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Evaluation of Pedestrian Risk on 700 N on Utah State University Campus

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EVALUATION OF PEDESTRIAN RISK ON 700 N ON UTAH STATE UNIVERSITY CAMPUS

by

Kirk Jackson

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Introduction

One of the biggest concerns that highway designers face when designing roadways is how to safely design the interface between highway users and pedestrians. This is never truer than on the Utah State University campus where pedestrian use is much higher than on an average road.

Utah State University purchased 700 N, the main collector road which runs through the heart of USU's campus, from the City of Logan in the summer of 2010. Since then, pedestrian safety on 700 N has become the first priority of USU Facilities in regards to their efforts to improve it. It has come to the attention of USU Facilities that 700 N is no longer in compliance with the current standards for roadway design (American Association of State Highway Transportation Officials, 2011). In addition, the signage for pedestrian crosswalks are not in compliance with the Manual for Uniform Traffic Control Devices for Highways and Streets (MUTCD), which although the regulations specified are not law, the regulations still reflect safety in uniformity concerning communicating to road users the risk of pedestrian collisions (American Association of State Highway Transportation Officials, American Traffic Safety Services Assosiation, Federal Highway Administration, Institute of Transportation Engineers, 2009). Section 2B.11 clearly defines the regulations for design of traffic control devices related to pedestrian crossings, which 700 N is in violation of; more will be discussed about this later. These violations of the regulations regarding traffic control and the geometric design of the roadway are not punishable by law, however they do point out safety violations that should be addressed by USU facilities in order to increase pedestrian safety.

Another approach to increasing pedestrian safety on 700 N is to reduce the user delay of traffic on 700 N. User delay is the amount of time that a road user experiences in addition to the time normally allotted to their route. Reducing user delay increases the flow of traffic through 700 N and minimizes the exposure time of traffic to pedestrians along the corridor. The major part of the solutions examined in this report deal specifically with reducing user delay and increasing flow on 700 N.

Another objective of this report is to analyze the current state of traffic and pedestrian flow along 700 N. 700 N is a collector road with two lanes, one in each direction. Ten pedestrian crosswalks traverse the length of the road from the intersection at 800 E and 1200 E. Several parking access points exist along this corridor including the USU Parking Terrace, an entrance and exit point at the parking lot in front of the University Inn and Taggart Student Center, an entrance and exit to the parking between the Animal Science building and the Janet Quincy Lawson Building, an exit from the alley between Edith Bowen Elementary School and Richards Hall which serves as an alternative exit from the parking lot north of the Center for Persons with Disabilities, and one more entrance and exit to the "Orange Lot" parking lot just north of the Engineering Laboratories building. The speed limit of 700 N is 24 mph. The lanes are 14 feet wide with a 12 foot parking lane on each side. Curb and gutter line the length of the road. Several bus turnouts exist for the bus stops: one in front of the Industrial Science Building, two in between Richard's Hall and Bullen Hall and two in front of the Education Building. 700 N also serves as an emergency fire and evacuation lane that services ambulances and fire engines in the event of a fire or other emergency on campus.

Figure 1 Aerial of 700 N through USU campus (USDA Farm Service Agency, 2012)

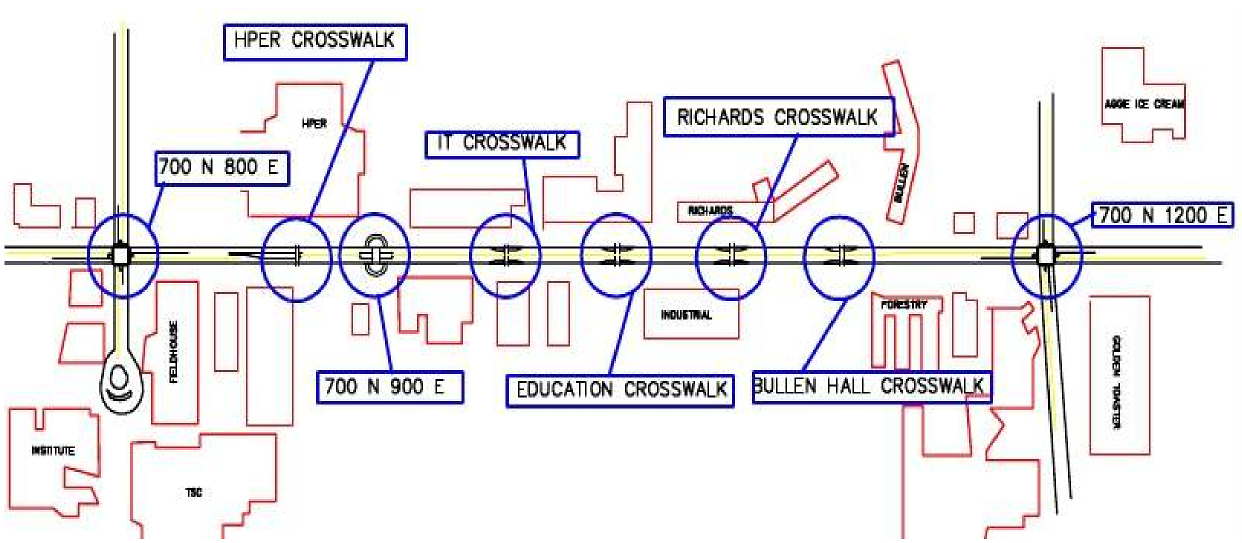


Figure 2 Current Crosswalk Orientation on 700 N

Analyzing the current state of traffic and pedestrian flow along 700 N is accomplished by creating a model of the current traffic flow. Once a model is created that accurately predicts observed conditions, the impacts of implementing design changes can be observed in the model. Three alternative design solutions were implemented and their impacts observed: closing 700 N to passenger cars at the request of USU Facilities, signalizing the crosswalks at the HPER Building crosswalk and at the main pedestrian corridor, and do nothing.

Of all the alternative solutions, it was found that signalizing the crosswalks at the HPER Building and the main pedestrian corridor had the highest cost benefit of all the solutions. More of this will be discussed later in the section titled Alternative Solutions.

Methodology

The first step in improving pedestrian safety along 700 N is to understand how the traffic behaves. Identifying patterns in traffic flow that increases risk of pedestrian vehicle collision allows for design of solutions that can accommodate these high risk situations. In order to understand these patterns requires the formation of a model that can accurately predict observed traffic conditions. It also requires the collection of traffic flow and pedestrian movement data. This section identifies the methods used to collect traffic flow and pedestrian movement data as well as the method for formulating the model used to evaluate the performance of alternative solutions.

Data Collection

The first step in developing a traffic model is to record current traffic flow patterns on normal business days. Traffic is observed at each point of interest, in this case at each intersection and crosswalk. The number of vehicles and pedestrians are counted for every movement at each intersection for each fifteen minute interval for a period of time sufficient to determine the peak movement periods. It was determined that in order to understand the system sufficiently that data should be collected at each intersection and at each crosswalk for a ten hour period from 7:30 am to 6:30 pm. Since collecting this data would be tedious and man power to conduct such a study was short, it was determined that the use of an automated system to collect this data would be a better approach. Miovision Scout video detection units were used to collect this data.

Miovision Scouts are a vehicle and pedestrian detection unit that uses video to collect this data. The units were borrowed from the Utah Transportation Center (UTC) with permission from Dr. Kevin Heaslip. This study was also a dry run for conducting such studies for the UTC as this equipment had not been used previously by the UTC. A summary of the dates and times that videos were collected are summarized in Table 1.

Table 1 Summary of Videos Collected

Location	Date	Beginning Time	Ending Time	Total Hours Collected
700 N 800 E	10/3/2011	7:31	18:31	11
700 N 900 E	10/3/2011	7:53	17:53	10
700 N 800 E	10/4/2011	7:41	18:41	11
700 N 900 E	10/4/2011	7:54	17:54	10
HPER Crosswalk	10/5/2011	7:59	18:59	11
Education Crosswalk	10/5/2011	7:00	18:00	11
HPER Crosswalk	10/6/2011	7:00	18:00	11
Education Crosswalk	10/6/2011	7:00	18:00	11
Elementary Crosswalk	10/11/2011	7:00	18:00	11
Richard's Hall Crosswalk	10/11/2011	7:00	18:00	11
Elementary Crosswalk	10/12/2011	7:00	18:00	11
700 N 1200 E	10/12/2011	7:00	18:00	11
Bullen Hall Crosswalk	10/13/2011	7:00	18:00	11
Bullen Hall Crosswalk	10/14/2011	7:00	18:00	11
Education Crosswalk	10/20/2011	7:00	18:00	11
Richard's Hall Crosswalk	3/21/2012	7:00	18:00	11
700 N 1200 E	3/22/2012	7:00	18:00	11

Figure 3 Miovision Scout Video Detection Unit (Miovision Technologies Inc., 2011)

It was possible to use these videos to collect the vehicle data needed, however this required a considerable amount of funding to accomplish. It was therefore the decision of S.E.C. to manually count the vehicles. The vehicles were individually analyzed by members of the S.E.C team. The iPhone app “TurnCount” was used to expedite this process. Figure 4 shows a screenshots of the “TurnCount” app. Figure 5 shows a screenshot of a sample of the video collected.

Figure 4 Screenshot of TurnCount

Data Processing

Once all the data from the videos was collected the videos were post processed into spreadsheets that summarized each intersection for which the data was collected. Appendix A contains each of these spreadsheets. Each movement was recorded in a separate column with each fifteen minute time interval in a separate row. The peak hour was determined for each movement and the peak hour factor was calculated as well. An example of such a spreadsheet is shown in Table 2. Considering the enormous amount of data collected, it became necessary to display the information in these spreadsheets graphically in order to understand patterns in the traffic flow. Figure 6 and Figure 7 show examples of such graphs. Appendix A also contains each of these graphs for each intersection.

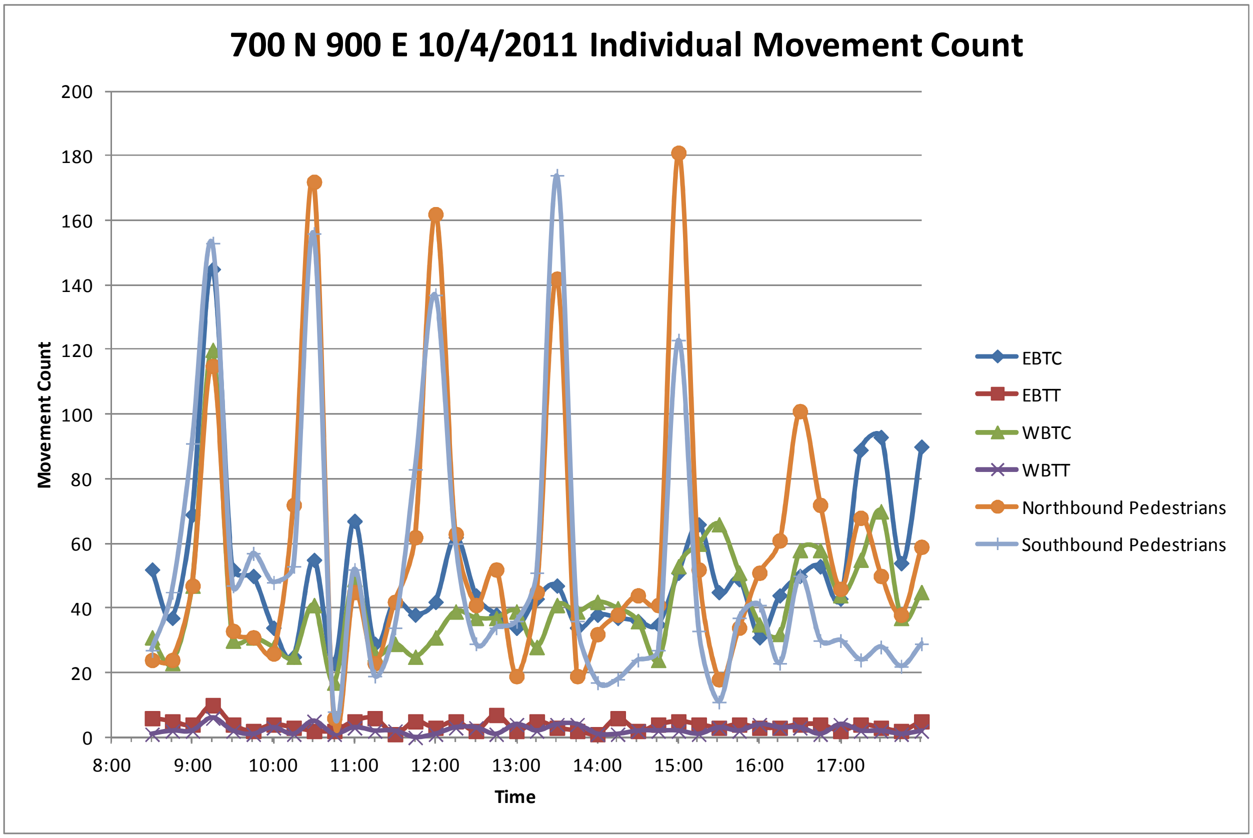


Figure 6 Sample Individual Movement Count

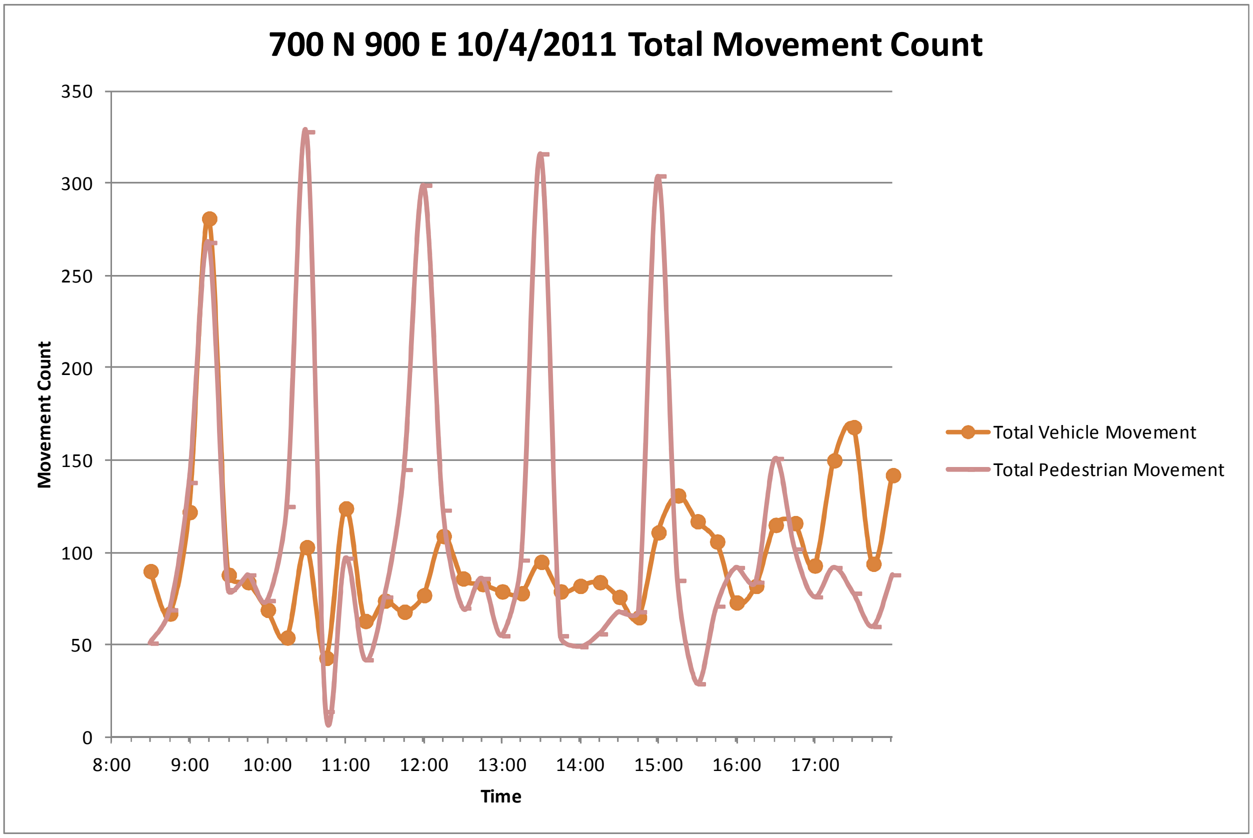


Figure 7 Sample Total Movement Count

Table 2 Intersection Count Summary Example

Intersection:		Hyper Cross Walk							
Date:		10/6/2011		Vehicle Peak Hour					
Weekday:		Thursday		Pedestrian Peak Hour					
Peak Hour:		15:15-16:15							
		Vehicle					Pedestrian		
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck				
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	NB Peds	SB Peds	TOTAL
8:00	8:15	113	12	51	1	177	58	49	107
8:15	8:30	51	6	43	1	103	63	42	105
8:30	8:45	62	5	69	3	140	18	29	47
8:45	9:00	47	7	40	1	96	2	11	13
9:00	9:15	56	6	34	2	99	23	26	49
9:15	9:30	79	2	61	3	145	118	110	228
9:30	9:45	50	5	42	6	107	20	24	44
9:45	10:00	35	6	37	1	80	9	13	22
10:00	10:15	63	8	36	4	111	33	31	64
10:15	10:30	58	5	51	3	118	191	71	262
10:30	10:45	29	4	66	5	105	25	30	55
10:45	11:00	30	2	24	1	58	19	11	30
11:00	11:15	51	6	28	1	86	43	16	59
11:15	11:30	59	3	71	2	137	121	221	342
11:30	11:45	69	5	52	2	130	54	30	84
11:45	12:00	51	5	52	1	110	38	35	73
12:00	12:15	28	3	34	1	70	9	62	71
12:15	12:30	82	3	77	2	168	90	74	164
12:30	12:45	61	2	41	4	108	26	11	37
12:45	13:00	33	1	31	1	67	19	6	25
13:00	13:15	30	1	38	4	75	9	20	29
13:15	13:30	38	3	35	1	81	55	63	118
13:30	13:45	58	3	52	1	114	30	66	96
13:45	14:00	87	2	100	3	195	84	86	170
14:00	14:15	66	0	62	2	131	79	22	101
14:15	14:30	69	2	44	2	118	33	40	73
14:30	14:45	45	3	35	4	90	35	40	75
14:45	15:00	45	2	33	3	84	30	46	76
15:00	15:15	54	1	69	3	127	40	0	48
15:15	**15:30**	**72**	**2**	**104**	**3**	**181**	**52**	**44**	**96**
15:30	**15:45**	**63**	**3**	**66**	**2**	**134**	**40**	**11**	**51**
15:45	**16:00**	**104**	**2**	**79**	**2**	**189**	**22**	**27**	**49**
16:00	**16:15**	**88**	**2**	**71**	**5**	**167**	**32**	**25**	**57**
16:15	16:30	72	1	86	2	164	28	33	61
16:30	16:45	52	2	61	3	119	25	24	49
16:45	17:00	52	2	61	3	119	25	24	49
	TOTAL	2102	127	1936	88	4303	1598	1473	3079
	PEAK HOUR VOLUME	327	9	320	12	671	146	107	253
	PEAK INTERVAL * 4	416	12	416	20	756	208	176	384
	PEAK HOUR FACTOR	0.786	0.750	0.769	0.600	0.888	0.702	0.608	0.659
	% Trucks in Peak Hour	3%		4%					
PEDESTRIAN PEAK		207	16	209	6	447	222	348	570
PEDESTRIAN PEAK		276	20	284	8	548	484	884	1368
PEDESTRIAN PEAK		0.750	0.800	0.736	0.750	0.816	0.459	0.394	0.417
% TRUCKS IN PEAK		7%		3%					

Modeling

The model was created using the Synchro 5 program. Syncrho 5 is a delay based model that performs a Level of Service analysis of each approach. The level of service is determined for each movement based on the expected delay. The inputs to the model are both the geometrics of the road and the volume expected. The current system can be modeled by entering the geometric properties of the road including number of lanes, length and widths of lanes, length of storage lanes, distances from intersection to intersection, turning radii, and speed limit. The volumes of both pedestrian and vehicle flows are also entered into the program, including percent of heavy vehicles, as well as the peak hour factor and growth factor. Signal timings can also be entered or the option to optimize the signal can also be used. In this case, the option to optimize the signal timing was used to try and simulate the best condition that the system could see. Figure 8 shows a screenshot of the initial screen. Figure 9 shows how the geometric properties of the intersections were added. Figure 10 shows how the volumes and peak hour factors were entered. Figure 11 shows the level of service analysis performed by Synchro 5.

