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To:	**BC Ministry of Transportation and Infrastructure**	Date:	**February 28, 2024**
Attention:	**Stephanie Rothman, ENV SP, Deputy Director**	Project No.:	**33036**
Cc:	**Matt Hawkins, MOTI; Kyle Forbes, Charter PDI; Dannielle Dessureault, Elevation**		
Reference:	**Bradner Road SLAT Operations Review**		
From:	**Matt Taylor, P.Eng., M.Eng., PTOE**		

1.0 Introduction

1.1 Study Purpose

To accommodate the construction of the new Bradner Road overpass (the overpass), in Abbotsford, BC, ISL Engineering and Land Services (ISL) reviewed the implementation of north-south single-lane alternating traffic (SLAT) operations on Bradner Road to form part of an eventual traffic management plan (TMP) to support construction work in the area. The purpose of this report is to review the traffic impacts of SLAT operations at this location.

1.2 Study Area

The site location is comprised of the overpass and its surrounding area, located between the Bradner and Aberdeen neighbourhoods, west of Abbotsford. Near the overpass, Bradner Road is a rural collector running in a north-south direction and bisecting Downes Road, which is an east-west rural collector. Both Roads are owned and operated by the City of Abbotsford (City). The study area is illustrated in **Figure 1.1**.

The two Bradner Road & Downes Road intersections (hereafter referred to as the north and south intersections) are separated by approximately 150 m and are both minor stop-controlled on the Downes Road approaches.

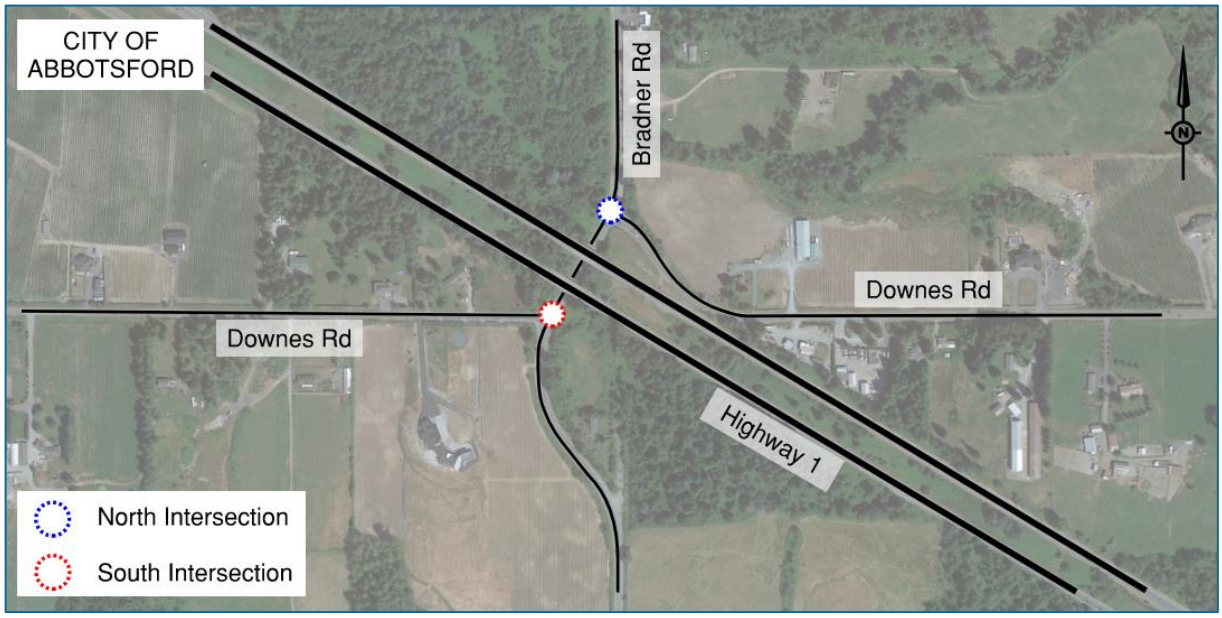


Figure 1.1 Site Location

1.3 Construction Work

Construction work will rely on Bradner Road to accommodate construction zones and equipment staging areas. Construction will last several years, and there will be some activities in all of the construction stages where traffic capacity along Bradner Road will need to be temporarily reduced to a single lane. This will require SLAT operations between the north and south intersections, which are to be controlled by temporary signals.

The proposed temporary signal configuration would provide the necessary signal heads on all Bradner Road and Downes Road approaches. The intersection pair would function as a single traffic signal with one controller. As suggested by PBX Engineering, the project's electrical consultant, a potential solution for the temporary traffic signals at this location would consist of wood signal poles with span wire signals and loop detectors. The implementation of temporary signals on both Bradner Road and Downes Road approaches is expected to help manage traffic operations under SLAT conditions.

1.4 Traffic Volumes

1.4.1 Traffic Data Collection

Traffic data were collected at the Bradner Road & Downes Road (north) intersection by Transtech Data Services, provided to ISL by the City. Turning movement count surveys were conducted on Wednesday, November 18, 2020, for AM (7:00 to 10:00) and PM (14:00 to 17:00). The peak hours of the study area were identified as 7:45 to 8:45 (AM) and 15:45 to 16:45 (PM). At the time of the survey, Bradner Road two-way traffic under the overpass was 582 and 684 vehicles during the AM and PM peak hours, respectively. The weekday AM and PM peak hour traffic volumes are summarized in **Table 1.1**.

Table 1.1 2020 Traffic Volumes at the North Intersection

Peak Hour	Downes Road		Bradner Road				TOTAL
	WBL	WBR	NBT	NBR	SBL	SBT	
AM	152	104	159	150	57	121	**743**
PM	107	55	180	180	147	217	**886**

In the absence of traffic data collected at the south intersection, ISL used volume balancing from the north intersection and trip distribution assumptions developed by looking into the local road network connections, likely trip origins and destinations, and existing density in the area. It was assumed that 75% of the northbound traffic approaching the north intersection would originate from Bradner Road, while the remaining 25% would come from Downes Road. Similarly, ISL assumed 75% of the southbound traffic departing from the north intersection would continue along Bradner Road, with the remaining 25% making a right turn onto Downes Road. Traffic passing through the area but not crossing under the overpass (eastbound right and northbound left turns) was assumed to have volumes similar to those observed at the north intersection.

1.4.2 COVID-19 Adjustment Factor

It is expected that the traffic data gathered from March 2020 to February 2021 might exhibit some degree of changes in travel patterns due to the COVID-19 pandemic. In the absence of multiple data points to accurately adjust/calibrate November 2020 traffic data, the raw traffic volumes were adjusted with a 5% increase to account for the possibility of lower vehicle volumes during the COVID-19 pandemic, thus providing a more robust assessment. This assumption was based on engineering judgment and previous experience analyzing the impacts of COVID-19 on traffic volumes in comparable locations.

1.4.3 Growth Rate

In addition to the previous COVID-19 5% adjustment factor, a linear growth rate of 2.0% per annum was assumed. While advanced works construction activities are scheduled to commence in 2023, the analysis focused on the horizon year of 2027, aligned with the anticipated completion of the main bridge construction. By relying on the 2027 forecasts, rather than 2023, a more comprehensive evaluation of future traffic operations is achieved, offering greater confidence in the assessment of long-term construction needs.

1.4.4 Traffic Diversion to Alternative Routes

Figure 1.2 shows the larger road network surrounding the overpass (shown in yellow). Since there are limited routes to cross Highway 1 besides Bradner Road (at 264 Street/Highway 13, 5.7 km to the northwest, and at Mt. Lehman Road, 4.0 km to the southeast), highway-crossing traffic is not expected to divert from Bradner Road onto alternative Highway 1 crossings.

