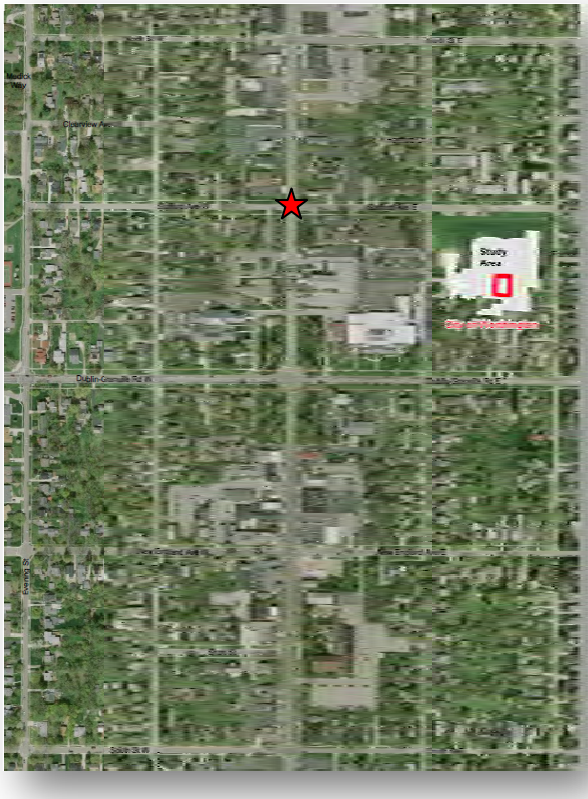
INNOVATIVE IDEAS
EXCEPTIONAL DESIGN
UNMATCHED CLIENT SERVICE

Old Worthington Mobility Study – Phase 1

High Street & Stafford Avenue

City of Worthington, Ohio



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DLZ Job No. 1521-1009-00

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Executive Summary

Background

The City of Worthington, located in Franklin County Ohio, is exploring the feasibility of implementing pedestrian feature improvements in Old Worthington area (from Stafford Avenue to Short Street, and between Morning Street and Evening Street, with an emphasis on the High Street (US 23) corridor), and identifying any potential degradation of traffic operations as a result of potential pedestrian improvements along High Street. ***Phase 1*** includes the intersection of High Street and Stafford Avenue.

Data Collection

DLZ utilized Miovision camera technology to perform a nine-hour turning movement count (7 AM – 9 AM, 11 AM – 1 PM, & 3 PM – 6 PM) at the intersection of High Street and Stafford Avenue in May 2015. Additional observations were completed by DLZ in May 2015. Forty-eight (48) pedestrians crossed High Street during the count period. DLZ also utilized ODOT's GCAT program to check for crashes. There were thirteen (13) crashes in the study area in the six year period of 2009-2015. There were six angle crashes and four crashes involving parked vehicles. There were no crashes involving bicyclists or pedestrians. There were no distinct crash patterns at this intersection.

Recommendations

A number of Alternatives were considered to be implemented at the intersection of High Street at Stafford Avenue:

I. ***Alternative 1*** - Advanced pedestrian warning signs
II. ***Alternative 2*** - Installation of a Rapid Rectangular Flashing Beacon (RRFB)
III. ***Alternative 3*** - Installation of overhead static pedestrian crossing signs
IV. ***Alternative 4*** - Installation of a Pedestrian Hybrid Beacon (PHB)

Numerous studies (TCRP-NCHRP 17-56, TCRP-NCHRP 562, FHWA-SA-12-012, FHWA-SA-14-014, and ITE- PHB 2012) have shown that the addition of a red beacon for vehicular traffic at a pedestrian crossing results in a higher level of motorists yielding, regardless of the street type (local road or major arterial street). The pedestrian hybrid beacon (PHB) includes this type of traffic control, providing positive guidance for drivers without implementing a typical traffic signal. PHBs are an intermediate between no traffic control and a traffic signal where the pedestrian volumes do not meet the traffic signal warrant requirements listed in the OMUTCD. In addition to the PHB having the capability to be integrated in a coordinated system without significant additional delay for High Street traffic, the alternating red signal operation allows vehicles to proceed once the pedestrian has cleared the travel lane, improving traffic flow. Therefore, it is

recommended to implement ***Alternative 4-*** Pedestrian Hybrid Beacon (PHB), along with additional advanced pedestrian warning signs (***Alternative 1***). Typical construction costs for a PHB are approximately $55,000. See ***Section VI – Conceptual Alternatives*** and ***Appendix E*** for more information.

