (vehicles per day)
West (Hills M2 Motorway, west of Pennant Hills Road)	9,991	14,547
South (Pennant Hills Road, south of Hills M2 Motorway)	17,791	21,087
East (Hills M2 Motorway, east of Pennant Hills Road)	2,173	4,013

In addition to the provision of the main alignment tunnels, the project would alter existing roads at both the northern and southern interchanges. This is likely to involve the addition of new movements and alteration of timing of traffic lights at existing intersections, which may result in deterioration of individual movement performance. Permanent alterations to pedestrian movements and existing property accesses may also be required (refer to **Section 5.2.15**).

As discussed in **Section 7.1.1**, the operational performance of the project has been assessed under the 'with project' scenario at the project opening year (2019) and ten years after opening (2029). This assessment involved the comparison of 2019 and 2029 traffic volumes forecast under the 'without project' scenario against those forecast under the 'with project' scenario. Traffic volumes forecast under the 'with project' scenario were provided from the strategic Sydney traffic model. Generally, growth along the Pennant Hills Road corridor under the 'with project' scenario is shown to be lower than growth forecast under the 'without project' scenario, due to the transfer of traffic to the completed main alignment tunnels.

Network performance

Table 7-24 presents peak hour mid-block traffic volumes and level of service under the 'with project' scenario for 2019 and 2029. When compared to mid-block performance in 2019 and 2029 under the 'without project' scenario (shown in **Table 7-25**), performance under the 'with project' scenario is generally shown to improve. This is due to the anticipated reduction in forecast traffic along Pennant Hills Road and a shift of this traffic into the main alignment tunnels. The slight improvements on the Hills M2 Motorway under the 'with project' scenario are attributable to the increased capacity associated with the integration works. The forecast of mid-block traffic volumes and level of service for the main alignment tunnels for 2019 and 2029 are shown in **Table 7-26**. The forecast shows that the tunnel would continue to perform well with increased vehicle numbers.

Table 7-27 provides a summary of peak hour performance (level of service) at key intersections along the Pennant Hills Road corridor under the 'with project' scenario for 2019 and 2029. When compared to intersection performance in 2019 and 2029 under the 'without project' scenario (refer to **Table 7-28**), performance under the 'with project' scenario is generally shown to improve.

Some key intersections are shown to experience significant congestion during one or both of the AM and PM peak periods in 2019, irrespective of the project. Similarly, performance results for 2029 demonstrate that most key intersections would experience significant congestion during one or both of the AM and PM peak periods, irrespective of the project as a result of background traffic growth. Once intersection demand exceeds capacity, results for average delay increase substantially. While the project would result in general improvements at these locations, it would not resolve longer term congestion entirely. The need to undertake additional works from time to time to address longer term congestion across the major network is subject to separate consideration by Roads and Maritime in its road network planning and management roles.

Where there is a reduction in the level of service of intersections around the northern interchange, opportunities to minimise these impacts would be investigated during detailed design.

Table 7-24 Mid-block traffic volumes and LoS (2019 and 2029) with project

Road	Location	Direction	Mid-block capacity	2019 Light vehicles	2019 Heavy vehicles	2019 V/C	2019 LoS	2029 Light vehicles	2029 Heavy vehicles	2029 V/C	2029 LoS
AM peak											
Pennant Hills Road	North Rocks Road to the Hills M2 Motorway interchange	Northbound	2,800	1,610	160	0.74	D	1,900	190	0.88	E
		Southbound	2,800	2,240	150	0.96	E	2,560	190	1.11	F
Pennant Hills Road	Hills M2 Motorway interchange to Castle Hill Road	Northbound	4,200	2,140	190	0.64	D	2,220	240	0.69	D
		Southbound	4,200	2,990	90	0.77	D	3,490	150	0.93	E
Pennant Hills Road	Castle Hill Road to Beecroft Road	Northbound	4,200	2,470	140	0.68	D	2,570	170	0.73	D
		Southbound	4,200	2,080	70	0.55	C	2,230	100	0.60	D
Pennant Hills Road	Beecroft Road to Comenarra Parkway	Northbound	4,200	3,260	170	0.90	E	3,470	250	1.00	E
		Southbound	4,200	3,130	110	0.82	E	3,620	90	0.92	E
Pennant Hills Road	Comenarra Parkway to Pacific Highway	Northbound	4,200	2,100	140	0.60	D	2,310	180	0.67	D
		Southbound	4,200	2,100	70	0.55	C	2,430	120	0.66	D
Pacific Highway	North of Pennant Hills Road	Northbound	2,800	1340	80	0.56	C	1,500	90	0.63	D
		Southbound	4,200	920	80	0.27	B	1,050	90	0.31	B
Pacific Highway	East of the M1 Pacific Motorway	Northbound	4,200	1,730	160	0.52	C	1,950	220	0.62	D
		Southbound	4,200	2,900	160	0.80	D	3,190	200	0.90	E
Hills M2 Motorway	West of the Pennant Hills Road interchange	Eastbound	6,900	4,090	460	0.79	D	4,970	470	0.92	E
		Westbound	6,900	2,760	270	0.51	C	3,170	340	0.60	C
Hills M2 Motorway	East of the Pennant Hills Road interchange	Eastbound	6,900	3,960	320	0.71	D	4,540	290	0.78	D
		Westbound	6,900	2,080	110	0.35	B	2,020	140	0.35	B

