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Dowling Associates, Inc.

Date: September 20, 2010

Memorandum

To: Paul Hom, El Dorado County Department of Transportation

cc: Silva Valley Parkway Interchange Traffic Analysis Project Development Team

From: Dowling Associates Inc.

Reference #: P08044.006

Subject: Environmental Mitigation and Ramp Metered Merge Analysis Memo

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As documented in the Caltrans approved Silva Valley Interchange Traffic Operations Study (Dowling Associates Inc., July, 2010), several mitigation strategies are presented for the various identified traffic impacts. This memorandum serves to clarify the preferred mitigation strategy for the westbound on-ramp at US-50/Bass Lake and optional mitigations for the White Rock Road/Latrobe Road intersection.

Although adding an additional lane on US-50 as shown on Table 25 (p. 51) will remedy the with-project (Silva Valley Interchange) traffic impact under 2020 conditions, the preferred mitigation strategy as discussed on page 52 is to meter the on-ramp. This mitigation strategy applies to the original phasing plan or the alternative phasing plan for the new Silva Valley Parkway Interchange.

2020 PM Peak Hour Merge Analysis Findings

As reported in Silva Valley Interchange Traffic Operations Study (Dowling Associates Inc., July, 2010), a queue spill-back analysis was performed to ascertain the metering rate for the westbound on-ramp at Bass Lake (Table 26 p. 52). Based on a discharge rate of 241 vph, merge operations are projected to improve from LOS F to LOS C. This is shown in **Table 1** and **Table 2** on the following page.

The Bass Lake Interchange improvement project is identified in the County Capital Improvement Program. As part of this programmed improvement, it is recommended that the westbound and eastbound ramp intersections will be signalized, modified for left turn storage and metered.

Ramp Metered Merge Analysis Findings

Merge analysis based on the ramp meter discharge rates established in **Table 3** through **Table 5** was performed at El Dorado Hills, Silva Valley and Bass Lake interchanges. Results for 2010, 2020 and 2030 plus project conditions are presented in **Table 6**, **Table 7** and **Table 8** respectively. It should be noted that the ramp metered merge analysis results for Silva Valley alternative phasing were included in the above mentioned memorandum and report.

White Rock Road/Latrobe Road Mitigations

Mitigation for White Rock Road/Latrobe Road for "with project" scenario have been identified on page 59 of the July 2010 report. The identified mitigation measure recommends adding a second northbound right turn lane, which will mitigate the intersection to acceptable LOS E or better. Other possible mitigation measures include converting the existing northbound right turn lane to a "free" right turn lane or adding a 3rd eastbound through lane. Synchro file outputs for both these alternative mitigation measures are presented as an attachment to this memo.

White Rock Road/Jorger Road Mitigations

The original Silva Valley Traffic Operations report analyzes White Rock Road/Jorger Cut-Off Road intersection as a two-way stop controlled intersection under 2030 conditions. However, this is anticipated to be signalized with the full Buildout of Silva Valley Interchange. The signalization of this intersection will result in acceptable LOS A conditions (AM delay = 1.7 seconds and PM delay = 3.6 seconds) during the AM and PM peak hours under 2030 conditions. The attachment to this memo presents the intersection LOS under 2030 conditions.

Table 1. 2020 PM Peak Hour Merge Analysis Worksheet (without Ramp Metering)

Merge Analysis : 2020 Plus Project																																																		
				Freeway-Ramp Components and Characteristics									Volume Adjustment																																					
				Freeway Data			On-Ramp Data						Volume Components			Terrain	Volume Composition																										Results of Merge Area							
ID	Interchange	Direction (NB or SB)	Ramp Type (On or Off)	Number of Lanes on Freeway (Each Direction), N	S_{FF} (mph)	Volume (vph)	Side of Ramp (Left or Right)	S_{FR} (mph)	Volume, V_R (vph)	Lanes on Ramp, N	Length of 1st Acceleration Lane, LA1 (ft.)	Length of 2nd Acceleration Lane, LA2 (ft.)	Freeway PHF	Ramp PHF	Adjacent Ramp PHF	Type (Level, Rolling, Mountainous, Grade, Composite)	Percent Trucks and Buses on Freeway (%)	E_T (fwy)	Percent Recreational Vehicles on Freeway (%)	E_R (fwy)	Percent Trucks and Buses on Ramp (%)	E_T (ramp)	Percent Recreational Vehicles on Ramp (%)	E_R (ramp)	Percent Trucks and Buses on Adjacent Ramp (%)	E_T (adjacent ramp)	Percent Recreational Vehicles on Adjacent Ramp (%)	E_R (adjacent ramp)	Driver Population Adjustment f_P	f_{HV} (fwy)	f_{HV} (ramp)	f_{HV} (adjacent ramp)	L_{EQ}	P_{FM} (1-Lane On-Ramp)	P_{FM} (2-Lane On-Ramp)	V_{12} (1-Lane On-Ramp)	V_{12} (2-Lane On-Ramp)	V_{FO}	V_{R12} or V_{R23} or V_{R34}	V_5	V_{F4eff}	V_{23} or V_{34}	Max. Downstream Freeway Flow, v (pc/h)	Max Desirable Flow Entering Influence Area, V_{R12} (pc/h)	Capacity Check: V_{FO} > Max.	Capacity Check: V_{R12} > Max.	Compute D_R (pc/mi/h)	M_s	Compute S_R (mph)	LOS
Non-Mitigated Conditions	Bass Lake to US 50 WB ON	WB	On	2	70	4,174	Right	35	333	2	500	1500	1	1	1	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	2%	1.5	0%	1.2	1	0.971	0.990	0.990		1.000	1.000	4299	4299	4635	4635				4800	4600	No	Yes	25.8	0.5	55	F

Table 2. 2020 PM Peak Hour Merge Analysis Worksheet (with Ramp Metering)

