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MEMORANDUM

TO: Juan Avendano, City of Cambridge

FROM: Jason Adams, P.E., PTOE

DATE: February 27, 2014

RE: Pearl Street Data Collection

McMahon Associates has compiled the following memorandum and data as part of the data collection on Pearl Street in Cambridge, Massachusetts. The data collected along Pearl Street included vehicular counts at Putnam Avenue, pedestrian counts at Lawrence Street, and three 48-hour automatic traffic recorders. The count locations are shown in Figure 1. A summary of the study area and collected traffic data is presented below.

Pearl Street and Putnam Avenue

The intersection of Pearl Street and Putnam Avenue is a two-phase, pre-timed signalized intersection. The southbound Pearl Street and eastbound and westbound Putnam Avenue approaches each provide a single lane approach to the intersection. Crosswalks are provided on all four legs of the intersection.

Manual turning movement counts at the intersection of Pearl Street and Putnam Avenue were completed on Wednesday November 13, 2013 from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM and on Saturday November 16, 2013 from 11:00 AM to 2:00 PM. The traffic counts recorded passenger cars, heavy vehicles, bicycles and pedestrians. The four consecutive 15-minute intervals with the highest recorded vehicle volumes during each of these count periods constitute the peak hours that are the basis of this traffic analysis provided in this memorandum. The weekday morning, weekday afternoon and Saturday midday peak hour traffic volumes are depicted in Figure 2.

Intersection capacity analysis was conducted at the intersection of Pearl Street and Putnam Avenue using Synchro 8 to evaluate the 2013 existing conditions during the weekday morning, weekday afternoon and Saturday midday peak hours. The level-of-service (LOS) and queue summaries resulting from the capacity analysis are presented in Table 1 and Table 2, respectively, and the Synchro worksheets are attached to this memorandum.

Table 1: Level of Service Analysis

Intersection	Movement	2013 AM			2013 PM			2013 SAT		
		LOS ¹	Delay ²	V/C ³	LOS	Delay	V/C	LOS	Delay	V/C
Pearl Street at Putnam Avenue	EB TR	B	14.1	0.40	B	11.9	0.29	B	11.0	0.15
	WB LT	B	12.5	0.20	B	17.1	0.56	B	12.1	0.17
	SB LTR	B	12.9	0.42	A	10.0	0.35	B	11.5	0.32
	<i>Overall</i>	<i>B</i>	<i>13.3</i>	<i>0.02</i>	<i>B</i>	<i>13.8</i>	<i>0.56</i>	<i>B</i>	<i>11.5</i>	<i>0.32</i>

1 Level-of-Service

2 Average vehicle delay in seconds

3 Volume to capacity ratio

Table 2: Queue Analysis

Intersection	Movement	2013 AM		2013 PM		2013 SAT	
		50th Q ¹	95th Q ²	50th Q	95th Q	50th Q	95th Q
Pearl Street at Putnam Avenue	EB TR	61	106	39	68	20	40
	WB LT	28	52	97	168	24	45
	SB LTR	51	101	33	63	36	68

1 50th Percentile Queue Length, in feet

2 95th Percentile Queue Length, in feet

At the intersection of Pearl Street and Putnam Avenue, the weekday morning peak hour was determined to occur from 8:00 AM to 9:00 AM. During the weekday morning peak hour the intersection was shown to operate at overall LOS B with an average vehicle delay of 13.3 seconds under the existing conditions. The eastbound and southbound approaches to the intersection are shown to experience 95th percentile queues of approximately four vehicles. All of the individual approaches to the intersection were shown to operate at LOS B during the weekday morning peak hour.

The weekday afternoon peak hour was determined to occur from 5:00 PM to 6:00 PM at the intersection of Pearl Street and Putnam Avenue. As shown in Table 1, during the weekday afternoon peak hour the intersection currently operates at overall LOS B with an average vehicle delay of 13.8 seconds. All of the individual approaches to the intersection were shown to operate at LOS B or better during the weekday afternoon peak hour. During the weekday afternoon peak hour, the 95th percentile queue at the westbound approach was shown to be approximate seven vehicles in length.

