AECOM Australia Pty Ltd
Level 21, 420 George Street
Sydney NSW 2000
PO Box Q410
QVB Post Office NSW 1230
Australia
www.aecom.com

+61 2 8934 0000 tel
+61 2 8934 0001 fax
ABN 20 093 846 925

Memorandum

To	Michael Gray	Page	1
CC	Peter Lee		
Subject	Quarry Road Intersection Development Application		
From	Sam Gray		
File/Ref No.		Date	10-Jul-2014

1.0 Introduction

AECOM was commissioned by Marsden Park Developments Pty Ltd to prepare traffic advice to assist Brown Consulting in their preparation of the Statement of Environmental Effects (SEE) for the Development Application (DA) for the Quarry Road / Richmond Road intersection.

This memorandum summarises the traffic impacts of the proposed Quarry Road collector and identifies the lane arrangements and turn bay lengths required to accommodate the predicted traffic demands in 2036.

This memorandum is structured as follows:

- Section 2: Background
- Section 3: Methodology
- Section 4: Operational Assessment (AM peak, PM peak and weekend peak)
- Section 5: Cycleway Provision Assessment
- Section 6: Conclusion

2.0 Background

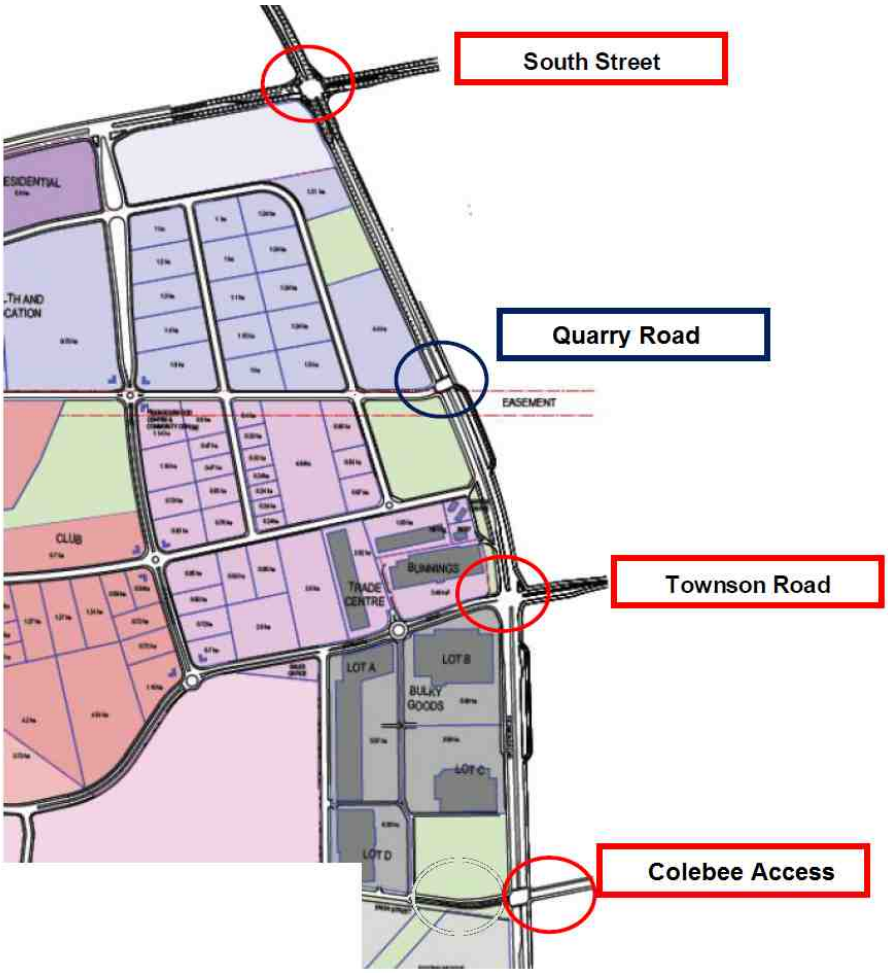
Sydney's Metropolitan Development Strategy identifies the need for an additional 770,000 homes in Sydney by 2036. The North West Growth Centre is one of the major growth areas in Sydney and is planned to accommodate a large portion of this growth. Richmond Road provides a key north-south link through the North West Growth Centre and forms the main road connection to the regional road system for the released precincts of Marsden Park Industrial, Marsden Park, Marsden Park North, Schofields West, Schofields and Colebee. Marsden Park Industrial Precinct is an accelerated employment area located on the western side of Richmond Road between Bells Creek and South Street.

The NSW Roads and Maritime Services (RMS) upgrade of Richmond Road is considered to be a significant step in the improvement of state infrastructure to support investment in the North West Growth Centre. The planned upgrading of what is essentially a two lane rural road to four, and ultimately six lanes, will benefit both the growth centre and the wider community.

In December 2011, AECOM prepared a Richmond Road Upgrade REF (Bells Creek to South Street) submission report (Traffic and Operational Assessment) on behalf of Marsden Park Developments Pty Ltd. The submission stated that the provision of South Street and Townson Road intersections along Richmond Road would have insufficient capacity for the demand forecasted to access the Marsden Park Industrial Precinct by 2036. The report identified the need to provide additional accesses to Richmond Road between Bells Creek and South Street. It recommended a new central collector road and intersection along Richmond Road (at Quarry Road) be built.

Figure 1 presents the layout of the network and the location of Quarry Road intersection with Richmond Road, along with the other access intersections at South Street, Townson Road and Colebee Access.

Figure 1: Proposed intersections along Richmond Road, Marsden Park.



3.0 Methodology

To identify the impact of introducing the Quarry Road intersection in 2036, AECOM:

- Generated the likely traffic caused by the Marsden Park Industrial Precinct.
- Generated the likely distribution of the aforementioned traffic around the Richmond Road corridor.
- Assessed the Quarry Road / Richmond Road intersection performance
- Assessed the requirements and impact of introducing a cycleway on Quarry Road.

3.1 Marsden Park Traffic Generation

The following assumptions were made to predict the number of trips generated by the wider Marsden Park Industrial Precinct in 2036:

- Traffic generated from the Sydney Business Park (SBP) within the Marsden Park Industrial Precinct was based on the land use assumptions identified in AECOM's *Sydney Business Park – Road Network Staging Modelling Report (June 2014)*. The SBP ultimate development form is assumed in 2036.
- Commercial business parks and industrial estates were assumed to have a gross floor area (GFA) equal to 35% of land area.
- Based on the RMS *Technical Direction: Guide to Traffic Generating Developments – Updated Surveys* (May 2013), the generation of traffic from "business parks" and "industrial estates" are considered to be

the same. Accordingly, the Sydney average AM and PM peak values were used to determine the trips generated from the industrial and commercial business park zones.

- Medium residential areas were assumed to contain one dwelling per 450 square metres.
- Based on the RMS *Guide to Traffic Generating Developments* (October 2002), the AM, PM and weekend peak values per dwelling were adopted for the medium residential area.
- The weekend trip rate for business parks / industrial lots was determined from the Richmond Road daily tube counts and weekend peak hour factor and applied to the RMS predicted daily rates.
- The RMS guidelines identifies that a discount for trip chaining (multi-visit trips) can typically be up to 25%. Based on the proposed land use and subsequent relative likelihood of trip chaining in Marsden Park Industrial Precinct, this assessment assumed a discount of 10% was applied to the precinct's traffic generation.
- It has been assumed that the South St extension to Bidwill and surrounding suburbs will provide an alternate access and egress point for the Precinct and spread traffic around the network. As a result, a discount of 15% was applied to site traffic (except SBP).

The trip generation for the AM, PM and weekend peak periods are presented in Table 1**,** Table 2 and Table 3 respectively.

Table 1: AM Peak hour trip generation

Land use	Units	Trip rate	Peak Hour Trips
Business parks and industrial estates	568,519 m^2	0.52 trips / 100m² GFA	2,957
Residential (medium density)	131 dwellings	0.5 per dwelling	66
Total (including 10% multi-visit trip discount then 15% South St extension discount)			2,313
SBP	211,480 m^2	Road Network Staging Modelling Report	1,708
Total			**4,021**

Table 2: PM Peak hour trip generation

Land use	Units	Trip rate	Peak Hour Trips
Business parks and industrial estates	568,519 m^2	0.56 trips / 100m² GFA	3,186
Residential (medium density)	131 dwellings	0.5 per dwelling	66
Total (including 10% multi-visit trip discount then 15% South St extension discount)			2,488
SBP	211,480 m^2	Road Network Staging Modelling Report	1,999
Total			**4,487**

Table 3: Weekend Peak hour trip generation

Land use	Units	Trip rate	Peak Hour Trips
Business parks and industrial estates	568,519 m^2	0.35 trips / 100m² GFA	1,962
Residential (medium density)	131 dwellings	0.5 per dwelling	66
Total (including 10% multi-visit trip discount then 15% South St extension discount)			1,552
SBP	211,480 m^2	Road Network Staging Modelling Report	3,675
Total			**5,227**

3.2 Richmond Road Background Traffic Generation

The Richmond Road background traffic was adopted from AECOM's *Sydney Business Park – Road Network Staging Modelling Report (June 2014)*. The growth rate was based on tube count data over the last three years and highlighted Richmond Road traffic will grow at 1.3% per annum. It has been assumed that background growth will continue at this rate along Richmond Road until 2036.

3.3 Network Traffic Distribution

The trips generation estimates from section 3.1 were distributed over the wider road network, based on the following assumptions:

- During the AM peak, 60% of trips will access lots within the site and 40% will egress lots.
- During the PM peak, 40% will access lots and 60% will egress.
- During the weekend peak, 50% will access lots and 50% will egress.
- With the exception of the SBP, all remaining site traffic has been split directionally 35% to/from the **North**, 5% to/from the **East** and 60% to/from the **South**.
- Of the traffic to/from the **North**, it was assumed that:
    - 75% would use the South Street intersection
    - 15% would use the Quarry Road intersection
    - 10% would use the Townson Road intersection.
- Of the traffic to/from the **East**, it was assumed that:
    - 50% would use the South Street intersection
    - 25% would use the Quarry Road intersection
    - 25% would use the Townson Road intersection.
- Of the traffic to/from the **South**, it was assumed that:
    - 30% would use the South Street intersection
    - 50% would use the Quarry Road intersection
    - 20% would use the Townson Road intersection.

3.4 Traffic Forecast

As a result of the traffic generation and distribution assumption made above, the following figures identify the predicted flows at the Quarry Road intersection in 2036.

Figure 2: AM Peak hour flow

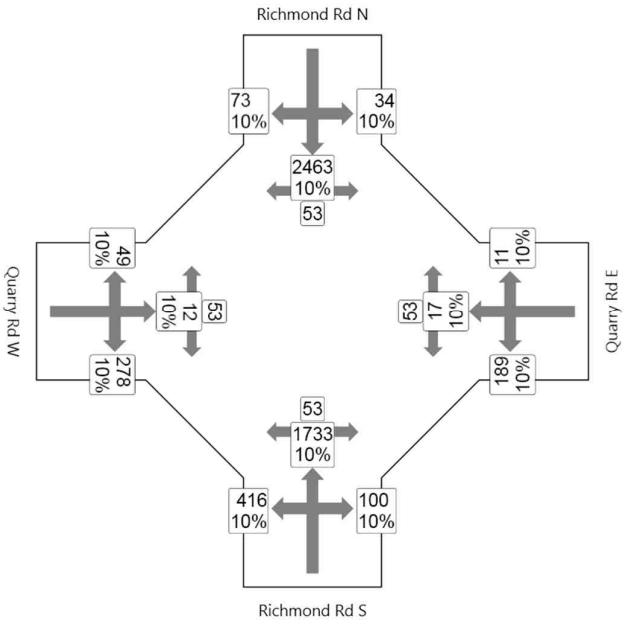


Figure 3: PM Peak hour flow

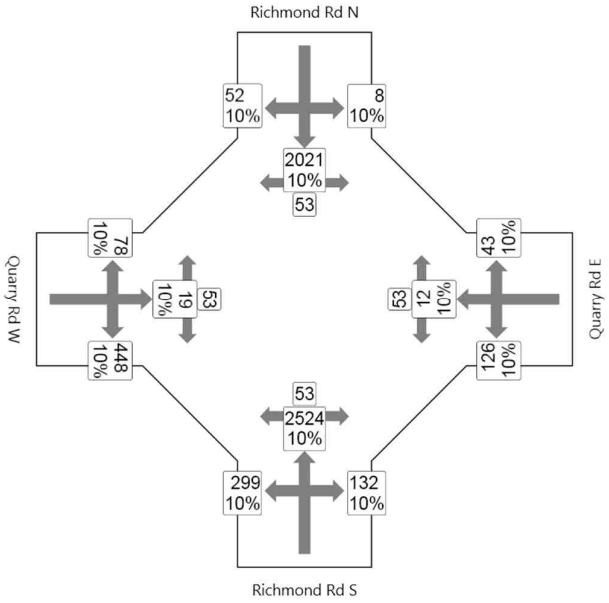
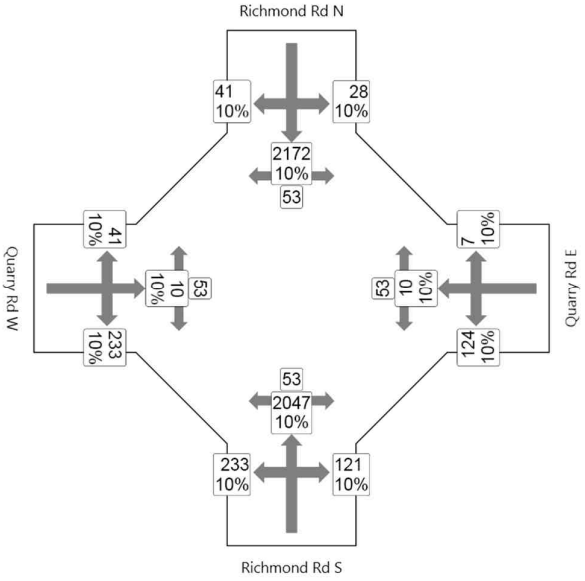


