GTAconsultants

Traffic Assessment Review
55 Coonara Avenue, West Pennant Hills

draft

Client // MU Group
Office // NSW
Reference // N148250
Date // 10/08/18

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Issue: A-Dr 10/08/18

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GTA Consultants Office: NSW

Quality Record

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Table of Contents

1.	**Introduction**	**1**
1.1	Background	1
1.2	Purpose of this Report	1
1.3	References	2
2.	**Existing Conditions**	**3**
2.1	Existing Network	4
2.2	Existing Traffic	5
2.3	Existing Network Performance	16
3.	**Traffic Impact Assessment**	**18**
3.1	Traffic Generation	18
3.2	Traffic Impact Assessment	34
3.3	Potential Impact on buses with and without the proposed development traffic	37
4.	**Conclusion**	**38**

Appendices

A: Survey Results

B: SIDRA INTERSECTION Results

C: Appendix Title

Figures

Figure 2.1:	Subject Site and Its Environs	3
Figure 2.2:	Coonara Avenue- looking southbound outside the site access point	4
Figure 2.3:	AM Peak Hour Volume	6
Figure 2.4:	PM Peak Hour Volume	6
Figure 2.5:	Existing AM Peak Hour Traffic Volumes	7
Figure 2.6:	Existing PM Peak Hour Traffic Volumes	8
Figure 2.7:	Observed Queue Length at Oakes Road / Aiken Road roundabout	10
Figure 2.8:	Observed Queue Length at Coonara Avenue / Highs Road / Taylor Street intersection	10
Figure 2.9:	Observed Queue Length at Coonara Avenue / Castle Hill Road / Edward Bennett Drive intersection	11
Figure 2.10:	Observed Queue Length at Highs Road / Castle Hill Road / County Drive intersection	12
Figure 2.11:	Observed Queue Length at Aiken Road during AM peak period	13

Figure 2.13:	Origin-Destination Analysis	15
Figure 3.1:	Percentage Traffic Distribution under Scenario 1	19
Figure 3.2:	Scenario 1 Development Traffic -AM Peak Hour	20
Figure 3.3:	Scenario 1 Development Traffic - PM Peak Hour	21
Figure 3.4:	Percentage Traffic Distribution under Scenario 2	24
Figure 3.5:	Scenario 2 Development Traffic -AM Peak Hour	25
Figure 3.6:	Scenario 2 Development Traffic - PM Peak Hour	26
Figure 3.7:	Percentage Traffic Distribution under Scenario 3	29
Figure 3.8:	Scenario 3 Development Traffic – AM Peak Hour	30
Figure 3.9:	Scenario 3 Development Traffic – PM Peak Hour	31
Figure 3.10:	Proposed Layout at Aiken Road / Oakes Road intersection	37

Tables

Table 2.1:	Origin-Destination Survey Locations	14
Table 2.2:	SIDRA INTERSECTION Level of Service Criteria	16
Table 2.3:	Existing Performance Results	16
Table 3.1:	Traffic Generation Estimates	18
Table 3.2:	Level of Service Summary	34
Table 3.3:	Scenario 1 Operating Conditions	34
Table 3.4:	Scenario 2 Operating Conditions	35
Table 3.5:	Scenario 3 Operating Conditions	36

1. Introduction

1.1 Background

GTA has been engaged by Mu Group (the client) to assess the wider network impacts of proposed rezoning of land at 55 Coonara Avenue West Pennant Hills. The site is presently zoned as office/commercial and is proposed to be zoned as a mix of high and low density residential. Mirvac proposes to develop a total of 600 dwellings (200 low density and 400 apartment style dwellings) within the site.

Anton Reich Consulting (ARC) have previously prepared a traffic impact assessment[1] (ARC Report) for the proposed development. Their assessment looked at the impact of the traffic generated by the development on the nearby intersection of Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive. The Hills Shire Council identified the need to assess the wider impacts of this development traffic particularly on congested intersections such as the Oakes Road/Aiken Road.

ARC have assessed comprehensive scenarios looking at trip generation for the site. It is noted that should the full commercial potential of the site be realised, it would generate significantly higher amount of traffic as compared to what is currently being proposed. As such, the zoned potential of the site was never realised with the highest occupancy being 3500 staff in 1980. This number has significantly dropped since then and 2015 estimates show that about 1200 staff are currently employed there.

With the decreasing employment figures, it can be deduced that the site was never really an attractive site for commercial operations and therefore never realised its full commercial potential. In assessing the potential impacts of the proposed residential development, trip rates and distribution calculated in Section 3 of the ARC Report have been utilised, noting that these are based on The Hills Shire Council (Council) trip rates.

1.2 Purpose of this Report

This report sets out an assessment of the anticipated traffic impacts of the proposed rezoning development, including consideration of the following:

i existing traffic conditions surrounding the site
ii the traffic generating characteristics of the proposed development
iii the transport impact of the rezoning proposal on the surrounding road network.

[1] 55 Coonara Avenue West Pennant Hills Planning Proposal Revision 4 Traffic Assessment July 2017

1.3 References

In preparing this report, reference has been made to the following:

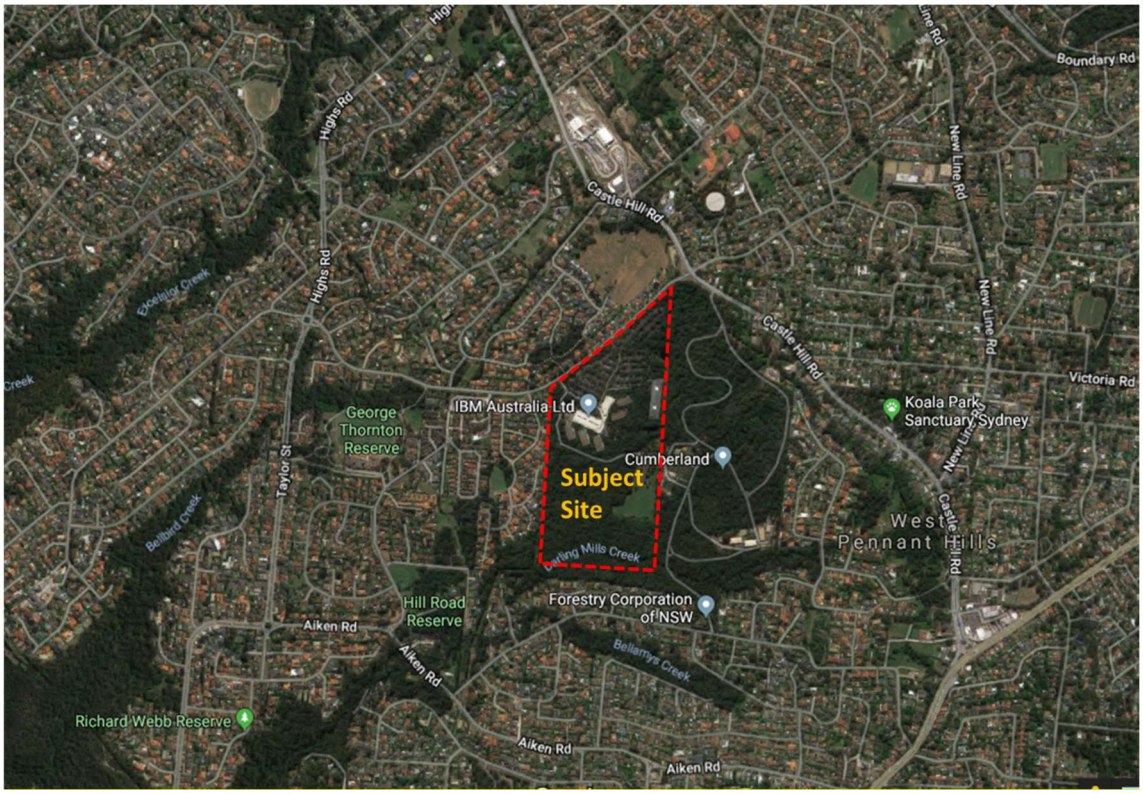
- an inspection of the site and its surrounds
- The Hills Shire Council Development Control Plan (DCP) 2012
- The Hills Shire Council Local Environmental Plan (LEP) 2012
- Anton Reich Consulting Traffic and Transport Traffic Assessment, July 2017
- West Pennant Hills Bus Priority Measure, Cardno, June 2010
- NorthConnex EIS (July 2014)
- other documents and data as referenced in this report.

2. Existing Conditions

The subject site is located at 55 Coonara Avenue, West Pennant Hills. The site currently has a land use classification as B7 Business Park and is occupied by NorthConnex.

The surrounding properties are predominately low density residential. There is a local shopping centre located 300m west of the site. The location of the subject site and its surrounding environs is shown in Figure 2.1.

Figure 2.1: Subject site and its environs



2.1 Existing Network

Coonara Avenue

Coonara Avenue is a collector road and on the northern boundary of the site running in the east-west direction. It is a two-way road with one lane in each direction and a posted speed limit of 50 km/hr. It is a 13m metre wide carriageway, set within a 20-metre-wide road reserve (approximately). Parking lane is marked along the length of Coonara Avenue subject to time restrictions on some sections.

Figure 2.2: Coonara Avenue- looking southbound outside the site access point

Source: Google Maps

Castle Hill Road

Castle Hill Road is a State Road and is generally two lanes in each direction with storage lanes provided for turning traffic. It has a posted speed limit of 60 km/hr.

Figure 2.3: Castle Hill Road – looking westbound

Source: Google Maps

2.2 Existing Traffic

2.2.1 Traffic Surveys

The following surveys were conducted by Council in order to understand the existing conditions within the study area:

- Classified Intersection Counts – Tuesday 5th June 2018Queue Length Surveys – Tuesday 5th June 2018
- Origin-Destination Surveys – Wednesday 7th February 2018

The following sections provide further details on each type of data collected.

Classified Intersection Counts

Classified intersection turn counts were collected at the following four intersections:

- Aiken Road & Oakes Road
- Coonara Avenue & Highs Road & Taylor St
- Coonara Ave & Castle Hill Rd & Edward Bennett Dr
- Highs Rd & Castle Hill Rd & Country Dr

The data was collected for the morning hours from 7 am to 9 am and afternoon hours of 4 pm to 6 pm. The total traffic volumes (summed up across all sites) are shown in Figure 2.4 and Figure 2.5 for AM and PM peak hours respectively. The intersection counts indicate the AM peak period for the study intersections is 8:00 to 9:00am and the PM peak is 4:30 to 5:30pm.

Figure 2.4: AM Peak Hour Volume

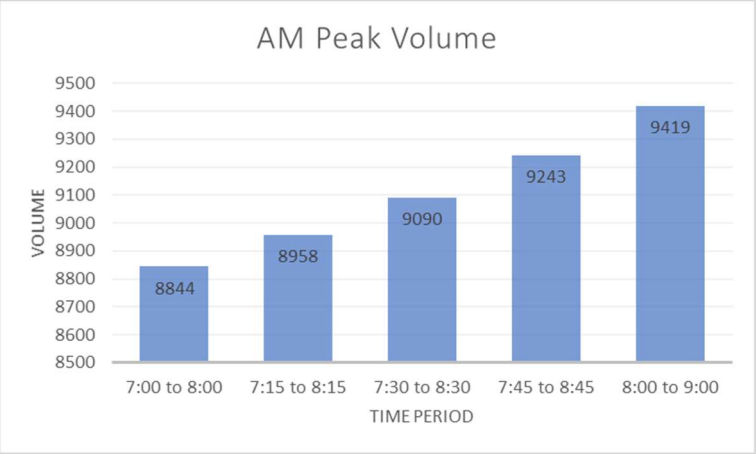
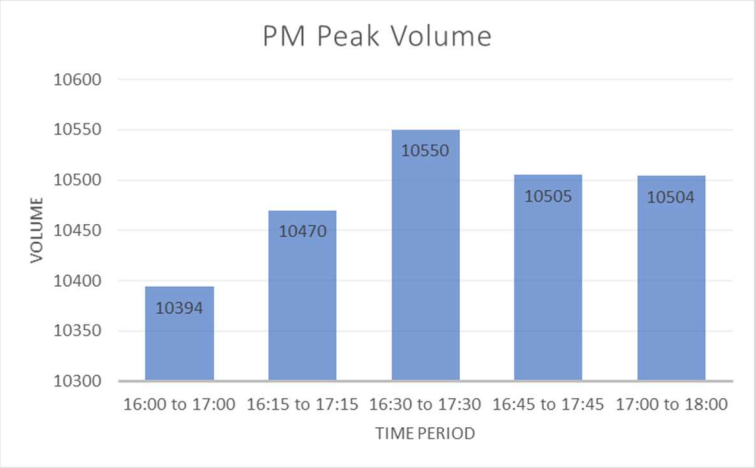


Figure 2.5: PM Peak Hour Volume



The observed peak hour turn traffic for all four intersections is shown in Figure 2.6 and Figure 2.7 for AM and PM peak hours respectively.

