USING SIDRA INTERSECTION TO MODEL A SMALL NETWORK WITH ROUNDABOUT METERING ON TWO APPROACHES

CASE STUDY OF THE INTERSECTION OF NORWEST BOULEVARD & LEXINGTON DRIVE IN BELLA VISTA, SYDNEY

Heru Jatmika

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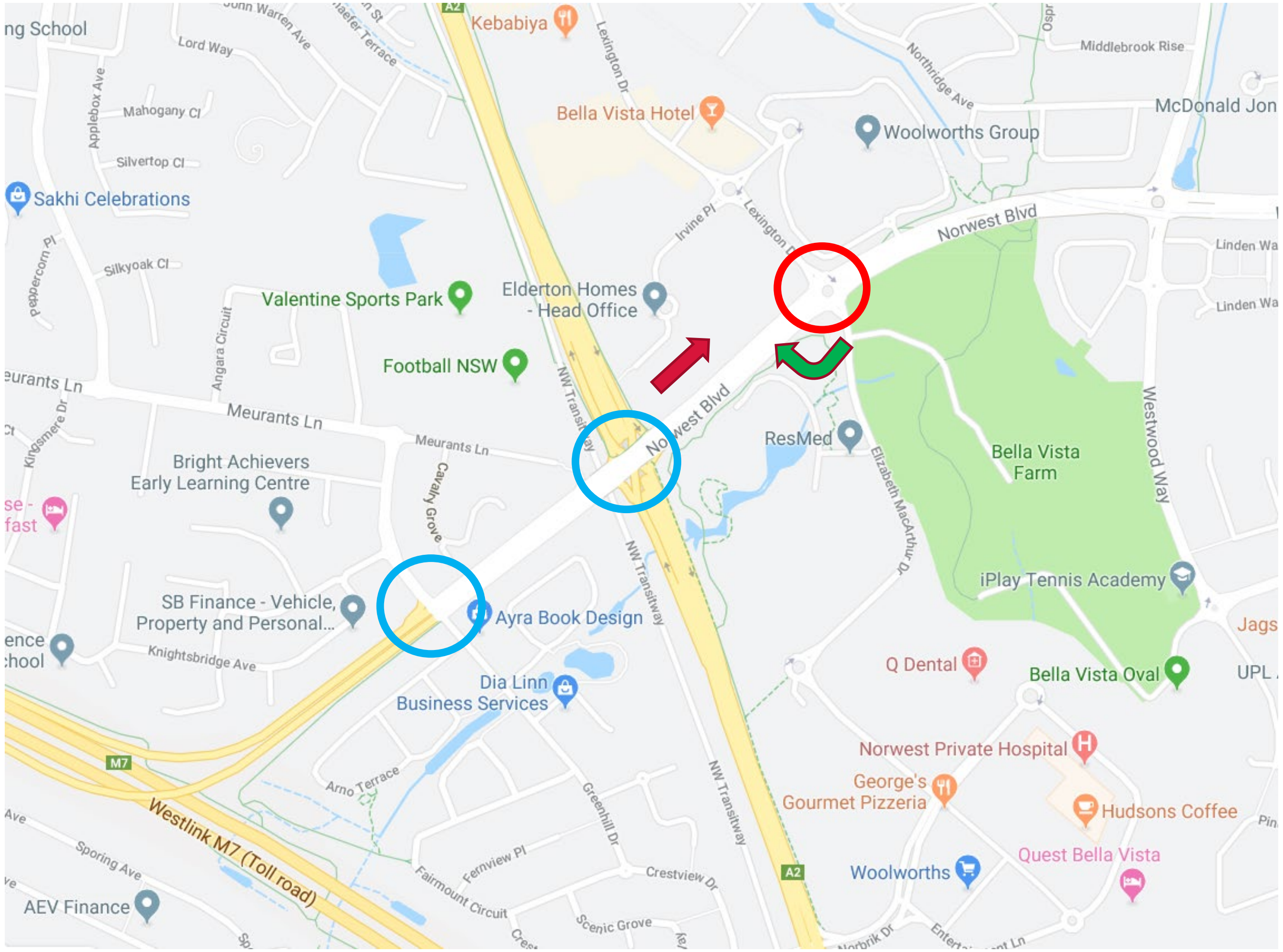
Sydney, 30 August 2019

