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MEMORANDUM

Date: September 14, 2010

To: Shabnam Barati, Impact Sciences

From: Ryan McClain

Subject: ***LBNL CRT Traffic Analysis Update***

WC10-2705.00

This memorandum summarizes the results of our traffic operations analysis for the proposed Computational Research and Theory (CRT) Facility project at Lawrence Berkeley National Laboratory (LBNL). This updates analysis previously completed for the CRT EIR in 2007 based on a revised project description for this and other LBNL projects.

Analysis for the EIR was performed using the Traffix software; however, all analysis contained in this memorandum was completed using the Synchro software, thus results may differ. Synchro was used because it better captures the effects of pedestrians and specific phasing at signalized intersections.

EXISTING CONDITIONS

Location and existing lane configurations for the four study intersections are shown on **Figure 1**. Existing traffic volumes used in this analysis are based on AM and PM peak period (7:00 to 9:00 AM and 4:00 to 6:00 PM) intersection turning movement volumes collected in 2002 and used in the UC Berkeley 2020 Long Range Development Plan (LRDP) EIR and LBNL 2006 LRDP EIR. More recent count data at the various study intersections was collected in 2006, 2007 and 2008; however, the 2002 data were used because the 2002 traffic volumes are generally higher than the more recent volumes and thus would result in a more conservative analysis. Existing traffic volumes are shown on **Figure 2**. Existing intersection delay and level of service (LOS) are presented in **Table 1**.

Table 1
Existing Conditions – Study Intersection LOS Summary

Intersection	Control	AM Peak Hour		PM Peak Hour	
		Delay (Seconds)[1]	LOS [1]	Delay (Seconds) [1]	LOS [1]
Hearst Avenue/Gayley Road/La Loma Avenue	Signalized	26	C	49	D
Stadium Rim Way/ Gayley Road	All-Way Stop-Controlled	30	D	**41**	**E**
Bancroft Way/ Piedmont Avenue [2]	All-Way Stop-Controlled	**>60 (v/c = 0.95)**	**F**	**>60 (v/c = 0.84)**	**F**
Durant Avenue/ Piedmont Avenue	All-Way Stop-Controlled	19	C	19	C

Source: Fehr & Peers, August 2010.

[1] *Signalized and all-way stop-controlled intersection delay and LOS based on average control delay per vehicle, according to the Highway Capacity Manual, Special Report 209, Transportation Research Board, 2000. For intersections operating at LOS F, the volume-to-capacity ratio (v/c) is also reported.*

[2] *Based on the 2000 HCM methodology, the intersection currently operates at LOS D during the AM peak hour and LOS C during the PM peak hour. Based on field observations and measurements, the intersection currently operates at LOS F during both AM and PM peak hours due to the high number of pedestrian crossings, which the 2000 HCM methodology does not account for.*

Bold *indicated an intersection operating at unacceptable LOS E or LOS F.*

TRIP GENERATION

Vehicle trip generation for the CRT project was based on trip generation rates established in the LRDP EIR. As documented in the 2006 LRDP EIR, the current 4,000 employees at the LBNL main hill site generate 5,700 daily trips, 610 AM peak hour trips, and 660 PM peak hour trips. The CRT facility is expected to increase the daily population of the LBNL main hill site by 135 employees. Using these rates results in 192 new daily trips, 21 new AM peak hour trips, and 22 new PM peak hour trips. These rates were also applied to the Solar Energy Research Center (SERC) project and Seismic Phase 2 project, also planned for construction at LBNL. Resulting daily and peak hour trip generation is presented in **Table 2**.

While using these trip generation rates for new employees is consistent with the LRDP, this represents a conservative estimate of new trips. Parking at LBNL is at capacity and these projects only provide additional disabled parking; therefore, it would be reasonable to assume that few additional vehicles would be accommodated at LBNL until additional parking is constructed. To present a conservative analysis, vehicle trip generation based on increase in population is used.

Table 2
Project Vehicle Trip Generation

Project	Increase in Daily LBNL Population	Trip Generation		
		Daily	AM Peak Hour	PM Peak Hour
Trip Generation Rate[1]		1.42	0.15	0.17
CRT	135	192	21	22
SERC	52	74	8	9
NZEB	10	14	2	2
BELLA	10	14	2	2
Guest House	10	14	2	2

Source: Fehr & Peers, 2010.

[1] *As documented in the LBNL 2006 LRDP EIR and stated on page 4.11-4, the current 4,000 employees at the LBNL main hill campus generate 5,700 daily trips, 610 AM peak hour trips, and 660 PM peak hour trips. This corresponds to trip generation rate of 1.42 daily trips, 0.15 AM peak hour, and 0.17 PM peak hour trips per employee. The values shown were quantified as follows (5,700/4,000 =1.42), (610/4,000=0.15), (660/4,000=0.17).*

SIGNIFICANCE CRITERIA

Based on City of Berkeley significance criteria, a project is considered to cause a significant impact at signalized and all-way stop intersections if it causes the following:

- Intersection operations degrade from LOS D to LOS E or worse *and* more than a 2-second increase in delay; or
- More than a 3-second increase in delay at intersections operating at LOS E without and with the project; or
- Intersection operations degrade from LOS E to LOS F *and* more than a 3-second increase in delay; or
- At intersections operating at LOS F without the project, a change in the volume-to-capacity ratio of more than 0.01;

NEAR-TERM CONDITIONS

The proposed project would be constructed and operational by 2013. Therefore the effects of the project's operational traffic were evaluated at the four study intersections under 2013 conditions with and without the project. Major projects completed after collection of existing condition data, currently under construction, or expected to be completed in the next few years would add to the traffic in the study area. The near-term projects included in this analysis are described below:

- ***Underhill Parking Structure***, recently completed by UC Berkeley, provides 690 net new parking spaces in the Southside area.
- ***Lower Hearst Parking Structure***, recently completed by UC Berkeley, provides 100 net new parking spaces in the Northside area.
- ***Southeast Campus Integrated Projects (SCIP)*** would consolidate existing parking spaces and provide 300 additional parking spaces in the southeast area of UC Berkeley campus. About 546 parking spaces would be provided at the Maxwell Family Field Parking Structure located at Stadium Rim Way, just east of Gayley Road.
- ***Solar Energy Research Center (SERC) Project***, located near the center of the LBNL site, would increase LBNL population by 57 persons.
- ***Net Zero Energy Building (NZEB)*** would increase the LBNL site population by no more than 10 persons.
- ***Guest House,*** located near the center of the LBNL site, would increase LBNL population by no more than 10 persons.
- ***Berkeley Lab Laser Accelerator (BELLA)***, located on the north side of the LBNL site, would increase LBNL population by no more than 10 persons.