Road	Location	Direction	Mid-block capacity	2019				2029			
				Light vehicles	Heavy vehicles	V/C	LoS	Light vehicles	Heavy vehicles	V/C	LoS
PM peak											
Pennant Hills Road	North Rocks Road to the Hills M2 Motorway interchange	Northbound	2,800	1,620	140	0.73	D	2,020	130	0.86	E
		Southbound	2,800	1,730	160	0.79	D	2,340	190	1.03	F
Pennant Hills Road	Hills M2 Motorway interchange to Castle Hill Road	Northbound	4,200	3,420	70	0.86	E	3,720	120	0.97	E
		Southbound	4,200	2,660	170	0.75	D	2,950	190	0.84	E
Pennant Hills Road	Castle Hill Road to Beecroft Road	Northbound	4,200	2,170	20	0.53	C	2,290	60	0.58	C
		Southbound	4,200	2,090	130	0.59	C	2,270	200	0.68	D
Pennant Hills Road	Beecroft Road to Comenarra Parkway	Northbound	4,200	3,530	30	0.86	E	3,870	60	0.97	E
		Southbound	4,200	2,480	120	0.67	D	2,620	190	0.76	D
Pennant Hills Road	Comenarra Parkway to Pacific Highway	Northbound	4,200	2,650	110	0.71	D	2,940	140	0.80	D
		Southbound	4,200	1,750	80	0.47	C	1,880	150	0.55	C
Pacific Highway	North of Pennant Hills Road	Northbound	2,800	1,280	80	0.54	C	1,400	100	0.60	D
		Southbound	4,200	1,360	50	0.36	B	1,500	60	0.40	B
Pacific Highway	East of the M1 Pacific Motorway	Northbound	4,200	2,970	80	0.76	D	3,200	90	0.82	E
		Southbound	4,200	1,880	100	0.52	C	1,990	120	0.56	C
Hills M2 Motorway	West of the Pennant Hills Road interchange	Eastbound	6,900	3,300	350	0.63	C	3,930	470	0.77	D
		Westbound	6,900	4,700	480	0.88	D	5,480	500	1.00	F
Hills M2 Motorway	East of the Pennant Hills Road interchange	Eastbound	6,900	2,360	150	0.41	C	2,640	210	0.47	C
		Westbound	6,900	4,540	280	0.78	D	5,320	390	0.93	E

Table 7-25 Comparison of mid-block traffic volumes and LoS (2019 and 2029) 'with project' and 'without project'

Road	Location	Direction	2019 without		2019 with		2029 without		2029 with	
			V/C	LoS	V/C	LoS	V/C	LoS	V/C	LoS
AM peak										
Pennant Hills Road	North Rocks Road to the Hills M2 Motorway interchange	Northbound	0.76	D	0.74	D	0.90	E	0.88	E
		Southbound	0.96	E	0.96	E	1.19	F	1.11	F
Pennant Hills Road	Hills M2 Motorway interchange to Castle Hill Road	Northbound	0.80	D	0.64	D	0.86	E	0.69	D
		Southbound	0.94	E	0.77	D	1.09	F	0.93	E
Pennant Hills Road	Castle Hill Road to Beecroft Road	Northbound	0.81	E	0.68	D	0.88	E	0.73	D
		Southbound	0.67	D	0.55	C	0.74	D	0.60	D
Pennant Hills Road	Beecroft Road to Comenarra Parkway	Northbound	1.05	F	0.90	E	1.19	F	1.00	E
		Southbound	0.95	E	0.82	E	1.13	F	0.92	E
Pennant Hills Road	Comenarra Parkway to Pacific Highway	Northbound	0.71	D	0.60	D	0.78	D	0.67	D
		Southbound	0.75	D	0.55	C	0.85	E	0.66	D
Pacific Highway	North of Pennant Hills Road	Northbound	0.63	D	0.56	C	0.64	D	0.63	D
		Southbound	0.33	B	0.27	B	0.35	B	0.31	B
Pacific Highway	East of the M1 Pacific Motorway	Northbound	0.46	C	0.52	C	0.54	C	0.62	D
		Southbound	0.83	E	0.80	D	0.86	E	0.90	E
Hills M2 Motorway	West of the Pennant Hills Road interchange	Eastbound	0.82	D	0.79	D	0.92	E	0.92	E
		Westbound	0.76	D	0.51	C	0.88	D	0.60	C
Hills M2 Motorway	East of the Pennant Hills Road interchange	Eastbound	0.75	D	0.71	D	0.80	D	0.78	D
		Westbound	0.37	B	0.35	B	0.39	B	0.35	B

Road	Location	Direction	2019 without		2019 with		2029 without		2029 with	
			V/C	LoS	V/C	LoS	V/C	LoS	V/C	LoS
PM Peak										
Pennant Hills Road	North Rocks Road to the Hills M2 Motorway interchange	Northbound	0.80	D	0.73	D	0.93	E	0.86	E
		Southbound	0.86	E	0.79	D	1.04	F	1.03	F
Pennant Hills Road	Hills M2 Motorway interchange to Castle Hill Road	Northbound	1.00	E	0.86	E	1.13	F	0.97	E
		Southbound	0.92	E	0.75	D	1.05	F	0.84	E
Pennant Hills Road	Castle Hill Road to Beecroft Road	Northbound	0.69	D	0.53	C	0.73	D	0.58	C
		Southbound	0.73	D	0.59	C	0.80	D	0.68	D
Pennant Hills Road	Beecroft Road to Comenarra Parkway	Northbound	1.00	F	0.86	E	1.14	F	0.97	E
		Southbound	0.90	E	0.67	D	1.00	E	0.76	D
Pennant Hills Road	Comenarra Parkway to Pacific Highway	Northbound	0.81	D	0.71	D	0.90	E	0.80	D
		Southbound	0.92	E	0.47	C	1.05	F	0.55	C
Pacific Highway	North of Pennant Hills Road	Northbound	0.50	C	0.54	C	0.58	C	0.60	D
		Southbound	0.44	C	0.36	B	0.50	C	0.40	B
Pacific Highway	East of the M1 Pacific Motorway	Northbound	0.78	D	0.76	D	0.85	E	0.82	E
		Southbound	0.47	C	0.52	C	0.53	C	0.56	C
Hills M2 Motorway	West of the Pennant Hills Road interchange	Eastbound	0.58	C	0.63	C	0.66	C	0.77	D
		Westbound	1.18	F	0.88	D	1.29	F	1.00	F
Hills M2 Motorway	East of the Pennant Hills Road interchange	Eastbound	0.46	C	0.41	C	0.50	C	0.47	C
		Westbound	0.76	D	0.78	D	0.82	D	0.93	E