NSW GOVERNMENT | Transport Roads & Maritime Services

BACKGROUND


Kebabiya
Bella Vista Hotel
Woolworths Group
McDonald Jon
Middlebrook Rise
Northridge Ave
Lexington Dr
Lord Way
Mahogany Cl
Silvertop Cl
Applebox Ave
Sakhi Celebrations
Silkyoak Cl
Peppercorn Pl
Valentine Sports Park
Elderton Homes
- Head Office
Irvine Pl
Norwest Blvd
Linden Wa
Football NSW
Angara Circuit
Meurants Ln
NW Transitway
ResMed
Bella Vista
Farm
Westwood Way
Elizabeth MacArthur Dr
Bright Achievers
Early Learning Centre
Cavalry Grove
iPlay Tennis Academy
SB Finance - Vehicle,
Property and Personal...
Ayra Book Design
Knightsbridge Ave
Jags
Q Dental
Bella Vista Oval
Dia Linn
Business Services
M7
Norwest Private Hospital
George's
Gourmet Pizzeria
Hudsons Coffee
Arno Terrace
Greenhill Dr
Westlink M7 (Toll road)
Quest Bella Vista
Woolworths
Sporing Ave
Fernview Pl
Crestview Dr
Fairmount Circuit
Scenic Grove
AEV Finance
A2

OBJECTIVES

- Improving road safety at M7 exit ramp – not efficiency
- Reducing the queue length & delay of western approach in the AM peak
- Enhancing throughput of eastbound movement at the roundabout

SCOPE

- TEMPORAL SCOPE
  - ✓ Weekday AM peak only (08:00 – 09:00)
- SPATIAL SCOPE – along Norwest Boulevard at:
  - ✓ *Lexington Drive (Rdb) – our focus*
  - ✓ *Old Windsor Road (TCS)*
  - ✓ *Green Hill Drive (TCS)*
- *TIME HORIZON*
  - ✓ *Short period of time*

METHODOLOGY

SIDRA only models one-approach metered roundabout and it has no template to model two-approach metered rdb – a quick practical method is developed given the urgency of the project.

1. *Calibrate the existing roundabout parameters*
2. *Calibrate the SPUI (and also another TCS)*
3. *Use the normal roundabout model & emulate the **two intervals of metering roundabout operations** :*
   - *Blank signal – the intersection operates as a **normal unsignalised roundabout*** (EF=0.83 & FS=130% on west approach)
   - *Red signal – the normal roundabout but **with 0 flow at E & S approaches***
4. *Calculate **capacity adjustment factors (CAFs)** on each approach by taking into account the **combined effects** of the Blank and Red intervals (time-weighted average of capacity results used)*
5. *Process the final calculation by using the CAF values from Step 4 in SIDRA network*