Figure 4: Weekend Peak hour flow



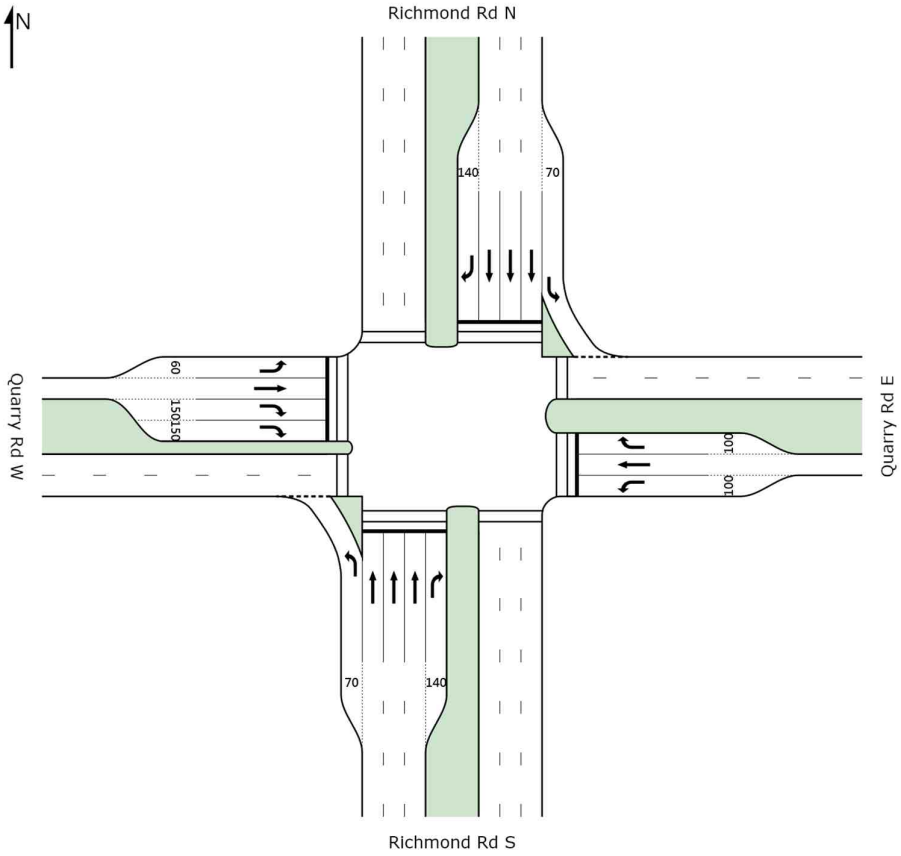
4.0 Operational Assessment

4.1 Intersection assessment

The Quarry Road intersection was assessed based on the forecasted volumes and distributions using the modelling software package SIDRA. Detailed outputs are provided in Appendix A.

The assessment identifies the predicted operating condition of the Quarry Road / Richmond Road intersection in 2036. It has been assumed that Richmond Road is upgraded to the ultimate configuration of three lanes northbound and three lanes southbound. The layout is shown below in Figure 5.

Figure 5: Proposed Intersection layout



The table below provides a summary of the operational performance of the intersection in 2036.

Table 4: Performance of Richmond Road / Quarry Road

Period	Demand (vph)	Level of Service (LoS)	Deg of Satn (v/c)	Ave. Delay (sec)	95% Back of Queue (m)	Approach with longest queue
AM Peak	5,375	C	0.92	37.3	450	Richmond Rd (North)
PM Peak	5,762	C	0.93	39.4	480	Richmond Rd (South)
Weekend Peak	5,067	C	0.85	32.5	310	Richmond Rd (North)

With the ultimate Richmond Road configuration in place, modelling indicated the intersection would operate with acceptable levels of delay in 2036. The AM, PM and weekend peaks would all operate at LoS C. Results suggested the introduction of the third northbound lane along Richmond Road was critical in accommodating the northbound flow in 2036. With a Degree of Saturation (DoS) of 0.93, modelling suggested the intersection operated close to theoretical capacity (DoS = 1.0). Modelling predicted the queue for the northbound movement on Richmond Road would reach 480m and would therefore not impede the upstream intersection at Townson Road (approximately 600m away). Results also suggested the queue for the large right turn site egress movement on the western leg would reach 115m. This queue would hence remain in the proposed 150m turn bay and would not affect the through movement.

4.2 Quarry Road (western leg) configuration

Based on the analysis, it was determined that to accommodate the predicted 2036 demands, the intersection's lane configuration on the western leg should contain:

- A 60m short left turn bay (excluding tapers).

- A full length shared through/right lane
- A 150m short dual right turning bay (excluding tapers).

It should be noted that sensitivity testing was also completed whereby alternative traffic distribution assumptions to those found in section 3.3 were tested. Scenarios with 10% more Precinct traffic travelling to/from the north and also 10% more Precinct traffic travelling to/from the south were assessed in the PM. Both these indicated that the configuration of western leg of Quarry Road listed above could accommodate the demands should the distributions change.

4.3 Wider network assessment

The following identifies the likely network improvement as a result of the introduction of Quarry Road:

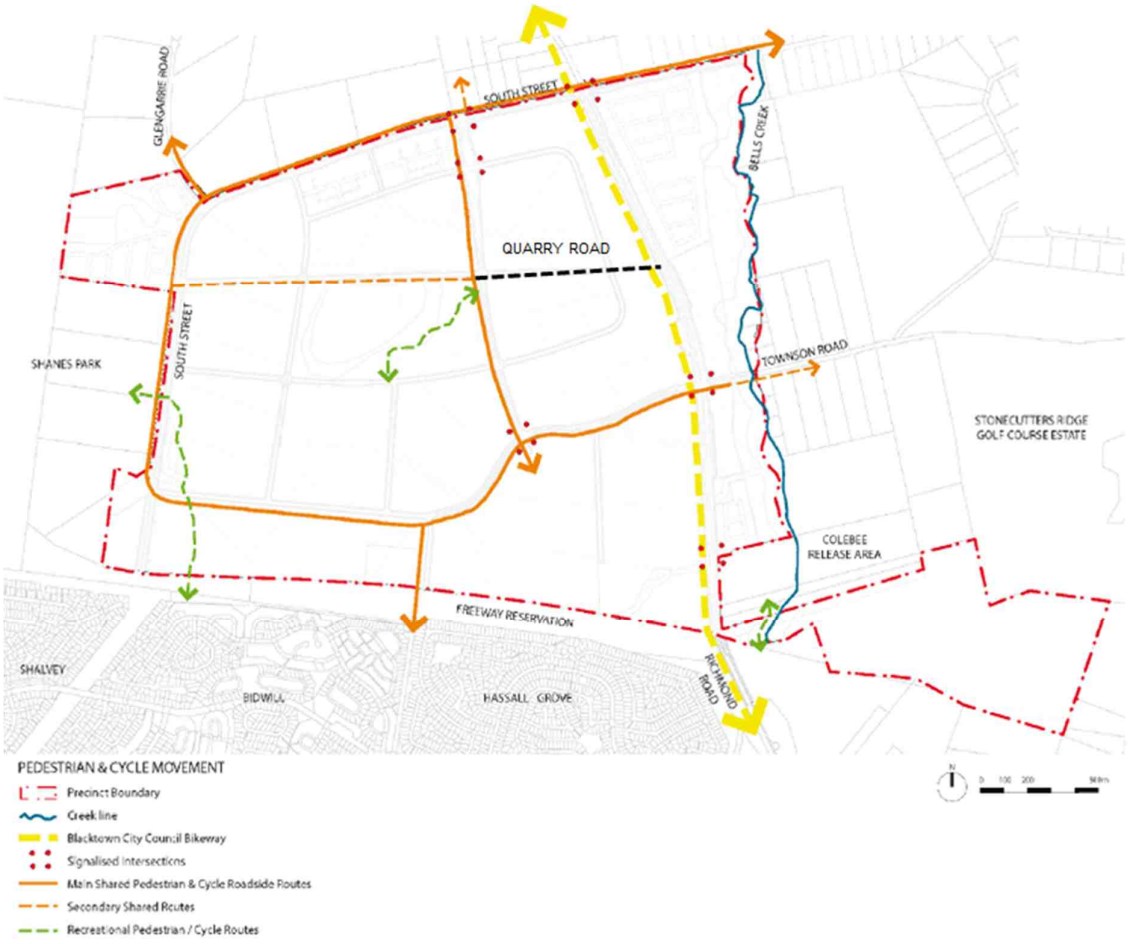
- Additional capacity for the Richmond Road corridor via closer spacing of signalised intersections between South Street and Townson Road. This will improve signal coordination and result in greater northbound and southbound throughput.
- Additional capacity for right turning Marsden Park Industrial Precinct **access** from north via an additional 140m right turn lane.
- Additional capacity for left turning Marsden Park Industrial Precinct **access** from south via an additional 70m left turn slip lane
- Additional capacity for right turning **egress** from the Marsden Park Industrial Precinct via additional dual right turn lanes.
- Additional capacity for left turning **egress** from the Marsden Park Industrial Precinct via an additional 60m left turn lanes.

These additional movements and improved signal coordination are predicted to cater for improvements at both the South Street and Townson. This is consistent with the earlier findings of the *Richmond Road Upgrade REF submission report (Traffic and Operational Assessment)*.

5.0 Cycleway Provision Assessment

Figure 6 shows the planned cycle network (with the addition of Quarry Road) in Marsden Park Industrial Precinct from the *Blacktown City Council (BCC) Growth Centre Precincts DCP 2009*. By providing a link between the main BCC cycleway along Richmond Road and the Precinct's internal shared cycle routes, a cycle provision along Quarry Road would serve to improve the network connectivity and encourage cycle travel with an alternative east-west link equidistant between South Street and Townson Road.

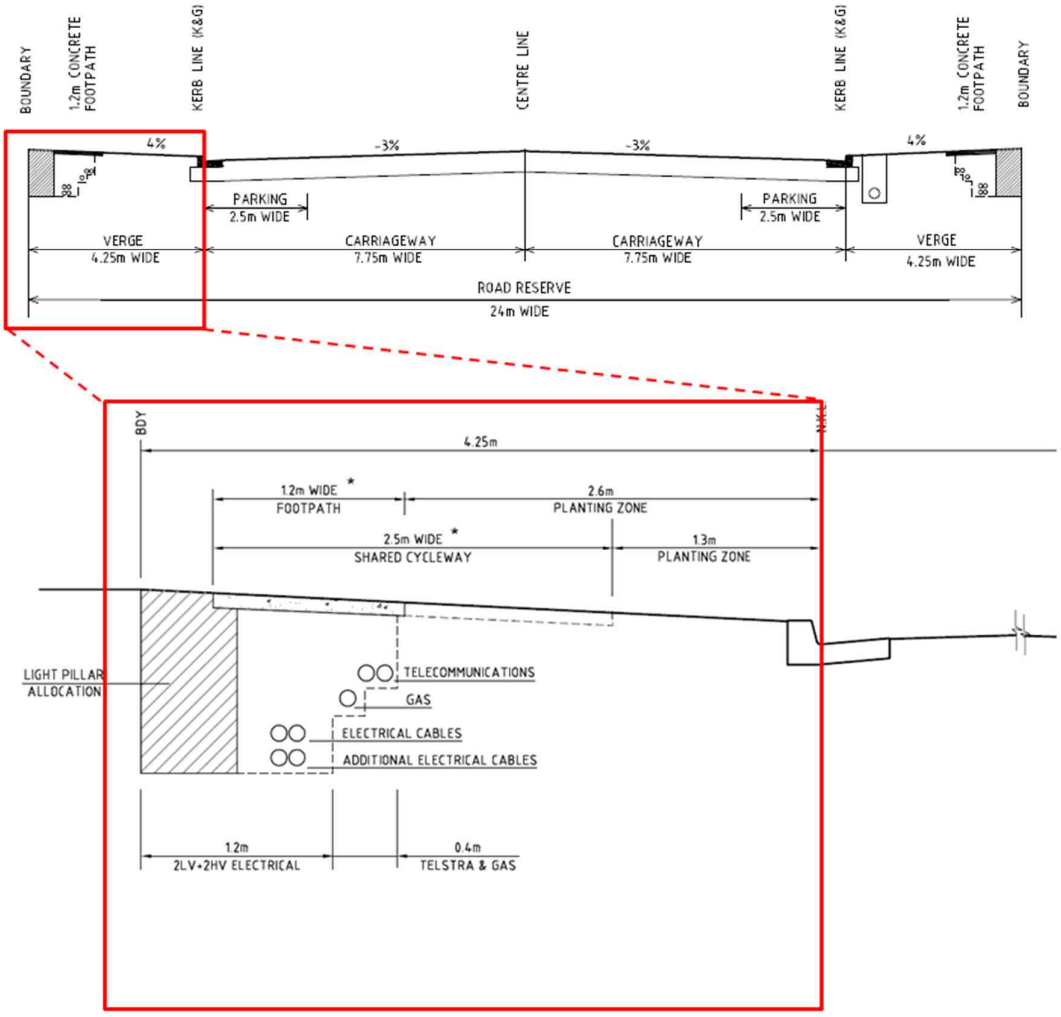
Figure 6: Pedestrian & Cycle Movement for the Marsden Park Industrial Precinct with proposed Quarry Road connection.