At the intersection of Pearl Street and Putnam Avenue the Saturday midday peak hour was determined to occur from 12:00 PM to 1:00 PM. The intersection is shown to operate at overall LOS B with an average vehicle delay of 11.5 seconds. All of the individual approaches to the

intersection were shown to operate at LOS B during the Saturday midday peak hour. The longest 95th percentile queue at the intersection is calculated to be approximately three vehicles in length at the southbound approach.

Pearl Street and Lawrence Street

The intersection of Pearl Street and Lawrence Street is an unsignalized T-intersection. Pearl Street runs in a north-south direction and Lawrence Street is a one-way street approaching the intersection from the west. The pedestrian accommodations at the intersection include crosswalks across the eastbound and northbound approaches and curb ramps for the Lawrence Street crosswalk. A bus stop on the northwestern corner of the intersection serves the MBTA Route 47.

Pedestrian crossing counts were completed on Wednesday November 13, 2013 from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM and on Saturday November 16, 2013 from 11:00 AM to 2:00 PM at the intersection of Pearl Street and Lawrence Street. The peak hours of pedestrian volumes are shown in Figure 3. During the weekday morning peak hour there were a total of 82 pedestrian crossings at the intersection with the majority of pedestrians traveling northbound towards Massachusetts Avenue. The afternoon peak hour included 68 total pedestrian crossings with the majority of pedestrians traveling southbound along Pearl Street away from Massachusetts Avenue. A total of 52 pedestrian crossings were observed during the Saturday midday peak hour with an approximately equal distribution of northbound and southbound traveling pedestrians.

Automatic Traffic Recorder Data Collection

Automatic Traffic Recorders (ATRs) were installed at three locations on Pearl Street for 48 hour periods between Wednesday November 13, 2013 and Friday November 15, 2013. The ATRs were installed on Pearl Street between Auburn Street and William Street, between Lawrence Street and Valentine Street, and between Tufts Street and Henry Street. Vehicular volumes, classifications, and speeds were recorded and are presented in Table 3 and Table 4 below.

Table 3: ATR Volumes

Pearl Street Volume	Auburn Street and William Street	Lawrence Street and Valentine Street	Tufts Street and Henry Street
ADT ¹	2728	2205	1664
% Passenger Cars	86%	83%	89%
% Heavy Vehicle	13%	16%	11%

¹ Average Daily Traffic

From Auburn Street in the north to Henry Street in the south, the average daily traffic volumes along Pearl Street are shown to decrease by approximately 1064 vehicles. The ATRs recorded between 11 and 16 percent heavy vehicles on Pearl Street.