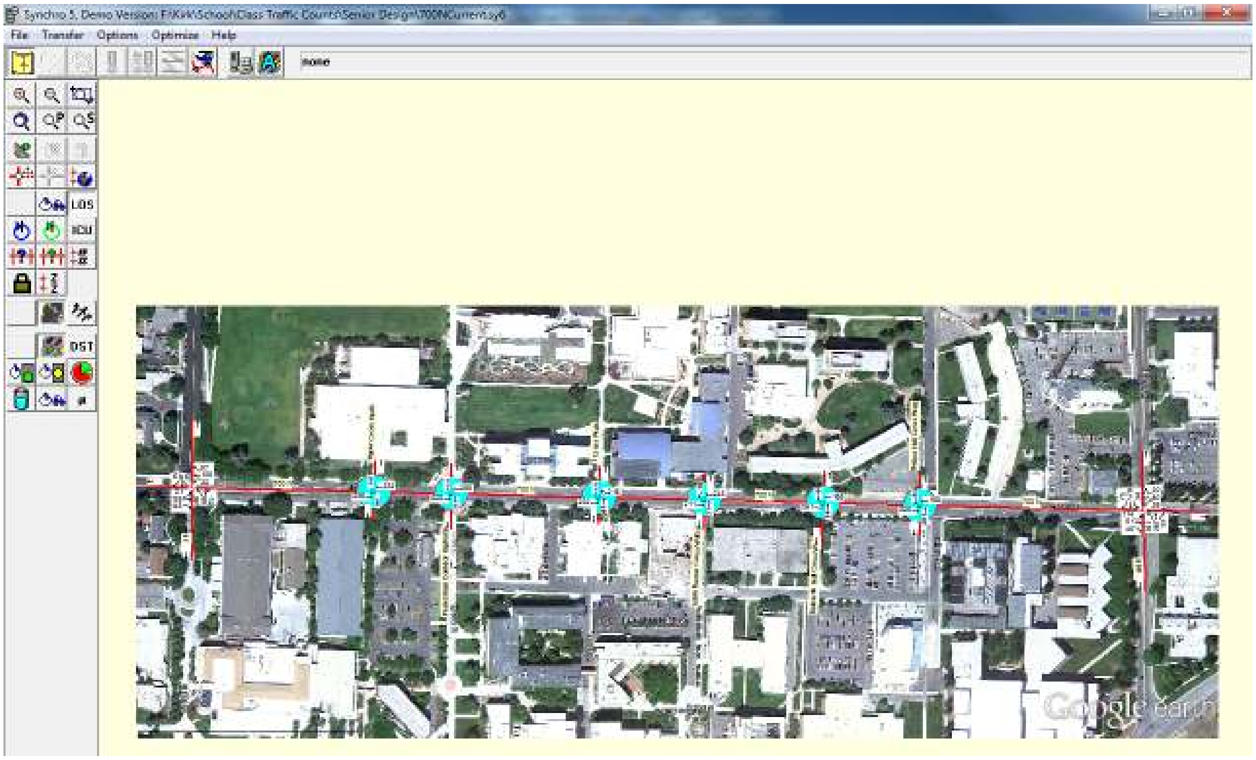
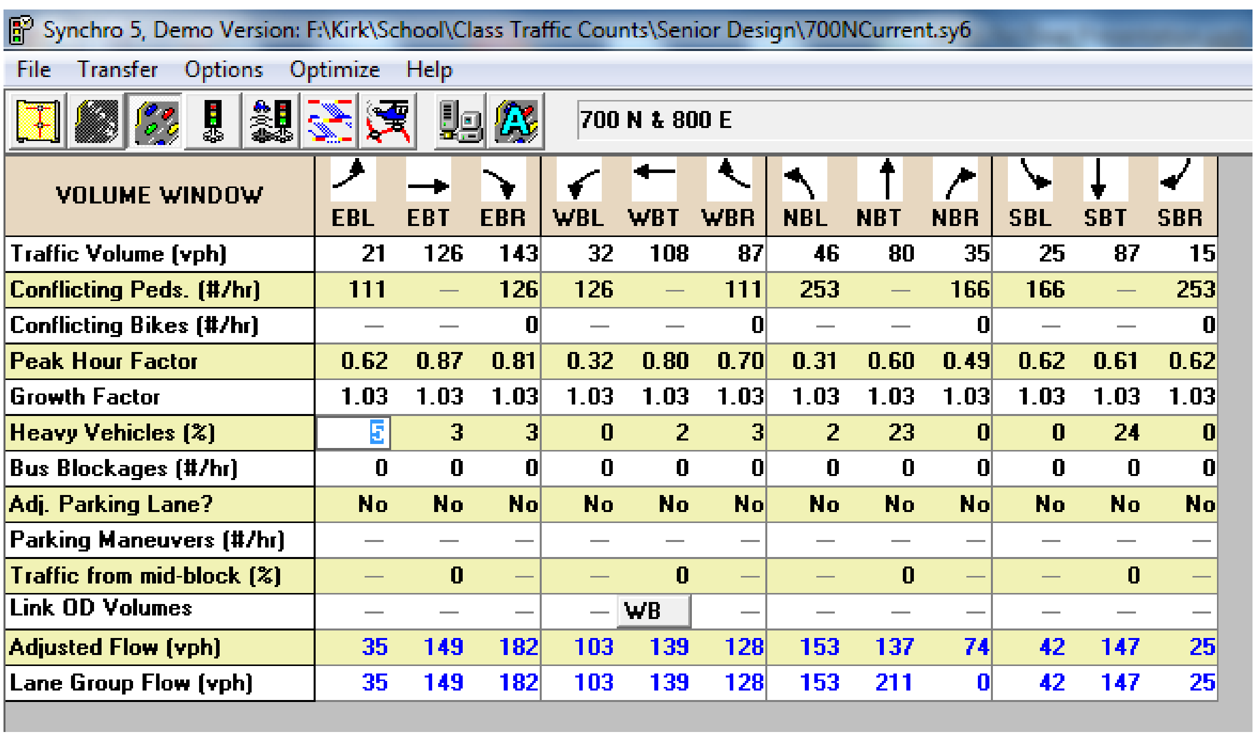
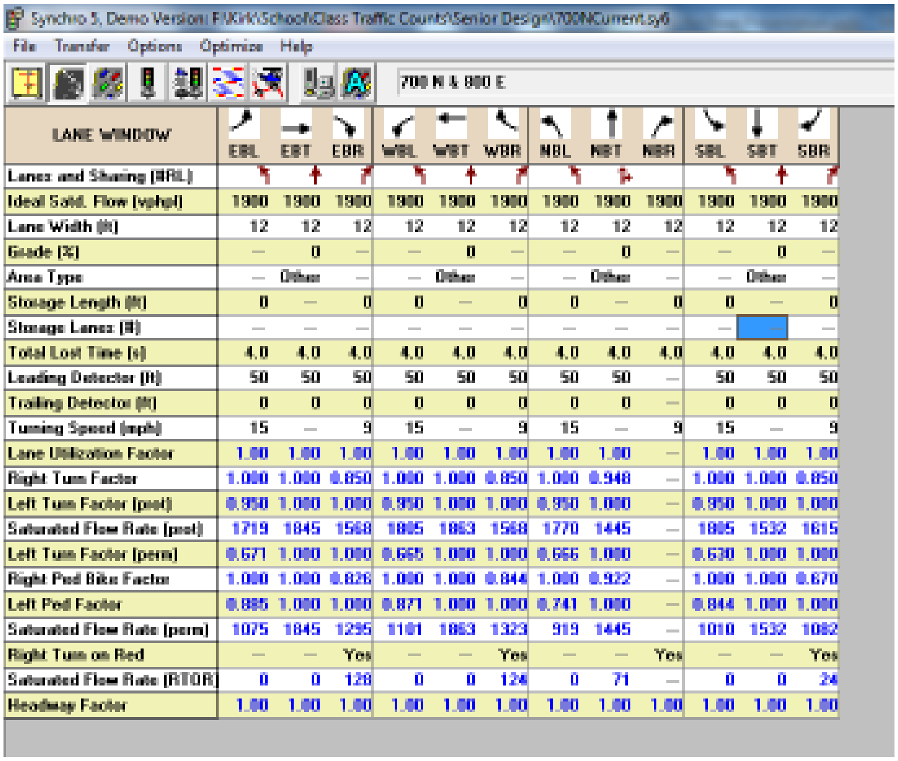


Figure 8 Synchro Analysis



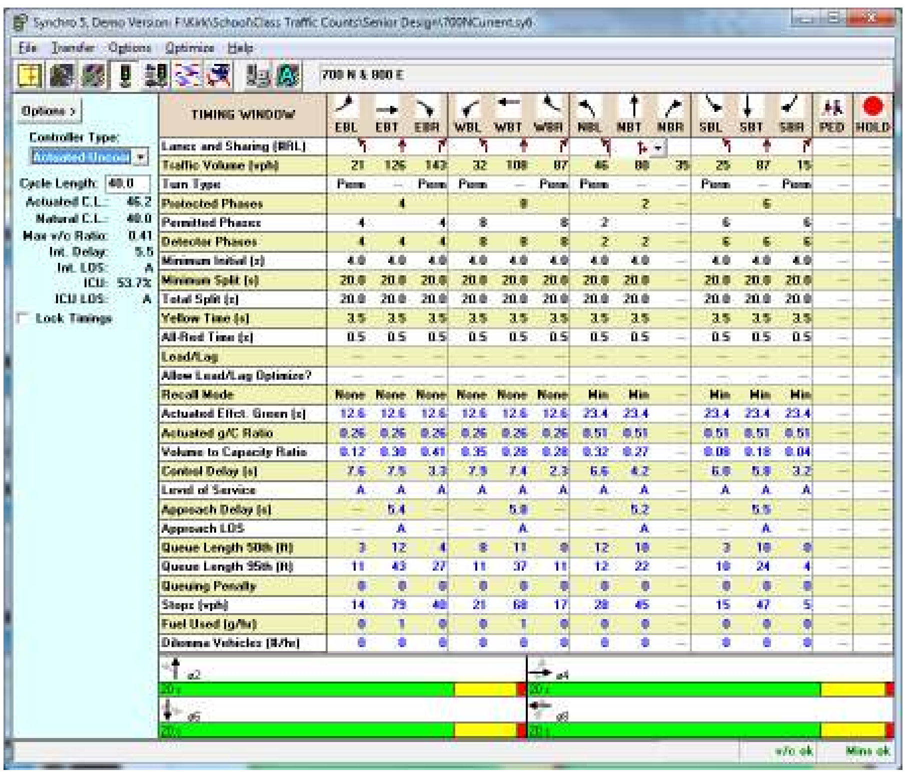
VOLUME WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Traffic Volume (vph)	21	126	143	32	108	87	46	80	35	25	87	15
Conflicting Peds. (#/hr)	111	—	126	126	—	111	253	—	166	166	—	253
Conflicting Bikes (#/hr)	—	—	0	—	—	0	—	—	0	—	—	0
Peak Hour Factor	0.62	0.87	0.81	0.32	0.80	0.70	0.31	0.60	0.49	0.62	0.61	0.62
Growth Factor	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
Heavy Vehicles (%)	5	3	3	0	2	3	2	23	0	0	24	0
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Adj. Parking Lane?	No	No	No	No	No	No	No	No	No	No	No	No
Parking Maneuvers (#/hr)	—	—	—	—	—	—	—	—	—	—	—	—
Traffic from mid-block (%)	—	0	—	—	0	—	—	0	—	—	0	—
Link OD Volumes	—	—	—	—	WB	—	—	—	—	—	—	—
Adjusted Flow (vph)	35	149	182	103	139	128	153	137	74	42	147	25
Lane Group Flow (vph)	35	149	182	103	139	128	153	211	0	42	147	25

Figure 9 Synchro Geometric Constraints



LANE WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lanes and Sharing (#RL)												
Ideal Satd. Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)	—	0	—	—	0	—	—	0	—	—	0	—
Area Type	—	Other	—	—	Other	—	—	Other	—	—	Other	—
Storage Length (ft)	0	—	0	0	—	0	0	—	0	0	—	0
Storage Lanes (#)	—	—	—	—	—	—	—	—	—	—		—
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
Leading Detector (ft)	50	50	50	50	50	50	50	50	—	50	50	50
Trailing Detector (ft)	0	0	0	0	0	0	0	0	—	0	0	0
Turning Speed (mph)	15	—	9	15	—	9	15	—	9	15	—	9
Lane Utilization Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	—	1.00	1.00	1.00
Right Turn Factor	1.000	1.000	0.850	1.000	1.000	0.850	1.000	0.948	—	1.000	1.000	0.850
Left Turn Factor (prot)	0.950	1.000	1.000	0.950	1.000	1.000	0.950	1.000	—	0.950	1.000	1.000
Saturated Flow Rate (prot)	1719	1845	1568	1805	1863	1568	1770	1445	—	1805	1532	1615
Left Turn Factor (perm)	0.671	1.000	1.000	0.665	1.000	1.000	0.666	1.000	—	0.630	1.000	1.000
Right Ped Bike Factor	1.000	1.000	0.826	1.000	1.000	0.844	1.000	0.922	—	1.000	1.000	0.670
Left Ped Factor	0.885	1.000	1.000	0.871	1.000	1.000	0.741	1.000	—	0.844	1.000	1.000
Saturated Flow Rate (perm)	1075	1845	1295	1101	1863	1323	919	1445	—	1010	1532	1082
Right Turn on Red	—	—	Yes	—	—	Yes	—	—	Yes	—	—	Yes
Saturated Flow Rate (RTOR)	0	0	128	0	0	124	0	71	—	0	0	24
Headway 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

Figure 10 Synchro Volume Constraints



TIMING WINDOW	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	21	126	143	32	108	87	46	80	35	25	87	15	—	—
Turn Type	Perm	—	Perm	Perm	—	Perm	Perm	—	—	Perm	—	Perm	—	—
Protected Phases		4			8			2	—		6			
Permitted Phases	4		4	8		8	2		—	6		6	—	—
Detector Phases	4	4	4	8	8	8	2	2	—	6	6	6	—	—
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	—	4.0	4.0	4.0	—	—
Minimum Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	—	20.0	20.0	20.0	—	—
Total Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	—	20.0	20.0	20.0	—	—
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	—	3.5	3.5	3.5	—	—
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	—	0.5	0.5	0.5	—	—
Lead/Lag	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Allow Lead/Lag Optimize?	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Recall Mode	None	None	None	None	None	None	Min	Min	—	Min	Min	Min	—	—
Actuated Effct. Green (s)	12.6	12.6	12.6	12.6	12.6	12.6	23.4	23.4	—	23.4	23.4	23.4	—	—
Actuated g/C Ratio	0.26	0.26	0.26	0.26	0.26	0.26	0.51	0.51	—	0.51	0.51	0.51	—	—
Volume to Capacity Ratio	0.12	0.30	0.41	0.35	0.28	0.28	0.32	0.27	—	0.08	0.18	0.04	—	—
Control Delay (s)	7.6	7.5	3.3	7.9	7.4	2.3	6.6	4.2	—	6.0	5.8	3.2	—	—
Level of Service	A	A	A	A	A	A	A	A	—	A	A	A	—	—
Approach Delay (s)	—	5.4	—	—	5.8	—	—	5.2	—	—	5.5	—	—	—
Approach LOS	—	A	—	—	A	—	—	A	—	—	A	—	—	—
Queue Length 50th (ft)	3	12	4	8	11	0	12	10	—	3	10	0	—	—
Queue Length 95th (ft)	11	43	27	11	37	11	12	22	—	10	24	4	—	—
Queuing Penalty	0	0	0	0	0	0	0	0	—	0	0	0	—	—
Stops (vph)	14	79	40	21	68	17	28	45	—	15	47	5	—	—
Fuel Used (g/hr)	0	1	0	0	1	0	0	0	—	0	0	0	—	—
Dilemma Vehicles (#/hr)	0	0	0	0	0	0	0	0	—	0	0	0	—	—

Figure 11 Synchro Level of Service Analysis

Analysis

The level of service of each approach in the system was calculated for each intersection for the current system. This process was repeated for each alternative solution. The following sections outline the analysis for the current system and doing nothing, for adding two HAWK signals, and for closing 700 N and adding two roundabouts.

Current System Do Nothing

The current system was evaluated using the level of service analysis. The level of service of the two signalized intersections at 700 N 800 E and 700 N 1200 E were both determined to be a LOS A. The level of service of the HPER Crosswalk, the 900 E Crosswalk, the IT Crosswalk, the Education Crosswalk, Richard’s Hall Crosswalk, and Bullen Hall Crosswalk were determined to be D, D+, B, B, B-, and B- respectively. A summary of the LOS of each intersection is shown in Figure 12.

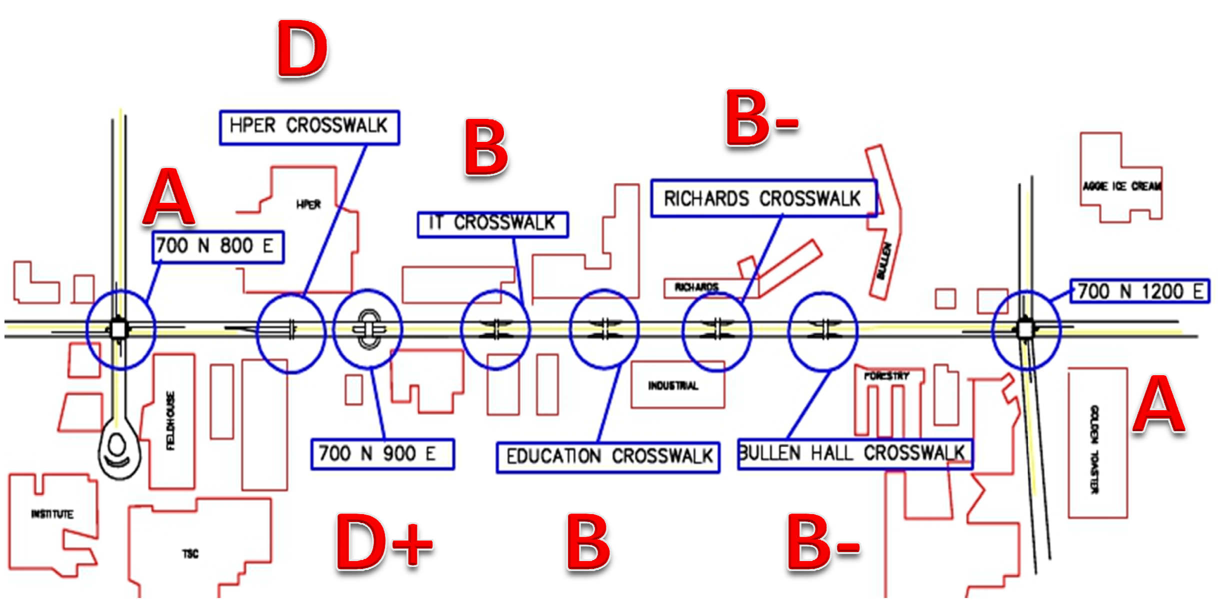


Figure 12 Current LOS of Intersections

As with most areas around the world the population of Logan and therefore Cache County, Utah is increasing. An increase in population in the valley would correlate to an increase in the number of student at Utah State University. With more and more people on campus, the possibility for congestion on 700 North would only increase, as would the possibility of serious accidents occurring. Based on data from the 2010 U.S. Census, the population of Cache County Utah has been increasing at a rate of about 2.5% for the last forty years (Logan Library 2012). The projected growth of Cache County is expected to continue increasing at that same rate for the next fifty years and the population of the valley could be more than double the current population. Table 3 and Figure 13 show the population data from 1970 to 2010 of both Logan, Utah and Cache County, Utah.