(Source: Blacktown City Council Growth Centre Precincts DCP 2009, diagram modified by AECOM 2014).

As identified in the BCC Council DCP, the Quarry Road Collector would need to accommodate a 24 metre wide midblock road reserve, including a 15.5 metre carriageway and 4.25 metre verge. The corresponding typical cross-section shows the verge can provide for a 2.5 metre wide shared off-road cycleway. This is shown in Figure 7.

Figure 7: Typical Collector Road Cross Section



(Source: Marsden Park Industrial Typical Road Cross Sections, Brown Consulting, diagram modified by AECOM 2014)

Based on the proposed lane configuration on the western leg of the Quarry Road intersection (identified in section 4.2), the road reserve would accommodate three approach lanes and two departures lanes. To cater for the proposed east-west Quarry Road cycleway connection, provision for a 2.5m shared path must be made within the 4.25m verge. Implementing cycleways that are segregated from road traffic (off-road) is consistent with best practices for cycleway planning. (It should be noted, the road reserve has insufficient capacity to accommodate an 'on-road' cycleway option with the road layout configuration identified in section 4.2).

6.0 Conclusion

Quarry Road would provide an additional access point to the Marsden Park Industrial Precinct along Richmond Road. This assessment identified that the intersection performed with acceptable levels of service and congestion during AM, PM and weekend peaks in 2036.

To accommodate the predicted demands, this assessment identified the need for Richmond Road to be upgraded to its ultimate configuration of a six lane, divided carriageway by 2036 and also identified that the western leg of Quarry Road should contain:

- A 60m short left turn bay (excluding tapers).
- A full length shared through/right lane

- A 150m short dual right turning bay (excluding tapers).

The lane configuration on the western leg of Quarry Road caters for an ‘off-road’ shared cycleway only. This would provide a cycleway connection for the Marsden Park Industrial Precinct and improve network connectivity for the wider Blacktown City Council area.

This assessment’s findings are consistent with those identified in the REF submissions report, which identified that the Quarry Road connection would be required to accommodate the 2036 demands across the wider road network.

Appendix A – Results

Figure 8: 2036 AM Results

MOVEMENT SUMMARY

Site: AM Peak_Ultimate_Config

Four-way intersection with 4 & 5-lane approaches and slip lanes (Signals)

Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Richmond Rd S											
1	L	416	10.0	0.313	10.4	LOS A	1.3	10.2	0.07	0.67	56.9
2	T	1733	10.0	0.648	24.1	LOS B	25.2	191.6	0.65	0.59	42.8
3	R	100	10.0	0.865	94.5	LOS F	8.0	60.7	1.00	0.89	17.3
Approach		2249	10.0	0.865	24.7	LOS B	25.2	191.6	0.56	0.62	42.1
East: Quarry Rd E											
4	L	189	10.0	0.890	65.3	LOS E	12.1	91.6	1.00	1.01	22.2
5	T	17	10.0	0.890	57.2	LOS E	12.1	91.6	1.00	1.01	19.8
6	R	11	10.0	0.095	80.8	LOS F	0.8	5.9	0.97	0.68	19.5
Approach		217	10.0	0.890	65.5	LOS E	12.1	91.6	1.00	0.99	21.8
North: Richmond Rd N											
7	L	34	10.0	0.029	10.3	LOS A	0.1	0.6	0.05	0.66	57.0
8	T	2463	10.0	0.921	41.8	LOS C	59.3	450.8	0.95	0.95	32.2
9	R	73	10.0	0.632	87.7	LOS F	5.5	41.5	1.00	0.78	18.4
Approach		2570	10.0	0.921	42.7	LOS D	59.3	450.8	0.94	0.95	31.8
West: Quarry Rd W											
10	L	49	10.0	0.218	47.4	LOS D	2.5	19.1	0.75	0.73	26.4
11	T	12	10.0	0.034	52.2	LOS D	0.7	5.4	0.84	0.59	21.5
12	R	278	10.0	0.415	65.3	LOS E	9.0	68.2	0.93	0.80	22.3
Approach		339	10.0	0.415	62.2	LOS E	9.0	68.2	0.90	0.78	22.8
All Vehicles		5375	10.0	0.921	37.3	LOS C	59.3	450.8	0.78	0.80	33.7

Figure 9: 2036 PM Results

MOVEMENT SUMMARY

Site: PM Peak_Ultimate_Config

Four-way intersection with 4 & 5-lane approaches and slip lanes (Signals)

Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Richmond Rd S											
1	L	299	10.0	0.222	10.3	LOS A	0.8	6.2	0.07	0.67	57.0
2	T	2524	10.0	0.931	43.6	LOS D	62.7	476.6	0.96	0.98	31.4
3	R	132	10.0	0.879	93.3	LOS F	10.5	80.1	1.00	0.90	17.5
Approach		2955	10.0	0.931	42.5	LOS C	62.7	476.6	0.87	0.95	31.7
East: Quarry Rd E											
4	L	126	10.0	0.628	55.2	LOS D	7.0	52.9	0.99	0.85	24.4
5	T	12	10.0	0.628	47.1	LOS D	7.0	52.9	0.99	0.85	21.9
6	R	43	10.0	0.620	90.8	LOS F	3.4	25.6	1.00	0.78	18.1
Approach		181	10.0	0.628	63.1	LOS E	7.0	52.9	1.00	0.83	22.4
North: Richmond Rd N											
7	L	8	10.0	0.007	10.4	LOS A	0.0	0.2	0.05	0.66	56.9
8	T	2021	10.0	0.746	25.1	LOS B	32.6	247.7	0.73	0.66	41.8
9	R	52	10.0	0.346	81.8	LOS F	3.6	27.5	0.96	0.75	19.4
Approach		2081	10.0	0.746	26.4	LOS B	32.6	247.7	0.73	0.67	40.8
West: Quarry Rd W											
10	L	78	10.0	0.339	45.9	LOS D	4.0	30.1	0.74	0.75	26.9
11	T	19	10.0	0.054	52.6	LOS D	1.1	8.5	0.65	0.61	21.4
12	R	448	10.0	0.668	68.7	LOS E	15.3	116.6	0.98	0.83	21.6
Approach		545	10.0	0.668	64.9	LOS E	15.3	116.6	0.94	0.81	22.2
All Vehicles		5762	10.0	0.931	39.4	LOS C	62.7	476.6	0.83	0.83	32.6

Figure 10: 2036 Weekend Results

MOVEMENT SUMMARY

Site: Weekend Peak_Ultimate_Config

Four-way intersection with 4 & 5-lane approaches and slip lanes (Signals)

Signals - Fixed Time Cycle Time = 140 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Richmond Rd S											
1	L	233	10.0	0.169	10.3	LOS A	0.5	4.1	0.06	0.67	57.1
2	T	2047	10.0	0.803	27.8	LOS B	34.9	264.9	0.82	0.75	39.6
3	R	121	10.0	0.814	84.5	LOS F	8.8	66.5	1.00	0.87	18.9
Approach		2401	10.0	0.814	29.0	LOS C	34.9	264.9	0.75	0.74	38.8
East: Quarry Rd E											
4	L	124	10.0	0.601	47.4	LOS D	6.1	46.4	0.99	0.81	26.5
5	T	10	10.0	0.601	39.3	LOS C	6.1	46.4	0.99	0.81	23.9
6	R	7	10.0	0.094	81.0	LOS F	0.5	3.7	0.99	0.66	19.5
Approach		141	10.0	0.601	48.5	LOS D	6.1	46.4	0.99	0.81	25.8
North: Richmond Rd N											
7	L	28	10.0	0.024	10.4	LOS A	0.1	0.5	0.05	0.66	56.9
8	T	2172	10.0	0.852	31.8	LOS C	41.3	313.5	0.87	0.82	37.1
9	R	41	10.0	0.276	76.8	LOS F	2.7	20.2	0.95	0.74	20.3
Approach		2241	10.0	0.852	32.4	LOS C	41.3	313.5	0.86	0.82	36.8
West: Quarry Rd W											
10	L	41	10.0	0.164	40.8	LOS C	1.9	14.1	0.70	0.72	28.5
11	T	10	10.0	0.026	47.0	LOS D	0.5	4.1	0.82	0.57	22.8
12	R	233	10.0	0.324	58.8	LOS E	6.8	51.7	0.90	0.79	23.7
Approach		284	10.0	0.324	55.8	LOS D	6.8	51.7	0.86	0.77	24.2
All Vehicles		5067	10.0	0.852	32.5	LOS C	41.3	313.5	0.82	0.78	36.2

Figure 11: 2036 PM '+10% Southbound Sensitivity' Results

MOVEMENT SUMMARY

Site: PM Peak_Ultimate_Config_ +10% SB

Four-way intersection with 4 & 5-lane approaches and slip lanes (Signals)

Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Richmond Rd S											
1	L	348	10.0	0.258	10.3	LOS A	0.9	6.9	0.07	0.67	57.1
2	T	2539	10.0	0.937	45.3	LOS D	64.4	489.6	0.97	1.00	30.7
3	R	132	10.0	0.879	93.3	LOS F	10.5	80.1	1.00	0.90	17.5
Approach		3019	10.0	0.937	43.4	LOS D	64.4	489.6	0.87	0.96	31.3
East: Quarry Rd E											
4	L	126	10.0	0.628	55.2	LOS D	7.0	52.9	0.99	0.85	24.4
5	T	12	10.0	0.628	47.1	LOS D	7.0	52.9	0.99	0.85	21.9
6	R	43	10.0	0.620	90.8	LOS F	3.4	25.6	1.00	0.78	18.1
Approach		181	10.0	0.628	63.1	LOS E	7.0	52.9	1.00	0.83	22.4
North: Richmond Rd N											
7	L	8	10.0	0.007	10.4	LOS A	0.0	0.2	0.05	0.66	56.9
8	T	2056	10.0	0.759	25.3	LOS B	33.7	256.3	0.74	0.67	41.6
9	R	37	10.0	0.246	80.9	LOS F	2.5	19.3	0.95	0.74	19.6
Approach		2101	10.0	0.759	26.2	LOS B	33.7	256.3	0.74	0.68	40.9
West: Quarry Rd W											
10	L	56	10.0	0.243	45.3	LOS D	2.8	21.3	0.73	0.74	27.0
11	T	19	10.0	0.054	52.6	LOS D	1.1	8.5	0.85	0.61	21.4
12	R	522	10.0	0.779	73.2	LOS F	19.0	144.4	1.00	0.89	20.8
Approach		597	10.0	0.779	70.0	LOS E	19.0	144.4	0.97	0.87	21.3
All Vehicles		5898	10.0	0.937	40.6	LOS C	64.4	489.6	0.84	0.84	32.1

Figure 12: 2036 PM '+10% Northbound Sensitivity' Results

MOVEMENT SUMMARY

Site: PM Peak_Ultimate_Config_ +10% NB

Four-way intersection with 4 & 5-lane approaches and slip lanes (Signals)