Table 4: ATR Speeds

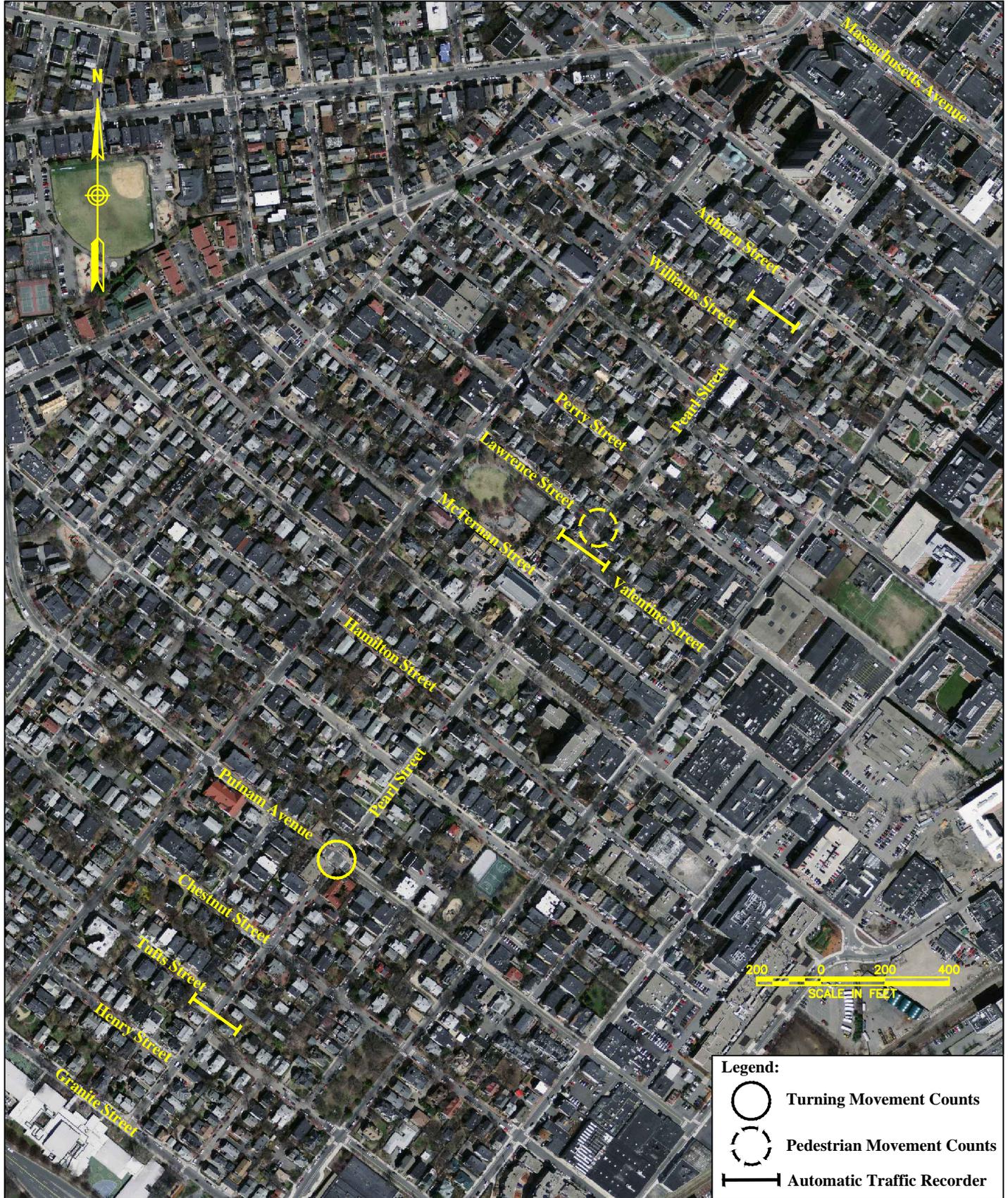
Pearl Street Speed (MPH)	Auburn Street and William Street	Lawrence Street and Valentine Street	Tufts Street and Henry Street
50th Percentile ¹	18	20	22
85th Percentile ²	23	26	27

1 50th Percentile Speed, in miles per hour

2 85th Percentile Speed, in miles per hour

As seen in Table 4, the 50th percentile speed on Pearl Street was recorded to be between 18 and 22 miles per hour. The 85th percentile speed was recorded between 23 and 27 miles per hour. The posted speed limit along Pearl Street is 25 miles per hour, which is approximately the 85th percentile speed recorded in the study. By comparing the values in Table 3 and Table 4, speeds along Pearl Street appear to increase as the traffic volumes decrease along Pearl Street from north to south.

Please find all of the data collected on Pearl Street attached to this memorandum for your use and review. If you require any additional information or have any questions, please do not hesitate to contact us.