ROUNDABOUT CALIBRATION

- *Calibrate the capacity model*

SIDRA Standard Roundabout Model Calibration

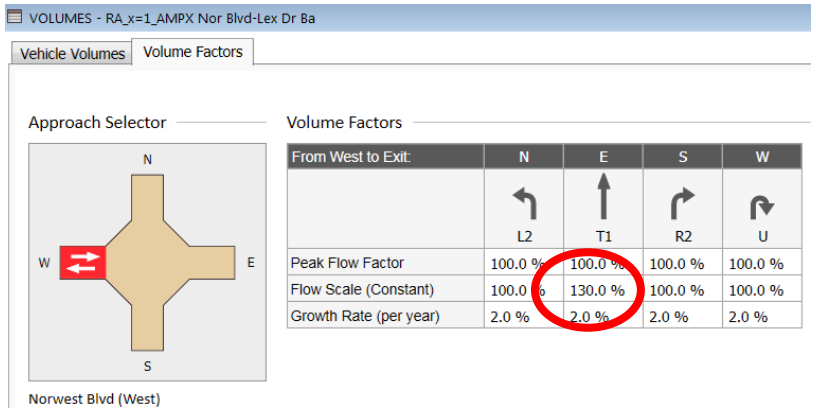
Approach:	S	E	N	W
Environment Factor	1.00	1.00	1.00	0.83
Entry/Circ Flow Adjustment	Medium	Medium	Medium	Medium

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %
South: Elizabeth Macarthur Dr					
Lane 1	66	0.0	291	0.227	100
Lane 2[d]	261	4.0	366	0.713	100
Approach	327	3.2		0.713	
East: Norwest Blvd (East)					
Lane 1	1038	6.1	1300	0.798	100
Lane 2[d]	1224	1.3	1534	0.798	100
Approach	2262	3.5		0.798	
North: Lexington Dr					
Lane 1[d]	281	3.2	724	0.388	100
Lane 2	65	3.0	437	0.149	100
Approach	346	3.1		0.388	
West: Norwest Blvd (West)					
Lane 1[d]	489	5.4	492	0.993	100
Lane 2	284	7.9	286	0.993	100
Approach	773	6.4		0.993	
Intersection	3708	4.0		0.993	

ROUNDABOUT CALIBRATION

- Calibrate the real demand model
- Use the flow scale (FS) to calibrate travel time data



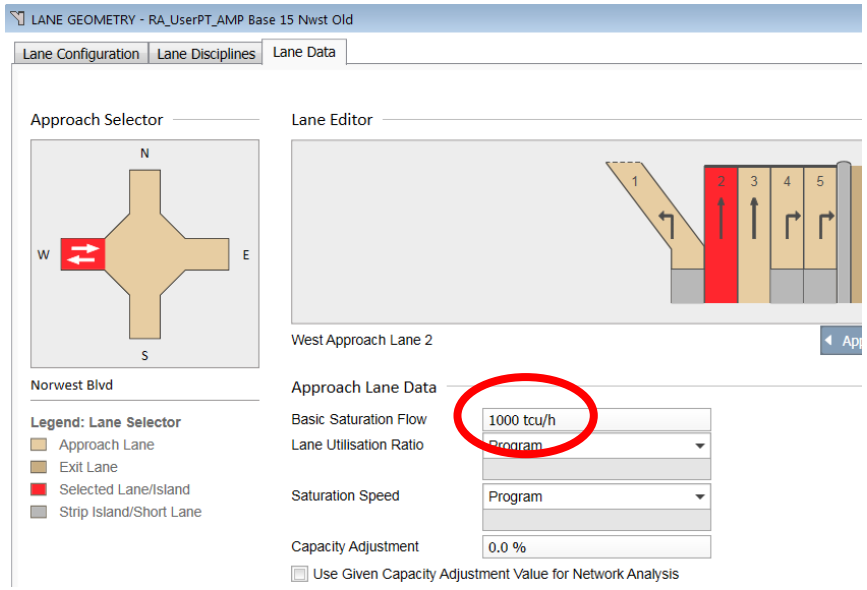
Intersection Negotiation and Travel Data
Site: RA_x=1_AMPX Nor Blvd-Lex Dr Base Flow Scale

