

The Parade / George Street Scramble Crossing

SIDRA Report

City of Norwood Payneham & St Peters

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Glossary

Term	Definition
Tcu/h	Through car units per hour. Measure of flows in passenger car units (i.e. heavy vehicles will be equivalent to multiple passenger car units)
Degree of saturation	<p>This defines the saturation level of the approach. Saturation levels of less than 1 indicate that the traffic approaching the intersection in the time period will be able to pass through (i.e. it is not saturated). Saturation level of 1 indicates the approach is saturated and the number of vehicles approaching will just be able to make it through the intersection. Saturation level of greater than 1 means that intersection is over saturated and more vehicles approach than what can pass through. This causes a build up of traffic and increased queue lengths/delay times.</p> <p>Saturation levels should be less than 0.9 for new intersections but can be between 0.9-1 for existing saturated intersections.</p>
95% queue distance	This represents the actual queuing experienced at the approach. This is an estimate of the worse case queue in the time period, not the average queue length.
LOS	Level of Service. This provides a ranking from A-F based on the delay times at the intersection. The ranking does not correspond to a certain traffic condition as such however it allows for comparison between scenarios. DPTI requires a minimum LOS of D
Phase	That part of a signal cycle during which one or more movements receive right of way subject to resolution of any vehicle or pedestrian conflicts by priority rules. A phase is identified by at least one movement gaining right of way at the start of it and at least one movement losing right of way at the end of it.
Fixed/variable phase	A fixed phase will operate to a set timing no matter the traffic conditions. A variable phase will use vehicle detection technology to only activate phases or to alter phases based on the traffic conditions (i.e. if no vehicles are detected then a phase may not run)
Cycle	A cycle is the complete set of phases.
Minimum green time	This is the minimum time that a green signal must be displayed.
Intergreen time	This is the time in which either a yellow or red light is displayed.

Term	Definition
Platooning effect	This is when the green time of signals in proximity of each other are linked so that the green times correspond. As such vehicles will arrive as a tighter group or platoon rather than scattered vehicles. This reduces delays and queue lengths as vehicles are arriving at the same time as the lights turn green rather than waiting for a full cycle.
Clearance time	This is the time it takes for a pedestrian to cross and clear the intersection. This is used for the flashing red signal.
SCATS	Sydney Coordinated Adaptive Traffic System. SCATS summary data is provided which shows the recorded phase times, phase signals, cycle lengths, green times, intergreen times and other signal related information.

1 Background

Oxygen Landscape Architects have prepared a Masterplan for The Parade on behalf of the City of Norwood Payneham & St Peters (Council). This Masterplan details the desired environment and proposed upgrades along the length of The Parade.

A key component of the Masterplan is a proposed pedestrian scramble crossing at the intersection of The Parade and George Street.

At the end of 2018 Tonkin provided Council with commentary and a cost estimate for the installation of a scramble crossing. Following this, Tonkin undertook a review of The Parade Masterplan which included SIDRA modelling of the proposed scramble crossing.

Council are now seeking approval from DPTI for the installation of a scramble crossing at the intersection of The Parade and George Street. This requires further SIDRA modelling to DPTI standard to consider the traffic impacts of the scramble crossing and assess potential improvements.

2 Existing Conditions

The existing intersection consists of two lanes in each direction along The Parade with a single lane in each direction along George Street. Although George Street only has a single lane on approach to the intersection, it is wide enough to allow for two vehicles to queue side by side and so acts as two short lanes.

All turning movements are filter movements:

- Right turning traffic has to give way to oncoming traffic and pedestrians
- Left turning traffic has to give way to pedestrians.

3 Inputs

3.1 Traffic Volumes

DPTI provided traffic counts undertaken in June 2017 for the intersection of The Parade and George Street. These traffic counts highlighted an AM Peak hour of 8:00-9:00 and a PM peak period of 15:30-16:30. It was noted that PM Peak hour corresponds to the typical school peak rather than the typical commuter peak of approximately 17:30-18:30.

An analysis of the raw data showed that the differences in traffic volumes between the 15:30-16:30 and 17:30-18:30 traffic periods were mostly minor with the major differences occurring along George Street. Some movements along The Parade had greater traffic volumes in the commuter peak compared to the school peak period. As previous comments raised by DPTI related to the commuter peak and the generally small differences in volumes, the commuter peak was adopted as the PM Peak period.

3.2 Traffic Type

Traffic data suggests the majority of heavy vehicles along The Parade consist of rigid vehicles and buses (Austroads vehicle class 3 to 5). The majority of heavy vehicle turning movements along The Parade consists of rigid vehicles, with the through movements dominated by buses. There were no buses recorded turning into George Street.

The heavy vehicle movements on George Street are dominated by heavy rigid vehicles, with only 6 buses recorded in the entire 11-hour period.

Based on DPTI SIDRA 7 guideline an average heavy vehicle length of 12.0m was adopted with a queue space of 14.0m (2.0m greater than the vehicle length). This was applied to all approaches on all scenarios.

3.3 Lane Dimensions

The length of each lane is measured from the intersection to the nearest controlled intersection. Side roads with give way controls don't significantly impact the queue space and so were not considered in measuring the lane length.

Although there is no formal line marking, the width of George Street allows for two vehicles to queue side by side. The site visit undertaken confirmed that this is the typical behaviour and so George Street has been modelled as two lanes. George Street remains at a width which can accommodate side by side queueing until the end of the no standing areas. At this point a vehicle could park on street which would reduce the width of the road. Based on this, the theoretical length vehicles are estimated to be able to queue side by side is approximately 40m on the southern leg and 45m on the northern leg of George Street. This represents the possible side by side queue lengths and not the observed lengths.

Below is a summary of the lane lengths (note that the SIDRA lane naming convention is from left to right in the direction of travel):

Table 3.1 Lane Lengths

Location	Lane	Length (m)	Termination of Lane
George Street (S)	1	320	Roundabout intersection with William Street
	2	40	Narrowing of lane

The Parade (E)	1	380	Signalised intersection with Portrush Road
	2	380	Signalised intersection with Portrush Road
George Street (N)	1	315	Roundabout intersection with Beulah Road
	2	45	Narrowing of lane
The Parade (W)	1	380	Signalised intersection with Osmond Terrace
	2	380	Signalised intersection with Osmond Terrace

The following are the lane and median widths adopted for the modelling, with the future case based on The Parade Masterplan:

Table 3.2 Lane and Median Widths

Location	Lane	Current Width (m)	Future Width (m)
George Street (S)	1	2.9	2.9
	2	3.2	3.2
The Parade (E)	1	3.8	3.0
	2	3.4	3.3
	Median	2.4	2.5
George Street (N)	1	2.7	3.5
	2	3.1	3.5
The Parade (W)	1	4.1	3.0
	2	3.4	3.3
	Median	2.3	2.5

3.4 Pedestrian Movements

Pedestrian movements were based on survey data from 7am to 7pm 15 June 2017. This data formed the basis for the pedestrian volumes used in all models.