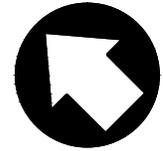
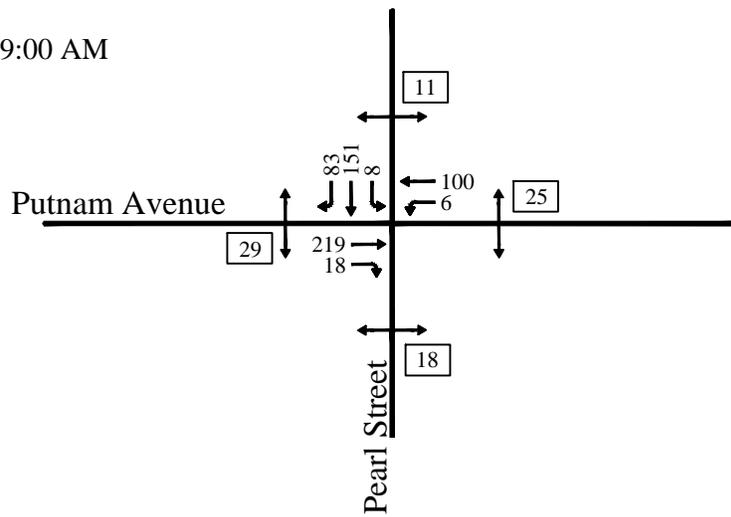


Legend:

-  Turning Movement Counts
-  Pedestrian Movement Counts
-  Automatic Traffic Recorder

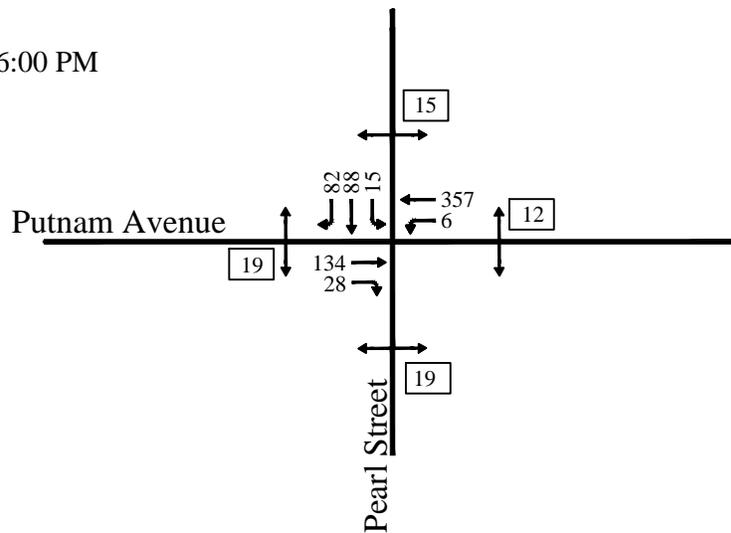
Figure 1
Study Location Map
Pearl Street Data Collection
Cambridge, Massachusetts

