

July 29, 2022

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From	Phil Guo, Rosie Harris	Project No.	12589113
Project Name	Mt Penang Parklands Baxter Track and One-Way Upgrades		
Subject	Traffic Analysis Memorandum		

1. Introduction

This technical memorandum has been prepared by GHD for Hunter and Central Coast Development Corporation (HCCDC) as an evaluation summary of the proposed upgrade works involving the one-way system on Parklands Road, McCabe Road, The Avenue and Carinya Street, and the extension of Parklands Road.

1.1 Purpose of this Memorandum

The purpose of this memorandum is to provide a desktop analysis of the impacts of the traffic redistribution due to the upgrade works within the Mount Penang Parklands (the Parklands), both for the existing traffic and with anticipated developments within the Parklands. Figure 1 denotes the extent of the Parklands, which encompasses the approximate 130 hectares of land owned by HCCDC.



Figure 1 Mt Penang parklands area and land-use precincts

1.2 Scope and limitations

This memorandum encompasses analysis of the Parklands and surrounding road network under existing traffic volumes and anticipated HCCDC developments only. Assessment of the network with the addition of proximate developments is detailed in the Mt Penang Parklands Traffic and Transport Impact Study Stage 2 report. A summary of this report is provided in Attachment 1.

1.2.1 Limitations statement

This memorandum has been prepared by GHD for HCCDC and may only be used and relied on by HCCDC for the purpose agreed between GHD and HCCDC as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than HCCDC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Existing conditions

2.1 Access and road network

Figure 2 depicts the internal road network of the Mt Penang Parklands. Access is provided solely at the intersection of The Avenue / Central Coast Highway / Curringa Road. All roads function as two-way, except for The Avenue between Carinya Street and McCabe Road. This requires vehicles using The Avenue northbound to circulate via Parklands Road to exit the Parklands.

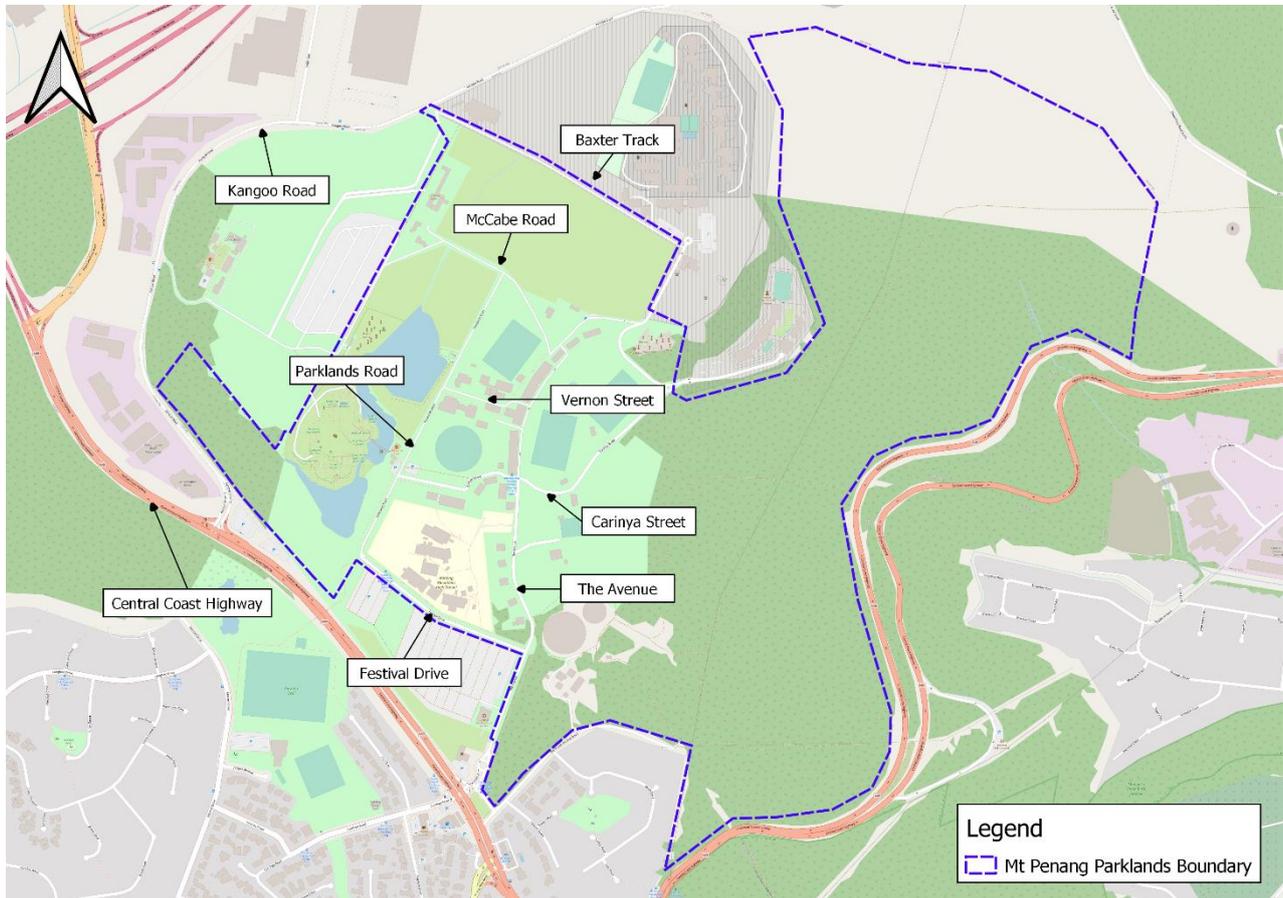


Figure 2 Mt Penang Parklands road network

Figure 3 depicts the location of key land-uses within the Parklands.

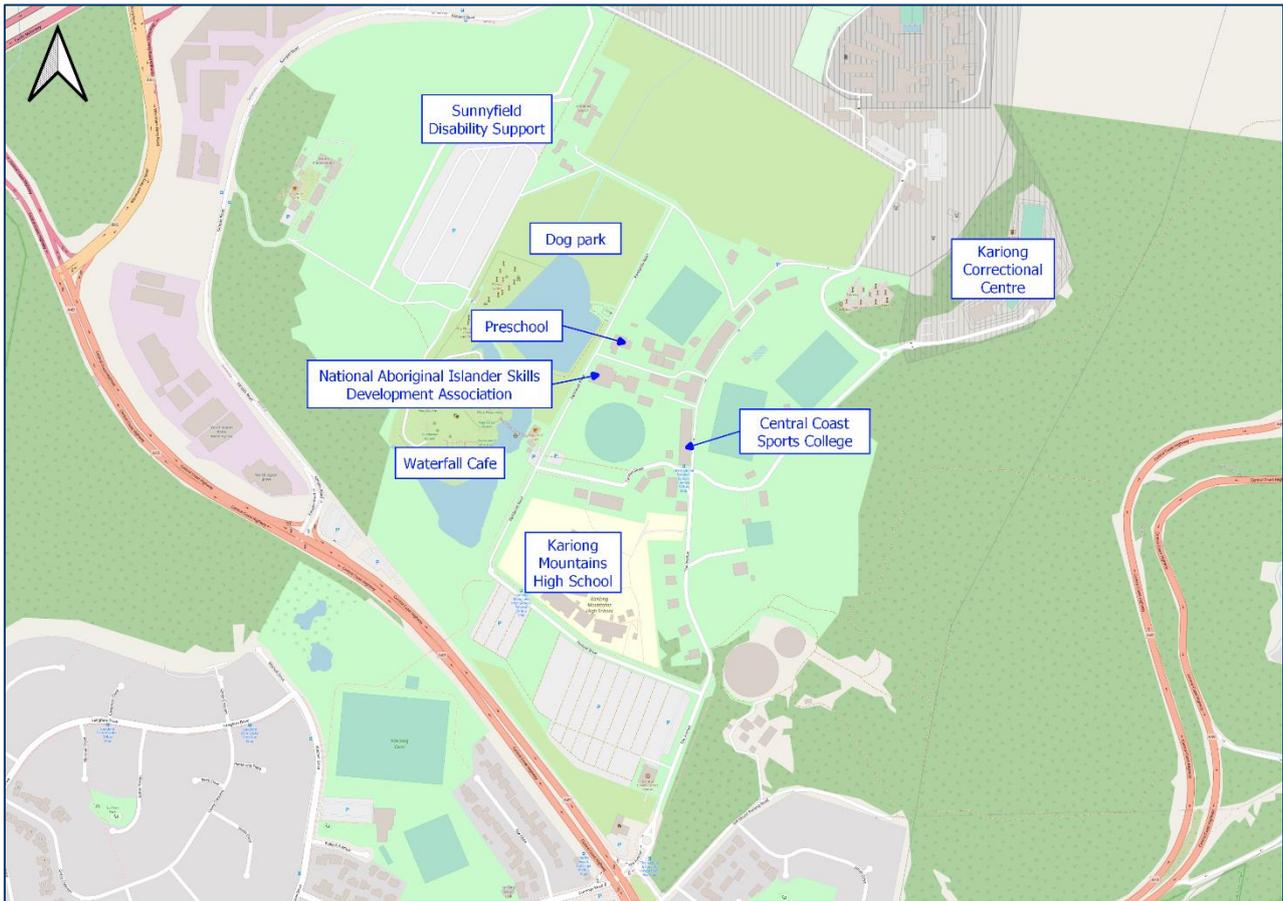


Figure 3 Mt Penang Parklands key land-uses

Major vehicle attractors include the two schools, café, and dog park. School traffic to Kariong Mountains High School uses Festival Drive for pick-up / drop-off, while the Central Coast Sports College uses The Avenue, Festival Drive, Parklands Road and Carinya Street.

2.2 Existing traffic volumes

Figure 4 and Figure 5 summarise the AM and PM peak hour traffic volumes for the internal Mt Penang Parklands Road network. To enable the analysis of traffic redistribution from key attractors in the Parklands, the 2020 base year modelled traffic volumes for the Mt Penang Traffic Study were used as a proxy for the existing traffic volumes. For the internal Mt Penang traffic, This traffic model has been calibrated to traffic counts obtained from the Mt Penang Gardens, Event Park & Parklands Traffic Assessment Report, prepared by Teraffic in 2018.