3.5 Model Year

All modelling is undertaken for the year the traffic data was undertaken (2017). No modelling of future traffic volumes or adjustments to the traffic data has been undertaken. This is important as no allowance has been made for future growth on either The Parade or George Street to account for increased development in the precinct.

4 Calibration

4.1 SCATS

SCATS data was provided by DPTI with the following description, TS 302 – The Parade / George Street: Norwood:

- 2 phases, fixed phase time
 - The Parade (east-west): which can run as A and C phases
 - George Street (north-south): which can run as B and D phases.
- Running phase sequence (phase diagrams are shown in Appendix A):
 - AM peak (0700-0900) A, D (operates as a simple two phase with the majority of green time allocated to The Parade (A))
 - All other times A, B, C, D (the lights still operate as 2 phases but the use of B and D phases allows alternative green times to achieve a more equitable distribution of time).
- Pedestrian auto introduction 0800-2000 Mon to Fri, 0900-1800 Sat and Sun
- Right turns filter at all times
- A phase is the stretch phase
- PC191 (The Parade / Edward Street) and TS246 (Osmond Terrace / The Parade) are linked to TS302
- Minimum green time of 5.0 seconds on all phases
- A and C phases have 6.0 seconds of intergreen time (Yellow = 4.0s, Red = 2.0s)
- B and D phases have 6.5 seconds of intergreen time (Yellow = 4.0s, Red = 2.5s)
- Maximum cycle time is 130 seconds during peak times

The following average phase times were provided:

Table 4.1 Phase Timings

Period	Time	Average CL	A	B	C	D
AM	0800-0900	130s	99s	-	-	31s
BUS	1300-1400	116s	26s	31s	28s	31s
PM	1645-1745	130s	40s	31s	28s	31s

Despite the SCATS data showing that the AM peak consists of phases A and D only, site inspections showed that the conditions match a phase of A, B, C and D. Consequently, the same phasing times were adopted for both the AM and PM peak periods, i.e. the PM peak phase was applied to the AM peak.

The following information was provided on pedestrian walking times:

Table 4.2 Pedestrian Timings

Pedestrian	Parallel Vehicle Phase	Walk	Clearance 1	Clearance 2	AM Activation	BUS Activation	PM Activation
P1	A, C	8.0s	8.0s	4.0s	28	61	56
P2	A, C	8.0s	10.0s	4.0s	28	61	56
P3	B, D	8.0s	17.0s	4.0s	28	61	56
P4	B, D	8.0s	15.0s	4.0s	28	61	56

4.2 Site Observations and Measurements

Site visits were undertaken in the PM peak on Wednesday 9 October and the AM peak on Thursday 10 October 2019.

Queue lengths, pedestrian movements, traffic behaviour and general observations were noted.

The following are general observations:

- Left turn movements were sometimes impeded by pedestrian movements. This was more frequent in the PM peak period
- Queue lengths were reduced due to coordination of traffic signals along The Parade. A platooning effect was observed for traffic in The Parade, with vehicles generally arriving at the same time as a green signal was displayed. This reduced the queue lengths. Consequently, the signal coordination along both legs of The Parade was set to favourable (4) in the AM peak and highly favourable (5) in the PM peak periods
- The main pedestrian movements occurred across the northern leg of George Street and the eastern leg of The Parade.
- The pedestrian queue space was estimated at 2.5m. This was applied to all approaches.

4.2.1 Saturation Flows

Saturation flows were measured on site, however this was difficult due to the short queue lengths. The recorded (SCATS) saturation flows were not considered to be reliable of the function of the intersection and when modelled did not reflect the performance of the intersection. Saturation flows of 1670 tcu/h were used for the base case due to the combined through/turning lanes and the pedestrian interference. Saturation flows of 1850 tcu/h were used for all of the scramble crossing models as the pedestrian interference is removed.

4.2.2 Effective Bay Lengths

The lengths where side by side queueing could occur on George Street was estimated on site. These estimates confirmed the original lengths used.

4.2.3 Lane Utilisation

Due to the filter right turns and side by side queueing on George Street, it was found that some lanes had greater utilisation than others, with vehicles attempting to avoid delays.

The following are the observed lane utilisations. Note that these are only shown for lanes where the utilisation was observed to be lower than standard, the utilisation for other lanes was left as default.

Table 4.3 Lane Utilisation

Road	Lane	Utilisation	Observations
George Street (S)	1	75%	Majority of vehicles used the right lane to either turn right or continue straight on George Street. Delays occurred with left lanes giving way to pedestrian movements, resulting in a higher utilisation of the right lane.
The Parade (E)	2	90%	The right lane experienced delays at times with vehicles waiting to undertake filter right movements. Small increase in utilisation of the left lane
George Street (N)	1	75%	As with George Street south.
The Parade (W)	2	95%	As with The Parade east.

5 Base Case

Based on the site observations and calibration, the base cases were developed. The layout of these cases is shown in Figure 5.1 below. (Note that this layout is a default layout of SIDRA rather than a drawn layout to reflect actual conditions). The plan shows two lanes in George Street to reflect that vehicles can queue side by side, although only one lane is actually marked.