Figure 2.6: Existing AM Peak Hour Traffic Volumes

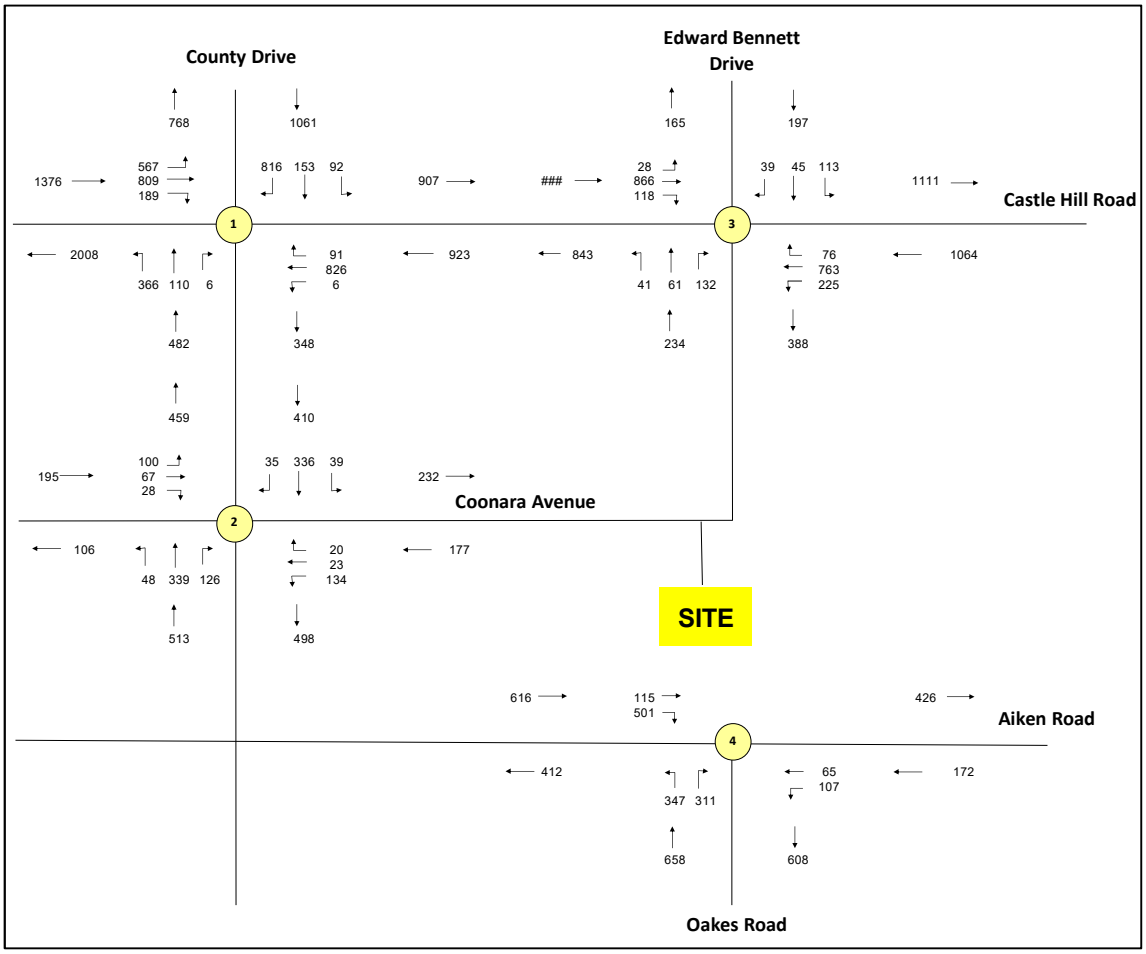
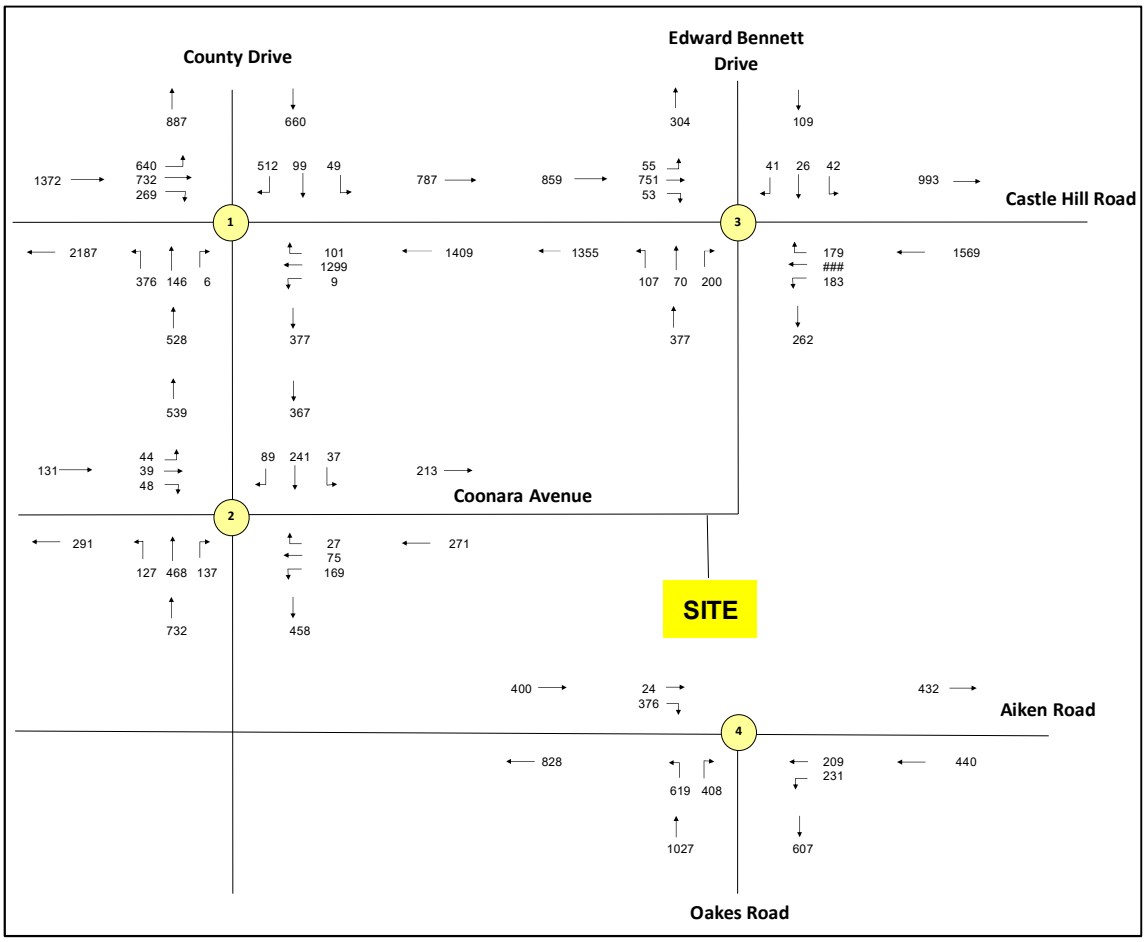
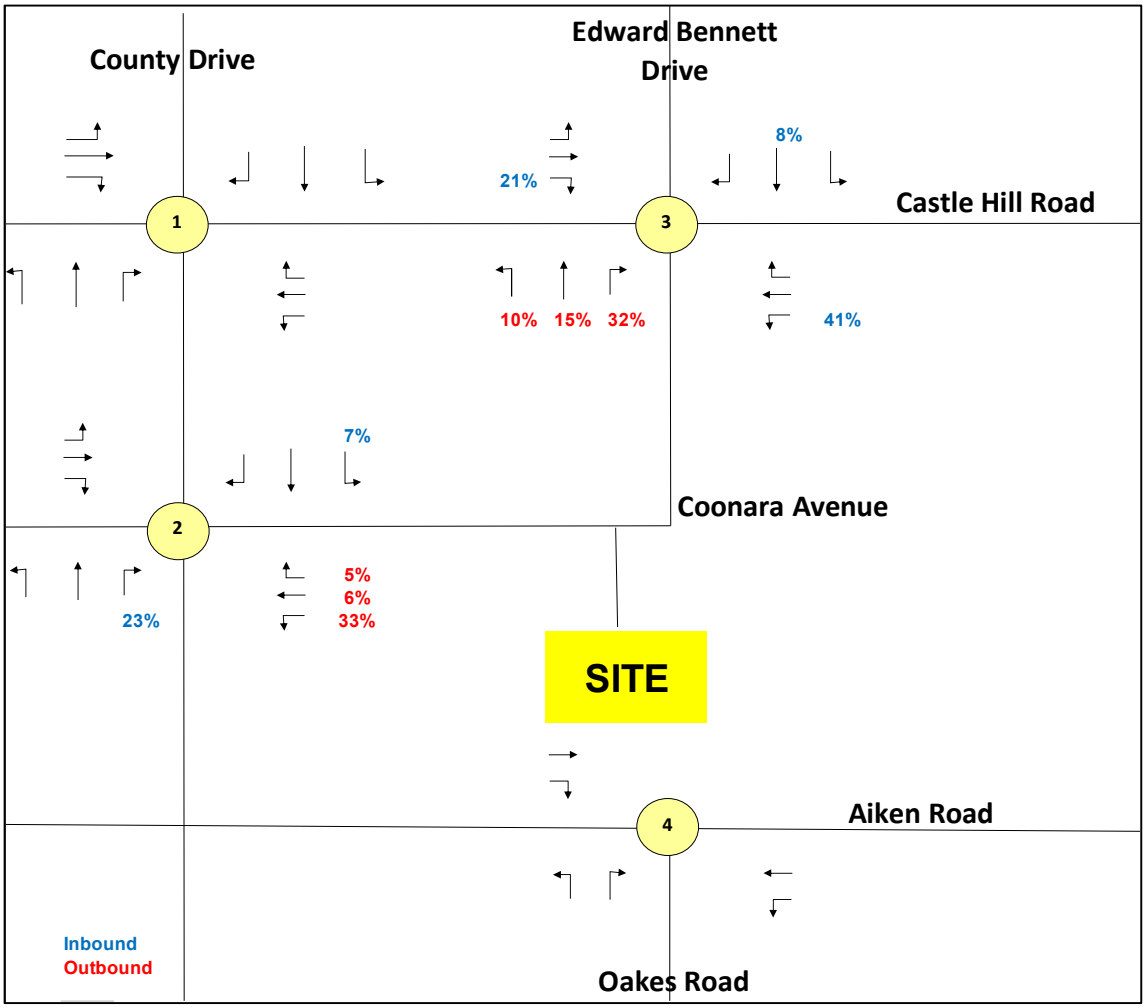


Figure 2.7: Existing PM Peak Hour Traffic Volumes



It is noted that traffic surveys did not include the site access. It is expected that the majority of traffic on Coonara Avenue would either have an origin or a destination at the site as the area is predominantly residential with a small shopping complex including a Woolworths located about 300 meters south of the site. Therefore the existing percentage split (Figure 2.9) inbound and outbound traffic is based on the existing survey data shown in Figure 2.6 and Figure 2.7.

Figure 2.8: Existing Percentage Traffic Distribution



Queue Length Surveys

Consistent with the Intersection count surveys, queue length data was collected for the morning hours from 7 am to 9 am and afternoon hours of 4pm to 6 pm. Observed queue lengths in each traffic lane for the assessed intersections is provided from Figure 2.9 to Figure 2.12

Figure 2.9: Observed Queue Length at Oakes Road / Aiken Road roundabout

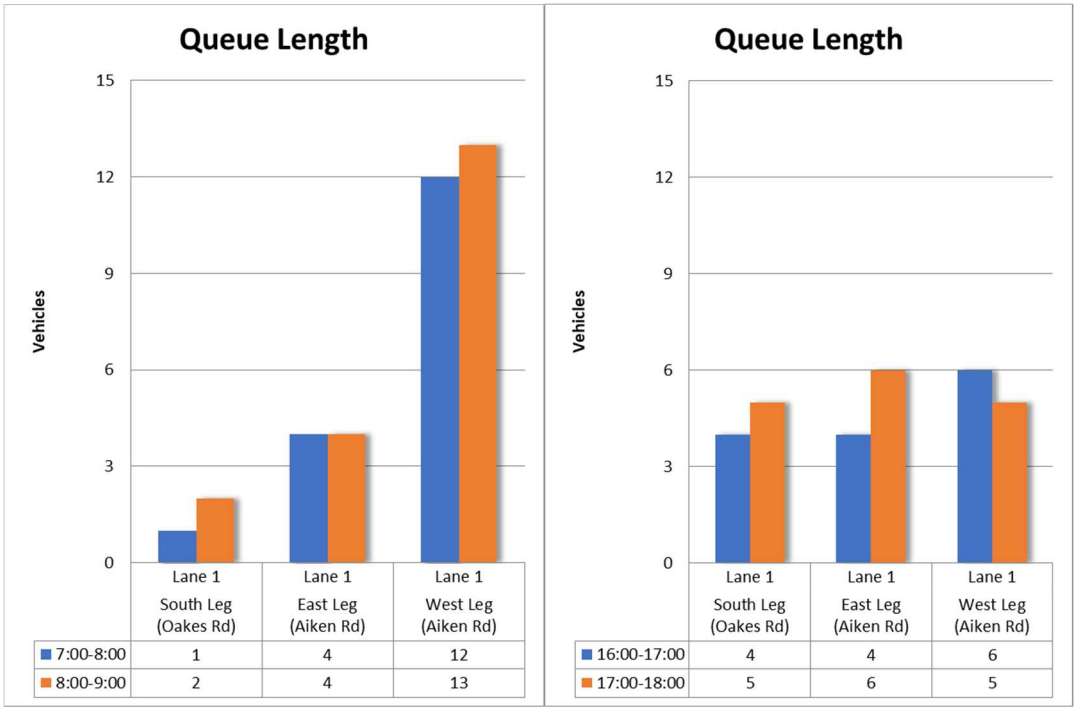


Figure 2.10: Observed Queue Length at Coonara Avenue / Highs Road / Taylor Street intersection

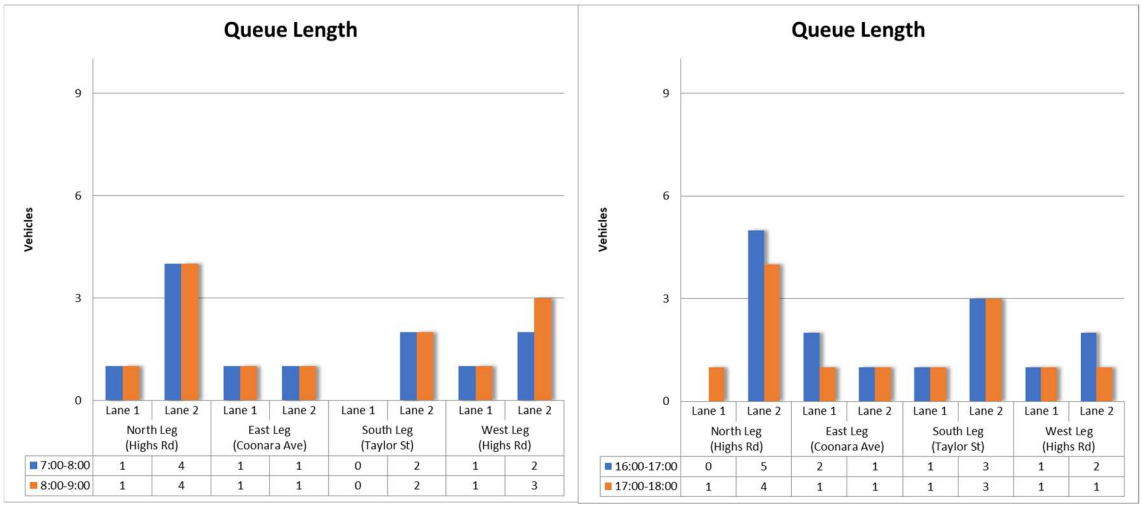
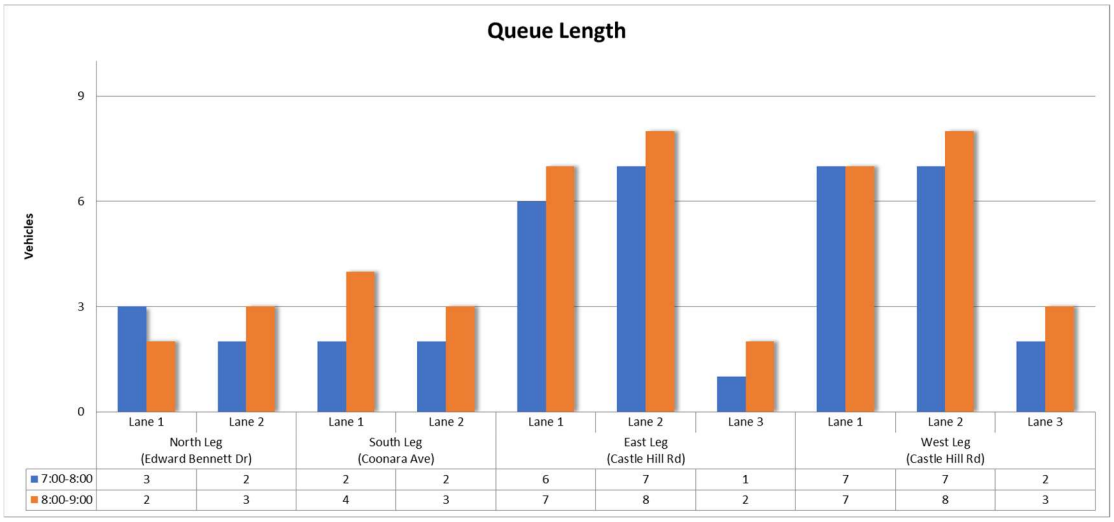
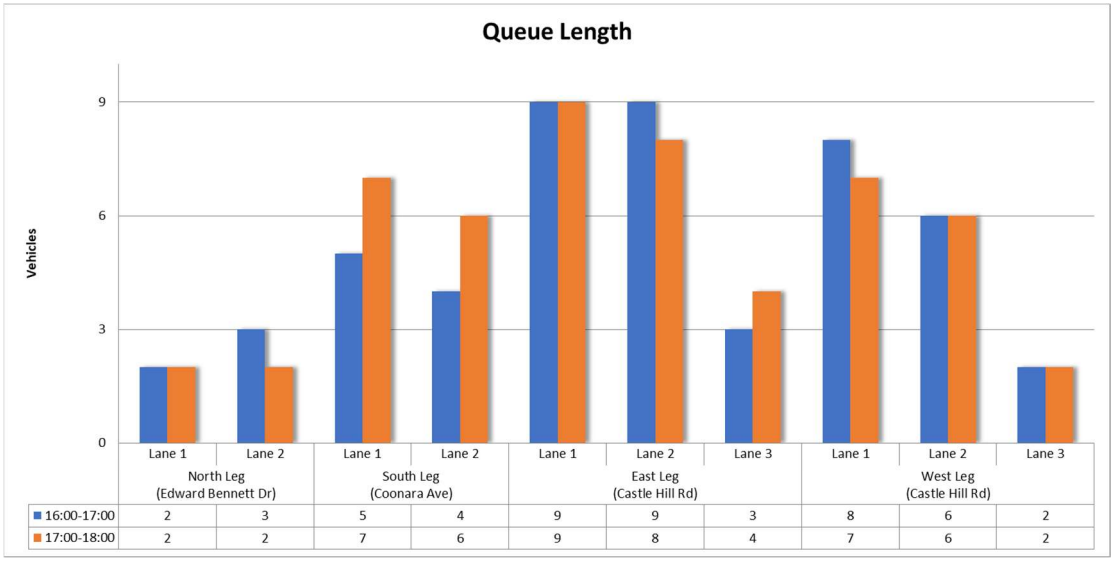