In contrast, for traffic currently travelling on Bradner Road and turning onto Downes Road (or vice-versa) that is not crossing Highway 1, more convenient routes are available to avoid additional delays caused by construction work. This is illustrated in the following figure, where routes that are expected to experience a decrease in traffic are shown in red while the alternative routes that are expected to experience an increase in traffic are shown in green. Traffic currently utilizing routes shown in red appears to use these routes as minor shortcuts or to avoid travelling on Fraser Highway and Townshipline Road. Traffic generated by existing land uses along these routes would be minimal.

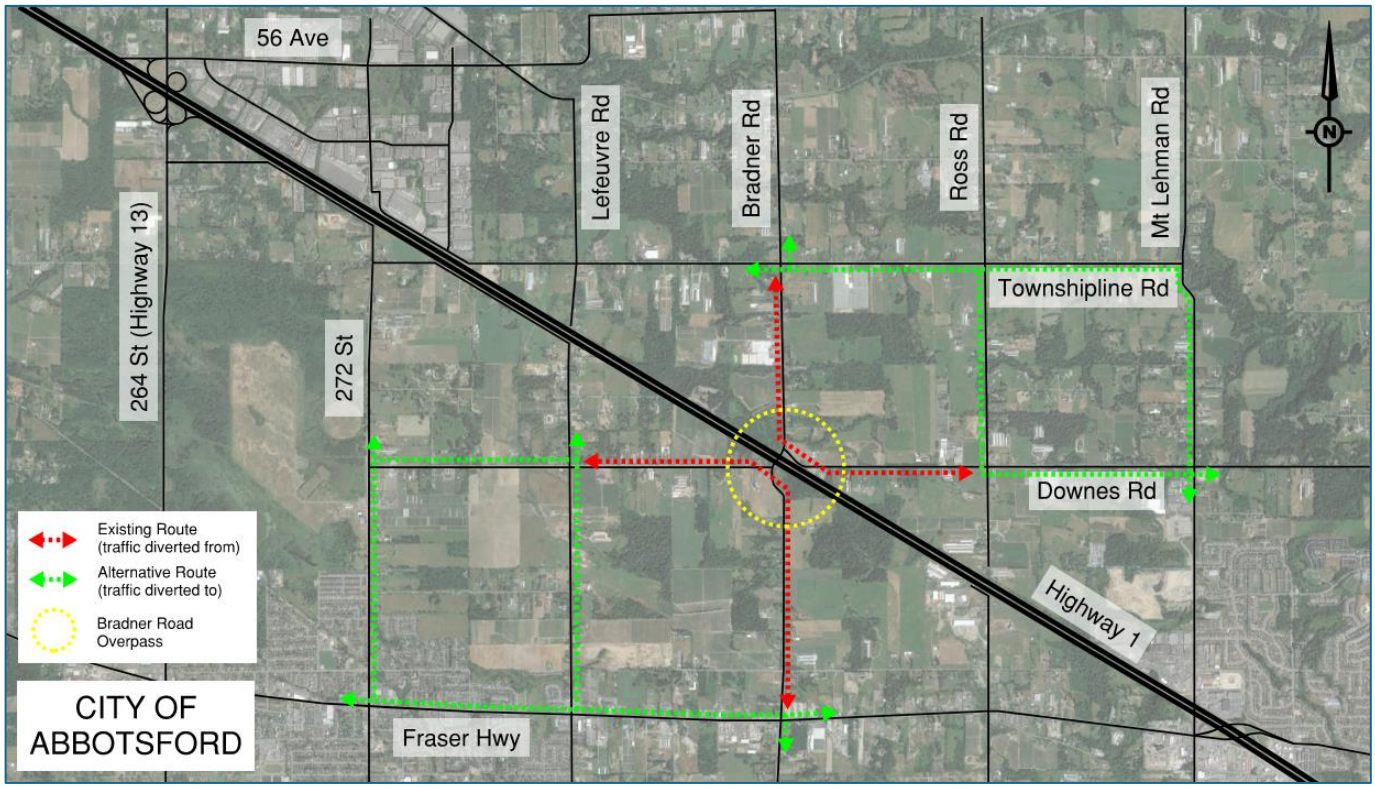


Figure 1.2 Traffic Diversion to Alternative Routes

Although movement restrictions are not proposed as part of the TMP, traffic that is not currently crossing Highway 1 at Bradner Road is expected to divert onto other routes unaffected by this construction work to minimize their travel

times through the area. To reflect this temporary change in travel patterns, ISL assumed 25 vehicles per hour would remain on the southbound left (SBL) and westbound right (WBR) at the north intersection, and for the northbound left (NBL) and eastbound right (EBR) at the south intersection, while the other traffic would divert.

The assumed 25-vehicle amount is based on engineering judgement, understanding the additional delay resulting from the SLAT conditions, along with a review of alternate routes available for drivers who travel through this area without crossing under the overpass. North of the overpass, Ross Road and Mt. Lehman Road are alternatives to Bradner Road. South of the overpass, Lefeuvre Road and 272nd Street are alternatives to Bradner Road. Based on a Google Maps review of typical travel times during the weekday PM peak hour period, these alternate routes provide similar travel times. Thus, it is likely that a significant portion of trips currently using Bradner Road will divert to alternate routes to avoid any additional congestion resulting from SLAT operations. Note that this assumption is only made for those vehicles travelling through these intersections that do not pass under the overpass.

Although this diversion of non-crossing traffic is expected to occur naturally as drivers adjust to the additional congestion, to minimize impacts during the adjustment period, it is recommended to strategically place signage in the vicinity of the overpass to inform drivers of the upcoming SLAT operations and encourage consideration for alternative routes, such as Lefeuvre Road and Ross Road for those travelling south and north of Highway 1, respectively. Without this diversion of traffic, the delay and congestion resulting from SLAT operations would be more significant as this non-crossing traffic utilizes the green times that would otherwise be available to vehicles crossing under Highway 1.

It is also noted that there are current and planned long-term road closures on Downes Road west of Bradner Road and potential upcoming road closures on Downes Road east of Bradner Road. During these periods, traffic turning to/from Downes Road at the study intersections will be zero, or near zero, depending on the extent of the closure. Under these conditions, the signal timing plan can be adjusted to remove the phase for these side-street movements.

1.5 2027 Traffic Forecasts

The weekday AM and PM 2027 peak hour traffic forecasts, based on the aforementioned traffic counts and adjustments, are noted in **Figure 1.3**.