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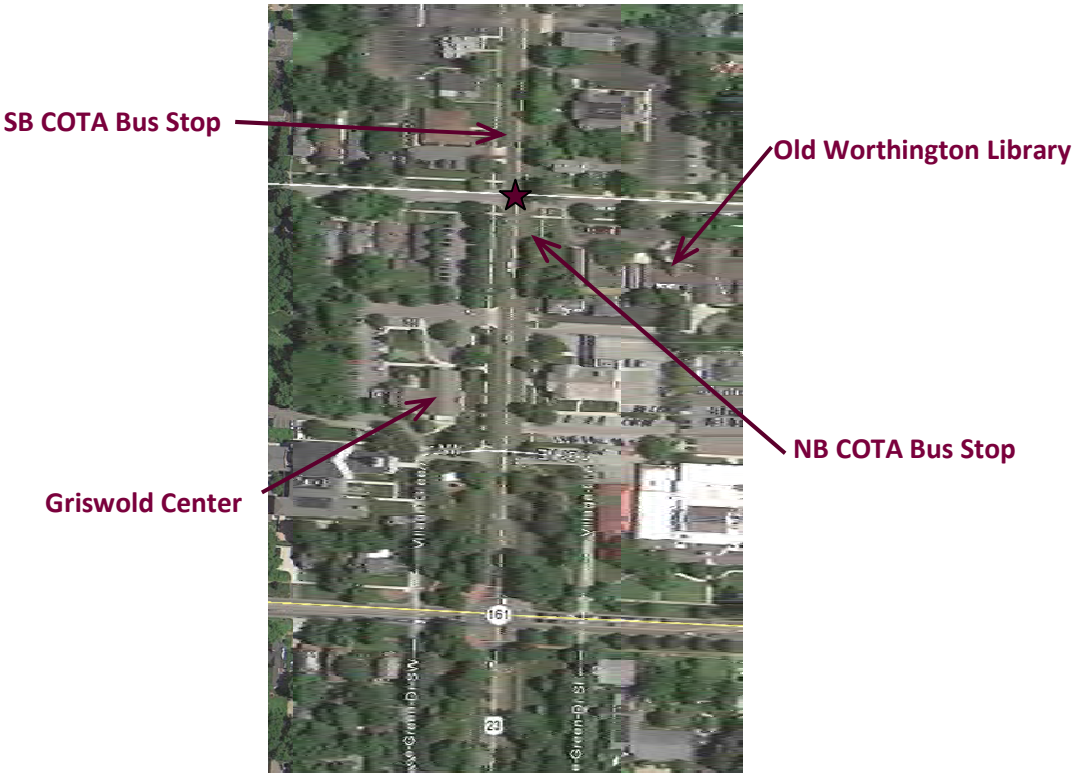
I. Background

The city of Worthington, located in Franklin County Ohio, is exploring the feasibility of implementing pedestrian feature improvements in Old Worthington (from Stafford Avenue to Short Street, and between Morning Street and Evening Street, with an emphasis on the High Street (US 23) corridor), and identifying any potential degradation of traffic operations as a result of potential pedestrian improvements along High Street. ***Phase 1*** includes the intersection of High Street and Stafford Avenue; see ***Figure 1*** below for a map of the study intersection.

The Griswold Center is located just southwest of the study intersection, and the Old Worthington Public Library is in close proximity to the intersection on the southeast corner. There is a COTA Bus Stop for northbound traffic located on the southeast corner of the intersection, and a COTA Bus Stop for southbound traffic located on the northwest corner of the intersection. The posted speed limit within the study area is 25 M.P.H.

Figure 1: Study Intersection



II. Data Collection & Observations

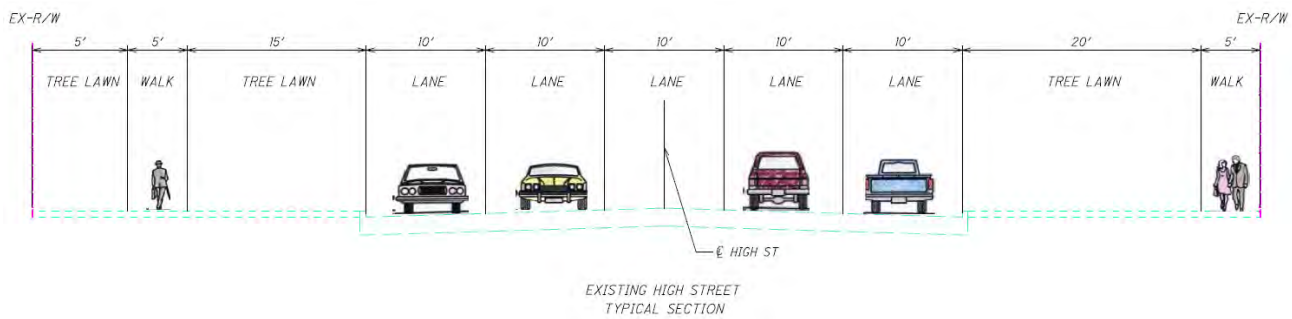
DLZ utilized Miovision camera technology to perform a nine-hour turning movement count (7 AM – 9 AM, 11 AM – 1 PM, & 3 PM – 6 PM) at the intersection of High Street and Stafford Avenue in May 2015 (see ***Appendix A***). Additional observations were completed by DLZ in May 2015 (see ***Appendix B*** for observation notes and photos.). Forty-eight (48) pedestrians crossed High Street during the count period.