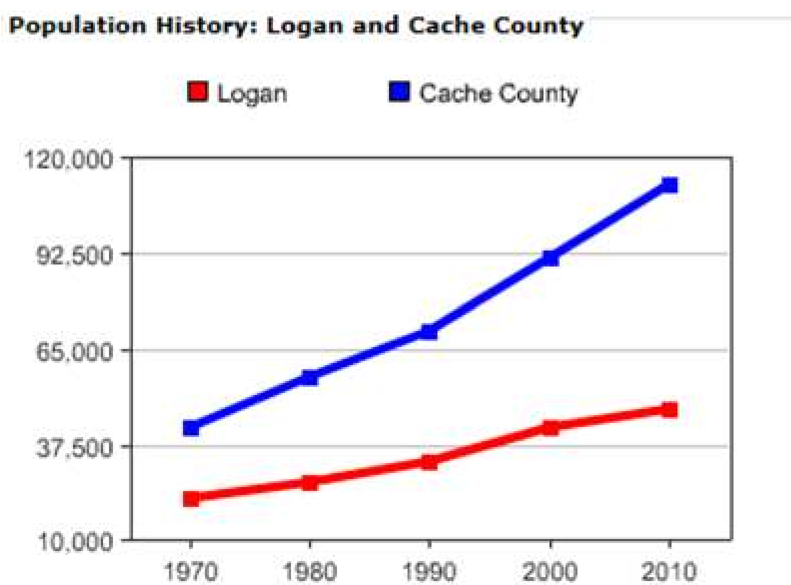


Figure 13 Population History Logan and Cache County

Table 3 U.S. Census Data, Cache County, Utah

Year	1970	1980	1990	2000	2010
Logan	22,333	26,844	32,762	42,670	48,174
Cache County	42,331	57,176	70,183	91,391	112,656

Table 4 and Figure 14 shown below shows the projected population growth for both Logan, Utah and Cache County Utah for the next 50 years through 2060 (Logan Library 2012). As is shown in the figure, the population is expected to increase form the current size of 149,322 to 331,594. This is more than double.

With the increasing population in Cache Valley and the rising number of students enrolled at Utah State University the system performance will only decrease; therefore, something must be done for 700 N in order to increase performance and student safety.

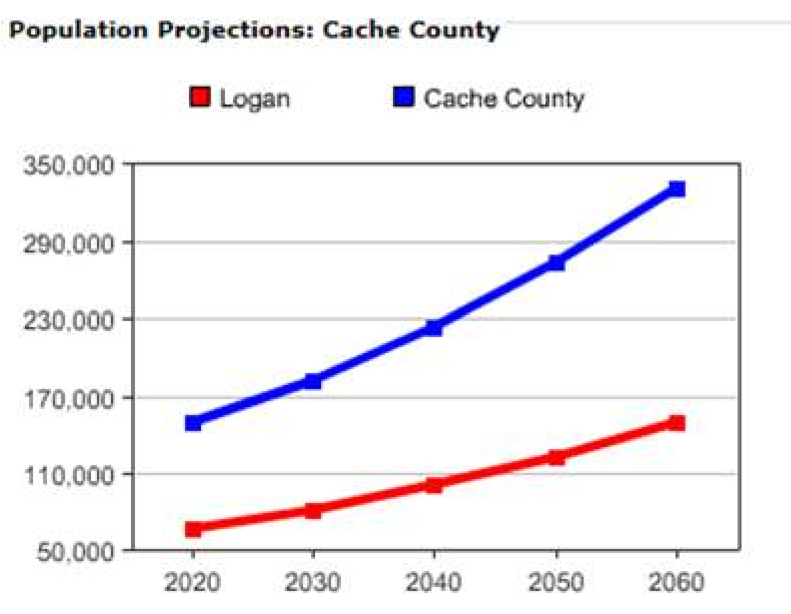


Figure 14 Population Projections for Cache County

Table 4 Census Population Projections Cache County

Year	2020	2030	2040	2050	2060
Logan	67,122	81,530	101,238	122,253	149,097
Cache County	149,322	181,921	223,442	274,527	331,594

With such a drastic increase in population, a similar increase would be expected for the population of Utah State University. The enrollment numbers hit an all-time high in the fall of 2011 (Utah State Today 2011). The student population increased 2.09% over 2010 in the fall of 2011. This increase was at a similar rate to that of the local population. With such a correlation it would be expected that the number of students on campus would increase at about 2% per year causing more concern for student safety at major crosswalks.

With the data from the U.S. Census of 2010 a growth factor was calculated, for use in the program Synchro, of 1.03. This factor is used to account for an increase in population when generating a traffic model.

The current system does not meet ASSHTO guidelines. As shown before, the current system is not performing well with some intersections having a level of service as low as D-. The option to do nothing for this road is not feasible.

HAWK Pedestrian Signals

High-intensity Activated Crosswalk (HAWK) is a combination of a beacon flasher and traffic control signaling technique. It is a new kind of signal designed to help pedestrian crossing. While different in appearance to the driver, to the pedestrian this signal works the same as any button-activated traffic signal in the district. It stops traffic with a red signal allowing pedestrians to cross safely.

Operation sequence

Using a hawk signal as a pedestrian is easy. Pedestrians only have to push button and wait for the walk signal to show up. In the driver case, they need to have a better feeling of the system sequence. An operation sequence for the drivers is shown below.

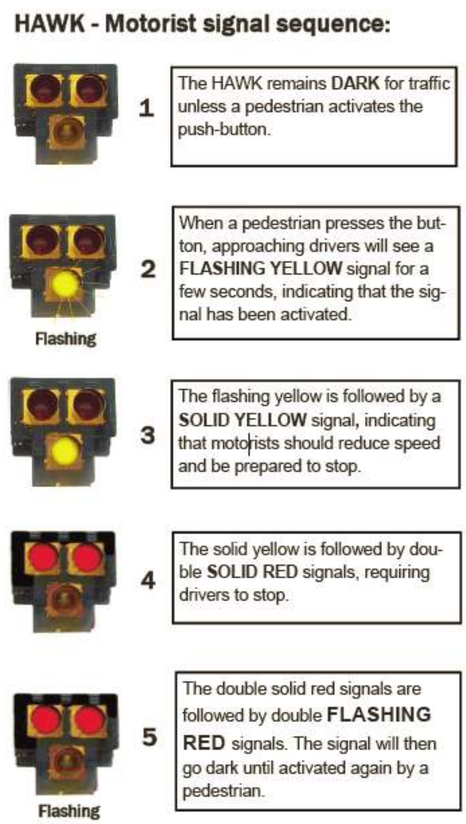


Figure 15 HAWK Motorist Signal Sequence

Hawk Signal Structural Support

Design Criteria for Structural Supports for Traffic Signals

Criterion #1

The plans for the proposed structural supports for traffic signals (supports) shall be in conformity with latest versions of pertinent specifications, standards, manuals, and guidelines and shall be specific to the proposed location. The supports must be designed to promote the safety and welfare of the public.

Criterion #2

The proposed supports shall be cost-effective, durable, and shall minimize post-construction maintenance and repair costs. Designers shall look to take advantage of local materials, construction techniques and labor.

Criterion #3

The proposed supports shall not, in their design and appearance, be inconsistent with the appearance of other existing structural supports in the neighborhood.

Principal requirements for designing of traffic signal structural supports

Traffic signal structures must be designed in accordance with AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (2001 Edition).

Traffic signal structures shall be designed to resist without destruction all applied loads as established by the Bureau of Traffic Engineering, including wind and fatigue loads developed by a wind velocity of at least 90 mph in accordance with AASHTO Standard Specifications (American Association of State Highway Transportation Officials, 2011). Any deflections caused by standard loads and/or wind shall never result in a clearance between the roadway and the lowest point of the signal assembly of less than 15 ft.

Pole and Mast Arm Assembly Materials

Members and components shall meet the requirements of the latest editions of the standards as follows (American Association of State Transportation Officials, 2001):

• Poles and mast arms

- ASTM A595 Grade A (55 ksi yield) or B (60 ksi yield) – for round members

- ASTM A570 or ASTM A572 Grade 55, 60, or 65 – for multi-sided members

- Steel plates

- ASTM A36 or ASTM A709 Grade 36 or ASTM A572 Grade 50

• Anchor bolts

- ASTM F1554 Grade 55

• Nuts for anchor bolts

- ASTM A563 Grade A Heavy Hex

• Washers for anchor bolts

- ASTM F436 Type I

• Bolts (other than anchor bolts)

- ASTM A325 Type I

• Nut covers

- ASTM B26

• Stainless Steel Screws

-AISI 316

• Caps

- ASTM A1011 Grade 55, 60, or 65 ksi, or

- ASTM B209, or

- Others, such as zinc, aluminum, and ASTM Steel A36

• Threaded Bars and Studs

- ASTM A36 or ASTM A307

All steel components shall be galvanized as to meet the requirements of the latest editions of the standards as follows:

• All nuts, bolts, washers, and threaded bars and studs

- ASTM A153 Class C or D (hot dip galvanized)

• Pole and mast arm and other steel accessories/items not included above

- ASTM A123

• All welding of steel shall conform to the requirements of ANSI/AWS D1.1.

The tables shown below are intended to help the designer to choose a pole diameter and thickness based on the mast arm length used in the design.

Table 5 AASHTO Design Criteria for Signal Arms (American Association of State Transportation Officials, 2001)

Table 4.1: Recommended Dimensions for Pole Diameters based on Mast Arm Lengths for 90 mph Winds

Mast Arm Length	Poles			
	D_{base}	$D_{at\ MA\ connection}$	Thickness	Base Plate
(ft)	(in)	(in)	(in)	(in)
20	11.0	8.3	0.239	18 x 18
24	11.0	8.3	0.239	18 x 18
28	11.5	8.8	0.239	18 x 18
32	12.5	9.8	0.239	18 x 18
36	13.0	10.3	0.239	18 x 18
40	13.0	10.3	0.239	18 x 18
For mast arm lengths of over 40 ft consult manufacturer				

Table 4.2: Recommended Dimensions for Mast Arm Diameters based on Mast Arm Lengths for 90 mph Winds

Mast Arm Length	Mast Arm		
	D_{base}	D_{tip}	Thickness
(ft)	(in)	(in)	(in)
20	7.5	4.7	0.179
24	8.5	5.1	0.179
28	9.0	5.1	0.179
32	9.0	4.5	0.239
36	9.5	4.5	0.239
40	10.0	4.4	0.239
44	10.5	4.3	0.239
48	11.0	4.3	0.239
For mast arm lengths of over 48 ft consult manufacturer			

In our case we selected a pole with a diameter of 11 inches and a thickness of 0.239 inches. A base plate of 18x18 inches will be used. Our selection was based in the fact that we are designing for only the pole.

Foundation design of the Hawk Pedestrian Systems

Since the foundation of the Hawk pedestrian system depends on the type of soil in the area it will be important to specify where exactly this project proposes where to implement the hawk signals. The locations are shown in the following figure

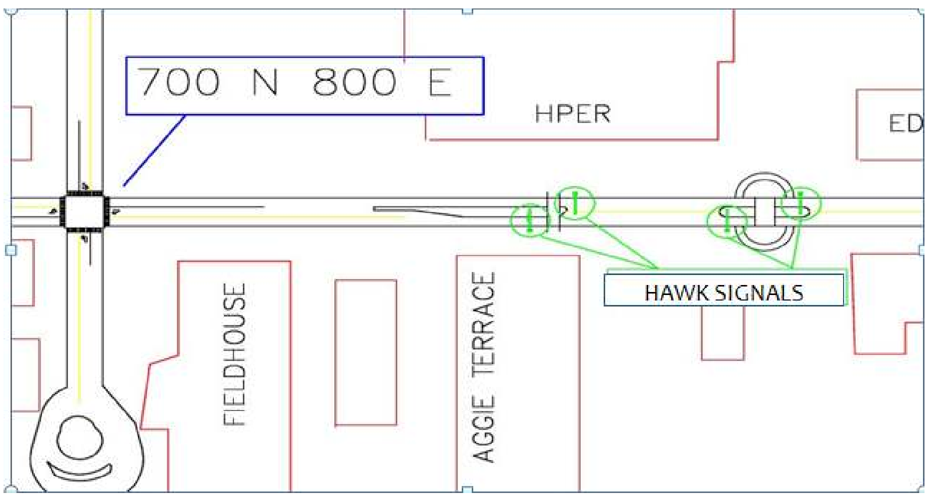


Figure 16 Proposed locations of the Hawk Signals

The 2001 AASTHTO design manual provides design guidance regarding foundations for the Haw pedestrian systems. It also provides information on the actual pile foundation, eccentrically loaded spread footings and procedure about how to calculate the depth of the drilled shafts. For the foundation design some of the factors that have been taken into consideration are the structure of the hawk signal, soil type, ground water and stiffness. The Structure of the haw signals have been already identified in the previous section as well as the stiffness. In order to get the soil type of the area where it is intended to implement the haws signals it is required to perform a standard penetration test which is out of the scope of this senior design project. Yet, Utah State facilities have in their possession such information. For haws signals the most common foundation is the concrete drilled shaft which is the one to be implemented for this project (American Association of State Highway Transportation Officials, 2011).

In order to calculate the embedment depth of the drilled shaft it will be used the Brom's Method. This method provides formulas to calculate the depth for cohesive soils and for cohesion less soil.

For Cohesive Soils

$$L^3 - \frac{2V_F L}{K_p \gamma D} - \frac{2M_F}{K_p \gamma D} = 0$$

$$K_p = \tan^2\left(45 + \frac{\phi}{2}\right)$$

ϕ = angle of internal friction (deg)

γ = effective unit weight of soil (k/ft^3)

Figure 17Soil Embedment Depth Cohesive (American Association of State Transportation Officials, 2001)

For Cohesionless soils

$$L = 1.5D + q\left[1 + \sqrt{2 + \frac{(4H + 6D)}{q}}\right]$$

$$H = \frac{M_F}{V_F} \qquad q = \frac{V_F}{9cD}$$

c = shear strength of cohesive soil (k/ft^2)

D = with or diameter of foundation (ft)

q = coefficient (ft)

M_F = applied moment at groundline including an appropriate safety

V_F = applied shear load at groundline including an appropriate safety

Figure 18 Soil Embedment Depth Cohesionless (American Association of State Transportation Officials, 2001)

The equation to be used will depend on the type of soil of the area where the hawk signals are going to be used. The input values for the equation to be used will be provided by the Utah State University in order to be able to calculate the depth of embedment.

The system was evaluated using the level of service analysis after adding two HAWK pedestrian signals at the locations specified. The level of service of the two signalized intersections at 700 N 800 E and 700 N 1200 E were both determined to be a LOS A. The level of service of the HPER Crosswalk, the 900 E Crosswalk, the IT Crosswalk, the Education Crosswalk, Richard's Hall Crosswalk, and Bullen Hall Crosswalk were determined to be A-, A, B, B, B-, and B- respectively. A summary of the LOS of each intersection is shown in Figure 19.

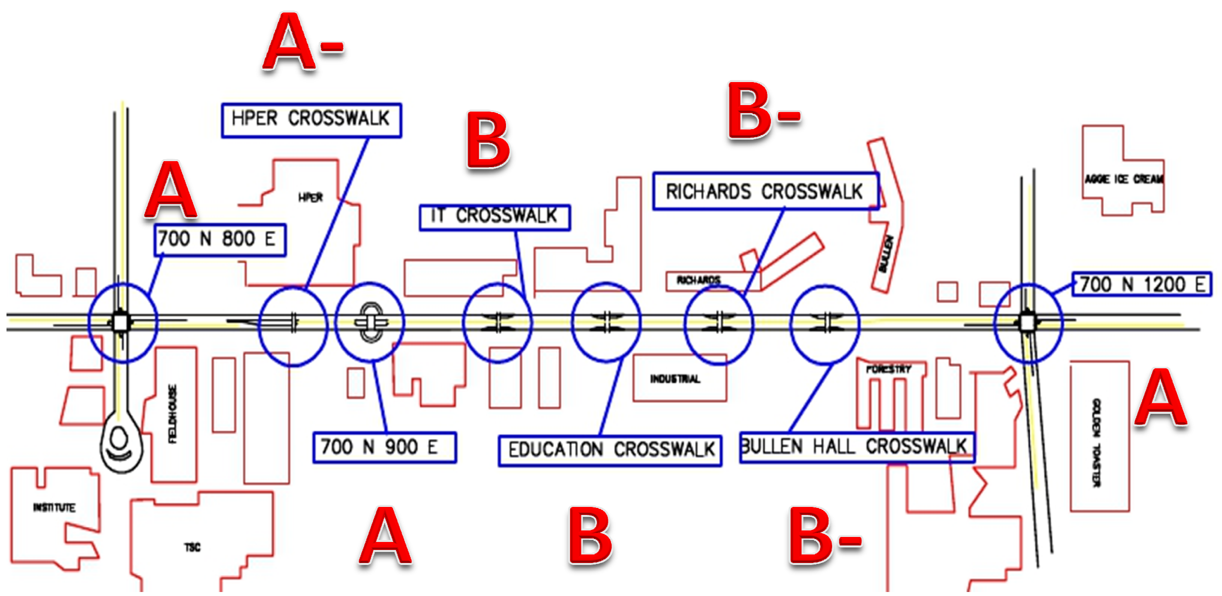


Figure 19 LOS After Adding HAWK Signals

The implementation of the HAWK signals is the proposed solution to the congestion on 700 North through the University campus. These signals have seen success and there are local examples in Salt Lake City, Utah. The cost for installing HAWK signals at one intersection would be anywhere from $80,000 to $120,000 (Page 2008).Whereas the proposed solution would require signals at two intersections; the total cost would be closer to $240,000. This is a minimal cost compared to the value of the students at Utah State. The traffic analysis from the program Synchro shows a decrease in user delay from about thirty seconds to as low as three seconds. This would decrease fuel consumption of cars idling and the potential of accidents on 700 North. According to Steve Mile from the University police, there have been several accidents on this road since 2008 with an average cost of about $2500. It is difficult to put a value on the lives of the students at Utah State, but the benefits of improving the system definitely outweigh the costs.

Closing 700 N and Adding Roundabouts

The facilities mentioned a roundabout solution closing off 700 N, similar to their previous construction in front of the TSC closing Champ Drive. A possible risk management solution to the 700 N was to close off the road to passenger vehicles and then implement two roundabouts. A roundabout would be constructed at both the east bound and west bound direction. The eastbound roundabout would be constructed on 900 E where the largest pedestrian traffic on campus currently is. The westbound roundabout would be constructed near the current Richard's crosswalk. These two roundabouts would allow passenger vehicles to access parking lots and drop off passengers.