Table 7-26 Mid-block traffic volumes and LoS for the main alignment tunnels

Period	Direction	Mid-block capacity	Light vehicles	Heavy vehicles	V/C	LoS
AM peak hour						
2019	Northbound	4,000	530	210	0.28	A
	Southbound	4,000	830	330	0.45	B
2029	Northbound	4,000	740	240	0.36	B
	Southbound	4,000	1,160	380	0.57	C
PM peak hour						
2019	Northbound	4,000	900	350	0.48	B
	Southbound	4,000	690	270	0.37	B
2029	Northbound	4,000	1,250	410	0.61	C
	Southbound	4,000	950	320	0.47	B

Table 7-27 Intersection performance (2019 and 2029) with project

Peak	2019				2029			
	Light vehicles	Heavy vehicles	Average delay (s)	LoS	Light vehicles	Heavy vehicles	Average delay (s)	LoS
Pennant Hills Road / North Rocks Road								
AM peak	4,780	370	>100	F	5,370	430	>100	F
PM peak	4,820	350	>100	F	5,680	360	>100	F
Hills M2 Motorway / Pennant Hills Road interchange								
AM peak	4,880	340	39.5	C	5,700	450	84.8	F
PM peak	5,240	270	68.8	E	6,140	350	>100	F
Pennant Hills Road / Copeland Road								
AM peak	5,080	330	>100	F	5,820	460	>100	F
PM peak	5,580	270	38.3	C	6,320	340	>100	F
Pennant Hills Road / Aiken Road								
AM peak	5,100	300	>100	F	5,720	420	>100	F
PM peak	6,100	250	17.2	B	6,850	310	45.3	D
Pennant Hills Road / Castle Hill Road								
AM peak	4,910	320	38.5	C	5,220	410	61.0	E
PM peak	5,930	220	82.3	F	6,410	360	>100	F
Pennant Hills Road / Beecroft Road (South)								
AM peak	5,270	280	34.1	C	5,790	360	>100	F
PM peak	5,610	150	84.4	F	6,090	270	>100	F
Pennant Hills Road / Beecroft Road (North)								
AM peak	6,400	300	42.1	C	7,090	360	86.7	F
PM peak	6,010	160	11.0	A	6,490	280	11.8	A
Pennant Hills Road / Boundary Road								
AM peak	6,430	370	61.6	E	7,080	410	66.4	E
PM peak	6,660	210	32.8	C	7,210	340	37.6	C

Peak	2019				2029			
	Light vehicles	Heavy vehicles	Average delay (s)	LoS	Light vehicles	Heavy vehicles	Average delay (s)	LoS
Pennant Hills Road / Yarrara Road								
AM peak	5,690	260	29.8	C	6,270	360	66.9	E
PM peak	6,060	170	34.6	C	6,440	280	66.8	E
Pennant Hills Road / Comenarra Parkway								
AM peak	4,680	320	44.4	D	5,300	440	>100	F
PM peak	5,200	150	47.2	D	5,720	200	71.8	F
M1 Pacific Motorway / Pennant Hills Road								
AM peak	4,700	340	71.9	F	5,420	440	>100	F
PM peak	4,640	270	29.4	C	5,420	390	93.5	F
Pennant Hills Road / Pacific Highway								
AM peak	3,450	330	41.6	C	4,160	410	>100	F
PM peak	3,480	200	34.3	C	4,060	280	93.4	F
M1 Pacific Motorway / Pacific Highway interchange								
AM peak	4,900	370	55.6	D	5,610	490	>100	F
PM peak	5,130	200	>100	F	5,500	240	>100	F

Table 7-28 Comparison of intersection performance (2019 and 2029) 'with project' and 'without project'

Peak	2019 without Average delay (s)	LoS	2019 with Average delay (s)	LoS	2029 without Average delay (s)	LoS	2029 with Average delay (s)	LoS
Pennant Hills Road / North Rocks Road								
AM peak	>100	F	>100	F	>100	F	>100	F
PM peak	>100	F	>100	F	>100	F	>100	F
Hills M2 Motorway / Pennant Hills Road								
AM peak	51.4	D	39.5	C	>100	F	84.8	F
PM peak	>100	F	68.8	E	>100	F	>100	F
Pennant Hills Road / Copeland Road								
AM peak	>100	F	>100	F	>100	F	>100	F
PM peak	>100	F	38.3	C	>100	F	>100	F
Pennant Hills Road / Aiken Road								
AM peak	63.9	E	>100	F	>100	F	>100	F
PM peak	27.8	B	17.2	B	61.9	E	45.3	D
Pennant Hills Road / Castle Hill Road								
AM peak	18.7	B	38.5	C	>100	F	61.0	E
PM peak	95.5	F	82.3	F	>100	F	>100	F
Pennant Hills Road / Beecroft Road (South)								
AM peak	>100	F	34.1	C	>100	F	>100	F
PM peak	>100	F	84.4	F	>100	F	>100	F
Pennant Hills Road / Beecroft Road (North)								
AM peak	>100	F	42.1	C	>100	F	86.7	F
PM peak	16.3	B	11.0	A	51.0	D	11.8	A