Signals - Fixed Time Cycle Time = 150 seconds (Optimum Cycle Time - Minimum Delay)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Richmond Rd S											
1	L	249	10.0	0.186	10.3	LOS A	0.7	5.1	0.06	0.67	57.0
2	T	2509	10.0	0.926	42.0	LOS C	61.1	464.2	0.95	0.96	32.1
3	R	132	10.0	0.879	93.3	LOS F	10.5	80.1	1.00	0.90	17.5
Approach		2890	10.0	0.926	41.7	LOS C	61.1	464.2	0.88	0.93	32.1
East: Quarry Rd E											
4	L	126	10.0	0.628	55.2	LOS D	7.0	52.9	0.99	0.85	24.4
5	T	12	10.0	0.628	47.1	LOS D	7.0	52.9	0.99	0.85	21.9
6	R	43	10.0	0.620	90.8	LOS F	3.4	25.6	1.00	0.78	18.1
Approach		181	10.0	0.628	63.1	LOS E	7.0	52.9	1.00	0.83	22.4
North: Richmond Rd N											
7	L	8	10.0	0.007	10.4	LOS A	0.0	0.2	0.05	0.66	56.9
8	T	1987	10.0	0.733	24.8	LOS B	31.5	239.7	0.72	0.65	42.0
9	R	67	10.0	0.446	82.7	LOS F	4.7	36.0	0.97	0.77	19.3
Approach		2062	10.0	0.733	26.6	LOS B	31.5	239.7	0.72	0.66	40.7
West: Quarry Rd W											
10	L	101	10.0	0.439	46.5	LOS D	5.2	39.6	0.75	0.76	26.7
11	T	19	10.0	0.054	52.6	LOS D	1.1	8.5	0.85	0.61	21.4
12	R	373	10.0	0.557	67.2	LOS E	12.4	94.6	0.96	0.82	21.9
Approach		493	10.0	0.557	62.4	LOS E	12.4	94.6	0.91	0.80	22.7
All Vehicles		5626	10.0	0.926	38.7	LOS C	61.1	464.2	0.83	0.82	33.0

Sydney Business Park

Road Network Staging Modelling

D R A F T

Sydney Business Park

Road Network Staging Modelling

Client: APP

ABN: 0

Prepared by

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

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Quality Information

Document Sydney Business Park

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Reviewed by Andy Yung

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Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	27-June-2014	Draft	Andy Yung Associate Director	
B	2-July-2014	Draft	Andy Yung Associate Director	

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1.0 Objective

The Sydney Business Park (SBP) lies within the Marsden Park Industrial Precinct located adjacent to Richmond Road in Sydney's northwest. Both the SBP and wider precinct are currently under development and construction. Richmond Road is being upgraded to dual carriageway, of which the southern section (Stage 1) is currently under construction and Stages 2 and 3 upgrades are about to start construction. Approximately two years ago, a high level strategic traffic assessment of the SBP was completed by AECOM. Since then, various SBP users have confirm their agreement with the SBP and will soon be operational. Each have produced Traffic Impact Assessments (TIA) which detail their predicted impacts within the business park.

To inform future planning of infrastructure staging and delivery, AECOM reviewed and amalgamated the predicted land use and traffic demands found in the TIAs and developed a network wide origin destination traffic matrix. A traffic network model was then developed to assess the future operation of the proposed access intersections along Richmond Road and the internal road network within the SBP. The model provided input into the staging of the internal road network required to service the future land users.

The models were developed to gain a greater appreciation of:

- the operation, capacity and longevity of the network with the sole SBP access intersection at Townson Road / Richmond Road;
- the operation, capacity and longevity of the network with the additional SBP access intersection at Mosque Road / Richmond Road;
- the need and timing of the additional SBP access intersection at Quarry Road / Richmond Road;

This report is structured as follows:

- Section 2: Traffic Generation
- Section 3: Modelling Assessment
- Section 4: Key Findings
- Section 5: Model construction methodology and assumptions
- Section 6: Additional assessments to be considered to further refine the SBP operation

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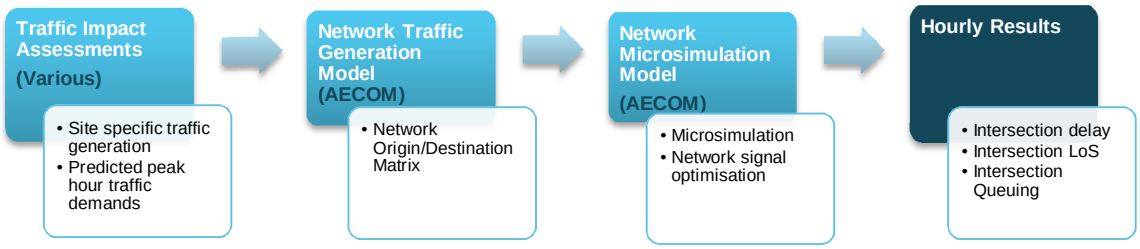
2.0 Model Construction Methodology

2.1 Overview of Modelling Process

The figure below describes an overview of the proposed modelling process used in the SBP network model.

Figure 1: Overview of modelling process



SOURCE: AECOM

2.2 Inputs and Assumptions

The following identifies the key inputs and assumptions used throughout the traffic microsimulation modelling.

2.2.1 Future Years of Assessment

The future years assessed were December 2015 and June 2016.

2.2.2 Modelling Period

A one hour morning, afternoon and weekend peak periods were assessed. To replicate congestion on the network before the peak hour started, all modelling used a fifteen minute 'warm up' period.

2.2.3 Traffic Assignment

The predicted traffic matrix was assigned to the road network based on delay. VISSIM's inbuilt traffic assignment tool was used with model runs converging traffic based on journey time delay. In Scenario C, where route choices were available, the traffic assignment catered for a robust assessment. Critically, it allowed the demands on the approaches of all intersections to balance based on delay and ensured a likely spread of traffic around the network.

2.2.4 Modelling Results

To replicate variability for a given day, all modelling was based on five random day seed runs. All results represented the average of these five individual seed runs.

2.2.5 Traffic Demands

As shown in Figure 1, the predicted demands for the future years stemmed from AECOMs network spreadsheet model.

2.2.6 Traffic Signals

All signalised intersections were all modelled as fixed time signals with cycle times of 150 seconds. The phasing splits and offset for all intersections were optimised based on the predicted demands.

2.2.7 Speed Limits

The following speed limits were used in the modelling:

- Richmond Road 80km/h
- All SBP internal roads 50km/h

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3.0 Traffic Demand

Prior to AECOM's assessment of the staging and operation of the SBP road network, various TIAs had been completed by each lot user within the business park. These identified the likely trip generation caused by the operation of the occupier across the AM, PM and weekend peaks. AECOM reviewed and amalgamated these predicted demands and consolidated them into a network traffic demand spreadsheet model.

3.1 Traffic Generation and Distribution

At the time of this assessment the confirmed tenants in the SBP were as follows:

- Swire Cold Storage
- Lindt Storage
- Bunnings Warehouse
- Costco
- IKEA
- ALDI
- Masters Home Improvement Centre
- Hargraves Complex

3.2 Assumptions

The following identifies the assumptions used in AECOM's traffic demand spreadsheet model for all scenarios:

- IKEA, Masters, Costco and Bunnings contain a 10% linked trip reduction;
- Hargraves and Masters contain a 20% linked trip reduction;
- Hourly lot trip distributions assumed to be:
    - 50% in and 50% out in the weekend peak hour;
    - 60% in and 40% out in the AM peak hour
    - 40% in and 60% out in the PM peak hour;
- Lindt's trip generation assumed prorated (to GFA) to Swire;
- ALDI's trip generation assumed prorated (to GFA) to Costco;
- SBP heavy vehicle percentage assumed to be:
    - 58% for Swire and Lindt;
    - 10% for all other sites;
- Richmond Road background traffic generation based on:
    - Known tube counts found in Swire's TIA;
    - Hourly peak factors based on known tube counts found in Swire's TIA;
    - Turning proportions identified in Swire's TIA;
    - Heavy vehicle percentage of 10%;
- Beginning in August 2015, the SBP generated additional site based trips associated with 5000m2 (GFA) per month. This contained a heavy vehicle percentage of 10%;
- All SBP site traffic was split 75%, 20% and 5% to/from the south, north and east respectively;
- An empirical weekend trip reduction factor (percentage of predicted trips versus observed trips) was implemented for all SBP weekend site traffic. This is described in detail in Appendix B

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3.3 Origin Destination Matrix

AECOM generated each peak hour Origin Destination matrix using the traffic modelling tool, LinSig. LinSig contains an inbuilt matrix estimation tool that generates OD matrices based on turn counts. It is the RMS preferred tool of analysis of network of intersections.

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4.0 Modelling Assessments

Three primary modelling scenarios were undertaken as follows:

1) Scenario B: Assessment of Townson Road / Richmond Road intersection – *assessment of predicted SBP traffic generation, intersection operation and longevity – December 2015;*

2) Scenario C: Assessment of Townson Road / Richmond Road intersection with the introduction of Mosque Road / Richmond Road intersection – *assessment of predicted SBP traffic generation, intersection operation and longevity – June 2016;*

3) Scenario D: Assessment of Townson Road / Richmond Road intersection with introduction of Mosque Road / Richmond Road intersection – *By increasing wider background SBP site traffic, identify when the failure of Scenario C occurs, hence determine the required opening of the additional SBP access intersection at Quarry Road / Richmond Road – Unknown;*

The key modelling outputs provided were:

- Level of Service (LoS);
- Average delay;
- Average queue length;

The development of these models is described in more detail in section 2.0.

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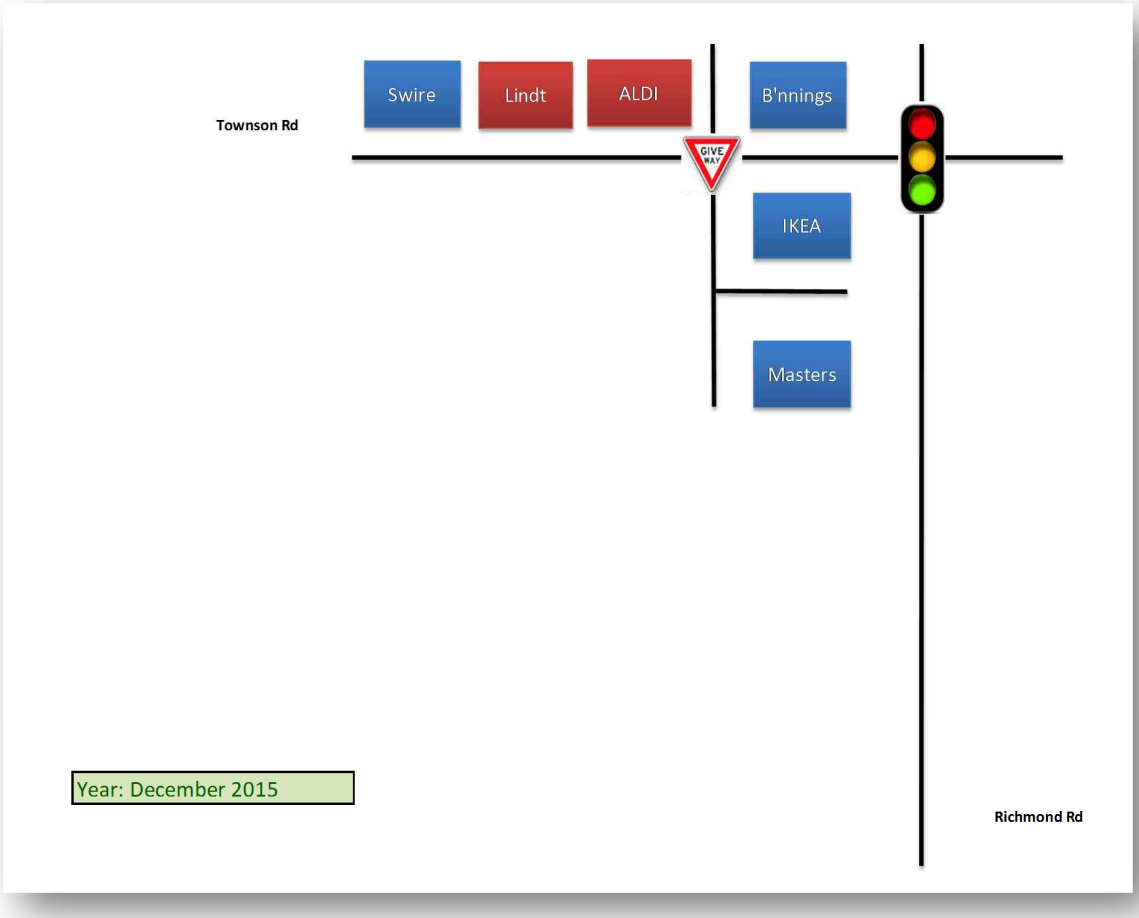
4.1 Scenario B

Shown below in Figure 2 is a schematic diagram that identifies the SBP road network and tenants that are predicted to be operational by December 2015.

Figure 2: Lot Occupation in December 2015



SOURCE: AECOM

The predicted traffic matrix for AM, PM and weekend peak hours can be found in Appendix C. Seen in Figure 3 below is the model's extent for Scenario B. Shown near (1) is the single SBP access intersection at Townson Road / Richmond Road and at (2) the internal roundabout at Townson Road / Road 18 Collector.