Other planned LBNL projects such as Seismic Phase 1, Seismic Phase 2, User Support Building, and Old Town demolition would not result in an increase in the daily population at LBNL. Thus, they are not expected to add additional traffic to the roadway network. New trips generated by other UC Berkeley projects such as the NEQSS, Law School Infill, Naval Architecture Restoration and Blum Center, and Warren Hall replacement are included in the trips associated with the parking structure projects.

Estimated traffic generated by the near-term projects was added to the existing conditions volumes to estimate intersection volumes under Near-Term No Project and is shown on **Figure 3**. Project trips generated by the CRT project were added to the Near-Term No Project traffic volumes to estimate Near-Term With Project volumes and are shown on **Figure 4**. Delay and LOS results for AM and PM peak hours under the Near-Term No Project and With Project conditions are presented in **Table 3**. As shown in the table, the CRT project would not cause a significant impact at the study intersections.

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Table 3
Near-Term Conditions – Study Intersection LOS Summary

Intersection	Control	Peak Hour	Near-Term No Project		Near-Term With Project	
			Delay (Seconds)[1]	LOS [1]	Delay (Seconds) [1]	LOS [1]
Hearst Avenue/Gayley Road/La Loma Avenue	Signalized	AM	33	C	35	D
		PM	**57**	**E**	**57**	**E**
Stadium Rim Way/ Gayley Road	All-Way Stop-Controlled	AM	**49**	**E**	**50**	**E**
		PM	**>60 (v/c = 1.15)**	**F**	**>60 (v/c = 1.16)**	**F**
Bancroft Way/ Piedmont Avenue [2]	All-Way Stop-Controlled	AM	**>60 (v/c = 1.01)**	**F**	**>60 (v/c = 1.02)**	**F**
		PM	**>60 (v/c = 0.88)**	**F**	**>60 (v/c = 0.88)**	**F**
Durant Avenue/ Piedmont Avenue	All-Way Stop-Controlled	AM	21	C	22	C
		PM	22	C	22	C

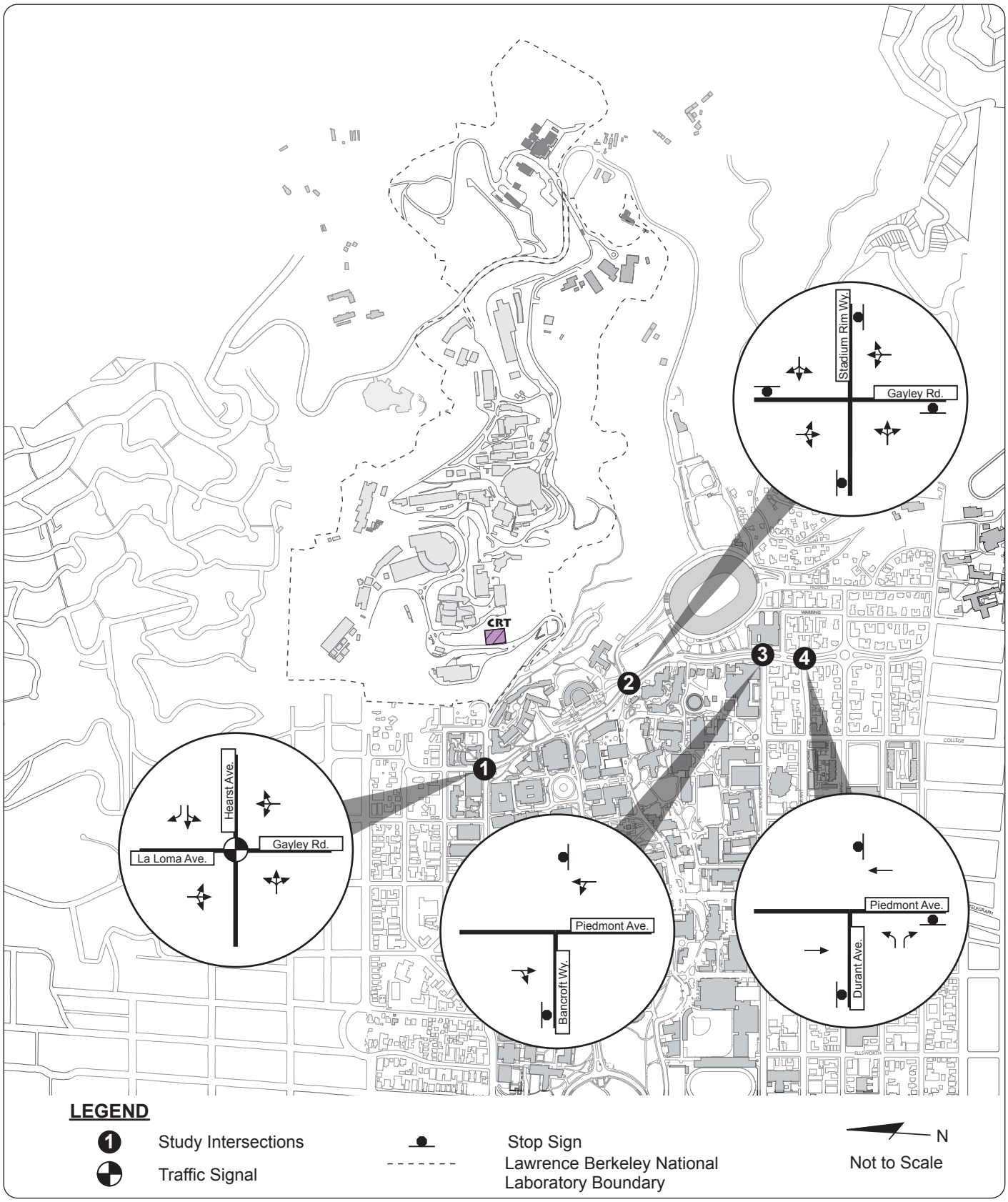
Source: Fehr & Peers, August 2010.