One problem with closing off 700 N is the current use by public transit such as CVTD and the Aggie Shuttle. Also the buildings on 700 N will still need emergency access. We have designed a gate system at each roundabout. This gate system will only open allowing public transit and emergency vehicles through. Public transit drivers are relatively more aware of pedestrians than passenger vehicles. Also the amount of traffic on 700 N would be exponentially decrease allowing pedestrians more safety and less chances of collision.

The island medians extending from the roundabouts on the both the east bound and west bound side will be continued on to the beginning of the turning lanes at 800 E and 1200 E. This will eliminate the cross walks in front of the HPER and the Forestry building. This will help prevent people from Jay walking in front of the field house or the fine arts buildings. Pedestrians will be persuaded to cross 700 N in the safe areas or the timed signals at 800 E and 1200 E.

The system was evaluated using the level of service analysis after closing 700 N and adding two roundabouts at the locations specified. The level of service of the two signalized intersections at 700 N 800 E and 700 N 1200 E were both determined to be a LOS A. The level of service of the HPER Crosswalk, the 900 E Crosswalk, the IT Crosswalk, the Education Crosswalk, Richard's Hall Crosswalk, and Bullen Hall Crosswalk were not determined. It was determined that closing 700 N would considerably change the traffic flow patterns. It would require a full scale planning study to understand how this change in the network would affect traffic flow in the future. A summary of the LOS of each intersection is shown in Figure 20.

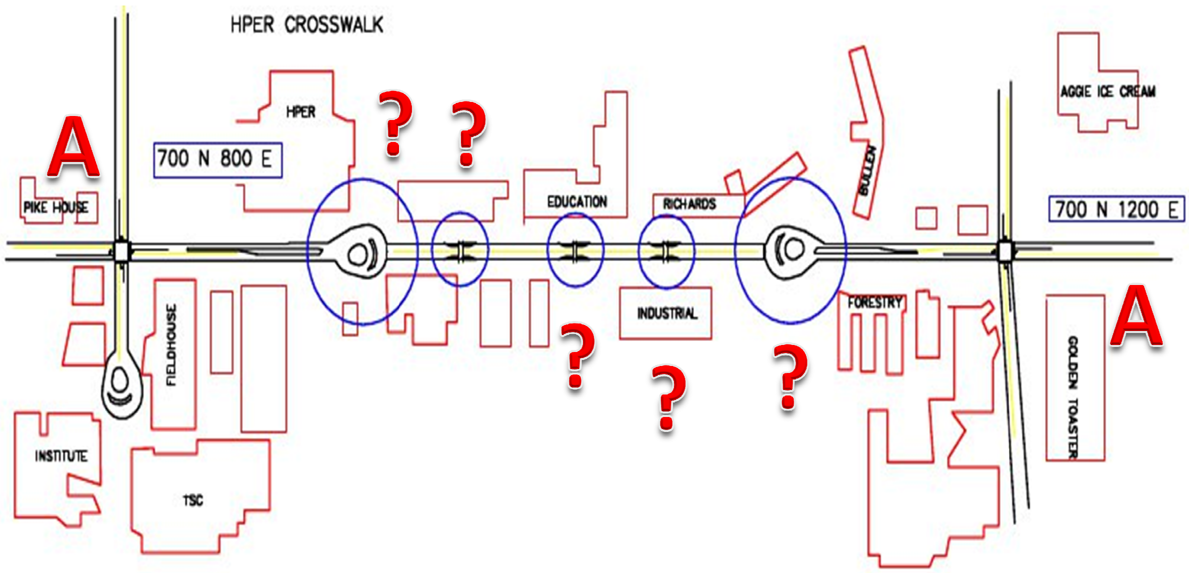


Figure 20 LOS of Intersections After Closing 700 N

Without knowing the actual change to the LOS after implementing roundabouts, it is unknown what the benefit would be. Based on general opinion, roundabouts would not be a desired solution and have are viewed negatively in the public's eye. Our preliminary analysis is that the roundabouts would not improve the system any more than the HAWK signals would. According to the NCHRP Synthesis 264 the average cost of installing roundabout is about $250,000 (NCHRP 2012). The closure of 700 North would require two roundabouts and would cost upwards of $500,000, much more than the cost of the HAWK signals. Whereas the cost of the roundabouts would be at least double that of the HAWK signals, the proposed alternative would be the implementation of the HAWK Pedestrian System.

Conclusion and Recommendations

After conducting a level of service analysis of the current condition of traffic flow on 700 N, it was determined that the system was not functioning sufficiently to provide safety to pedestrians crossing 700 N. The LOS of the HPER crosswalk and the 900 E crosswalk were determined to be below serviceable conditions. It was determined that a solution needed to be implemented to address this issue. The level of service analysis was performed on three alternative solutions to determine which alternative would be most cost effective. Adding two HAWK signals, one at each of the failing intersections, increased performance of the network the most and was the least cost constraining. Adding the HAWK signals reduced overall user delay from 30 seconds to 3 seconds, increasing the LOS from a D to an A. It is therefore recommended that USU facilities, in order to increase traffic flow, reduce user delay, and most importantly increase pedestrian safety along 700 N on USU campus, signalize the pedestrian crosswalks at the HPER building and at 900 E using the HAWK pedestrian signals.

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Appendix A – Traffic Data

Intersection: 700 N 800 E

Date: 10/3/2011 | Vehicle Peak Hour

Weekday: Monday | Pedestrian Peak Hour

Peak Hour: 11:15-12:15

		Vehicle																									Pedestrian								
		DIRECTION:	From South					DIRECTION:	From North					DIRECTION:	From West					DIRECTION:	From East						Pedestrian from		Pedestrian from		Pedestrian from		Pedestrian from		
From	To	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truck	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truck	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truck	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truck		North	West	North	East	South	East	South	West	
Code		NBLC	NBLT	NBTC	NBTT	NBRC	NBRT	SBLC	SBLT	SBTC	SBTT	SBRC	SBRT	EBLC	EBLT	EBTC	EBTT	EBRC	EBRT	WBLC	WBLT	WBTC	WBTT	WBRC	WBRT	TOTAL	PSER	PSEL	PSWL	PSWR	PNWR	PNWL	PNEL	PNER	TOTAL
7:30	7:45	9	0	14	2	3	0	9	0	8	7	3	7	0	0	14	0	14	1	6	0	38	1	42	0	63	29	11	8	0	3	5	6	10	72
7:45	8:00	6	0	4	2	6	2	5	0	11	8	5	8	3	2	10	2	15	0	2	1	28	1	32	1	69	21	4	5	6	5	3	6	11	61
8:00	8:15	6	1	14	2	3	0	12	0	13	7	9	7	1	1	10	0	19	1	5	0	24	2	36	0	80	18	9	18	3	9	6	7	26	96
8:15	8:30	7	0	15	3	6	0	3	0	7	4	3	4	4	0	17	2	30	0	5	1	27	1	42	1	74	26	11	15	4	7	2	12	12	89
8:30	8:45	2	0	8	5	2	1	2	0	9	7	2	7	2	0	32	1	45	2	2	0	29	1	47	3	109	3	6	11	12	4	6	10	11	63
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10:15	10:30	32	2	26	4	18	0	15	1	22	4	3	4	3	1	24	1	42	2	23	0	29	1	17	2	122	90	41	18	40	16	3	133	19	360
10:30	10:45	14	3	6	3	14	0	4	0	5	6	2	6	3	0	14	1	19	1	7	1	14	1	2	3	61	16	8	5	10	11	3	27	3	83
10:45	11:00	21	2	7	4	7	0	0	0	5	7	1	7	1	1	10	2	15	2	9	1	11	0	2	1	51	16	8	10	4	4	5	15	2	64
11:00	11:15	28	2	7	7	15	2	2	0	2	4	2	4	1	0	15	1	26	2	17	0	21	1	8	2	59	53	8	11	11	7	3	26	11	130
11:15	**11:30**	**36**	**1**	**26**	**3**	**18**	**0**	**9**	**0**	**27**	**5**	**1**	**5**	**6**	**0**	**35**	**2**	**43**	**2**	**25**	**0**	**27**	**1**	**6**	**2**	**135**	**71**	**20**	**25**	**50**	**29**	**4**	**203**	**8**	410
11:30	**11:45**	**3**	**0**	**15**	**7**	**6**	**0**	**3**	**0**	**15**	**7**	**6**	**7**	**4**	**0**	**33**	**0**	**30**	**1**	**4**	**0**	**33**	**0**	**30**	**1**	**106**	**8**	**5**	**7**	**5**	**8**	**5**	**7**	**5**	50
11:45	**12:00**	**3**	**0**	**9**	**6**	**2**	**0**	**10**	**0**	**15**	**3**	**6**	**3**	**8**	**1**	**26**	**1**	**43**	**1**	**2**	**0**	**28**	**1**	**23**	**0**	**191**	**15**	**8**	**12**	**9**	**24**	**10**	**6**	**6**	90
12:00	**12:15**	**3**	**0**	**12**	**2**	**9**	**0**	**3**	**0**	**9**	**6**	**2**	**6**	**2**	**0**	**28**	**1**	**23**	**0**	**1**	**0**	**18**	**0**	**25**	**0**	**80**	**22**	**7**	**6**	**7**	**15**	**8**	**10**	**9**	84
12:15	12:30	12	0	14	5	5	0	12	0	14	5	5	5	6	0	36	1	49	1	6	0	36	1	49	1	134	37	17	28	13	37	17	28	13	190
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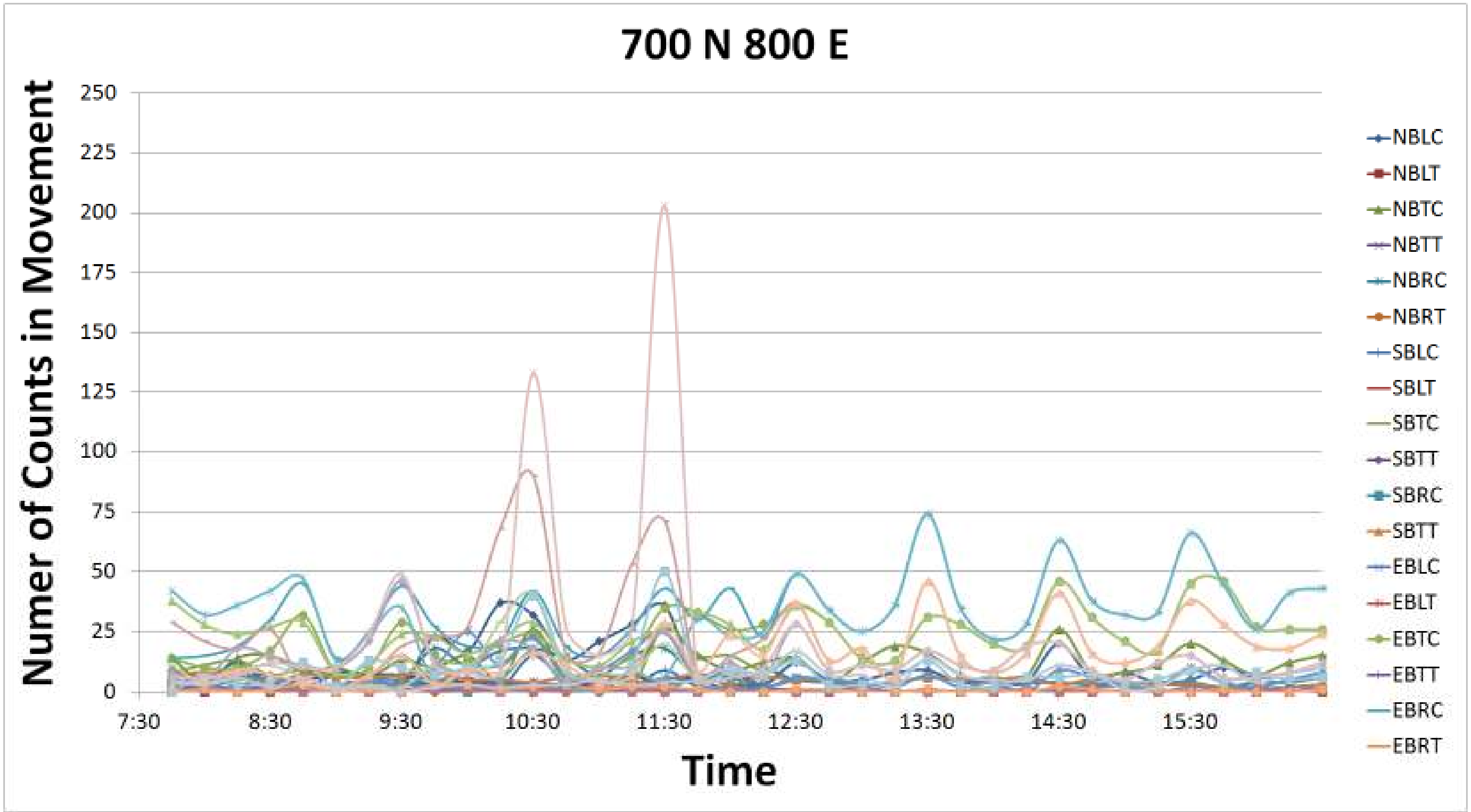
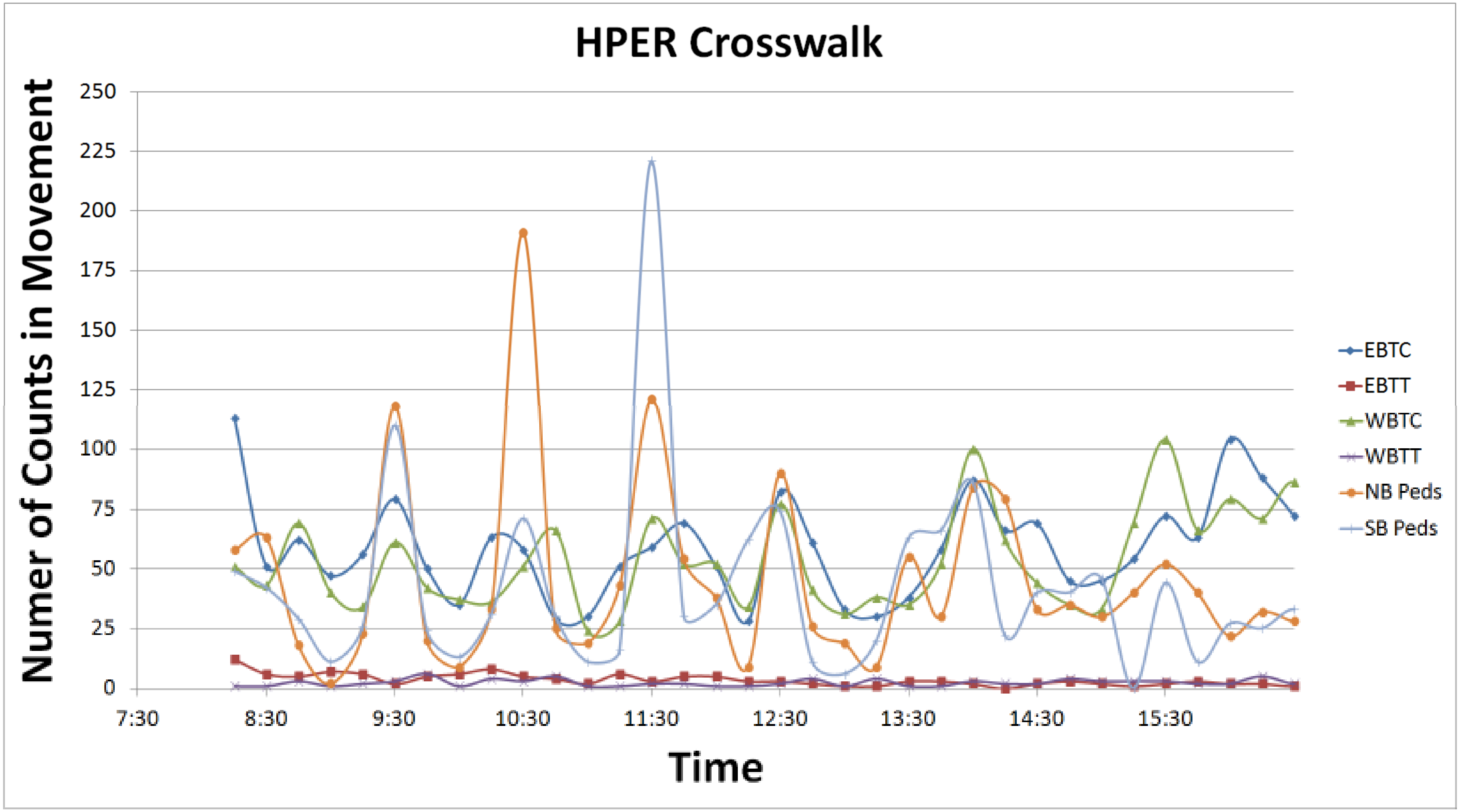
TOTAL		394	19	424	148	239	6	238	3	405	177	134	177	133	13	837	42	1204	28	242	10	907	37	1091	34	3465	906	330	477	318	559	201	785	271	3847
PEAK HOUR VOLUME		45	1	62	18	35	0	25	0	66	21	15	21	20	1	122	4	139	4	32	0	106	2	84	3	512	116	40	50	71	76	27	226	28	634
PEAK INTERVAL * 4		144	4	104	28	72	0	40	0	108	28	24	28	32	4	140	8	172	8	100	0	132	4	120	8	764	284	80	100	200	116	40	812	36	1640
PEAK HOUR FACTOR		0.313	0.250	0.596	0.643	0.486	0.000	0.625	0.000	0.611	0.750	0.625	0.750	0.625	0.250	0.871	0.500	0.808	0.500	0.320	0.000	0.803	0.500	0.700	0.375	0.670	0.408	0.500	0.500	0.355	0.655	0.675	0.278	0.778	0.387
% Trucks in Peak Hour		2%		23%		0%		0%		24%		58%		5%		3%		3%		0%		2%		3%											
ESTRIAN PEAK HOUR VOL		23	0	39	18	20	0	30	0	42	19	17	19	21	2	119	3	149	3	14	1	111	2	131	2	498	87	39	55	32	89	42	53	31	428
DESTRIAN PEAK INTERVAL		48	0	56	24	36	0	48	0	60	24	24	24	32	4	144	4	196	4	24	4	144	4	196	4	764	148	68	112	52	148	68	112	52	760
ESTRIAN PEAK HOUR FAC		0.479	#DIV/0!	0.696	0.750	0.556	#DIV/0!	0.625	#DIV/0!	0.700	0.792	0.708	0.792	0.656	0.500	0.826	0.750	0.760	0.750	0.583	0.250	0.771	0.500	0.668	0.500	0.652	0.588	0.574	0.491	0.615	0.601	0.618	0.473	0.596	0.563
% TRUCKS IN PEAK HOUR		0%		32%		0%		0%		31%		53%		9%		2%		2%		7%		2%		2%											

