SR 104/Paradise Bay-Shine Road – Intersection Safety Improvements

WIN: C10401D

SR 104 MP 13.74 to MP 13.78

Intersection Control Evaluation

February 2019

Region Traffic Engineer Approval:

Steve Kim — 2/5/19 — Date

Olympic Region Traffic Engineer

HQ Traffic Approval:

Brian Walsh — 2/6/19 — Date

State Traffic Design & Operations Manager

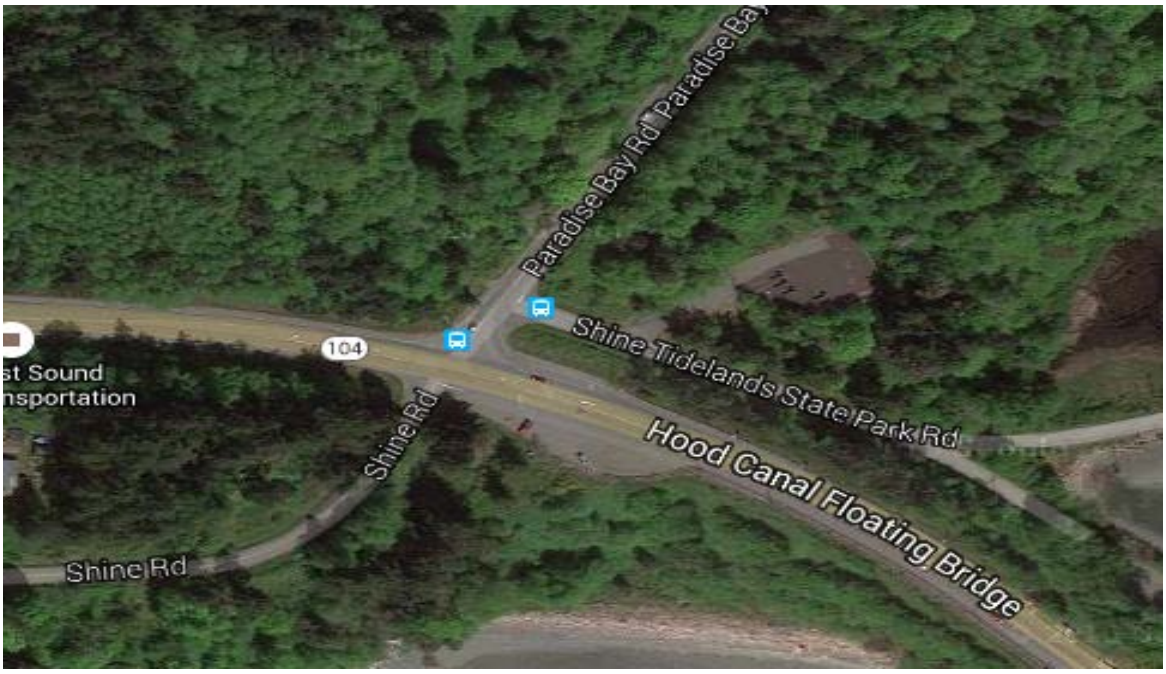
SR 104/Paradise Bay-Shine Road – Intersection Safety Improvements

Intersection Control Evaluation

Background and Project Needs

SR 104 is functionally classified as a rural-principal arterial. It is a limited access, partially controlled, one lane in each direction. This intersection is the first intersection west of the Hood Canal Bridge and is subject to long platoons for traffic during a bridge opening. This intersection is in Jefferson County, has rolling terrain and is an NHS route. The posted speed within the project limits is 40 mph. SR 104 had a 2017 AADT of 17,800 with about 7.3% trucks.

This project is categorized as an I-2 Safety Improvement (Collision Reduction) project. The intersection of SR 104/Shine Road is an Intersection Analysis Location (IAL) for the year 2016. Ninety percent of the 26 total crashes (2009 – 2015 crash history) at this intersection were entering at angle type crashes from Paradise Road. This project will provide improved intersection control, which has the potential to reduce number and severity of crashes.