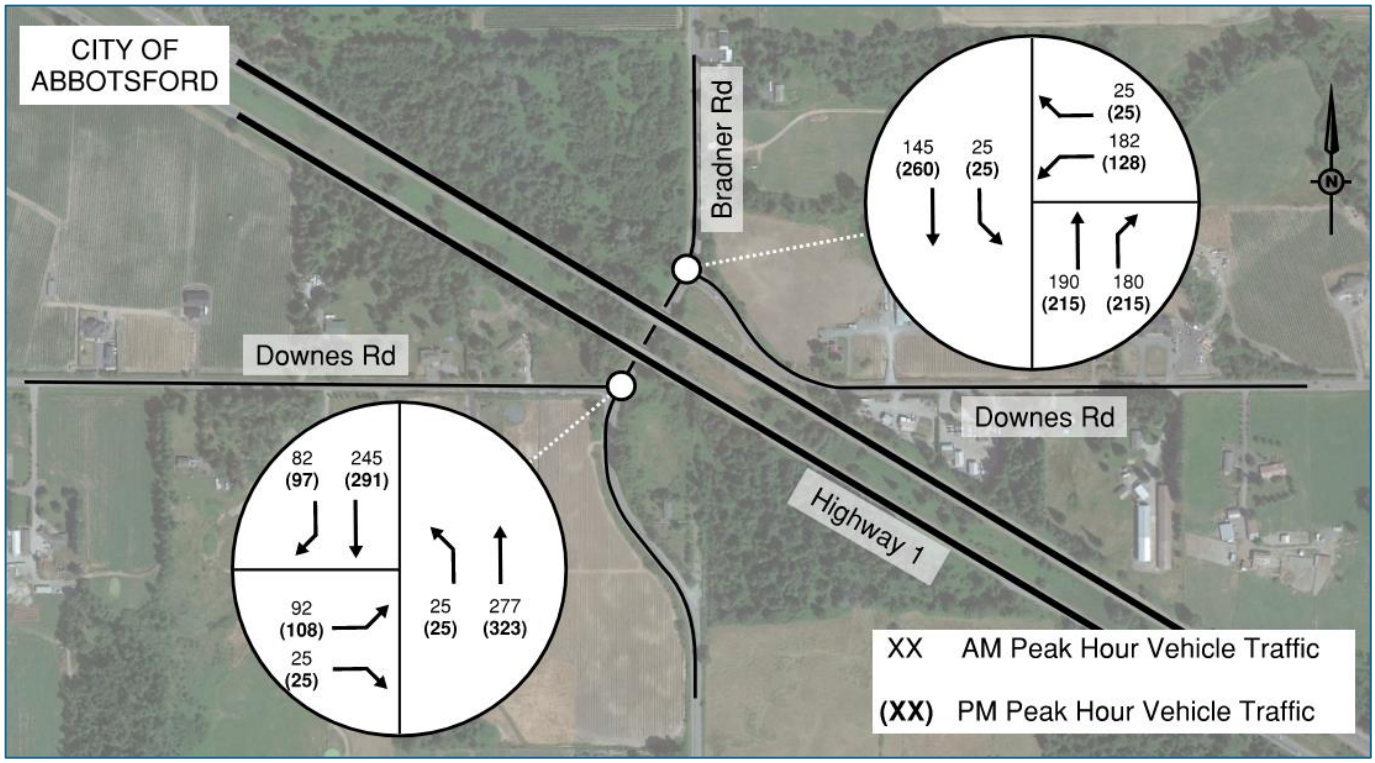


Figure 1.3 2027 Peak Hour Traffic Forecasts

2.0 Analysis Methodology and Assumptions

2.1 Software

Traffic operations analysis was performed using SimTraffic software, Synchro's (Version 11) micro-simulation tool. Synchro is based on the standard methods of the Highway Capacity Manual (HCM) and uses measures of effectiveness such as volume-to-capacity (V/C) ratio, delay (seconds per vehicle), and level of service (LOS). Because Synchro has no specific built-in tool to assess SLAT-like operations, ISL used SimTraffic to estimate delay and queuing. Synchro and SimTraffic reports are available in **Appendix A**.

2.2 Criteria

Understanding this is a temporary construction condition under SLAT operations, performance metrics are expected to deteriorate compared to existing conditions. Assessing the effectiveness of the proposed traffic control using typical performance criteria may not be as meaningful. However, ensuring the signal has the capacity to clear incoming traffic and that the 95th percentile queues not reach upstream intersections is still critical.

Delay, LOS, and 95th percentile queues will be used as measures of effectiveness to assess operations. LOS is defined as the average vehicle delay (seconds per vehicle) and the thresholds for signalized intersections are shown in **Table 2.1**.

Table 2.1 LOS Definition for Signalized Intersections in HCM

Traffic Control	Level of Service (LOS)	A	B	C	D	E	F
Signalized	Average Delay (s/veh)	0-10	10-20	20-35	35-55	55-80	>80

Although the traffic analysis is based on standard performance metrics applied to signalized intersections, as noted, an increased expectation for and tolerance of longer delays is reasonable given the construction-related closure.

2.3 Assumptions

Peak hour factors (PHF) were coded per intersection as per the City's noted guidelines for traffic modelling at 0.93 and 0.94 for the AM and PM peak hour periods, respectively.

Heavy vehicle percentages (HV%) were coded per movement as per the observed heavy vehicle traffic. Given the number of heavy vehicle traffic arriving at or departing from the south leg of the north intersection, heavy vehicle turning movements for the south intersection were calculated following the same methodology used to forecast 2027 general traffic as in **Section 1**. Then, the resulting heavy vehicle volumes were divided by the 2027 traffic forecasts from **Figure 1.3** to calculate 2027 heavy vehicle percentages for both intersections. The resulting heavy vehicle volumes at the south intersection are in line with the approximately 8% to 10% noted by the City as being appropriate based on screeline counts in the area.

Lane widths were kept at Synchro's default value of 3.6 m, and the temporary speed in the study area during construction was assumed at 30 km/h as a conservative assumption. Even though the posted speed limit is expected to be 50 km/h, because of roadside construction and SLAT operations, it was assumed that actual speeds may be slower.

2.4 Signal Configuration and Timing

The analysis performed utilizes traffic signals to model operations in Synchro. Signals at the north and south intersections were set clustered into the same controller to ensure the two signals work cohesively. The signal phases are actuated with minimum recall on all movements. Left turns on Bradner Road were set to split phase as they will run unopposed by conflicting traffic. Left turns on Downes Road were set to protected-only phases.

Section 404 of the BC Ministry of Transportation Engineering and Infrastructure (BC MoTI) *Electrical and Traffic Engineering Manual* (Signal Design Manual) notes a methodology to assess SLAT operations in one-way bridge signals, based on modelling the all-red bridge clearance time using the green time for the side street.

The all-red clearance time across a bridge from the BC MoTI's Signal Design Manual (Equation 20 from Section 404.6) is as follows, where R is all-red clearance time (s), V is travel speed (km/h), and D is the distance between stop bars. The distance between the southbound stop bar at the north intersection to the clearance point at the south intersection (and vice-versa) was measured at approximately 170 m. Despite an anticipated 50 km/h posted speed limit, actual speeds may be slower (30 km/h) because of roadside construction and SLAT operations. Given this, 30 km/h was used to develop the all-red phase duration as a conservative assumption.

$$R = \frac{3.6 * D}{V} = \frac{3.6 * 170}{30} = 20.4\ seconds$$

At this location, there is side street traffic at Downes Road that has to be incorporated into the model. Therefore, instead of using the side street green time to simulate the all-red single-lane clearance time, non-standard phasing was used to include two "hold" phases to represent the all-red single-lane clearance time. During these hold phases, signals would stop new traffic from entering the single lane while giving time for traffic on the single lane to clear at the other end. Incoming traffic from under the overpass will be received by a green light to ensure vehicles safely clear the single lane and the downstream intersection.

Per the above, ISL assumed 20.4 seconds for each of the two all-red single-lane clearance times. Through and left-turn phases' yellow times were set to 3.5 seconds, the minimum allowed by the BC MoTI Signal Design Manual. All-red times were only applied to lead left-turning phases, as the all-red single-lane clearance (hold) phases will serve as the all-red time for the north-south through-movement phases.

Cycle lengths for weekday AM and PM peak hour periods were set to 160 seconds. The cycle length was optimized through a sensitivity analysis in which the cycle length was changed in increments of 10 seconds, balancing movement delay and 95th percentile queues.

Figures 2.1 and **2.2** show the proposed cycle lengths and signal phase durations, as coded in Synchro (shown bar lengths are not to scale, they are only provided for illustration purposes). Intersections #1 and #2 in the signal diagrams represent the north and south intersections, respectively.