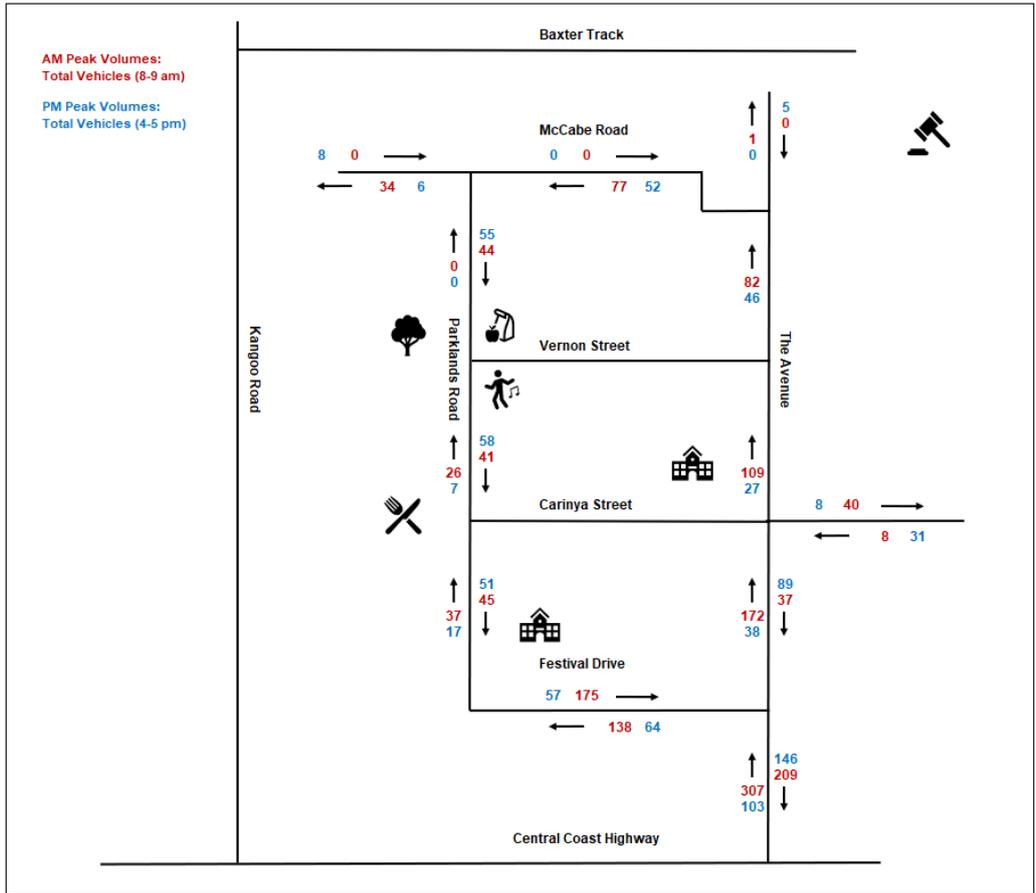


Figure 4 Existing traffic volumes (total)

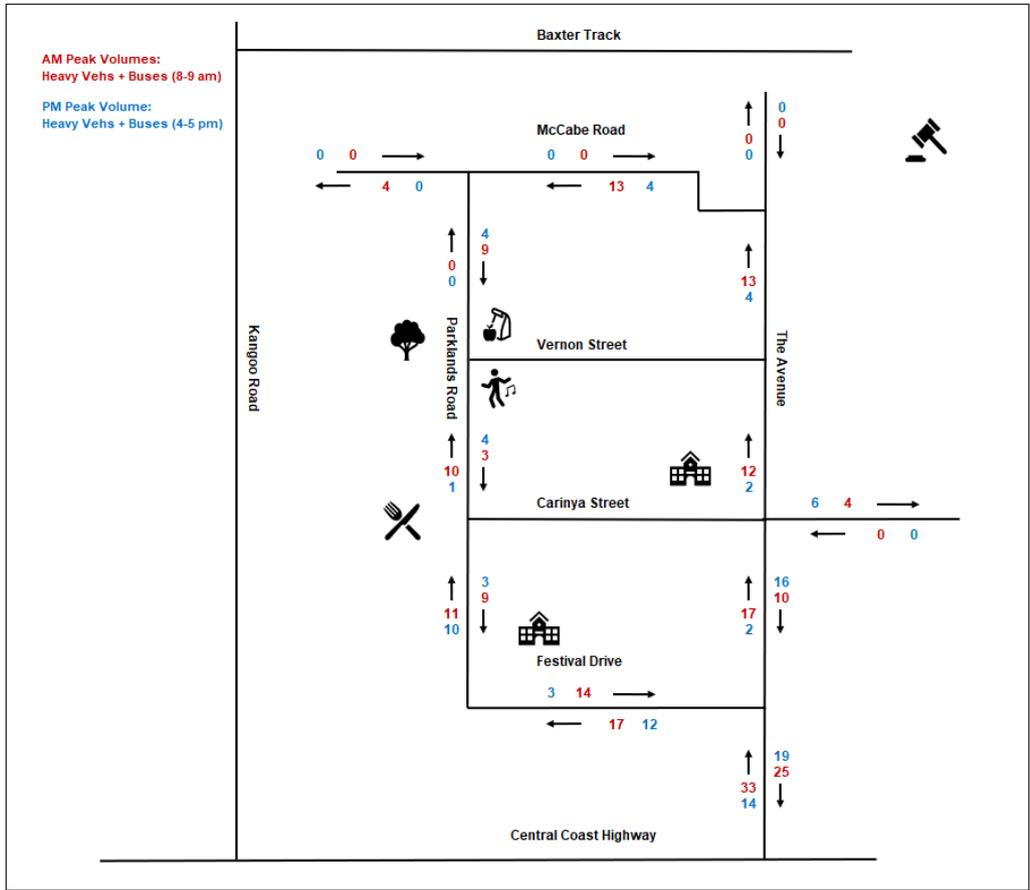


Figure 5 Existing traffic volumes (heavy vehicles + buses)

The volumes documented above have been based on the outcomes of base case traffic modelling for the year of 2020. The traffic modelling groups all traffic entering and exiting the network into discrete zones. Consequently, the above traffic volumes are based on the following assumptions:

- All Kariong Mountains High School traffic originates from and is destined to Festival Drive
- All café, gardens and dog park traffic originates from and is destined to a 'zone' at Carinya Street between Parklands Road and The Avenue. Access is provided by both Festival Drive and The Avenue.
- All Central Coast Sports School and pre-school traffic originates from and is destined to a 'zone' at Vernon Street
- Sunnyfield Disability Services is accessed via McCabe Street
- Kariong Correctional Centre is accessed via Carinya Street, east of The Avenue. Construction of the Baxter Track / Kangoo Road access is anticipated to be completed in late 2022, at which point, all Kariong Correctional Facility traffic will shift to this access.

3. Proposed upgrades

3.1 Upgrades arrangement

The Parklands Road, Utilities and Related Works Project involve the following upgrades:

- Extension of Parklands Road to Baxter Track, providing an alternative access to and from the Parklands, once connected to the Baxter Track upgrade
- Conversion of Parklands Road to one-way northbound between Carinya Street and McCabe Road
- Conversion of The Avenue to one-way southbound between McCabe Road and Festival Drive
- Carinya Street and Vernon Road, although shown as one-way westbound and two-way respectively, can be either two-way or one-way in opposite directions. For the purposes of the assessment, they have both been assumed two-way.

The one-way network has been proposed to improve overall safety for all users, including pedestrians and cyclists. The additional access also improves safety, as well as improving network resilience, by providing an alternative exit in the event of emergency or flow breakdown.

A snapshot of the proposed arrangement is provided in Figure 6.

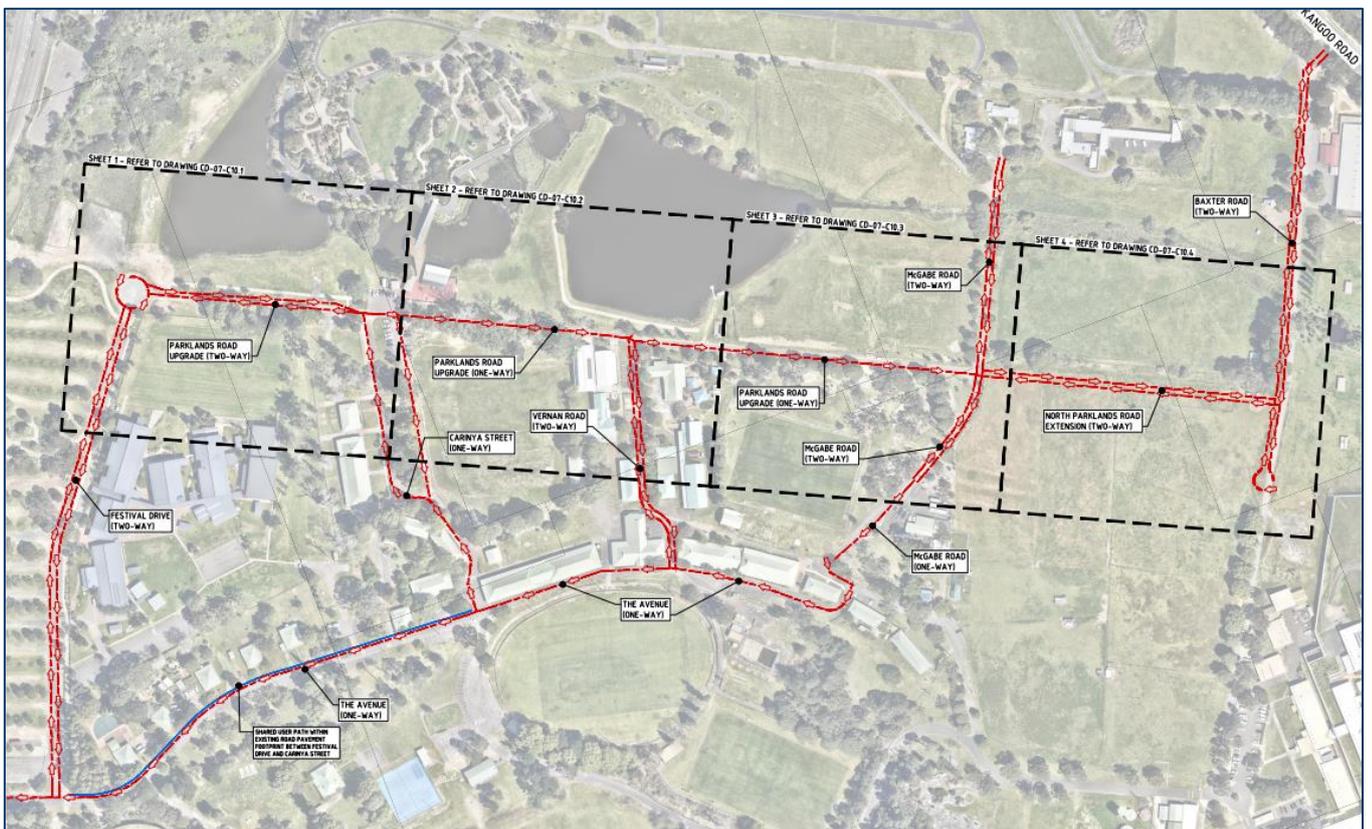


Figure 6 Proposed road network arrangement

3.2 Traffic volumes

Figure 7 and Figure 8 summarise the redistributed traffic volumes, based on the upgraded road network. This assumes that:

- Sunnyfield Disability Services use Baxter Track as primary access
- Dog park and parklands users' egress via Baxter Track, but enter via The Avenue
- Buses to and from Central Coast Sports School use Baxter Track and McCabe Road for pick-up and drop-off.
- A nominal 10% of general traffic to and from the Central Coast Sports School and pre-school use Baxter Track as the access, with the remaining 90% using The Avenue.
- Kariong Correctional Services traffic uses Baxter Track as a primary access. Construction of the Baxter Track / Kangoo Road access is anticipated to be completed in late 2022. Previous analysis of this intersection was completed to inform this upgrade, and is documented in a memorandum titled 'Traffic Assessment of Baxter Track and Kangoo Road, Parklands', prepared by GHD in September 2021. Attachment 1 provides a summary of this outcomes of this analysis.