This is a 4-leg intersection, about 800 ft. west of the west end of the Hood Canal Floating Bridge. In the westbound direction, a climbing lane begins just past the intersection. There is left-turn channelization on mainline for both directions of travel. There is a right-turn lane for the westbound direction that serves the Paradise Bay Rd. There is no channelization on either

of the minor legs. The vertical grade from the Hood Canal Bridge approaching this intersection is around an incline of 5%, and the 85th percentile speeds are around 45 mph.

This intersection met signal warrants based on a 2005 count.

There are times when SR 104 is closed for bridge openings. Given the close proximity of the Hood Canal Bridge, at these times eastbound traffic will often queue well to the west of this intersection. After the bridge is open to traffic, there are often times large platoons of traffic heading both directions.

Alternatives

Given the safety performance of the existing minor-street stop control, maintaining the existing control is not considered as an alternative for the project. A single-lane roundabout and signalized intersection were evaluated as part of this analysis. SIDRA was used for the roundabout analysis and Synchro was used for the signal analysis. Please refer to appendices for SIDRA and Synchro reports.

Existing 2018 PM Peak (PM was critical peak*)				
Intersection Leg	Single-Lane Roundabout		Signalized Intersection	
	Level of Service	Ave Delay (s)	Level of Service	Ave Delay (s)
SR 104 (West)	A	8.8	B	19.7
SR 104 (East)	A	6.1	C	22.9
Shine Road	A	5.1	C	21.6
Paradise Bay RD	A	9.6	B	19.5
Overall I/S	**A**	**6.4**	**C**	**20.9**

*does not represent platoon from bridge opening

Feasibility

Both the signalized intersection and the single-lane roundabout are feasible alternatives. Below, we will discuss the advantages and disadvantages of each.

Signalized Intersection – The signalized intersection will likely have a smaller footprint than that of a roundabout, and therefore have minimal to no right-of-way needs. SR 104/Paradise Bay-Shine RD intersection is on a curve and has a downward sloping profile (east-west direction). One concern is the potential for rear-ends generated by a stopped queue from the signal. Another safety concern with a signal is the potential for red light running.

Single-Lane Roundabout – Per the operational analysis above, the roundabout out-performed the signalized intersection during the PM peak hour. During off-peak hours, it is expected that the roundabout would also out-perform the signal because of the low delay for all entering vehicles. In addition, off-peak hours would typically have free-flow conditions and therefore

higher vehicular speeds. Roundabouts are a preferred intersection control for high speed facilities because of their proven safety performance. During a Hood Canal Bridge closure, traffic on SR 3 can back up 1 to 2 miles (see graphic below). When the bridge opens, a platoon of traffic will send a steady stream of vehicles on SR 104 towards the Shine Road/Paradise Bay Road intersection. With the roundabout alternative, it may be difficult for traffic on Paradise Bay Road and Shine Road to enter westbound SR 104 due to gap availability.

One solution to remedy this concern is installing a metered-entrance single-lane roundabout. Metered entrances are endorsed by FHWA in their Roundabout Guide (Chapter 8.1):

> 8.1.1 Metered entrance Roundabouts operate effectively only when there are sufficient longer and acceptable gaps between vehicles in the circulatory lanes. If there is a heavy movement of circulating drivers, then entering drivers at the next downstream entry may not be able to enter. This situation occurs most commonly during the peak periods, and the performance of the roundabout can be greatly improved with entrance metering. The concept of entrance metering at roundabouts is similar to ramp metering on freeways. A convenient sign is a changeable one that reads "Stop on red signal" and shows the usual yield sign for a roundabout otherwise. The sign would also include a yellow and red signal above the sign. The operation of the sign would be to show drivers the roundabout sign, display the yellow light and the sign "Stop on red signal," and finally display the red light and the same text sign. This would cause entering vehicles to stop and allow the vehicles at the downstream entrance to proceed. A queue length detector on the downstream entrance may be used to indicate to the signal controller when the metering should be activated and deactivated. Once on the circulatory roadway, vehicles are not stopped from leaving the roundabout.