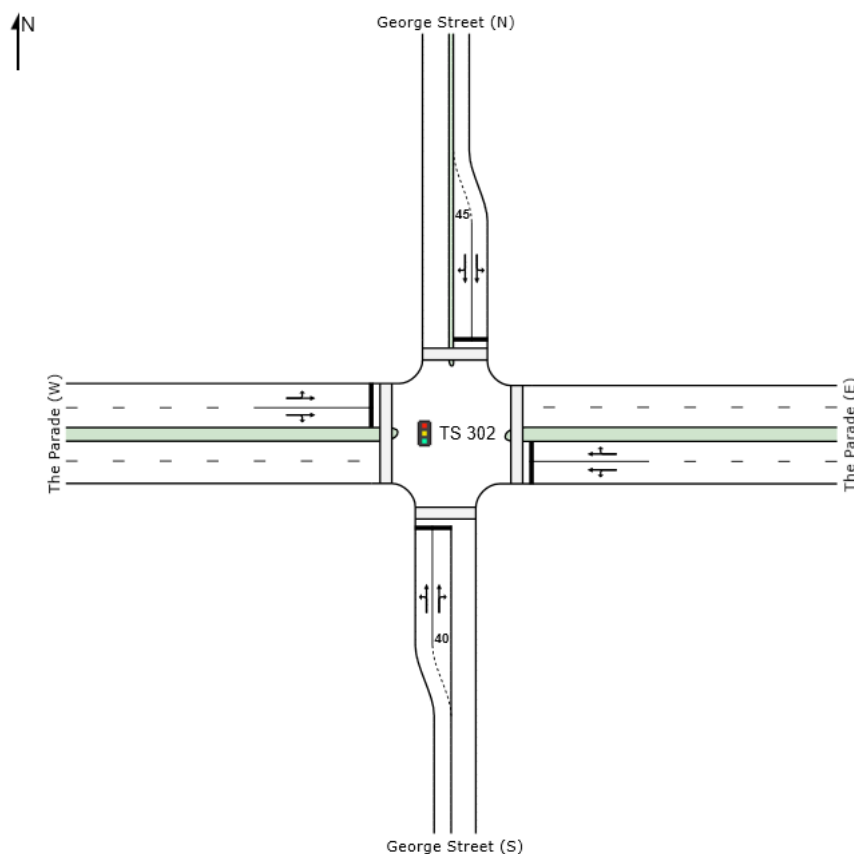


Figure 5.1 Base Case Intersection Layout

5.1 AM Peak

The following are the key outputs from the Base Case AM Peak.

Table 5.1 AM Peak Base Case LOS

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	B	19.5	34.0	486	0.334
The Parade (E)	B	14.2	80.5	11.3	0.693
George Street (N)	C	21.6	50.0	7.1	0.538
The Parade (W)	B	16.3	39.4	5.3	0.426
All Vehicles	B	17.0	80.5	11.3	0.693

5.2 PM Peak

The following are the key outputs from the Base Case PM Peak.

Table 5.2 PM Peak Base Case LOS

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	C	20.1	37.9	5.4	0.408
The Parade (E)	B	13.6	41.0	5.7	0.521
George Street (N)	C	22.0	50.4	7.2	0.512
The Parade (W)	C	21.2	123.2	17.4	0.875
All Vehicles	B	19.5	123.2	17.4	0.875

6 Option 1 – Base Case with Scramble Crossing

Option 1 involves the addition of the scramble crossing phase to the existing intersection configuration and lane arrangements. The phasing has been changed to a three-phase sequence with Phase A consisting of vehicle movements along The Parade, Phase B consisting of vehicle movements along George Street and Phase C consisting of the scramble crossing phase.

Four scenarios have been modelled

- Option 1A – Modified Base Case + Scramble + Filter Right Turn Movements
- Option 1B – Modified Base Case + Scramble + No Right Turn Movements from the Parade in Both Peaks
- Option 1C – Modified Base Case + Scramble + No Right Turn Movements from the Parade in Respective Peaks
- Option 1D – As per Option 1C with manually altered phase timing to improve flows on The Parade

The modification of the base case involves changes to the George Street approaches to reflect the proposed concept plan. This includes formalising the two lanes, with a right turn only lane and a through/left turn lane. The width of the northern leg of George Street is to be reduced so that two lanes are only provided for a length of 18m (including taper length). This provides an approximate queueing length of 11m.

The timing for each phase was set to automatic, with a user given cycle time of 130 seconds, matching the existing cycle time.

The maximum diagonal distance across the intersection was estimated at 25m. With a walking speed of 1.2m/s, this results in a crossing time of 21 seconds. The clearance time was set to 23 seconds, with a minimum walk time of 5 seconds (as specified for new crossings in DPTI SIDRA 7 Guideline) and 4 seconds minimum clearance overlap. This results in a phase time of 33 seconds for the scramble crossing phase. DPTI have requested a minimum walk time of 8 seconds, and so this has also been modelled for each scenario. Each option is therefore shown with either a 5 second green walk time (minimum accepted standard) or 8 second green walk time (as per current).

Pedestrian movements were removed from all phases other than the scramble crossing phase.

Options 1B, 1C and 1D involve the removal of right turn movements along The Parade in the peak periods. It is assumed that when right turns are banned, 50% of the recorded right turn movements will be converted to through movements, where vehicles will turn at the next available right turn. The other 50% are assumed to turn prior to the George Street intersection and so are removed from the model.

The intersection layout for Option 1 is shown in Figure 6.1 opposite.