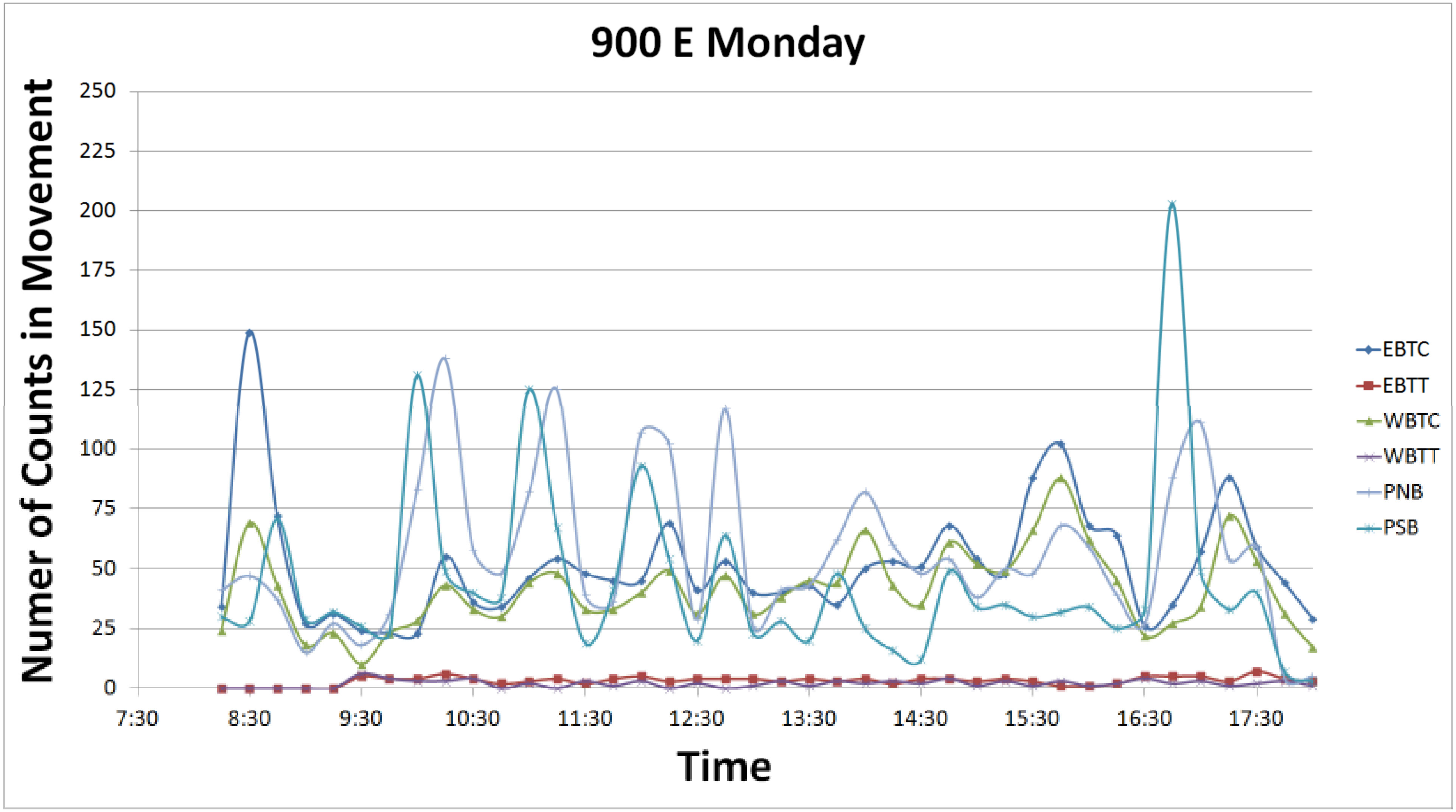

700 N 800 E
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:30
8:30
9:30
10:30
11:30
12:30
13:30
14:30
15:30
Time
NBLC
NBLT
NBTC
NBTT
NBRC
NBRT
SBLC
SBLT
SBTC
SBTT
SBRC
SBTT
EBLC
EBLT
EBTC
EBTT
EBRC
EBRT

Intersection:		Hyper Cross Walk							
Date:		10/6/2011			Vehicle Peak Hour				
Weekday:		Thursday			Pedestrian Peak Hour				
Peak Hour:		15:15-16:15							
				Vehicle				Pedestrian	
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck				
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	NB Peds	SB Peds	TOTAL
8:00	8:15	113	12	51	1	177	58	49	107
8:15	8:30	51	6	43	1	103	63	42	105
8:30	8:45	62	5	69	3	140	18	29	47
8:45	9:00	47	7	40	1	96	2	11	13
9:00	9:15	56	6	34	2	99	23	26	49
9:15	9:30	79	2	61	3	145	118	110	228
9:30	9:45	50	5	42	6	107	20	24	44
9:45	10:00	35	6	37	1	80	9	13	22
10:00	10:15	63	8	36	4	111	33	31	64
10:15	10:30	58	5	51	3	118	191	71	262
10:30	10:45	29	4	66	5	105	25	30	55
10:45	11:00	30	2	24	1	58	19	11	30
11:00	11:15	51	6	28	1	86	43	16	59
11:15	11:30	59	3	71	2	137	121	221	342
11:30	11:45	69	5	52	2	130	54	30	84
11:45	12:00	51	5	52	1	110	38	35	73
12:00	12:15	28	3	34	1	70	9	62	71
12:15	12:30	82	3	77	2	168	90	74	164
12:30	12:45	61	2	41	4	108	26	11	37
12:45	13:00	33	1	31	1	67	19	6	25
13:00	13:15	30	1	38	4	75	9	20	29
13:15	13:30	38	3	35	1	81	55	63	118
13:30	13:45	58	3	52	1	114	30	66	96
13:45	14:00	87	2	100	3	195	84	86	170
14:00	14:15	66	0	62	2	131	79	22	101
14:15	14:30	69	2	44	2	118	33	40	73
14:30	14:45	45	3	35	4	90	35	40	75
14:45	15:00	45	2	33	3	84	30	46	76
15:00	15:15	54	1	69	3	127	40	0	48
15:15	**15:30**	**72**	**2**	**104**	**3**	**181**	**52**	**44**	**96**
15:30	**15:45**	**63**	**3**	**66**	**2**	**134**	**40**	**11**	**51**
15:45	**16:00**	**104**	**2**	**79**	**2**	**189**	**22**	**27**	**49**
16:00	**16:15**	**88**	**2**	**71**	**5**	**167**	**32**	**25**	**57**
16:15	16:30	72	1	86	2	164	28	33	61
16:30	16:45	52	2	61	3	119	25	24	49
16:45	17:00	52	2	61	3	119	25	24	49
	TOTAL	2102	127	1936	88	4303	1598	1473	3079
PEAK HOUR VOLUME		327	9	320	12	671	146	107	253
PEAK INTERVAL * 4		416	12	416	20	756	208	176	384
PEAK HOUR FACTOR		0.786	0.750	0.769	0.600	0.888	0.702	0.608	0.659
Trucks in Peak Hour		3%		4%					
TRIAN PEAK HOUR VO		207	16	209	6	447	222	348	570
STRIAN PEAK INTERV		276	20	284	8	548	484	884	1368
TRIAN PEAK HOUR FA		0.750	0.800	0.736	0.750	0.816	0.459	0.394	0.417
TRUCKS IN PEAK HOU		7%		3%					

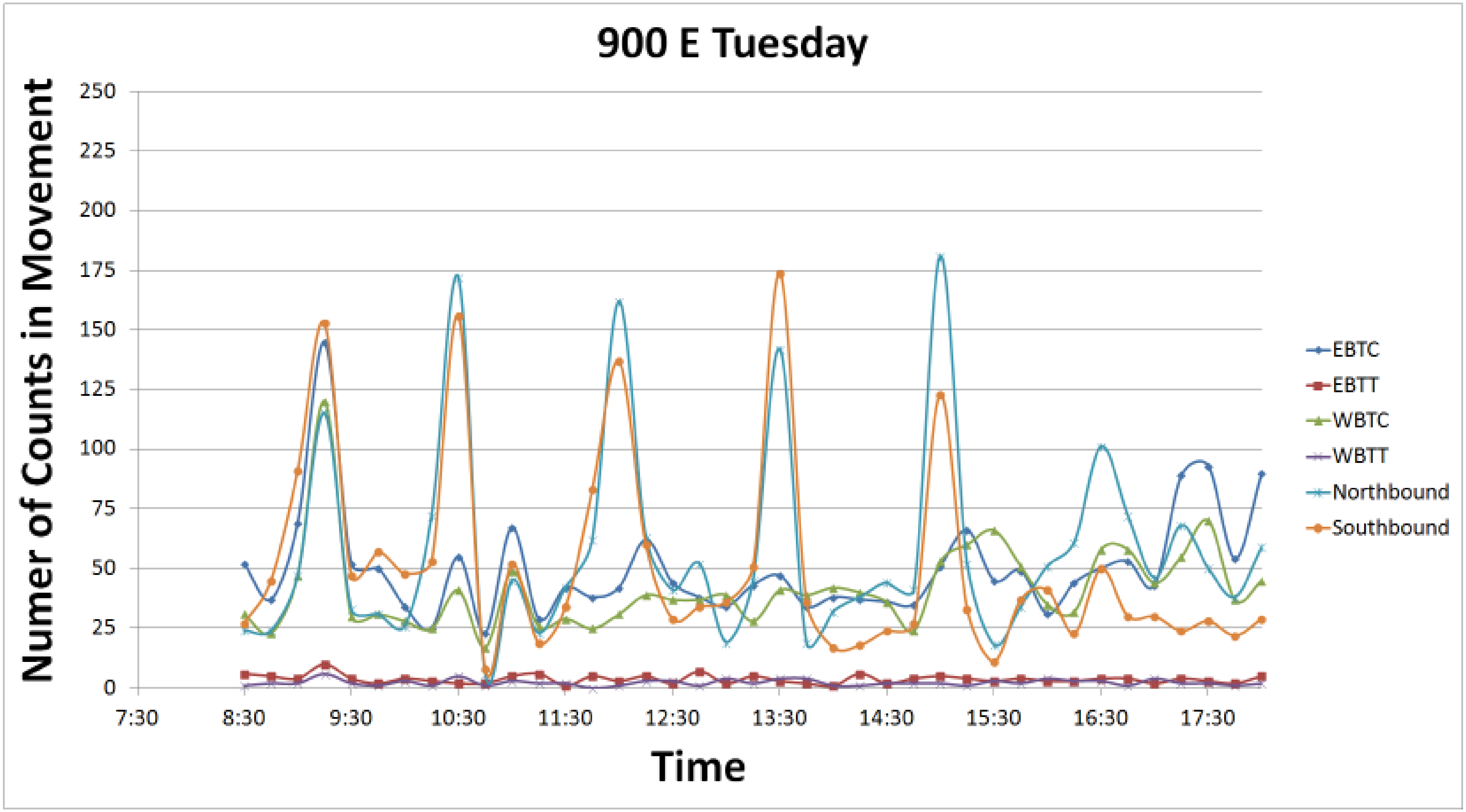

HPER Crosswalk
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:30
8:30
9:30
10:30
11:30
12:30
13:30
14:30
15:30
Time
EBTC
EBTT
WBTC
WBTT
NB Peds
SB Peds

Intersection:	700 N 900 E							
Date:	10/3/2011		Vehicle Peak Hour					
Weekday:	Monday		Pedestrian Peak Hour					
Peak Hour:	15:15-16:15							

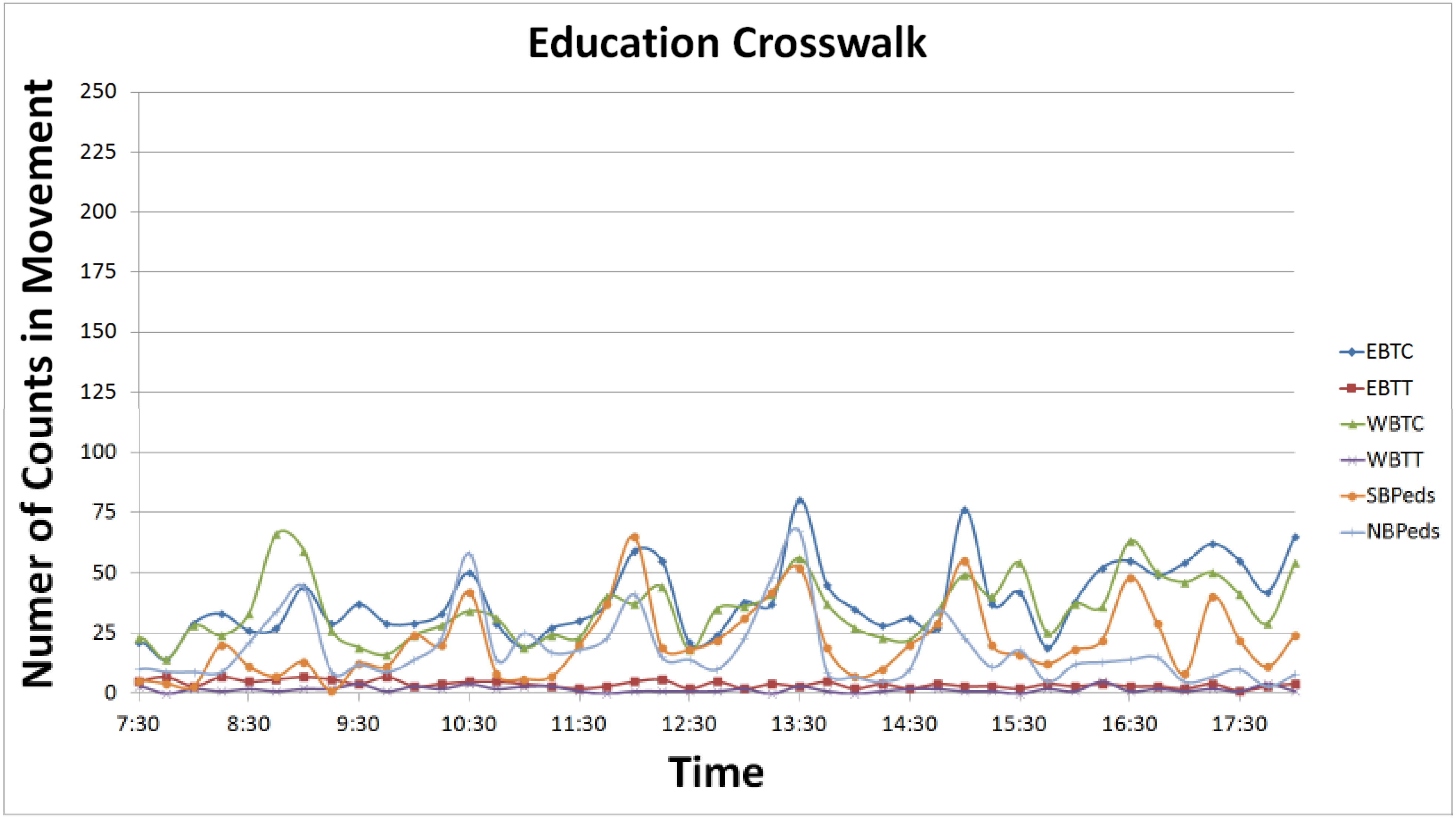
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck		Pedestrian		
Code		EBTC	EBTT	WBTC	WBTT	TOTAL VEH	PNB	PSB	TOTAL PEDI
8:00	8:15	34	0	24	0	58	41	30	71
8:15	8:30	149	0	69	0	218	47	28	75
8:30	8:45	72	0	43	0	115	37	71	108
8:45	9:00	27	0	18	0	45	15	29	44
9:00	9:15	31	0	23	0	54	27	32	59
9:15	9:30	24	5	10	6	45	18	26	44
9:30	9:45	23	4	23	4	54	31	23	54
9:45	10:00	23	4	28	3	58	83	131	214
10:00	10:15	55	6	43	3	107	138	49	187
10:15	10:30	36	4	33	4	77	58	40	98
10:30	10:45	34	2	30	0	66	48	38	86
10:45	11:00	46	3	44	2	95	82	125	207
11:00	11:15	54	4	48	0	106	125	67	192
11:15	11:30	48	2	33	3	86	39	19	58
11:30	11:45	45	4	33	1	83	36	41	77
11:45	12:00	45	5	40	3	93	107	93	200
12:00	12:15	69	3	49	0	121	102	54	156
12:15	12:30	41	4	31	2	78	29	20	49
12:30	12:45	53	4	47	0	104	117	64	181
12:45	13:00	40	4	31	1	76	26	23	49
13:00	13:15	40	3	38	3	84	41	28	69
13:15	13:30	43	4	45	1	93	43	20	63
13:30	13:45	35	3	44	3	85	62	48	110
13:45	14:00	50	4	66	2	122	82	25	107
14:00	14:15	53	2	43	3	101	60	16	76
14:15	14:30	51	4	35	2	92	48	12	60
14:30	14:45	68	4	61	4	137	54	49	103
14:45	15:00	54	3	52	1	110	38	34	72
15:00	15:15	48	4	49	3	104	50	35	85
15:15	**15:30**	**88**	**3**	**66**	**1**	**158**	**48**	**30**	**78**
15:30	**15:45**	**102**	**1**	**88**	**3**	**194**	**68**	**32**	**100**
15:45	**16:00**	**68**	**1**	**62**	**1**	**132**	**59**	**34**	**93**
16:00	**16:15**	**64**	**2**	**45**	**2**	**113**	**39**	**25**	**64**
16:15	16:30	26	5	22	4	57	27	33	60
16:30	16:45	35	5	27	2	69	88	203	291
16:45	17:00	57	5	34	3	99	111	49	160
17:00	17:15	88	3	72	1	164	54	33	87
17:15	17:30	59	7	53	2	121	59	40	99
17:30	17:45	44	4	31	3	82	4	7	11
17:45	18:00	29	3	17	1	50	5	3	8
	TOTAL	2051	128	1650	77	3906	2246	1759	4005
: HOUR VOLUME		322	7	261	7	597	214	121	335
AK INTERVAL * 4		408	12	352	12	776	272	136	400
K HOUR FACTOR		0.789	0.583	0.741	0.583	0.769	0.787	0.890	0.838
:ks in Peak Hour			2%		3%				
PEDESTRIAN PEA		206	15	147	6	342	213	135	348
PEDESTRIAN PEA		352	16	188	12	416	468	256	724
PEDESTRIAN PEA		0.585	0.938	0.782	0.500	0.822	0.455	0.527	0.481
% TRUCKS IN PE			8%		6%				


900 E Monday
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:30
8:30
9:30
10:30
11:30
12:30
13:30
14:30
15:30
16:30
17:30
Time
EBTC
EBTT
WBTC
WBTT
PNB
PSB