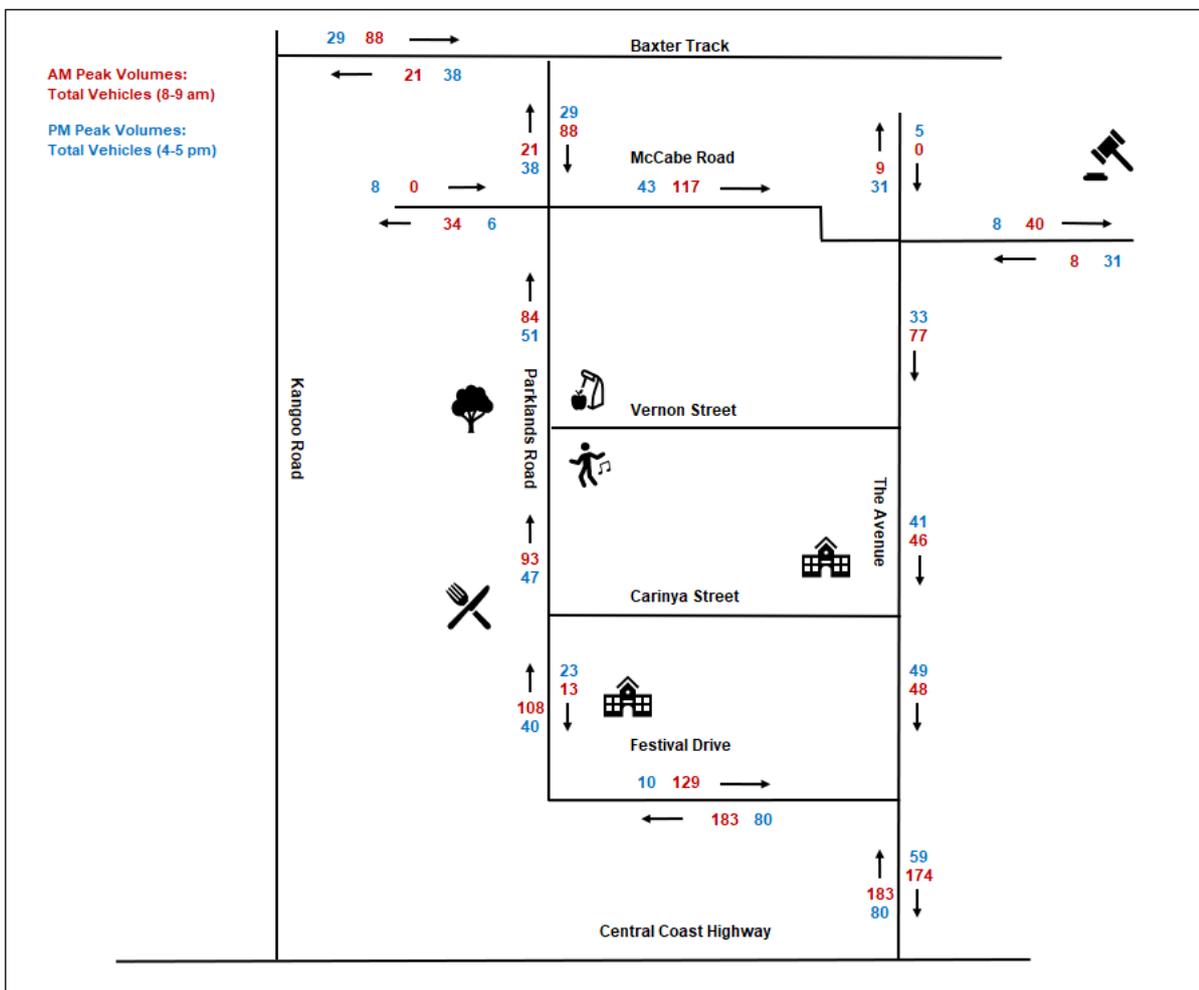


Figure 7 Redistributed traffic volumes (total vehicles)

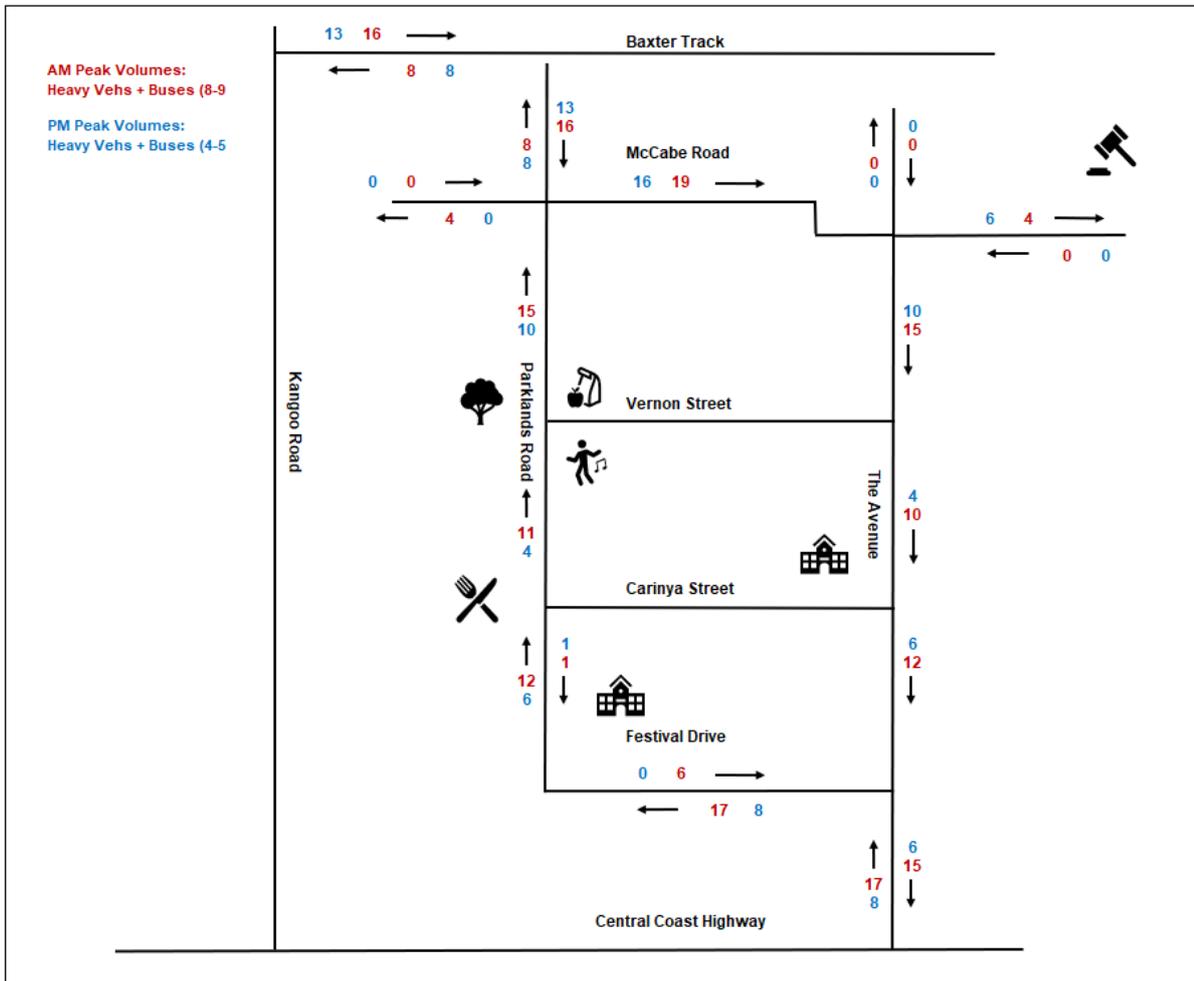


Figure 8 Redistributed traffic volumes (heavy vehicles + buses)

The redistributed traffic volumes show that the only major bidirectional traffic volume increases occur on Parklands Road in the AM peak. Here, traffic volumes increase on Parklands Road and decrease on The Avenue due to traffic circulating around the one-way system to reach the destination from Parklands Road northbound. It is anticipated that these increases can be accommodated on Parklands Road, as:

- The conflict points at intersections have been reduced due to the conversion to a one-way system
- Traffic volumes on Parklands Road are anticipated to be less than that on the existing northbound one-way section of The Avenue. Base year (2020) traffic modelling developed by GHD in 2020 has shown that this section operates with minimal delay.

There are also estimated to be 109 vehicles accessing the Parklands from Baxter Track in the AM peak hour, and 67 in the PM peak. These vehicles were assumed to previously access via the Central Coast Highway / The Avenue intersection, and as such, this increase at Baxter Track is paired with a decrease in traffic volumes at The Avenue / Central Coast Highway intersection.

A summary of the proposed upgrades capturing the neighbouring projects as well as the broader traffic network is provided in Attachment 1. These works included an analysis of the forecast performance of Baxter Track / Kangaroo Road, which suggested it has sufficient capacity to meet the increased 2031 and 2041 demands. Consequently, the performance of the intersection under the existing redirected volumes is to be expected.