[1] *Signalized and all-way stop-controlled intersection delay and LOS based on average control delay per vehicle for the intersection according to the Highway Capacity Manual, Special Report 209, Transportation Research Board, 2000. For intersections operating at LOS F, the volume-to-capacity ratio (v/c) is also reported.*

[2] *Based on the 2000 HCM methodology, the intersection would operate at LOS F during the AM peak hour and LOS D during the PM peak hour under Near-Term No Project and Near-Term With Project conditions. Based on field observations and measurements, the intersection currently operates at LOS F during both AM and PM peak hours due to the high number of pedestrian crossings, which the 2000 HCM methodology does not account for. Thus, the intersection would continue to operate at LOS F during both AM and PM peak hours under Near-Term No Project and Near-Term With Project conditions.*

Bold *indicates an intersection operating at unacceptable LOS E or LOS F.*

Please contact us with any questions.



LBNL CRT EA

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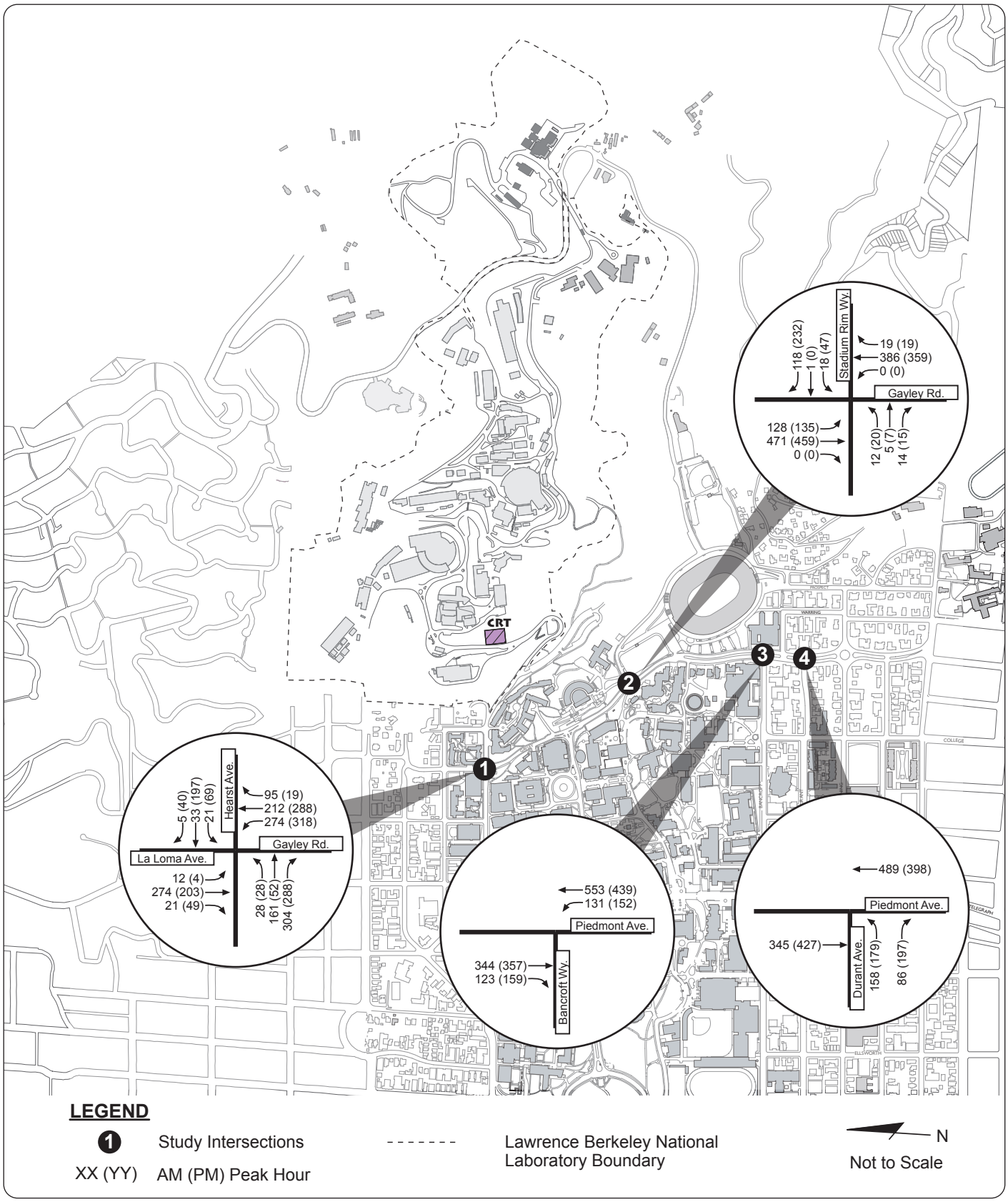
WC10-2705_1_StudyInt