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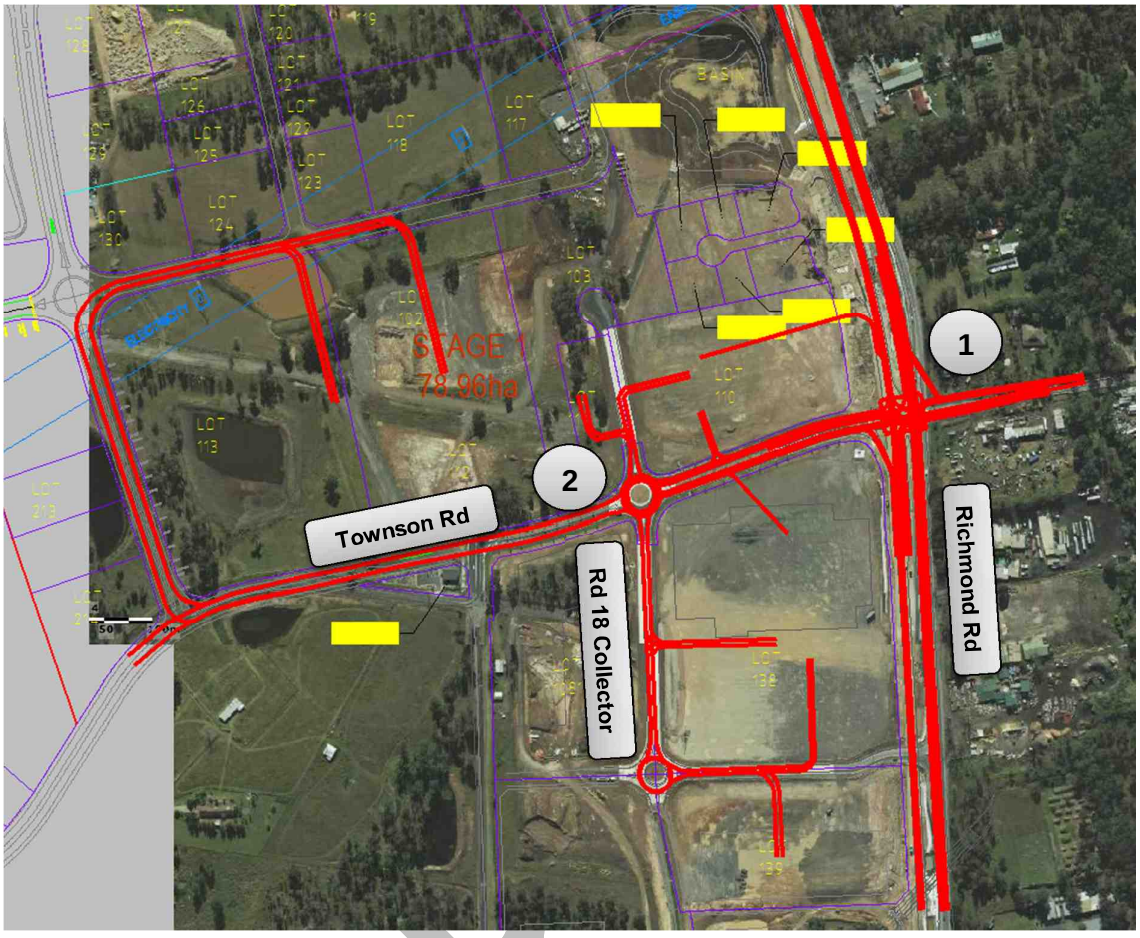
Figure 3: Scenario B model extents



SOURCE: AECOM

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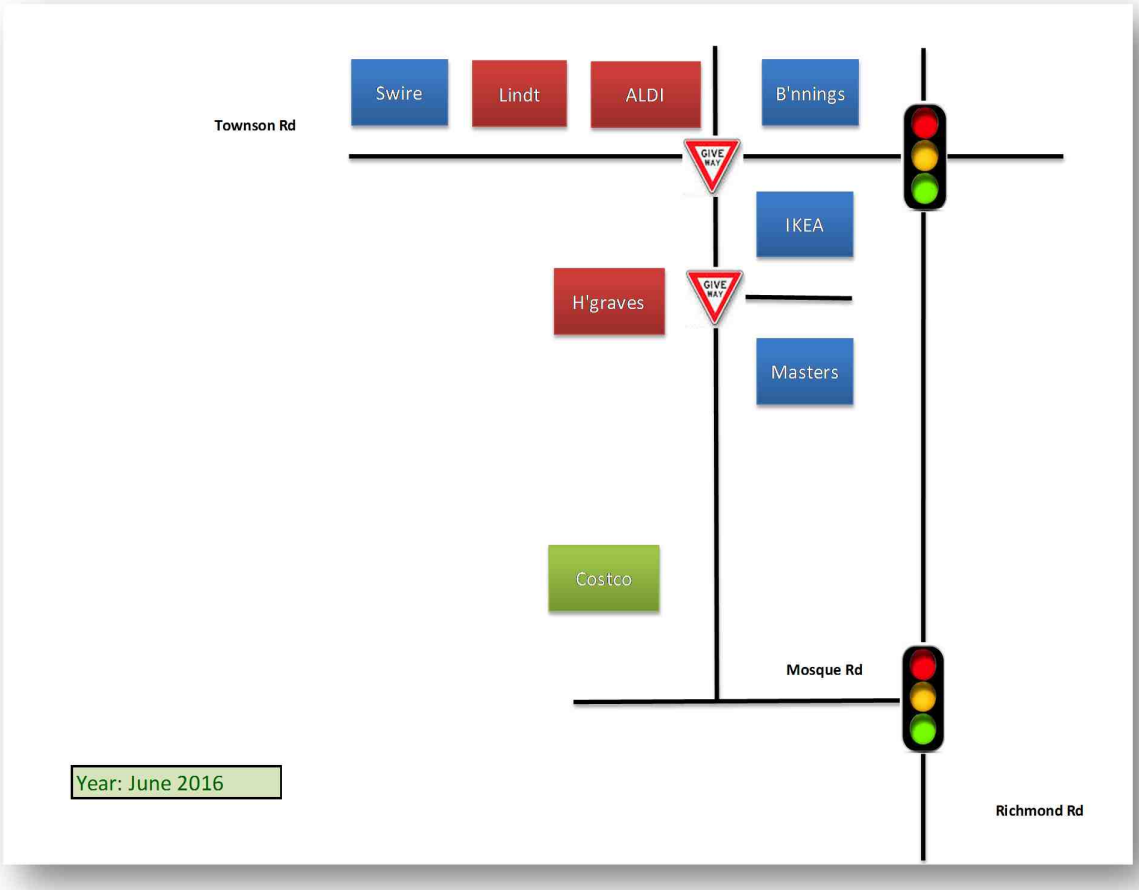
4.2 Scenario C

Shown below in Figure 4 is a schematic diagram that identifies the SBP road network and the lot occupiers that will be operational by June 2016. Mosque Road access is introduced as a result of Costco in operation by mid 2016.

Figure 4: Lot Occupation in June 2016



SOURCE: AECOM

The predicted traffic matrix for the AM, PM and weekend peak hours can be found in Appendix C. Seen in Figure 5 below is the model's extent for Scenario C. Shown are the two SBP access intersections at Townson Road / Richmond Road (1) and Mosque Road / Richmond Road (3). Also seen are the two internal roundabouts at Townson Road / Road 18 Collector (2) and Road 18 Collector / EastWest Link Road (4).

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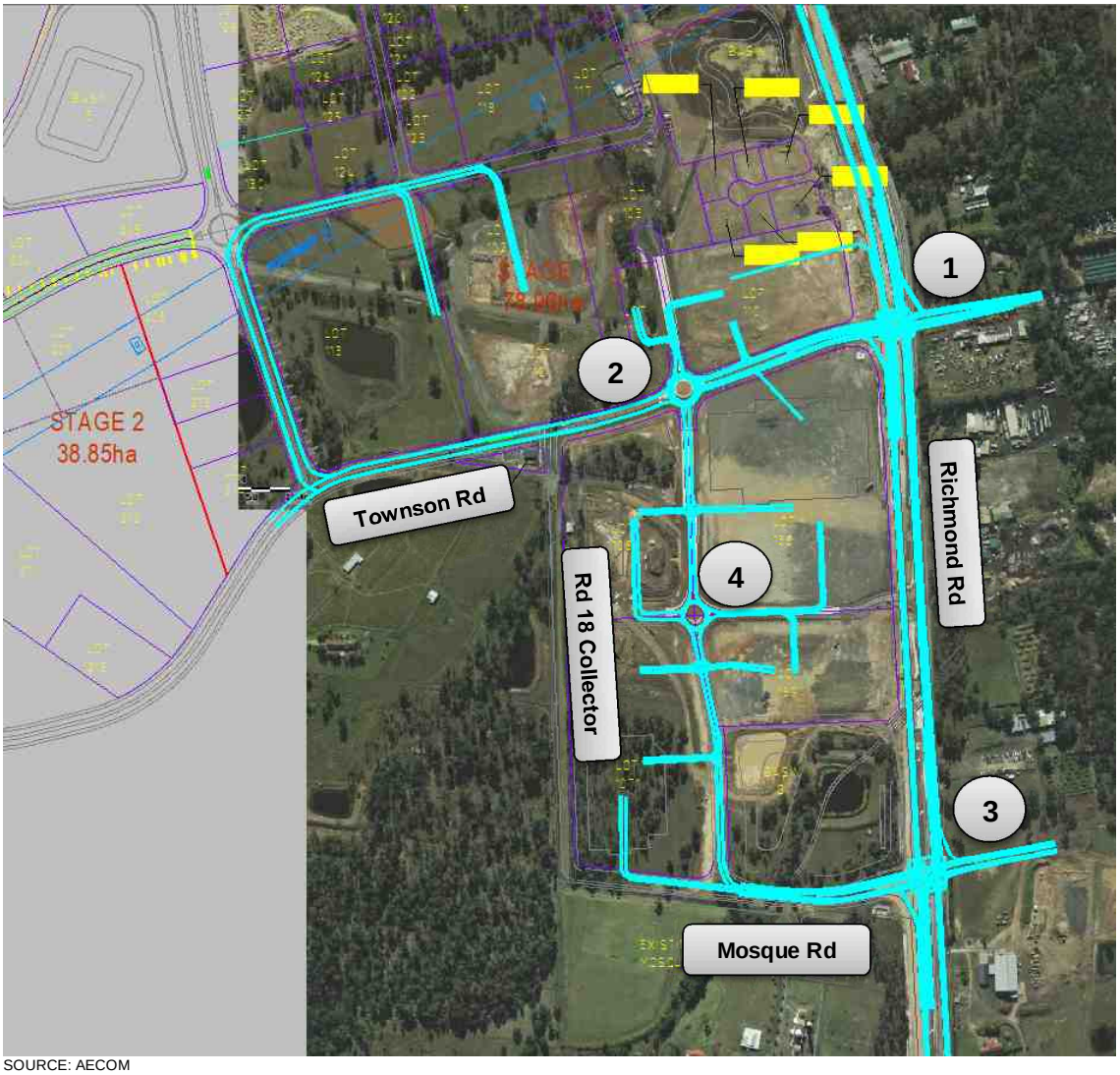
Figure 5: Scenario C model extents



SOURCE: AECOM

4.3 Scenario D

The predicted traffic matrix for the AM, PM and weekend peak hours can be found in Appendix C. Because the Scenario D assessment was aimed at identifying the date of failure of Scenario C, their networks are equal.

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5.0 Key Modelling Findings

The following describes the key findings of the three modelling scenario assessments conducted by AECOM.

5.1 Scenario B

Table 1 below summarises the SBP road network operation in December 2015. It highlights the Level of Service (LoS), average delay per movement and average queue length per movement for the AM, PM and Weekend peak hours at the intersections of:

- Townson Road / Richmond Road;
- Road 18 Collector / Townson Road

Level of Service is measure that determines the arrival performance of vehicles as a function of the average vehicle delay. LoS performances range from A to F, where F represents 'failure', or 'excessive' delay.

Across the SBP road network in December 2015, modelling results indicated that the average delay per vehicle at the intersection of Townson Road / Richmond resulted in LoS D. This highlighted that the proposed road network performed on the threshold of acceptable performance. It is recommended that the additional intersection at Mosque Road / Richmond Road be introduced post December 2015.