Figure 2.11: Observed Queue Length at Coonara Avenue / Castle Hill Road / Edward Bennett Drive intersection

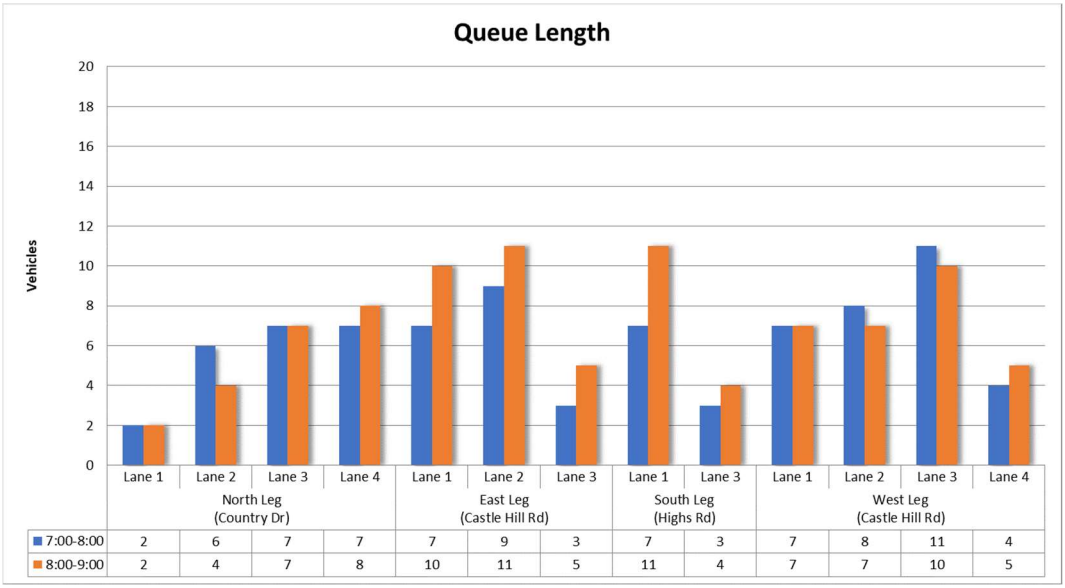


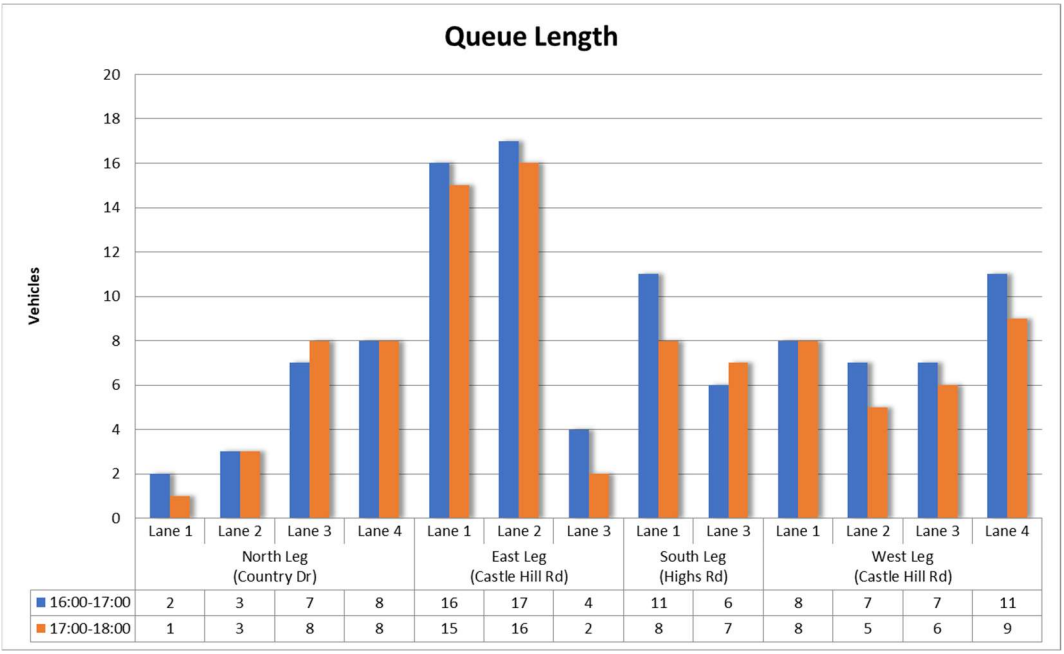
	North Leg (Edward Bennett Dr)		South Leg (Coonara Ave)		East Leg (Castle Hill Rd)			West Leg (Castle Hill Rd)		
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3
7:00-8:00	3	2	2	2	6	7	1	7	7	2
8:00-9:00	2	3	4	3	7	8	2	7	8	3



	North Leg (Edward Bennett Dr)		South Leg (Coonara Ave)		East Leg (Castle Hill Rd)			West Leg (Castle Hill Rd)		
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 3	Lane 1	Lane 2	Lane 3
16:00-17:00	2	3	5	4	9	9	3	8	6	2
17:00-18:00	2	2	7	6	9	8	4	7	6	2

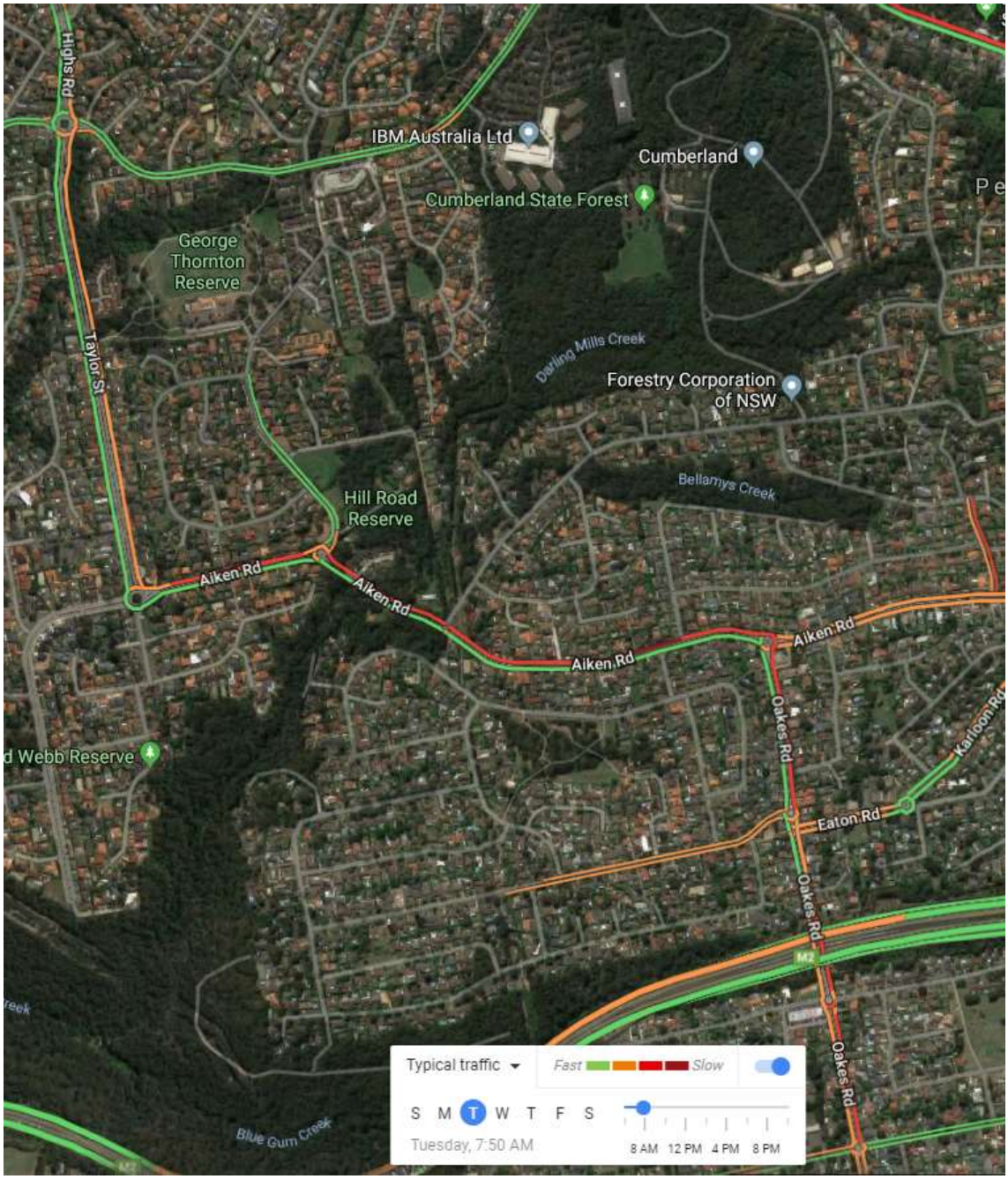
Figure 2.12: Observed Queue Length at Highs Road / Castle Hill Road / County Drive intersection





It is noted that the collection of queue length data is very subjective as it depends on the person collecting data to quantify the queue length. Desktop review and local knowledge indicated that long moving queues are observed at Aiken Road in the eastbound direction that extend from Oakes Road all the way back to Taylor Street during the AM peak period. A screenshot from Google Traffic is provided in Figure 2.13.

Figure 2.13: Observed Queue Length at Aiken Road during AM peak period



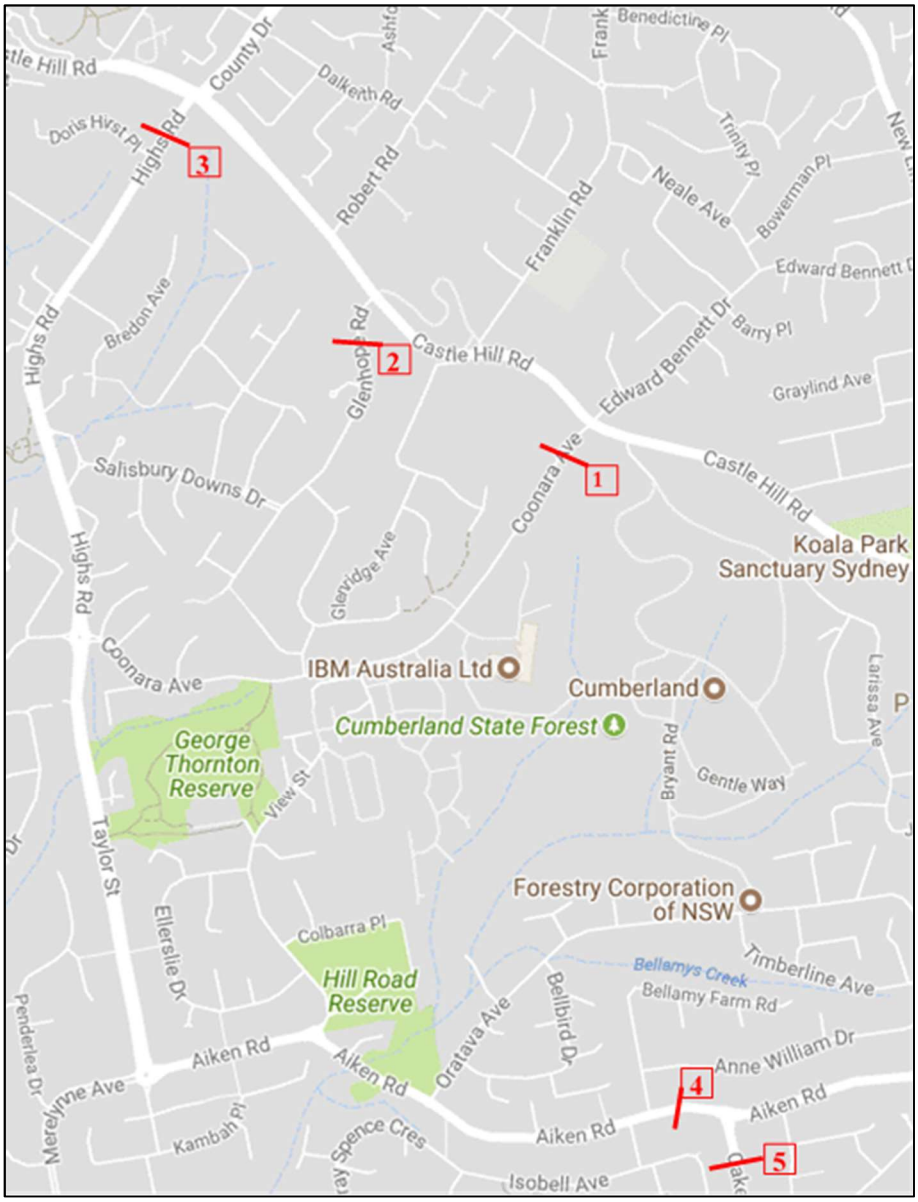
Origin Destination Surveys

To determine travel patterns in the study area, an O-D survey was commissioned by Council on 7th February 2018 at five survey locations for the AM peak period only in the southbound/ eastbound direction. Locations of the five O-D survey stations are described in Table 2.1and shown graphically in Figure 2.14.