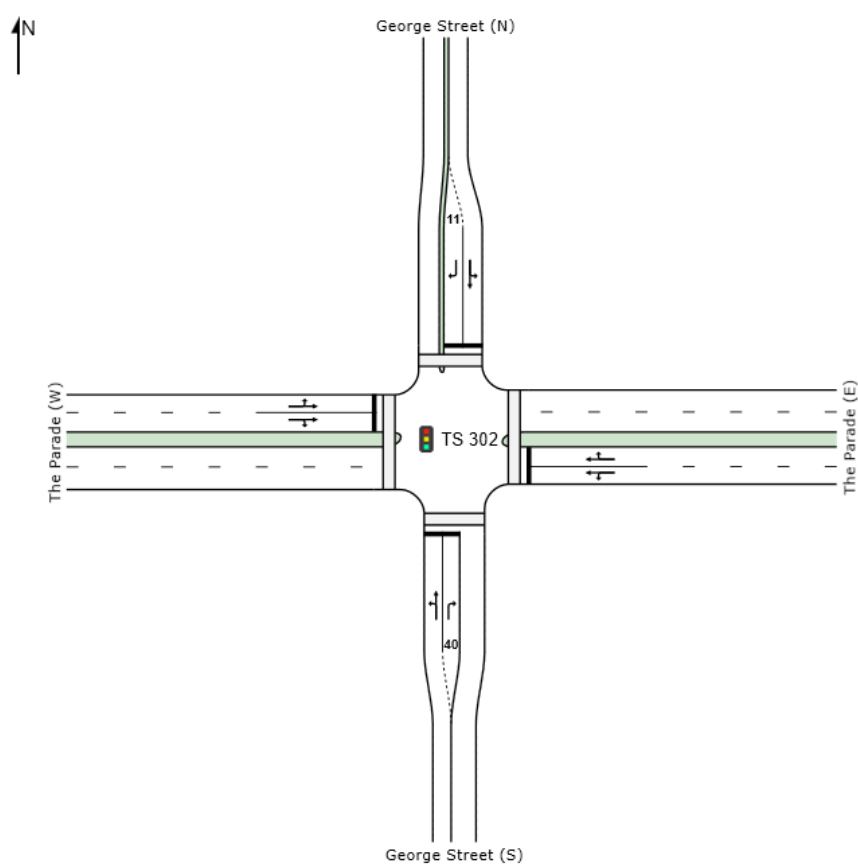


Figure 6.1 Option 1 Intersection Layout

6.1 Option 1A – Filter Right Turns

The following are the key outputs from Option 1A.

Table 6.1 AM Peak Option 1A LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	38.1	93.6	13.3	0.469
The Parade (E)	F	103.7	431.8	60.5	1.046
George Street (N)	F	95.5	142.1	20.3	1.097
The Parade (W)	D	44.9	162.5	21.9	0.742
All Vehicles	E	79.9	431.8	60.5	1.097

Table 6.2 PM Peak Option 1A LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	48.9	105.3	14.9	0.668
The Parade (E)	C	29.4	113.0	15.7	1.008
George Street (N)	F	116.2	162.7	23.2	1.196
The Parade (W)	E	58.1	394.0	55.4	0.988
All Vehicles	E	61.8	394.0	55.4	1.196

In both the AM and PM peak periods the queue distance on George Street north is likely to extend past the intersection with Webbe Street. It is likely that vehicles will be queued across Webbe Street in the AM and PM peak periods.

In the AM and PM peak period it is possible that vehicles will queue across the carpark entrance on the southern leg of George Street.

In the AM peak period, queues lengths may extend along the eastern leg of The Parade, across the intersection with Portrush Road. This may cause vehicles to queue over the intersection.

In the PM peak period vehicles may queue along The Parade west, to the intersection with Osmond Terrace. This may cause issues with traffic flows at this intersection.

Queueing issues may be observed at the intersections of The Parade with Edward Street and Queen Street, with queues likely to extent past these intersections in the peak periods.

The outputs for Option 1A with 8 second pedestrian walk time are shown below:

Table 6.3 AM Peak Option 1A LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	39.9	96.0	13.6	0.493
The Parade (E)	F	113.9	449.8	63.0	1.064
George Street (N)	F	117.8	161.5	23.1	1.164
The Parade (W)	D	46.6	166.7	22.5	0.758
All Vehicles	F	89.6	449.8	63.0	1.164

Table 6.4 PM Peak Option 1A LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	47.9	104.1	14.8	0.647
The Parade (E)	C	28.9	129.4	18.0	0.671
George Street (N)	F	102.3	158.2	22.6	1.136
The Parade (W)	E	71.5	402.7	56.7	1.012
All Vehicles	E	64.4	402.7	56.7	1.136

The overall performance of the intersection reduces with increasing from E to F in the morning peak.

6.2 Option 1B – No Right Turns from The Parade

Option 1B is as per Option 1A, however the right turn movements from The Parade into George Street were removed in both directions in both peak periods.

The following are the key outputs from Option 1B.

Table 6.5 AM Peak Option 1B LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	C	34.0	88.0	12.5	0.423
The Parade (E)	E	57.7	238.3	33.4	0.922
George Street (N)	D	54.7	98.6	13.9	0.944
The Parade (W)	D	41.4	79.7	10.8	0.462
All Vehicles	D	50.1	238.3	33.4	0.944

Table 6.6 PM Peak Option 1B LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	39.0	93.3	13.2	0.503
The Parade (E)	C	26.6	65.9	9.2	0.429
George Street (N)	D	44.6	116.2	16.6	0.818
The Parade (W)	C	31.8	171.6	24.2	0.805
All Vehicles	C	34.5	171.6	24.2	0.818

In both the AM and PM peak periods the queue distance on George Street north may extend to the intersection with Webbe Street.

In the AM and PM peak period it is possible that vehicles will queue across the carpark entrance on the southern leg of George Street.

In the AM peak period, queues lengths may extend along the eastern leg of The Parade to the intersection with Queen Street. This may cause vehicles to queue over the intersection.

The outputs for Option 1B with 8 second pedestrian walk time are shown below:

Table 6.7 AM Peak Option 1B LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	C	34.8	89.2	12.6	0.432
The Parade (E)	E	70.3	273.1	38.3	0.975
George Street (N)	E	60.9	101.5	14.3	0.975
The Parade (W)	D	43.3	82.5	11.1	0.489
All Vehicles	E	57.4	273.1	38.3	0.975

Table 6.8 PM Peak Option 1B LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	39.9	94.5	13.4	0.516
The Parade (E)	C	28.7	69.6	9.7	0.451
George Street (N)	D	47.2	119.3	17.0	0.851
The Parade (W)	C	35.7	185.3	26.1	0.846
All Vehicles	C	37.2	185.3	26.1	0.851

6.3 Option 1C – No Right Turn from The Parade Westbound in AM Peak and Eastbound in PM Peak

Option 1C is similar to Option 1B, however right turns are only banned in one direction in each peak period. This direction corresponds to the primary peak traffic direction.

The following are the key outputs from Option 1C.

Table 6.9 AM Peak Option 1C LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	C	34.0	88.0	12.5	0.423
The Parade (E)	E	57.7	238.3	33.4	0.922
George Street (N)	D	54.7	98.6	13.9	0.944
The Parade (W)	D	51.4	153.9	20.8	0.755
All Vehicles	D	52.3	238.3	33.4	0.944

Table 6.10 PM Peak Option 1C LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	43.7	99.3	14.1	0.575
The Parade (E)	C	29.3	109.0	15.1	0.605
George Street (N)	D	45.5	121.4	17.3	0.700
The Parade (W)	C	25.1	143.9	20.3	0.717
All Vehicles	C	33.2	143.9	20.3	0.717

In both the AM and PM peak periods the queue distance on George Street north may extend to the intersection with Webbe Street.

In the AM and PM peak period it is possible that vehicles will queue across the carpark entrance on the southern leg of George Street.