During observations, DLZ noticed a number of pedestrians crossing High Street at Stafford Avenue. There was a total of seven (7) during the morning observations (8:15-8:30 AM), five (5) during midday observations (12:40-12:55 PM), and sixteen (16) during the afternoon observations (3:00-3:30). The pedestrians experienced similar situations; pedestrians consistently waited over a minute to cross High Street, and were forced to race through oncoming traffic as northbound or southbound vehicles did not yield unless the pedestrian was in their lane. At times, pedestrians were waiting in the two-way left-turn lane for a gap in traffic to finish crossing High Street. In some instances, vehicles did yield to pedestrians that were more aggressive in attempting to cross High Street. The majority of pedestrians observed crossing High Street were going to or from the Old Worthington Library, especially during the afternoon observation period; thirteen (13) of the pedestrians observed crossing High Street were schoolchildren going to the library after school was released for one of the various after-school programs. (The Ohio Manual of Uniform Traffic Control Devices, OMUTCD, defines "schoolchildren" to include elementary through high school students.) During the observation periods, numerous pedestrians were also witnessed walking along Stafford Avenue up to High Street, and then continued south along High Street instead of crossing.

III. Existing Geometry

High Street consists of a 5-lane cross section, with two travel lanes for northbound/southbound traffic and a two-way left-turn lane operating with free flow within the study area. The eastbound and westbound approaches on Stafford Avenue consist of a single left/thru/right lane, and are stop controlled. There is on-street parking along the south side of Stafford Avenue (there are restricted hours west of High Street from 8:00-10:00 AM and 2:00-4:00 PM). There is no on street parking along High Street. There are ADA curb ramps located on each corner, with marked crosswalks on Stafford Avenue and without a marked crosswalk on High Street. Pedestrian lighting is present on both sides of High Street. See ***Figure 2*** on the following page for a typical section of High Street in the study area.

Figure 2: High Street Typical Section



IV. Crash Data

DLZ utilized ODOT's GCAT program to check for crashes. There were thirteen (13) crashes in the study area in the six year period of 2009-2015. There were six angle crashes and four crashes involving parked vehicles. There were no crashes involving bicyclists or pedestrians. There were no distinct crash patterns at this intersection. See ***Appendix C*** for crash data within the study area.

V. Traffic Control Analysis

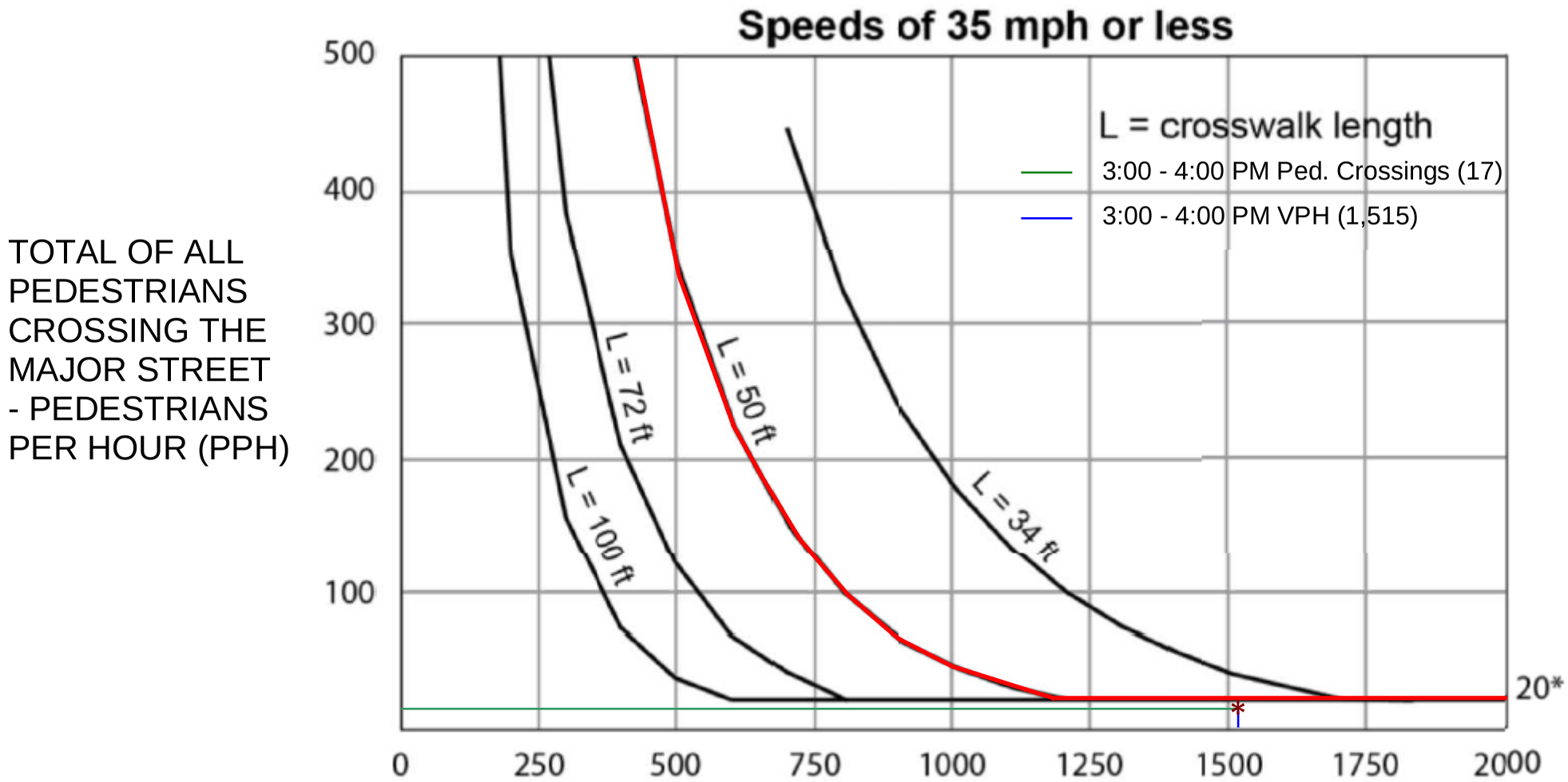
A review of the traffic counts indicates that a traffic signal is not justified per the requirements listed in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) and the Traffic Engineering Manual (TEM) at the High Street and Stafford Avenue intersection. The minimum number of pedestrians crossing the mainline for Warrant 4 (Pedestrian) is 90 per hour, and traffic counts showed only seventeen (17) pedestrians crossing in the highest hour.