Weekday Morning
Peak Hour: 8:00 AM - 9:00 AM

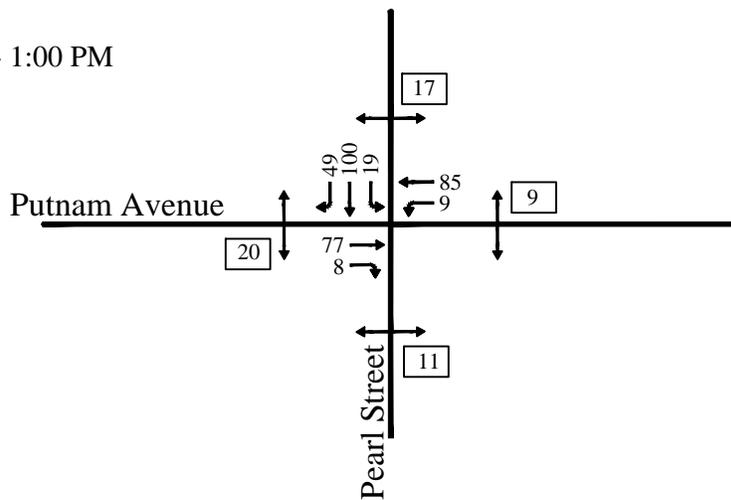


SCHEMATIC-
NOT TO SCALE

Weekday Afternoon
Peak Hour: 5:00 PM - 6:00 PM



Saturday Midday
Peak Hour: 12:00 PM - 1:00 PM

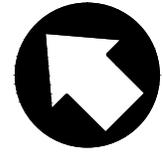
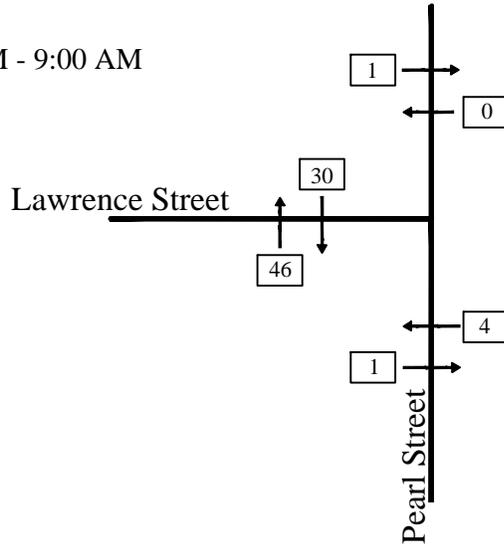


Legend

- xx Vehicular Volume
- xx Pedestrian Volume

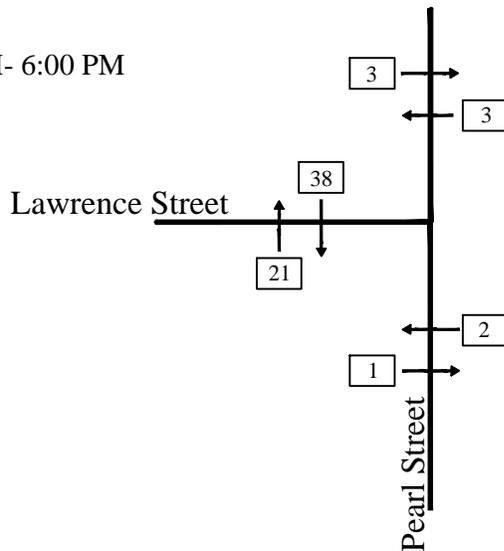
Figure 2
Putnam Avenue Traffic Volumes
Pearl Street Data Collection
Cambridge, Massachusetts