Merge Analysis with Ramp Metering : 2020 Plus Project																																																		
				Freeway-Ramp Components and Characteristics									Volume Adjustment																																					
				Freeway Data			On-Ramp Data						Volume Components			Terrain	Volume Composition																										Results of Merge Area							
ID	Interchange	Direction (NB or SB)	Ramp Type (On or Off)	Number of Lanes on Freeway (Each Direction), N	S_{FF} (mph)	Volume (vph)	Side of Ramp (Left or Right)	S_{FR} (mph)	Volume, V_R (vph)	Lanes on Ramp, N	Length of 1st Acceleration Lane, LA1 (ft.)	Length of 2nd Acceleration Lane, LA2 (ft.)	Freeway PHF	Ramp PHF	Adjacent Ramp PHF	Type (Level, Rolling, Mountainous, Grade, Composite)	Percent Trucks and Buses on Freeway (%)	E_T (fwy)	Percent Recreational Vehicles on Freeway (%)	E_R (fwy)	Percent Trucks and Buses on Ramp (%)	E_T (ramp)	Percent Recreational Vehicles on Ramp (%)	E_R (ramp)	Percent Trucks and Buses on Adjacent Ramp (%)	E_T (adjacent ramp)	Percent Recreational Vehicles on Adjacent Ramp (%)	E_R (adjacent ramp)	Driver Population Adjustment f_P	f_{HV} (fwy)	f_{HV} (ramp)	f_{HV} (adjacent ramp)	L_{EQ}	P_{FM} (1-Lane On-Ramp)	P_{FM} (2-Lane On-Ramp)	V_{12} (1-Lane On-Ramp)	V_{12} (2-Lane On-Ramp)	V_{FO}	V_{R12} or V_{R23} or V_{R34}	V_5	V_{F4eff}	V_{23} or V_{34}	Max. Downstream Freeway Flow, v (pc/h)	Max Desirable Flow Entering Influence Area, V_{R12} (pc/h)	Capacity Check: V_{FO} > Max.	Capacity Check: V_{R12} > Max.	Compute D_R (pc/mi/h)	M_s	Compute S_R (mph)	LOS
Non-Mitigated Conditions	Bass Lake to US 50 WB ON	WB	On	2	70	4,174	Right	35	241	2	500	1500	1	1	1	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	2%	1.5	0%	1.2	1	0.971	0.990	0.990		1.000	1.000	4299	4299	4542	4542				4800	4600	No	No	25.1	0.5	56	C

Table 3. Ramp Meter Discharge Rates for 2010 Plus Project Conditions

	El Dorado Hills I/C				Silva Valley I/C				Bass Lake I/C			
	WB On-Ramp		EB On-Ramp		WB On-Ramp		EB On-Ramp		WB On-Ramp		EB On-Ramp	
Description	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**
Arrival Rate:												
Forecasted Traffic Volumes (vph)	2,004	1,680	826	1,091	487	379	840	832	709	327	101	120
Percentage of HOV Vehicles [1]	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	0%	0%	0%	0%
HOV Vehicles	230	193	95	125	56	44	97	96	0	0	0	0
Adjusted Traffic Volumes (vph) [2]	1,774	1,487	731	966	431	335	743	736	709	327	101	120
Peak Hour Factor (PHF)	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Proportion of Heavy Vehicle	6%	6%	6%	6%	6%	6%	6%	6%	2%	2%	2%	2%
Proportion of RVs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Factor for Heavy Vehicle and RVs	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.97	0.97	0.97	0.97
Flow Rate (pcph) [3]	2,101	1,762	866	1,144	511	397	881	872	794	366	113	134
Average Arrival Rate (pcps)	0.58	0.49	0.24	0.32	0.14	0.11	0.24	0.24	0.22	0.10	0.03	0.04
Peak 15-min Arrival Rate (pc)	525	440	217	286	128	99	220	218	198	92	28	34
Peak 5-min Arrival Rate (pc)	175	147	72	95	43	33	73	73	66	31	9	11
Assumptions/Given:												
Average Car Length (ft)	25	25	25	25	25	25	25	25	25	25	25	25
Approx. Storage Length (ft per lane) [4]	850	850	925	925	500	500	700	700	650	650	650	650
Number of On-Ramp Lanes	2	2	2	2	1	1	2	2	1	1	1	1
Approx Total Storage Capacity (ft)	1,700	1,700	1,850	1,850	500	500	1,400	1,400	650	650	650	650
Discharge Rate:												
Maximum Capacity or Discharge Rate (pcph) [5]	1,830	1,490	570	850	430	320	660	650	690	270	270	270
Average Discharge Rate (pcps)	0.51	0.41	0.16	0.24	0.12	0.09	0.18	0.18	0.19	0.08	0.08	0.08
Peak 15-min Discharge Rate (pc)	458	373	143	213	108	80	165	163	173	68	68	68
Peak 5-min Discharge Rate (pc)	153	124	48	71	36	27	55	54	58	23	23	23
Resultant Ramp Flow Rate without HOV (vph) [6]	1,545	1,258	481	717	363	270	557	549	616	241	241	241
Resultant Ramp Flow Rate with HOV (vph)	**1775**	**1451**	**576**	**843**	**419**	**314**	**654**	**644**	**616**	**241**	**241**	**241**
Peak 15-min Results:												
Residual Queue Length (veh) [7]	68	68	74	73	20	19	55	56	26	24	0	0
Residual Queue Length (ft)	1,695	1,697	1,851	1,837	504	484	1,380	1,390	649	601	0	0
Resultant Queue Spillback (ft) [8]	0	0	1	0	4	0	0	0	0	0	0	0
Resultant Queue Spillback (veh)	0	0	0	0	0	0	0	0	0	0	0	0
Peak 5-min Results:												
Residual Queue Length (veh) [7]	23	23	25	24	7	6	18	19	9	8	0	0
Residual Queue Length (ft)	565	566	617	612	168	161	460	463	216	200	0	0
Resultant Queue Spillback (ft) [8]	0	0	0	0	0	0	0	0	0	0	0	0
Resultant Queue Spillback (veh)	0	0	0	0	0	0	0	0	0	0	0	0

[1] - Forecasted volumes were reduced by 11.5% to account for an HOV bypass lane as assumed in PSR for Silva Valley and El Dorado Hills I/C

[2] - Forecasted traffic volumes were not reduced to exclude HOV-lane traffic

[3] - Computed as traffic volumes divided by a PHF and Factor for Heavy Vehicles

[4] - Based on Geometric Designs provided by Mark Thomas (Silva Valley I/C), Quincy (El Dorado Hills I/C) and engineering judgement

[5] - Adjusted iteratively to avoid queue spillbacks

[6] - Based on Highway Design Manual (HDM), Sixth Edition. Min = 240 vphpl and Max = 900 vphpl

[7] - Difference of corresponding arrival rate and departure rate

[8] - Queues in feet exceeding the available storage capacity

Shaded box with bold letter indicates spillbacks

vph = vehicles per hour, vps = vehicles per second, vphpl = vehicles per hour per lane, pcph = passenger cars per hour