Table 2.1: Origin-Destination Survey Locations

Number	Direction	Road	Location
1S	Southbound	Coonara Avenue	south of Castle Hill Road
2S	Southbound	Glenhope Road	south of Castle Hill Road
3S	Southbound	Highs Road	south of Castle Hill Road
4E	Eastbound	Aitken Road	west of Oakes Road
5S	Southbound	Oakes Road	south of Aitken Road

Figure 2.14: Origin- Destination Survey Locations



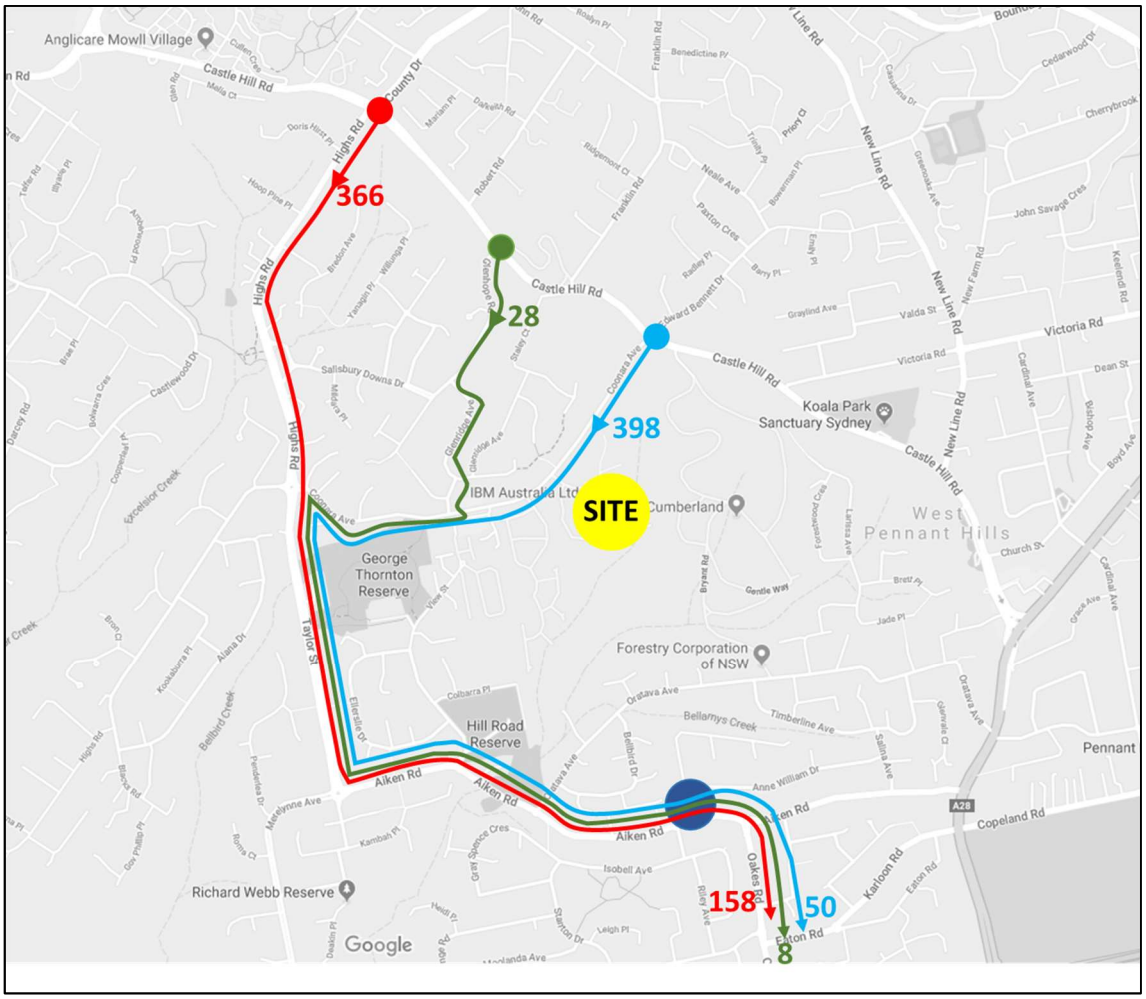
The O-D surveys provide an understanding of how many vehicles utilise Oakes Road to travel towards Paramatta and Carlingford and their respective origins.

Following was observed from the O-D data analysis:

- About 608 vehicles per hour are observed to travel southbound at Oakes Road (Station 5S)
- 36% (216 vehicles) of this southbound traffic is observed to arrive from the three stations in total, namely Coonara Avenue, Glenhope Road and Highs Road.
    - About 158 (26%) vehicles arrive from the Highs Road Station (3S)
    - About 50 (8%) vehicles arrive from the Coonara Avenue Station (1S)
    - About 8 (1%) vehicles arrive from the Glenhope Road intersection (2S)
- Similar amount of traffic is observed travelling southbound at Coonara Avenue (388 veh per hour) and at Highs Road (356 veh per hour)
    - A higher proportion of traffic at Highs Road travels towards Oakes Road (SB) from Highs Road (44%) as compared to Coonara Avenue (13%).

The O-D analysis is shown graphically in Figure 2.15.

Figure 2.15: Origin-Destination Analysis



2.3 Existing Network Performance

The operation of the key intersections within the study area have been assessed using SIDRA INTERSECTION[2], a computer-based modelling package which calculates intersection performance.

The commonly used measure of intersection performance, as defined by the Road and Maritime, is vehicle delay. SIDRA INTERSECTION determines the average delay that vehicles encounter and provides a measure of the level of service.

Table 2.2 shows the criteria that SIDRA INTERSECTION adopts in assessing the level of service. For the purposes of this assessment LOS D is considered acceptable.

Degree of saturation (DOS) is defined as the ration of demand (in vehicles per hour) over the capacity. DOS is a good measure of spare capacity available at the intersection. A DOS >0.9 implies that the intersection is performing close to capacity.

For a signalised intersection an overall average delay is reported whereas for a roundabout the worst movement is reported.

Table 2.2: SIDRA INTERSECTION Level of Service Criteria

Level of Service (LOS)	Average Delay per vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Sign
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Near capacity	Near capacity, accident study required
E	57 to 70	At capacity, at signals incidents will cause excessive delays	At capacity, requires other control mode
F	Greater than 70	Extra capacity required	Extreme delay, major treatment required

Table 2.3 presents a summary of the existing operation of the intersection, with detailed results presented in Appendix B of this report.

Table 2.3: Existing Performance Results

Intersection	Control	Peak	Degree of Saturation (DOS)	Average Delay (sec)	95th Percentile Queue (m)	Level of Service (LOS)
Highs Road/ Castle Hill Road/ County Drive	Signals	AM	0.92	39	164	C
		PM	0.95	46	308	D
Coonara Avenue/ Highs Road/ Taylor Street	Roundabout	AM	0.10	10	4	A
		PM	0.07	9	2	A
Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive	Signals	AM	0.91	34	169	C
		PM	0.89	33	290	C
Aiken Road/ Oakes Road	Roundabout	AM	0.96	44	170	D
		PM	0.47	10	25	A

[2] Program used under license from Akcelik & Associates Pty Ltd.

The following can be observed from the intersection performance results:

- All intersections assessed are performing at acceptable levels (LOS D) or better except for the Aiken Road / Oakes Road roundabout during the AM peak hour.
- The right turn from Aiken Road to Oakes Road is operating at acceptable LOS D, however has a high degree of saturation (>0.9). This is due to the southbound queues at Oakes Road spilling back from upstream intersections as observed in Figure 2.9. Any further increase in traffic will significantly impact the performance of this roundabout.

It is noted that, should the upstream queues not impact the performance of the Aiken Road / Oakes Road roundabout, the roundabout is expected to operate at acceptable levels

3. Traffic Impact Assessment

3.1 Traffic Generation

For the purposes of this assessment the trips generated by the proposed development have been added to the observed traffic volumes at the adjacent intersections. This approach does not exclude traffic generated by the existing land uses at the site (included in the traffic surveys) and is therefore considered on the conservative side

3.1.1 Trip Rates

Traffic generation estimates for the proposed development have been sourced from Section 3 of the ARC Report. Estimated peak hour traffic volumes resulting from the proposal are set out in Table 3.1.

Table 3.1: Traffic Generation Estimates

Period	Traffic Generation Rate (trips)
AM Peak	339
PM Peak	347

Table 3.1 indicates that the site could potentially generate 339 vehicle movements in the AM peak hour and up to 347 vehicle movements in the PM peak hour.

The following trip inbound / outbound distribution has been applied (as per the ARC Report):

- AM Peak hour
  - Arrival – 20%
  - Departure – 80%
- PM Peak Hour
  - Arrival – 80%
  - Departure – 20%

3.1.2 Trip Distribution

With the development of the NorthConnex and the Sydney Metro station it is anticipated that congestion levels at Castle Hill Road and at Pennant Hills Road are likely to reduce. Traffic distribution may also change after opening of the NorthConnex and Sydney Metro in 2019. Therefore, for a robust analysis three different trip distribution analysis have been tested.

- Scenario 1 – 80% traffic to/from Castle Hill Road
- Scenario 2 – 20% traffic to/from Castle Hill Road
- Scenario 3 – 50% traffic to/from Castle Hill Road

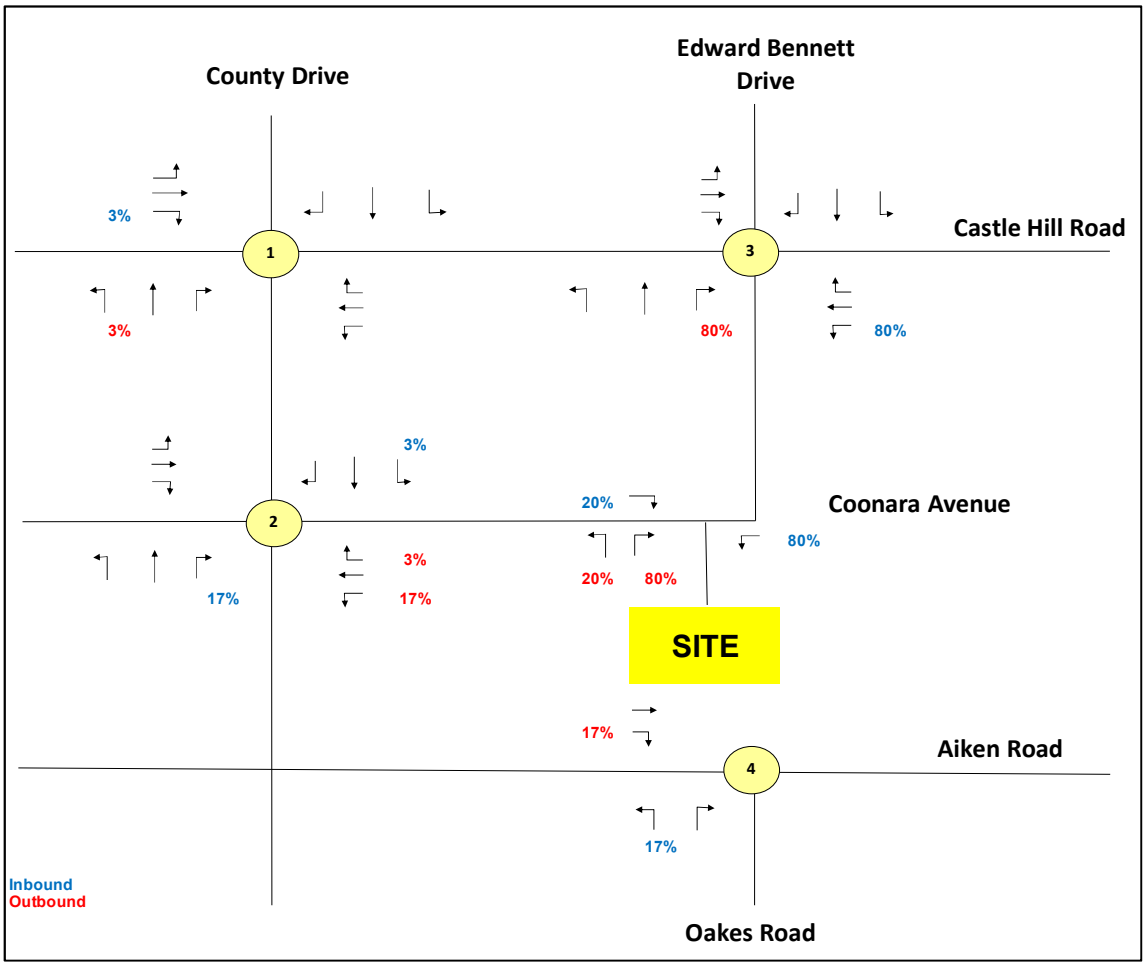
Scenario 1

For the purposes of estimating vehicle movements, the following directional distributions have been assumed:

- Taylor Street 17 per cent
- Highs Road 3 per cent
- Castle Hill Road (via Coonara Avenue) 80 per cent.

Figure 3.1 graphically shows the percentage of traffic distribution across the four intersections.

Figure 3.1: Percentage Traffic Distribution under Scenario 1



Additional traffic generated due to the development under Scenario 1 is shown in Figure 3.2 for the AM peak hour and Figure 3.3 for the PM peak hour.