STUDY INTERSECTION LOCATIONS, LANE CONFIGURATIONS AND TRAFFIC CONTROL

FIGURE 1



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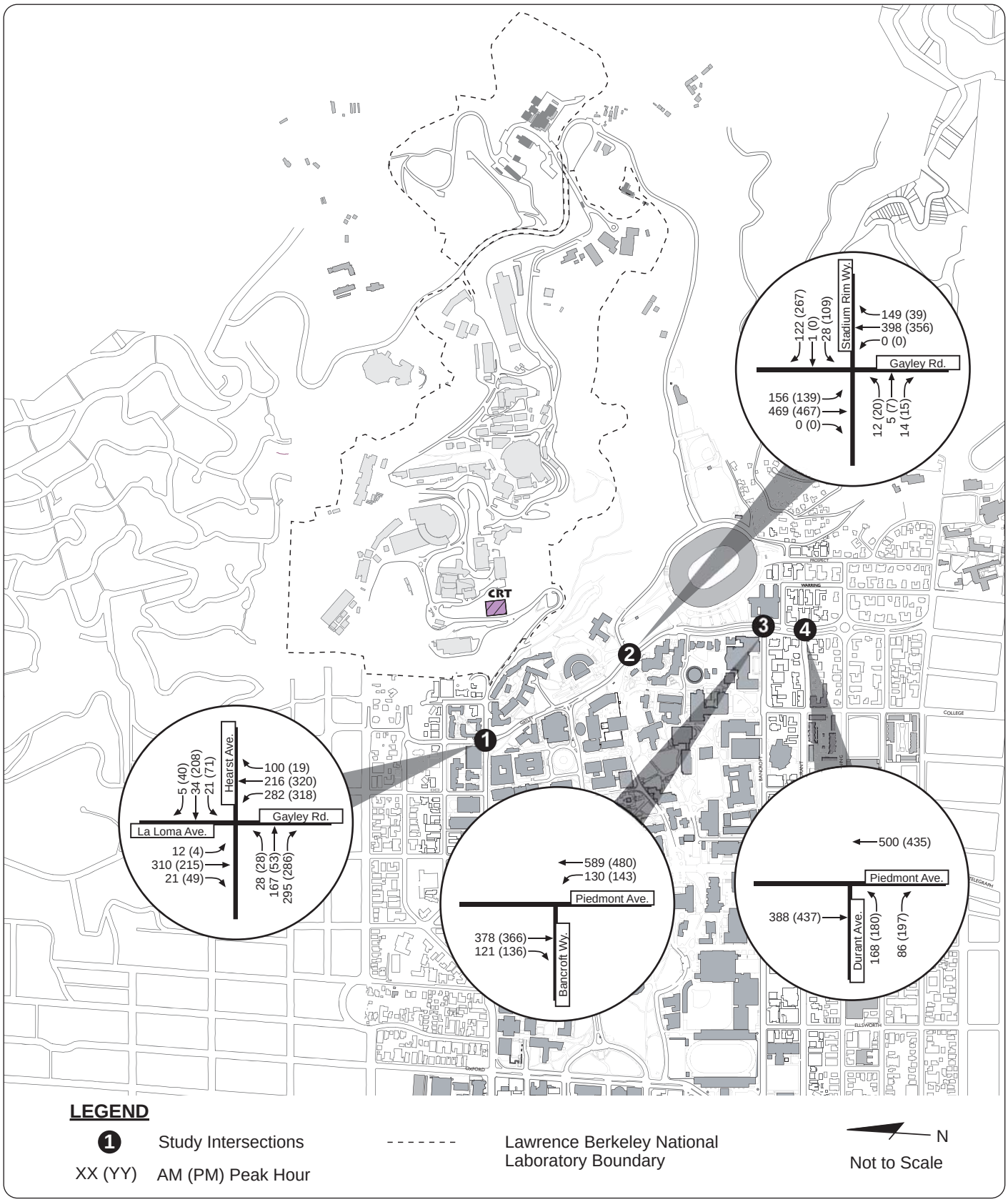
WC10-2705_2_ExVol

EXISTING PEAK HOUR TRAFFIC VOLUMES

FIGURE 2



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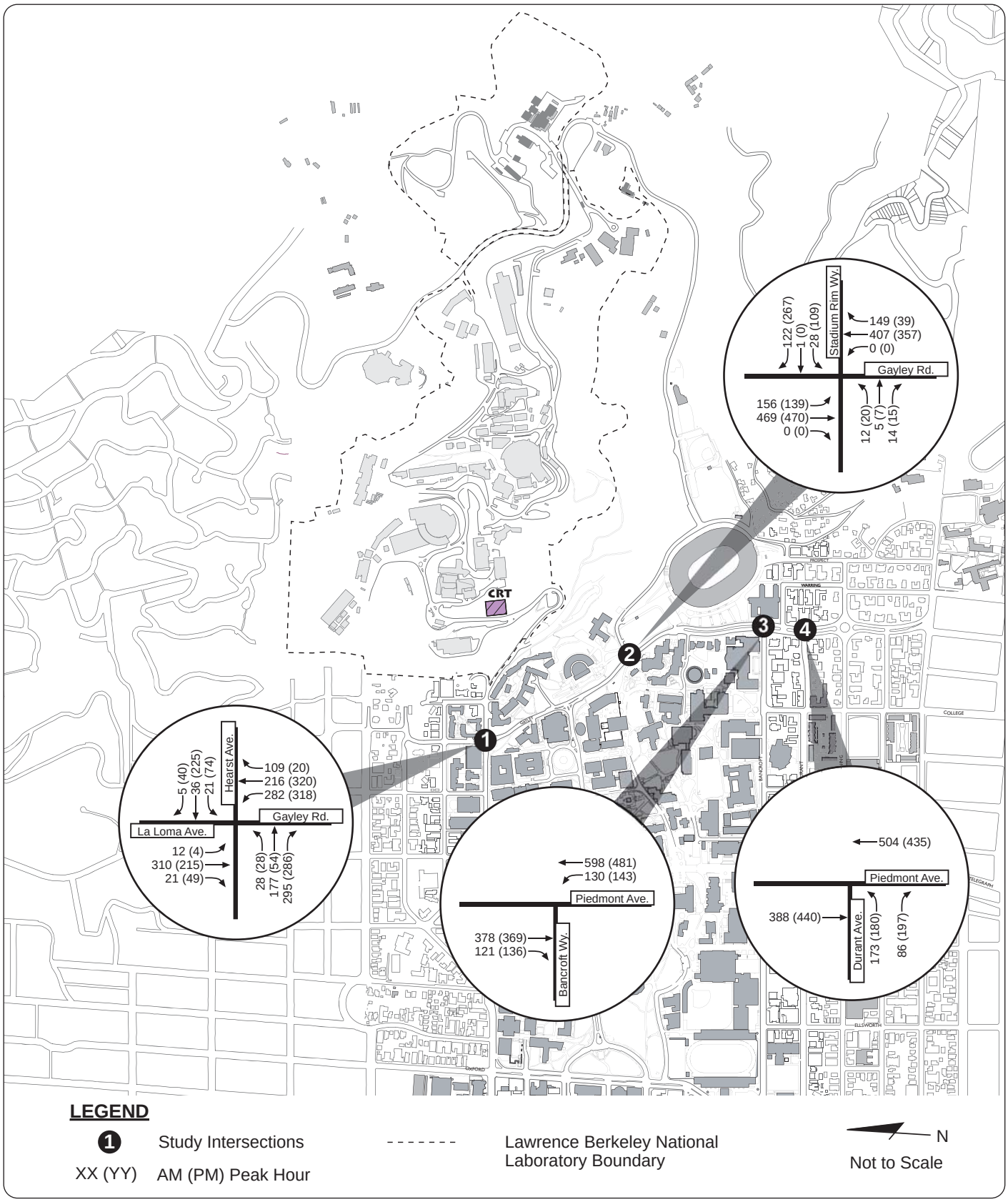
NEAR-TERM NO PROJECT CONDITIONS PEAK HOUR TRAFFIC VOLUMES