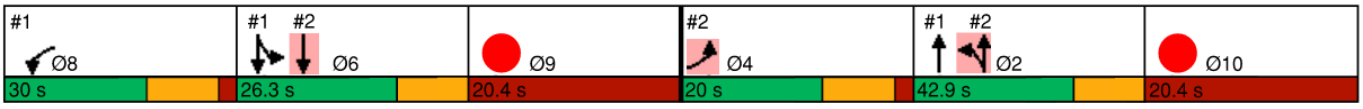


Figure 2.1 AM Peak Hour Signal Cycle (160 seconds)

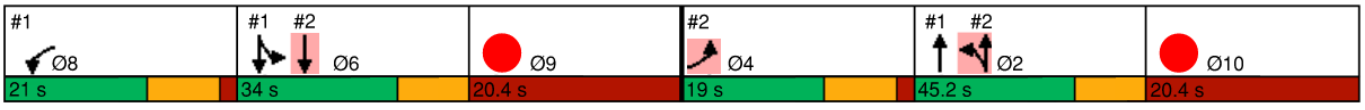


Figure 2.2 PM Peak Hour Signal Cycle (160 seconds)

The all-red single-lane clearance phases (Ø9 and Ø10) will permit vehicles between the intersections to clear by having green indicators at the downstream intersection while still showing red for all other movements until the vehicles have cleared the downstream intersection.

The above signal timing plan is made using 2027 traffic forecasts. Although signal timing plans for earlier years of construction could be produced adjusting to their respective year traffic forecasts, ISL does not expect this would yield materially different signal timings or operational results.

It should be noted that there are plans for closures on Downes Road that are expected to take place during the construction of the new overpass. This has not been accounted for in the analysis; should road closures be implemented on Downes Road, Ø4 and Ø8 may be eliminated to the benefit of additional green time for the Bradner Road through phases (Ø2 and Ø6).

An electrical design for this intersection will be required that includes the interconnect between the intersections and the details of the timing and phasing.

3.0 Traffic Analysis

The 2027 temporary SLAT traffic operations are broken down in **Tables 3.1** to **3.2**. Synchro and SimTraffic worksheets are provided at the back of this document.

Table 3.1 North Intersection 2027 SLAT Traffic Operations

Peak Hour	Measure of Effectiveness	Downes Road			Bradner Road						Intersection Overall
		Westbound			Northbound			Southbound			
		WBL	WBR	Overall	NBT	NBR	Overall	SBL	SBT	Overall	
	Available Storage (m)	1,700		-	150		-	1,500		-	-
AM	Applied Volume	182	25	207	190	180	370	25	145	170	747
	Delay (s/veh)	66	52	65	0	0	0	56	63	61	63
	Level of Service	E	D	E	A	A	A	E	E	E	E
	95th Percentile Queue (m)	98		-	0		-	88		-	-
PM	Applied Volume	128	25	153	215	215	430	25	260	285	868
	Delay (s/veh)	75	54	71	0	0	0	71	77	76	75
	Level of Service	E	D	E	A	A	A	E	E	E	E
	95th Percentile Queue (m)	72		-	0		-	144		-	-

Table 3.2 South Intersection 2027 SLAT Traffic Operations

Peak Hour	Measure of Effectiveness	Downes Road			Bradner Road						Intersection Overall
		Eastbound			Northbound			Southbound			
		EBL	EBR	Overall	NBL	NBT	Overall	SBT	SBR	Overall	
	Available Storage (m)	1,600		-	1,600		-	150		-	-
AM	Applied Volume	92	25	117	25	277	302	245	82	327	746
	Delay (s/veh)	65	37	59	57	53	53	0	0	0	55
	Level of Service	E	D	E	E	D	D	A	A	A	D
	95th Percentile Queue (m)	61		-	121		-	0		-	-
PM	Applied Volume	108	25	133	25	323	348	291	97	388	869
	Delay (s/veh)	79	55	74	64	62	62	0	0	0	65
	Level of Service	E	D	E	E	E	E	A	A	A	E
	95th Percentile Queue (m)	75		-	159		-	0		-	-

The analysis results showed that, upon implementation of signalized SLAT operations and by 2027, vehicles will experience delays between 40 and 80 seconds during the weekday peak hours. LOS E is expected for most movements, with a few operating at LOS D. Although these performance metrics would likely not be recommended for permanent conditions, it is ISL's professional opinion that these are within reasonable expectations for construction-related traffic delay in which two-way traffic is constrained to a single alternating lane.

95th percentile queues are expected to be cleared well in advance of reaching upstream intersections at Ross Road (to the east), Lefeuvre Road (to the west), Maclure Road (to the south), and Townshipline Road (to the north). Some private driveways near the overpass might experience additional delays in case of longer queues. 95th percentile queues are shown in **Figure 3.1**.

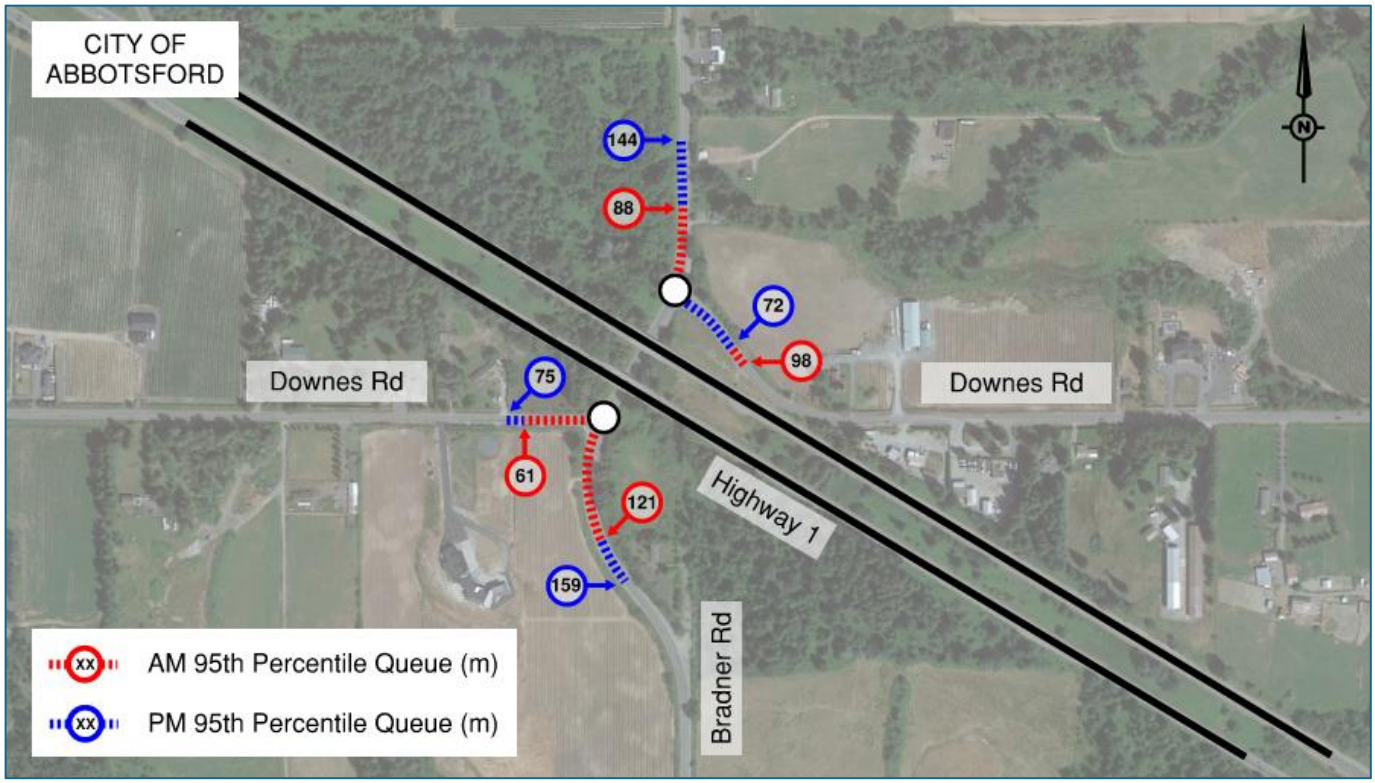


Figure 3.1 Anticipated 2027 95th Percentile Queues Under SLAT Operations

4.0 Conclusions

Overall, signalized SLAT was deemed to be a feasible way to manage traffic in support of the upcoming construction work at the overpass.