Figure 3.2: Scenario 1 Development Traffic -AM Peak Hour

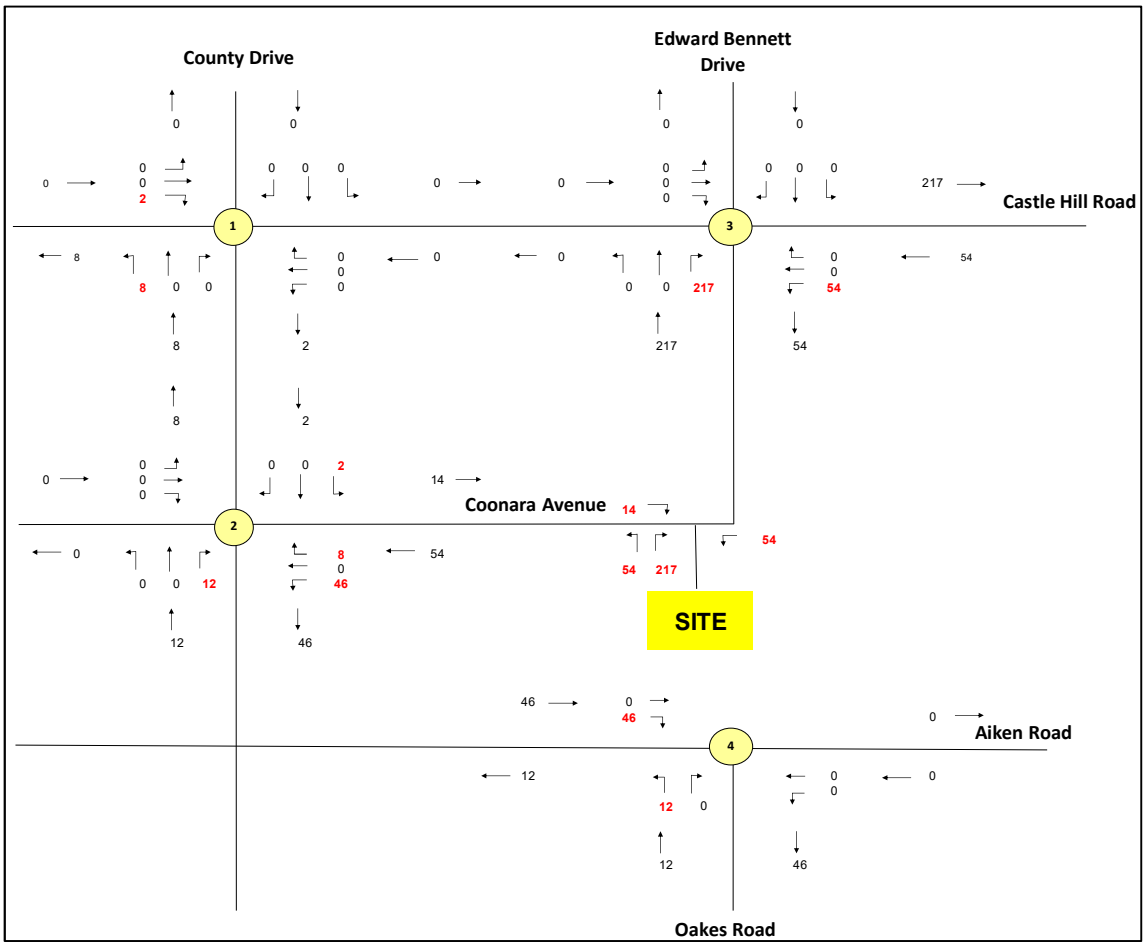
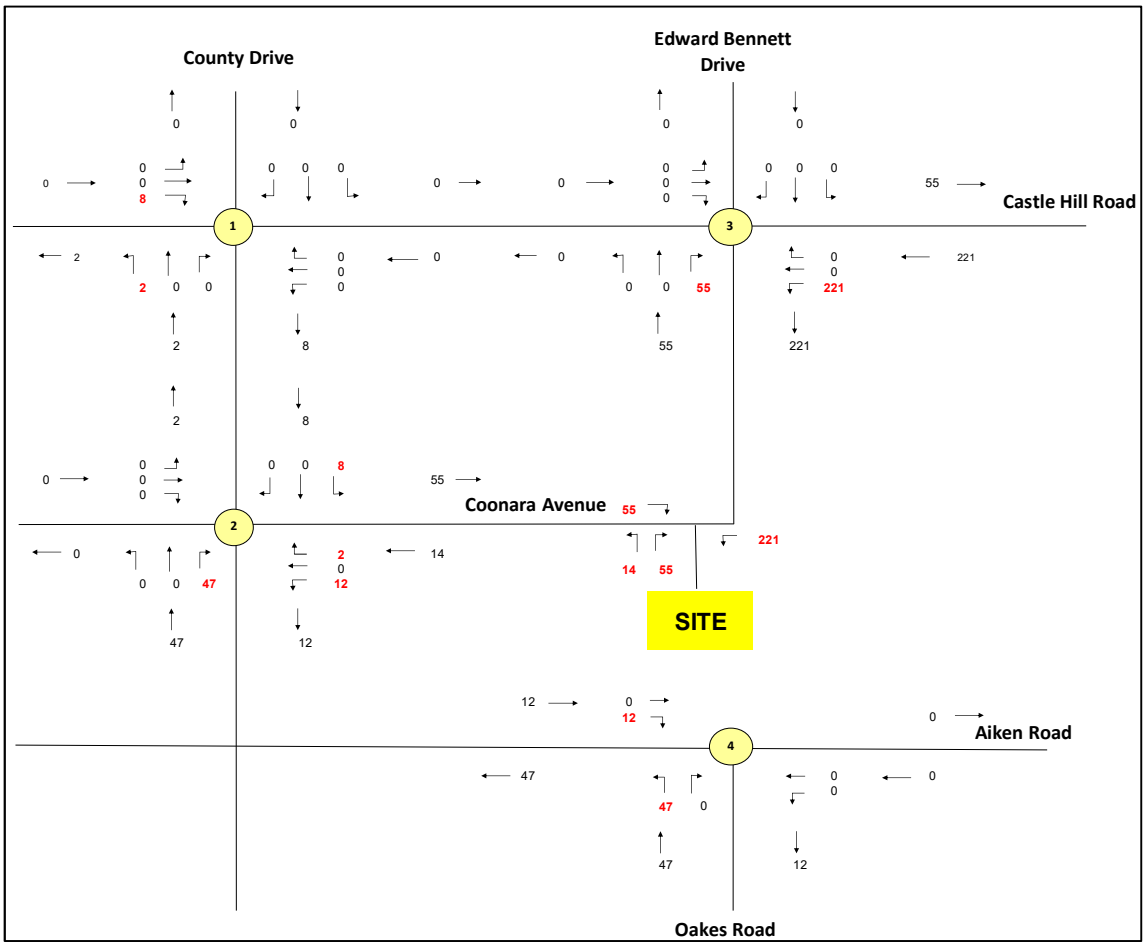


Figure 3.3: Scenario 1 Development Traffic - PM Peak Hour



Total traffic with the proposed development under Scenario 1 is shown in Figure 3.4 and Figure 3.5 for AM and PM peak hours respectively.

Figure 3.4: Scenario 1 total traffic with proposed development – AM Peak Hour

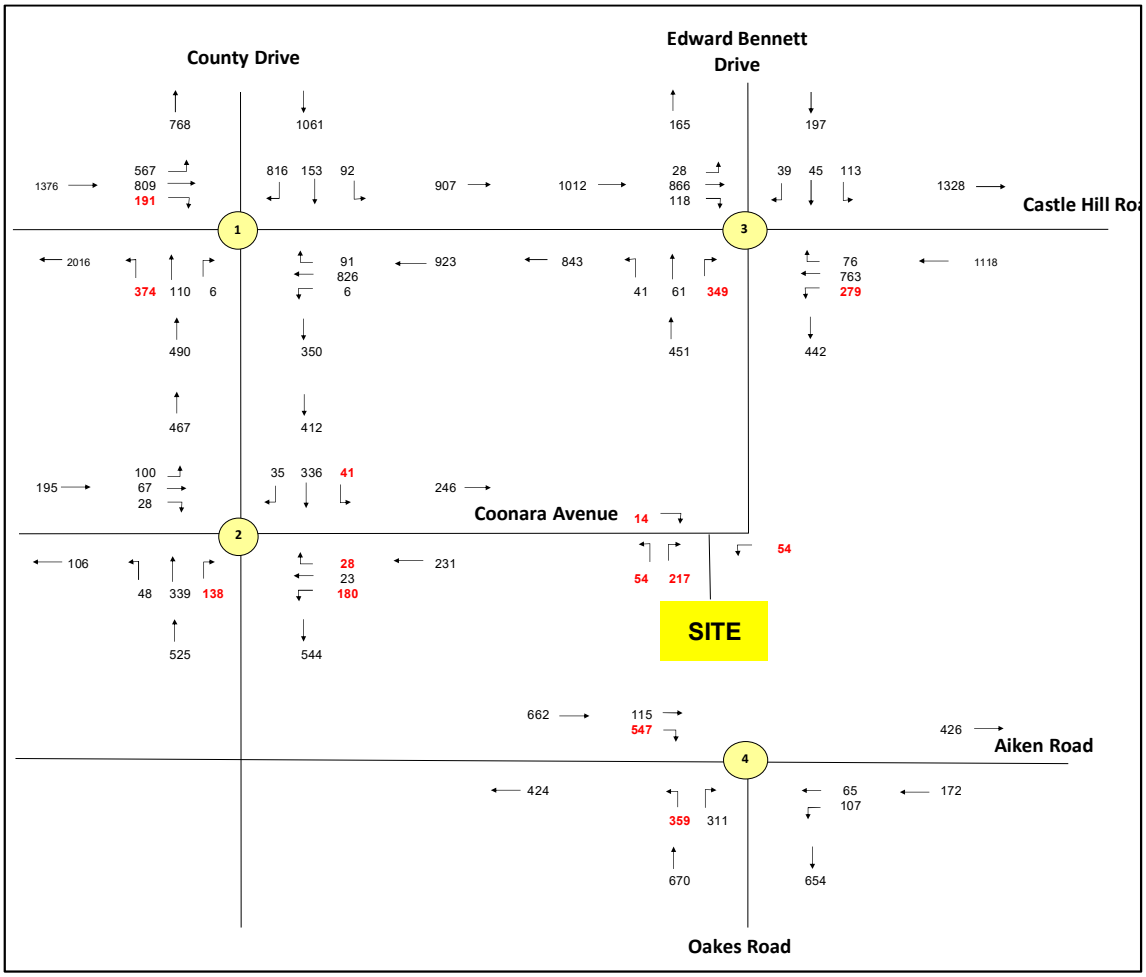
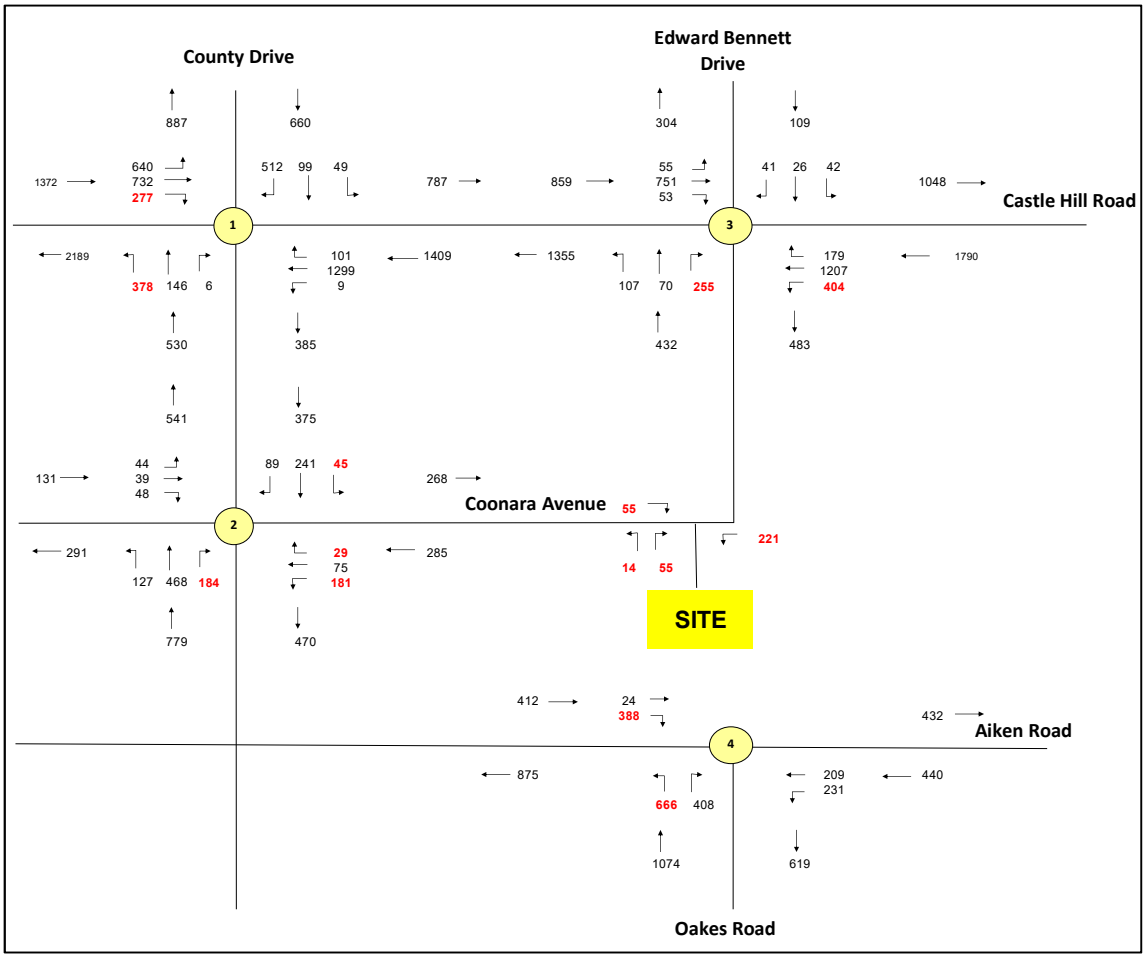


Figure 3.5: Scenario 1 total traffic with proposed development – PM Peak Hour



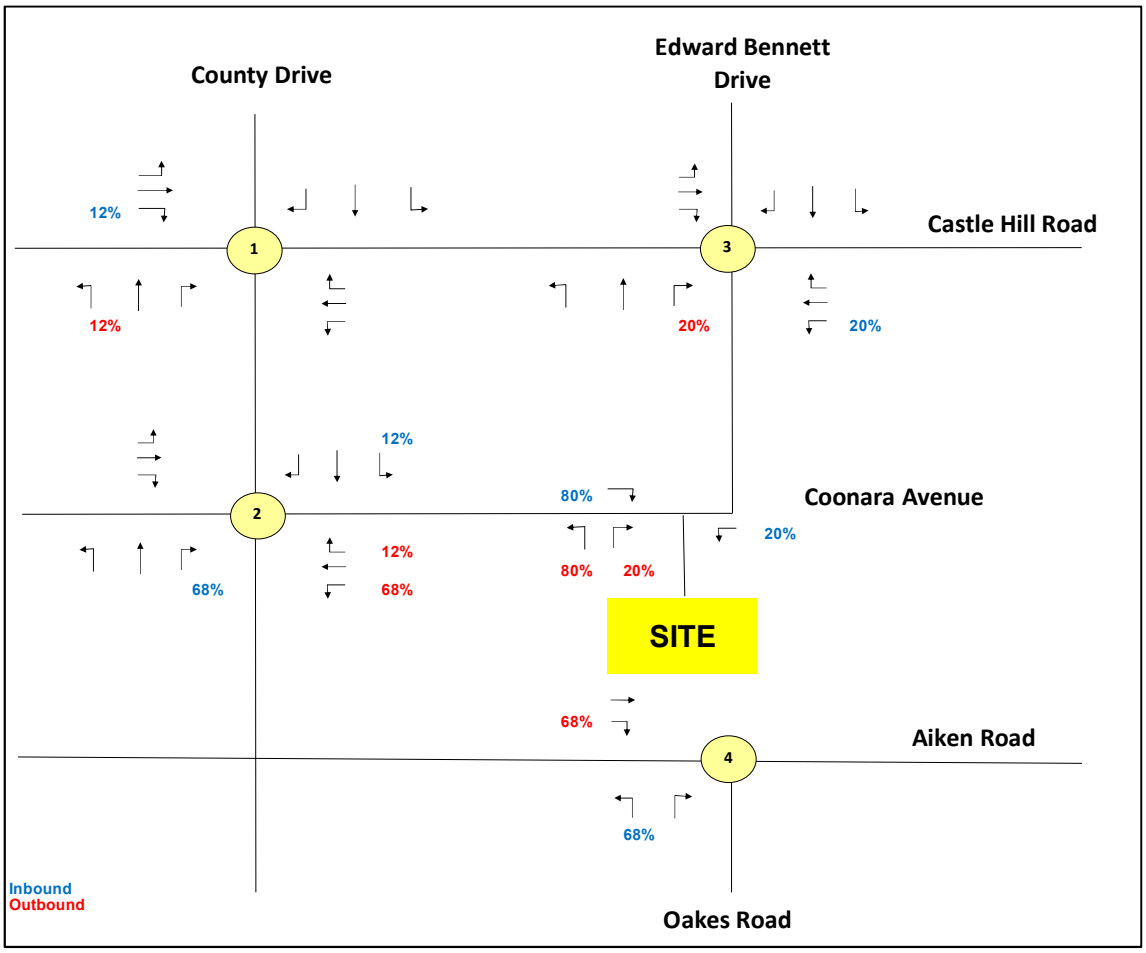
Scenario 2

For the purposes of estimating vehicle movements, the following directional distributions have been assumed under Scenario 2:

- Taylor Street 68 per cent
- Highs Road 12 per cent
- Castle Hill Road (via Coonara Avenue) 20 per cent.