Given that this volume constitutes greater than an increase in traffic on Kangaroo Road of 39% in the AM and 20% in the PM peak (based on the volumes in Figure 9), the performance of the Kangaroo Road / Central Coast Highway intersection is outlined in the following section.

3.3 Kangoo Road / Central Coast Highway intersection performance

Figure 9 shows the estimated 2022 traffic volumes at Kangoo Road / Central Coast Highway. Traffic volumes were based on data collected on Wednesday 19 February, 2020 (prior to any COVID-19 measures affecting travel patterns). Growth rates from the Strategic Transport Forecasting Model (STFM) were then used to grow the data to 2022 levels. These growth rates are listed in Table 1.

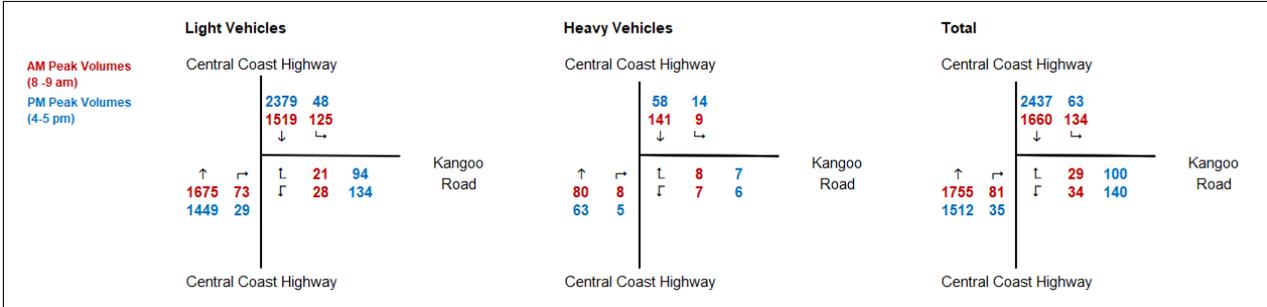


Figure 9 Kangoo Road intersection volumes (2022 estimated, without Baxter Track access)

Table 1 STFM growth rates (2020 – 2022)

Link	AM Annual Growth		PM Annual Growth	
	Northbound	Southbound	Northbound	Southbound
Central Coast Highway (South of Kangoo Road)	2.1%	5.4%	4.2%	1.3%
Central Coast Highway (North of Kangoo Road)	2.1%	5.3%	4.3%	1.3%

Figure 10 shows the volumes at Kangoo Road / Central Coast Highway with the Parklands Road extension and other Parklands works. This assumes that all additional volumes using Baxter Track to enter the Parklands will access via the Central Coast Highway / Kangoo Road intersection. Volumes have been distributed based on the existing traffic distribution into and out of Kangoo Road.

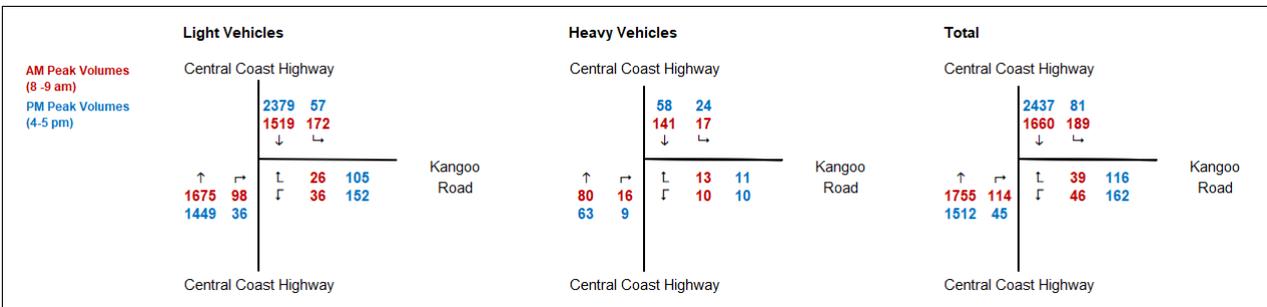


Figure 10 Kangoo Road intersection volumes (2022 estimated, with Baxter Track access)

Figure 11 shows the SIDRA layout for Kangoo Road / Central Coast Highway.

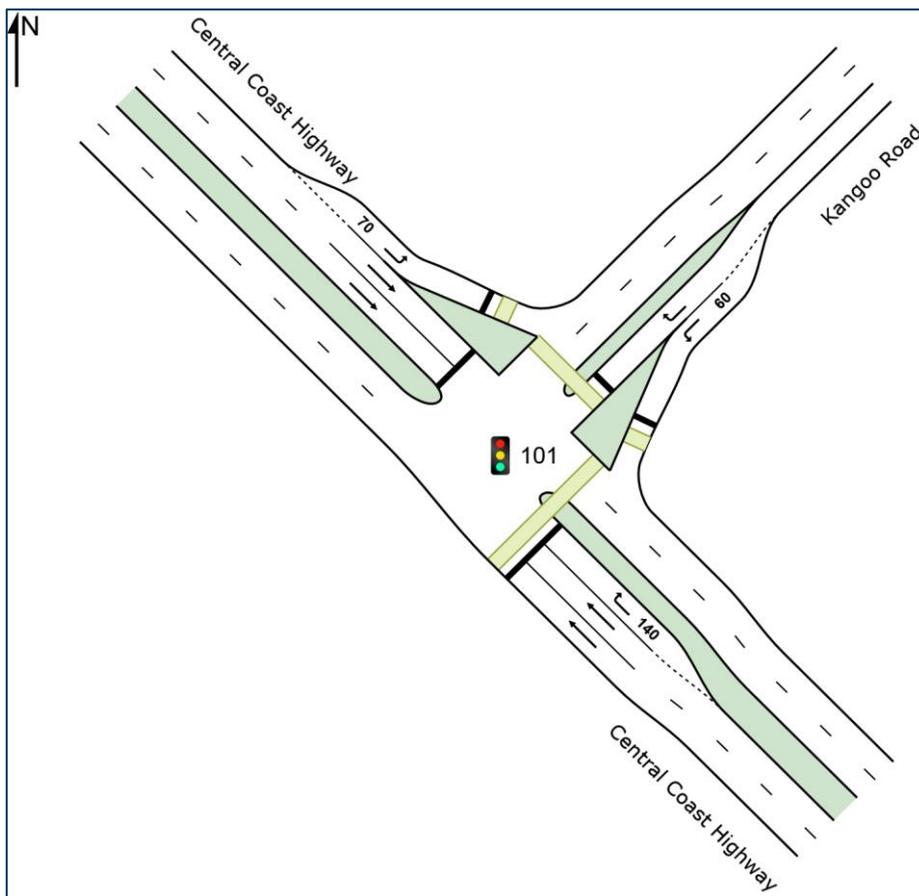


Figure 11 Kangaroo Road / Central Coast Highway SIDRA layout

The layout has been assessed for both the ‘with Baxter Track access’ and ‘without Baxter Track access’ arrangements. Table 2 provides a summary of the results.

Acceptable levels of operation for a signalised intersection are generally measured by:

- Level of service (LOS) (based on delay) not exceeding D
- Degree of saturation (DOS) not exceeding 90%

Table 2 SIDRA results

Peak	Scenario	Average delay (s)	LOS	DOS	Maximum 95 th % queue (m)
AM	Without Baxter Track	8	A	67%	209 (Central Coast Highway southbound)
	With Baxter Track	10	A	71%	238 (Central Coast Highway southbound)
PM	Without Baxter Track	13	B	87%	480 (Central Coast Highway southbound)
	With Baxter Track	15	B	87%	485 (Central Coast Highway southbound)

The above results indicate that with the Baxter Track traffic, the decreases to performance of the Kangaroo Road / Central Coast Highway intersection are marginal. In both peaks, average delay decreases by only 2 seconds and the LOS remains the same. Increases to queues and DOS are also marginal. This suggests that the Kangaroo Road / Central Coast Highway intersection will perform similarly with the additional traffic from the Baxter Track access. It is also noted that this marginal decrease in perform occurs in tandem with the improvement to performance at the Central Coast Highway / The Avenue intersection due to the decrease in traffic on The Avenue.

4. Forecast traffic

A high-level assessment of development traffic has also been completed to determine the impact of the redistribution of traffic due to the proposed works.

Traffic volumes have been estimated based on projected land-uses and building areas defined in the Mount Penang Parklands Urban Design Study, prepared by Place Logic in 2019. Table 3 summarises the development traffic anticipated for the Parklands, as previously determined in the transport modelling works for the Mount Penang Parklands. It is acknowledged that the estimates of traffic generated by the development precincts are conservative, and all development is subject to the future planning assessment / approval process.

Both the Kangoo Road Commercial Precinct and Highway Commercial Precincts have been subdivided from the Parklands and are not under the control of HCCDC. As such, the trips associated with these precincts have been excluded from the analysis.

Table 3 Development traffic estimates

Precinct	Hourly AM Peak Development Traffic (Vehicle Trips) (8 – 9 am)	Hourly PM Peak Development Traffic (Vehicle Trips) (4 – 5 pm)
	<i>Trips / Hour</i>	
Festival / Gardens	66	91
Baxter Track Mixed Use	120	100
Heritage Precinct	19	18
Sports Precinct	92	92
Phillip House Mixed Use Precinct	0	0
Bushland (no development)	0	0
Total	297	301

For all development areas, it is assumed that 80% of trips are entering and 20% exiting in the AM peak, with the converse in the PM peak.

Figure 12 to Figure 15 shows background + development traffic under the existing layout and proposed upgrade layouts respectively. The redistribution assumes the following based on likely entry and exit points:

- All Baxter Track mixed use traffic accesses via the Kangoo Road / Baxter Track intersection
- All Festival / Gardens enters via The Avenue, but 20% egresses via Baxter Track
- 90% of Heritage Precinct and Sports Precinct traffic enters and exits via The Avenue, with the remaining via Baxter Track.