Although delays of up to approximately 80 seconds would likely not be acceptable for permanent conditions, it is ISL's professional opinion that these are within reasonable expectations for construction-related traffic delays in which two-way traffic is constrained to a single alternating lane.

The 95th percentile queue lengths were not found to cause upstream impacts, as there are no public road intersections in proximity to the north and south intersections of Downes Road.

Most traffic currently travelling on Bradner Road and turning onto Downes Road (or vice-versa) that is not crossing Highway 1 is anticipated to divert onto other routes unaffected by construction work to avoid peak period congestion in the area. This would also be the case upon ongoing and future Downes Road temporary closures, such as the current Downes Road closure between Bradner Road and Lefeuvre Road by BC Hydro.

Although no turning restrictions are planned as part of the TMP, this assessment assumed traffic diversion will occur naturally as drivers adjust to the impacts of SLAT operations, as a response to the additional travel delay in the area. To minimize impacts during the adjustment period, it is recommended to strategically place signage in the vicinity of the overpass to inform drivers of the upcoming SLAT operations and encourage consideration for alternative routes, such as Lefeuvre Road and Ross Road for those travelling south and north of Highway 1, respectively.

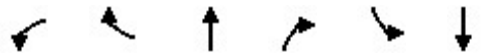
Permit to Practice
ISL Engineering and Land Services Ltd.
RR Signature:
RR EGBC ID: 189286
Date: 2024-02-28

Permit Number 1000419
Engineers & Geoscientists British Columbia

Matt Taylor, P.Eng., M.Eng., PTOE
Traffic Discipline Lead

APPENDIX A
Synchro/SimTraffic Reports

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø4	Ø9	Ø10
Lane Configurations									
Traffic Volume (vph)	182	25	0	0	25	145			
Future Volume (vph)	182	25	0	0	25	145			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900			
Storage Length (m)	0.0	15.0		0.0	0.0				
Storage Lanes	1	0		0	0				
Taper Length (m)	7.5				7.5				
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Frt	0.984								
Flt Protected	0.958					0.993			
Satd. Flow (prot)	1713	0	1681	0	0	1675			
Flt Permitted	0.958					0.993			
Satd. Flow (perm)	1713	0	1681	0	0	1675			
Right Turn on Red		Yes		Yes					
Satd. Flow (RTOR)	4								
Link Speed (k/h)	30		30			30			
Link Distance (m)	619.1		51.7			393.2			
Travel Time (s)	74.3		6.2			47.2			
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93			
Heavy Vehicles (%)	2%	23%	13%	2%	5%	14%			
Adj. Flow (vph)	196	27	0	0	27	156			
Shared Lane Traffic (%)									
Lane Group Flow (vph)	223	0	0	0	0	183			
Enter Blocked Intersection	No	No	No	No	No	No			
Lane Alignment	Left	Right	Left	Right	Left	Left			
Median Width(m)	3.6		0.0			0.0			
Link Offset(m)	0.0		0.0			0.0			
Crosswalk Width(m)	1.0		1.0			1.0			
Two way Left Turn Lane									
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Turning Speed (k/h)	25	15		15	25				
Number of Detectors	1		2		1	2			
Detector Template	Left		Thru		Left	Thru			
Leading Detector (m)	2.0		10.0		2.0	10.0			
Trailing Detector (m)	0.0		0.0		0.0	0.0			
Detector 1 Position(m)	0.0		0.0		0.0	0.0			
Detector 1 Size(m)	2.0		0.6		2.0	0.6			
Detector 1 Type	Cl+Ex		Cl+Ex		Cl+Ex	Cl+Ex			
Detector 1 Channel									
Detector 1 Extend (s)	0.0		0.0		0.0	0.0			
Detector 1 Queue (s)	0.0		0.0		0.0	0.0			
Detector 1 Delay (s)	0.0		0.0		0.0	0.0			
Detector 2 Position(m)			9.4			9.4			
Detector 2 Size(m)			0.6			0.6			
Detector 2 Type			Cl+Ex			Cl+Ex			
Detector 2 Channel									
Detector 2 Extend (s)			0.0			0.0			
Turn Type	Prot				Split	NA			
Protected Phases	8		2		6	6	4	9	10

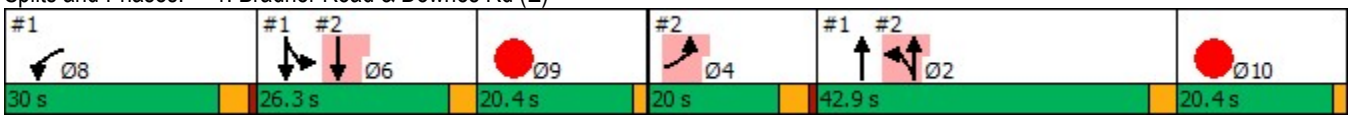


Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø4	Ø9	Ø10
Permitted Phases									
Detector Phase	8		2		6	6			
Switch Phase									
Minimum Initial (s)	5.0		7.0		7.0	7.0	5.0	5.0	5.0
Minimum Split (s)	9.5		10.5		10.5	10.5	9.5	20.4	20.4
Total Split (s)	30.0		42.9		26.3	26.3	20.0	20.4	20.4
Total Split (%)	18.8%		26.8%		16.4%	16.4%	13%	13%	13%
Maximum Green (s)	25.5		39.4		22.8	22.8	15.5	18.4	18.4
Yellow Time (s)	3.5		3.5		3.5	3.5	3.5	2.0	2.0
All-Red Time (s)	1.0		0.0		0.0	0.0	1.0	0.0	0.0
Lost Time Adjust (s)	0.0		0.0			0.0			
Total Lost Time (s)	4.5		3.5			3.5			
Lead/Lag	Lead		Lag		Lag	Lag	Lead		
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes		
Vehicle Extension (s)	3.0		3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	Min		Min		Min	Min	Min	Max	Max
Act Effct Green (s)	22.3					19.7			
Actuated g/C Ratio	0.15					0.14			
v/c Ratio	0.84					0.80			
Control Delay	85.3					87.7			
Queue Delay	0.0					0.0			
Total Delay	85.3					87.7			
LOS	F					F			
Approach Delay	85.3					87.7			
Approach LOS	F					F			
90th %ile Green (s)	25.5		39.4		22.8	22.8	15.5	18.4	18.4
90th %ile Term Code	Max		Max		Max	Max	Max	MaxR	MaxR
70th %ile Green (s)	25.5		38.0		22.8	22.8	15.5	18.4	18.4
70th %ile Term Code	Max		Gap		Max	Max	Max	MaxR	MaxR
50th %ile Green (s)	25.5		33.1		22.5	22.5	15.5	18.4	18.4
50th %ile Term Code	Max		Gap		Gap	Gap	Max	MaxR	MaxR
30th %ile Green (s)	21.0		27.3		18.4	18.4	13.7	18.4	18.4
30th %ile Term Code	Gap		Gap		Gap	Gap	Gap	MaxR	MaxR
10th %ile Green (s)	15.1		19.6		13.2	13.2	9.8	18.4	18.4
10th %ile Term Code	Gap		Gap		Gap	Gap	Gap	MaxR	MaxR
Queue Length 50th (m)	68.1					57.0			
Queue Length 95th (m)	#115.5					#97.6			
Internal Link Dist (m)	595.1		27.7			369.2			
Turn Bay Length (m)									
Base Capacity (vph)	309					267			
Starvation Cap Reductn	0					0			
Spillback Cap Reductn	0					0			
Storage Cap Reductn	0					0			
Reduced v/c Ratio	0.72					0.69			