Figure 3.6 graphically shows the percentage of traffic distribution under Scenario 2 across the four intersections.

Figure 3.6: Percentage Traffic Distribution under Scenario 2



Additional traffic generated due to the development under scenario 2 is shown in Figure 3.7 for the AM peak hour and Figure 3.8 for the PM peak hour.

Figure 3.7: Scenario 2 Development Traffic -AM Peak Hour

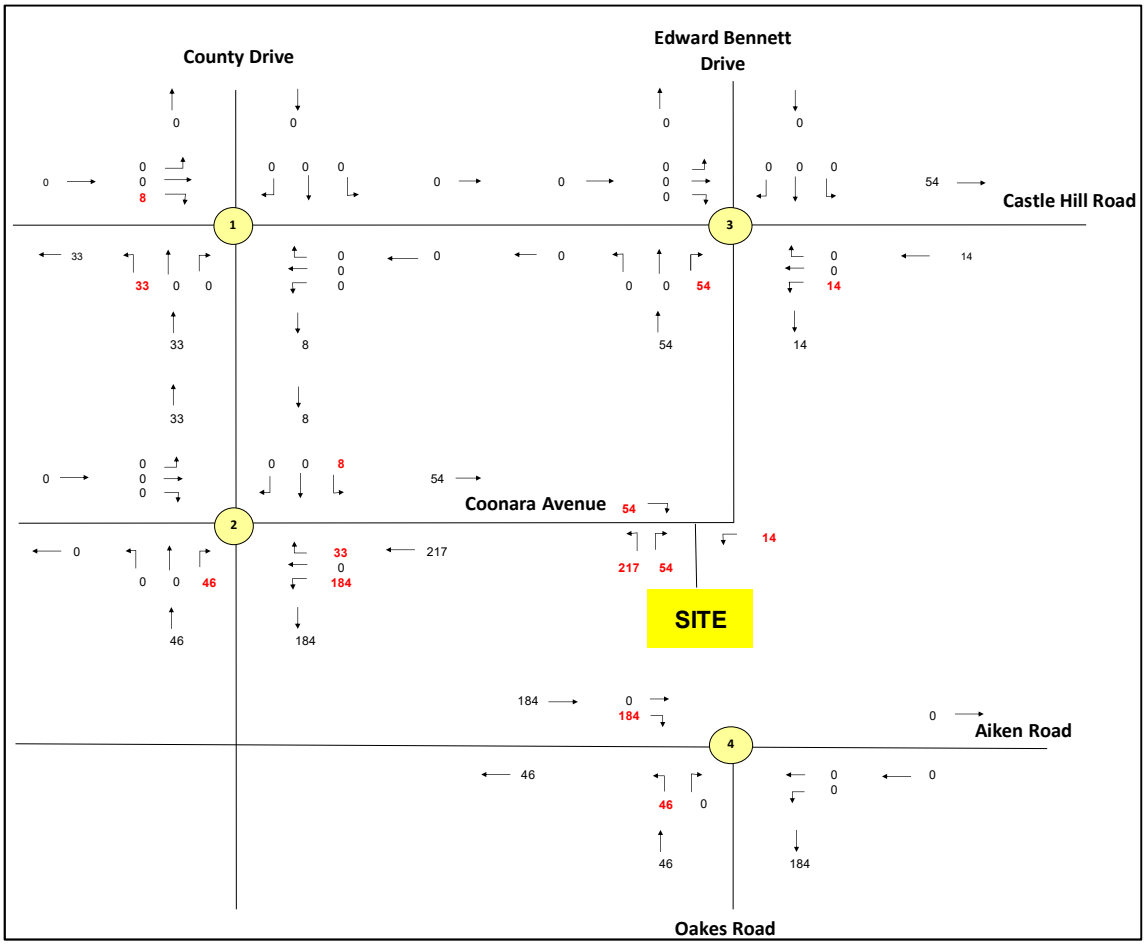
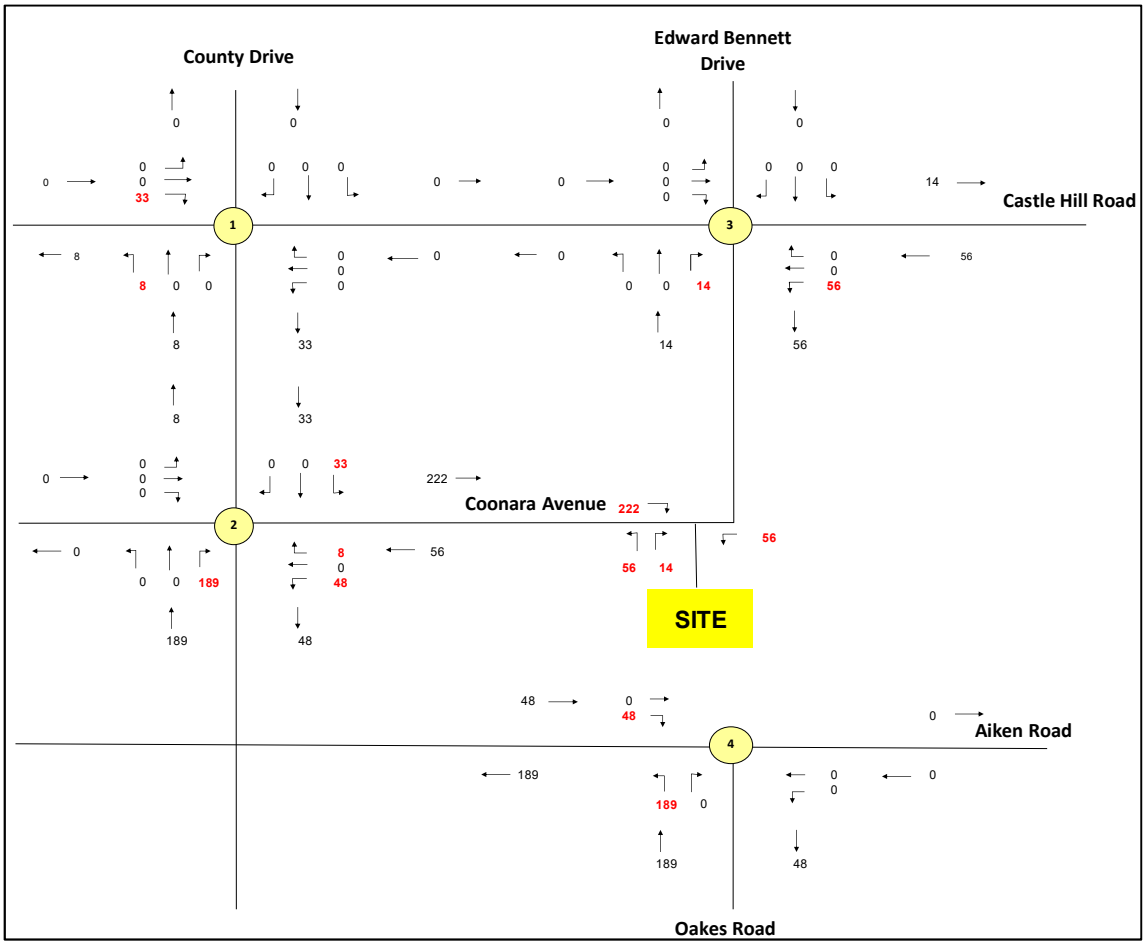


Figure 3.8: Scenario 2 Development Traffic - PM Peak Hour



Total traffic with the proposed development under Scenario 2 is shown in Figure 3.9 and Figure 3.10 for AM and PM peak hours respectively.

Figure 3.9: Scenario 2 Total Traffic - AM Peak Hour

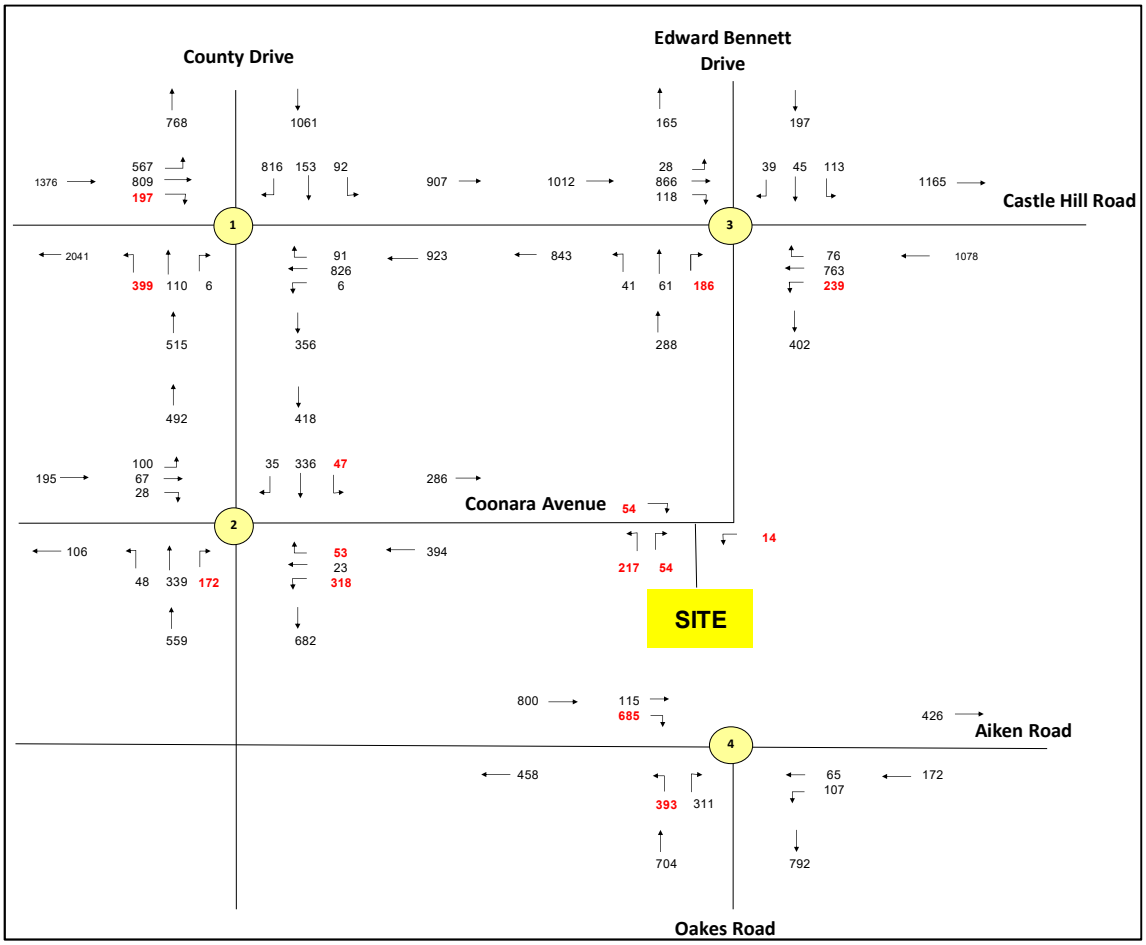
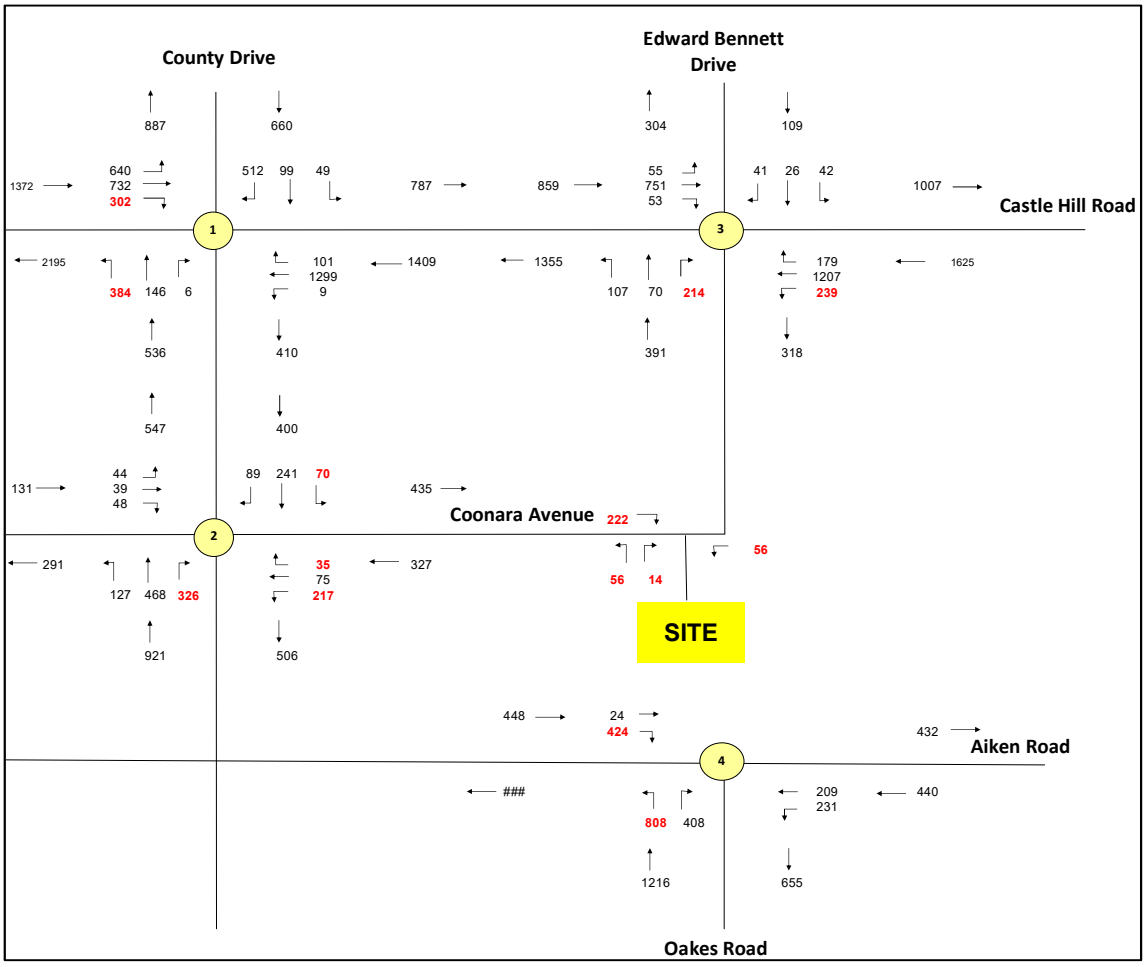