Weekend Peak Results

Table 1: Scenario B Weekend Peak Results

Intersection	Approach	Turn	Volume (veh)	Control Delay (s)	Level of Service	Queue Avg. (m)
Townson / Mid Collector	Mid Collector (N)	L	180.4	36.9	C	14.1
Townson / Mid Collector	Mid Collector (N)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (N)	R	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	R	351.6	20.0	B	7.0
Townson / Mid Collector	Townson (E)	L	537.6	9.5	A	2.7
Townson / Mid Collector	Townson (E)	T	55.4	9.1	A	3.0
Townson / Mid Collector	Townson (E)	R	177.6	10.0	A	2.8
Townson / Mid Collector	Townson (W)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Townson (W)	T	56.6	6.7	A	0.0
Townson / Mid Collector	Townson (W)	R	0.0	0.0	A	0.0
Townson / Mid Collector	-	MAX	537.6	36.9	C	6.1
Townson / Richmond	Richmond (N)	L	30.6	5.4	A	7.3
Townson / Richmond	Richmond (N)	T	1277.2	30.5	C	46.2
Townson / Richmond	Richmond (N)	R	175.6	111.4	F	46.2
Townson / Richmond	Richmond (S)	L	639.4	17.6	B	47.4
Townson / Richmond	Richmond (S)	T	1240.4	51.5	D	84.0
Townson / Richmond	Richmond (S)	R	38.4	75.3	F	82.9
Townson / Richmond	Townson (E)	L	152.6	56.0	E	50.0
Townson / Richmond	Townson (E)	T	41.6	68.7	E	52.0
Townson / Richmond	Townson (E)	R	172.0	144.9	F	51.5
Townson / Richmond	Townson (W)	L	172.6	35.6	C	84.5
Townson / Richmond	Townson (W)	T	41.0	94.1	F	86.4
Townson / Richmond	Townson (W)	R	644.8	94.3	F	85.8
Townson / Richmond	-	AVERAGE	385.5	52.7	D	64.2

SOURCE: AECOM

During the weekend peak hour, modelling indicated the Richmond Road throughput, both northbound and southbound, was relatively strong with approximately 2,000 and 1,500 vehicles per hour each respectively. Results indicated that the average delay per vehicle for these movements were 51.5 seconds and 30.5 seconds respectively. Modelling suggested that the sole SBP access intersection at Townson Road / Richmond Road was on the threshold of capacity. The average delay for all vehicles was 52.7 seconds (LoS D). Results also indicated

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that the roundabout at Townson Road / Road 18 Collector operated with acceptable performance. Modelling did suggest that vehicles on the northern approach (those vehicles egressing ALDI and Bunnings) received some moderate delay and operated at LoS C.

Modelling also indicated that some of the SBP access and egress movements operated with relatively high delay. The right turn access movement from the northern approach of Richmond Road had an average delay of 111.4 seconds and an average queue of 100m. Critically, this queue remained in the proposed turn bay of 140m and hence did not affect the through movement on Richmond Road. The remaining left turn and through access movements (from the southern approach and eastern approach respectively) both were predicted to operate with minimal delay and congestion. Additionally, both the right turn and through egress movements on the western approach of Towson Road operated with an average delay of 94 seconds. The resulting average maximum queue on the western approach was approximately 200m which was on the threshold of impeding on the roundabout at Townson Road / Road 18 Collector which is approximately 230m away. Results suggested the remaining left turn egress movement received low delay and congestion.

Figure 6: Richmond Road / Townson Road intersection looking northbound in Scenario B

The figure above shows a snapshot of the worst queuing predicted in the weekend peak hour in December 2015 at the Richmond Road / Townson Road intersection. Seen in the foreground are vehicles queuing for the northbound movement along Richmond Road. Shown in the middle of the figure is the large dual right turning egressing movement out of the SBP. Finally in the background, the queue for the right turning accessing movement into the SBP can be seen.

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Figure 7: Townson Road / Road 18 Collector intersection looking eastbound in Scenario B

The figure above shows a snapshot of the worst queuing predicted in the weekend peak hour in December 2015 at the roundabout at Townson Road / Road 18 Collector. Seen in the foreground are ALDI and Bunnings egressing vehicles queuing on the north leg of the roundabout. Shown in the background of the figure is Richmond Road.

PM Peak Results

Table 2: Scenario B Evening Peak Results

Intersection	Approach	Turn	Volume (veh)	Control Delay (s)	Level of Service	Queue Avg. (m)
Townson / Mid Collector	Mid Collector (N)	L	153.6	9.4	A	1.6
Townson / Mid Collector	Mid Collector (N)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (N)	R	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	R	209.0	6.6	A	0.7
Townson / Mid Collector	Townson (E)	L	214.4	3.7	A	0.1
Townson / Mid Collector	Townson (E)	T	63.4	3.9	A	0.1
Townson / Mid Collector	Townson (E)	R	94.4	4.5	A	0.1
Townson / Mid Collector	Townson (W)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Townson (W)	T	91.4	4.1	A	0.0
Townson / Mid Collector	Townson (W)	R	0.0	0.0	A	0.0
Townson / Mid Collector	-	MAX	223.2	9.4	A	1.2
Townson / Richmond	Richmond (N)	L	29.4	3.2	A	1.9
Townson / Richmond	Richmond (N)	T	1146.4	28.3	B	30.1
Townson / Richmond	Richmond (N)	R	81.2	105.7	F	30.4
Townson / Richmond	Richmond (S)	L	312.2	16.6	B	54.2
Townson / Richmond	Richmond (S)	T	1595.8	43.3	D	90.0
Townson / Richmond	Richmond (S)	R	40.4	80.3	F	89.4
Townson / Richmond	Townson (E)	L	133.2	41.6	C	26.4
Townson / Richmond	Townson (E)	T	18.0	55.9	E	30.6
Townson / Richmond	Townson (E)	R	147.0	94.0	F	29.7
Townson / Richmond	Townson (W)	L	125.6	39.4	C	36.1
Townson / Richmond	Townson (W)	T	27.4	60.2	E	36.0
Townson / Richmond	Townson (W)	R	470.4	67.0	E	36.5
Townson / Richmond	-	AVERAGE	343.9	42.9	D	56.3

SOURCE: AECOM

During the evening peak hour, modelling suggested the sole SBP access intersection at Townson Road / Richmond Road performed with some spare capacity. The average delay for all vehicles was 42.9 seconds (LoS D). Results also indicated that the roundabout at Townson Road / Road 18 Collector operated with minimal delay. Modelling indicated that some of the SBP access and egress movements operated with relatively high delay. The right turn access movement from the northern approach of Richmond Road had an average delay of 105.7 seconds and an average queue of 80m. This queue remained in the proposed 140m turn bay. Additionally, both the right turn and through egress movements on the western approach of Towson Road operated with moderate delay, with an average of 67 seconds per vehicle. The resulting average maximum queue on the western approach was approximately 100m.

AM Peak Results

Figure 8: Scenario B Morning Peak Results

Intersection	Approach	Turn	Volume (veh)	Control Delay (s)	Level of Service	Queue Avg. (m)
Townson / Mid Collector	Mid Collector (N)	L	60.4	4.9	A	0.2
Townson / Mid Collector	Mid Collector (N)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (N)	R	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	R	138.2	5.7	A	0.4
Townson / Mid Collector	Townson (E)	L	319.4	4.4	A	0.1
Townson / Mid Collector	Townson (E)	T	88.4	4.3	A	0.1
Townson / Mid Collector	Townson (E)	R	86.8	5.2	A	0.1
Townson / Mid Collector	Townson (W)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Townson (W)	T	57.2	3.2	A	0.0
Townson / Mid Collector	Townson (W)	R	0.0	0.0	A	0.0
Townson / Mid Collector	-	**MAX**	319.4	5.7	A	0.2
Townson / Richmond	Richmond (N)	L	82.6	7.1	A	6.1
Townson / Richmond	Richmond (N)	T	1469.6	29.2	C	35.1
Townson / Richmond	Richmond (N)	R	103.4	70.8	F	35.0
Townson / Richmond	Richmond (S)	L	384.8	5.2	A	9.4
Townson / Richmond	Richmond (S)	T	989.0	35.6	C	36.6
Townson / Richmond	Richmond (S)	R	71.0	69.5	E	36.4
Townson / Richmond	Townson (E)	L	101.4	39.6	C	13.4
Townson / Richmond	Townson (E)	T	25.0	54.4	D	15.0
Townson / Richmond	Townson (E)	R	82.2	69.1	E	15.0
Townson / Richmond	Townson (W)	L	68.2	31.5	C	19.4
Townson / Richmond	Townson (W)	T	16.6	52.6	D	19.4
Townson / Richmond	Townson (W)	R	262.4	59.7	E	19.4
Townson / Richmond	-	**AVERAGE**	304.7	33.6	C	29.5

Across the morning peak, modelling indicated the SBP road network operated with minimal delay and spare capacity. Results suggested that the sole SBP access intersection at Townson Road / Richmond Road operated with an average delay of 33.6 seconds (LoS C). Modelling did suggest that right turning vehicles on the northern approach, those accessing the SBP, received some moderate delay. The resulting queue however, remained in the turn bay. Results also indicated that the roundabout at Townson Road / Road 18 Collector operated with minimal delay, LoS A.

5.2 Scenario C

Table 3 below summarises the SBP road network performance in June 2016. It highlights the Level of Service (LoS), average delay per movement and average queue length per movement for the AM, PM and Weekend peak hours at the intersections of:

- Townson Road / Richmond Road;
- Mid Collector / Townson Road;
- Mosque Road / Richmond Road;

Across the road network, modelling results indicated that the introduction of the additional access intersection at Mosque Road / Richmond Road catered for the introduction of the Costco and Hargraves sites and the wider predicted SBP traffic in June 2016. Critically, the new intersection provided an alternate egress point for southbound site traffic. This improved the spread of traffic around SBP's internal road network which lead to in improved operations at the intersection at Townson Road / Richmond Road. Nonetheless, across the network, results indicated the network performed on the threshold of acceptable delay and LoS. It is recommended that the additional intersection at Quarry Road / Richmond Road be introduced by (or before) June 2016.

Weekend Peak Results

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Table 3: Scenario C Weekend Peak Results

Intersection	Approach	Turn	Volume (veh)	Control Delay (s)	Level of Service	Queue Avg. (m)
Mosque / Richmond	Mosque (E)	L	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (E)	T	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (E)	R	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (W)	L	20.4	60.9	E	98.7
Mosque / Richmond	Mosque (W)	T	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (W)	R	705.2	102.9	F	99.2
Mosque / Richmond	Richmond (N)	L	0.0	0.0	A	0.0
Mosque / Richmond	Richmond (N)	T	1830.2	28.4	B	54.9
Mosque / Richmond	Richmond (N)	R	57.6	100.6	F	55.1
Mosque / Richmond	Richmond (S)	L	655.2	33.2	C	1.7
Mosque / Richmond	Richmond (S)	T	1705.8	58.9	E	181.5
Mosque / Richmond	Richmond (S)	R	0.0	0.0	A	0.0
Mosque / Richmond	-	**AVERAGE**	414.5	51.0	D	97.8
Townson / Mid Collector	Mid Collector (N)	L	137.2	18.7	B	6.0
Townson / Mid Collector	Mid Collector (N)	T	43.2	21.7	B	6.0
Townson / Mid Collector	Mid Collector (N)	R	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	L	16.8	21.3	B	5.2
Townson / Mid Collector	Mid Collector (S)	T	39.8	23.1	B	5.3
Townson / Mid Collector	Mid Collector (S)	R	378.2	21.0	B	5.2
Townson / Mid Collector	Townson (E)	L	518.6	11.7	A	5.5
Townson / Mid Collector	Townson (E)	T	53.4	10.0	A	5.6
Townson / Mid Collector	Townson (E)	R	135.2	11.8	A	5.8
Townson / Mid Collector	Townson (W)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Townson (W)	R	72.4	8.2	A	0.1
Townson / Mid Collector	-	**MAX**	518.6	23.1	B	6.8
Townson / Richmond	Richmond (N)	L	30.4	5.1	A	6.8
Townson / Richmond	Richmond (N)	T	1344.2	27.9	B	44.2
Townson / Richmond	Richmond (N)	R	237.8	84.4	F	44.1
Townson / Richmond	Richmond (S)	L	427.2	12.1	A	11.1
Townson / Richmond	Richmond (S)	T	1246.4	32.3	C	39.7
Townson / Richmond	Richmond (S)	R	43.2	78.2	F	38.6
Townson / Richmond	Townson (E)	L	153.6	65.2	E	40.9
Townson / Richmond	Townson (E)	T	71.2	70.1	E	43.1
Townson / Richmond	Townson (E)	R	166.4	104.6	F	42.7
Townson / Richmond	Townson (W)	L	276.4	36.1	C	33.8
Townson / Richmond	Townson (W)	T	70.0	64.9	E	34.0
Townson / Richmond	Townson (W)	R	393.2	63.3	E	34.3
Townson / Richmond	-	**AVERAGE**	371.7	40.0	C	37.6

SOURCE: AECOM

In Scenario C, the introduction of the additional access intersection at Mosque Road / Richmond Road catered for strong signal coordination along Richmond Road. When compared with Scenario B, the coordination resulted in improved throughput along the corridor. Results indicated that the Mosque Road / Richmond Road operated with an average delay per vehicle of 51.0 seconds (LoS D).