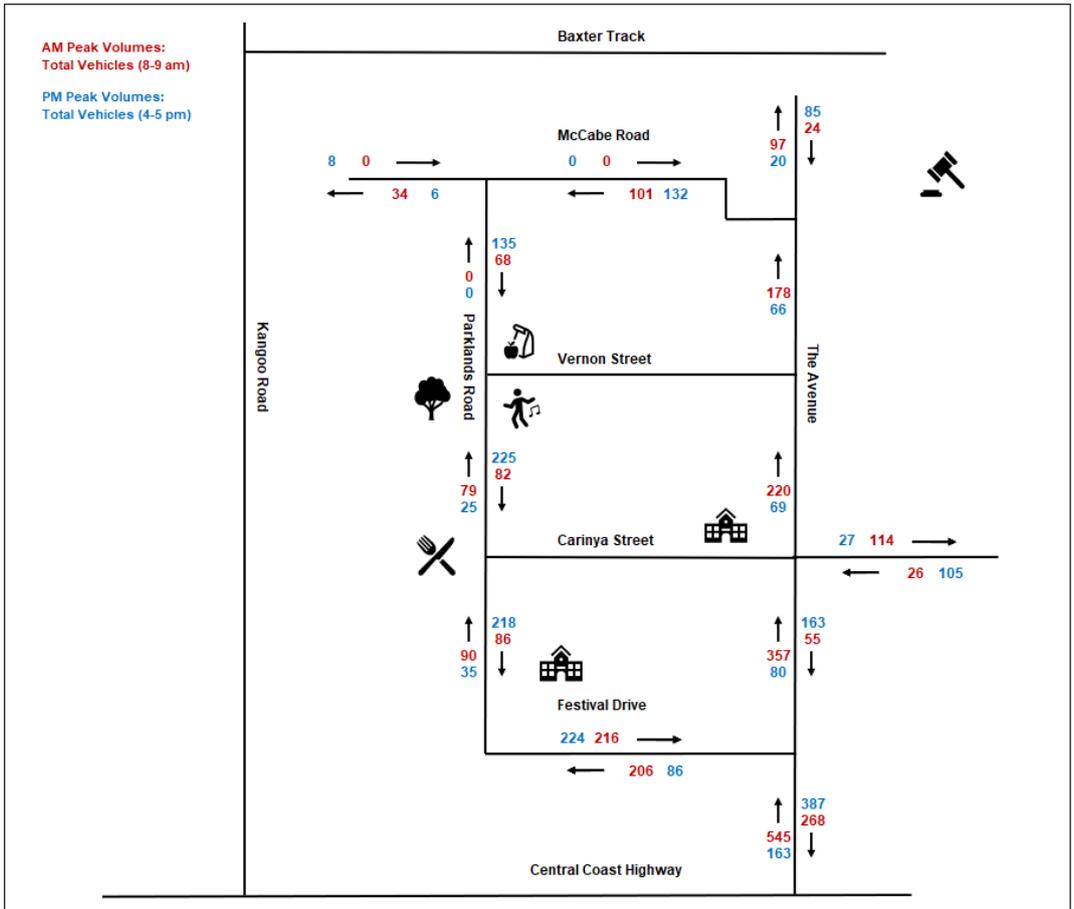


Figure 12 Background + development traffic distribution (total vehicles, existing arrangement)

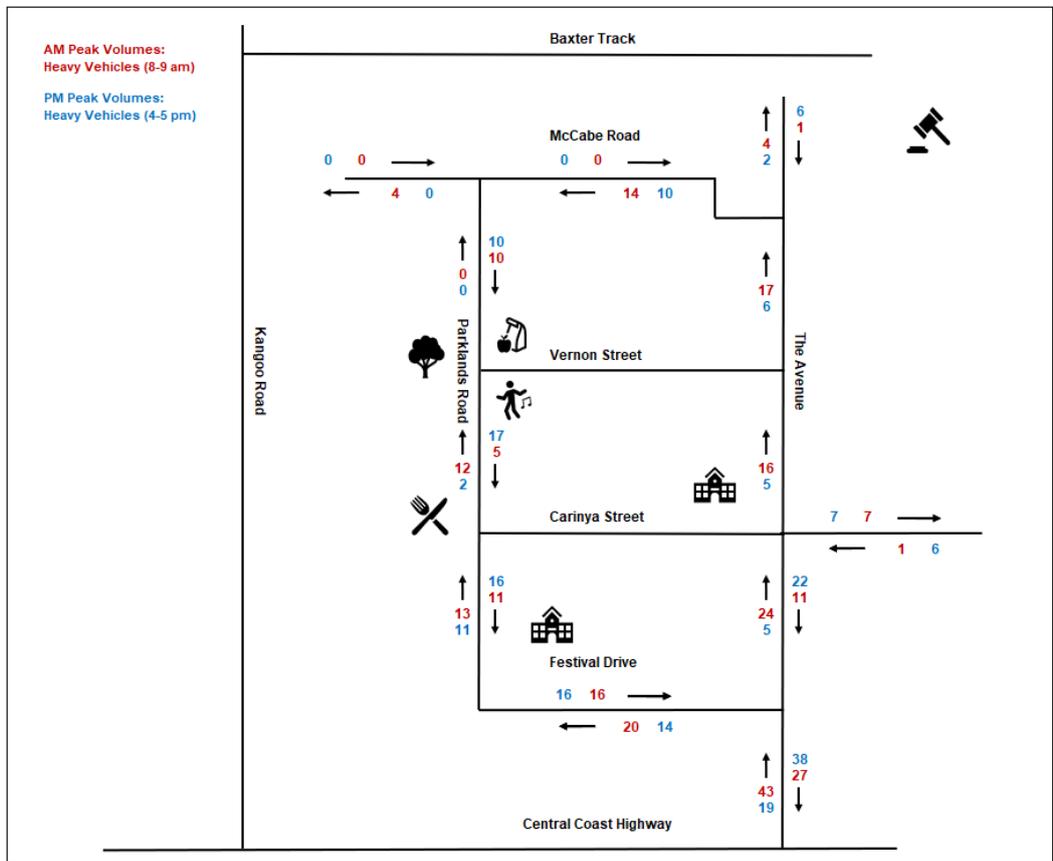


Figure 13 Background + development traffic distribution (heavy vehicles, existing arrangement)

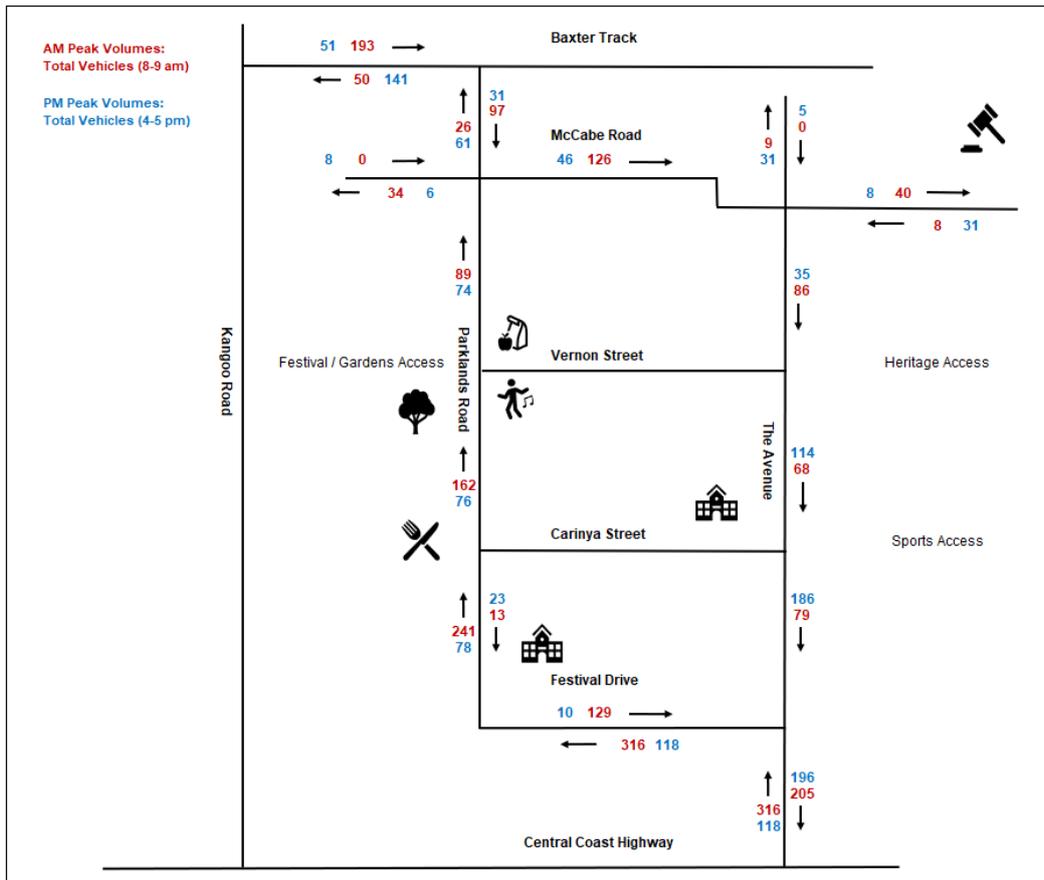


Figure 14 Background + development traffic distribution (total vehicles, proposed upgrade arrangement)

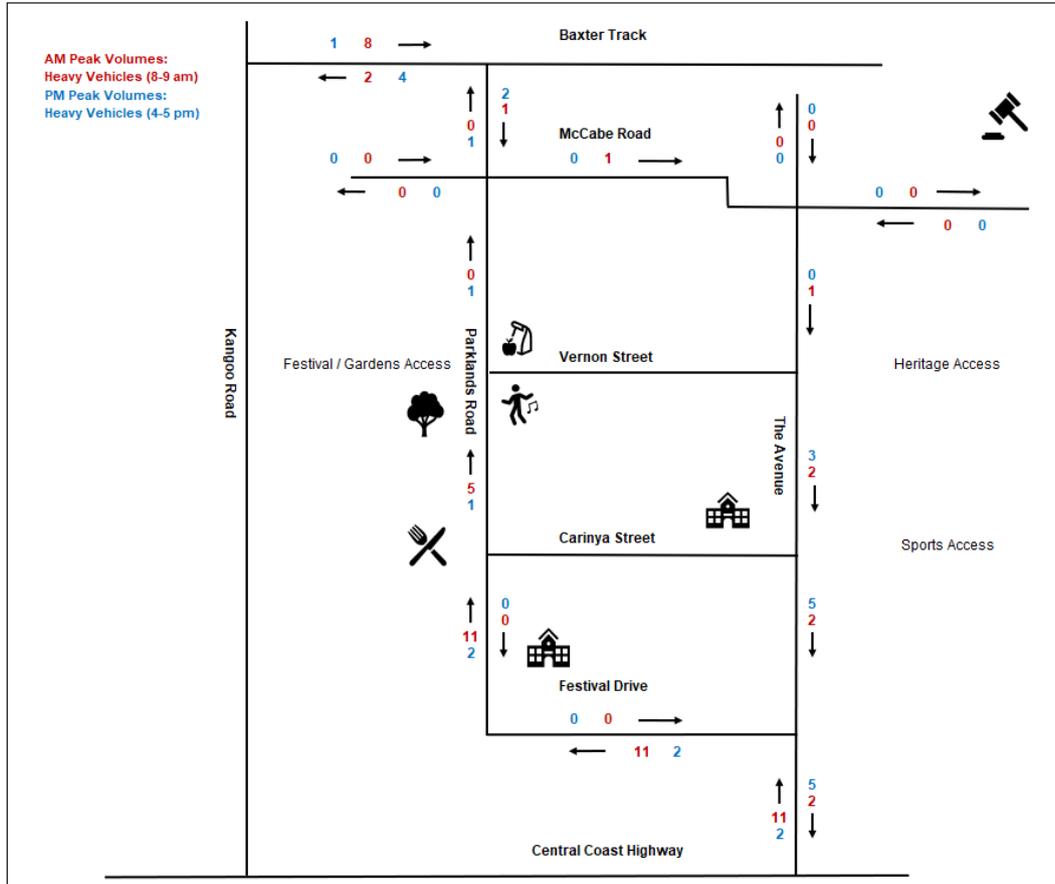


Figure 15 Background + development traffic distribution (heavy vehicles, proposed upgrade arrangement)