An additional analysis was completed for Warrant 5 (School Crossing). According to the TEM, the minimum requirement for schoolchildren crossing the major street in one study period is twenty (20), and the number of gaps calculated must be less than one gap per minute during the study period. There were only seventeen (17) total pedestrians counted during the highest pedestrian traffic hour, therefore the warrant is not met. However, using the equations listed from Section 402-3.4 from the TEM, the number of gaps in traffic long enough for a pedestrian to cross the major street was also calculated in order to determine possible safety issues for pedestrians at this intersection. The number of gaps calculated for the one hour study period is one (1), which is less than one per minute at the intersection; there is only one (1) gap in traffic long enough for a pedestrian to entirely cross High Street.

The OMUTCD does contain guidelines for the Pedestrian Hybrid Beacon (PHB), which is intended for areas with high pedestrian traffic that do not meet traffic signal warrants. Comparing the vehicular traffic and pedestrian traffic reveals the guidelines are not met. However it is very close; the minimum number of required pedestrians crossing the mainline in one hour is twenty (20), and traffic counts showed seventeen (17). However, the Old Worthington Library and the Griswold Center are significant pedestrian generators and this number could potentially be greater than twenty (20) depending on programs sponsored by the library and/or the Griswold Center. Some of the programs the Old Worthington Library hosts are: a Homework Help Center for students grades K-12 after school hours; a "Teen Gaming Tuesday" every Tuesday for teenagers; a Summer Reading Club program for kids/adults; and "Stories and Such" which is an interactive program for young children and caregivers. The Griswold Center hosts numerous programs, from fitness/wellness classes and daycare to youth day camps and educational workshops. Based on engineering judgment, a PHB is justified at this location. ***Figure 3*** on the following page shows the Pedestrian Hybrid Beacon analysis.

Figure 3: Guidelines for the Installation of a Pedestrian Hybrid Beacon on Low-Speed Roadways (OMUTCD Figure 4F-1)

High St @ Stafford St.



MAJOR STREET - TOTAL OF BOTH APPROACHES -VEHICLES PER HOUR (VPH)
*Note: 20 pph applies as the lower threshold volume

VI. Conceptual Alternatives

The analysis of the vehicular and pedestrian traffic counts and the crash data indicate there is justification for additional traffic control. While the crash data does not show a problem, there is a higher potential for a pedestrian crash in this area, especially in the afternoon peak period. Studies (FHWA Publication HRT-04-100 "Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations", 2005) have shown that the installation of marked crosswalks at un-signalized intersections or mid-block locations without any other improvements is not as safe as unmarked crossings because pedestrians and drivers are not as alert to crossing conflicts. Therefore, the installation of marked crosswalks should have additional static or active warning signs. The following alternatives provide ideas for enhanced pedestrian circulation.

Alternative #1 – Pedestrian Warning Signs

At a minimum, advanced pedestrian crossing signs (see ***Figure 4***) should be installed on High Street warning drivers that they are entering an area of higher than normal pedestrian activity, especially for southbound High Street, which enters the study area with a wider cross section (northbound High Street traffic comes from the downtown area and widens at the south edge of the Village Green, just south of S.R. 161). Typical costs per sign are around $150.00.

Figure 4: Source - Road Traffic Signs

Alternative #2 –Crosswalk with Rectangular Rapid Flashing Beacons (RRFB)

Alternative 2 consists of installing a marked crosswalk on High Street and a Rectangular Rapid Flashing Beacon (RRFB) on the south side of the intersection. An RRFB is an actuated flashing signal, complete with ADA compliant pushbuttons and with LED indicators used at marked or unmarked crosswalks. The signals operate with a wig-wag rapid flickering pattern to alert drivers of a pedestrian crossing. Studies (FHWA-HRT-10-043) have shown installation of an RRFB improves pedestrian safety and increases driver yielding. Costs range between $16,000-$25,000 to install plus regular operation and maintenance costs.

More information is located in ***Appendix D***.