In the AM peak period, queues lengths may extend along the eastern leg of The Parade to the intersection with Queen Street. This may cause vehicles to queue over the intersection.

The outputs for Option 1C with 8 second pedestrian walk time are shown below:

Table 6.11 AM Peak Option 1C LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	35.6	90.3	12.8	0.442
The Parade (E)	E	63.1	253.6	35.5	0.948
George Street (N)	E	69.9	115.8	16.5	1.000
The Parade (W)	D	55.4	178.5	24.1	0.827
All Vehicles	D	58.9	253.6	35.5	1.000

Table 6.12 PM Peak Option 1C LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	45.9	101.7	14.4	0.608
The Parade (E)	C	30.5	114.9	15.9	0.626
George Street (N)	D	48.5	127.3	18.2	0.742
The Parade (W)	C	26.2	148.5	20.9	0.733
All Vehicles	C	34.9	148.5	20.9	0.742

6.4 Option 1D – Option 1C with Alternate Phasing

As shown in appendix A, The Parade and George Street have similar times allocated to associated phases, with George Street having greater time allocated in the AM peak period. This is due to SIDRA balancing the traffic conditions on each road. As The Parade is a much more significant route than George Street, Option 1D considers manual alterations to the phasing to improve conditions along The Parade at the detriment of George Street.

As The Parade meets a minimum LOS of D in the PM peak period, the phasing was not altered in this period. Therefore, the only changes are in the AM peak period.

The following are the outputs from Option 1D (noting the PM peak is the same as Option 1C):

Table 6.13 AM Peak Option 1D LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	40.0	96.2	13.6	0.498
The Parade (E)	D	39.6	181.6	25.4	0.776
George Street (N)	F	119.0	162.5	23.2	1.167
The Parade (W)	D	41.2	107.4	14.5	0.544
All Vehicles	E	57.1	181.6	25.4	1.167

Table 6.14 PM Peak Option 1D LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	43.7	99.3	14.1	0.575
The Parade (E)	C	29.3	109.0	15.1	0.605
George Street (N)	D	45.5	121.4	17.3	0.700
The Parade (W)	C	25.1	143.9	20.3	0.717
All Vehicles	C	33.2	143.9	20.3	0.717

In both the AM and PM peak periods the queue distance on George Street north may extend to the intersection with Webbe Street.

In the AM and PM peak period it is possible that vehicles will queue across the carpark entrance on the southern leg of George Street.

The outputs for Option 1D with 8 second minimum pedestrian walk time are shown below:

Table 6.15 AM Peak Option 1D LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	41.9	98.6	14.0	0.523
The Parade (E)	D	41.2	187.2	26.2	0.794
George Street (N)	F	150.7	188.0	26.9	1.261
The Parade (W)	D	42.5	112.3	15.2	0.567
All Vehicles	E	65.2	188.0	26.9	1.261

Table 6.16 PM Peak Option 1D LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	45.9	101.7	14.4	0.608
The Parade (E)	C	30.5	115.1	16.0	0.627
George Street (N)	D	48.5	127.3	18.2	0.742
The Parade (W)	C	26.2	148.5	20.9	0.733
All Vehicles	C	34.9	148.5	20.9	0.742

6.5 Summary

The minimum level of service accepted by DPTI is D. The following table shows the worst-case level of service and if it meets DPTI's requirements.

Table 6.17 Option 1 LOS Summary

Option	Approach	LOS	Complies	LOS 8 Second Min Walk Time
1A AM Peak	George Street (N)	F	No	F
	All Vehicles	E	No	F
1A PM Peak	George Street (N)	F	No	F
	All Vehicles	E	No	E
1B AM Peak	The Parade (E)	E	No	E
	All Vehicles	D	Yes	E
1B PM Peak	George Street (N)	D	Yes	D
	All Vehicles	C	Yes	D
1C AM Peak	The Parade (E)	E	No	E
	All Vehicles	D	Yes	E
1C PM Peak	George Street (N)	D	Yes	D
	All Vehicles	C	Yes	C
1D AM Peak	George Street (N)	F	No	F
	All Vehicles	E	No	E

Option 1B and Option 1C reach the minimum level of service of D in the PM peak period, however they do not reach this standard in the AM peak period. All other options fail to meet the minimum standard in both peak periods. It is expected that queue lengths will significantly increase in all of the options. Option 1A may have issues with queueing across intersections and access point along both legs of George Street and The Parade. Options 1B and 1C may have issues with queueing across intersections on the both legs of George Street and eastern leg of The Parade.

Overall Option 1D performs worse than Option 1C in the AM peak period due to reduction in phase timing allocated to George Street, which causes significant issues with the northern leg of George Street. Although overall Option 1C performs better than Option 1D, The Parade has much greater significance to the broader road network than George Street. As such Option 1D still has merit as it improves the conditions along The Parade. The significance of roads to the network cannot be modelled in SIDRA and so SIDRA alone should not be used to decide the preference between Option 1C and 1D.

The LOS is decreased for a number of approaches/intersections when the minimum walk time is increased from 5 seconds to 8 seconds. In addition to this, the delay times and queue lengths increase across the Options. Retention of the 8 second green walk time may be difficult.

7 Option 2 – Scramble Crossing with Right Turn Lanes on The Parade

Option 2 involves the same parameters as Option 1, however right turn lanes are added to both approaches along The Parade. Council provided the maximum distance for the right turn storage lane on the eastern and western approaches of 22m and 30m respectively. This distance prevents impacts to existing trees in the median island. This maximum distance has been applied to all Option 2 models.

The right turn lanes have a width of 2.8m, which is made up of the median island (which has been removed on both approaches) and a reduction in the outside lane width.

Lane movements have been changed such as the outside lanes allow for left turn and through movements, the middle lane allows for through movements only and the inside turn lanes allow for right turn movements only.

The intersection layout for Option 2 is shown in Figure 7.1 below.