The above volume plots indicate that:

- As for the existing traffic scenario, with the proposed upgrade works, bidirectional traffic volumes are only expected to increase on Parklands Road in the AM peak. This is due to the additional circulating traffic that would previously access via The Avenue northbound. This increase in volumes is expected to be accommodated as:
 - Volumes remain below 200 vehicles / hour. Similar volumes are currently accommodated on The Avenue south of Carinya Street.
 - There are fewer conflict points due to the conversion of traffic to one-way
- The addition of the Baxter Track access significantly reduces the volumes at The Avenue / Central Coast Highway access. It is assumed that all traffic to Baxter Track Mixed-Use precinct would use the new access intersection, and as such, the volumes on both The Avenue and Festival Drive eastbound are expected to decrease significantly with the proposed upgrade works.
- An additional 200 vehicles can be expected on Kangoo Road in both the AM and PM peaks with the proposed upgrade works and development traffic. Based on the analysis of the Baxter Track / Kangoo Road intersection documented in Section 3 of Attachment 1, it can be expected that this intersection has sufficient capacity to meet these demands, as it shown to operate sufficiently with higher demands than this.
- Under the existing arrangement, the additional development traffic would induce higher demands at the sole access point at the Central Coast Highway / The Avenue intersection. With the proposed upgrades, this traffic decreases at The Avenue, but increases at the new access via Central Coast Highway / Kangoo Road. Additional traffic impact assessments would be required to be completed if future developments are proposed.

5. Construction traffic impact

5.1 Potential construction traffic generation

It is expected that construction traffic impacts associated with the proposal would be generated by construction vehicles, namely workers and heavy vehicles, accessing and egressing the site.

5.2 Work activities

The proposal will include the following key work activities:

- Clearing and grubbing, topsoil removal
- Site access establishment for local traffic
- Existing asset and property demolitions
- Permanent kerb and pavement shared path and stormwater system
- Intersection construction

5.3 Construction timeframe

Construction is anticipated to start in early 2023 with the detailed timeframe to be advised by HCCDC. The working hours for the construction sites would be as follows and subject to the construction traffic management plan (CTMP).

- Monday to Friday (7.00 am to 6.00 pm)
- Saturday (8.00 am to 1.00 pm)
- Sunday and public holidays (no work)

5.4 Construction activity traffic generation

5.4.1 Staff movement

During the proposed works, it is anticipated that up to a maximum of 20 personnel per day would be likely to access the proposal. This is dependent on the construction staging and the construction contractor.

5.4.2 Vehicle traffic generation

It is estimated that light vehicle movements to the proposal are in the order of 10 vehicles daily across the site. It is assumed that there will be some level of car sharing. These volumes equate to, on average less than five vehicles every hour over the peak hour arrival and departure periods.

The traffic generation associated with heavy vehicles has been based on the concept design and it is assumed that heavy vehicle truck movements are to be less than five vehicles per hour (access and egress) at the construction site. Trucks are expected to deliver material and to remove spoil.

The expected volume of construction worker trips and heavy vehicle trips are low and would fall within typical daily fluctuations with no expected adverse impacts to the operation of the adjoining road network. Construction workers would be expected to access the site works area in the morning and exit in the afternoon/evening.

Due to the low construction traffic generated by the proposal, no traffic modelling has been carried out.

5.5 Construction traffic access and trip distribution

It is anticipated that the construction traffic would access the construction site with the existing road network. The arrangement will be subject to the CTMP.

5.6 Parking for construction workers

It is anticipated that parking for construction workers will be restricted to designated compounds and areas for construction workers only. As such, there should be minimal impact to on-street parking and traffic flow on the existing road network. The arrangement will be subject to the CTMP.

5.7 Public transport

It is anticipated that during the construction, the impact on the public transport, such as the school bus within the site will be minimum.

6. Conclusion

This memorandum has documented the traffic analysis of the Mt Penang Parklands road network under a series of proposed road upgrades. The proposed upgrade works comprise the extension of Parklands Road to Baxters Track, and conversion of the network to a one-way circulatory system with The Avenue southbound and Parklands Road northbound. Carinya Street and Vernon Road can either remain two-way or be converted to a one-way pair (opposite directions) without notable impact.

These upgrades provide an overall improvement to pedestrian safety by consolidating vehicle movements and improving available space for active transport. The alternative access to and from the site also improves the site safety and emergency response, as well as improves access in the event of flow breakdown.

A desktop review of the traffic performance impacts of these upgrades has yielded the following outcomes:

- Under the proposed upgrade works, the bidirectional traffic volumes are expected to decrease on most links due to the alternative access providing a more direct route to many locations in the Parklands.
- Parklands Road traffic volumes are anticipated to increase due to vehicles circulating northbound on Parklands Road to reach destinations on The Avenue. This is paired with a decrease in traffic volumes on The Avenue northbound. Regardless, given the volumes remain low and the one-way system reduces conflict points, Parklands Road is expected to have sufficient capacity.
- Volumes also increase on Kangoo Road due to the additional access point at Baxter Track. The increase in volumes has minimal adverse impact to the Kangoo Road / Central Coast Highway intersection performance. This marginal increase directly corresponds with reduced impacts at The Avenue / Central Coast Highway intersection.
- The proposed upgrade arrangement provides further benefit with the additional development traffic volumes, as the access at Baxter Track reduces the volume of traffic circulating the Parklands road network to reach the northern land-uses. It is recommended, however, that the impact of additional development traffic at the accesses to the Parklands from Central Coast Highway (Kangoo Road and The Avenue) is assessed, if and when developments progress through the planning / approval phase.
- Construction traffic is expected to be low compared to the overall traffic through the site, and as such, minimal impact is expected.

Attachment 1

Mt Penang Parklands TTIS Summary

13 July 2022

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From	Phil Guo, Rosie Harris, Profita Keo	Project No.	12548506
Project Name	Mt Penang Parkland Additional Traffic Study		
Subject	Summary of findings on proposed one way system and Parklands North upgrade to support REF		

1. Introduction

1.1 Purpose of this Memorandum

The primary objective of the Mt Penang Parklands Traffic and Transport Study is to assess the potential traffic impact of proposed developments on the operation of the road network within the Parklands, and the broader road network including Central Coast Highway.

This technical memorandum has been prepared by GHD for Hunter and Central Coast Development Corporation (HCCDC) as an evaluation summary of the proposed REF works involving the one-way system on Parklands Road, McCabe Road, The Avenue and Carinya Street, based on the findings documented in TTIS Stage 2 report.

It is acknowledged that additional analysis may be undertaken to further support the REF.

1.2 Limitations

This technical memorandum has been prepared by GHD for Hunter & Central Coast Development Corporation. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.

2. Proposed One-Way System

2.1 Potential Arrangement Options

Two potential one-way arrangement options on Parklands Road and The Avenue (see Figure 2-1 and Figure 2-2, noting the one-way roads are represented by red dashed lines) were investigated with regard to operational efficiency, with the aim to:

- Reduce traffic impact on The Avenue by decreasing traffic throughput, particularly within the 'heritage core' area
- Improve active transport outcomes for pedestrian and cyclist safety and connectivity

To maintain reasonable accessibility, both options retain a number of two-way roads (represented by green solid lines), as per existing conditions. This has been recommended on Festival Drive and the southern section of Parklands Road (south of Carinya Street), to provide two-way access to Kariong Mountains High School, the Gardens and the Café, as well as the northern section of Parklands Road (north of McCabe Road) to facilitate two-way access to the Parklands from Kangoo Road.

It is worth noting that the directional traffic distribution differs between the AM and PM peak periods.



Figure 2-1 Option 1 (anti-clockwise): Parklands Road (southbound) / The Avenue (northbound)



Figure 2-2 Option 2 (clockwise): Parklands Road (northbound) / The Avenue (southbound)

2.2 Summary of Traffic Modelling Results

A summary of results for the investigation of the potential arrangements of the one-way system are provided in Table 1, with respect to the objectives outlined in Table 2. Each option was assessed for the AM peak (7-9 am) and PM peak (4-6 pm) in 2031.