Intersection Summary	
Area Type:	Other
Cycle Length: 160	
Actuated Cycle Length: 144.7	

Natural Cycle: 115	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.86	
Intersection Signal Delay: 86.4	Intersection LOS: F
Intersection Capacity Utilization 27.7%	ICU Level of Service A
Analysis Period (min) 15	
90th %ile Actuated Cycle: 160	
70th %ile Actuated Cycle: 158.6	
50th %ile Actuated Cycle: 153.4	
30th %ile Actuated Cycle: 137.2	
10th %ile Actuated Cycle: 114.5	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 1: Bradner Road & Downes Rd (E)



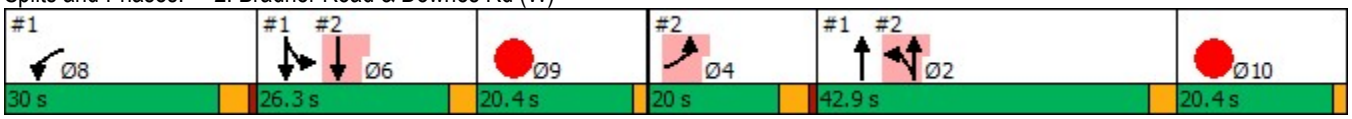
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø8	Ø9	Ø10
Lane Configurations									
Traffic Volume (vph)	92	25	25	277	0	0			
Future Volume (vph)	92	25	25	277	0	0			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900			
Storage Length (m)	0.0	15.0	0.0			0.0			
Storage Lanes	1	0	0			0			
Taper Length (m)	7.5		7.5						
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Frt	0.971								
Flt Protected	0.962			0.996					
Satd. Flow (prot)	1665	0	0	1771	1810	0			
Flt Permitted	0.962			0.996					
Satd. Flow (perm)	1665	0	0	1771	1810	0			
Right Turn on Red		Yes				Yes			
Satd. Flow (RTOR)	7								
Link Speed (k/h)	30			30	30				
Link Distance (m)	591.6			367.4	60.5				
Travel Time (s)	71.0			44.1	7.3				
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93			
Heavy Vehicles (%)	7%	5%	5%	7%	5%	5%			
Adj. Flow (vph)	99	27	27	298	0	0			
Shared Lane Traffic (%)									
Lane Group Flow (vph)	126	0	0	325	0	0			
Enter Blocked Intersection	No	No	No	No	No	No			
Lane Alignment	Left	Right	Left	Left	Left	Right			
Median Width(m)	3.6			0.0	0.0				
Link Offset(m)	0.0			0.0	0.0				
Crosswalk Width(m)	1.0			1.0	1.0				
Two way Left Turn Lane									
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Turning Speed (k/h)	25	15	25			15			
Number of Detectors	1		1	2	2				
Detector Template	Left		Left	Thru	Thru				
Leading Detector (m)	2.0		2.0	10.0	10.0				
Trailing Detector (m)	0.0		0.0	0.0	0.0				
Detector 1 Position(m)	0.0		0.0	0.0	0.0				
Detector 1 Size(m)	2.0		2.0	0.6	0.6				
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex				
Detector 1 Channel									
Detector 1 Extend (s)	0.0		0.0	0.0	0.0				
Detector 1 Queue (s)	0.0		0.0	0.0	0.0				
Detector 1 Delay (s)	0.0		0.0	0.0	0.0				
Detector 2 Position(m)				9.4	9.4				
Detector 2 Size(m)				0.6	0.6				
Detector 2 Type				Cl+Ex	Cl+Ex				
Detector 2 Channel									
Detector 2 Extend (s)				0.0	0.0				
Turn Type	Prot		Split	NA					
Protected Phases	4		2	2	6		8	9	10

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø8	Ø9	Ø10
Permitted Phases									
Detector Phase	4		2	2	6				
Switch Phase									
Minimum Initial (s)	5.0		7.0	7.0	7.0		5.0	5.0	5.0
Minimum Split (s)	9.5		10.5	10.5	10.5		9.5	20.4	20.4
Total Split (s)	20.0		42.9	42.9	26.3		30.0	20.4	20.4
Total Split (%)	12.5%		26.8%	26.8%	16.4%		19%	13%	13%
Maximum Green (s)	15.5		39.4	39.4	22.8		25.5	18.4	18.4
Yellow Time (s)	3.5		3.5	3.5	3.5		3.5	2.0	2.0
All-Red Time (s)	1.0		0.0	0.0	0.0		1.0	0.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0				
Total Lost Time (s)	4.5			3.5	3.5				
Lead/Lag	Lead		Lag	Lag	Lag		Lead		
Lead-Lag Optimize?	Yes		Yes	Yes	Yes		Yes		
Vehicle Extension (s)	3.0		3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	Min		Min	Min	Min		Min	Max	Max
Act Effct Green (s)	13.9			31.0					
Actuated g/C Ratio	0.10			0.21					
v/c Ratio	0.76			0.86					
Control Delay	90.1			77.2					
Queue Delay	0.0			0.0					
Total Delay	90.1			77.2					
LOS	F			E					
Approach Delay	90.1			77.2					
Approach LOS	F			E					
90th %ile Green (s)	15.5		39.4	39.4	22.8		25.5	18.4	18.4
90th %ile Term Code	Max		Max	Max	Max		Max	MaxR	MaxR
70th %ile Green (s)	15.5		38.0	38.0	22.8		25.5	18.4	18.4
70th %ile Term Code	Max		Gap	Gap	Max		Max	MaxR	MaxR
50th %ile Green (s)	15.5		33.1	33.1	22.5		25.5	18.4	18.4
50th %ile Term Code	Max		Gap	Gap	Gap		Max	MaxR	MaxR
30th %ile Green (s)	13.7		27.3	27.3	18.4		21.0	18.4	18.4
30th %ile Term Code	Gap		Gap	Gap	Gap		Gap	MaxR	MaxR
10th %ile Green (s)	9.8		19.6	19.6	13.2		15.1	18.4	18.4
10th %ile Term Code	Gap		Gap	Gap	Gap		Gap	MaxR	MaxR
Queue Length 50th (m)	37.6			101.2					
Queue Length 95th (m)	#73.7			139.8					
Internal Link Dist (m)	567.6			343.4	36.5				
Turn Bay Length (m)									
Base Capacity (vph)	187			489					
Starvation Cap Reductn	0			0					
Spillback Cap Reductn	0			0					
Storage Cap Reductn	0			0					
Reduced v/c Ratio	0.67			0.66					

Intersection Summary	
Area Type:	Other
Cycle Length: 160	
Actuated Cycle Length: 144.7	

Natural Cycle: 115	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.86	
Intersection Signal Delay: 80.8	Intersection LOS: F
Intersection Capacity Utilization 29.7%	ICU Level of Service A
Analysis Period (min) 15	
90th %ile Actuated Cycle: 160	
70th %ile Actuated Cycle: 158.6	
50th %ile Actuated Cycle: 153.4	
30th %ile Actuated Cycle: 137.2	
10th %ile Actuated Cycle: 114.5	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Bradner Road & Downes Rd (W)



1: Bradner Road & Downes Rd (E) Performance by movement

Movement	WBL	WBR	SBL	SBT	All
Denied Del/Veh (s)	0.2	0.2	0.2	0.2	0.2
Total Del/Veh (s)	66.3	51.6	55.6	62.5	63.1