A similar treatment has been used at a roundabout in Kennewick, WA on the state highway system with operational issues that are expected at Shine Road.

Detection loops can be placed on Paradise Bay Road and Shine Road. When these legs of traffic had been delayed for more than a fixed period or exceed a length of queue, a ramp meter signal can be activated on SR 104 to relieve some of the traffic pressure on the minor legs. This metering signal will likely be activated only during a bridge opening and will deactivate when the SR 104 platoon has cleared.

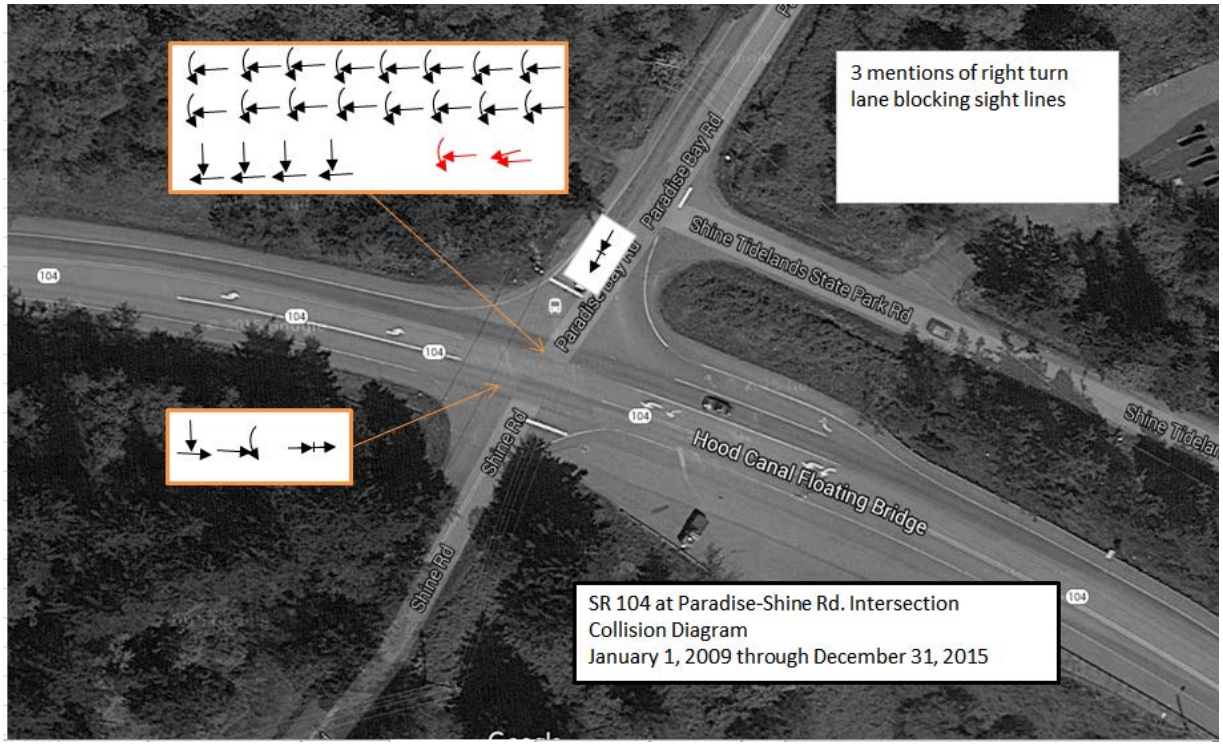
Typical backup on SR 3 during Hood Canal Bridge closure.

Relative to a roundabout, a signal does not process vehicles as efficiently. With or without a bridge closure, a signal would propagate longer queues which would increase the potential for high speed, rear end crashes.