FIGURE 3



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NEAR-TERM WITH PROJECT CONDITIONS PEAK HOUR TRAFFIC VOLUMES

FIGURE 4

Synchro Analysis Worksheets

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Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
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	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.96		1.00	0.86		0.97			0.99	
Flpb, ped/bikes		0.98	1.00		0.99	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.98			0.99	
Flt Protected		0.99	1.00		0.98	1.00		0.98			1.00	
Satd. Flow (prot)		1819	1520		1817	1363		1693			1825	
Flt Permitted		0.96	1.00		0.87	1.00		0.68			0.98	
Satd. Flow (perm)		1758	1520		1618	1363		1184			1784	
Volume (vph)	28	161	304	21	33	5	274	212	95	12	274	21
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)	30	175	330	23	36	5	298	230	103	13	298	23
RTOR Reduction (vph)	0	0	218	0	0	3	0	11	0	0	4	0
Lane Group Flow (vph)	0	205	112	0	59	2	0	620	0	0	330	0
Confl. Peds. (#/hr)	60		10	10		60	45		70	70		45
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		595	514		548	461		638			961	
v/s Ratio Prot												
v/s Ratio Perm		c0.12	0.07		0.04	0.00		c0.52			0.18	
v/c Ratio		0.34	0.22		0.11	0.00		0.97			0.34	
Uniform Delay, d1		16.1	15.4		14.8	14.2		14.5			8.5	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		1.6	1.0		0.4	0.0		29.5			1.0	
Delay (s)		17.7	16.3		15.2	14.3		44.0			9.5	
Level of Service		B	B		B	B		D			A	
Approach Delay (s)		16.8			15.1			44.0			9.5	
Approach LOS		B			B			D			A	

Intersection Summary			
HCM Average Control Delay	26.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	12	5	14	18	1	118	0	386	19	128	471	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	13	5	15	19	1	127	0	415	20	138	506	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	33	147	435	644
Volume Left (vph)	13	19	0	138
Volume Right (vph)	15	127	20	0
Hadj (s)	-0.16	-0.46	0.01	0.08
Departure Headway (s)	6.9	6.2	5.4	5.2
Degree Utilization, x	0.06	0.25	0.66	0.93
Capacity (veh/h)	465	540	651	644
Control Delay (s)	10.4	11.3	18.1	42.3
Approach Delay (s)	10.4	11.3	18.1	42.3
Approach LOS	B	B	C	E

Intersection Summary			
Delay	29.5		
HCM Level of Service	D		
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	0	0	131	553	344	123
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	144	608	378	135

Direction, Lane #	NB 1	SB 1	SB 2
Volume Total (vph)	752	378	135
Volume Left (vph)	144	0	0
Volume Right (vph)	0	0	135
Hadj (s)	0.07	0.03	-0.67
Departure Headway (s)	4.6	5.0	4.3
Degree Utilization, x	0.95	0.53	0.16
Capacity (veh/h)	781	711	821
Control Delay (s)	41.8	12.3	7.0
Approach Delay (s)	41.8	10.9	
Approach LOS	E	B	

Intersection Summary			
Delay	29.3		
HCM Level of Service	D		
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	158	86	0	489	345	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	168	91	0	520	367	0

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total (vph)	168	91	520	367
Volume Left (vph)	168	0	0	0
Volume Right (vph)	0	91	0	0
Hadj (s)	0.53	-0.67	0.03	0.03
Departure Headway (s)	7.3	6.1	5.4	5.6
Degree Utilization, x	0.34	0.16	0.78	0.57
Capacity (veh/h)	455	538	656	624
Control Delay (s)	12.9	9.0	24.4	15.7
Approach Delay (s)	11.6		24.4	15.7
Approach LOS	B		C	C

Intersection Summary			
Delay	18.7		
HCM Level of Service	C		
Intersection Capacity Utilization	41.2%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
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	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.89		1.00	0.78		0.99			0.93	
Flpb, ped/bikes		0.96	1.00		0.98	1.00		0.89			1.00	
Frt		1.00	0.85		1.00	0.85		1.00			0.97	
Flt Protected		0.98	1.00		0.99	1.00		0.98			1.00	
Satd. Flow (prot)		1754	1416		1802	1229		1596			1678	
Flt Permitted		0.85	1.00		0.90	1.00		0.69			0.99	
Satd. Flow (perm)		1520	1416		1647	1229		1136			1668	
Volume (vph)	28	52	288	69	197	40	318	288	19	4	203	49
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	31	57	316	76	216	44	349	316	21	4	223	54
RTOR Reduction (vph)	0	0	174	0	0	20	0	1	0	0	12	0
Lane Group Flow (vph)	0	88	142	0	292	24	0	685	0	0	269	0
Confl. Peds. (#/hr)	95		40	40		95	170		95	95		170
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		543	506		588	439		600			882	
v/s Ratio Prot												
v/s Ratio Perm		0.06	0.10		c0.18	0.02		c0.60			0.16	
v/c Ratio		0.16	0.28		0.50	0.05		1.14			0.30	
Uniform Delay, d1		15.4	16.1		17.6	14.8		16.5			9.3	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.6	1.4		3.0	0.2		82.2			0.9	
Delay (s)		16.0	17.5		20.6	15.0		98.7			10.2	
Level of Service		B	B		C	B		F			B	
Approach Delay (s)		17.1			19.8			98.7			10.2	
Approach LOS		B			B			F			B	