TRAVEL SPEED, TRAVEL DISTANCE AND TRAVEL TIME

From Approach	To Exit	Turn	Running Speed km/h	Travel Speed km/h	Travel Distance m	Travel Time s	Total Travel Dem Flows veh-km/h	Distance Arv Flows veh-km/h	Tot.Trav. Time veh-h/h
West: Norwest Blvd (West)									
	West	U	31.3	7.0	709.0#	363.5#	0.7	0.7	0.1
	North	L2	21.3	5.4	528.8#	[illegible]	94.7	94.7	17.4
	East	T1	31.9	8.5	873.3#	369.1#	660.8	660.8	77.6
	South	R2	31.9	8.3	879.0#	[illegible]	9.7	9.7	1.2

SPUI (TCS 3273) CALIBRATION

- Use SCATS signal timings
- Set basic SF of thru lanes of western approach to 1000 tcu/h (through trial & error)



- Use the flow scale to the eastbound thru lanes

SPUI (TCS 3273) CALIBRATION

- Results (with FS = 130%)

LANE SUMMARY

Site: 3273 [RA_UserPT_AMP Base 15 Nwst Old Windsor MF W S X=1 FS]

Network: 1 [RA_Recalibrate_Rdb_SPUI_AMP Bas 2016 FS V

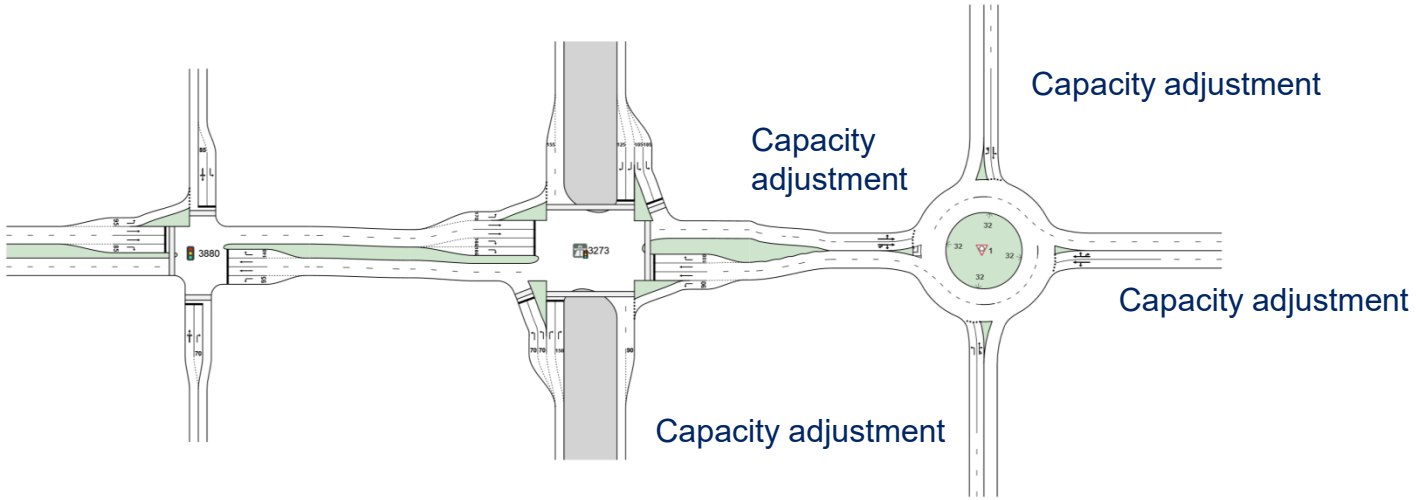
Intersection of Norwest Blvd and Old Windsor Rd
AMP Base 2015
Single Point Interchange (Signals) - Fixed Time Coordinated Cycle Time = 102 seconds (User-Given Phase Times)