Modelling suggested that the introduction of Mosque Road access lead to improved performance at the Townson Road / Richmond Road intersection. It no longer operated on the threshold of capacity. When compared to Scenario B, the average vehicle delay decreased from 52.7 seconds to 40.0 seconds (LoS D to LoS C respectively) indicating spare capacity.

When compared to Scenario B, results also indicated that the roundabout at Townson Road / Road 18 Collector operated with improved performance in Scenario C. With the improved spread of site traffic, modelling suggested that vehicles egressing ALDI and Bunnings on the northern approach of the roundabout no longer received delays and operated at LoS B.

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Modelling predicted some of the SBP site traffic's movements operated with relatively high delay. The introduction of the Mosque Road intersection reduced the delay at these movements; however results indicated that the opening of the Costco and Hargraves sites offset most of the benefit. The right turn SBP access movements from the northern approaches of Townson Road / Richmond Road and Mosque Road / Richmond Road had average delays of 84.4 seconds and 100.6 seconds respectively. It should be noted that both the average max queues for these movements remained in their proposed turn bays and hence did not affect the through movement on Richmond Road corridor. Additionally, both the right turn egress movements on the western approaches of Towson Road and Mosque Road operated with average delays of 63.3 seconds and 102.9 seconds. These delays resulted in average maximum queues of approximately 85m and 210m both of which are not predicted to impede on their upstream intersections.

Figure 9: Richmond Road / Townson Road intersection looking northbound in Scenario C

The figure above shows a snapshot of the worst queuing predicted in the weekend peak hour in June 2016 at the Richmond Road / Townson Road intersection. Seen in the foreground are vehicles queuing for the northbound movement along Richmond Road. Shown in the middle of the figure is the large dual right turning egressing from the SBP. Finally in the background, the right turning accessing movement into the SBP can be seen.

D R A F T

Table 4: Richmond Road / Mosque Road intersection looking northbound in Scenario C

The figure above shows a snapshot of the worst queuing predicted in the weekend peak hour in June 2016 at the Richmond Road / Mosque Road intersection. Seen in the foreground are vehicles queuing for the northbound movement along Richmond Road. Shown in the middle of the figure is the new large dual right turning egressing movement out of the SBP as a result of the introduction of the Mosque Road intersection.

D R A F T

PM Peak Results

Table 5: Scenario C Evening Peak Results

Intersection	Approach	Turn	Volume (veh)	Control Delay (s)	Level of Service	Queue Avg. (m)
Mosque / Richmond	Mosque (E)	L	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (E)	T	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (E)	R	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (W)	L	10.2	25.2	B	22.7
Mosque / Richmond	Mosque (W)	T	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (W)	R	435.6	55.6	E	23.4
Mosque / Richmond	Richmond (N)	L	0.0	0.0	A	0.0
Mosque / Richmond	Richmond (N)	T	1747.2	26.5	B	46.3
Mosque / Richmond	Richmond (N)	R	44.6	73.9	F	46.5
Mosque / Richmond	Richmond (S)	L	381.2	35.7	C	0.1
Mosque / Richmond	Richmond (S)	T	1824.8	65.0	E	211.9
Mosque / Richmond	Richmond (S)	R	0.0	0.0	A	0.0
Mosque / Richmond	-	AVERAGE	370.3	46.4	D	108.0
Townson / Mid Collector	Mid Collector (N)	L	151.6	12.2	A	2.3
Townson / Mid Collector	Mid Collector (N)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (N)	R	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	L	19.6	7.9	A	1.4
Townson / Mid Collector	Mid Collector (S)	T	22.8	9.0	A	1.5
Townson / Mid Collector	Mid Collector (S)	R	390.2	8.7	A	1.5
Townson / Mid Collector	Townson (E)	L	233.0	3.7	A	0.1
Townson / Mid Collector	Townson (E)	T	51.4	3.8	A	0.1
Townson / Mid Collector	Townson (E)	R	73.4	4.2	A	0.0
Townson / Mid Collector	Townson (W)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Townson (W)	R	105.6	5.8	A	0.1
Townson / Mid Collector	-	MAX	390.2	12.2	A	1.5
Townson / Richmond	Richmond (N)	L	29.8	3.2	A	4.6
Townson / Richmond	Richmond (N)	T	1201.2	27.3	B	37.2
Townson / Richmond	Richmond (N)	R	117.8	114.2	F	37.5
Townson / Richmond	Richmond (S)	L	201.8	4.8	A	1.6
Townson / Richmond	Richmond (S)	T	1594.8	18.8	B	26.8
Townson / Richmond	Richmond (S)	R	42.0	83.2	F	26.9
Townson / Richmond	Townson (E)	L	135.4	44.9	D	25.7
Townson / Richmond	Townson (E)	T	36.6	66.2	E	26.9
Townson / Richmond	Townson (E)	R	147.2	85.0	F	27.7
Townson / Richmond	Townson (W)	L	229.2	42.8	D	38.6
Townson / Richmond	Townson (W)	T	57.8	66.4	E	38.5
Townson / Richmond	Townson (W)	R	466.0	66.6	E	38.7
Townson / Richmond	-	AVERAGE	355.0	34.4	C	30.8

SOURCE: AECOM

During the evening peak hour, modelling predicted the signalised intersections at Townson Road / Richmond Road and Mosque Road / Richmond Road and the roundabout intersection at Townson Road / Road 18 Collector performed with spare capacity and acceptable levels of delay.

The introduction of the additional SBP access intersection at Mosque Road resulted in improved spread of site traffic which benefited the Townson Road / Richmond intersection. Compared to Scenario B, the average delay at the intersection in Scenario C improved from 42.9 seconds to 34.4 seconds (LoS D to LoS C). Modelling indicated both the right turn egress movements on the western approaches of Towson Road and Mosque Road operated with moderate delay, with average delays of 66.6 seconds and 55.6 seconds respectively.

AM Peak Results

D R A F T

Figure 10: Scenario C Morning Peak Results

Intersection	Approach	Turn	Volume (veh)	Control Delay (s)	Level of Service	Queue Avg. (m)
Mosque / Richmond	Mosque (E)	L	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (E)	T	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (E)	R	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (W)	L	14.8	32.9	C	16.4
Mosque / Richmond	Mosque (W)	T	0.0	0.0	A	0.0
Mosque / Richmond	Mosque (W)	R	313.8	54.7	D	17.3
Mosque / Richmond	Richmond (N)	L	0.0	0.0	A	0.0
Mosque / Richmond	Richmond (N)	T	1774.2	30.7	C	54.7
Mosque / Richmond	Richmond (N)	R	28.4	62.9	E	54.5
Mosque / Richmond	Richmond (S)	L	803.6	8.6	A	0.9
Mosque / Richmond	Richmond (S)	T	1035.6	28.7	C	27.0
Mosque / Richmond	Richmond (S)	R	0.0	0.0	A	0.0
Mosque / Richmond	-	AVERAGE	330.9	27.8	B	33.5
Townson / Mid Collector	Mid Collector (N)	L	61.4	5.9	A	0.3
Townson / Mid Collector	Mid Collector (N)	T	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (N)	R	0.0	0.0	A	0.0
Townson / Mid Collector	Mid Collector (S)	L	64.2	11.6	A	0.4
Townson / Mid Collector	Mid Collector (S)	T	72.4	14.3	A	0.4
Townson / Mid Collector	Mid Collector (S)	R	248.0	9.9	A	0.4
Townson / Mid Collector	Townson (E)	L	202.4	4.9	A	0.2
Townson / Mid Collector	Townson (E)	T	21.0	3.6	A	0.2
Townson / Mid Collector	Townson (E)	R	16.6	5.1	A	0.2
Townson / Mid Collector	Townson (W)	L	0.0	0.0	A	0.0
Townson / Mid Collector	Townson (W)	R	58.2	4.4	A	0.0
Townson / Mid Collector	-	MAX	248.6	14.3	A	0.4
Townson / Richmond	Richmond (N)	L	85.8	7.1	A	7.8
Townson / Richmond	Richmond (N)	T	1516.0	29.8	C	43.8
Townson / Richmond	Richmond (N)	R	179.6	82.9	F	43.8
Townson / Richmond	Richmond (S)	L	0.0	0.0	A	0.0
Townson / Richmond	Richmond (S)	T	1012.6	14.2	A	15.0
Townson / Richmond	Richmond (S)	R	39.0	77.0	F	15.0
Townson / Richmond	Townson (E)	L	102.4	40.8	C	13.7
Townson / Richmond	Townson (E)	T	47.6	55.0	D	14.5
Townson / Richmond	Townson (E)	R	80.6	62.7	E	14.8
Townson / Richmond	Townson (W)	L	125.4	35.8	C	19.3
Townson / Richmond	Townson (W)	T	66.4	62.0	E	19.3
Townson / Richmond	Townson (W)	R	196.8	58.3	E	19.4
Townson / Richmond	-	AVERAGE	287.7	31.9	C	29.4

Across the morning peak, modelling indicated the SBP road network operated with minimal delay and spare capacity. Both the left turn slip lanes (on the western arms of Townson Road / Richmond Road and Mosque Road / Richmond Road) catered for access to the SBP with minimal delay. Overall, results suggested that these intersections operated with average delays of 31.9 seconds and 27.8 seconds (LoS C and LoS B respectively). Modelling did suggest that right turning vehicles on the northern approach of the Townson Road intersection received some moderate delay. The resulting queue however, remained in the turn bay. Results also indicated that the roundabout at Townson Road / Road 18 Collector operated with minimal delay, LoS A.

5.3 Scenario D

As stated in section 5.2, the SBP road network in Scenario C is on the threshold of acceptable performance and operation. It is recommended that the additional intersection at Quarry Road / Richmond Road be introduced shortly after June 2016 with additional development in operation. As such, the assessment of Scenario D, was not required at this stage.

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6.0 Opportunities for Further Analysis

6.1.1 Scenario E

As mentioned in section 5.3 the introduction of the additional SBP access intersection at Quarry Road / Richmond Road was required by June 2016 (Scenario C). Hence the assessment of Scenario D was not required. However, due to the proposed configuration of the SBP internal road network, it is likely that only Swire and Lindt site traffic would make use of the Quarry Road intersection. As a result, it is recommended that a new Scenario E be tested. Namely:

- Identify the longevity of wider SBP network with the introduction of the additional access intersection at Quarry Road / Richmond Road. In particular, identify the date the network reaches capacity

6.1.2 Richmond Road Traffic Proportions

As stated in section 3.2, it was assumed all SBP site traffic was split 75%, 20% and 5% to/from the south, north and east along Richmond Road / Townson Road respectively. In order to gain a more robust understanding of this assumption, it is recommended that sensitivity testing be completed for all scenarios. Two new proportion splits of 85%, 10% and 5% to/from the south, north and east and 65%, 30% and 5% to/from the south, north and east is recommended.

6.1.3 Site Operation Review

When the SBP tenants open business and become operational, it is recommended that confirmation of the predicted trip generations and distribution used in this modelling be reassessed. Similar to the assessment conducted at Rouse Hill Town Centre (seen in Appendix B), site observations and a subsequent model review is recommended.

6.1.4 Vehicle Actuated Signals

As described in section 2.2.6, the traffic signals at all intersections in the modelling have been assumed to run on fixed time programs. Compared to fixed time signalling, vehicle actuated signals have variable phase times based on actual demands on each approach which ultimately yield greater throughput and lower delay. Hence to gain more realistic operations and hence additional benefits for Scenario B and C, it is recommended that the microsimulation model be updated with vehicle actuated signals.