Table 1 Summary of assessed options

Option	The Avenue and The Parklands Road	Parklands North
Option 1	One-way anticlockwise system: The Avenue (northbound) / Parklands Road (southbound)	As per design from HCCDC
	One-way system and improved kerbside function reduces crash likelihood and severity, and improves street amenity Worse than Option 2 by: <ul style="list-style-type: none"> Increase of 175 veh/hr on The Avenue Increase of 75 veh/hr on existing Festival Drive (eastbound) Reduced capacity for vehicles exiting Mt Penang Parklands via The Avenue 	Minor delays (i.e. LoS A) experienced; capacity is adequate
Option 2	One-way clockwise system: The Avenue (southbound) / Parklands Road (northbound)	As per design from HCCDC
	One-way system and improved kerbside function reduces crash likelihood and severity, and improves street amenity Better than benchmark by: <ul style="list-style-type: none"> Reduction of 220 veh/hr (PM) on The Avenue Better than Option 1 by: <ul style="list-style-type: none"> Reduction of 175 veh/hr (AM) on The Avenue Reduction of 75 veh/hr on existing Festival Drive (eastbound) Additional capacity for vehicles exiting Mt Penang via The Avenue 	Minor delays (i.e. LoS A) experienced; capacity is adequate
Benchmark Scenario (developed for comparison only)	Two-way system on The Avenue and Parklands Road	As per existing layout

Table 2 Traffic objectives used to assess proposed options

#	Objectives	Discussion Section
1	Traffic reduction on The Avenue, within Heritage core area	2.3.1
2	Traffic reduction on one-way system, compared to two-way system	0
3	Promoting safety benefits	2.3.3
4	Promoting kerbside function	2.3.4

2.3 Benefits

2.3.1 Traffic Reduction on The Avenue (within Heritage Core Area)

Option 2 proposes The Avenue to be southbound only, spurring a number of observations (see Figure 2-3):

- A reduction of traffic volume, up to 220 veh/hr, on The Avenue by 2031, in comparison to the existing two-way arrangement
- A reduction of up to 175 vehicles on The Avenue by 2031, in comparison to Option 1
- Other benefits include:
 - Reduction in traffic volume on Festival Drive in the eastbound direction, consequently easing access to Kariong Mountains High School
 - Additional queueing capacity and a more direct route for vehicles exiting Mt Penang via the Avenue, which is a critical movement in the PM peak

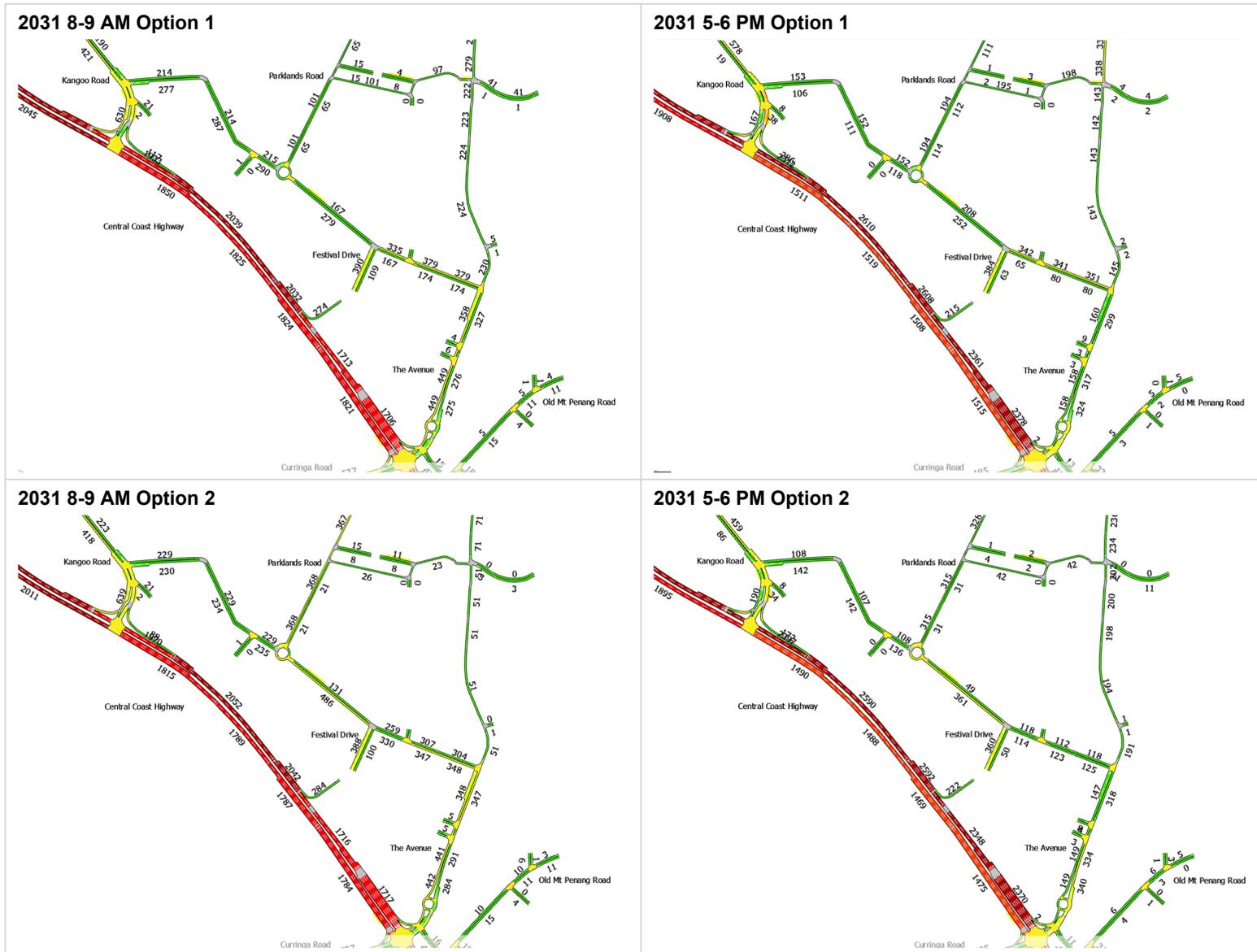


Figure 2-3 Comparison of traffic volume between Option 1 & 2 (2031), The Avenue (within Heritage Core Area)

Differences in traffic volume between Option 1 and Option 2 are provided in Table 3 for the AM peak. It becomes obvious that the one-way system proposed in Option 2 would significantly reduce the traffic volume on The Avenue, particularly in the AM peak. Observed in Option 2, an increase in traffic on Festival Drive in the westbound direction is also anticipated, facilitating northbound traffic via Parklands Road.

Additional benefits provided by Option 2 are listed in Table 4.

Table 3 Traffic volume comparison between Option 1 & 2

Predicted Traffic Volume	Option 1		Option 2	
	Northbound	Southbound	Northbound	Southbound
The Avenue, north of Festival Drive	225	-	-	50
Parklands Road, north of Festival Drive	100	65	270	20
AM	Eastbound	Westbound	Eastbound	Westbound
Festival Drive, west of The Avenue	380	175	305	350
Festival Drive extension	215	280	230	230

Note: Traffic volumes are summarised from Figure 2-3 (rounded to the nearest 5 vehicles / hour).

Table 4 Additional benefits of Option 2

Additional Benefits	
<p>Reduction of eastbound traffic on Festival Drive</p> <p>With The Avenue converted to a single direction in Option 2, the southbound section on The Avenue provides a more direct route for vehicles to access Central Coast Highway via the intersection with The Avenue, instead of using Festival Drive in the eastbound direction, which provides access to the Kariong Mountains High School.</p>	 <p>Reduction of traffic on Festival Drive in eastbound, compared to Option 1</p>
<p>Additional queuing storage space for existing Mt Penang</p> <p>Queuing is anticipated at The Avenue accessing CCH in the future. As such, the arrangement in Option 2 provides additional road capacity and queueing space for the southbound vehicles, as vehicles can use both The Avenue and Festival Drive to exit the Parklands, rather than just Festival Drive in Option 1.</p>	 <p>Additional queue storage space for traffic exiting Mt Penang (particularly PM peak), compared to Option 1</p>
<p>More opportunities for route choice within Mt Penang</p> <p>In order to arrive at Central Coast Highway through the Avenue, Option 2 provides more direct routes for those from the Parklands.</p>	

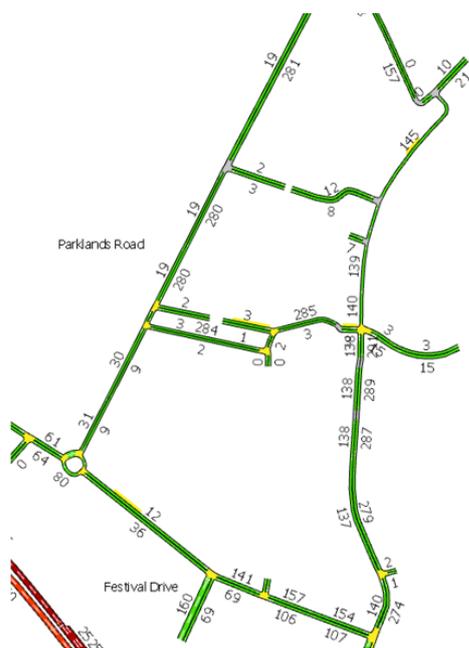
2.3.2 Traffic Reduction on One-Way System (vs. Two-Way System)

The benefits of both Option 1 and Option 2 include the potential reduction of vehicular movement on The Avenue within the Heritage core area. For demonstration purposes, the comparison was made between Option 2 (i.e. one-way arrangement where The Avenue is southbound) and Benchmark Scenario (two-way arrangement) as listed in Table 1.

Comparing the traffic volume for each option, the results demonstrate that:

- During the AM peak, traffic volume reduced from over 210 vehicles (Benchmark) to 50 vehicles (Option 2) i.e. up to 160 veh/hr, within the Heritage core area
- During the PM peak, a reduction in traffic volume, up to 220 veh/hr, on The Avenue was simulated for Option 2 compared to Benchmark Scenario, as highlighted in Figure 2-4.

Two-ways: The Avenue and Parklands Road
Traffic volumes (veh/hr) PM peak in 2031



Option 2: The Avenue Southbound; Parklands Road Northbound
Traffic volumes (veh/hr) PM peak in 2031



Figure 2-4 Reduction of traffic volumes on The Avenue and Parklands Road – PM peak

The results also demonstrated that an increase in traffic volume on Parklands Road and Festival Drive is anticipated, particularly for traffic accessing the Parklands North. They are no longer able to use The Avenue following its conversion to a southbound one-way arrangement.

2.3.3 Safety Benefits

There is an evolving perception of the function of roads, from solely transporting people and goods, to now also providing safety, liveability and enjoyment of a road in a community, particularly within Heritage and Sports Precinct. The anticipated benefits of the one-way system proposed in both Option 1 and Option 2 are primarily derived from the reduction of vehicular movement on Parklands North or The Avenue, as well as the one-way nature of the movement. This results in positive amenities and a safer road environment for all users including pedestrians and cyclists, particularly near facilities such as schools, cafés and gardens. Increased space efficiency resulting from reduced lanes in the one-way system gives rise to the opportunity for safety infrastructures like pedestrian fencing and pedestrian crossings, shared lanes and cycling

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facilities. Therefore, it becomes imperative to manage vehicle volumes and provide a more inclusive road environment in order to see these positive benefits.