Figure 3.10: Scenario 2 Total Traffic - PM Peak Hour



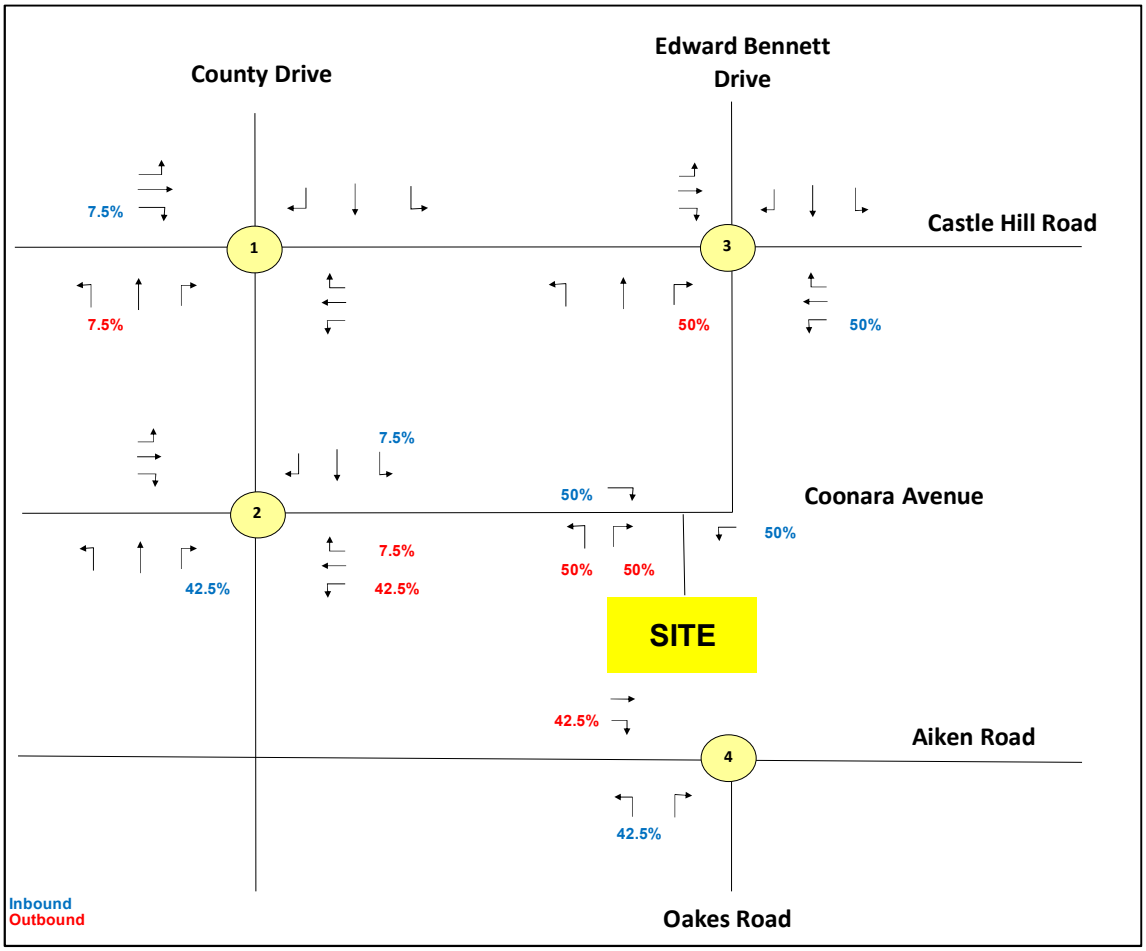
Scenario 3

For the purposes of estimating vehicle movements, the following directional distributions have been assumed:

- Taylor Street 42.5 per cent
- Highs Road 7.5 per cent
- Castle Hill Road (via Coonara Avenue) 50 per cent.

Figure 3.11 graphically shows the percentage of traffic distribution under Scenario 3 across the four intersections.

Figure 3.11: Percentage Traffic Distribution under Scenario 3



Additional traffic generated due to the development under scenario 3 is shown in Figure 3.12 for the AM peak hour and Figure 3.13 for the PM Peak hour.

Figure 3.12: Scenario 3 Development Traffic – AM Peak Hour

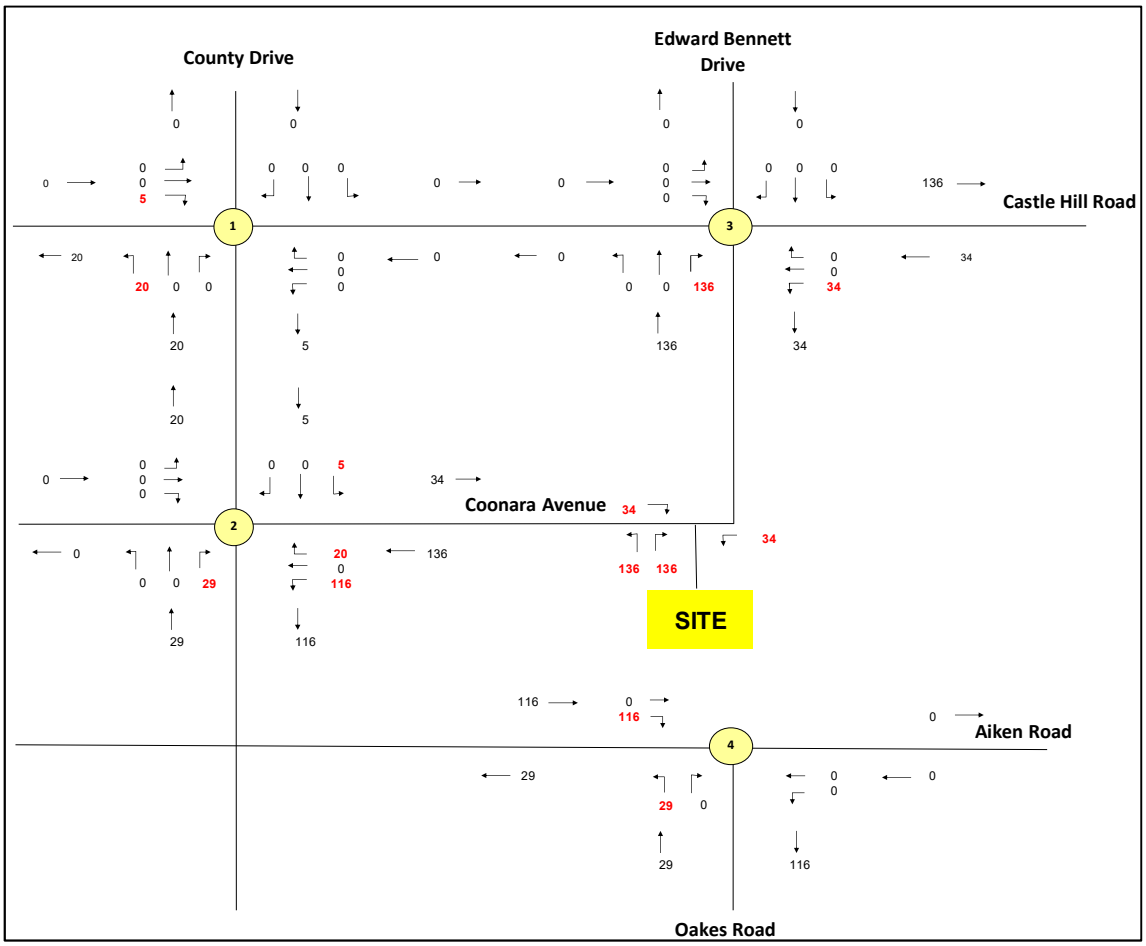
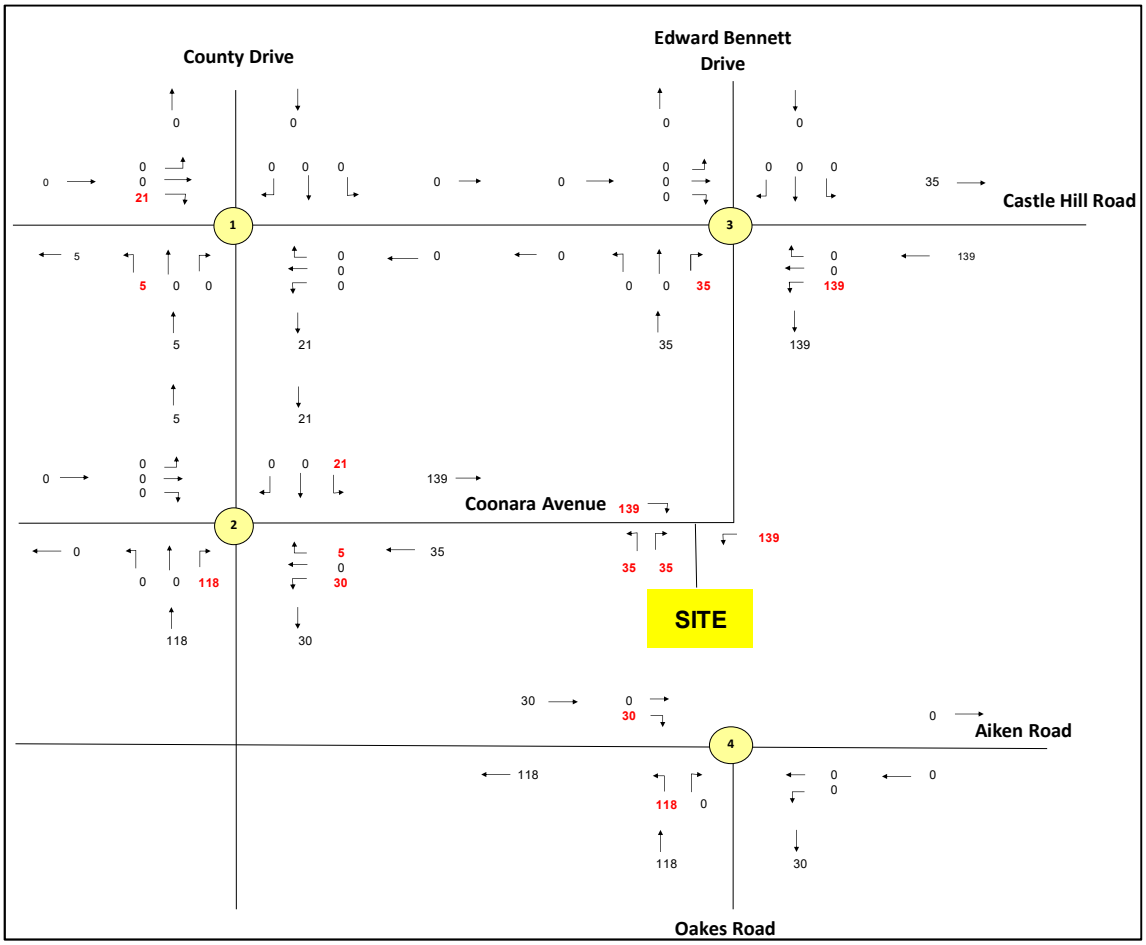


Figure 3.13: Scenario 3 Development Traffic – PM Peak Hour



Total traffic with the proposed development under Scenario 2 is shown in Figure 3.14 and Figure 3.15 for AM and PM peak hours respectively.