Peak	2019 without Average delay (s)	LoS	2019 with Average delay (s)	LoS	2029 without Average delay (s)	LoS	2029 with Average delay (s)	LoS
Pennant Hills Road / Boundary Road								
AM peak	63.2	E	61.6	E	>100	F	66.4	E
PM peak	41.1	C	32.8	C	72.7	F	37.6	C
Pennant Hills Road / Yarrara Road								
AM peak	>100	F	29.8	C	>100	F	66.9	E
PM peak	>100	F	34.6	C	>100	F	66.8	E
Pennant Hills Road / Comenarra Parkway								
AM peak	>100	F	44.4	D	>100	F	>100	F
PM peak	>100	F	47.2	D	>100	F	71.8	F
M1 Pacific Motorway / Pennant Hills Road								
AM peak	45.5	D	71.9	F	>100	F	>100	F
PM peak	79.5	F	29.4	C	>100	F	93.5	F
Pennant Hills Road / Pacific Highway								
AM peak	>100	F	41.6	C	>100	F	>100	F
PM peak	53.2	D	34.3	C	>100	F	93.4	F
M1 Pacific Motorway / Pacific Highway								
AM peak	94.5	F	55.6	D	>100	F	>100	F
PM peak	69.1	E	>100	F	>100	F	>100	F

Broader network performance

A strategic traffic forecast across key components of the broader Sydney network has also been undertaken for areas where the project may result in changes, including further north along the M1 Pacific Motorway, the Westlink M7 Motorway and a number of key arterial roads. The results for the M1 Pacific Motorway and the Westlink M7 Motorway with and without the project for 2019 and 2029 are presented in the tables below. Results for a range of arterial roads are provided in the technical working paper: traffic and transport (**Appendix E)**.

Anticipated peak hour traffic volumes on the M1 Pacific Motorway, between the Ku-ring-gai Interchange and the Windy Banks interchange, in the 2019 and 2029 'with project' scenario are presented in **Table 7-29**.

Table 7-29 Comparison of peak hour traffic volumes (2019 and 2029 'without project' and 'with project') – M1 Pacific Motorway

Direction	Light vehicles				Heavy vehicles			
	2019		2029		2019		2029	
	without	with	without	with	without	with	without	with
AM Peak Hour								
Northbound	1,580	1,550	1,610	1,610	270	270	320	320
Southbound	3,920	3,860	4,620	4,620	290	300	360	360
PM Peak Hour								
Northbound	4,060	3,960	4,580	4,580	270	280	340	340
Southbound	2,000	1,980	2,030	2,030	230	250	310	310

A comparison of the mid-block levels of service on the M1 Pacific Motorway, between the Ku-Ring-Gai Interchange and the Windy Banks Interchange, under the 'without project' and 'with project' scenarios are provided for 2019 and 2029 in **Table 7-30** and **Table 7-31**. The data in the tables demonstrates that the project would not affect the volume / capacity or the level of service on the M1 Pacific Motorway between the Ku-Ring-Gai Interchange and the Windy Banks Interchange in either 2019 or 2029, beyond what is expected to occur in the absence of the project.

Table 7-30 Mid-block traffic volumes and LoS (2019 'without project' and 'with project') – M1 Pacific Motorway

Direction	Mid-block capacity	2019 – without project				2019 – with project			
		Light vehicles	Heavy vehicles	V/C	LoS	Light vehicles	Heavy vehicles	V/C	LoS
AM peak hour									
Northbound	6,900	1,580	270	0.34	B	1,550	270	0.34	B
Southbound	6,900	3,920	290	0.69	C	3,860	300	0.68	C
PM peak hour									
Northbound	6,900	4,060	270	0.70	D	3,960	280	0.69	C
Southbound	6,900	2,000	230	0.38	B	1,980	250	0.39	B

Table 7-31 Mid-block traffic volumes and LoS (2029 'without project' and 'with project') – M1 Pacific Motorway

Direction	Mid-block capacity	2029 – without project				2029 – with project			
		Light vehicles	Heavy vehicles	V/C	LoS	Light vehicles	Heavy vehicles	V/C	LoS
AM peak hour									
Northbound	6,900	1,610	320	0.37	B	1,610	320	0.37	B
Southbound	6,900	4,620	360	0.82	D	4,620	360	0.82	D
PM peak hour									
Northbound	6,900	4,580	340	0.81	D	4,580	340	0.81	D
Southbound	6,900	2,030	310	0.42	B	2,030	310	0.42	B

Anticipated peak hour traffic volumes on two sections of the Westlink M7 Motorway in the 2019 and 2029 'with project' scenarios are presented, for light vehicles in **Table 7-32** and for heavy vehicles in **Table 7-33**.