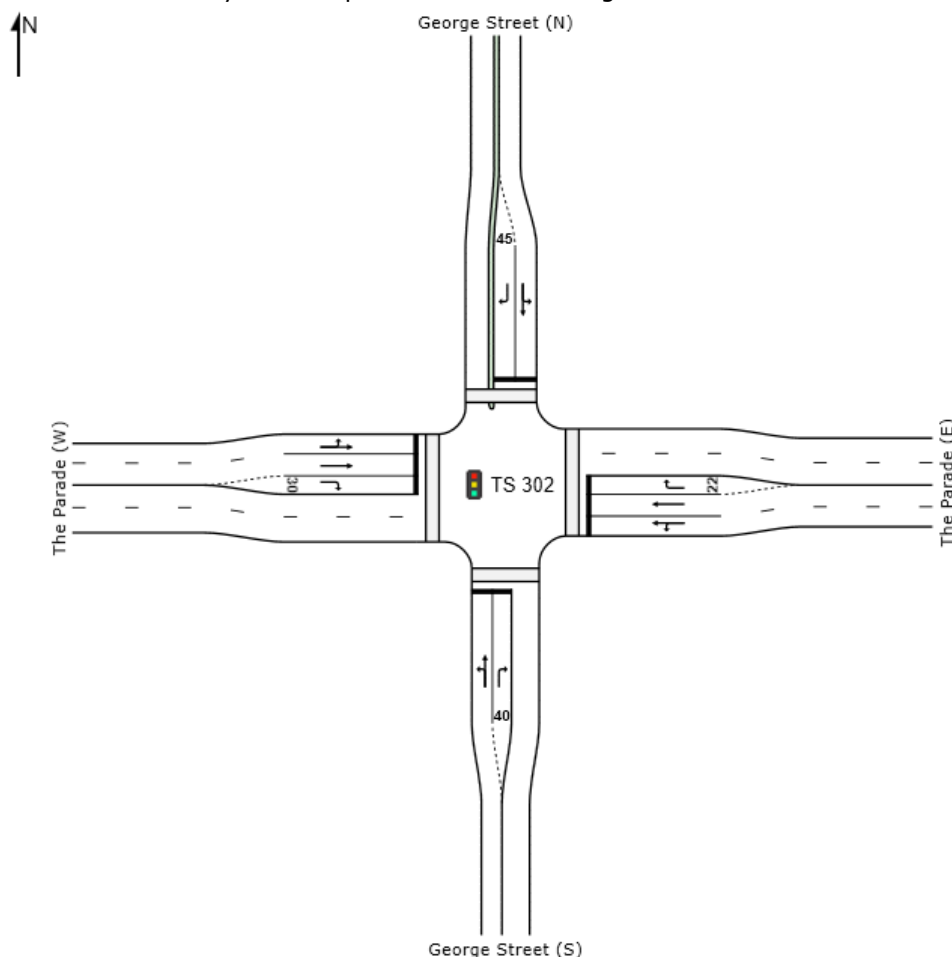


Figure 7.1 Option 2 Intersection Layout

7.1 Option 2A – Right Turn Lanes with Filter Right Turns

This option maintains the same signalling as Option 1A with the addition of right turn lanes.

The following are the key outputs from Option 2A.

Table 7.1 AM Peak Option 2A LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	C	33.9	87.8	12.4	0.418
The Parade (E)	E	60.9	254.9	35.7	0.942
George Street (N)	D	54.3	98.5	13.9	0.942
The Parade (W)	D	43.3	80.4	10.9	0.466
All Vehicles	D	51.8	254.9	35.7	0.942

Table 7.2 PM Peak Option 2A LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	41.8	96.7	13.7	0.538
The Parade (E)	C	27.6	63.1	8.8	0.479
George Street (N)	D	54.4	126.0	18.0	0.921
The Parade (W)	C	28.4	169.1	23.8	0.786
All Vehicles	D	35.6	169.1	23.8	0.921

In both the AM and PM peak periods the queue distance on George Street north may extend to the intersection with Webbe Street.

In the AM and PM peak period it is possible that vehicles will queue across the carpark entrance on the southern leg of George Street.

In the AM peak period, queues lengths may extend along the eastern leg of The Parade to the intersection with Queen Street. This may cause vehicles to queue over the intersection.

The outputs for Option 2A with 8 second minimum pedestrian walk time are shown below:

Table 7.3 AM Peak Option 2A LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	C	34.7	89.0	12.6	0.428
The Parade (E)	E	76.3	294.9	41.3	0.994
George Street (N)	E	60.3	101.3	14.3	0.972
The Parade (W)	D	45.2	82.2	11.1	0.488
All Vehicles	D	60.2	294.9	41.3	0.994

Table 7.4 PM Peak Option 2A LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	40.9	95.5	13.5	0.524
The Parade (E)	C	32.4	74.8	10.4	0.643
George Street (N)	D	50.3	122.5	17.5	0.883
The Parade (W)	D	36.2	200.7	28.3	0.868
All Vehicles	D	38.9	200.7	28.3	0.883

7.2 Option 2B – Right Turn Lanes with Controlled Right Turns

Option 2B is as per Option 2A however the phasing has been changed to allow controlled right turns along The Parade. Right turns along George Street are still filter turns.

An additional phase has been added to the cycle which consists of right turn movements along The Parade only.

The following are the key outputs from Option 2B.

Table 7.5 AM Peak Option 2B LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	38.1	93.6	13.3	0.469
The Parade (E)	F	133.7	394.5	55.3	1.110
George Street (N)	F	95.5	142.1	20.3	1.097
The Parade (W)	D	48.8	89.7	12.2	0.560
All Vehicles	F	93.5	394.5	55.3	1.110

Table 7.6 PM Peak Option 2B LOS – 5 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	50.0	106.3	15.1	0.680
The Parade (E)	C	32.9	71.6	10.0	0.704
George Street (N)	E	57.3	143.6	20.5	0.834
The Parade (W)	D	37.1	187.4	26.4	0.844
All Vehicles	D	42.3	187.4	26.4	0.844

In both the AM and PM peak periods the queue distance on George Street north may extend to the intersection with Webbe Street.

In the AM and PM peak period it is possible that vehicles will queue across the carpark entrance on the southern leg of George Street

In the AM peak period, queues lengths may extend along the eastern leg of The Parade, across the intersection with Portrush Road. This may cause vehicles to queue over the intersection.