Weekday Morning
Peak Hour: 8:00 AM - 9:00 AM

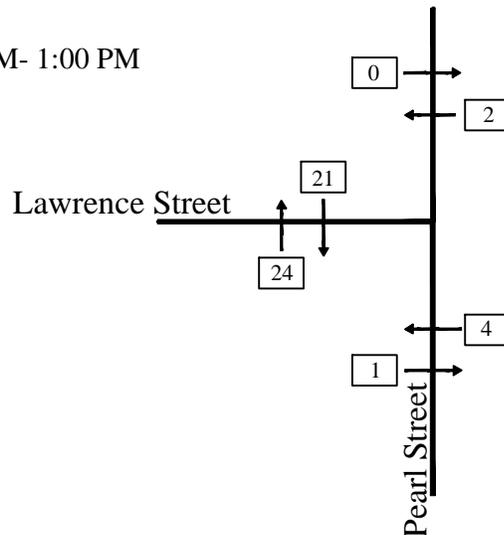


SCHEMATIC-
NOT TO SCALE

Weekday Afternoon
Peak Hour: 5:00 PM- 6:00 PM



Saturday Midday
Peak Hour: 12:00 PM- 1:00 PM



Legend

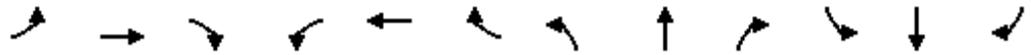
XX Pedestrian Volume

City of Cambridge
3: Pearl Street & Putnam Avenue

Existing 2013
Weekday AM



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	219	18	6	100	0	0	0	0	8	151	83
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. 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
Ped Bike Factor		1.00			1.00						0.98	
Frt		0.990									0.954	
Flt Protected					0.997						0.998	
Satd. Flow (prot)	0	1799	0	0	1747	0	0	0	0	0	1688	0
Flt Permitted					0.974						0.998	
Satd. Flow (perm)	0	1799	0	0	1704	0	0	0	0	0	1686	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		9									53	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		444			401			759			441	
Travel Time (s)		10.1			9.1			17.3			10.0	
Confl. Peds. (#/hr)	11		18	18		11				25		29
Peak Hour Factor	0.86	0.86	0.86	0.80	0.80	0.80	0.80	0.80	0.80	0.89	0.89	0.89
Heavy Vehicles (%)	0%	4%	6%	0%	9%	0%	0%	0%	0%	0%	1%	12%
Adj. Flow (vph)	0	255	21	8	125	0	0	0	0	9	170	93
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	276	0	0	133	0	0	0	0	0	272	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8						6	
Permitted Phases				8						6		
Minimum Split (s)		28.0		28.0	28.0					27.0	27.0	
Total Split (s)		28.0		28.0	28.0					27.0	27.0	
Total Split (%)		50.9%		50.9%	50.9%					49.1%	49.1%	
Maximum Green (s)		21.0		21.0	21.0					20.0	20.0	
Yellow Time (s)		3.0		3.0	3.0					3.0	3.0	
All-Red Time (s)		4.0		4.0	4.0					4.0	4.0	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		7.0			7.0						7.0	
Lead/Lag												
Lead-Lag Optimize?												
Walk Time (s)		16.0		16.0	16.0					16.0	16.0	
Flash Dont Walk (s)		1.0		1.0	1.0					1.0	1.0	
Pedestrian Calls (#/hr)		0		0	0					0	0	
Act Effct Green (s)		21.0			21.0						20.0	
Actuated g/C Ratio		0.38			0.38						0.36	
v/c Ratio		0.40			0.20						0.42	
Control Delay		14.1			12.5						12.9	
Queue Delay		0.0			0.0						0.0	
Total Delay		14.1			12.5						12.9	
LOS		B			B						B	
Approach Delay		14.1			12.5						12.9	
Approach LOS		B			B						B	
Queue Length 50th (ft)		61			28						51	
Queue Length 95th (ft)		106			52						101	
Internal Link Dist (ft)		364			321			679			361	

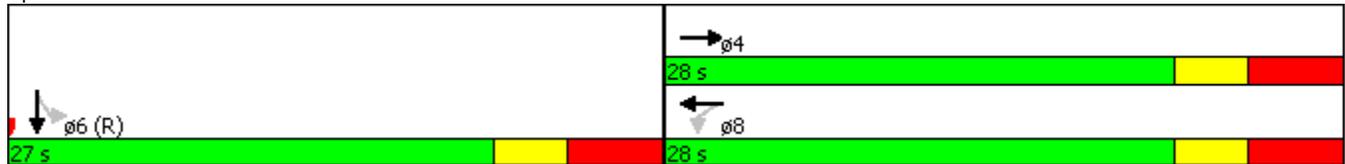


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Turn Bay Length (ft)												
Base Capacity (vph)		692			650						646	
Starvation Cap Reductn		0			0						0	
Spillback Cap Reductn		0			0						0	
Storage Cap Reductn		0			0						0	
Reduced v/c Ratio		0.40			0.20						0.42	

Intersection Summary

Area Type:	Other
Cycle Length:	55
Actuated Cycle Length:	55
Offset:	0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
Natural Cycle:	55
Control Type:	Pretimed
Maximum v/c Ratio:	0.42
Intersection Signal Delay:	13.3
Intersection LOS:	B
Intersection Capacity Utilization	40.2%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 3: Pearl Street & Putnam Avenue