Figure 3.14: Scenario 3 Total Traffic – AM Peak Hour

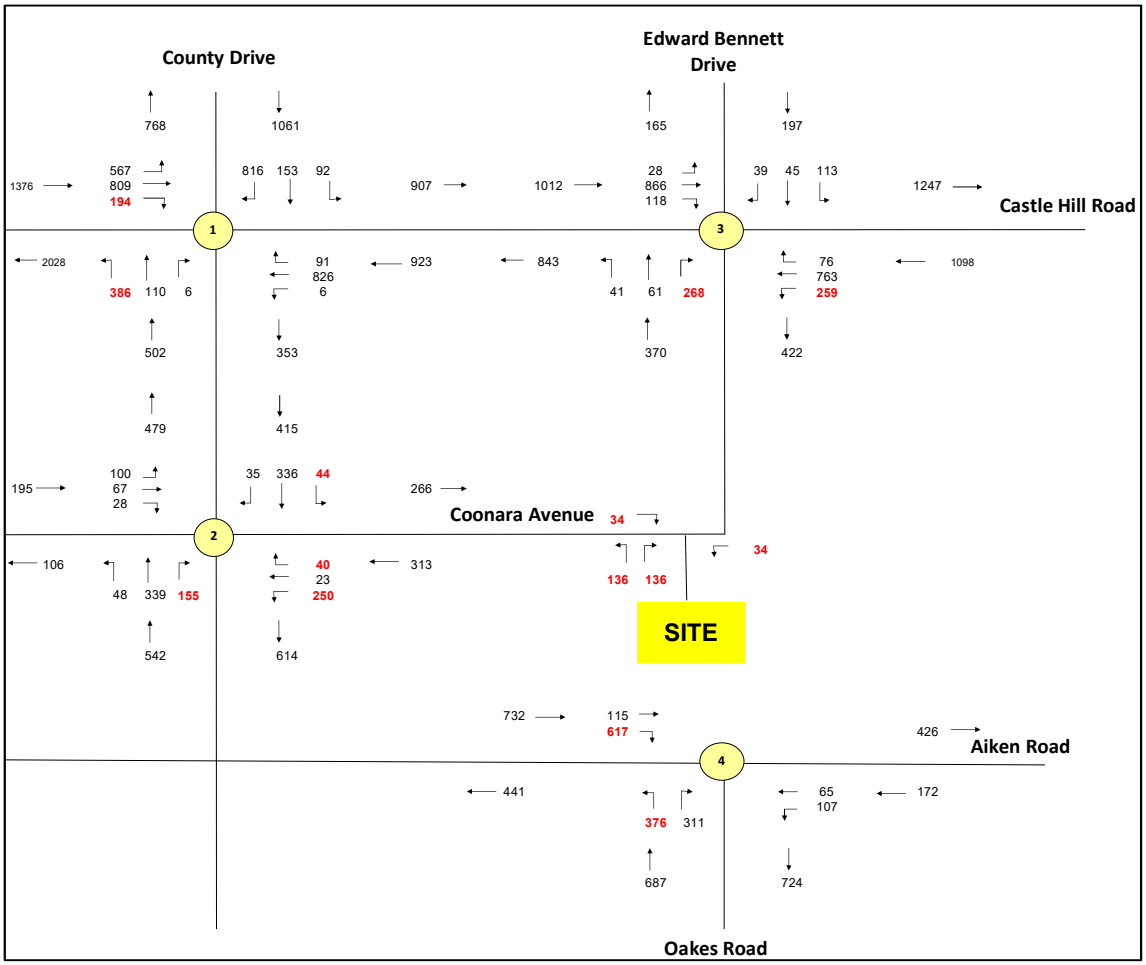
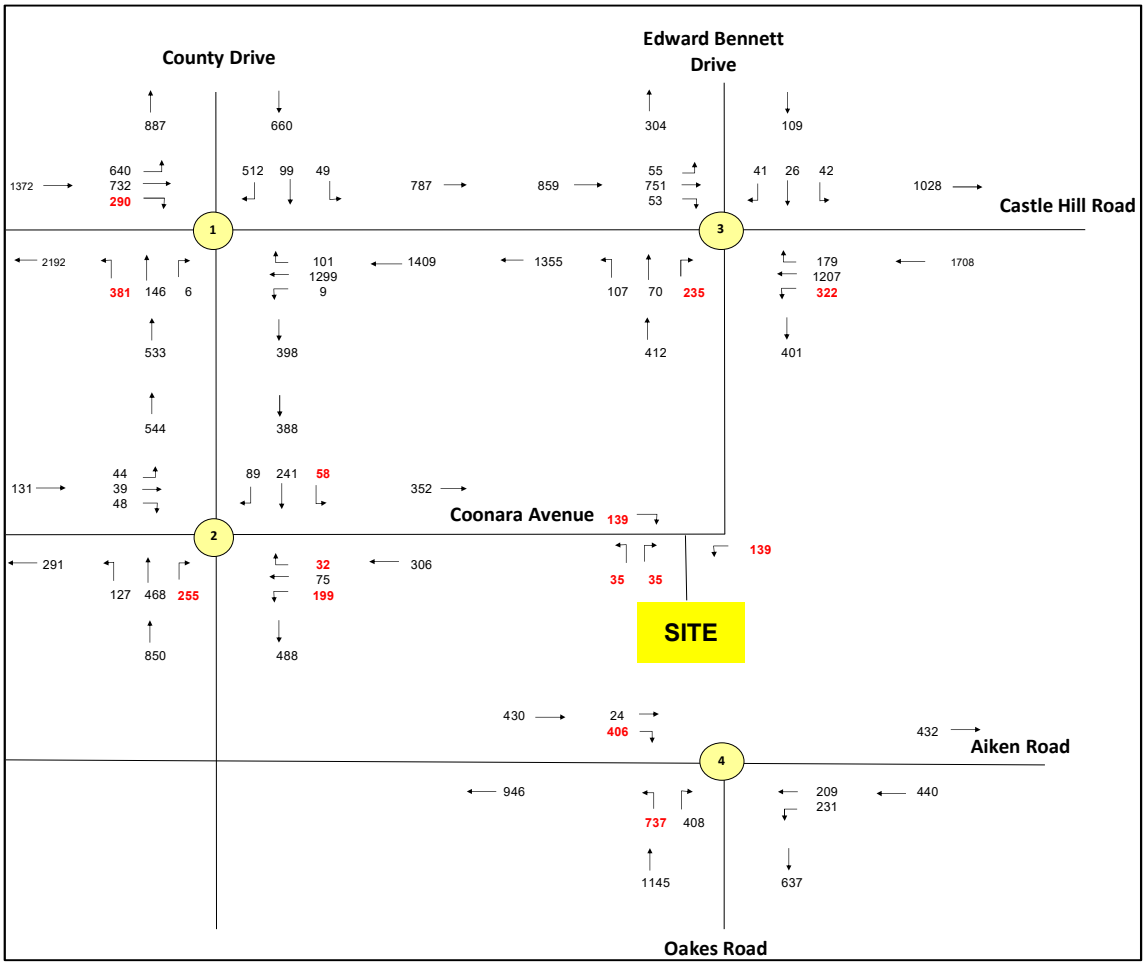


Figure 3.15: Scenario 3 Total Traffic – PM Peak Hour



3.2 Traffic Impact Assessment

All four intersections were assessed in SIDRA using volumes estimated for the three distribution scenarios. The LOS results are summarised in Table 3.2 with detailed results provided in Appendix B.

Table 3.2: Level of Service Summary

Intersection	Peak	Existing Conditions	Scenario 1	Scenario 2	Scenario 3
Highs Road/ Castle Hill Road/ County Drive	AM	C	C	C	C
	PM	D	D	D	D
Coonara Avenue/ Highs Road/ Taylor Street	AM	A	A	A	A
	PM	A	A	A	A
Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive	AM	C	C	C	C
	PM	C	D	C	C
Aiken Road/ Oakes Road	AM	D	F	F	F
	PM	A	A	A	A

With the development traffic, all four intersections are expected to operate at similar levels (acceptable LOS D or better) which is comparable to the existing conditions for both the AM and the PM peak hours for all scenarios tested. The Aiken Road/ Oakes Road roundabout is operating at capacity under existing condition and the additional development traffic leads to its deterioration in performance. As outlined in Section 2, the operation of this roundabout is impacted by the upstream queues and should this constraint be removed, the roundabout itself is expected to perform at acceptable levels. Therefore, the impacts from the development traffic is considered minimal at this roundabout and it only exacerbates the existing congestion issues.

Scenario 1 Performance

The performance of all four intersections is summarised in Table 3.3.

Table 3.3: Scenario 1 Operating Conditions

Intersection	Peak	Degree of Saturation (DOS)	Average Delay (sec)	95th Percentile Queue (m)	Level of Service (LOS)
Highs Road/ Castle Hill Road/ County Drive	AM	0.95	40	163	C
	PM	0.95	46	305	D
Coonara Avenue/ Highs Road/ Taylor Street	AM	0.10	10	3	A
	PM	0.08	10	2	A
Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive	AM	0.94	42	234	C
	PM	0.92	46	437	D
Aiken Road/ Oakes Road	AM	1.04	87	332	F
	PM	0.73	10	27	A

The following can be observed from Scenario 1 results:

- Except for the Aiken Road / Oakes Road roundabout, all intersections are performing at acceptable LOS D or better
- Long queues (>200 meters) and a high DOS (>0.9) are observed at Highs Road/ Castle Hill Road/ County Drive intersection indicating that the intersection is operating at capacity during the PM peak hour
- Long queues (>200 meters) and a high DOS (>0.9) are observed at Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive intersection indicating that the intersection is operating at capacity during the PM peak hour

Scenario 2 Performance

The performance of all four intersections is summarised in Table 3.4

Table 3.4: Scenario 2 Operating Conditions

Intersection	Peak	Degree of Saturation (DOS)	Average Delay (sec)	95th Percentile Queue (m)	Level of Service (LOS)
Highs Road/ Castle Hill Road/ County Drive	AM	0.95	42	178	C
	PM	0.96	49	318	D
Coonara Avenue/ Highs Road/ Taylor Street	AM	0.12	10	3	A
	PM	0.09	10	3	A
Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive	AM	0.92	36	181	C
	PM	0.94	36	323	C
Aiken Road/ Oakes Road	AM	1.29	284	979	F
	PM	0.82	11	5	A

The following can be observed from Scenario 2 results:

- Except for the Aiken Road / Oakes Road roundabout, all intersections are performing at acceptable LOS D or better
- Long queues (>200 meters) and a high DOS (>0.9) are observed at Highs Road/ Castle Hill Road/ County Drive intersection indicating that the intersection is operating at capacity during the PM peak hour
- Long queues (>200 meters) and a high DOS (>0.9) are observed at Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive intersection indicating that the intersection is operating at capacity during the PM peak hour

Scenario 3 Performance

The performance of all four intersections is summarised in Table 3.5

Table 3.5: Scenario 3 Operating Conditions

Intersection	Peak	Degree of Saturation (DOS)	Average Delay (sec)	95th Percentile Queue (m)	Level of Service (LOS)
Highs Road/ Castle Hill Road/ County Drive	AM	0.92	41	176	C
	PM	0.97	53	309	D
Coonara Avenue/ Highs Road/ Taylor Street	AM	0.11	10	4	A
	PM	0.08	10	3	A
Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive	AM	0.93	39	208	C
	PM	0.88	40	364	C
Aiken Road/ Oakes Road	AM	1.17	180	643	F
	PM	0.52	11	29	A

The following can be observed from Scenario 3 results:

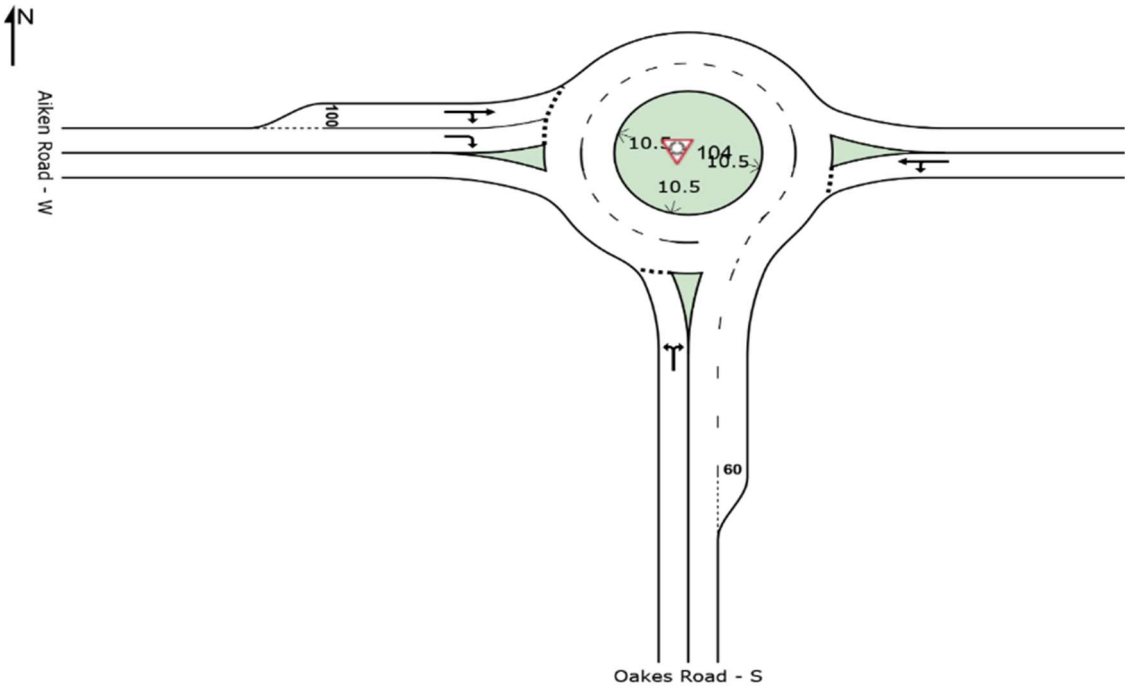
- Except for the Aiken Road / Oakes Road roundabout, all intersections are performing at acceptable LOS D or better
- Long queues (>200 meters) and a high DOS (>0.9) are observed at Highs Road/ Castle Hill Road/ County Drive intersection indicating that the intersection is operating at capacity during the PM peak hour
- Long queues (>200 meters) and a high DOS (>0.9) are observed at Coonara Avenue/ Castle Hill Road/ Edward Bennett Drive intersection indicating that the intersection is operating at capacity during both AM and PM peak hour

Mitigation Measures

As discussed in Section 3.1.2, travel patterns in the vicinity of the site are likely to change due to the NorthConnex and Sydney Metro opening in year 2019. As such it is expected that congestion levels at Castle Hill Road and Pennant Hills Road improve which may attract some of the existing rut running trips to revert back to the arterial road network. This change in travel patterns offers opportunities for improved performance at the Aiken Road / Oakes Road intersection.

In case the future congestion levels remain at the level observed currently, a potential upgrade option was assessed at the Aiken Road / Oakes Road roundabout. A layout change was assessed for Scenario 2 conditions as this scenario generates the highest proportion of development traffic at this intersection. The proposed layout is shown in Figure 3.16.

Figure 3.16: Proposed Layout at Aiken Road / Oakes Road intersection



The dual right turn provides additional storage capacity and the SIDRA results illustrate that the intersection performs at LOS B and has a DOS of 0.85. Detailed SIDRA results are provided in Appendix B.

3.3 Potential Impact on buses with and without the proposed development traffic

The West Pennant Hills Bus Priority Measures Business Case was prepared by Cardno in June 2010 (the Bus Priority Cardno Report). In general, it proposes to provide dedicated Bus lane along Highs Road and Aiken Road all the way to Oakes Road Roundabout. As the program provides a separate bus lane, it would be expected that impacts to bus travel times resulting from the additional traffic generated by the development would be minimal. Notwithstanding, any additional traffic at intersections where bus priorities cannot be incorporated (give-way or roundabout intersection) is likely to increase delays to bus travel times.

Given the amount of infrastructure upgrades within the area, the travel patterns and levels of congestion are likely to change with some local traffic routes likely to experience reductions in volumes. However, the extent and probability of those changes is still uncertain and outside the scope of this assessment.

4. Conclusion

Based on the analysis and discussions presented within this report it can be concluded the additional traffic generated by the proposed development as such has marginal impact on the performance of the existing network. The SIDRA analysis indicates that there are existing capacity constraints at Castle Hill Road, Oakes Road and Aiken Road. The opening of NorthConnex may help remove some trips from the major corridor in turn relieve congestion on local roads.

The Aiken Road / Oakes Road roundabout is currently performing at capacity and any increase in traffic will lead to long queues and delays at this roundabout. The poor performance of this roundabout is attributed to downstream queues spiling back all the way to this roundabout and reducing its capacity. Therefore, the poor performance of this roundabout due to additional traffic cannot be directly attributed to the development traffic as the additional traffic only aggravates the underlying issue.

Appendix A

Survey Results

Appendix B

SIDRA INTERSECTION Results

Appendix B

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