- Advantages
  - Improves visibility of pedestrians and crossing; improves pedestrian safety.
  - Provides positive crossing guidance.
  - Able to be solar powered and wireless.
  - Lower costs to install and operate than traffic signals or PHBs Driver compliance rates greater than 80% (typical installation includes two RRFBs per approach or overhead installation for multi-lane roadways).
- Disadvantages
  - Cannot be part of a coordinated system such as a traffic signal or PHB; pedestrians would cause more disruption of vehicular traffic flow.
  - Does not provide a red/stop condition for drivers.
  - Wide roads/multi-lane roads can make curb/side of road signing more difficult for drivers to see.
  - Device is under Interim FHWA approval.

Figure 5: RRFB & Solar Panel

Figure 6: Typical RRFB Installation for Multi-Lane Roadways (Oregon)

Alternative #3 – Overhead Pedestrian Crossing Signs

Alternative 3 involves installation of a marked crosswalk crossing High Street (on the south side of the intersection) and an overhead Pedestrian Crossing sign, similar to what is currently in operation at the Village Green South and Short Street locations. The overhead signing would be activated by a pedestrian utilizing an ADA compliant pushbutton when crossing. Costs would range from $15,000- $20,000.

Figure 7: Existing Pedestrian Crossing at Village Green South Drive

- Advantages
  - Improves visibility of pedestrian crossing for drivers in areas with on-street parking, landscaping, or any other visual obstruction exists.
  - Provides positive crossing guidance.
  - Can be incorporated with decorative mast arm poles.
- Disadvantages
  - Cannot be part of a coordinated system such as a traffic signal or PHB; pedestrians would cause more disruption of vehicular traffic flow.
  - Does not provide a red/stop condition for drivers.
  - Studies have shown that installation of beacons improves driver yielding up to 80% more than static signing.

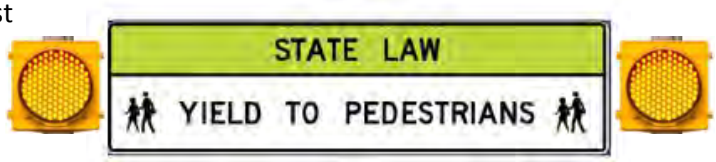


Figure 8: Overhead Pedestrian Crossing Signs

Alternative #4 –Pedestrian Hybrid Beacon (PHB)

Alternative 4 consists of installing Pedestrian Hybrid Beacon (PHB; also know as a High Intensity Activated Crosswalk or HAWK) on the south side of the intersection. The PHB is a pedestrian activated warning device located on a mast arm over a roadway. The beacons consist of two red LED lenses above a single yellow LED lens, which remain dark until activated. A pedestrian will actuate the system utilizing an ADA compliant pushbutton, which activates the beacon. The beacon flashes the yellow indicator on the major street, warning drivers to prepare to stop. Then, the yellow signal

will turn solid, allowing vehicles to stop if it is safe to do so. When the all red indicators start, the vehicle stop phase begins. After a brief time period, the red beacons begin to alternate flashing, allowing drivers to proceed only if the crosswalk is clear. When the beacons turn dark, traffic is allowed to proceed. Costs for a PHB interconnected to the coordinated signals along High Street would be approximately $55,000 to install plus regular operation and maintenance costs. See ***Figure 11*** at the end of this report and ***Appendix E*** for more information on PHBs.

- Advantages
  - Higher visibility of pedestrians and crossing; improves pedestrian safety.
  - Provides positive crossing guidance
  - Provides solid red indicator for drivers (positive stop control).
  - Lower costs to install and operate than a traffic signal.
  - Can be integrated into a coordinated system to minimize disruptions in traffic flow.
  - Reduction in pedestrian related crashes by 69% and total crashes by 29%.
  - Can be incorporated with decorative mast arm poles.
- Disadvantages
  - Higher cost than RRFB installations.
  - New type of device to the area will result in a learning curve (need a PR campaign)

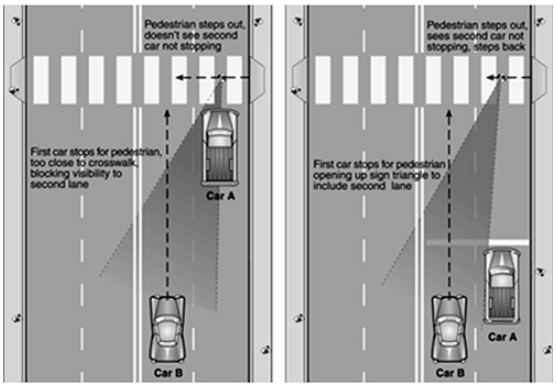


Figure 9: Sight Distance Advantage with PHB Installation

Figure 10: Pedestrian Hybrid Beacon Installation

Various other alternatives were considered, such as in-pavement lighting, refugee islands, or installing a crosswalk only. In-pavement lighting is not considered viable due to maintenance issues

ranging from damage due to snow plows and indicator lenses becoming dirty from dirt/grit requiring regular cleaning. A refugee island will not work at this location, as the left-turn lane is needed for vehicular traffic on High Street for the northbound and southbound left turns. Studies have also shown that installing a crosswalk at an unsignalized intersection or mid-block location without any other improvements is less safe for pedestrians than an unmarked crossing.