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	95% Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Old Windsor Rd															
Lane 1	128	10.0	128	10.0	493	0.259	100	24.7	LOS B	3.5	26.6	Short	70	0.0	NA
Lane 2	128	10.0	128	10.0	493	0.259	100	24.7	LOS B	3.5	26.6	Short	70	0.0	NA
Lane 3	118	5.0	118	5.0	173	0.680	100	57.0	LOS E	6.0	44.0	Full	500	-38.6[N3]	0.0
Lane 4	164	5.0	164	5.0	242	0.680	100	55.5	LOS D	8.2	59.9	Short	150	-14.0[N3]	NA
Approach	537	7.4	537	7.4		0.680		41.2	LOS C	8.2	59.9				
East: Norwest Blvd															
Lane 1	299	4.5	299	4.5	1135	0.263	100	13.1	LOS A	5.4	39.3	Short	90	0.0	NA
Lane 2	315	7.5	314	7.5	583	0.539	100	31.3	LOS C	13.0	96.8	Full	330	0.0	0.0
Lane 3	315	7.5	314	7.5	583	0.539	100	31.3	LOS C	13.0	96.8	Full	330	0.0	0.0
Lane 4	60	7.0	60	7.0	382	0.157	100	43.9	LOS D	2.4	18.2	Short	130	0.0	NA
Approach	988	6.6	988	6.6		0.539		26.6	LOS B	13.0	96.8				
North: Old Windsor Rd															
Lane 1	20	13.0	20	13.0	256	0.077	100	27.7	LOS B	0.6	4.7	Short	105	-38.6[N3]	NA
Lane 2	27	13.0	27	13.0	358	0.077	100	27.1	LOS B	0.8	6.4	Short	105	-14.0[N3]	NA
Lane 3	38	3.0	38	3.0	285	0.131	100	49.0	LOS D	1.6	11.7	Full	500	0.0	0.0
Lane 4	38	3.0	38	3.0	285	0.131	100	49.0	LOS D	1.6	11.7	Short	125	0.0	NA
Approach	122	6.9	122	6.9		0.131		40.7	LOS C	1.6	11.7				
West: Norwest Blvd															
Lane 1	202	5.0	202	5.0	1433	0.141	100	7.8	LOS A	1.5	11.0	Short	170	0.0	NA
Lane 2	240	7.0	240	7.0	242	0.992	100	92.1	LOS F	20.1	148.8	Full	330	-38.6[N3]	0.0
Lane 3	336	7.0	336	7.0	339	0.992	100	78.9	LOS F	26.9	199.5	Full	330	-14.0[N3]	0.0
Lane 4	258	4.0	258	4.0	425	0.607	62[6]	45.1	LOS D	10.0	72.3	Short	165	0.0	NA
Lane 5	414	4.0	414	4.0	425	0.974	100	81.7	LOS F	24.7	178.5	Short	165	0.0	NA
Approach	1450	5.3	1450	5.3		0.992		66.0	LOS E	26.9	199.5				
Intersection	3097	6.1	3097	6.1		0.992		48.1	LOS D	26.9	199.5				

THE USE OF CAPACITY ADJUSTMENT FACTORS (CAF)