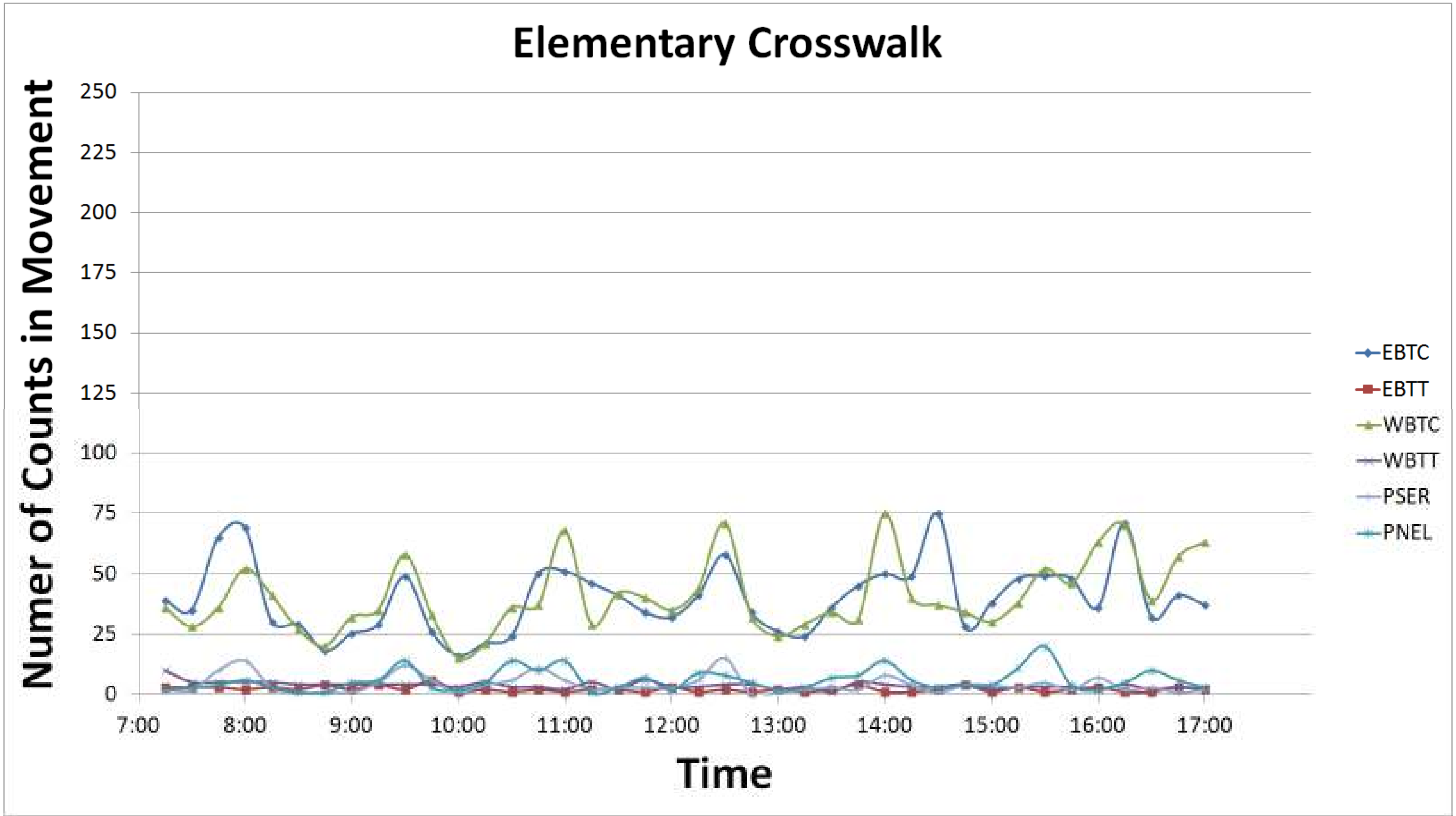
Date:		10/4/2012		Vehicle Peak Hour					
Weekday:		Tuesday		Pedestrian Peak Hour					
Peak Hour:		17:00-18:00							
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck		Pedestrians		
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	Northbour	Southbour	TOTAL
8:15	8:30	52	6	31	1	90	24	27	51
8:30	8:45	37	5	23	2	67	24	45	69
8:45	9:00	69	4	47	2	122	47	91	138
9:00	9:15	145	10	120	6	281	115	153	268
9:15	9:30	52	4	30	2	88	33	47	80
9:30	9:45	50	2	31	1	84	31	57	88
9:45	10:00	34	4	28	3	69	26	48	74
10:00	10:15	25	3	25	1	54	72	53	125
10:15	10:30	55	2	41	5	103	172	156	328
10:30	10:45	23	2	17	1	43	6	8	14
10:45	11:00	67	5	49	3	124	45	52	97
11:00	11:15	29	6	26	2	63	23	19	42
11:15	11:30	42	1	29	2	74	42	34	76
11:30	11:45	38	5	25	0	68	62	83	145
11:45	12:00	42	3	31	1	77	162	137	299
12:00	12:15	62	5	39	3	109	63	60	123
12:15	12:30	44	2	37	3	86	41	29	70
12:30	12:45	38	7	37	1	83	52	34	86
12:45	13:00	34	2	39	4	79	19	36	55
13:00	13:15	43	5	28	2	78	45	51	96
13:15	13:30	47	3	41	4	95	142	174	316
13:30	13:45	34	2	39	4	79	19	36	55
13:45	14:00	38	1	42	1	82	32	17	49
14:00	14:15	37	6	40	1	84	38	18	56
14:15	14:30	36	2	36	2	76	44	24	68
14:30	14:45	35	4	24	2	65	41	27	68
14:45	15:00	51	5	53	2	111	181	123	304
15:00	15:15	66	4	60	1	131	52	33	85
15:15	15:30	45	3	66	3	117	18	11	29
15:30	15:45	49	4	51	2	106	34	37	71
15:45	16:00	31	3	35	4	73	51	41	92
16:00	16:15	44	3	32	3	82	61	23	84
16:15	16:30	50	4	58	3	115	101	50	151
16:30	16:45	53	4	58	1	116	72	30	102
16:45	17:00	43	2	44	4	93	46	30	76
17:00	**17:15**	**89**	**4**	**55**	**2**	**150**	**68**	**24**	**92**
17:15	**17:30**	**93**	**3**	**70**	**2**	**168**	**50**	**28**	**78**
17:30	**17:45**	**54**	**2**	**37**	**1**	**94**	**38**	**22**	**60**
17:45	**18:00**	**90**	**5**	**45**	**2**	**142**	**59**	**29**	**88**
	TOTAL	1966	147	1619	89	3821	2251	1997	4248
PEAK HOUR VOLUME		326	14	207	7	554	215	103	318
PEAK INTERVAL * 4		372	20	280	8	672	272	116	368
PEAK HOUR FACTOR		0.876	0.700	0.739	0.875	0.824	0.790	0.888	0.864
% Trucks in Peak Hour		4%		3%					
PEDESTRIAN PEAK HC		184	16	141	10	326	157	150	307
PEDESTRIAN PEAK INT		248	28	156	16	344	208	204	384
PEDESTRIAN PEAK HC		0.742	0.571	0.904	0.625	0.948	0.755	0.735	0.799
% TRUCKS IN PEAK HC		7%		5%					


900 E Tuesday
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:30
8:30
9:30
10:30
11:30
12:30
13:30
14:30
15:30
16:30
17:30
Time
EBTC
EBTT
WBTC
WBTT
Northbound
Southbound

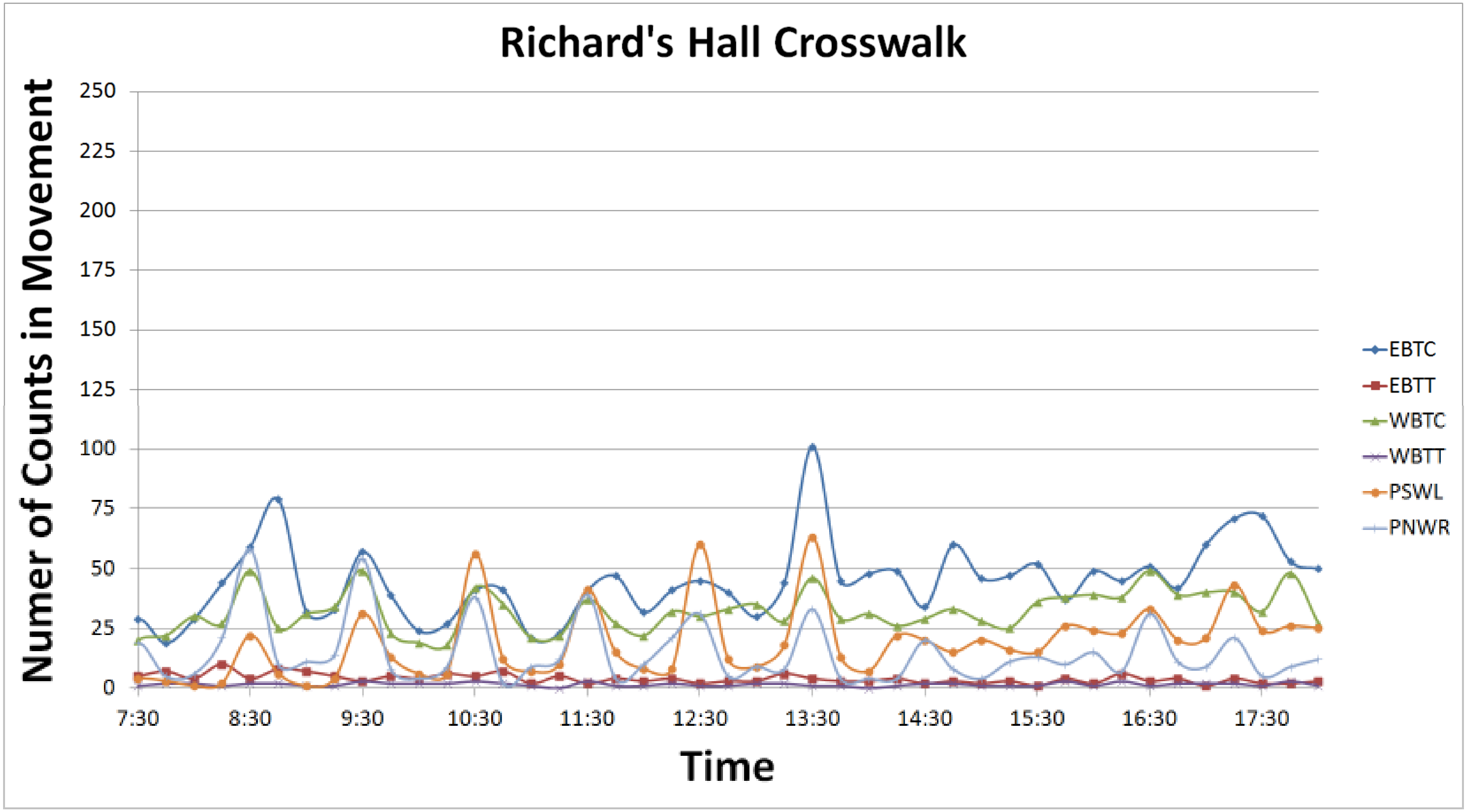
	Intersection:	IT Cross Walk							
	Date:	3/21/2012		Vehicle Peak Hour					
	Weekday:	Tuesday		Pedestrian Peak Hour					
	Peak Hour:	16:15-17:15							
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck		Pedestrian		
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	SBPeds	NBPeds	TOTAL
7:00	7:15	6	0	10	1	17	0	1	1
7:15	7:30	21	5	23	3	54	5	10	15
7:30	7:45	14	7	14	0	42	4	9	13
7:45	8:00	29	3	28	2	65	3	9	12
8:00	8:15	33	7	24	1	67	20	9	29
8:15	8:30	26	5	33	2	67	11	21	32
8:30	8:45	27	6	66	1	104	7	34	41
8:45	9:00	44	7	59	2	112	13	44	57
9:00	9:15	29	6	26	2	67	1	9	10
9:15	9:30	37	4	19	4	65	12	12	24
9:30	9:45	29	7	16	1	55	11	9	20
9:45	10:00	29	3	24	3	59	24	14	38
10:00	10:15	33	4	28	2	67	20	23	43
10:15	10:30	50	5	34	4	94	42	58	100
10:30	10:45	29	5	31	2	68	8	14	22
10:45	11:00	19	4	19	3	45	6	25	31
11:00	11:15	27	3	24	3	57	7	17	24
11:15	11:30	30	2	23	1	56	20	18	38
11:30	11:45	37	3	40	0	82	37	23	60
11:45	12:00	59	5	37	1	105	65	41	106
12:00	12:15	55	6	44	1	108	19	15	34
12:15	12:30	21	2	18	1	44	18	14	32
12:30	12:45	24	5	35	1	66	22	10	32
12:45	13:00	38	2	36	2	79	31	23	54
13:00	13:15	37	4	41	0	82	42	48	90
13:15	13:30	80	3	56	3	145	52	67	119
13:30	13:45	45	5	37	1	88	19	9	28
13:45	14:00	35	2	27	0	66	7	7	14
14:00	14:15	28	4	23	1	57	10	5	15
14:15	14:30	31	2	22	2	58	20	10	30
14:30	14:45	27	4	34	2	69	29	34	63
14:45	15:00	76	3	49	1	131	55	23	78
15:00	15:15	37	3	40	1	82	20	11	31
15:15	15:30	42	2	54	0	102	16	18	34
15:30	15:45	19	4	25	2	52	12	5	17
15:45	16:00	38	3	37	1	80	18	12	30
16:00	16:15	52	4	36	5	97	22	13	35
16:15	**16:30**	**55**	**3**	**63**	**1**	**125**	**48**	**14**	**62**
16:30	**16:45**	**49**	**3**	**50**	**2**	**104**	**29**	**15**	**44**
16:45	**17:00**	**54**	**2**	**46**	**1**	**104**	**8**	**5**	**13**
17:00	**17:15**	**62**	**4**	**50**	**2**	**118**	**40**	**7**	**47**
17:15	17:30	55	1	41	1	99	22	10	32
17:30	17:45	42	3	29	4	78	11	3	14
17:45	18:00	65	4	54	1	124	24	8	32
	TOTAL	1675	169	1525	74	3506	910	786	1696
PEAK HOUR VOLUME		220	12	209	6	451	125	41	166
PEAK INTERVAL * 4		248	16	252	8	500	192	60	248
PEAK HOUR FACTOR		0.887	0.750	0.829	0.750	0.902	0.651	0.683	0.669
6 Trucks in Peak Hour		5%		3%					
PEDESTRIAN PEAK HC		179	14	168	6	372	147	148	295
PEDESTRIAN PEAK IN		320	20	224	12	580	208	268	476
PEDESTRIAN PEAK HC		0.559	0.700	0.750	0.500	0.641	0.707	0.552	0.620
% TRUCKS IN PEAK HC		7%		3%					


Education Crosswalk
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:30
8:30
9:30
10:30
11:30
12:30
13:30
14:30
15:30
16:30
17:30
Time
EBTC
EBTT
WBTC
WBTT
SBPeds
NBPeds

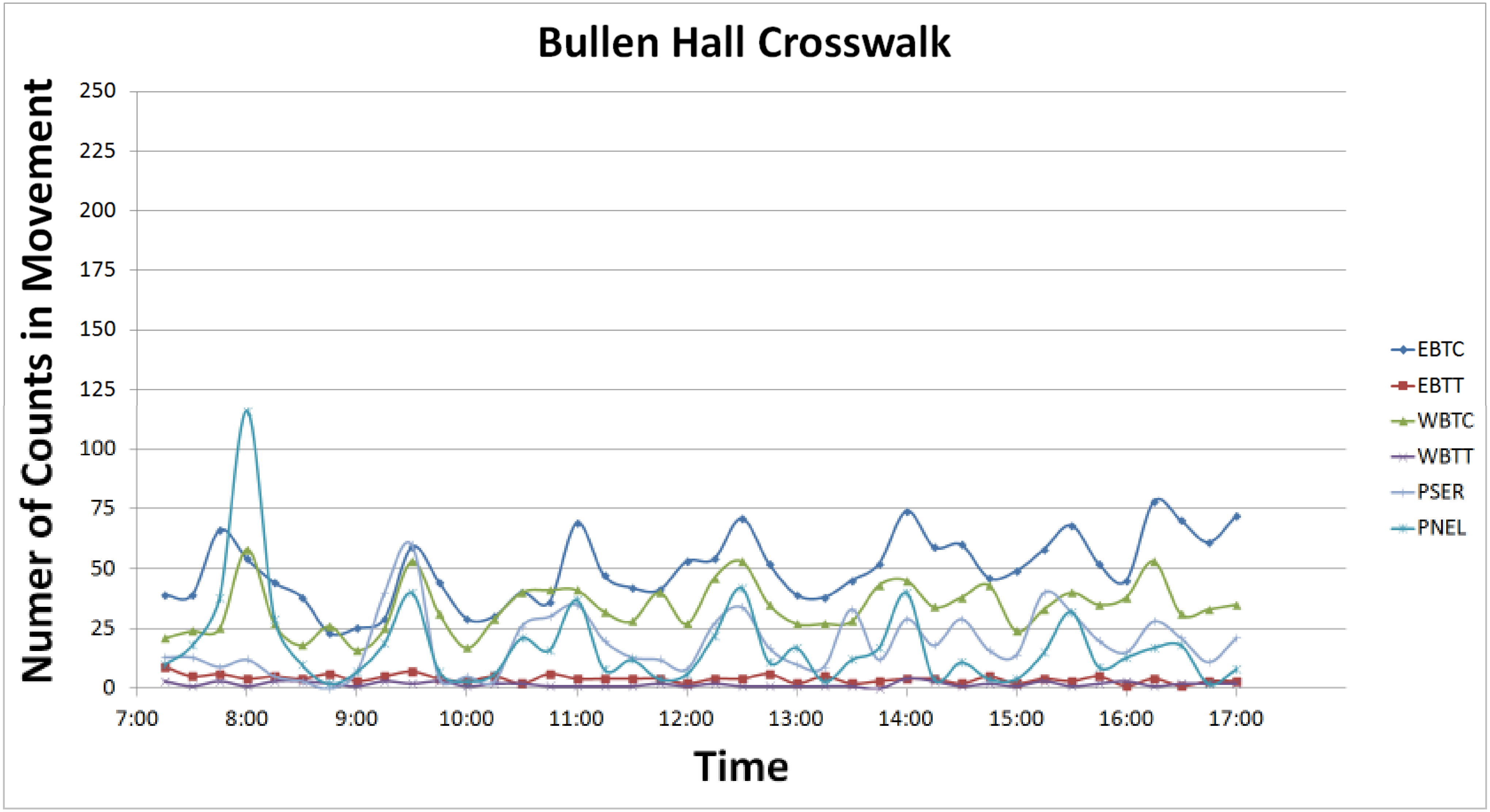
Intersection:	Elementary Cross Walk								
Date:	10/11/2011		Vehicle Peak Hour						
Weekday:	Monday		Pedestrian Peak Hour						
Peak Hour:	15:15-16:15								
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck		North	South	
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	PSER	PNEL	TOTAL
7:00	7:15	39	3	36	10	90	2	2	4
7:15	7:30	35	3	28	5	73	2	3	5
7:30	7:45	65	3	36	5	109	10	4	14
7:45	8:00	69	2	52	5	140	14	6	20
8:00	8:15	30	3	41	5	82	3	3	6
8:15	8:30	29	2	27	4	62	1	1	2
8:30	8:45	18	4	20	4	51	1	1	2
8:45	9:00	25	2	32	4	66	1	5	6
9:00	9:15	29	4	35	4	73	5	6	11
9:15	9:30	49	2	58	4	120	12	14	26
9:30	9:45	26	6	33	4	73	6	3	9
9:45	10:00	16	1	15	3	35	1	2	3
10:00	10:15	21	2	21	5	49	4	5	9
10:15	10:30	24	1	36	3	66	6	14	20
10:30	10:45	50	2	37	3	96	11	10	21
10:45	11:00	51	1	68	2	125	6	14	20
11:00	11:15	46	2	29	5	83	2	1	3
11:15	11:30	41	2	42	2	88	3	3	6
11:30	11:45	34	1	40	6	83	3	7	10
11:45	12:00	32	3	35	3	77	3	2	5
12:00	12:15	41	1	44	3	97	6	9	15
12:15	12:30	58	2	71	4	139	15	8	23
12:30	12:45	34	1	32	4	83	0	5	5
12:45	13:00	26	2	24	2	55	1	2	3
13:00	13:15	24	1	29	3	68	2	3	5
13:15	13:30	36	2	34	1	75	3	7	10
13:30	13:45	45	4	31	5	93	2	8	10
13:45	14:00	50	1	75	4	138	8	14	22
14:00	14:15	49	1	40	3	99	4	6	10
14:15	14:30	75	2	37	3	117	1	3	4
14:30	14:45	28	4	34	4	73	4	4	8
14:45	15:00	38	1	30	2	74	4	4	8
15:00	15:15	48	3	38	3	96	3	11	14
15:15	**15:30**	**49**	**1**	**52**	**3**	**111**	**5**	**20**	**25**
15:30	**15:45**	**48**	**2**	**46**	**3**	**104**	**2**	**4**	**6**
15:45	**16:00**	**36**	**3**	**63**	**2**	**107**	**7**	**2**	**9**
16:00	**16:15**	**71**	**1**	**70**	**4**	**154**	**2**	**5**	**7**
16:15	16:30	32	1	39	2	83	3	10	13
16:30	16:45	41	3	57	3	108	1	6	7
16:45	17:00	37	2	63	2	112	2	3	5
	TOTAL	1595	87	1630	146	3627	171	240	411
PEAK HOUR VOLUME		204	7	231	12	476	16	31	47
PEAK INTERVAL * 4		284	12	280	16	616	28	80	100
PEAK HOUR FACTOR		0.72	0.58	0.83	0.75	0.77	0.57	0.39	0.47
Trucks in Peak Hour		3%		5%					
PEDESTRIAN PEAK H		146	6	162	13	336	27	43	70
PEDESTRIAN PEAK IN		204	8	272	20	500	44	56	84
PEDESTRIAN PEAK H		0.716	0.750	0.596	0.650	0.672	0.614	0.768	0.833
% TRUCKS IN PEAK H		4%		7%					