Intersection Summary			
HCM Average Control Delay	49.3	HCM Level of Service	D
HCM Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	86.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	7	15	47	0	232	0	359	19	135	459	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	7	16	49	0	244	0	378	20	142	483	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	44	294	398	625
Volume Left (vph)	21	49	0	142
Volume Right (vph)	16	244	20	0
Hadj (s)	-0.09	-0.43	0.00	0.08
Departure Headway (s)	7.6	6.4	6.1	5.9
Degree Utilization, x	0.09	0.52	0.68	1.03
Capacity (veh/h)	406	542	571	603
Control Delay (s)	11.4	16.0	20.9	67.5
Approach Delay (s)	11.4	16.0	20.9	67.5
Approach LOS	B	C	C	F

Intersection Summary			
Delay	41.0		
HCM Level of Service	E		
Intersection Capacity Utilization	79.2%	ICU Level of Service	D
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	0	0	152	439	357	159
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	0	0	169	488	397	177

Direction, Lane #	NB 1	SB 1	SB 2
Volume Total (vph)	657	397	177
Volume Left (vph)	169	0	0
Volume Right (vph)	0	0	177
Hadj (s)	0.09	0.03	-0.67
Departure Headway (s)	4.6	5.0	4.3
Degree Utilization, x	0.84	0.55	0.21
Capacity (veh/h)	775	715	828
Control Delay (s)	26.5	12.6	7.2
Approach Delay (s)	26.5	11.0	
Approach LOS	D	B	

Intersection Summary			
Delay	19.2		
HCM Level of Service	C		
Intersection Capacity Utilization	57.0%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	179	197	0	398	427	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	188	207	0	419	449	0

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total (vph)	188	207	419	449
Volume Left (vph)	188	0	0	0
Volume Right (vph)	0	207	0	0
Hadj (s)	0.53	-0.67	0.03	0.03
Departure Headway (s)	7.4	6.2	5.9	5.8
Degree Utilization, x	0.39	0.36	0.69	0.73
Capacity (veh/h)	458	543	590	592
Control Delay (s)	13.9	11.4	20.8	23.0
Approach Delay (s)	12.6		20.8	23.0
Approach LOS	B		C	C

Intersection Summary			
Delay	19.0		
HCM Level of Service	C		
Intersection Capacity Utilization	41.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
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	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.96		1.00	0.86		0.97			0.99	
Flpb, ped/bikes		0.98	1.00		0.99	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.98			0.99	
Flt Protected		0.99	1.00		0.98	1.00		0.98			1.00	
Satd. Flow (prot)		1820	1520		1818	1363		1694			1829	
Flt Permitted		0.96	1.00		0.87	1.00		0.66			0.98	
Satd. Flow (perm)		1761	1520		1618	1363		1142			1790	
Volume (vph)	28	167	295	21	34	5	282	216	100	12	310	21
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)	30	182	321	23	37	5	307	235	109	13	337	23
RTOR Reduction (vph)	0	0	212	0	0	3	0	11	0	0	4	0
Lane Group Flow (vph)	0	212	109	0	60	2	0	640	0	0	369	0
Confl. Peds. (#/hr)	60		10	10		60	45		70	70		45
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		596	514		548	461		615			964	
v/s Ratio Prot												
v/s Ratio Perm		c0.12	0.07		0.04	0.00		c0.56			0.21	
v/c Ratio		0.36	0.21		0.11	0.00		1.04			0.38	
Uniform Delay, d1		16.2	15.3		14.8	14.2		15.0			8.7	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		1.7	0.9		0.4	0.0		47.2			1.2	
Delay (s)		17.8	16.3		15.2	14.3		62.2			9.9	
Level of Service		B	B		B	B		E			A	
Approach Delay (s)		16.9			15.1			62.2			9.9	
Approach LOS		B			B			E			A	

Intersection Summary			
HCM Average Control Delay	33.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.8%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	12	5	14	28	1	122	0	398	149	156	469	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	13	5	15	30	1	131	0	428	160	168	504	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	33	162	588	672
Volume Left (vph)	13	30	0	168
Volume Right (vph)	15	131	160	0
Hadj (s)	-0.16	-0.41	-0.13	0.08
Departure Headway (s)	7.4	6.6	5.4	5.6
Degree Utilization, x	0.07	0.30	0.88	1.04
Capacity (veh/h)	452	518	660	642
Control Delay (s)	11.0	12.4	35.7	70.3
Approach Delay (s)	11.0	12.4	35.7	70.3
Approach LOS	B	B	E	F

Intersection Summary			
Delay	48.5		
HCM Level of Service	E		
Intersection Capacity Utilization	83.3%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	0	0	130	589	378	121
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	143	647	415	133

Direction, Lane #	NB 1	SB 1	SB 2
Volume Total (vph)	790	415	133
Volume Left (vph)	143	0	0
Volume Right (vph)	0	0	133
Hadj (s)	0.07	0.03	-0.67
Departure Headway (s)	4.6	5.0	4.3
Degree Utilization, x	1.01	0.58	0.16
Capacity (veh/h)	790	713	822
Control Delay (s)	54.6	13.5	6.9
Approach Delay (s)	54.6	11.9	
Approach LOS	F	B	

Intersection Summary			
Delay	37.1		
HCM Level of Service	E		
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	168	86	0	500	388	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	179	91	0	532	413	0

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total (vph)	179	91	532	413
Volume Left (vph)	179	0	0	0
Volume Right (vph)	0	91	0	0
Hadj (s)	0.53	-0.67	0.03	0.03
Departure Headway (s)	7.5	6.3	5.5	5.7
Degree Utilization, x	0.37	0.16	0.81	0.65
Capacity (veh/h)	451	531	641	607
Control Delay (s)	13.7	9.3	28.1	18.7
Approach Delay (s)	12.2		28.1	18.7
Approach LOS	B		D	C