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Appendix A

Model Register

D R A F T

Table 6: Model Register

PROJECT NUMBER:														60198124
Project Name:														Sydney Business Park Staging Modelling
Junction ref: (max 5 digits)														
MODEL FILE NAME														Description
Number								Time Period		Year of flow			EXisting/Proposed/ Revision	
								AM PM WE		2 digit			X P R	
01	S	C	N	R	O	B	-	AM	-	1	5	-	P	Scenario B: Assessment of Townson Road / Richmond Road intersection – assessment of predicted SBP traffic generation, intersection operation and longevity – December 2015;
02	S	C	N	R	O	B	-	PM	-	1	5	-	P	Scenario B: Assessment of Townson Road / Richmond Road intersection – assessment of predicted SBP traffic generation, intersection operation and longevity – December 2015;
03	S	C	N	R	O	B	-	WE	-	1	5	-	P	Scenario B: Assessment of Townson Road / Richmond Road intersection – assessment of predicted SBP traffic generation, intersection operation and longevity – December 2015;
04	S	C	N	R	O	C	-	AM	-	1	6	-	P	Scenario C: Assessment of Townson Road / Richmond Road intersection with the introduction of Mosque Road / Richmond Road intersection – assessment of predicted SBP traffic generation, intersection operation and longevity – June 2016;
05	S	C	N	R	O	C	-	PM	-	1	6	-	P	Scenario C: Assessment of Townson Road / Richmond Road intersection with the introduction of Mosque Road / Richmond Road intersection – assessment of predicted SBP traffic generation, intersection operation and longevity – June 2016;
06	S	C	N	R	O	C	-	WE	-	1	6	-	P	Scenario C: Assessment of Townson Road / Richmond Road intersection with the introduction of Mosque Road / Richmond Road intersection – assessment of predicted SBP traffic generation, intersection operation and longevity – June 2016;

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Appendix B

Rouse Hill Town Centre Trip Analysis

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Table 7: Rouse Hill Town Centre Trip Analysis

Land Use	Floor Area (GLFA)	Category			SATURDAY	Floor Area	RTA rates	Potential trips
Woolworths	4,718	SM	ST	Slow Trade	ST	0	0.038	0
Coles	4,208	SM	FT	Fast Trade	FT	22,471	0.013	292
Big W	8,228	FT	SS	Specialty Shops	SS	32,212	0.107	3447
Target	6,918	FT	SM	Supermarkets	SM	8,926	0.147	1312
Cinema	6,142	SS	OM	Office, medical and other related business	OM	9,078	0	0
Mini Majors	4,966	FT						5,051
Retail - Main Mall Specialty	21,656	SS					Actual generated trips	3,370
Retail - Large Format	2,359	FT						67%
Retail - Main Mall Food Specialty	4,116	SS					Reduction Factor	33%
Retail - Restaurants	298	SS						
Sub-total	63,609							
Other Areas	Floor Area (GFA)							
Commercial	3,742	OM						
Library	3,234	OM						
Learning	2,102	OM						
Sub-total	9,078							
Total	72,687							

D R A F T

Appendix C

Origin Destination Matrices

D R A F T

Figure 11: Scenario B AM

HV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	145	8	1	6	0	4	2	0	5	1	0	172
B	99	0	7	3	19	1	17	7	0	17	5	0	175
C	8	10	0	0	2	0	1	0	0	1	0	0	22
D	0	2	0	0	0	0	0	0	0	0	0	0	2
E	4	13	1	0	0	0	0	0	0	0	0	0	18
F	0	1	0	0	0	0	0	0	0	0	0	0	1
G	3	11	1	0	0	0	0	0	0	0	0	0	15
H	1	5	0	0	0	0	0	0	0	0	0	0	6
I	0	0	0	0	0	0	0	0	0	0	0	0	0
J	3	12	1	0	0	0	0	0	0	0	0	0	16
K	1	4	0	0	0	0	0	0	0	0	0	0	5
L	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot	119	203	18	4	27	1	22	9	0	23	6	0	432

LV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	1323	76	6	3	0	44	17	0	3	12	0	1484
B	890	0	63	29	15	0	150	63	0	13	48	0	1271
C	74	92	0	1	1	0	11	4	0	1	3	0	187
D	4	20	1	0	0	0	0	0	0	0	0	0	25
E	2	9	0	0	0	0	0	0	0	0	0	0	11
F	0	0	0	0	0	0	0	0	0	0	0	0	0
G	29	101	8	0	0	0	0	0	0	0	0	0	138
H	11	42	3	0	0	0	0	0	0	0	0	0	56
I	0	0	0	0	0	0	0	0	0	0	0	0	0
J	2	9	0	0	0	0	0	0	0	0	0	0	11
K	8	32	2	0	0	0	0	0	0	0	0	0	42
L	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot	1020	1628	153	36	19	0	205	84	0	17	63	0	3225

Table 8: Scenario B PM

HV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	115	3	2	4	0	3	1	0	3	1	0	132
B	161	0	4	6	13	1	11	5	0	12	4	0	217
C	15	13	0	0	1	0	1	0	0	1	0	0	31
D	2	10	0	0	0	0	0	0	0	0	0	0	12
E	6	19	1	0	0	0	0	0	0	0	0	0	26
F	0	1	0	0	0	0	0	0	0	0	0	0	1
G	4	18	1	0	0	0	0	0	0	0	0	0	23
H	2	7	0	0	0	0	0	0	0	0	0	0	9
I	0	0	0	0	0	0	0	0	0	0	0	0	0
J	5	17	1	0	0	0	0	0	0	0	0	0	23
K	2	6	0	0	0	0	0	0	0	0	0	0	8
L	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot	197	206	10	8	18	1	15	6	0	16	5	0	482

LV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	1029	26	14	2	1	29	11	0	2	9	0	1123
B	1437	0	36	58	9	5	101	42	0	9	38	0	1735
C	134	120	0	3	0	0	7	3	0	0	2	0	269
D	21	86	5	0	0	0	0	0	0	0	0	0	112
E	3	15	1	0	0	0	0	0	0	0	0	0	19
F	1	5	0	0	0	0	0	0	0	0	0	0	6
G	44	150	11	0	0	0	0	0	0	0	0	0	205
H	17	63	4	0	0	0	0	0	0	0	0	0	84
I	0	0	0	0	0	0	0	0	0	0	0	0	0
J	3	13	1	0	0	0	0	0	0	0	0	0	17
K	14	57	3	0	0	0	0	0	0	0	0	0	74
L	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot	1674	1538	87	75	11	6	137	56	0	11	49	0	3644

Table 9: Scenario B WE

D R A F T

HV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	127	3	3	3	0	8	3	0	2	2	0	151
B	124	0	4	14	11	1	29	11	0	10	7	0	211
C	17	15	0	1	1	0	2	1	0	1	0	0	38
D	3	14	1	0	0	0	0	0	0	0	0	0	18
E	3	11	1	0	0	0	0	0	0	0	0	0	15
F	0	1	0	0	0	0	0	0	0	0	0	0	1
G	8	29	2	0	0	0	0	0	0	0	0	0	39
H	3	11	1	0	0	0	0	0	0	0	0	0	15
I	0	0	0	0	0	0	0	0	0	0	0	0	0
J	2	10	1	0	0	0	0	0	0	0	0	0	13
K	2	7	0	0	0	0	0	0	0	0	0	0	9
L	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot	162	225	13	18	15	1	39	15	0	13	9	0	510

LV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	1145	27	30	2	1	75	27	0	1	14	0	1322
B	1114	0	36	125	8	7	258	100	0	7	62	0	1717
C	154	137	0	7	0	0	19	7	0	0	3	0	327
D	30	125	7	0	0	0	0	0	0	0	0	0	162
E	2	8	0	0	0	0	0	0	0	0	0	0	10
F	2	7	0	0	0	0	0	0	0	0	0	0	9
G	75	258	19	0	0	0	0	0	0	0	0	0	352
H	27	100	7	0	0	0	0	0	0	0	0	0	134
I	0	0	0	0	0	0	0	0	0	0	0	0	0
J	1	7	0	0	0	0	0	0	0	0	0	0	8
K	14	62	3	0	0	0	0	0	0	0	0	0	79
L	0	0	0	0	0	0	0	0	0	0	0	0	0
Tot	1419	1849	99	162	10	8	352	134	0	8	79	0	4120

D R A F T

Figure 12: Scenario C AM

HV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	148	9	1	6	0	4	2	5	5	1	6	187
B	100	0	7	3	19	0	18	7	18	17	5	20	214
C	8	10	0	0	1	0	1	0	1	1	0	1	23
D	0	2	0	0	0	0	0	0	0	0	0	0	2
E	4	13	1	0	0	0	0	0	0	0	0	0	18
F	0	0	0	0	0	0	0	0	0	0	0	0	0
G	3	11	1	0	0	0	0	0	0	0	0	0	15
H	1	4	0	0	0	0	0	0	0	0	0	0	5
I	3	12	1	0	0	0	0	0	0	0	0	0	16
J	3	12	1	0	0	0	0	0	0	0	0	0	16
K	1	4	0	0	0	0	0	0	0	0	0	0	5
L	4	13	1	0	0	0	0	0	0	0	0	0	18
Tot	127	229	21	4	26	0	23	9	24	23	6	27	519

LV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	1333	77	6	3	0	41	17	44	3	10	53	1587
B	897	0	64	30	15	0	154	63	157	14	50	179	1623
C	74	92	0	1	1	0	10	4	11	1	2	14	210
D	4	20	1	0	0	0	0	0	0	0	0	0	25
E	2	10	0	0	0	0	0	0	0	0	0	0	12
F	0	0	0	0	0	0	0	0	0	0	0	0	0
G	27	103	7	0	0	0	0	0	0	0	0	0	137
H	11	42	3	0	0	0	0	0	0	0	0	0	56
I	29	104	7	0	0	0	0	0	0	0	0	0	140
J	2	9	0	0	0	0	0	0	0	0	0	0	11
K	7	33	1	0	0	0	0	0	0	0	0	0	41
L	35	120	9	0	0	0	0	0	0	0	0	0	164
Tot	1088	1866	169	37	19	0	205	84	212	18	62	246	4006

Table 10: Scenario C PM

HV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	115	3	1	4	0	3	1	3	3	1	5	139
B	161	0	4	6	13	2	11	5	12	12	4	16	246
C	15	13	0	0	1	0	1	0	1	1	0	1	33
D	2	10	0	0	0	0	0	0	0	0	0	0	12
E	5	19	1	0	0	0	0	0	0	0	0	0	25
F	0	2	0	0	0	0	0	0	0	0	0	0	2
G	5	17	1	0	0	0	0	0	0	0	0	0	23
H	2	7	0	0	0	0	0	0	0	0	0	0	9
I	5	18	1	0	0	0	0	0	0	0	0	0	24
J	5	17	1	0	0	0	0	0	0	0	0	0	23
K	1	6	0	0	0	0	0	0	0	0	0	0	7
L	7	24	2	0	0	0	0	0	0	0	0	0	33
Tot	208	248	13	7	18	2	15	6	16	16	5	22	576

LV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	1037	27	13	2	3	27	11	29	2	8	43	1202
B	1448	0	36	59	10	13	103	42	104	9	39	143	2006
C	134	120	0	3	0	1	7	3	8	0	2	11	289
D	19	89	4	0	0	0	0	0	0	0	0	0	112
E	3	15	1	0	0	0	0	0	0	0	0	0	19
F	3	13	1	0	0	0	0	0	0	0	0	0	17
G	41	154	10	0	0	0	0	0	0	0	0	0	205
H	17	63	4	0	0	0	0	0	0	0	0	0	84
I	44	156	11	0	0	0	0	0	0	0	0	0	211
J	3	14	1	0	0	0	0	0	0	0	0	0	18
K	13	59	3	0	0	0	0	0	0	0	0	0	75
L	64	214	17	0	0	0	0	0	0	0	0	0	295
Tot	1789	1934	115	75	12	17	137	56	141	11	49	197	4533

D R A F T

Table 11: Scenario C WE

HV

	Richmond Rd (N)	Richmond Rd (S)	Townson Rd (E)	Bunnings	Swire	Townson Rd (W)	IKEA	Masters	Hargraves	Lindt	ALDI	Costco	
	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	128	3	3	3	1	8	3	5	2	1	8	165
B	125	0	4	14	11	2	29	11	18	10	7	25	256
C	17	15	0	1	1	0	2	1	1	1	0	2	41
D	3	14	1	0	0	0	0	0	0	0	0	0	18
E	3	11	1	0	0	0	0	0	0	0	0	0	15
F	1	2	0	0	0	0	0	0	0	0	0	0	3
G	8	29	2	0	0	0	0	0	0	0	0	0	39
H	3	11	1	0	0	0	0	0	0	0	0	0	15
I	5	18	1	0	0	0	0	0	0	0	0	0	24
J	2	10	1	0	0	0	0	0	0	0	0	0	13
K	1	7	0	0	0	0	0	0	0	0	0	0	8
L	8	25	2	0	0	0	0	0	0	0	0	0	35
Tot	176	270	16	18	15	3	39	15	24	13	8	35	632

LV

	A	B	C	D	E	F	G	H	I	J	K	L	Tot
A	0	1154	27	28	2	4	72	27	46	1	13	68	1442
B	1123	0	36	128	8	18	262	100	164	7	63	230	2139
C	154	137	0	6	0	1	18	7	12	0	3	18	356
D	28	128	6	0	0	0	0	0	0	0	0	0	162
E	2	8	0	0	0	0	0	0	0	0	0	0	10
F	4	18	1	0	0	0	0	0	0	0	0	0	23
G	72	262	18	0	0	0	0	0	0	0	0	0	352
H	27	100	7	0	0	0	0	0	0	0	0	0	134
I	46	163	12	0	0	0	0	0	0	0	0	0	221
J	1	7	0	0	0	0	0	0	0	0	0	0	8
K	13	63	3	0	0	0	0	0	0	0	0	0	79
L	69	230	18	0	0	0	0	0	0	0	0	0	317
Tot	1539	2270	128	162	10	23	352	134	222	8	79	316	5243