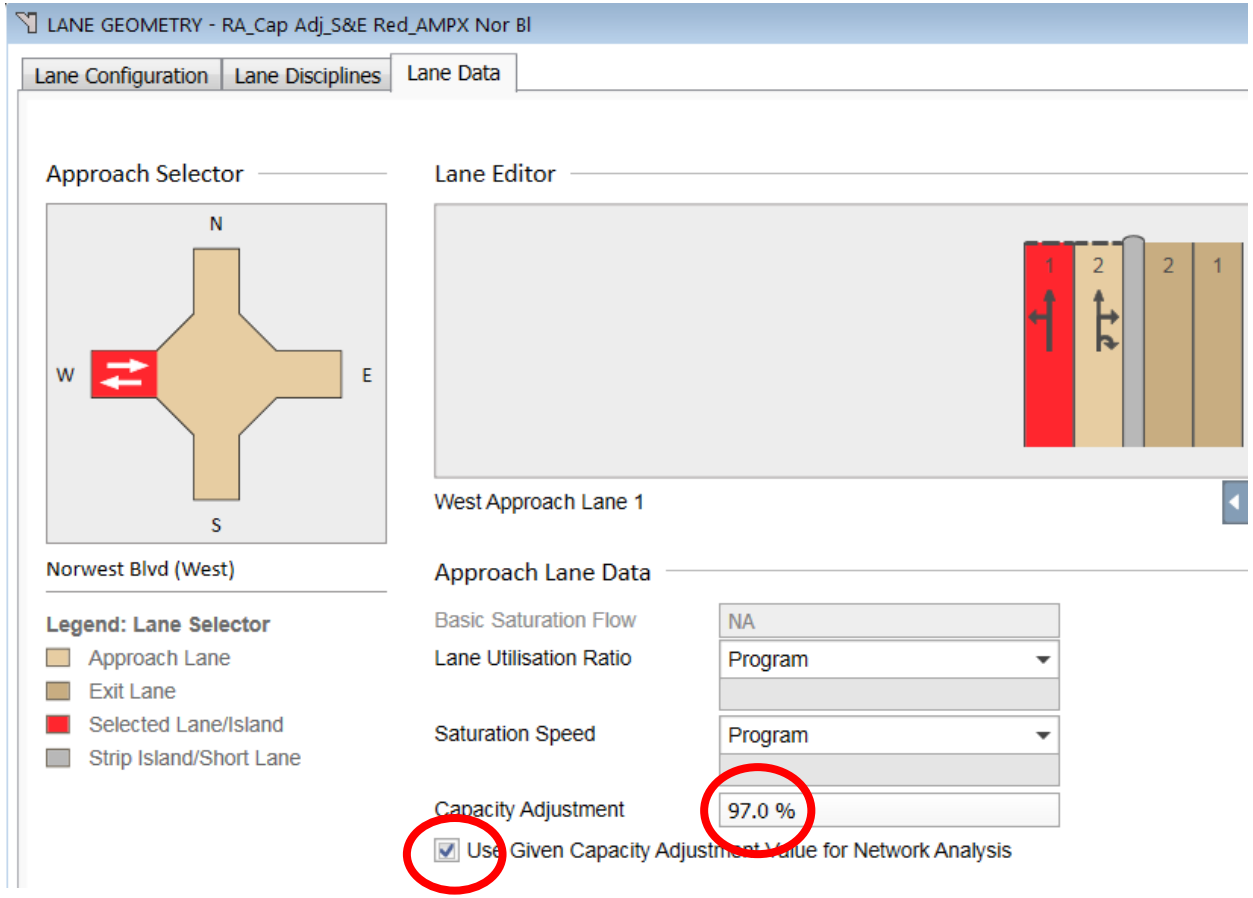
- The operations of two-approach metered roundabout is emulated by using a normal unsignalised roundabout with capacity adjustment factors



- The calibrated CAF values are: 97% (lane 1) & 125% (lane 2) for west approach
- For East & South approaches, calibrated CAF values are -33.3% for every lane

FINAL CALCULATION

- Use the calibrated capacity adjustment factors



MODELLING RESULTS (EF=0.83 & FS=130%)

LANE SUMMARY

Site: 1 [RA_Cap Adj_S&E Red_AMPX Nor Blvd-Lex Dr Base]

Network: 1 [RA_S&E Metered_Recalibrate_Rdb_SPUI_AMP Base 2016 FS V3]