2: Bradner Road & Downes Rd (W) Performance by movement

Movement	EBL	EBR	NBL	NBT	All
Denied Del/Veh (s)	0.2	0.2	0.4	0.3	0.3
Total Del/Veh (s)	64.8	37.0	56.6	53.2	54.9

Total Network Performance

Denied Del/Veh (s)	0.3
Total Del/Veh (s)	59.4

Intersection: 1: Bradner Road & Downes Rd (E)

Movement	WB	SB
Directions Served	LR	LT
Maximum Queue (m)	105.6	97.7
Average Queue (m)	60.4	53.3
95th Queue (m)	97.6	88.3
Link Distance (m)	614.9	391.1
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 2: Bradner Road & Downes Rd (W)

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (m)	72.9	136.0
Average Queue (m)	33.2	81.1
95th Queue (m)	60.8	120.5
Link Distance (m)	585.0	362.2
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

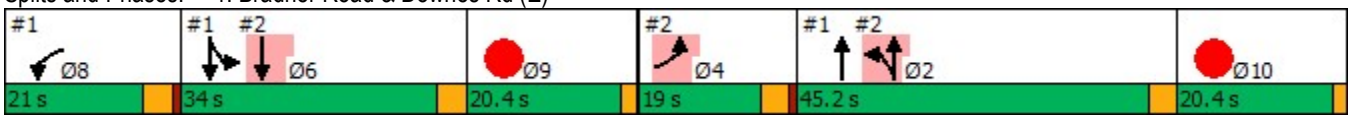
Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø4	Ø9	Ø10
Lane Configurations									
Traffic Volume (vph)	128	25	0	0	25	260			
Future Volume (vph)	128	25	0	0	25	260			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900			
Storage Length (m)	0.0	15.0		0.0	0.0				
Storage Lanes	1	0		0	0				
Taper Length (m)	7.5				7.5				
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Frt	0.978								
Flt Protected	0.960					0.996			
Satd. Flow (prot)	1713	0	1776	0	0	1781			
Flt Permitted	0.960					0.996			
Satd. Flow (perm)	1713	0	1776	0	0	1781			
Right Turn on Red		Yes		Yes					
Satd. Flow (RTOR)	5								
Link Speed (k/h)	30		50			30			
Link Distance (m)	619.1		51.7			393.2			
Travel Time (s)	74.3		3.7			47.2			
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94			
Heavy Vehicles (%)	4%	5%	7%	8%	9%	6%			
Adj. Flow (vph)	136	27	0	0	27	277			
Shared Lane Traffic (%)									
Lane Group Flow (vph)	163	0	0	0	0	304			
Enter Blocked Intersection	No	No	No	No	No	No			
Lane Alignment	Left	Right	Left	Right	Left	Left			
Median Width(m)	3.6		0.0			0.0			
Link Offset(m)	0.0		0.0			0.0			
Crosswalk Width(m)	1.0		1.0			1.0			
Two way Left Turn Lane									
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Turning Speed (k/h)	100	100		100	100				
Number of Detectors	1		2		1	2			
Detector Template	Left		Thru		Left	Thru			
Leading Detector (m)	2.0		10.0		2.0	10.0			
Trailing Detector (m)	0.0		0.0		0.0	0.0			
Detector 1 Position(m)	0.0		0.0		0.0	0.0			
Detector 1 Size(m)	2.0		0.6		2.0	0.6			
Detector 1 Type	Cl+Ex		Cl+Ex		Cl+Ex	Cl+Ex			
Detector 1 Channel									
Detector 1 Extend (s)	0.0		0.0		0.0	0.0			
Detector 1 Queue (s)	0.0		0.0		0.0	0.0			
Detector 1 Delay (s)	0.0		0.0		0.0	0.0			
Detector 2 Position(m)			9.4			9.4			
Detector 2 Size(m)			0.6			0.6			
Detector 2 Type			Cl+Ex			Cl+Ex			
Detector 2 Channel									
Detector 2 Extend (s)			0.0			0.0			
Turn Type	Prot				Split	NA			
Protected Phases	8		2		6	6	4	9	10

Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	Ø4	Ø9	Ø10
Permitted Phases									
Detector Phase	8		2		6	6			
Switch Phase									
Minimum Initial (s)	5.0		7.0		7.0	7.0	5.0	5.0	5.0
Minimum Split (s)	9.5		11.5		11.5	11.5	9.5	20.4	20.4
Total Split (s)	21.0		45.2		34.0	34.0	19.0	20.4	20.4
Total Split (%)	13.1%		28.3%		21.3%	21.3%	12%	13%	13%
Maximum Green (s)	16.5		41.7		30.5	30.5	14.5	18.4	18.4
Yellow Time (s)	3.5		3.5		3.5	3.5	3.5	2.0	2.0
All-Red Time (s)	1.0		0.0		0.0	0.0	1.0	0.0	0.0
Lost Time Adjust (s)	0.0		0.0			0.0			
Total Lost Time (s)	4.5		3.5			3.5			
Lead/Lag	Lead		Lag		Lag	Lag	Lead		
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes		
Vehicle Extension (s)	3.0		3.0		3.0	3.0	3.0	3.0	3.0
Recall Mode	Min		Min		Min	Min	Min	Max	Max
Act Effct Green (s)	16.1					28.6			
Actuated g/C Ratio	0.11					0.19			
v/c Ratio	0.88					0.91			
Control Delay	106.2					91.4			
Queue Delay	0.0					0.0			
Total Delay	106.2					91.4			
LOS	F					F			
Approach Delay	106.2					91.4			
Approach LOS	F					F			
90th %ile Green (s)	16.5		41.7		30.5	30.5	14.5	18.4	18.4
90th %ile Term Code	Max		Max		Max	Max	Max	MaxR	MaxR
70th %ile Green (s)	16.5		41.7		30.5	30.5	14.5	18.4	18.4
70th %ile Term Code	Max		Max		Max	Max	Max	MaxR	MaxR
50th %ile Green (s)	16.5		38.7		30.5	30.5	14.5	18.4	18.4
50th %ile Term Code	Max		Gap		Max	Max	Max	MaxR	MaxR
30th %ile Green (s)	16.5		33.5		29.5	29.5	14.5	18.4	18.4
30th %ile Term Code	Max		Gap		Gap	Gap	Max	MaxR	MaxR
10th %ile Green (s)	14.3		25.5		22.6	22.6	13.7	18.4	18.4
10th %ile Term Code	Gap		Gap		Gap	Gap	Gap	MaxR	MaxR
Queue Length 50th (m)	52.2					98.2			
Queue Length 95th (m)	#100.5					#156.9			
Internal Link Dist (m)	595.1		27.7			369.2			
Turn Bay Length (m)									
Base Capacity (vph)	191					358			
Starvation Cap Reductn	0					0			
Spillback Cap Reductn	0					0			
Storage Cap Reductn	0					0			
Reduced v/c Ratio	0.85					0.85			

Intersection Summary	
Area Type:	Other
Cycle Length: 160	
Actuated Cycle Length: 152.1	

Natural Cycle: 135	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.91	
Intersection Signal Delay: 96.6	Intersection LOS: F
Intersection Capacity Utilization 30.8%	ICU Level of Service A
Analysis Period (min) 15	
90th %ile Actuated Cycle: 160	
70th %ile Actuated Cycle: 160	
50th %ile Actuated Cycle: 157	
30th %ile Actuated Cycle: 150.8	
10th %ile Actuated Cycle: 132.9	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 1: Bradner Road & Downes Rd (E)