VII. Capacity Analysis

Further analysis was completed using *Synchro 9.*0 software in order to determine how the study intersection operates with the existing traffic control (stop control for Stafford Avenue) and if a PHB was installed (in order to model a PHB, the intersection was analyzed as a typical traffic signal, with a pedestrian recall phase used for the side street timing). Using the *Synchro* model developed for the IR-270/US-23 construction project (which includes the existing timings and offsets in use today), these two (2) scenarios were analyzed to determine capacity, Level of Service, and Model of Effectiveness (MOE).

Capacity is the volume of traffic that can pass through a roadway facility in a given amount of time (vehicles/hour). The concept of *Level of Service* (LOS) is a qualitative measure of the operation of traffic flow. LOS considers such factors as speed, travel time, freedom to maneuver, traffic interruptions, driver inconvenience, safety, and delay. For different transportation facilities, the LOS is based on different measures of effectiveness.

Signalized and unsignalized intersections are measured for average control delay in seconds per vehicle. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final deceleration delay. The delay measurement for vehicles at a signalized intersection is a combination of driver discomfort, driver frustration, and lost travel time.

The LOS rating system as described in the 2010 Highway Capacity Manual gives a value of A through F to each type of roadway facility representing best to worst traffic conditions. When designing roadway improvements, it is desirable to accommodate peak hour volumes at a LOS C or D. ***Table 1*** and ***Table 2*** summarize the Levels of Service for signalized and unsignalized intersections.

Table 1: LOS Criteria for Signalized Intersections

Level of Service	Average Control Delay
A	< 10 seconds per vehicle
B	> 10 sec. but not more than 20 sec. per vehicle
C	> 20 sec. but not more than 35 sec. per vehicle
D	> 35 sec. but not more than 55 sec. per vehicle
E	> 55 sec. but not more than 80 sec. per vehicle
F	> 80 seconds per vehicle

Table 2: LOS Criteria for Unsignalized Intersections

Level of Service	Average Control Delay
A	0-10 seconds per vehicle
B	10-15 seconds per vehicle
C	15-25 seconds per vehicle
D	25-35 seconds per vehicle
E	35-50 seconds per vehicle
F	> 50 seconds per vehicle

Capacity analysis was completed for the existing traffic control and if a PHB were to be installed at the intersection of High Street at Stafford Avenue. Analysis shows that the existing traffic control (stop control on Stafford) operates at acceptable Levels of Service during the AM peak hour, Mid-Day peak hour, and PM peak hour, with the worst LOS and delay occurring during the AM peak hour with LOS D and delay of 25.3 seconds (LOS D is acceptable in urban conditions) on the side street (Stafford Avenue). Analysis with a PHB shows the intersection operating with acceptable LOS and delay as well, with the northbound through delay of only 3.2 seconds (LOS A) during the am peak hour. During the other times of the day, the northbound and southbound through average delays are all under 5.0 seconds, which is a LOS A. For the PHB, the delays for vehicles on Stafford will be the same as the existing condition since the traffic control on the side street will stay the same (drivers will still be under a stop controlled condition). ***Table 3*** on the following page summarizes the LOS and delay results for vehicles.

Table 3: LOS & Delay Summary

Intersection	Analysis Period	Direction	Existing Condition*		PHB	
			LOS	Delay	LOS	Delay
High & Stafford	AM Peak Hour	Northbound	A	0.0	A	3.2
		Southbound	A	0.0	A	1.9
	Mid-Day Peak Hour	Northbound	A	0.0	A	4.1
		Southbound	A	0.0	A	1.9
	PM Peak Hour	Northbound	A	0.0	A	2.7
		Southbound	A	0.0	A	1.5

Level of Service and Delay information obtained from Synchro.
*Since traffic on High Street does not stop, there is no delay for the existing condition.

A PHB can be implemented into a coordinated signal system; therefore coordination with the existing signals along High Street was also checked with this scenario. Although Stafford is only 750 feet north of SR-161, the Time Space Diagrams (see ***Appendix F***) shows the intersection can be incorporated within the coordinated system with minimal additional delay for traffic on High Street. The Measure of Effectiveness for each of the scenarios analyzed is also located in ***Appendix F***.

Analysis of delay for the pedestrians with the PHB shows the average delay for a pedestrian crossing High Street will be 25.5 seconds during the AM and PM peak hours once the pedestrian push button is pressed. Actual delay will vary between one second and 118 seconds for most of day depending on when the push button is activated during the traffic signal cycle; however, in most cases, the pedestrian would wait between 40 to 80 seconds. Another analysis was also completed with the PHB operating at a half cycle, so the PHB would operate on a 60-second cycle during the AM and midday hours and a 65-second cycle during the PM peak hours, which would result in less delay for a pedestrian crossing High Street. However, by having the PHB operate on a half-cycle, the delay for southbound vehicular traffic would be a LOS C with an average delay of 20 seconds in the AM peak hour and a LOS B with 19 seconds of delay during the PM peak hour.