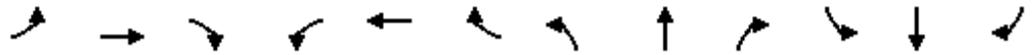


City of Cambridge
3: Pearl Street & Putnam Avenue

Existing 2013
Weekday PM



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	134	28	6	357	0	0	0	0	15	88	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. 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
Ped Bike Factor		0.99			1.00						0.98	
Frt		0.977									0.940	
Flt Protected					0.999						0.996	
Satd. Flow (prot)	0	1798	0	0	1839	0	0	0	0	0	1680	0
Flt Permitted					0.995						0.996	
Satd. Flow (perm)	0	1798	0	0	1831	0	0	0	0	0	1677	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		22									81	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		444			401			759			441	
Travel Time (s)		10.1			9.1			17.3			10.0	
Confl. Peds. (#/hr)	15		19	19		15	19		12	12		19
Peak Hour Factor	0.80	0.80	0.80	0.93	0.93	0.93	0.80	0.80	0.80	0.80	0.80	0.80
Heavy Vehicles (%)	0%	2%	4%	17%	3%	0%	0%	0%	0%	0%	1%	7%
Adj. Flow (vph)	0	168	35	6	384	0	0	0	0	19	110	102
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	203	0	0	390	0	0	0	0	0	231	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8							6
Permitted Phases				8						6		
Minimum Split (s)		28.0		28.0	28.0					27.0	27.0	
Total Split (s)		28.0		28.0	28.0					27.0	27.0	
Total Split (%)		50.9%		50.9%	50.9%					49.1%	49.1%	
Maximum Green (s)		21.0		21.0	21.0					20.0	20.0	
Yellow Time (s)		3.0		3.0	3.0					3.0	3.0	
All-Red Time (s)		4.0		4.0	4.0					4.0	4.0	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		7.0			7.0						7.0	
Lead/Lag												
Lead-Lag Optimize?												
Walk Time (s)		16.0		16.0	16.0					16.0	16.0	
Flash Dont Walk (s)		1.0		1.0	1.0					1.0	1.0	
Pedestrian Calls (#/hr)		0		0	0					0	0	
Act Effct Green (s)		21.0			21.0						20.0	
Actuated g/C Ratio		0.38			0.38						0.36	
v/c Ratio		0.29			0.56						0.35	
Control Delay		11.9			17.1						10.0	
Queue Delay		0.0			0.0						0.0	
Total Delay		11.9			17.1						10.0	
LOS		B			B						A	
Approach Delay		11.9			17.1						10.0	
Approach LOS		B			B						A	
Queue Length 50th (ft)		39			97						33	
Queue Length 95th (ft)		68			168						63	
Internal Link Dist (ft)		364			321			679			361	

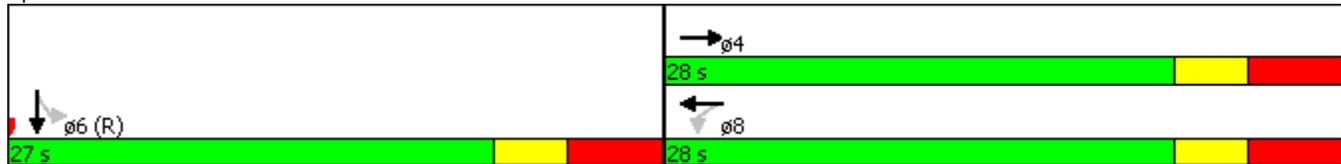


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Turn Bay Length (ft)												
Base Capacity (vph)		700			699						661	
Starvation Cap Reductn		0			0						0	
Spillback Cap Reductn		0			0						0	
Storage Cap Reductn		0			0						0	
Reduced v/c Ratio		0.29			0.56						0.35	