Safety Analysis

From the 2016 IAL (2009 – 2015 crash history), there were a total of 2 serious injuries and 24 non-serious crashes. 23 out of the 26 crashes were entering-at-angle crashes, and 25 out of the 26 crashes were intersection related.

First Collision Type	Fatal	Serious (indicated by red arrows below)	Total Crashes
Entering-At-Angle	0	1	23
Same Direction Sideswipe	0	1	1
Rear-End	0	0	2



Under Federal Law, 23 United States Code Section 409, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, and planning for safety enhancements or for developing safety projects which may be implemented using Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceedings.

Since 2016, there has been 4 other crashes; 2 suspected serious injury crashes. 3 of the 4 crashes were entering-at-angle crashes.

The roundabout alternative will potentially eliminate all of the entering-at angle crashes and significantly reduce severity of crashes relative to the signal alternative.

Community Engagement

Community engagement is expected to be conducted in the Spring of 2019. WSDOT will present both the roundabout and signal alternatives.

Selection and Conclusion

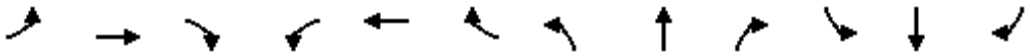
A single-lane roundabout is recommended for this intersection based on the safety improvements and operational benefits. A metered-entrance single lane roundabout should be considered in the future if operational issues with a bridge opening is determined to be an

issue. At a minimum during the initial construction, the hardware and conduit for a metered roundabout should be installed.

Attachments:
SIDRA Analysis
Synchro Analysis

HCM 6th Signalized Intersection Summary
3: Shine Rd/Paradise Bay Rd & SR 104

10/10/2018



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	561	2	10	569	130	1	0	13	88	2	6
Future Volume (veh/h)	1	561	2	10	569	130	1	0	13	88	2	6
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1646	1800	1800	1800	1800	1800	1786	1786	1786	1786	1786	1786
Adj Flow Rate, veh/h	4	660	4	12	862	213	4	0	28	104	4	12
Peak Hour Factor	0.25	0.85	0.50	0.83	0.66	0.61	0.25	0.92	0.46	0.85	0.50	0.50
Percent Heavy Veh, %	11	0	0	0	0	0	1	1	1	1	1	1
Cap, veh/h	8	766	5	196	967	819	81	27	348	416	19	37
Arrive On Green	0.01	0.43	0.43	0.11	0.54	0.54	0.26	0.00	0.26	0.26	0.26	0.26
Sat Flow, veh/h	1567	1787	11	1714	1800	1525	85	105	1333	1216	74	143
Grp Volume(v), veh/h	4	0	664	12	862	213	32	0	0	120	0	0
Grp Sat Flow(s),veh/h/ln	1567	0	1798	1714	1800	1525	1523	0	0	1433	0	0
Q Serve(g_s), s	0.2	0.0	23.0	0.4	29.3	5.2	0.0	0.0	0.0	3.4	0.0	0.0
Cycle Q Clear(g_c), s	0.2	0.0	23.0	0.4	29.3	5.2	1.1	0.0	0.0	4.5	0.0	0.0
Prop In Lane	1.00		0.01	1.00		1.00	0.12		0.87	0.87		0.10
Lane Grp Cap(c), veh/h	8	0	770	196	967	819	457	0	0	472	0	0
V/C Ratio(X)	0.48	0.00	0.86	0.06	0.89	0.26	0.07	0.00	0.00	0.25	0.00	0.00
Avail Cap(c_a), veh/h	114	0	1136	196	1137	964	457	0	0	472	0	0
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	34.1	0.0	17.8	27.2	14.2	8.6	19.2	0.0	0.0	20.4	0.0	0.0
Incr Delay (d2), s/veh	36.6	0.0	4.7	0.1	8.1	0.2	0.3	0.0	0.0	1.3	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	9.5	0.2	12.1	1.5	0.4	0.0	0.0	1.6	0.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	70.8	0.0	22.6	27.3	22.3	8.7	19.5	0.0	0.0	21.6	0.0	0.0
LnGrp LOS	E	A	C	C	C	A	B	A	A	C	A	A
Approach Vol, veh/h		668			1087			32			120	
Approach Delay, s/veh		22.9			19.7			19.5			21.6	
Approach LOS		C			B			B			C	