Table 7-32 Comparison of peak hour light vehicle volumes (2019 and 2029 'without project' and 'with project') – Westlink M7 Motorway

Location	Direction	Light vehicles			
		2019 without	2019 with	2029 without	2029 with
AM peak hour					
Old Windsor Road to Hills M2 Motorway	Eastbound	1,760	1,790	2,350	2,510
	Westbound	1,580	1,580	1,800	1,900
The Horsley Drive to Old Wallgrove Road	Northbound	3,260	2,770	3,560	3,500
	Southbound	2,680	2,910	3,270	3,700
PM peak hour					
Old Windsor Road to Hills M2 Motorway	Eastbound	1,910	1,990	2,090	2,360
	Westbound	2,890	2,950	3,440	3,760
The Horsley Drive to Old Wallgrove Road	Northbound	3,350	3,480	3,880	4,440
	Southbound	3,340	3,370	3,570	3,960

Table 7-33 Comparison of peak hour heavy vehicle volumes (2019 and 2029 'without project' and 'with project') – Westlink M7 Motorway

Location	Direction	Heavy vehicles			
		2019 without	2019 with	2029 without	2029 with
AM peak hour					
Old Windsor Road to Hills M2 Motorway	Eastbound	180	110	230	90
	Westbound	200	170	250	160
The Horsley Drive to Old Wallgrove Road	Northbound	730	270	720	280
	Southbound	460	610	510	560
PM peak hour					
Old Windsor Road to Hills M2 Motorway	Eastbound	200	170	260	230
	Westbound	270	220	300	220
The Horsley Drive to Old Wallgrove Road	Northbound	540	310	560	290
	Southbound	490	300	500	280

A comparison of the mid-block level of service on two representative sections of the Westlink M7 Motorway under the 'without project' and 'with project' scenarios in 2019 and 2029 are provided in **Table 7-34** and **Table 7-35**. The data in the tables demonstrates that the project would:

- In 2019:
  - Improve the volume / capacity ratio and level of service eastbound between Old Windsor Road and the Hills M2 Motorway in the AM peak.
  - Improve the volume / capacity ratio and level of service northbound between The Horsley Drive and Old Wallgrove Road in the AM and PM peaks.
  - Improve the volume / capacity ratio and level of service southbound between The Horsley Drive and Old Wallgrove Road in the PM peak.
  - Reduce the volume / capacity ratio and level of service southbound between The Horsley Drive and Old Wallgrove Road in the AM peak.
- In 2029:
  - Slightly improve the volume / capacity ratio eastbound and westbound between Old Windsor Road and the Hills M2 Motorway in the AM peak.
  - Improve the volume / capacity ratio and level of service northbound between The Horsley Drive and Old Wallgrove Road in the AM peak.
  - Slightly reduce the volume / capacity ratio southbound between The Horsley Drive and Old Wallgrove Road in the AM peak.

Table 7-34 Mid-block traffic volumes and LoS (2019 'without project' and 'with project') – Westlink M7 Motorway

Location	Direction	Mid-block capacity	2019 – without project				2019 – with project			
			Light vehicles	Heavy vehicles	V/C	LoS	Light vehicles	Heavy vehicles	V/C	LoS
AM Peak Hour										
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	1,760	180	0.50	C	1,790	110	0.46	B
	Westbound	4,600	1,580	200	0.47	B	1,580	170	0.45	B
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,260	730	1.17	F	2,770	270	0.77	D
	Southbound	4,600	2,680	460	0.88	D	2,910	610	1.02	F
PM Peak Hour										
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	1,910	200	0.55	C	1,990	170	0.54	C
	Westbound	4,600	2,890	270	0.80	D	2,950	220	0.78	D
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,350	540	1.07	F	3,480	310	0.95	E
	Southbound	4,600	3,340	490	1.04	F	3,370	300	0.93	E

Table 7-35 Mid-block traffic volumes and LoS (2029 'without project' and 'with project') – Westlink M7 Motorway

Location	Direction	Mid-block capacity	2029 – without project				2029 – with project			
			Light vehicles	Heavy vehicles	V/C	LoS	Light vehicles	Heavy vehicles	V/C	LoS
AM peak hour										
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	2,350	230	0.66	C	2,510	90	0.60	C
	Westbound	4,600	1,800	250	0.55	C	1,900	160	0.52	C
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,560	720	1.23	F	3,500	280	0.94	E
	Southbound	4,600	3,270	510	1.04	F	3,700	560	1.16	F
PM peak hour										
Old Windsor Road to Hills M2 Motorway	Eastbound	4,600	2,090	260	0.62	C	2,360	230	0.66	C
	Westbound	4,600	3,440	300	0.94	E	3,760	220	0.96	E
The Horsley Drive to Old Wallgrove Road	Northbound	4,600	3,880	560	1.20	F	4,440	290	1.15	F
	Southbound	4,600	3,570	500	1.10	F	3,960	280	1.04	F

Travel times

Average travel times in 2019 and 2029 along Pennant Hills Road between the Hills M2 Motorway and the M1 Pacific Motorway, a distance of around eight kilometres, are presented in **Table 7-36**. 2013 travel times are also presented for comparison. These figures show a general reduction in average peak hour travel time along Pennant Hills Road in 2019 and 2029 under the 'with project' scenario. With the project, a northbound journey along Pennant Hills Road during the PM peak in 2029 is forecast to take 21 minutes less than it would take under the 'without project' scenario.