Table 4. Ramp Meter Discharge Rates for 2020 Plus Project Conditions

	El Dorado Hills I/C				Silva Valley I/C				Bass Lake I/C			
	WB On-Ramp		EB On-Ramp		WB On-Ramp		EB On-Ramp		WB On-Ramp		EB On-Ramp	
Description	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**	**AM Peak**	**PM Peak**
Arrival Rate:												
Forecasted Traffic Volumes (vph)	1,886	1,628	899	1,194	899	694	1,203	1,657	730	333	142	147
Percentage of HOV Vehicles [1]	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	0%	0%	0%	0%
HOV Vehicles	217	187	103	137	103	80	138	191	0	0	0	0
Adjusted Traffic Volumes (vph) [2]	1,669	1,441	796	1,057	796	614	1,065	1,466	730	333	142	147
Peak Hour Factor (PHF)	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Proportion of Heavy Vehicle	6%	6%	6%	6%	6%	6%	6%	6%	2%	2%	2%	2%
Proportion of RVs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Factor for Heavy Vehicle and RVs	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.97	0.97	0.97	0.97
Flow Rate (pcph) [3]	1,978	1,707	943	1,252	943	728	1,261	1,737	817	373	159	165
Average Arrival Rate (pcps)	0.55	0.47	0.26	0.35	0.26	0.20	0.35	0.48	0.23	0.10	0.04	0.05
Peak 15-min Arrival Rate (pc)	494	427	236	313	236	182	315	434	204	93	40	41
Peak 5-min Arrival Rate (pc)	165	142	79	104	79	61	105	145	68	31	13	14
Assumptions/Given:												
Average Car Length (ft)	25	25	25	25	25	25	25	25	25	25	25	25
Approx. Storage Length (ft per lane) [4]	850	850	925	925	500	500	700	700	650	650	650	650
Number of On-Ramp Lanes	2	2	2	2	1	1	2	2	2	2	1	1
Approx Total Storage Capacity (ft)	1,700	1,700	1,850	1,850	500	500	1,400	1,400	1,300	1,300	650	650
Discharge Rate:												
Maximum Capacity or Discharge Rate (pcph) [5]	1,710	1,440	650	960	865	650	1,040	1,515	610	270	270	270
Average Discharge Rate (pcps)	0.48	0.40	0.18	0.27	0.24	0.18	0.29	0.42	0.17	0.08	0.08	0.08
Peak 15-min Discharge Rate (pc)	428	360	163	240	216	163	260	379	153	68	68	68
Peak 5-min Discharge Rate (pc)	143	120	54	80	72	54	87	126	51	23	23	23
Resultant Ramp Flow Rate without HOV (vph) [6]	1,443	1,215	549	810	730	549	878	1,279	545	241	241	241
Resultant Ramp Flow Rate with HOV (vph)	**1,660**	**1,403**	**652**	**948**	**833**	**628**	**1,016**	**1,469**	**545**	**241**	**241**	**241**
Peak 15-min Results:												
Residual Queue Length (veh) [7]	67	67	73	73	19	19	55	56	52	26	0	0
Residual Queue Length (ft)	1,672	1,669	1,829	1,825	485	486	1,384	1,390	1,296	643	0	0
Resultant Queue Spillback (ft) [8]	0	0	0	0	0	0	0	0	0	0	0	0
Resultant Queue Spillback (veh)	0	0	0	0	0	0	0	0	0	0	0	0
Peak 5-min Results:												
Residual Queue Length (veh) [7]	22	22	24	24	6	6	18	19	17	9	0	0
Residual Queue Length (ft)	557	556	610	608	162	162	461	463	432	214	0	0
Resultant Queue Spillback (ft) [8]	0	0	0	0	0	0	0	0	0	0	0	0
Resultant Queue Spillback (veh)	0	0	0	0	0	0	0	0	0	0	0	0

[1] - Forecasted volumes were reduced by 11.5% to account for an HOV bypass lane as assumed in PSR for Silva Valley and El Dorado Hills I/C

[2] - Forecasted traffic volumes were not reduced to exclude HOV-lane traffic

[3] - Computed as traffic volumes divided by a PHF and Factor for Heavy Vehicles

[4] - Based on Geometric Designs provided by Mark Thomas (Silva Valley I/C), Quincy (El Dorado Hills I/C) and engineering judgement

[5] - Adjusted iteratively to avoid queue spillbacks

[6] - Based on Highway Design Manual (HDM), Sixth Edition. Min = 240 vphpl and Max = 900 vphpl

[7] - Difference of corresponding arrival rate and departure rate

[8] - Queues in feet exceeding the available storage capacity

Shaded box with bold letter indicates spillbacks

vph = vehicles per hour, vps = vehicles per second, vphpl = vehicles per hour per lane, pcph = passenger cars per hour