Intersection Summary

Area Type:	Other
Cycle Length:	55
Actuated Cycle Length:	55
Offset:	0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
Natural Cycle:	55
Control Type:	Pretimed
Maximum v/c Ratio:	0.56
Intersection Signal Delay:	13.8
Intersection LOS:	B
Intersection Capacity Utilization	53.2%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 3: Pearl Street & Putnam Avenue



City of Cambridge
3: Pearl Street & Putnam Avenue

Existing 2013
Weekday SAT



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	77	8	6	85	0	0	0	0	19	100	49
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Util. 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
Ped Bike Factor		1.00			1.00							0.98
Frt		0.987										0.960
Flt Protected					0.997							0.994
Satd. Flow (prot)	0	1852	0	0	1826	0	0	0	0	0	1696	0
Flt Permitted					0.980							0.994
Satd. Flow (perm)	0	1852	0	0	1793	0	0	0	0	0	1693	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		10										43
Link Speed (mph)		30			30			30				30
Link Distance (ft)		444			401			759				441
Travel Time (s)		10.1			9.1			17.3				10.0
Confl. Peds. (#/hr)	17		11	11		17	20		9	9		20
Peak Hour Factor	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.82	0.82	0.82
Heavy Vehicles (%)	0%	1%	0%	0%	4%	0%	0%	0%	0%	5%	3%	10%
Adj. Flow (vph)	0	96	10	8	106	0	0	0	0	23	122	60
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	106	0	0	114	0	0	0	0	0	205	0
Turn Type		NA		Perm	NA					Perm	NA	
Protected Phases		4			8							6
Permitted Phases				8						6		
Minimum Split (s)		28.0		28.0	28.0					27.0	27.0	
Total Split (s)		28.0		28.0	28.0					27.0	27.0	
Total Split (%)		50.9%		50.9%	50.9%					49.1%	49.1%	
Maximum Green (s)		21.0		21.0	21.0					20.0	20.0	
Yellow Time (s)		3.0		3.0	3.0					3.0	3.0	
All-Red Time (s)		4.0		4.0	4.0					4.0	4.0	
Lost Time Adjust (s)		0.0			0.0						0.0	
Total Lost Time (s)		7.0			7.0						7.0	
Lead/Lag												
Lead-Lag Optimize?												
Walk Time (s)		16.0		16.0	16.0					16.0	16.0	
Flash Dont Walk (s)		1.0		1.0	1.0					1.0	1.0	
Pedestrian Calls (#/hr)		0		0	0					0	0	
Act Effct Green (s)		21.0			21.0						20.0	
Actuated g/C Ratio		0.38			0.38						0.36	
v/c Ratio		0.15			0.17						0.32	
Control Delay		11.0			12.1						11.5	
Queue Delay		0.0			0.0						0.0	
Total Delay		11.0			12.1						11.5	
LOS		B			B						B	
Approach Delay		11.0			12.1						11.5	
Approach LOS		B			B						B	
Queue Length 50th (ft)		20			24						36	
Queue Length 95th (ft)		40			45						68	
Internal Link Dist (ft)		364			321			679			361	



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Turn Bay Length (ft)												
Base Capacity (vph)		713			684						643	
Starvation Cap Reductn		0			0						0	
Spillback Cap Reductn		0			0						0	
Storage Cap Reductn		0			0						0	
Reduced v/c Ratio		0.15			0.17						0.32	

Intersection Summary

Area Type:	Other
Cycle Length:	55
Actuated Cycle Length:	55
Offset:	0 (0%), Referenced to phase 2: and 6:SBTL, Start of Green
Natural Cycle:	55
Control Type:	Pretimed
Maximum v/c Ratio:	0.32
Intersection Signal Delay:	11.5
Intersection LOS:	B
Intersection Capacity Utilization	42.4%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 3: Pearl Street & Putnam Avenue