Table 7-36 Comparison of average travel times along Pennant Hills Road (2019 and 2029)

Direction	Average travel time (minutes)				
	2013	2019 Without project	2019 With project	2029 Without project	2029 With project
AM peak					
Northbound	14	16	13	18	15
Southbound	18	27	20	39	30
PM peak					
Northbound	19	31	18	46	25
Southbound	13	16	13	19	14

Estimated travel times for motorists using the completed main alignment tunnels have been modelled to provide an indication of how the project would perform in 2019 and 2029. In both 2019 and 2029, the average time taken to travel along the length of the completed main alignment tunnels during the AM and PM peaks is anticipated to be six minutes in the northbound direction and five minutes in the southbound direction. Anticipated travel times in the tunnel for the years 2019 and 2029 have been compared to anticipated travel times on Pennant Hills Road without the project in **Table 7-37**. This shows that the project would offer a maximum travel time saving of up to 40 minutes in 2029 (in the northbound direction in the PM peak) over a situation where the project is not built.

Table 7-37 Comparison of average travel times along Pennant Hills Road (2019 and 2029)

Direction	Average travel time (minutes)				
	2013	2019 Pennant Hills Road without project	2019 Tunnel with project	2029 Pennant Hills Road without project	2029 Tunnel with project
AM peak					
Northbound	14	16	6	18	6
Southbound	18	27	5	39	5
PM peak					
Northbound	19	31	6	46	6
Southbound	13	16	5	19	5

Travel times between the tunnel and Pennant Hills Road with the project have also been compared. The completed project would offer travel time savings of about six to 15 minutes in 2019 and nine to 25 minutes in 2029 when compared to Pennant Hills Road. This travel time saving would be of benefit to all motorists, particularly commuters, commercial vehicles and freight vehicles.

Compared to Pennant Hills Road, the Pacific Highway is also predicted to experience a benefit from the project, but slightly less in terms of improvements in travel time. In 2019 under the 'with project' scenario, northbound PM peak travel along the Pacific Highway between the M1 Pacific Motorway and the Ryde Road / Mona Vale Road interchange, a distance of 5.4 kilometres, is anticipated to take four minutes less than it would under the 'without project' scenario. By 2029 under the 'with project' scenario, the same northbound PM peak journey is anticipated to take five minutes less than it would under the 'without project' scenario.

Results for the Hills M2 Motorway between Pennant Hills Road and Windsor Road indicate that most movements would remain largely unchanged in 2019 and 2029 under the 'with project' scenario, with the exception of improvements in the westbound PM peak. Under the 'with project' scenario, time taken to travel westbound along this stretch of the Hills M2 Motorway during the PM peak would decrease by 13 minutes in 2019 and by 24 minutes in 2029, compared to times under the 'without project' scenario.

Road safety

As discussed in **Section 3.4**, one of the key objectives of the project is to provide a high standard motorway that is safe and reliable for road users. In line with current motorway standards, this would include provision of grade separated interchanges and physically separated carriageways. Further, the project would provide wider lanes and an improved alignment when compared to Pennant Hills Road.

A comparison of the recent crash history for the Hills M2 Motorway against that of Pennant Hills Road demonstrates the relative safety benefits of motorway standard roads, being significantly lower crash frequencies and lower associated costs per kilometre travelled (refer to **Section 7.1.2**). Given that the project would provide a level of safety at least consistent with typical motorway conditions, and assuming that data analysed for the Hills M2 Motorway is demonstrative of these conditions, the project would provide an alternative route to Pennant Hills Road that has a significantly higher level of safety.

Table 7-38 presents projected crash statistics for 2029, based on historic crash rates and the assumption that incidents on the project would occur at the same rates as on the Hills M2 Motorway.

Table 7-38 Projected crash statistics (2029)

Route	Crash rate per 100MVKM			Cost per 100MVKM
	Total	Fatal	Injury	
The project				
Northern interchange to southern interchange	23.0	0.0	9.6	$3,483,600
Pennant Hills Road				
Hills M2 Motorway to Pacific Highway	201.4	0.2	70.5	$14,651,200
Combined project area				
The project and Pennant Hills Road combined	224.4	0.2	80.1	$10,712,100

(Source: Roads and Maritime Crash Data, TfNSW Centre for Road Safety Data, and Roads and Maritime Economic Analysis Manual (Economic parameters for 2009))

The project would be expected to have a significantly lower frequency of crashes (and corresponding lower crash costs per kilometre travelled) compared to Pennant Hills Road. Traffic using the project as an alternative to Pennant Hills Road would be four times less likely to be involved in an injury crash, and about five times less likely to be involved in a crash of any type.

In addition, the anticipated transfer of traffic from Pennant Hills Road to the project would reduce congestion and intersection conflicts along Pennant Hills Road. As such, the project is expected to reduce the frequency and cost of crashes occurring on Pennant Hills Road when compared to future conditions without the project. Similarly, transfer of traffic onto the Hills M2 Motorway as a result of the project is anticipated to improve the level of safety of nearby arterial roads.

Public transport, pedestrians and cyclists

Predicted improvements in performance along Pennant Hills Road under the 'with project' scenario are anticipated to result in the following improvements to bus services.

- Higher travel speeds and reduced intersection delays along Pennant Hills Road would result in improved bus travel times.
- Delays to services caused by traffic incidents and congestion would be reduced as a result of a decrease in the frequency of traffic crashes and reduced congestion along Pennant Hills Road.
- Reduced potential for crashes caused by buses stopping on Pennant Hills Road.
- Travel times to and from bus stops in the surrounding area by supplementary travel modes (car, walking and cycling) would be shortened, due to reduced congestion along Pennant Hills Road.
- Improved amenity and pedestrian safety for bus users waiting at stops on Pennant Hills Road.