Table 5. Ramp Meter Discharge Rates for 2030 Plus Project Conditions

	El Dorado Hills I/C				Silva Valley I/C (Two Point Merge)								Silva Valley I/C (Single Point Merge)		Bass Lake I/C			
	WB On-Ramp		EB On-Ramp		NB to WB On-Ramp		SB to WB On-Ramp		NB to EB On-Ramp		SB to EB On-Ramp		EB On-Ramp		WB On-Ramp		EB On-Ramp	
Description	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
Arrival Rate:																		
Forecasted Traffic Volumes (vph)	1,767	1,575	968	1,297	570	599	739	409	987	1,274	575	648	1,562	1,922	1,114	529	183	174
Percentage of HOV Vehicles [1]	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	23.0%	23.0%	0%	0%	0%	0%
HOV Vehicles	203	181	111	149	66	69	85	47	114	147	66	75	359	442	0	0	0	0
Adjusted Traffic Volumes (vph) [2]	1,564	1,394	857	1,148	504	530	654	362	873	1,127	509	573	1,203	1,480	1,114	529	183	174
Peak Hour Factor (PHF)	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Proportion of Heavy Vehicle	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	2%	2%	2%	2%
Proportion of RVs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Factor for Heavy Vehicle and RVs	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.97	0.97	0.97	0.97
Flow Rate (pcph) [3]	1,853	1,651	1,015	1,360	598	628	775	429	1,035	1,336	603	679	1,425	1,753	1,247	592	205	195
Average Arrival Rate (pcps)	0.51	0.46	0.28	0.38	0.17	0.17	0.22	0.12	0.29	0.37	0.17	0.19	0.40	0.49	0.35	0.16	0.06	0.05
Peak 15-min Arrival Rate (pc)	463	413	254	340	149	157	194	107	259	334	151	170	356	438	312	148	51	49
Peak 5-min Arrival Rate (pc)	154	138	85	113	50	52	65	36	86	111	50	57	119	146	104	49	17	16
Assumptions/Given:																		
Average Car Length (ft)	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Approx. Storage Length (ft per lane) [4]	850	850	925	925	500	500	500	500	700	700	580	580	500	500	650	650	650	650
Number of On-Ramp Lanes	2	2	2	2	1	1	1	1	2	2	1	1	2	2	2	2	1	1
Approx Total Storage Capacity (ft)	1,700	1,700	1,850	1,850	500	500	500	500	1,400	1,400	580	580	1,000	1,000	1,300	1,300	650	650
Discharge Rate:																		
Maximum Capacity or Discharge Rate (pcph) [5]	1,585	1,380	720	1,065	520	550	695	350	815	1,115	510	590	1,265	1,595	1,040	480	270	270
Average Discharge Rate (pcps)	0.44	0.38	0.20	0.30	0.14	0.15	0.19	0.10	0.23	0.31	0.14	0.16	0.35	0.44	0.29	0.13	0.08	0.08
Peak 15-min Discharge Rate (pc)	396	345	180	266	130	138	174	88	204	279	128	148	316	399	260	120	68	68
Peak 5-min Discharge Rate (pc)	132	115	60	89	43	46	58	29	68	93	43	49	105	133	87	40	23	23
Resultant Ramp Flow Rate without HOV (vph) [6]	1,338	1,165	608	899	439	464	587	295	688	941	430	498	1,068	1,346	929	429	241	241
Resultant Ramp Flow Rate with HOV (vph)	**1,541**	**1,346**	**719**	**1,048**	**504**	**533**	**672**	**342**	**801**	**1,088**	**497**	**573**	**1,427**	**1,788**	**929**	**429**	**241**	**241**
Peak 15-min Results:																		
Residual Queue Length (veh) [7]	67	68	74	74	19	20	20	20	55	55	23	22	40	40	52	28	0	0
Residual Queue Length (ft)	1,673	1,696	1,844	1,843	485	488	499	493	1,374	1,380	581	559	1,000	990	1,295	702	0	0
Resultant Queue Spillback (ft) [8]	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Resultant Queue Spillback (veh)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peak 5-min Results:																		
Residual Queue Length (veh) [7]	22	23	25	25	6	7	7	7	18	18	8	7	13	13	17	9	0	0
Residual Queue Length (ft)	558	565	615	614	162	163	166	164	458	460	194	186	333	330	432	234	0	0
Resultant Queue Spillback (ft) [8]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Resultant Queue Spillback (veh)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

[1] - Forecasted volumes were reduced by 11.5% to account for an HOV bypass lane as assumed in PSR for Silva Valley and El Dorado Hills I/C
[2] - Forecasted traffic volumes were not reduced to exclude HOV-lane traffic
[3] - Computed as traffic volumes divided by a PHF and Factor for Heavy Vehicles
[4] - Based on Geometric Designs provided by Mark Thomas (Silva Valley I/C), Quincy (El Dorado Hills I/C) and engineering judgement
[5] - Adjusted iteratively to avoid queue spillbacks
[6] - Based on Highway Design Manual (HDM), Sixth Edition. Min = 240 vphpl and Max = 900 vphpl
[7] - Difference of corresponding arrival rate and departure rate
[8] - Queues in feet exceeding the available storage capacity
Shaded box with bold letter indicates spillbacks
vph = vehicles per hour, vps = vehicles per second, vphpl = vehicles per hour per lane, pcph = passenger cars per hour

Table 6. 2010 Plus Project Merge Analysis with Ramp Metering

				Freeway-Ramp Components and Characteristics									Volume Adjustment																														Results of Merge Area							
				Freeway Data			On-Ramp Data						Volume Components			Terrain	Volume Composition																																	
ID	Interchange	Direction (NB or SB)	Ramp Type (On or Off)	Number of Lanes on Freeway (Each Direction), N	S_{FF} (mph)	Volume (vph)	Side of Ramp (Left or Right)	S_{FR} (mph)	Volume, V_R (vph)	Lanes on Ramp, N	Length of 1st Acceleration Lane, LA1 (ft.)	Length of 2nd Acceleration Lane, LA2 (ft.)	Freeway PHF	Ramp PHF	Adjacent Ramp PHF	Type (Level, Rolling, Mountainous, Grade, Composite)	Percent Trucks and Buses on Freeway (%)	E_T (fwy)	Percent Recreational Vehicles on Freeway (%)	E_R (fwy)	Percent Trucks and Buses on Ramp (%)	E_T (ramp)	Percent Recreational Vehicles on Ramp (%)	E_R (ramp)	Percent Trucks and Buses on Adjacent Ramp (%)	E_T (adjacent ramp)	Percent Recreational Vehicles on Adjacent Ramp (%)	E_R (adjacent ramp)	Driver Population Adjustment f_P	f_{HV} (fwy)	f_{HV} (ramp)	f_{HV} (adjacent ramp)	L_{EQ}	P_{FM} (1-Lane On-Ramp)	P_{FM} (2-Lane On-Ramp)	V_{12} (1-Lane On-Ramp)	V_{12} (2-Lane On-Ramp)	V_{FO}	V_{R12} or V_{R23} or V_{R34}	V_5	V_{F4eff}	V_{23} or V_{34}	Max. Downstream Freeway Flow, v (pc/h)	Max Desirable Flow Entering Influence Area, V_{R12} (pc/h)	Capacity Check: V_{FO} > Max.	Capacity Check: V_{R12} > Max.	Compute D_R (pc/mi/h)	M_s	Compute S_R (mph)	LOS
AM Peak Hour																																																		
Ramp Metered	EDH to US 50 WB ON	WB	On	3	70	2,150	Right	35	1775	1	500		1	1	0	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	1386	1301	4279	3321				7200	4600	No	No	27.4	0.4	59	C
	Silva Valley Pkwy to US 50 EB ON	EB	On	3	70	1,868	Right	35	654	1	500		1	1	0	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971		0.592	0.555	1138	1068	2597	1811				7200	4600	No	No	16.2	0.3	61	B
	Silva Valley Pkwy to US 50 WB ON	WB	On	3	70	2,621	Right	35	419	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	4031.84	0.644	0.555	1739	1499	3132	2171				7200	4600	No	No	12.8	0.3	63	B
	Bass Lake to US 50 EB ON	EB	On	3	70	2,416	Right	35	101	1	500		1	1	0	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	1557	1461	2743	1667				7200	4600	No	No	15.3	0.3	61	B
	Bass Lake to US 50 WB ON	WB	On	2	70	2,692	Right	35	616	1	1500		1	1	0	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.990	0.971		1.000	1.000	2773	2773	3395	3395				4800	4600	No	No	22.3	0.3	61	C
PM Peak Hour																																																		
Ramp Metered	EDH to US 50 WB ON	WB	On	3	70	2,168	Right	35	1451	1	500		1	1	1	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	1398	1311	3944	2979				7200	4600	No	No	24.8	0.4	60	C
	Silva Valley Pkwy to US 50 EB ON	EB	On	3	70	3,180	Right	35	644	1	500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971		0.592	0.555	1937	1818	3939	2601				7200	4600	No	No	22.3	0.3	61	C
	Silva Valley Pkwy to US 50 WB ON	WB	On	3	70	2,451	Right	35	314	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	1977.05	0.620	0.555	1564	1401	2848	1887				7200	4600	No	No	10.6	0.2	63	B
	Bass Lake to US 50 EB ON	EB	On	3	70	3,351	Right	35	120	1	500		1	1	1	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2161	2027	3784	2292				7200	4600	No	No	20.2	0.3	61	C
	Bass Lake to US 50 WB ON	WB	On	2	70	2,850	Right	35	241	1	1500		1	1	1	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.990	0.971		1.000	1.000	2936	2936	3180	3180				4800	4600	No	No	20.8	0.3	61	C