The outputs for Option 2B with 8 second minimum pedestrian walk time are shown below:

Table 7.7 AM Peak Option 2B LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	39.9	96.0	13.6	0.493
The Parade (E)	F	157.9	428.6	60.1	1.147
George Street (N)	F	117.8	161.5	23.1	1.164
The Parade (W)	D	49.7	91.1	12.3	0.578
All Vehicles	F	109.0	428.6	60.1	1.164

Table 7.8 PM Peak Option 2B LOS – 8 Second Walk Time

Approach	Level of Service (LOS)	Average Delay (s)	95% Queue Distance (m)	95% Queue Distance (vehicles)	Degree of Saturation
George Street (S)	D	53.3	111.2	15.8	0.728
The Parade (E)	C	33.9	73.5	10.2	0.704
George Street (N)	E	64.0	155.1	22.2	0.881
The Parade (W)	D	39.2	195.1	27.5	0.865
All Vehicles	D	45.2	195.1	27.5	0.881

7.3 Summary

The following table shows the worst-case level of service and if it meets DPTIs requirements.

Table 7.9 Option 2 LOS Summary

Option	Approach	LOS	Complies	LOS 8 Second Min Walk Time
2A AM Peak	The Parade (E)	E	No	E
	All Vehicles	D	Yes	E
2A PM Peak	George Street (N)	D	Yes	D
	All Vehicles	D	Yes	D
2B AM Peak	The Parade (E)	F	No	F
	All Vehicles	F	No	F
2B PM Peak	George Street (N)	E	No	E
	All Vehicles	D	Yes	D

Option 2A meets a minimum LOS of D in the PM peak period, however it does not meet this standard in the AM peak period. Option 2B does not meet the minimum LOS requirements in the AM or PM peak period. There may also be concerns with queueing in both options, with concerns relating to both legs of George Street and the eastern leg of The Parade.

The LOS is decreased for a number of approaches/intersections when the minimum walk time is increased from 5 seconds to 8 seconds. In addition to this, the delay times and queue lengths increase across the Options.

8 Summary

A summary of all of the LOS for each approach in each option is shown below, with a summary of the phase split for each option shown in Appendix B.

Table 8.1 Option Summary Table

Location	Level of Service						
	Base	Option 1A Filter Right Turns	Option 1B No Right Turns (both directions)	Option 1C No Right Turns in Peak (one direction)	Option 1D As Per 1C with Alternate Phasing	Option 2A Right Turn Lanes with Filter Turns	Option 2B Right Turn Lanes with Controlled Turns
George Street (S)							
AM Peak	B	D	C	C	D	C	D
PM Peak	C	D	D	D	D	D	D
The Parade (E)							
AM Peak	B	F	E	E	D	E	F
PM Peak	B	C	C	C	C	C	C
George Street (N)							
AM Peak	C	F	D	D	F	D	F
PM Peak	C	F	D	D	D	D	E
The Parade (W)							
AM Peak	B	D	D	D	D	D	D
PM Peak	C	E	C	C	C	C	D

None of the options meet the minimum LOS requirement of D for all approaches in both peak periods. Options 1B, 1C and 2A meet the minimum requirement for all legs in PM peak period and all legs apart from The Parade (E) in the AM peak period. For this leg the LOS is E. Option 1D reaches a LOS of D for all legs in the PM peak period and all legs apart from George Street (N) in the AM peak period.

All options have a lower LOS than the base case, which has an average LOS of B/C across all of the approaches.

A number of options may have issues with increased queue lengths resulting in vehicles queued over adjacent intersections. It is noted that the 95% queue distance has been assessed and so although the SIDRA model shows that queueing across the intersections will occur, it is not likely to be frequent.

Options 1B, 1C, 1D, 2A and 2B may result in vehicles queued across the intersection of Webbe Street and the northern leg of George Street in both peak periods, the intersection of the southern leg of George Street and the carpark entrance in both peak periods and the intersection of the eastern leg of The Parade and Queen Street in the AM peak period. It is noted that option 2B may result in vehicles queued over the intersection of the eastern leg of The Parade and Portrush Road in the AM peak period.

Option 1A may result in vehicles queues across the intersections of The Parade and Portrush Road, The Parade and Osmond Terrace, George Street and Webbe Street and George Street and the carpark adjacent Coles.

Edward Street does not allow for right turns onto The Parade, however right turns from The Parade into Edwards Street are allowed.

The intersection of The Parade and Queen Street is an unsignalised intersection which allows for all turning movements. This may have concerns if queue lengths extend over the intersection, with increased difficulty in completing right turn movements.

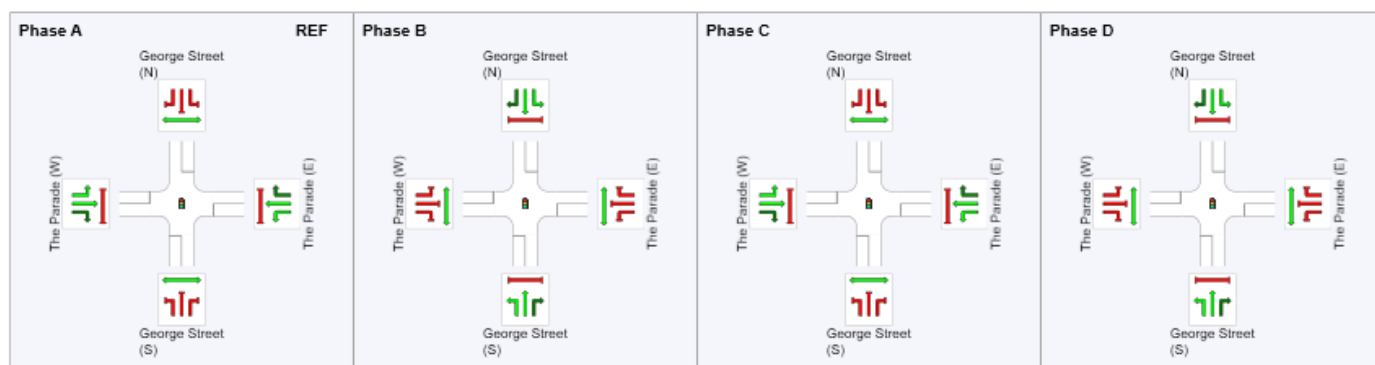
Osmond Terrace and Portrush Road are major roads and so impacts to these are significant.

Overall the recommendations are Options 1B, 1C and 2A from a LOS approach. All of these options have the same LOS for each approach leg. Considering other aspects of the layouts such as the construction cost and the street environment, Options 1B and 1C are recommended over Option 2A as they require less construction work.