On completion of the Hills M2 Motorway integration works, the existing westbound bus lane would be returned to exclusive use by bus services. Bus travel times are anticipated to be consistent with existing conditions as there would be no change to the capacity available within the dedicated bus lane.

Shorter travel times for rail passengers travelling to and from Beecroft, Pennant Hills, Thornleigh and Normanhurst Railway Stations are anticipated as a result of reduced traffic volumes (and associated travel delays) on the road network within the vicinity of the project.

Under the 'with project' scenario, cyclists may experience the following benefits:

- Reduced delays for on road cyclists at intersections along Pennant Hills Road.
- Improved cyclist safety (reduced potential for crashes with other road users) as a result of lower traffic volumes, particularly lower volumes of heavy vehicles. However, the project is not anticipated to generate additional cycling trips on Pennant Hills Road.
- Improved amenity for cyclists.

On completion of the project, cycle access would be restored to the breakdown lane on the Hills M2 Motorway and the M1 Pacific Motorway. In addition, pedestrian facilities would be reopened to the public following completion of works associated with the Darling Mills Creek viaduct.

Pedestrians within the vicinity of the project may experience improvements in overall amenity due to lower volumes of traffic and associated improvements in air quality, reduced noise, and enhanced pedestrian safety.

Public transport opportunities

A number of public transport services currently operate along the Pennant Hills Road corridor. Numerous bus services operate along Pennant Hills Road in between the M1 Pacific Motorway and Hills M2 Motorway, with frequent services operating during peak hours. The corridor is serviced by the high-frequency, high-capacity metrobus service M60, as well as numerous services connecting the corridor to the central business district, Castle Hill and Dural.

The Northern Railway Line stations at Pennant Hills, Thornleigh and Normanhurst are also located along the corridor. North West Rail Link, although close in proximity to the Pennant Hills Road corridor, is expected to service a separate catchment area. As a result, strong demand for integrated bus and rail services along Pennant Hills Roads will continue beyond the delivery of the North West Rail Link in 2019.

The project is expected to attract through-traffic away from Pennant Hills Road and into the tunnels, including a large number of heavy vehicles. This is expected to reduce congestion and free up road space, providing opportunities to implement changes to improve the operation of bus services and local traffic movements.

Roads and Maritime and Transport for NSW have carried out a preliminary assessment of the public transport improvements that could be delivered due a reduction in traffic congestion on Pennant Hills Road.

Sydney's Bus Future (Transport for NSW, 2013a) is a 20 year bus plan that sets out to deliver a simpler, faster and better bus network for customers. Specifically to Pennant Hills Road, Sydney's Bus Future also targets the corridor as part of a bus rapid route between Hornsby and Baulkham Hills (via Castle Hill).

Pennant Hills Road has been targeted for bus priority treatment to address bus pinch points along the road, including around Boundary Road. In conjunction with this, Sydney's Bus Future includes an action to investigate opportunities for improved bus public transport along Pennant Hills Road, consistent with the objective of the project.

Sydney's Bus Future proposes that bus rapid routes would form a backbone to the new bus network in Sydney, offering fast and reliable bus travel for customers between major centres. They would include 'turn up and go' services which would operate at least every ten minutes between 6 am and 7 pm on weekdays and every 15 minutes on weekends. Bus stops would be placed around every 800 metres to one kilometre.

As part of a bus rapid route, Pennant Hills Road would provide high quality public transport services which would support growth areas, be integrated with the North West Rail Link, and would give the road greater integration in the cross-metropolitan network.

Specific actions to improve bus services along Pennant Hills Road may include:

- Signal re-phasing, or changing the pattern of traffic signals at key intersections, to ease traffic flows across Pennant Hill Road by focusing on longer stopping time for through traffic and increased entry time for side traffic.
- Bus stop relocations along the corridor to be closer to intersections, taking advantage of the additional stopping time created by signal re-phasing to reduce overall journey time.
- Bus priority measures at key intersections to provide better bus reliability.
- More frequent bus services on Pennant Hills Road in the event that congestion levels are lowered following the delivery of the project.

Preliminary work has identified a number of traffic control improvements that could be made at specific intersections along Pennant Hills Road.

These intersections tend to contribute to slow peak speeds, and hence would benefit from treatments to deliver bus priority measures and improve cross traffic flows across Pennant Hills Road. Cross traffic is not expected to change greatly with the delivery of the project. Targeted intersection improvements could help improve public transport services along the corridor as well as local traffic movements. These improvement opportunities have been identified in **Table 7-39**.

Table 7-39 Summary of public transport improvement opportunities

Location	Opportunities identified
Along Pennant Hills Road	• Signal re-phasing. • Additional bus services. • Relocation of bus stops.
Boundary Road	• Longer right-turn phase for buses turning right from Pennant Hills Road onto Boundary Road. • Bus queue jump' for buses turning left onto Pennant Hills Road.
Beecroft Road	• 'Bus queue jump' for buses travelling south on Pennant Hills Road.
Cardinal Avenue	• Longer right-turn phase for buses turning right onto Pennant Hills Road. • Longer right-turn phase for buses turning right onto Cardinal Avenue.

Location	Opportunities identified
Castle Hill Road	• 'Bus queue jump' for through buses travelling south on Pennant Hills Road. • Longer right-turn phase for southbound buses turning right onto Castle Hill Road. • 'Bus queue jump' for through buses travelling north on Pennant Hills Road.
Railway Street	• Longer right-turn phase for buses turning right onto Pennant Hills Road.
Aiken Road	• Longer right-turn phase for buses turning right onto Pennant Hills Road.
Phyllis Avenue	• 'Bus queue jump' for buses travelling north on Pennant Hills Road.
Comenarra Parkway	• 'Bus queue jump' for buses travelling south on Pennant Hills Road.