Elementary Crosswalk
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
Time
EBTC
EBTT
WBTC
WBTT
PSER
PNEL

Intersection:		Richards Hall							
Date:		3/20/2012		Vehicle Peak Hour					
Weekday:		Tuesday		Pedestrian Peak Hour					
Peak Hour:		16:45-17:45							
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck		North	South	
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	PSWL	PNWR	TOTAL
7:00	7:15	14	3	5	1	24	1	4	5
7:15	7:30	29	5	20	1	55	4	19	23
7:30	7:45	19	7	22	2	51	3	5	8
7:45	8:00	29	4	30	2	66	1	6	7
8:00	8:15	44	10	27	1	82	2	21	23
8:15	8:30	59	4	49	2	114	22	58	80
8:30	8:45	79	8	25	2	114	6	10	16
8:45	9:00	32	7	31	1	71	1	11	12
9:00	9:15	33	5	34	1	73	4	14	18
9:15	9:30	57	3	49	3	112	31	54	85
9:30	9:45	39	5	23	2	70	13	8	21
9:45	10:00	24	4	19	2	50	6	4	10
10:00	10:15	27	6	18	2	55	6	9	15
10:15	10:30	41	5	42	3	93	56	38	94
10:30	10:45	41	7	35	2	85	12	2	14
10:45	11:00	21	2	21	1	45	7	9	16
11:00	11:15	23	5	22	0	53	10	12	22
11:15	11:30	41	2	37	3	83	41	39	80
11:30	11:45	47	4	27	1	79	15	4	19
11:45	12:00	32	3	22	1	58	8	10	18
12:00	12:15	41	4	32	2	80	8	21	29
12:15	12:30	45	2	30	1	78	60	31	91
12:30	12:45	40	3	33	1	77	12	5	17
12:45	13:00	30	3	35	2	71	9	9	18
13:00	13:15	44	6	28	2	80	18	8	26
13:15	13:30	101	4	46	1	155	63	33	96
13:30	13:45	45	3	29	1	80	13	4	17
13:45	14:00	48	3	31	0	82	7	4	11
14:00	14:15	49	4	26	1	81	22	4	26
14:15	14:30	34	2	29	2	67	20	20	40
14:30	14:45	60	3	33	2	100	15	8	23
14:45	15:00	46	2	28	1	77	20	4	24
15:00	15:15	47	3	25	1	76	16	11	27
15:15	15:30	52	1	36	1	90	15	13	28
15:30	15:45	37	4	38	3	82	26	10	36
15:45	16:00	49	2	39	1	91	24	15	39
16:00	16:15	45	6	38	3	92	23	7	30
16:15	16:30	51	3	49	1	105	33	31	64
16:30	16:45	42	4	39	2	87	20	11	31
16:45	**17:00**	**60**	**1**	**40**	**2**	**104**	**21**	**9**	**30**
17:00	**17:15**	**71**	**4**	**40**	**2**	**118**	**43**	**21**	**64**
17:15	**17:30**	**72**	**2**	**32**	**1**	**107**	**24**	**5**	**29**
17:30	**17:45**	**53**	**2**	**48**	**3**	**106**	**26**	**9**	**35**
17:45	18:00	50	3	27	1	83	25	12	37
	TOTAL	1943	173	1389	70	3602	812	642	1454
PEAK HOUR VOLUME		256	9	160	8	435	114	44	158
PEAK INTERVAL * 4		288	16	192	12	472	172	84	256
PEAK HOUR FACTOR		0.889	0.563	0.833	0.667	0.922	0.663	0.524	0.617
Trucks in Peak Hour		3%		5%					
PEDESTRIAN PEAK H		224	12	168	7	414	117	72	189
PEDESTRIAN PEAK IN		284	16	196	8	472	172	124	256
PEDESTRIAN PEAK H		0.789	0.750	0.857	0.875	0.877	0.680	0.581	0.738
% TRUCKS IN PEAK H		5%		4%					

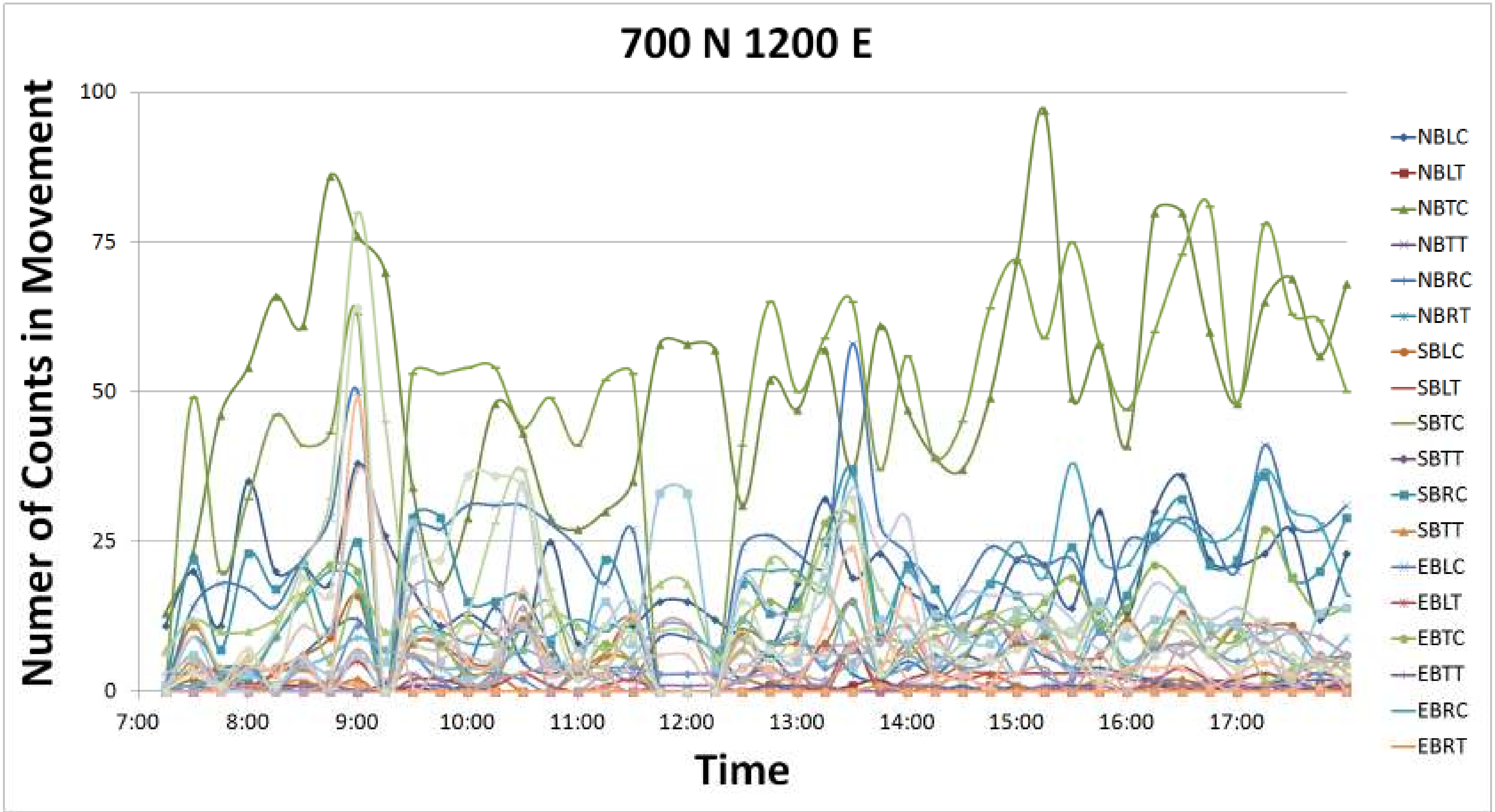

Richard's Hall Crosswalk
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:30
8:30
9:30
10:30
11:30
12:30
13:30
14:30
15:30
16:30
17:30
Time
EBTC
EBTT
WBTC
WBTT
PSWL
PNWR

Intersection:		Bullen							
Date:		10/13/2011		Vehicle Peak Hour					
Weekday:		Thursday		Pedestrian Peak Hour					
Peak Hour:		16:00-17:00							
From	To	Thru Car	Thru Truck	Thru Car	Thru Truck		North	South	
Code		EBTC	EBTT	WBTC	WBTT	TOTAL	PSER	PNEL	TOTAL
7:00	7:15	39	9	21	3	81	13	10	15
7:15	7:30	39	5	24	1	73	13	18	28
7:30	7:45	66	6	25	3	100	9	38	47
7:45	8:00	54	4	58	1	118	12	116	128
8:00	8:15	44	5	27	3	79	5	29	34
8:15	8:30	38	4	18	3	64	3	10	13
8:30	8:45	23	6	26	2	57	0	2	2
8:45	9:00	25	3	16	1	46	7	7	13
9:00	9:15	29	5	25	3	62	40	19	59
9:15	9:30	59	7	53	2	123	60	40	99
9:30	9:45	44	4	31	3	82	4	7	11
9:45	10:00	29	3	17	1	50	5	3	8
10:00	10:15	30	5	29	2	66	3	6	9
10:15	10:30	40	2	40	2	85	26	21	47
10:30	10:45	36	6	41	1	91	30	16	43
10:45	11:00	69	4	41	1	119	35	37	70
11:00	11:15	47	4	32	1	90	20	8	24
11:15	11:30	42	4	28	1	78	13	12	23
11:30	11:45	41	4	40	2	90	12	4	15
11:45	12:00	53	2	27	1	84	8	6	13
12:00	12:15	54	4	46	2	118	27	22	39
12:15	12:30	71	4	53	1	134	34	42	73
12:30	12:45	52	6	35	1	102	17	11	21
12:45	13:00	39	2	27	1	74	10	17	23
13:00	13:15	38	5	27	1	72	9	3	12
13:15	13:30	45	2	28	1	79	33	12	44
13:30	13:45	52	3	43	0	102	12	17	28
13:45	14:00	74	4	45	4	130	29	40	67
14:00	14:15	59	4	34	3	107	18	4	17
14:15	14:30	60	2	38	1	113	29	11	28
14:30	14:45	46	5	43	2	98	16	4	19
14:45	15:00	49	2	24	1	80	14	4	14
15:00	15:15	58	4	33	3	103	40	15	53
15:15	15:30	68	3	40	1	119	32	32	61
15:30	15:45	52	5	35	2	94	20	9	29
15:45	16:00	45	1	38	3	88	15	13	28
16:00	**16:15**	**78**	**4**	**53**	**1**	**140**	**28**	**17**	**41**
16:15	**16:30**	**70**	**1**	**31**	**2**	**104**	**21**	**18**	**39**
16:30	**16:45**	**61**	**3**	**33**	**2**	**102**	**11**	**2**	**12**
16:45	**17:00**	**72**	**3**	**35**	**2**	**121**	**21**	**8**	**22**
	TOTAL	1990	159	1360	71	3718	754	710	1371
PEAK HOUR VOLUME		281	11	152	7	467	81	45	114
PEAK INTERVAL * 4		312	16	212	8	560	112	72	164
PEAK HOUR FACTOR		0.90	0.69	0.72	0.88	0.83	0.72	0.63	0.70
Trucks in Peak Hour		4%		4%					
PEDESTRIAN PEAK H		203	20	134	8	370	39	201	237
PEDESTRIAN PEAK IN		264	24	232	12	472	52	464	512
PEDESTRIAN PEAK H		0.769	0.833	0.578	0.667	0.784	0.750	0.433	0.463
% TRUCKS IN PEAK H		9%		6%					


Bullen Hall Crosswalk
Numer of Counts in Movement
250
225
200
175
150
125
100
75
50
25
0
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
Time
EBTC
EBTT
WBTC
WBTT
PSER
PNEL

Intersection: 700 N 1200 E
Date: 3/22/2012 — Vehicle Peak Hour
Weekday: Thursday — Pedestrian Peak Hour
Peak Hour: 8:30-9:30

												Vehicle																		Pedestrian					
		DIRECTIOI			From South			DIRECTIOI			From North			DIRECTIOI			From West			DIRECTIOI			From East				Pedestrian from SE		Pedestrian from SW		Pedestrian from NW		Pedestrian from NE		
From	To	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truc	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truc	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truc	Left Car	Left Truck	Thru Car	Thru Truck	Right Car	Right Truck		North	West	North	East	South	East	South	West	
Code		NBLC	NBLT	NBTC	NBTT	NBRC	NBRT	SBLC	SBLT	SBTC	SBTT	SBRC	SBTT	EBLC	EBLT	EBTC	EBTT	EBRC	EBRT	WBLC	WBLT	WBTC	WBTT	WBRC	WBRT	TOTAL	PSER	PSEL	PSWL	PSWR	PNWR	PNWL	PNEL	PNER	TOTAL
7:00	7:15	11	0	13	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	7	1	1	0	37	1	6	0	1	0	0	3	0	11
7:15	7:30	20	0	23	0	3	0	2	0	49	11	22	11	14	4	5	1	9	0	1	0	12	0	1	0	60	6	12	0	6	4	9	5	3	29
7:30	7:45	11	1	46	1	4	0	1	0	20	3	7	3	18	3	2	0	4	0	2	0	10	1	3	0	79	1	4	1	0	0	1	1	1	6
7:45	8:00	35	1	54	0	4	1	3	0	32	0	23	0	17	1	3	0	2	0	4	0	10	0	3	0	112	1	5	0	3	6	0	4	7	13
8:00	8:15	20	1	66	0	1	0	4	0	46	3	17	3	14	3	9	0	9	1	1	0	12	0	1	0	102	1	10	0	1	3	0	4	1	16
8:15	8:30	21	1	61	1	6	0	6	1	41	4	21	4	22	4	16	0	15	2	1	0	16	1	4	0	112	4	21	0	5	6	6	11	19	41
8:30	**8:45**	**18**	**1**	**86**	**0**	**10**	**0**	**9**	**1**	**43**	**1**	**10**	**1**	**29**	**1**	**21**	**0**	**20**	**0**	**2**	**0**	**5**	**1**	**6**	**1**	**130**	**1**	**32**	**0**	**3**	**1**	**0**	**10**	**16**	**46**
8:45	**9:00**	**38**	**0**	**76**	**0**	**12**	**0**	**16**	**0**	**63**	**2**	**25**	**2**	**50**	**5**	**20**	**0**	**18**	**0**	**11**	**0**	**17**	**0**	**9**	**1**	**164**	**7**	**80**	**0**	**6**	**49**	**6**	**37**	**64**	**130**
9:00	**9:15**	**26**	**1**	**70**	**0**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**0**	**10**	**1**	**7**	**1**	**128**	**2**	**45**	**0**	**5**	**0**	**0**	**24**	**0**	**76**
9:15	**9:30**	**17**	**0**	**34**	**1**	**6**	**0**	**8**	**0**	**53**	**8**	**29**	**8**	**27**	**2**	**9**	**1**	**10**	**0**	**6**	**0**	**13**	**3**	**6**	**0**	**86**	**6**	**9**	**17**	**28**	**13**	**9**	**1**	**22**	**44**
9:30	9:45	11	0	18	0	2	0	8	0	53	8	29	8	27	2	9	1	10	0	2	0	9	0	4	0	48	4	7	17	5	13	9	5	22	21
9:45	10:00	13	0	29	1	4	1	5	0	54	3	15	3	31	1	2	0	8	0	0	0	12	0	4	0	65	1	13	2	2	5	6	9	36	25
10:00	10:15	10	0	48	0	14	0	5	0	54	3	15	3	31	1	2	0	8	0	3	0	8	0	4	0	88	2	28	2	5	5	6	10	36	45
10:15	10:30	7	0	43	0	5	0	12	0	44	0	16	0	31	3	11	0	10	0	2	0	7	0	7	0	71	3	37	14	11	17	35	11	34	62
10:30	10:45	25	0	29	0	3	0	6	0	49	0	8	0	28	1	15	0	9	0	0	0	13	0	5	0	76	4	17	0	5	3	5	3	15	29
10:45	11:00	8	0	27	0	4	0	3	0	41	3	3	3	24	0	4	0	12	0	4	0	11	0	4	0	58	2	7	0	4	5	7	4	2	17
11:00	11:15	11	0	30	0	4	0	6	0	52	6	22	6	18	1	8	0	10	1	4	0	7	0	2	0	58	3	4	3	15	3	11	0	11	22
11:15	11:30	11	0	35	0	2	0	12	0	53	5	13	5	27	2	5	0	12	0	4	0	12	0	6	0	70	0	10	3	8	13	15	5	9	23
11:30	11:45	15	0	58	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	18	1	11	0	115	11	10	0	33	0	0	6	0	60
11:45	12:00	15	0	58	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	18	1	11	0	115	11	10	0	33	0	0	6	0	60
12:00	12:15	12	0	57	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	6	1	7	0	93	2	5	0	4	0	0	1	0	12
12:15	12:30	9	0	31	0	2	0	10	0	41	2	18	2	24	2	12	0	19	0	2	0	7	0	12	0	65	7	10	2	4	4	19	9	15	30
12:30	12:45	7	1	52	1	6	1	8	0	65	1	13	1	26	4	15	1	20	0	7	0	22	0	8	0	105	2	5	3	7	4	14	3	7	17
12:45	13:00	18	0	47	1	2	1	8	0	50	3	15	3	23	1	14	0	20	0	9	0	19	1	10	0	108	3	11	3	5	2	12	6	7	25
13:00	13:15	32	0	57	1	8	1	8	0	59	0	25	0	21	1	28	0	17	0	4	0	17	1	5	0	126	7	25	2	19	11	16	6	21	57
13:15	13:30	19	1	37	0	3	0	15	0	65	7	37	7	58	8	29	0	36	0	7	0	10	0	15	0	92	8	28	5	4	24	34	7	32	47
13:30	13:45	23	2	61	0	2	0	3	0	37	1	9	1	28	0	11	1	12	0	3	0	5	0	3	1	101	9	17	8	12	4	24	11	3	49
13:45	14:00	17	0	47	0	5	0	8	0	56	1	21	1	23	2	8	1	20	1	4	0	7	1	6	0	87	6	11	11	8	17	29	2	12	27
14:00	14:15	14	1	39	0	3	0	3	0	39	1	17	1	12	3	9	1	13	0	6	0	11	1	4	0	79	9	5	4	13	2	5	3	8	30
14:15	14:30	9	0	37	1	6	1	5	0	45	3	10	3	17	2	11	0	13	0	4	0	10	0	6	0	74	3	8	11	9	3	16	2	5	22
14:30	14:45	12	1	49	0	5	0	12	0	64	3	18	3	24	3	13	1	18	0	5	0	10	1	10	0	93	1	12	12	8	1	16	6	5	27
14:45	15:00	22	0	72	1	8	1	8	0	72	1	16	1	22	3	11	0	25	0	10	0	12	0	3	0	131	3	14	9	13	10	16	3	7	33
15:00	15:15	21	0	97	0	6	0	9	0	59	0	12	0	21	3	15	1	19	0	3	0	11	1	10	0	150	4	13	7	11	7	16	12	8	40
15:15	15:30	14	0	49	0	4	0	6	1	75	0	24	0	22	3	19	1	38	0	2	0	6	0	4	0	79	0	9	3	10	6	12	6	10	25
15:30	15:45	30	0	58	0	4	0	6	0	58	2	10	2	13	3	11	1	22	0	10	0	14	1	12	0	130	6	14	3	15	1	7	3	2	38
15:45	16:00	13	0	41	0	3	0	12	0	47	0	16	0	25	2	14	0	21	0	4	0	3	0	5	0	69	0	2	3	9	4	10	0	11	11
16:00	16:15	30	1	80	1	2	1	7	0	60	1	26	1	25	2	21	2	28	0	7	0	10	2	9	0	143	0	9	8	12	4	18	6	6	27
16:15	16:30	36	0	80	1	2	1	13	0	73	2	32	2	29	4	17	0	28	1	8	0	12	1	17	0	158	8	10	6	12	4	15	7	12	37
16:30	16:45	22	1	60	0	1	0	7	0	81	0	21	0	26	2	10	2	25	0	7	0	7	1	6	0	105	6	6	9	11	1	12	2	7	25
16:45	17:00	21	0	48	0	2	0	11	1	48	0	22	0	20	2	9	0	27	0	5	0	11	1	8	0	96	2	8	12	11	3	14	1	4	22
17:00	17:15	23	1	65	1	3	1	11	0	78	0	36	0	41	3	27	1	37	0	7	0	2	0	10	0	113	1	12	8	7	5	11	12	7	32
17:15	17:30	27	1	69	2	2	2	11	0	63	0	19	0	28	2	19	0	30	0	5	0	4	1	10	0	124	2	5	10	2	3	10	1	6	10
17:30	17:45	12	1	56	0	2	0	6	0	62	1	20	1	27	3	13	1	28	0	3	0	5	1	5	0	86	6	4	9	13	1	6	5	4	28
17:45	18:00	23	0	68	0	2	0	6	0	50	1	29	1	31	2	14	1	16	0	6	1	5	2	9	0	116	3	4	6	14	3	5	0	2	21
	TOTAL	809	17	2261	14	200	12	299	4	2094	90	741	90	994	94	491	18	698	6	192	1	453	27	293	3	4297	169	614	213	412	270	462	273	499	1468
PEAK HOUR VOLUME		99	2	266	1	33	0	33	1	159	11	64	11	106	8	50	1	48	0	26	0	45	5	28	2	508	16	166	17	42	63	15	72	102	296
PEAK INTERVAL * 4		152	4	344	4	48	0	64	4	252	32	116	32	200	20	84	4	80	0	44	0	68	12	36	4	656	28	320	68	112	196	36	148	256	520
PEAK HOUR FACTOR		0.651	0.500	0.773	0.250	0.688	0.000	0.516	0.250	0.631	0.344	0.552	0.344	0.530	0.400	0.595	0.250	0.600	0.000	0.591	0.000	0.662	0.417	0.778	0.500	0.774	0.571	0.519	0.250	0.375	0.321	0.417	0.486	0.398	0.569
, Trucks in Peak Hour			2%		0%		0%		3%		6%		15%		7%		2%		0%		0%		10%		7%										
TRIAN PEAK HOUR V(		99	2	266	1	33	0	33	1	159	11	64	11	106	8	50	1	48	0	26	0	45	5	28	2	508	16	166	17	42	63	15	72	102	296
STRIAN PEAK INTERV.		152	4	344	4	48	0	64	4	252	32	116	32	200	20	84	4	80	0	44	0	68	12	36	4	656	28	320	68	112	196	36	148	256	520
TRIAN PEAK HOUR F/		0.651	0.500	0.773	0.250	0.688	0.000	0.516	0.250	0.631	0.344	0.552	0.344	0.530	0.400	0.595	0.250	0.600	0.000	0.591	0.000	0.662	0.417	0.778	0.500	0.774	0.571	0.519	0.250	0.375	0.321	0.417	0.486	0.398	0.569
TRUCKS IN PEAK HOU			2%		0%		0%		3%		6%		15%		7%		2%		0%		0%		10%		7%										