Table 7. 2020 Plus Project Merge Analysis with Ramp Metering

				Freeway-Ramp Components and Characteristics									Volume Adjustment																														Results of Merge Area							
				Freeway Data			On-Ramp Data						Volume Components			Terrain	Volume Composition																																	
ID	Interchange	Direction (NB or SB)	Ramp Type (On or Off)	Number of Lanes on Freeway (Each Direction), N	S_{FF} (mph)	Volume (vph)	Side of Ramp (Left or Right)	S_{FR} (mph)	Volume, V_R (vph)	Lanes on Ramp, N	Length of 1st Acceleration Lane, LA1 (ft.)	Length of 2nd Acceleration Lane, LA2 (ft.)	Freeway PHF	Ramp PHF	Adjacent Ramp PHF	Type (Level, Rolling, Mountainous, Grade, Composite)	Percent Trucks and Buses on Freeway (%)	E_T (fwy)	Percent Recreational Vehicles on Freeway (%)	E_R (fwy)	Percent Trucks and Buses on Ramp (%)	E_T (ramp)	Percent Recreational Vehicles on Ramp (%)	E_R (ramp)	Percent Trucks and Buses on Adjacent Ramp (%)	E_T (adjacent ramp)	Percent Recreational Vehicles on Adjacent Ramp (%)	E_R (adjacent ramp)	Driver Population Adjustment f_P	f_{HV} (fwy)	f_{HV} (ramp)	f_{HV} (adjacent ramp)	L_{EQ}	P_{FM} (1-Lane On-Ramp)	P_{FM} (2-Lane On-Ramp)	V_{12} (1-Lane On-Ramp)	V_{12} (2-Lane On-Ramp)	V_{FO}	V_{R12} or V_{R23} or V_{R34}	V_5	V_{F4eff}	V_{23} or V_{34}	Max. Downstream Freeway Flow, v (pc/h)	Max Desirable Flow Entering Influence Area, V_{R12} (pc/h)	Capacity Check: V_{FO} > Max.	Capacity Check: V_{R12} > Max.	Compute D_R (pc/mi/h)	M_s	Compute S_R (mph)	LOS
AM Peak Hour																																																		
Ramp Metered	EDH to US 50 WB ON	WB	On	3	70	3,341	Right	35	1660	1	500		1	1	0	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2154	2021	5452	3964				7200	4600	No	No	32.4	0.5	56	D
	Silva Valley Pkwy to US 50 EB ON	EB	On	3	70	2,593	Right	35	1016	1	500		1	1	0	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971		0.592	0.555	1580	1482	3718	2627				7200	4600	No	No	22.3	0.3	60	C
	Silva Valley Pkwy to US 50 WB ON	WB	On	3	70	3,465	Right	35	833	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	4031.84	0.644	0.555	2299	1981	4427	3157				7200	4600	No	No	20.3	0.3	61	C
	Bass Lake to US 50 EB ON	EB	On	3	70	3,376	Right	35	142	1	500		1	1	0	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2177	2042	3835	2332				7200	4600	No	No	20.5	0.3	61	C
	Bass Lake to US 50 WB ON	WB	On	2	70	3,791	Right	35	545	2	500	1500	1	1	0	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	2%	1.5	0%	1.2	1	0.971	0.990	0.990		1.000	1.000	3905	3905	4455	4455				4800	4600	No	No	24.3	0.5	57	C
PM Peak Hour																																																		
Ramp Metered	EDH to US 50 WB ON	WB	On	3	70	3,217	Right	35	1403	1	500		1	1	1	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2074	1946	5036	3603				7200	4600	No	No	29.7	0.4	58	D
	Silva Valley Pkwy to US 50 EB ON	EB	On	3	70	4,587	Right	35	1469	1	500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971		0.592	0.555	2795	2622	6238	4308				7200	4600	No	No	35.2	0.6	54	E
	Silva Valley Pkwy to US 50 WB ON	WB	On	3	70	3,142	Right	35	628	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	1977.05	0.620	0.555	2005	1796	3883	2652				7200	4600	No	No	16.5	0.3	62	B
	Bass Lake to US 50 EB ON	EB	On	3	70	5,406	Right	35	147	1	500		1	1	1	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	3486	3271	6053	3646				7200	4600	No	No	30.7	0.4	58	D
	Bass Lake to US 50 WB ON	WB	On	2	70	4,174	Right	35	241	2	500	1500	1	1	1	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	2%	1.5	0%	1.2	1	0.971	0.990	0.990		1.000	1.000	4299	4299	4543	4543				4800	4600	No	No	25.1	0.5	56	C