A number of other transport improvements along Pennant Hills Road could be delivered in the medium- to long-term. Such opportunities could include:

- Reconfiguring the bus route network to take advantage of easier crossing of the corridor at junctions, in alignment with Sydney's Bus Future strategy
- Linking the wide transport network better with railway stations in the area
- Improving walking and cycling infrastructure along and across the corridor.

These options for improving public transport are at a preliminary stage. More detailed work would be undertaken by Roads and Maritime and Transport for NSW to investigate public transport improvements and intersection treatments that could be delivered on Pennant Hills Road after the opening of the project. These potential public transport improvements do not form part of this project and would be subject to separate planning processes and approvals as appropriate.

Emergency vehicles

As described in **Section 5.2.16**, operational emergency systems would be included in the design of the project, such as emergency shoulders, breakdown bays, egress for pedestrians and access for emergency services. Facilities for emergency vehicles would include:

- Vehicle cross passages between the two main alignment tunnels around the Wilson Road and Trelawney Street tunnel support facilities.
- Vehicle breakdown bays on the Hills M2 Motorway and the M1 Pacific Motorway prior to and after the main alignment tunnel portals.

Tunnel maintenance

Like other Sydney motorway tunnels, the tunnels would need to be closed from time to time in order to carry out periodic maintenance works. These closures would be undertaken during periods of low traffic and would be co-ordinated with Roads and Maritime and the Traffic Management Centre. During these closures, traffic would be directed to utilise Pennant Hills Road which provides an alternate parallel route.

7.1.5 Environmental management measures

The project has been designed and planned in order to avoid and minimise traffic related impacts. For example, sites have been chosen to allow construction access and egress directly to and from Pennant Hills Road, the Hills M2 Motorway or the M1 Pacific Motorway. A central parking facility for construction workers has also been planned in order to minimise local traffic and parking impacts around construction sites. Despite this, impacts would occur, especially during the construction phase of the project due to the introduction of heavy vehicles. Mitigation and management measures would be implemented to avoid, minimise or manage these impacts to traffic and transport. These mitigation and management measures are listed in **Table 7-40**.

Table 7-40 Environmental management measures - traffic and transport

Impact	No.	Environmental management measure	Timing
Construction			
General	TT1	A traffic management plan(s) (TMP) would be prepared as part of the construction environmental management plan(s) (CEMP). The TMP would include: • Signage requirements (eg temporary speed restrictions, changes to the road environment, traffic management controls deployed). • Lane possession and approval process during periods of online construction (eg line marking and temporary barriers). • Traffic control devices such as temporary traffic signals. • A local and regional communications strategy. This would include methods to provide advanced notice of any major or prolonged impacts (eg leaflets and local media), and real-time information regarding current impacts (eg variable message signs, radio traffic news). • Details of both the general approach to be used for access and egress to worksites (with consideration of minimum sight distances, maximum grade allowances, etc), and the specific controls required at selected locations (signage, barriers, signalling requirements). • Any specific provisions required to manage potential impacts to sensitive users such as schools, child care centres, health facilities, etc).	Pre-construction
Impacts to road network performance (delays) and safety	TT2	Construction methods and staging would be designed to minimise road closures, subject to other project constraints, and ensure that disruptions to existing traffic are minimised as much as feasible and reasonable.	Construction
	TT3	Offline construction would be carried out wherever feasible and reasonable.	Construction

Impact	No.	Environmental management measure	Timing
	TT4	Works which would significantly reduce the performance of the road network would be scheduled for periods of typically lower traffic volumes where feasible and reasonable.	Construction
	TT5	Where offline construction is not practical, and for tie-ins between online and offline sections of the project, construction sequencing and any temporary works identified would aim to minimise user delay while providing sufficient flexibility for the selected contractor to safely and efficiently construct the project.	Construction
	TT6	Signage would be used to clearly indicate the traffic controls in use. This could also include temporary speed restrictions and passing constraints if required to maintain road safety levels.	Construction
	TT7	In some instances lane closures would be implemented to remove road traffic from construction zones altogether. Where practical this is proposed to occur outside of peak periods including at night to maintain network capacity.	Construction
	TT8	Access to local roads / streets and properties would be maintained. If local roads / streets need to be closed (short or long term), arrangements would be made to provide access to properties of affected residents and their visitors.	Construction
	TT9	Road occupancy licences would be obtained for work that impacts traffic on existing roads.	Construction
Impacts to emergency services	TT10	The TMP would be developed in consultation with local emergency services and procedures would be implemented to maintain priority access and a safe environment for emergency vehicles to travel through construction areas.	Construction
	TT11	Local emergency services would be frequently updated on the staging and progress of construction works.	Construction
	TT12	Communication systems would be in place with traffic controllers to provide appropriate access and routes (eg gaps in concrete barriers, side-tracks, wide verges etc) for emergency vehicles to bypass queued traffic.	Construction
Operation			
Impacts to road safety	OpTT1	A road safety audit would be undertaken by qualified auditors as part of the detailed design, and again immediately prior to project opening, to examine the design from a road safety perspective and identify potential safety issues. This process would be undertaken in accordance with the Roads and Maritime Accident Reduction Guide Part 2: Road Safety Audits (RTA, 2005a).	Detailed design and prior to operation

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