VIII. Recommendations

Numerous studies (TCRP-NCHRP 17-56, TCRP-NCHRP 562, FHWA-SA-12-012, FHWA-SA-14-014, and ITE- PHB 2012) have shown that the addition of a red beacon for vehicular traffic at a pedestrian crossing results in a higher level of motorists yielding, regardless of the street type (local road or major arterial street). The pedestrian hybrid beacon (PHB) includes this type of traffic control, providing positive guidance for drivers without implementing a typical traffic signal. PHBs are an intermediate between no traffic control and a traffic signal where the pedestrian volumes do not meet the traffic signal warrant requirements listed in the OMUTCD. In addition to the PHB having the

capability to be integrated in a coordinated system without significant additional delay for High Street traffic, the alternating red signal operation allows vehicles to proceed once the pedestrian has cleared the travel lane, improving traffic flow. Therefore, it is recommended to implement ***Alternative 4-*** Pedestrian Hybrid Beacon (PHB), along with additional advanced pedestrian warning signs (***Alternative 1***).

	DRIVERS		PEDESTRIANS	
	Will See...	Will Do...	Will See...	Will Do...
1		Proceed with caution.		Push the button to activate the system.
2	FLASHING	Slow down, prepare to stop. A pedestrian has activated the system.		Wait.
3		Stop if it is safe to do so.		Continue to wait.
4		STOP. A pedestrian is in the crosswalk.		Start crossing when all vehicles are stopped.
5	FLASHING	STOP. Proceed with caution if the crosswalk is clear.	09	Continue crossing; the signal will count down.
6		Proceed with caution.		Push the button to activate the system.

Figure 11: PHB Operation Guide

Appendix A: Traffic Count Data

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015
Page No: 1

Turning Movement Data

Start Time	Southbound Approach Southbound						Westbound Approach Westbound						Northbound Approach Northbound						Eastbound Approach Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
7:00 AM	23	113	2	0	1	138	0	0	0	0	0	0	3	99	0	0	0	102	0	0	0	0	0	0	240
7:15 AM	51	114	1	0	6	166	7	4	0	0	0	11	0	132	1	0	0	133	3	0	1	0	0	4	314
7:30 AM	52	148	2	0	3	202	6	3	1	0	2	10	2	163	4	0	0	169	2	1	5	0	0	8	389
7:45 AM	10	144	17	0	0	171	6	0	0	0	1	6	7	225	7	0	0	239	7	3	1	0	1	11	427
Hourly Total	136	519	22	0	10	677	19	7	1	0	3	27	12	619	12	0	0	643	12	4	7	0	1	23	1370
8:00 AM	6	151	8	0	0	165	6	1	3	0	1	10	6	186	9	0	1	201	9	2	4	0	2	15	391
8:15 AM	12	157	14	0	0	183	12	2	2	0	2	16	9	181	9	0	0	199	9	3	4	0	1	16	414
8:30 AM	9	151	11	0	0	171	7	1	1	0	2	9	9	167	3	0	0	179	5	1	4	0	0	10	369
8:45 AM	7	137	8	0	0	152	3	0	1	0	1	4	5	183	3	0	0	191	2	2	2	0	0	6	353
Hourly Total	34	596	41	0	0	671	28	4	7	0	6	39	29	717	24	0	1	770	25	8	14	0	3	47	1527
9:00 AM	5	105	8	0	0	118	8	0	6	0	2	14	3	144	3	0	0	150	4	0	2	0	1	6	288
9:15 AM	8	121	9	0	0	138	5	0	1	0	1	6	6	151	2	0	1	159	3	0	3	0	0	6	309
9:30 AM	4	123	10	0	0	137	7	1	2	0	1	10	6	157	2	0	0	165	2	0	3	0	2	5	317
9:45 AM	7	123	11	0	0	141	5	1	1	0	0	7	11	151	0	0	0	162	5	3	3	0	0	11	321
Hourly Total	24	472	38	0	0	534	25	2	10	0	4	37	26	603	7	0	1	636	14	3	11	0	3	28	1235
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11:00 AM	8	138	11	0	0	157	7	0	0	0	0	7	7	131	0	0	0	138	2	0	0	0	2	2	304
11:15 AM	1	154	10	0	0	165	11	1	1	0	4	13	11	155	2	0	0	168	2	0	3	0	0	5	351
11:30 AM	2	178	13	0	0	193	12	0	3	0	1	15	12	162	1	0	0	175	6	2	5	0	0	13	396
11:45 AM	2	173	10	0	0	185	12	1	2	0	3	15	4	166	0	0	1	170	8	1	4	0	2	13	383
Hourly Total	13	643	44	0	0	700	42	2	6	0	8	50	34	614	3	0	1	651	18	3	12	0	4	33	1434
12:00 PM	8	174	6	0	2	188	12	1	2	0	2	15	10	159	9	0	0	178	7	0	1	0	0	8	389
12:15 PM	3	179	13	0	1	195	8	2	2	0	1	12	9	153	3	0	4	165	5	1	3	0	3	9	381
12:30 PM	6	165	5	0	0	176	4	1	0	0	3	5	3	186	0	0	0	189	0	0	4	0	0	4	374
12:45 PM	5	176	4	0	0	185	7	0	7	0	2	14	11	183	3	0	0	197	6	1	2	0	0	9	405
Hourly Total	22	694	28	0	3	744	31	4	11	0	8	46	33	681	15	0	4	729	18	2	10	0	3	30	1549
1:00 PM	5	172	7	0	1	184	8	2	1	0	1	11	7	183	1	0	0	191	5	0	1	0	3	6	392
1:15 PM	7	169	6	0	1	182	13	1	2	0	1	16	6	162	2	0	0	170	2	3	3	0	0	8	376
1:30 PM	5	152	10	0	0	167	8	1	3	0	2	12	9	176	4	0	0	189	2	0	4	0	1	6	374
1:45 PM	6	137	7	0	0	150	4	5	3	0	1	12	8	160	1	0	0	169	8	0	3	0	2	11	342
Hourly Total	23	630	30	0	2	683	33	9	9	0	5	51	30	681	8	0	0	719	17	3	11	0	6	31	1484
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3:00 PM	5	166	15	0	0	186	12	1	1	0	0	14	14	156	3	0	6	173	8	3	3	0	1	14	387
3:15 PM	4	169	9	0	0	182	11	2	3	0	4	16	11	169	2	0	0	182	1	3	1	0	0	5	385
3:30 PM	3	178	18	0	0	199	14	1	0	0	3	15	16	181	5	0	6	202	6	0	1	0	4	7	423
3:45 PM	9	161	6	0	1	176	21	2	5	0	5	28	14	196	5	0	4	215	10	3	4	0	3	17	436
Hourly Total	21	674	48	0	1	743	58	6	9	0	12	73	55	702	15	0	16	772	25	9	9	0	8	43	1631
4:00 PM	8	176	12	0	0	196	21	1	2	0	5	24	17	174	3	0	1	194	3	2	2	0	2	7	421
4:15 PM	8	164	8	0	1	180	14	1	3	0	3	18	10	168	3	0	2	181	1	1	1	0	2	3	382
4:30 PM	7	193	5	0	0	205	12	3	1	0	4	16	3	205	3	0	1	211	2	0	1	0	0	3	435