Intersection Summary			
Delay	21.4		
HCM Level of Service	C		
Intersection Capacity Utilization	42.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
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	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.89		1.00	0.78		0.99			0.93	
Flpb, ped/bikes		0.96	1.00		0.98	1.00		0.90			1.00	
Frt		1.00	0.85		1.00	0.85		1.00			0.98	
Flt Protected		0.98	1.00		0.99	1.00		0.98			1.00	
Satd. Flow (prot)		1759	1416		1803	1229		1614			1686	
Flt Permitted		0.85	1.00		0.90	1.00		0.70			0.99	
Satd. Flow (perm)		1519	1416		1650	1229		1151			1676	
Volume (vph)	28	53	286	71	208	40	318	320	19	4	215	49
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	31	58	314	78	229	44	349	352	21	4	236	54
RTOR Reduction (vph)	0	0	168	0	0	19	0	1	0	0	12	0
Lane Group Flow (vph)	0	89	146	0	307	25	0	721	0	0	282	0
Confl. Peds. (#/hr)	95		40	40		95	170		95	95		170
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		543	506		589	439		608			886	
v/s Ratio Prot												
v/s Ratio Perm		0.06	0.10		c0.19	0.02		c0.63			0.17	
v/c Ratio		0.16	0.29		0.52	0.06		1.19			0.32	
Uniform Delay, d1		15.4	16.1		17.8	14.8		16.5			9.4	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.6	1.4		3.3	0.2		99.2			0.9	
Delay (s)		16.0	17.6		21.0	15.0		115.7			10.3	
Level of Service		B	B		C	B		F			B	
Approach Delay (s)		17.2			20.3			115.7			10.3	
Approach LOS		B			C			F			B	

Intersection Summary			
HCM Average Control Delay	56.9	HCM Level of Service	E
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.2%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	7	15	109	0	267	0	356	39	139	467	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	7	16	115	0	281	0	375	41	146	492	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	44	396	416	638
Volume Left (vph)	21	115	0	146
Volume Right (vph)	16	281	41	0
Hadj (s)	-0.09	-0.33	-0.03	0.08
Departure Headway (s)	8.2	6.6	6.6	6.5
Degree Utilization, x	0.10	0.72	0.76	1.15
Capacity (veh/h)	369	396	533	552
Control Delay (s)	12.2	24.9	27.5	110.4
Approach Delay (s)	12.2	24.9	27.5	110.4
Approach LOS	B	C	D	F

Intersection Summary			
Delay	61.8		
HCM Level of Service	F		
Intersection Capacity Utilization	88.2%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	0	0	143	480	366	136
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	0	0	159	533	407	151

Direction, Lane #	NB 1	SB 1	SB 2
Volume Total (vph)	692	407	151
Volume Left (vph)	159	0	0
Volume Right (vph)	0	0	151
Hadj (s)	0.08	0.03	-0.67
Departure Headway (s)	4.6	5.0	4.3
Degree Utilization, x	0.88	0.56	0.18
Capacity (veh/h)	778	711	823
Control Delay (s)	31.3	13.1	7.0
Approach Delay (s)	31.3	11.4	
Approach LOS	D	B	

Intersection Summary			
Delay	22.5		
HCM Level of Service	C		
Intersection Capacity Utilization	59.1%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	180	197	0	435	437	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	189	207	0	458	460	0

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total (vph)	189	207	458	460
Volume Left (vph)	189	0	0	0
Volume Right (vph)	0	207	0	0
Hadj (s)	0.53	-0.67	0.03	0.03
Departure Headway (s)	7.6	6.4	6.0	6.0
Degree Utilization, x	0.40	0.37	0.76	0.76
Capacity (veh/h)	449	531	587	585
Control Delay (s)	14.3	11.8	25.1	25.3
Approach Delay (s)	13.0		25.1	25.3
Approach LOS	B		D	D

Intersection Summary			
Delay	21.6		
HCM Level of Service	C		
Intersection Capacity Utilization	41.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
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	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.96		1.00	0.86		0.97			0.99	
Flpb, ped/bikes		0.98	1.00		0.99	1.00		0.98			1.00	
Frt		1.00	0.85		1.00	0.85		0.98			0.99	
Flt Protected		0.99	1.00		0.98	1.00		0.98			1.00	
Satd. Flow (prot)		1822	1520		1819	1363		1689			1829	
Flt Permitted		0.96	1.00		0.87	1.00		0.66			0.98	
Satd. Flow (perm)		1765	1520		1620	1363		1144			1790	
Volume (vph)	28	177	295	21	36	5	282	216	109	12	310	21
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)	30	192	321	23	39	5	307	235	118	13	337	23
RTOR Reduction (vph)	0	0	212	0	0	3	0	12	0	0	4	0
Lane Group Flow (vph)	0	222	109	0	62	2	0	648	0	0	369	0
Confl. Peds. (#/hr)	60		10	10		60	45		70	70		45
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		21.5	21.5		21.5	21.5		34.5			34.5	
Effective Green, g (s)		22.0	22.0		22.0	22.0		35.0			35.0	
Actuated g/C Ratio		0.34	0.34		0.34	0.34		0.54			0.54	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		597	514		548	461		616			964	
v/s Ratio Prot												
v/s Ratio Perm		c0.13	0.07		0.04	0.00		c0.57			0.21	
v/c Ratio		0.37	0.21		0.11	0.00		1.05			0.38	
Uniform Delay, d1		16.3	15.3		14.8	14.2		15.0			8.7	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		1.8	0.9		0.4	0.0		50.7			1.2	
Delay (s)		18.0	16.3		15.2	14.3		65.7			9.9	
Level of Service		B	B		B	B		E			A	
Approach Delay (s)		17.0			15.1			65.7			9.9	
Approach LOS		B			B			E			A	

Intersection Summary			
HCM Average Control Delay	34.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	65.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	83.5%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	12	5	14	28	1	122	0	407	149	156	469	0
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	13	5	15	30	1	131	0	438	160	168	504	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	33	162	598	672
Volume Left (vph)	13	30	0	168
Volume Right (vph)	15	131	160	0
Hadj (s)	-0.16	-0.41	-0.13	0.08
Departure Headway (s)	7.4	6.6	5.4	5.6
Degree Utilization, x	0.07	0.30	0.90	1.05
Capacity (veh/h)	452	518	660	642
Control Delay (s)	11.0	12.4	38.0	71.5
Approach Delay (s)	11.0	12.4	38.0	71.5
Approach LOS	B	B	E	F