Timer - Assigned Phs		2	3	4		6	7	8				
Phs Duration (G+Y+Rc), s		22.5	12.4	34.0		22.5	4.9	41.5				
Change Period (Y+Rc), s		4.5	4.5	4.5		4.5	4.5	4.5				
Max Green Setting (Gmax), s		18.0	5.0	43.5		18.0	5.0	43.5				
Max Q Clear Time (g_c+I1), s		3.1	2.4	25.0		6.5	2.2	31.3				
Green Ext Time (p_c), s		0.1	0.0	4.4		0.4	0.0	5.7				

Intersection Summary	
HCM 6th Ctrl Delay	20.9
HCM 6th LOS	C

Intersection: 3: Shine Rd/Paradise Bay Rd & SR 104

Movement	EB	WB	WB	WB	NB	SB
Directions Served	TR	L	T	R	LTR	LTR
Maximum Queue (ft)	227	40	153	53	36	92
Average Queue (ft)	140	15	114	28	11	35
95th Queue (ft)	213	42	162	60	36	84
Link Distance (ft)	762		920		925	803
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		200		200		
Storage Blk Time (%)	1					
Queuing Penalty (veh)	0					

Network Summary

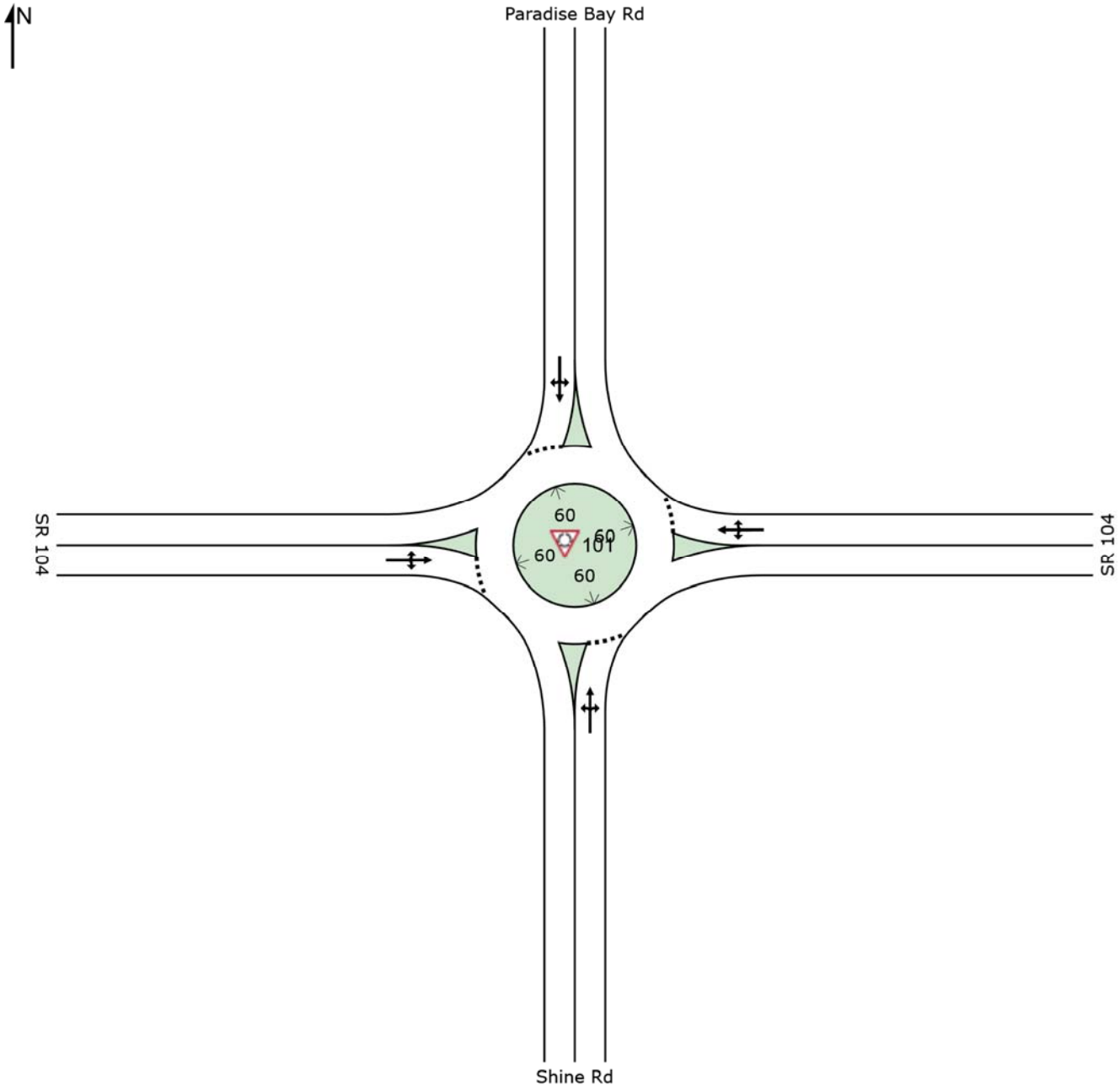
Network wide Queuing Penalty: 0

SITE LAYOUT

Site: 101 [SR 104/Paradise/Shine 1-lane 2018 PM]

SR 104/Paradise/Shine 1-lane

Roundabout



MOVEMENT SUMMARY

Site: 101 [SR 104/Paradise/Shine 1-lane 2018 PM]

SR 104/Paradise/Shine 1-lane

Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance ft	Prop. Queued	Effective Stop Rate per veh	Average Speed mph
South: Shine Rd											