Norwest Blvd-Lexington Dr-Elizabeth Macarthur Dr
2015 AM Peak

Roundabout

Lane Use and Performance

	Demand Flows Total veh/h	HV %	Arrival Flows Total veh/h	HV %	Cap. veh/h	Deg. Satn v/c	Lane Util. %	Average Delay sec	Level of Service	Aver. Back of Queue Veh	Dist m	Lane Config	Lane Length m	Cap. Adj. %	Prob. Block. %
South: Elizabeth Macarthur Dr															
Lane 1	66	0.0	66	0.0	174	0.379	100	16.2	LOS B	0.6	4.2	Full	500	-33.0 N2	0.0
Lane 2 d	261	4.0	261	4.0	242	1.080	100	140.6	LOS F	8.8	63.5	Full	500	-33.0 N2	0.0
Approach	327	3.2	327	3.2		1.080		115.5	LOS F	8.8	63.5				
East: Norwest Blvd (East)															
Lane 1	1038	6.1	1038	6.1	871	1.192	100	181.8	LOS F	56.9	419.3	Full	500	-33.0 N2	34.9
Lane 2 d	1224	1.3	1224	1.3	1027	1.192	100	186.8	LOS F	66.0	467.3	Full	500	-33.0 N2	43.1
Approach	2262	3.5	2262	3.5		1.192		184.5	LOS F	66.0	467.3				
North: Lexington Dr															
Lane 1 d	281	3.2	281	3.2	650	0.432	100	9.0	LOS A	1.2	8.7	Full	160	0.0	0.0
Lane 2	65	3.0	65	3.0	397	0.164	100	16.3	LOS B	0.3	2.4	Full	160	0.0	0.0
Approach	346	3.1	346	3.1		0.432		10.4	LOS A	1.2	8.7				
West: Norwest Blvd (West)															
Lane 1 d	571	5.8	571	5.8	1190	0.479	100	16.1	LOS B	4.6	33.8	Full	330	97.0 N2	0.0
Lane 2	377	7.9	377	7.9	787	0.479	100	23.4	LOS B	4.1	30.8	Full	330	125.0 N2	0.0
Approach	948	6.7	948	6.7		0.479		19.0	LOS B	4.6	33.8				
Intersection	3883	4.2	3883	4.2		1.192		122.8	LOS F	66.0	467.3				

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Network Data dialog (Network tab).
Lane LOS values are based on average delay per lane.
Intersection and Approach LOS values are based on average delay for all lanes.
Roundabout Capacity Model: SIDRA Standard.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Largest change in Average Back of Queue or Degree of Saturation for any lane during the last three iterations: 0.4 %
Number of Iterations: 5 (maximum specified: 15)

d Dominant lane on roundabout approach

COMMENTS ON MODELLING RESULTS

- Queue length at the western approach of the roundabout is underestimated:
  - The method of emulating a two-approach metered roundabout using zero volumes was devised for a quick solution in urgent project
  - The method appears to overestimate capacities of the controlling approach (West approach), probably because the method we used did not increase circulating flow rates during blank interval resulting from vehicles queued during red interval & platooned during saturated portions of blank intervals
  - The analysis did not involve calculating timings at SPUI & other TCS due to improved traffic condition with the metered roundabout operations
  - The use of default queue jam space data – shorter than rolling queue jam space
  - The use of one-hour volume period instead of 15-minute period
  - Traffic re-assignment and induced traffic was not captured
  - SPUI gating effects is assumed to continue to occur - even though the metering rdb operation increases throughput – e.g. basic SF is still 1000 tcu/h for the EB thru lanes

FIELD MONITORING

- The metering device began to operate on 14 August 2017 & constantly monitored
  - Slow reaction times of motorists (10 – 15 sec loss time) - in the first month of metering device operation
  - Different roundabout operation settings - in the first four months of metering operations – cycle length was set to 120 seconds with 30 sec red time (the proposed cycle length was 60 sec and red time is 20 sec)
- In November 2017, EB thru traffic increased by 45% (between 8 and 9 weekday AM peak)
- In February 2018 the cycle time was changed to 90 sec with 30 sec red time
- In July 2019, Metro began to operate – the impact is still being monitored

CONCLUSIONS

- SIDRA was used to model a two-approach metered roundabout towards a quick practical solution
- Metering signals were successfully implemented at the subject intersection but it is only for a short term purpose
- Further analysis using a new volume data is being considered at this stage