2.3.4 Kerbside Function

Kerbsides are commonly associated with private vehicle parking, however contemporary views are shifting this perception, placing a larger emphasis on pedestrian-friendly environments. Particularly in local areas attracting valued communities and visitors, such as residential, recreational and commercial areas, an evolution of kerbside function observes a balancing act between road access and mixed usage, including parklets, café dining and bike parking. This is still in parallel with providing adequate connections with the wider transport network, facilitating the safe, reliable and efficient movement of people and goods (Austroads. *Integrating Safe System with Movement and Place for Vulnerable Road Users*. 2020).

Benefits of these kerbsides experienced by people include positive amenity, increased on-street activity, increased active and public transport use, long-term sustainability, reduced noise and emissions pollution, as well as social equity. Economic benefits are also experienced by local businesses (Austroads. *Integrating Safe System with Movement and Place for Vulnerable Road Users*. 2020).

Kerbside function that reduces vehicle volume and speed, helps aim to eliminate death and serious injury under the Safe System Approach. Increased space efficiency also gives rise to infrastructure to provide additional protection to pedestrians, such as fencing, speed management and pedestrian crossings.

Converting the existing two-way (undivided) road to a one-way road would improve the kerbside function along Parklands Road and The Avenue, improving street accessibility and amenities through:

- Widening of existing footpaths
- Additional shared paths for both pedestrians and cyclists
- Additional green space or plants along the kerb and footpaths
- Kerbside parking for visitors of local facilities, in addition to designated car parks.

This transformation is shown as an example in Figure 2-5 and Figure 2-6, whereby the northbound carriageway (represented by the 'up' arrow) is used to extend the footpath and provide parklets containing green space and plants.



Figure 2-5 Two-way arrangement example



Figure 2-6 One-way arrangement example: improved kerbside function and widening of footpath

An analysis of Bankstown City Plaza, as a similar case study with a dense pedestrian environment, boasts a one-way traffic lane, a shared zone, and pedestrian amenities featuring lighting, seating and wayfinding. Wide footpaths neatly accommodate large pedestrian volumes, on top of alfresco dining and outdoor retail displays. A low number of vehicles, shorter crossing distances, as well as plants in lieu of pedestrian fencing, help to reduce the possibility of crashes between vehicles and pedestrians. Kerbsides have also been extended to reduce the length people walk over a raised pedestrian crossing, shown in Figure 2-7. The slow road environment ultimately promotes a comfortable active transport experience, whilst still maintaining adequate connections to bus and rail (NSW Centre for Road Safety. *Safe System Assessment Framework for Movement and Place Practitioners*. 2021).



Figure 2-7 Bankstown City Plaza: extended kerbsides to reduce length of raised pedestrian crossing

3. Parklands North

The future location of Parklands connection to Baxter is currently under review with the intention to provide a north-south link between existing Parklands to Baxter to suit the future urban design of this area. It is also noted that:

- The traffic on Kangoo Road north of Baxter Track was predicted to be limited. As part of the Stage 1 traffic modelling, GHD has estimated the bidirectional future volumes on Kangoo Road north of Baxter Track to be less than 100 veh/h, as shown in Figure 3-1.
- Existing land-uses would also use Baxter Track and Parklands Road following the extension of Parklands Road to Baxter Track and the formalisation of the Kangoo Road / Baxter Track intersection. These include the Sunnyfield Community Services Hub and the Juvenile Justice Centre. These land-uses are not major contributors to peak hour traffic. Conservatively, it is assumed that these trips contribute approximately 50 vehicles / hour on the North South Link during peak periods.

Kangoo Road / Baxter Track intersection will operate within capacity with the proposed design layout (see Figure 3-2) as a priority-controlled intersection, experiencing an LoS A, acceptable DoS and minor delays, based on the results from the microsimulation traffic model. It was predicted that the traffic will be accommodated by the proposed single lane (per direction) of Baxter Track.

Further road safety investigations should be undertaken during the concept design stage.

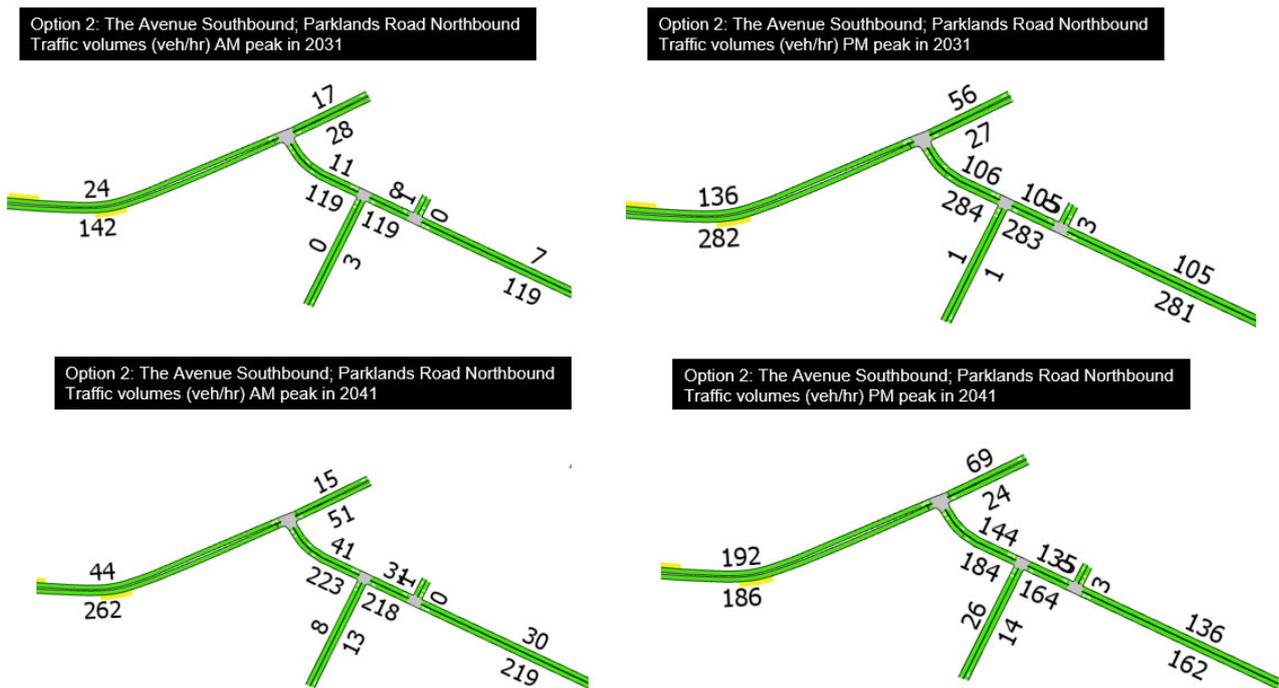


Figure 3-1 Traffic volume at Kangoo Road / Baxter Track intersection (2031 / 2041)

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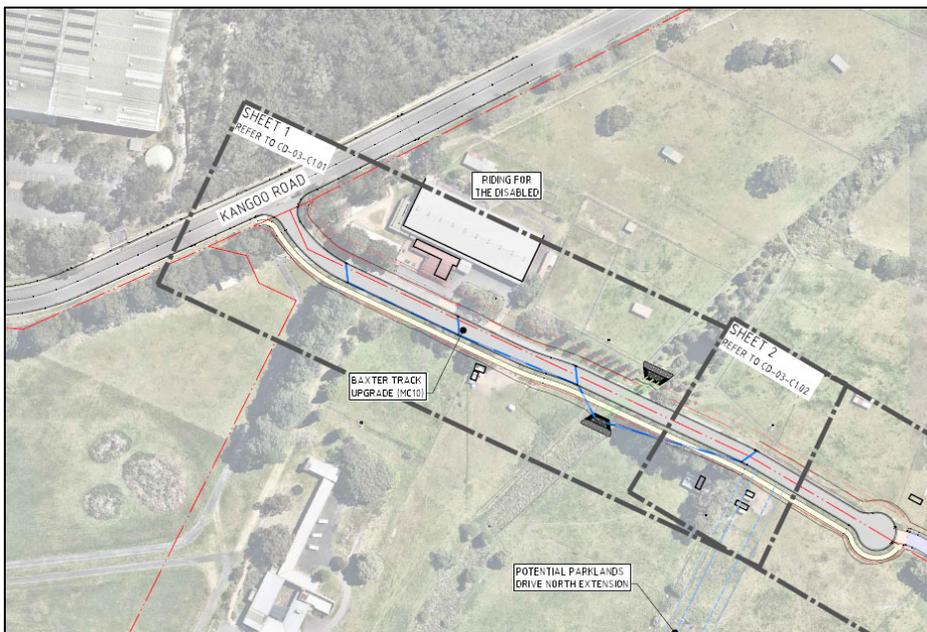


Figure 3-2 Concept design layout, Kangoo Road / Baxter Road

4. Conclusion

In summary, a clockwise one-way system (Option 2) on Parklands Road and The Avenue was found to be superior to both a two-way system and anti-clockwise system (Option 1), observing a traffic volume reduction. It was found that the proposed Kangoo Road / Baxter Track intersection layout is anticipated to operate within capacity. Additional investigations should be carried out as a consequence of the school expansions, with respect to pedestrian infrastructure, public transport and traffic management.

Assessment of the proposed one-way system on The Avenue and Parklands Road was undertaken. Two options were assessed: Option 1 follows an anti-clockwise direction, whilst Option 2 follows a clockwise direction (see Figure 2-1 and Figure 2-2). One-way systems have positive safety benefits, including reduced road exposure, crash conflict points, and crash impact speeds. Kerbside functions are improved through upgrades in footpaths, shared paths, green space and kerbside parking.

The traffic modelling results (summarised in Table 1) indicate that Option 2 is the preferred option, observing:

- A reduction of traffic volume on The Avenue in comparison to the existing two-way arrangement and Option 1
- A reduction in traffic volume on Festival Drive in the eastbound direction, consequently improving access to Kariong Mountains High School
- Additional queueing capacity and a more direct route for vehicles exiting Mt Penang, via the Avenue toward Central Coast Highway, which is critical in the congested PM peak

Kangoo Road / Baxter Track intersection is anticipated to operate within capacity, with the proposed design layout provided by HCCDC being a priority-controlled intersection. Based on the results from the microsimulation traffic model, it is expected to experience an LoS A, acceptable DoS and minor delays. It was predicted that the proposed single lane (per direction) on Baxter Track provided adequate capacity. Further road safety investigation is undertaken as part of the road safety audit during the concept design stage.