Intersection Summary			
Delay	49.9		
HCM Level of Service	E		
Intersection Capacity Utilization	83.8%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	0	0	130	598	378	121
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91
Hourly flow rate (vph)	0	0	143	657	415	133

Direction, Lane #	NB 1	SB 1	SB 2
Volume Total (vph)	800	415	133
Volume Left (vph)	143	0	0
Volume Right (vph)	0	0	133
Hadj (s)	0.07	0.03	-0.67
Departure Headway (s)	4.6	5.0	4.3
Degree Utilization, x	1.02	0.58	0.16
Capacity (veh/h)	789	713	822
Control Delay (s)	57.9	13.5	6.9
Approach Delay (s)	57.9	11.9	
Approach LOS	F	B	

Intersection Summary			
Delay	39.2		
HCM Level of Service	E		
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	173	86	0	504	388	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	184	91	0	536	413	0

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total (vph)	184	91	536	413
Volume Left (vph)	184	0	0	0
Volume Right (vph)	0	91	0	0
Hadj (s)	0.53	-0.67	0.03	0.03
Departure Headway (s)	7.5	6.3	5.5	5.7
Degree Utilization, x	0.39	0.16	0.83	0.66
Capacity (veh/h)	451	531	638	604
Control Delay (s)	14.0	9.3	29.2	18.9
Approach Delay (s)	12.4		29.2	18.9
Approach LOS	B		D	C

Intersection Summary			
Delay	22.0		
HCM Level of Service	C		
Intersection Capacity Utilization	42.8%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
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	
Lane Util. Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Frpb, ped/bikes		1.00	0.89		1.00	0.78		0.99			0.93	
Flpb, ped/bikes		0.96	1.00		0.98	1.00		0.90			1.00	
Frt		1.00	0.85		1.00	0.85		1.00			0.98	
Flt Protected		0.98	1.00		0.99	1.00		0.98			1.00	
Satd. Flow (prot)		1764	1416		1805	1229		1614			1686	
Flt Permitted		0.85	1.00		0.90	1.00		0.70			0.99	
Satd. Flow (perm)		1516	1416		1653	1229		1151			1676	
Volume (vph)	28	54	286	74	225	40	318	320	20	4	215	49
Peak-hour factor, PHF	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Adj. Flow (vph)	31	59	314	81	247	44	349	352	22	4	236	54
RTOR Reduction (vph)	0	0	168	0	0	18	0	1	0	0	12	0
Lane Group Flow (vph)	0	90	146	0	328	26	0	722	0	0	282	0
Confl. Peds. (#/hr)	95		40	40		95	170		95	95		170
Turn Type	Perm		Perm	Perm		Perm	Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)		24.5	24.5		24.5	24.5		36.5			36.5	
Effective Green, g (s)		25.0	25.0		25.0	25.0		37.0			37.0	
Actuated g/C Ratio		0.36	0.36		0.36	0.36		0.53			0.53	
Clearance Time (s)		4.5	4.5		4.5	4.5		4.5			4.5	
Lane Grp Cap (vph)		541	506		590	439		608			886	
v/s Ratio Prot												
v/s Ratio Perm		0.06	0.10		c0.20	0.02		c0.63			0.17	
v/c Ratio		0.17	0.29		0.56	0.06		1.19			0.32	
Uniform Delay, d1		15.4	16.1		18.0	14.8		16.5			9.4	
Progression Factor		1.00	1.00		1.00	1.00		1.00			1.00	
Incremental Delay, d2		0.7	1.4		3.7	0.3		99.9			0.9	
Delay (s)		16.0	17.6		21.8	15.0		116.4			10.3	
Level of Service		B	B		C	B		F			B	
Approach Delay (s)		17.2			21.0			116.4			10.3	
Approach LOS		B			C			F			B	

Intersection Summary			
HCM Average Control Delay	56.9	HCM Level of Service	E
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	89.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	20	7	15	109	0	267	0	357	39	139	470	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	21	7	16	115	0	281	0	376	41	146	495	0

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total (vph)	44	396	417	641
Volume Left (vph)	21	115	0	146
Volume Right (vph)	16	281	41	0
Hadj (s)	-0.09	-0.33	-0.03	0.08
Departure Headway (s)	8.2	6.6	6.6	6.5
Degree Utilization, x	0.10	0.72	0.76	1.16
Capacity (veh/h)	369	396	533	552
Control Delay (s)	12.2	25.0	27.7	112.7
Approach Delay (s)	12.2	25.0	27.7	112.7
Approach LOS	B	C	D	F

Intersection Summary			
Delay	62.9		
HCM Level of Service	F		
Intersection Capacity Utilization	88.4%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	0	0	143	481	369	136
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	0	0	159	534	410	151

Direction, Lane #	NB 1	SB 1	SB 2
Volume Total (vph)	693	410	151
Volume Left (vph)	159	0	0
Volume Right (vph)	0	0	151
Hadj (s)	0.08	0.03	-0.67
Departure Headway (s)	4.6	5.0	4.3
Degree Utilization, x	0.88	0.57	0.18
Capacity (veh/h)	778	711	822
Control Delay (s)	31.6	13.2	7.0
Approach Delay (s)	31.6	11.5	
Approach LOS	D	B	

Intersection Summary			
Delay	22.6		
HCM Level of Service	C		
Intersection Capacity Utilization	59.3%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Sign Control	Stop			Stop	Stop	
Volume (vph)	180	197	0	435	440	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Hourly flow rate (vph)	189	207	0	458	463	0

Direction, Lane #	EB 1	EB 2	NB 1	SB 1
Volume Total (vph)	189	207	458	463
Volume Left (vph)	189	0	0	0
Volume Right (vph)	0	207	0	0
Hadj (s)	0.53	-0.67	0.03	0.03
Departure Headway (s)	7.6	6.4	6.0	6.0
Degree Utilization, x	0.40	0.37	0.76	0.77
Capacity (veh/h)	448	530	586	585
Control Delay (s)	14.4	11.8	25.2	25.8
Approach Delay (s)	13.0		25.2	25.8
Approach LOS	B		D	D

Intersection Summary			
Delay	21.7		
HCM Level of Service	C		
Intersection Capacity Utilization	42.0%	ICU Level of Service	A
Analysis Period (min)	15		