700 N 1200 E
Numer of Counts in Movement
100
75
50
25
0
7:00
8:00
9:00
10:00
11:00
12:00
13:00
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15:00
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Time
NBLC
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NBTT
NBRC
NBRT
SBLC
SBLT
SBTC
SBTT
SBRC
SBTT
EBLC
EBLT
EBTC
EBTT
EBRC
EBRT

Appendix B – Group Member Hours

Team: Solution Engineering Consultants (SEC)
Individual (last name, first name): Butler, Jerry
Hours worked on team project

Week #	Start Day	End Day	Su	Mo	Tu	We	Th	Fr	Sa	Week Tota	Task(s)
1	26-Aug	3-Sep	0	0	0	0	0	0	0	0	
2	4-Sep	10-Sep	0	0	0	0	0	0	0	0	
3	11-Sep	17-Sep	0	1	0	0	0	0	0	1	Compiling report
4	18-Sep	24-Sep	0	0	0	0	0	0	0	0	
5	25-Sep	1-Oct	0	0	1	0	0	0	0	1	Making timeline (group)
6	2-Oct	8-Oct	0	0	1	0	1	0	0	2	Collecting data
7	9-Oct	15-Oct	0	0	0	0	0	0	0	0	
8	16-Oct	22-Oct	0	0	0	0.5	0	0	0	0.5	Group Mtg
9	23-Oct	29-Oct	0	0	0	0	0	0	0	0	
10	30-Oct	5-Nov	0	0	0	0	0	0	0	0	
11	6-Nov	12-Nov	0	0	0	0	0	0	0	0	
12	13-Nov	19-Nov	0	0	0	0	0	0	0	0	
13	20-Nov	26-Nov	0	0	0	0	0	0	0	0	
14	27-Nov	3-Dec	0	0	0	0	0	0	0	0	
15	4-Dec	10-Dec	0	3.5	0	0	0	0	0	3.5	Compile slideshow
						Semester total				8	
1	8-Jan	14-Jan	0	0	0	0	0	0	5	5	Data Processing
2	15-Jan	21-Jan	0	5	0	0	0	5	0	10	Data Processing
3	22-Jan	28-Jan	0	0	0	0	3	0	0	3	Data Processing
4	29-Jan	4-Feb	0	0	0	0	0	0	0	0	
5	5-Feb	11-Feb	0	0	0	0	0	0	4	4	Data Processing
6	12-Feb	18-Feb	0	0	0	0	0	0	0	0	
7	19-Feb	25-Feb	0	0	0	0	0	0	0	0	
8	26-Feb	3-Mar	0	0	3	0	0	0	0	3	Data Processing
9	4-Mar	10-Mar	0	0	0	0	3	0	0	3	Data Processing
10	11-Mar	17-Mar	0	0	0	0	0	0	0	0	
11	18-Mar	24-Mar	0	0	0.5	0.5	5	1	9	16	Data Processing
12	25-Mar	31-Mar	0	0	0	0	0	0	0	0	
13	1-Apr	7-Apr	0	0	0	0	0	0	0	0	
14	8-Apr	14-Apr	0	0	0	0	0	0	0.5	0.5	Slide Presentation Practice
15	15-Apr	21-Apr	0	0	0	0	0	0	0	0	
16	22-Apr	28-Apr	0.5	0	0	0	0	0	0	0.5	Slide Presentation
17	29-Apr	5-May	0	0	0	0	0	0	0	0	
						Semester total				45	

Certification.

I declare that I worked at least the number of hours I report above for each week during the semester.

[signature]
Signature

2 May 2012
Date

JERRY E. BUTLER
Name

Team: Solution Engineering Consultants (SEC)
Individual (last name, first name): Omar Castillo
Hours worked on team project

Week #	Start Day	End Day	Su	Mo	Tu	We	Th	Fr	Sa	Week Tota	Task(s)
1	8-Jan	14-Jan	0	0	0	0	0	0	0	0	
2	15-Jan	21-Jan	0	0	0	0	0	0	5	5	Data Collection
3	22-Jan	28-Jan	0	0	0	0	0	0	0	0	
4	29-Jan	4-Feb	0	0	0	0	0	0	0	0	
5	5-Feb	11-Feb	0	0	2	0	0	0	2	3.5	Reaserch in foundation traffic poles
6	12-Feb	18-Feb	0	0	0	0	0	0	0	0	
7	19-Feb	25-Feb	0	0	0	0	0	0	0	0	
8	26-Feb	3-Mar	0	0	0	0	0	0	0	0	
9	4-Mar	10-Mar	0	2	0	0	0	0	3	4	Research foundation traffic poles
10	11-Mar	17-Mar	0	0	0	0	0	0	0	0	
11	18-Mar	24-Mar	0	0	0	0	0	0	0	0	
12	25-Mar	31-Mar	0	0	0	0	0	0	7	6.5	Data collection
13	1-Apr	7-Apr	0	0	0	0	0	0	0	0	
14	8-Apr	14-Apr	0	0	0	1	0	0	0	1	
15	15-Apr	21-Apr	1	0	0	0	0	0	0	1	
16	22-Apr	28-Apr	0	2	2	0	0	1.5	0	5.5	Practice presentation and presentation, ppt
17	29-Apr	5-May	0	0	0	0	0	0	0	0	
							Semester total			26.5	

Certification.
I declare that I worked at least the number of hours I report above for each week during the semester.

Signature ______________________ Date ____________

Name ______________________

Team: Solution Engineering Consultants (SEC)
Individual (last name, first name): Jackson, Kirk
Hours worked on team project

Week #	Start Day	End Day	Su	Mo	Tu	We	Th	Fr	Sa	Week Tota	Task(s)
1	26-Aug	3-Sep	0	0	1	0	0	0	0	1	Class work
2	4-Sep	10-Sep	0	0	1	0	1	0	0	2	Class work
3	11-Sep	17-Sep	0	0	1	0	0	0	0	1	Class work
4	18-Sep	24-Sep	0	0	0	1	0	0	0	1	Meeting With Advisor
5	25-Sep	1-Oct	0	0	0	1	0	0	0	1	Meeting With Advisor
6	2-Oct	8-Oct	0	2.3	2.3	1.5	2	0	0	8	Data Collection
7	9-Oct	15-Oct	0	1.5	0.5	0	0	0	0	2	Data Collection
8	16-Oct	22-Oct	0	0	1	1	0	0	0	2	Meet with Advisor and Team
9	23-Oct	29-Oct	0	0	1	1	0	0	0	2	Meet with Advisor and Team
10	30-Oct	5-Nov	0	0	1	1	0	0	0	2	Meet with Advisor and Team
11	6-Nov	12-Nov	0	3	1	0	0	0	0	4	Data Processing
12	13-Nov	19-Nov	0	0	1	0	0	0	0	1	Meeting With Advisor
13	20-Nov	26-Nov	0	0	0	0	0	0	0	0	
14	27-Nov	3-Dec	0	1	1	0	1	1.5	0	4.5	Presentation and meeting with team. Meeting with USU.
15	4-Dec	10-Dec	0	0	0	0	0	0	0	0	
						Semester total				31.5	
1	8-Jan	14-Jan	0	0	0	0	0	0	4	4	Data Processing
2	15-Jan	21-Jan	0	5	0	0	0	4	0	9	Data Processing
3	22-Jan	28-Jan	0	0	0	0	6	0	0	6	Data Processing
4	29-Jan	4-Feb	0	0	0	0	0	0	0	0	
5	5-Feb	11-Feb	0	0	0	0	0	0	4	4	Data Processing
6	12-Feb	18-Feb	0	0	0	0	0	0	0	0	
7	19-Feb	25-Feb	0	0	0	0	0	0	0	0	
8	26-Feb	3-Mar	0	5.5	4	0	0	0	0	9.5	Data Processing
9	4-Mar	10-Mar	0	0	0	0	0	0	0	0	
10	11-Mar	17-Mar	0	0	4.5	0	0	0	0	4.5	Data Processing
11	18-Mar	24-Mar	0	2	0	0	0	0	12	14	Create Model
12	25-Mar	31-Mar	0	0	4	0	0	0	0	4	Edit Model
13	1-Apr	7-Apr	0	0	6	0	0	0	0	6	Edit Model
14	8-Apr	14-Apr	0	0	0	0	0	4	0	4	Create Solution Model
15	15-Apr	21-Apr	0	0	0	0	0	1	0	1	Presentation Preparation
16	22-Apr	28-Apr	0	0	0	2	3	1	8	14	Presentation and Project Write Up
17	29-Apr	5-May	0	0	0	0	0	0	0	0	
						Semester total				65	

Certification.
I declare that I worked at least the number of hours I report above for each week during the semester.

[signature] 5/2/12
Signature Date

KIRK JACKSON
Name

Team: Solution Engineering Consultants (SEC)

Individual (last name, first name): Lamb, Josh

Hours worked on team project

Week #	Start Day	End Day	Su	Mo	Tu	We	Th	Fr	Sa	Week Tota	Task(s)
1	26-Aug	3-Sep	0	0	0.5	0	0	0	0	0.5	Class + meeting after
2	4-Sep	10-Sep	0	0	0	0	0	0	0	0	
3	11-Sep	17-Sep	0	1	1.5	0	0	0	0	2.5	Compiling report / Finishing Summary
4	18-Sep	24-Sep	0	0	0	0	0	0	0	0	
5	25-Sep	1-Oct	0	0	0.5	0	0	0	0	0.5	Making timeline (group)
6	2-Oct	8-Oct	0	0.5	1	0	0	0	0	1.5	Collecting data / Contacts / Retrieving Data Collectors
7	9-Oct	15-Oct	0	0	0	0	1	0	0	1	Retrieving data collectors
8	16-Oct	22-Oct	0	0	0	1	0	0	0	1	Group Meeting
9	23-Oct	29-Oct	0	0	0	0	1	0	0	1	Collecting Data
10	30-Oct	5-Nov	0	0	0	0	0	0	0	0	
11	6-Nov	12-Nov	0	0	1	0	0	0	2	3	Group Meeting Updating Status / Acquiring Video Editing Software
12	13-Nov	19-Nov	0	0	0	0	0	0	0	0	
13	20-Nov	26-Nov	0	0	0	0	0	0	0	0	
14	27-Nov	3-Dec	0	0	0	0	0	0	0	0	
15	4-Dec	10-Dec	0	1	0.5	0	0	0	0	1.5	Editing December Class Presentation/ Presentation
						Semester total				12.5	
1	8-Jan	14-Jan	0	0	0	0	0	0	5	5	Counted Veh/Ped
2	15-Jan	21-Jan	0	4.5	0	0	0	0	0	4.5	Counted Veh/Ped
3	22-Jan	28-Jan	0	0	0	0	0	2	0	2	Counted Veh/Ped
4	29-Jan	4-Feb	0	0	0	0	0	0	0	0	
5	5-Feb	11-Feb	2	0	2	0	0	0	0	4	Roundabout Research
6	12-Feb	18-Feb	0	0	0	0	0	0	4	4	Counted Veh/Ped
7	19-Feb	25-Feb	0	0	0	0	0	0	0	0	
8	26-Feb	3-Mar	0	0	0	1	0	0	0	1	Group Meeting
9	4-Mar	10-Mar	0	0	0	0	0	0	6	6	Counted Veh/Data
10	11-Mar	17-Mar	0	0	0	1	0	0	0	1	Group Meeting
11	18-Mar	24-Mar	0	0	0	0	0	0	0	0	
12	25-Mar	31-Mar	0	0	0	0	0	0	0	0	
13	1-Apr	7-Apr	0	0	0	0	0	2	3	5	Autocad Drafting
14	8-Apr	14-Apr	0	0	0	1	0	2	4	7	Autocad Drafting/Group Meeting
15	15-Apr	21-Apr	0	0	0	0	1	1.5	0	2.5	Group Meeting/Presentation
16	22-Apr	28-Apr	0	0	0	0	0	0	0	0	
17	29-Apr	5-May	0	0	0	0	0	0	0	0	
						Semester total				~~65~~ 4225	

Certification.

I declare that I worked at least the number of hours I report above for each week during the semester.

Signature — 5/2/12 Date

Joshua Lamb

Name

Team: Solution Engineering Consultants (SEC)
Individual (last name, first name): Leckie, Levi
Hours worked on team project

Week #	Start Day	End Day	Su	Mo	Tu	We	Th	Fr	Sa	Week Tota	Task(s)
1	26-Aug	3-Sep	0	0	0	0	0	0	0	0	
2	4-Sep	10-Sep	0	0	0	0	0	0	0	0	
3	11-Sep	17-Sep	0	1	0	0	0	0	0	1	Compiling report
4	18-Sep	24-Sep	0	0	0	0	0	0	0	0	
5	25-Sep	1-Oct	0	0	0.5	0	0	0	0	0.5	Making timeline (group)
6	2-Oct	8-Oct	0	0.5	1	0	0	0	0	1.5	Collecting data/Contacts
7	9-Oct	15-Oct	0	0	0	0	0	0	0	0	
8	16-Oct	22-Oct	0	0.5	0.5	0	0	0	0	1	Meeting/contacts
9	23-Oct	29-Oct	0	0	0	0	0	0	0	0	No meeting
10	30-Oct	5-Nov	0	0	0	0	0	0	0	0	No meeting
11	6-Nov	12-Nov	0	0	0	0	0	0	0	0	
12	13-Nov	19-Nov	0	0.3	0	0	0	0	0	0.25	Meeting
13	20-Nov	26-Nov	0	0	0	0	0	0	0	0	
14	27-Nov	3-Dec	0	0.5	0	0	0	0	0	0.5	Research
15	4-Dec	10-Dec	0	0	1.5	0	0	0	0	1.5	Presentation Prep
							Semester total			6.25	
1	8-Jan	14-Jan	0	0	0	0	0	0	0	0	
2	15-Jan	21-Jan	0	0	0	0	0	0	0	0	
3	22-Jan	28-Jan	0	0	0	0	0	0	0	0	
4	29-Jan	4-Feb	0	0	0	0	0	0	0	0	
5	5-Feb	11-Feb	0	0	0	0	0	0	0	0	
6	12-Feb	18-Feb	0	0	0	0	0	0	0	0	
7	19-Feb	25-Feb	0	0	0	0	0	0	0	0	
8	26-Feb	3-Mar	0	0	0	0	0	0	0	0	
9	4-Mar	10-Mar	0	0	0	0	0	0	0	0	
10	11-Mar	17-Mar	0	0	0	0	0	0	0	0	
11	18-Mar	24-Mar	0	0	0	0	0	0	0	0	
12	25-Mar	31-Mar	0	0	0	0	0	0	0	0	
13	1-Apr	7-Apr	0	0	0	0	0	0	0	0	
14	8-Apr	14-Apr	0	0.5	0	2	0	0.5	0	3	Contacting Sources/Researching Growth Factor/Pop.
15	15-Apr	21-Apr	0	0	0	2	0	1	0	3	Slides and Practice
16	22-Apr	28-Apr	0	0	0	0	0	0	0	0	
17	29-Apr	5-May	0	0	2	0	0	0	0	2	Writing Report
							Semester total			8	

Certification.
I declare that I worked at least the number of hours I report above for each week during the semester.

_______________________________ _____________
Signature Date

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Name