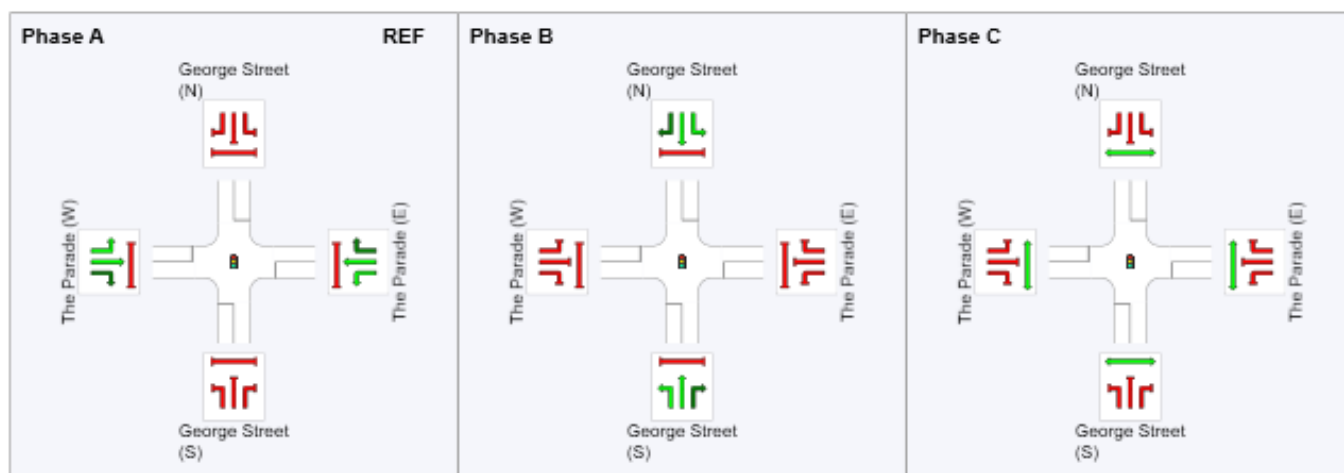
We recommend consideration be given to reducing the green walk time from 8 to 5 seconds.

Appendix A – Phase Diagrams

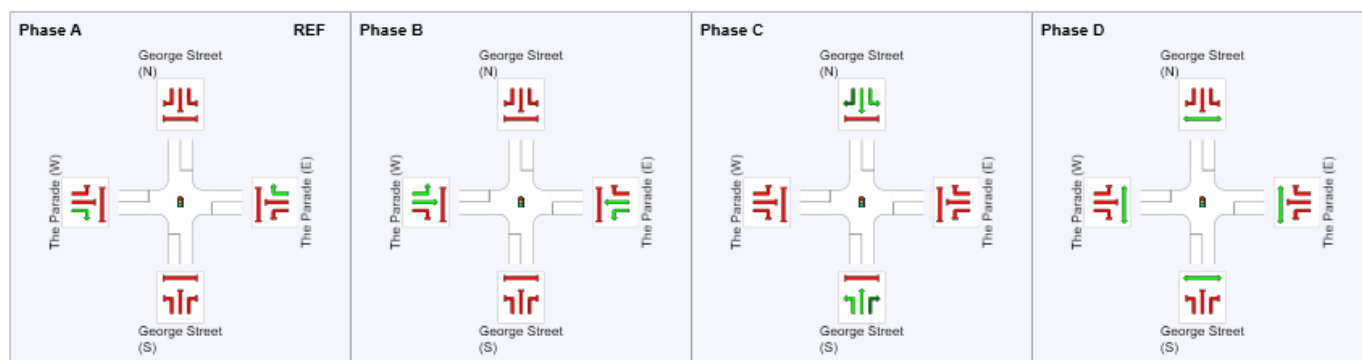
Base Case:



Option 1/2A



Option 2B



Appendix B – Phase Split

5 Second Min Walk Time:

Option	Phase Time, seconds (Phase Split)			
	Phase A	Phase B	Phase C	Phase D
Base Case AM Peak	40 (31%)	31 (24%)	28 (22%)	31 (24%)
Base Case PM Peak	40 (31%)	31 (24%)	28 (22%)	31 (24%)
Option 1A AM Peak	48 (37%)	52 (40%)	30 (23%)	-
Option 1A PM Peak	57 (44%)	43 (33%)	30 (23%)	-
Option 1B AM Peak	43 (33%)	57 (44%)	30 (23%)	-
Option 1B PM Peak	47 (36%)	53 (41%)	30 (23%)	-
Option 1C AM Peak	43 (33%)	57 (44%)	30 (23%)	-
Option 1C PM Peak	52 (40%)	48 (37%)	30 (23%)	-
Option 1D AM Peak	50 (38%)	50 (38%)	30 (23%)	-
Option 1D PM Peak	52 (40%)	48 (37%)	30 (23%)	-
Option 2A AM Peak	43 (33%)	57 (44%)	30 (23%)	-
Option 2A PM Peak	50 (38%)	50 (38%)	30 (23%)	-
Option 2B AM Peak	11 (8%)	37 (28%)	52 (40%)	30 (23%)
Option 2B PM Peak	12 (9%)	46 (35%)	42 (32%)	30 (23%)

8 Second Min Walk Time:

Option	Phase Time, seconds (Phase Split)			
	Phase A	Phase B	Phase C	Phase D
Base Case AM Peak	40 (31%)	31 (24%)	28 (22%)	31 (24%)
Base Case PM Peak	40 (31%)	31 (24%)	28 (22%)	31 (24%)
Option 1A AM Peak	47 (36%)	50 (38%)	33 (25%)	-
Option 1A PM Peak	53 (41%)	44 (34%)	33 (25%)	-
Option 1B AM Peak	41 (32%)	56 (43%)	33 (25%)	-
Option 1B PM Peak	45 (35%)	52 (40%)	33 (25%)	-
Option 1C AM Peak	42 (32%)	55 (42%)	33 (25%)	-
Option 1C PM Peak	51 (39%)	46 (35%)	33 (25%)	-
Option 1D AM Peak	49 (38%)	48 (37%)	33 (25%)	-
Option 1D PM Peak	51 (39%)	46 (35%)	33 (25%)	-
Option 2A AM Peak	41 (32%)	56 (43%)	33 (25%)	-
Option 2A PM Peak	46 (35%)	51 (39%)	33 (25%)	-
Option 2B AM Peak	11 (8%)	36 (28%)	50 (38%)	33 (25%)
Option 2B PM Peak	12 (9%)	45 (35%)	40 (31%)	33 (25%)