Table 8. 2030 Plus Project Merge Analysis with Ramp Metering

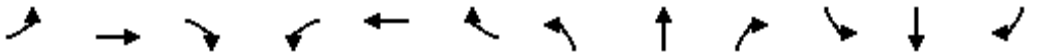
				Freeway-Ramp Components and Characteristics									Volume Adjustment																														Results of Merge Area							
				Freeway Data			On-Ramp Data						Volume Components			Terrain	Volume Composition																																	
ID	Interchange	Direction (NB or SB)	Ramp Type (On or Off)	Number of Lanes on Freeway (Each Direction), N	S_{FF} (mph)	Volume (vph)	Side of Ramp (Left or Right)	S_{FR} (mph)	Volume, V_R (vph)	Lanes on Ramp, N	Length of 1st Acceleration Lane, LA1 (ft.)	Length of 2nd Acceleration Lane, LA2 (ft.)	Freeway PHF	Ramp PHF	Adjacent Ramp PHF	Type (Level, Rolling, Mountainous, Grade, Composite)	Percent Trucks and Buses on Freeway (%)	E_T (fwy)	Percent Recreational Vehicles on Freeway (%)	E_R (fwy)	Percent Trucks and Buses on Ramp (%)	E_T (ramp)	Percent Recreational Vehicles on Ramp (%)	E_R (ramp)	Percent Trucks and Buses on Adjacent Ramp (%)	E_T (adjacent ramp)	Percent Recreational Vehicles on Adjacent Ramp (%)	E_R (adjacent ramp)	Driver Population Adjustment f_P	f_{HV} (fwy)	f_{HV} (ramp)	f_{HV} (adjacent ramp)	L_{EQ}	P_{FM} (1-Lane On-Ramp)	P_{FM} (2-Lane On-Ramp)	V_{12} (1-Lane On-Ramp)	V_{12} (2-Lane On-Ramp)	V_{FO}	V_{R12} or V_{R23} or V_{R34}	V_5	V_{F4eff}	V_{23} or V_{34}	Max. Downstream Freeway Flow, v (pc/h)	Max Desirable Flow Entering Influence Area, V_{R12} (pc/h)	Capacity Check: V_{FO} > Max.	Capacity Check: V_{R12} > Max.	Compute D_R (pc/mi/h)	M_s	Compute S_R (mph)	LOS
AM Peak Hour																																																		
Ramp Metered	EDH to US 50 WB ON	WB	On	3	70	4,600	Right	35	1541	1	500		1	1	0	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2966	2783	6694	4646				7200	4600	No	Yes	37.8	0.7	51	F
	Silva Valley Pkwy to US 50 EB ON	EB	On	3	70	3,320	Right	35	1427	1	500		1	1	0	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971		0.592	0.555	2023	1898	4890	3493				7200	4600	No	No	28.9	0.4	58	D
	Silva Valley Pkwy NB to US 50 WB ON	WB	On	2	70	4,377	Right	35	504	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	4031.84	1.000	1.000	4508	4508	5028	5028				4800	4600	Yes	Yes	35.0	0.8	47	F
	Silva Valley Pkwy SB to US 50 WB ON	WB	On	3	70	4,882	Right	35	672	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	4031.84	0.644	0.555	3239	2791	5720	3931				7200	4600	No	No	26.4	0.4	58	C
	Bass Lake to US 50 EB ON	EB	On	3	70	4,334	Right	35	183	1	500		1	1	0	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2794	2622	4923	2993				7200	4600	No	No	25.6	0.4	60	C
	Bass Lake to US 50 WB ON	WB	On	2	70	4,638	Right	35	929	2	500	1500	1	1	0	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.990	0.971		1.000	1.000	4777	4777	5715	5715				4800	4600	Yes	Yes	33.9	1.3	33	F
PM Peak Hour																																																		
Ramp Metered	EDH to US 50 WB ON	WB	On	3	70	4,651	Right	35	1346	1	500		1	1	1	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	2999	2814	6537	4466				7200	4600	No	No	36.5	0.6	52	E
	Silva Valley Pkwy to US 50 EB ON	EB	On	3	70	5,995	Right	35	1788	1	500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971		0.592	0.555	3653	3427	8017	5495				7200	4600	Yes	Yes	44.4	1.2	35	F
	Silva Valley Pkwy NB to US 50 WB ON	WB	On	2	70	4,218	Right	35	533	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	1977.05	1.000	1.000	4345	4345	4894	4894				4800	4600	Yes	Yes	34.0	0.7	49	F
	Silva Valley Pkwy SB to US 50 WB ON	WB	On	3	70	4,748	Right	35	342	1	1500		1	1	1	Level	6%	1.5	0%	1.2	6%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.971	0.971	1977.05	0.620	0.555	3029	2714	5243	3382				7200	4600	No	No	22.3	0.3	61	C
	Bass Lake to US 50 EB ON	EB	On	3	70	6,966	Right	35	174	1	500		1	1	1	Rolling	6%	2.5	0%	2	6%	2.5	0%	2	6%	2.5	0%	2	1	0.917	0.917	0.917		0.592	0.555	4491	4214	7783	4681				7200	4600	Yes	Yes	38.8	0.7	50	F
	Bass Lake to US 50 WB ON	WB	On	2	70	5,211	Right	35	429	2	500	1500	1	1	1	Level	6%	1.5	0%	1.2	2%	1.5	0%	1.2	6%	1.5	0%	1.2	1	0.971	0.990	0.971		1.000	1.000	5367	5367	5800	5800				4800	4600	Yes	Yes	34.8	1.4	30	F