3	L2	1	0.0	0.014	9.5	LOS A	0.1	1.4	0.22	0.51	36.2
8	T1	1	0.0	0.014	5.0	LOS A	0.1	1.4	0.22	0.51	36.3
18	R2	14	0.0	0.014	4.8	LOS A	0.1	1.4	0.22	0.51	35.4
Approach		16	0.0	0.014	5.1	LOS A	0.1	1.4	0.22	0.51	35.5
East: SR 104											
1	L2	11	0.0	0.712	10.4	LOS B	7.1	183.4	0.54	0.53	35.1
6	T1	618	5.0	0.712	6.1	LOS A	7.1	183.4	0.54	0.53	35.1
16	R2	141	1.0	0.712	5.7	LOS A	7.1	183.4	0.54	0.53	34.4
Approach		771	4.2	0.712	6.1	LOS A	7.1	183.4	0.54	0.53	35.0
North: Paradise Bay Rd											
7	L2	1	3.0	0.005	12.6	LOS B	0.0	0.7	0.64	0.61	33.9
4	T1	1	3.0	0.005	8.1	LOS A	0.0	0.7	0.64	0.61	34.1
14	R2	1	3.0	0.005	7.9	LOS A	0.0	0.7	0.64	0.61	33.3
Approach		3	3.0	0.005	9.6	LOS A	0.0	0.7	0.64	0.61	33.8
West: SR 104											
5	L2	96	2.0	0.087	9.1	LOS A	0.4	10.5	0.08	0.63	34.3
2	T1	2	0.0	0.087	4.7	LOS A	0.4	10.5	0.08	0.63	34.5
12	R2	7	0.0	0.087	4.4	LOS A	0.4	10.5	0.08	0.63	33.7
Approach		104	1.8	0.087	8.8	LOS A	0.4	10.5	0.08	0.63	34.3
All Vehicles		895	3.8	0.712	6.4	LOS A	7.1	183.4	0.48	0.55	34.9

Site Level of Service (LOS) Method: Delay & v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if v/c > 1 irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6).
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.