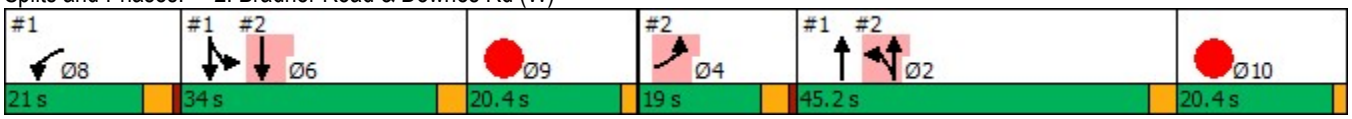
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø8	Ø9	Ø10
Lane Configurations									
Traffic Volume (vph)	108	25	25	323	0	0			
Future Volume (vph)	108	25	25	323	0	0			
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900			
Storage Length (m)	0.0	15.0	0.0			0.0			
Storage Lanes	1	0	0			0			
Taper Length (m)	7.5		7.5						
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Frt	0.974								
Flt Protected	0.961			0.996					
Satd. Flow (prot)	1655	0	0	1756	1810	0			
Flt Permitted	0.961			0.996					
Satd. Flow (perm)	1655	0	0	1756	1810	0			
Right Turn on Red		Yes				Yes			
Satd. Flow (RTOR)	6								
Link Speed (k/h)	30			30	50				
Link Distance (m)	591.6			367.4	60.5				
Travel Time (s)	71.0			44.1	4.4				
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94			
Heavy Vehicles (%)	8%	5%	5%	8%	5%	5%			
Adj. Flow (vph)	115	27	27	344	0	0			
Shared Lane Traffic (%)									
Lane Group Flow (vph)	142	0	0	371	0	0			
Enter Blocked Intersection	No	No	No	No	No	No			
Lane Alignment	Left	Right	Left	Left	Left	Right			
Median Width(m)	3.6			0.0	0.0				
Link Offset(m)	0.0			0.0	0.0				
Crosswalk Width(m)	1.0			1.0	1.0				
Two way Left Turn Lane									
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00			
Turning Speed (k/h)	100	100	100			100			
Number of Detectors	1		1	2	2				
Detector Template	Left		Left	Thru	Thru				
Leading Detector (m)	2.0		2.0	10.0	10.0				
Trailing Detector (m)	0.0		0.0	0.0	0.0				
Detector 1 Position(m)	0.0		0.0	0.0	0.0				
Detector 1 Size(m)	2.0		2.0	0.6	0.6				
Detector 1 Type	Cl+Ex		Cl+Ex	Cl+Ex	Cl+Ex				
Detector 1 Channel									
Detector 1 Extend (s)	0.0		0.0	0.0	0.0				
Detector 1 Queue (s)	0.0		0.0	0.0	0.0				
Detector 1 Delay (s)	0.0		0.0	0.0	0.0				
Detector 2 Position(m)				9.4	9.4				
Detector 2 Size(m)				0.6	0.6				
Detector 2 Type				Cl+Ex	Cl+Ex				
Detector 2 Channel									
Detector 2 Extend (s)				0.0	0.0				
Turn Type	Prot		Split	NA					
Protected Phases	4		2	2	6		8	9	10

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR	Ø8	Ø9	Ø10
Permitted Phases									
Detector Phase	4		2	2	6				
Switch Phase									
Minimum Initial (s)	5.0		7.0	7.0	7.0		5.0	5.0	5.0
Minimum Split (s)	9.5		11.5	11.5	11.5		9.5	20.4	20.4
Total Split (s)	19.0		45.2	45.2	34.0		21.0	20.4	20.4
Total Split (%)	11.9%		28.3%	28.3%	21.3%		13%	13%	13%
Maximum Green (s)	14.5		41.7	41.7	30.5		16.5	18.4	18.4
Yellow Time (s)	3.5		3.5	3.5	3.5		3.5	2.0	2.0
All-Red Time (s)	1.0		0.0	0.0	0.0		1.0	0.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0				
Total Lost Time (s)	4.5			3.5	3.5				
Lead/Lag	Lead		Lag	Lag	Lag		Lead		
Lead-Lag Optimize?	Yes		Yes	Yes	Yes		Yes		
Vehicle Extension (s)	3.0		3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	Min		Min	Min	Min		Min	Max	Max
Act Effct Green (s)	14.4			35.9					
Actuated g/C Ratio	0.09			0.24					
v/c Ratio	0.88			0.90					
Control Delay	110.0			80.9					
Queue Delay	0.0			0.0					
Total Delay	110.0			80.9					
LOS	F			F					
Approach Delay	110.0			80.9					
Approach LOS	F			F					
90th %ile Green (s)	14.5		41.7	41.7	30.5		16.5	18.4	18.4
90th %ile Term Code	Max		Max	Max	Max		Max	MaxR	MaxR
70th %ile Green (s)	14.5		41.7	41.7	30.5		16.5	18.4	18.4
70th %ile Term Code	Max		Max	Max	Max		Max	MaxR	MaxR
50th %ile Green (s)	14.5		38.7	38.7	30.5		16.5	18.4	18.4
50th %ile Term Code	Max		Gap	Gap	Max		Max	MaxR	MaxR
30th %ile Green (s)	14.5		33.5	33.5	29.5		16.5	18.4	18.4
30th %ile Term Code	Max		Gap	Gap	Gap		Max	MaxR	MaxR
10th %ile Green (s)	13.7		25.5	25.5	22.6		14.3	18.4	18.4
10th %ile Term Code	Gap		Gap	Gap	Gap		Gap	MaxR	MaxR
Queue Length 50th (m)	45.1			117.4					
Queue Length 95th (m)	#91.7			#166.6					
Internal Link Dist (m)	567.6			343.4	36.5				
Turn Bay Length (m)									
Base Capacity (vph)	163			483					
Starvation Cap Reductn	0			0					
Spillback Cap Reductn	0			0					
Storage Cap Reductn	0			0					
Reduced v/c Ratio	0.87			0.77					

Intersection Summary	
Area Type:	Other
Cycle Length: 160	
Actuated Cycle Length: 152.1	

Natural Cycle: 135	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.91	
Intersection Signal Delay: 89.0	Intersection LOS: F
Intersection Capacity Utilization 33.0%	ICU Level of Service A
Analysis Period (min) 15	
90th %ile Actuated Cycle: 160	
70th %ile Actuated Cycle: 160	
50th %ile Actuated Cycle: 157	
30th %ile Actuated Cycle: 150.8	
10th %ile Actuated Cycle: 132.9	
# 95th percentile volume exceeds capacity, queue may be longer.	
Queue shown is maximum after two cycles.	

Splits and Phases: 2: Bradner Road & Downes Rd (W)



1: Bradner Road & Downes Rd (E) Performance by movement

Movement	WBL	WBR	SBL	SBT	All
Denied Del/Veh (s)	0.2	0.1	0.3	0.3	0.3
Total Del/Veh (s)	74.7	53.8	70.5	76.7	74.5

2: Bradner Road & Downes Rd (W) Performance by movement

Movement	EBL	EBR	NBL	NBT	All
Denied Del/Veh (s)	0.2	0.2	0.3	0.4	0.3
Total Del/Veh (s)	78.6	54.8	64.1	61.9	64.9

Total Network Performance

Denied Del/Veh (s)	0.3
Total Del/Veh (s)	70.4

Intersection: 1: Bradner Road & Downes Rd (E)

Movement	WB	SB
Directions Served	LR	LT
Maximum Queue (m)	77.6	155.1
Average Queue (m)	45.6	91.6
95th Queue (m)	72.4	143.5
Link Distance (m)	614.9	391.1
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 2: Bradner Road & Downes Rd (W)

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (m)	85.4	170.4
Average Queue (m)	42.6	103.4
95th Queue (m)	74.8	158.6
Link Distance (m)	585.0	362.2
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (m)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0