ATTACHMENT

Synchro Worksheets for White Rock Road/Latrobe Road – Mitigation Options

117: White Rock Rd & Latrobe Rd

AM Peak

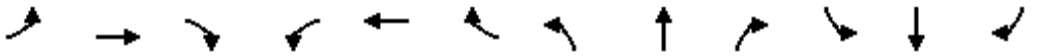


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	576	94	791	560	510	332	1131	550	162	1940	661
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	380	626	102	860	609	554	361	1229	598	176	2109	718
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	6
Lane Group Flow (vph)	380	626	102	860	609	554	361	1229	598	176	2109	712
Turn Type	Prot		Perm	Prot		pm+ov	Prot		Free	Prot		pm+ov
Protected Phases	7	4		3	8	1	5	2		1	6	7
Permitted Phases			4			8			Free			6
Actuated Green, G (s)	22.0	19.0	19.0	27.0	24.0	46.6	11.0	35.4	120.0	22.6	47.0	69.0
Effective Green, g (s)	22.0	19.0	19.0	27.0	24.0	46.6	11.0	35.4	120.0	22.6	47.0	69.0
Actuated g/C Ratio	0.18	0.16	0.16	0.22	0.20	0.39	0.09	0.29	1.00	0.19	0.39	0.58
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	629	560	251	772	708	615	315	1890	1583	647	1992	963
v/s Ratio Prot	0.11	c0.18		c0.25	0.17	c0.17	c0.11	0.19		0.05	c0.41	0.14
v/s Ratio Perm			0.06			0.18			0.38			0.31
v/c Ratio	0.60	1.12	0.41	1.11	0.86	0.90	1.15	0.65	0.38	0.27	1.06	0.74
Uniform Delay, d1	45.0	50.5	45.4	46.5	46.4	34.5	54.5	36.9	0.0	41.7	36.5	18.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.6	74.7	1.1	68.4	10.4	16.3	96.3	1.8	0.7	0.2	37.8	3.0
Delay (s)	46.6	125.2	46.5	114.9	56.8	50.9	150.8	38.7	0.7	41.9	74.3	21.8
Level of Service	D	F	D	F	E	D	F	D	A	D	E	C
Approach Delay (s)		91.0			79.9			46.8			59.9	
Approach LOS		F			E			D			E	

Intersection Summary			
HCM Average Control Delay	65.4	HCM Level of Service	E
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	98.8%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

117: White Rock Rd & Latrobe Rd

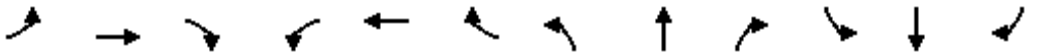
AM Peak



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	350	576	94	791	560	510	332	1131	550	162	1940	661
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	380	626	102	860	609	554	361	1229	598	176	2109	718
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	103	0	0	8
Lane Group Flow (vph)	380	626	102	860	609	554	361	1229	495	176	2109	710
Turn Type	Prot		Perm	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	7	4		3	8	1	5	2	3	1	6	7
Permitted Phases			4			8			2			6
Actuated Green, G (s)	20.7	16.0	16.0	31.0	26.3	49.6	13.0	43.7	74.7	23.3	54.0	74.7
Effective Green, g (s)	20.7	16.0	16.0	31.0	26.3	49.6	13.0	43.7	74.7	23.3	54.0	74.7
Actuated g/C Ratio	0.16	0.12	0.12	0.24	0.20	0.38	0.10	0.34	0.57	0.18	0.42	0.57
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	547	626	195	819	716	604	343	2154	910	615	2112	958
v/s Ratio Prot	0.11	0.12		c0.25	0.17	c0.16	c0.11	0.19	0.13	0.05	c0.41	0.12
v/s Ratio Perm			0.06			0.19			0.18			0.33
v/c Ratio	0.69	1.00	0.52	1.05	0.85	0.92	1.05	0.57	0.54	0.29	1.00	0.74
Uniform Delay, d1	51.7	57.0	53.4	49.5	50.0	38.2	58.5	35.4	17.1	46.2	38.0	20.5
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.8	36.0	2.5	45.4	9.5	18.8	63.0	1.1	0.7	0.3	19.3	3.1
Delay (s)	55.5	93.0	55.9	94.9	59.5	57.0	121.5	36.5	17.8	46.4	57.2	23.6
Level of Service	E	F	E	F	E	E	F	D	B	D	E	C
Approach Delay (s)		76.7			73.9			45.4			48.5	
Approach LOS		E			E			D			D	

Intersection Summary			
HCM Average Control Delay	57.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	94.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

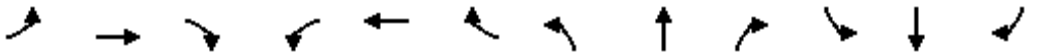
117: White Rock Rd & Latrobe Rd



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	410	768	127	798	485	401	451	1585	842	508	1614	385
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	446	835	138	867	527	436	490	1723	915	552	1754	418
RTOR Reduction (vph)	0	0	89	0	0	10	0	0	0	0	0	20
Lane Group Flow (vph)	446	835	49	867	527	426	490	1723	915	552	1754	398
Turn Type	Prot		Perm	Prot		pm+ov	Prot		Free	Prot		pm+ov
Protected Phases	7	4		3	8	1	5	2		1	6	7
Permitted Phases			4			8			Free			6
Actuated Green, G (s)	23.2	29.0	29.0	31.0	36.8	59.8	18.0	41.0	140.0	23.0	46.0	69.2
Effective Green, g (s)	23.2	29.0	29.0	31.0	36.8	59.8	18.0	41.0	140.0	23.0	46.0	69.2
Actuated g/C Ratio	0.17	0.21	0.21	0.22	0.26	0.43	0.13	0.29	1.00	0.16	0.33	0.49
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	569	733	328	760	930	676	441	1877	1583	564	1671	782
v/s Ratio Prot	0.13	c0.24		c0.25	0.15	0.10	0.14	0.27		c0.16	c0.34	0.08
v/s Ratio Perm			0.03			0.17			0.58			0.17
v/c Ratio	0.78	1.14	0.15	1.14	0.57	0.63	1.11	0.92	0.58	0.98	1.05	0.51
Uniform Delay, d1	56.0	55.5	45.4	54.5	44.7	31.4	61.0	47.9	0.0	58.3	47.0	23.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	7.0	78.6	0.2	78.8	0.8	1.9	76.6	8.7	1.5	32.1	36.3	0.5
Delay (s)	63.0	134.1	45.6	133.3	45.5	33.4	137.6	56.6	1.5	90.4	83.3	24.4
Level of Service	E	F	D	F	D	C	F	E	A	F	F	C
Approach Delay (s)		103.2			84.2			53.2			75.7	
Approach LOS		F			F			D			E	

Intersection Summary			
HCM Average Control Delay	74.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	101.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

117: White Rock Rd & Latrobe Rd

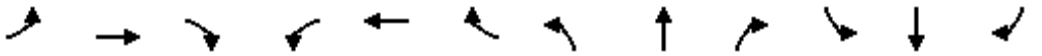


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	410	768	127	798	485	401	451	1585	842	508	1614	385
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.95	1.00	0.97	0.86	1.00	0.97	0.91	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	3539	1583	3433	6408	1583	3433	5085	1583
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	446	835	138	867	527	436	490	1723	915	552	1754	418
RTOR Reduction (vph)	0	0	118	0	0	4	0	0	2	0	0	16
Lane Group Flow (vph)	446	835	20	867	527	432	490	1723	913	552	1754	402
Turn Type	Prot		Perm	Prot		pm+ov	Prot		pm+ov	Prot		pm+ov
Protected Phases	7	4		3	8	1	5	2	3	1	6	7
Permitted Phases			4			8			2			6
Actuated Green, G (s)	16.6	16.0	16.0	26.0	25.4	43.4	14.0	34.0	60.0	18.0	38.0	54.6
Effective Green, g (s)	16.6	16.0	16.0	26.0	25.4	43.4	14.0	34.0	60.0	18.0	38.0	54.6
Actuated g/C Ratio	0.15	0.15	0.15	0.24	0.23	0.39	0.13	0.31	0.55	0.16	0.35	0.50
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	518	740	230	811	817	625	437	1981	863	562	1757	786
v/s Ratio Prot	0.13	c0.16		c0.25	0.15	0.11	0.14	0.27	c0.25	c0.16	0.34	0.08
v/s Ratio Perm			0.01			0.16			0.33			0.18
v/c Ratio	0.86	1.13	0.09	1.07	0.65	0.69	1.12	0.87	1.06	0.98	1.00	0.51
Uniform Delay, d1	45.6	47.0	40.7	42.0	38.2	27.7	48.0	35.9	25.0	45.8	36.0	18.7
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	13.7	74.4	0.2	51.7	1.8	3.3	80.4	5.5	47.0	33.2	21.1	0.6
Delay (s)	59.3	121.4	40.8	93.7	40.0	31.0	128.4	41.5	72.0	79.1	57.0	19.3
Level of Service	E	F	D	F	D	C	F	D	E	E	E	B
Approach Delay (s)		94.0			63.3			64.0			55.7	
Approach LOS		F			E			E			E	

Intersection Summary			
HCM Average Control Delay	66.1	HCM Level of Service	E
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	95.0%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

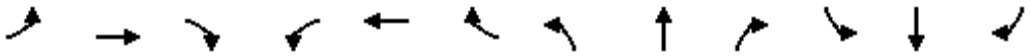
ATTACHMENT

Synchro Worksheets for White Rock Road/Jorger Cut-Off Road – Signalized Alternative



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	2	0	2	0	0	0	2	2785	0	0	1957	2
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0				4.0	4.0			4.0	
Lane Util. Factor		1.00	1.00				1.00	0.91			0.91	
Frt		1.00	0.85				1.00	1.00			1.00	
Flt Protected		0.95	1.00				0.95	1.00			1.00	
Satd. Flow (prot)		1770	1583				1770	5085			5085	
Flt Permitted		0.95	1.00				0.95	1.00			1.00	
Satd. Flow (perm)		1770	1583				1770	5085			5085	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	2	0	2	0	0	0	2	3027	0	0	2127	2
RTOR Reduction (vph)	0	0	2	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	2	0	0	0	0	2	3027	0	0	2129	0
Turn Type	Perm		Perm	Split		Perm	Prot			Prot		
Protected Phases		4		8	8		5	2		1	6	
Permitted Phases	4		4			8						
Actuated Green, G (s)		1.5	1.5				0.7	86.6			81.9	
Effective Green, g (s)		1.5	1.5				0.7	86.6			81.9	
Actuated g/C Ratio		0.02	0.02				0.01	0.90			0.85	
Clearance Time (s)		4.0	4.0				4.0	4.0			4.0	
Vehicle Extension (s)		3.0	3.0				3.0	3.0			3.0	
Lane Grp Cap (vph)		28	25				13	4582			4334	
v/s Ratio Prot							0.00	c0.60			0.42	
v/s Ratio Perm		0.00	0.00									
v/c Ratio		0.07	0.00				0.15	0.66			0.49	
Uniform Delay, d1		46.6	46.6				47.4	1.2			1.8	
Progression Factor		1.00	1.00				1.00	1.00			1.00	
Incremental Delay, d2		1.1	0.0				5.5	0.4			0.1	
Delay (s)		47.7	46.6				52.9	1.5			1.9	
Level of Service		D	D				D	A			A	
Approach Delay (s)		47.1			0.0			1.6			1.9	
Approach LOS		D			A			A			A	

Intersection Summary			
HCM Average Control Delay	1.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	96.1	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	2	0	2	2	0	2	8	1933	0	0	1883	4
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0	4.0		4.0	4.0	4.0	4.0			4.0	
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.91			0.91	
Frt		1.00	0.85		1.00	0.85	1.00	1.00			1.00	
Flt Protected		0.95	1.00		0.95	1.00	0.95	1.00			1.00	
Satd. Flow (prot)		1770	1583		1770	1583	1770	5085			5084	
Flt Permitted		0.95	1.00		0.95	1.00	0.95	1.00			1.00	
Satd. Flow (perm)		1770	1583		1770	1583	1770	5085			5084	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	2	0	2	2	0	2	9	2101	0	0	2047	4
RTOR Reduction (vph)	0	0	2	0	0	2	0	0	0	0	0	0
Lane Group Flow (vph)	0	2	0	0	2	0	9	2101	0	0	2051	0
Turn Type	Split		Perm	Split		Perm	Prot			Prot		
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases			4			8						
Actuated Green, G (s)		0.9	0.9		0.9	0.9	0.6	56.1			51.5	
Effective Green, g (s)		0.9	0.9		0.9	0.9	0.6	56.1			51.5	
Actuated g/C Ratio		0.01	0.01		0.01	0.01	0.01	0.80			0.74	
Clearance Time (s)		4.0	4.0		4.0	4.0	4.0	4.0			4.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0			3.0	
Lane Grp Cap (vph)		23	20		23	20	15	4081			3746	
v/s Ratio Prot		c0.00			c0.00		0.01	c0.41			c0.40	
v/s Ratio Perm			0.00			0.00						
v/c Ratio		0.09	0.00		0.09	0.00	0.60	0.51			0.55	
Uniform Delay, d1		34.1	34.1		34.1	34.1	34.5	2.3			4.1	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00			1.00	
Incremental Delay, d2		1.6	0.0		1.6	0.0	51.0	0.1			0.2	
Delay (s)		35.7	34.1		35.7	34.1	85.6	2.4			4.2	
Level of Service		D	C		D	C	F	A			A	
Approach Delay (s)		34.9			34.9			2.8			4.2	
Approach LOS		C			C			A			A	

Intersection Summary			
HCM Average Control Delay	3.6	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	69.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	54.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			