4:45 PM	12	229	6	0	0	247	15	0	5	0	4	20	14	173	0	0	1	187	4	2	3	0	0	9	463
Hourly Total	35	762	31	0	1	828	62	5	11	0	16	78	44	720	9	0	5	773	10	5	7	0	4	22	1701
5:00 PM	7	232	12	0	0	251	14	1	1	0	6	16	7	180	3	0	0	190	4	0	1	0	2	5	462
5:15 PM	9	219	5	0	0	233	10	0	1	0	2	11	12	191	1	0	0	204	4	0	1	0	0	5	453
5:30 PM	7	195	10	0	2	212	11	3	2	0	1	16	9	189	5	0	0	203	5	2	0	0	0	7	438
5:45 PM	10	195	11	0	1	216	10	0	2	0	2	12	9	195	4	0	0	208	3	0	3	0	0	6	442
Hourly Total	33	841	38	0	3	912	45	4	6	0	11	55	37	755	13	0	0	805	16	2	5	0	2	23	1795
Grand Total	341	5831	320	0	20	6492	343	43	70	0	73	456	300	6092	106	0	28	6498	155	39	86	0	34	280	13726
Approach %	5.3	89.8	4.9	0.0	-	-	75.2	9.4	15.4	0.0	-	-	4.6	93.8	1.6	0.0	-	-	55.4	13.9	30.7	0.0	-	-	-
Total %	2.5	42.5	2.3	0.0	-	47.3	2.5	0.3	0.5	0.0	-	3.3	2.2	44.4	0.8	0.0	-	47.3	1.1	0.3	0.6	0.0	-	2.0	-
Lights	338	5674	301	0	-	6313	338	40	70	0	-	448	287	5901	105	0	-	6293	152	38	85	0	-	275	13329
% Lights	99.1	97.3	94.1	-	-	97.2	98.5	93.0	100.0	-	-	98.2	95.7	96.9	99.1	-	-	96.8	98.1	97.4	98.8	-	-	98.2	97.1
Mediums	3	136	19	0	-	158	5	3	0	0	-	8	13	178	1	0	-	192	3	1	1	0	-	5	363
% Mediums	0.9	2.3	5.9	-	-	2.4	1.5	7.0	0.0	-	-	1.8	4.3	2.9	0.9	-	-	3.0	1.9	2.6	1.2	-	-	1.8	2.6
Articulated Trucks	0	21	0	0	-	21	0	0	0	0	-	0	0	13	0	0	-	13	0	0	0	0	-	0	34
% Articulated Trucks	0.0	0.4	0.0	-	-	0.3	0.0	0.0	0.0	-	-	0.0	0.0	0.2	0.0	-	-	0.2	0.0	0.0	0.0	-	-	0.0	0.2
Bicycles on Crosswalk	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	5	-	-	-	-	-	5	-	-
% Bicycles on Crosswalk	-	-	-	-	5.0	-	-	-	-	-	1.4	-	-	-	-	-	17.9	-	-	-	-	-	14.7	-	-
Pedestrians	-	-	-	-	19	-	-	-	-	-	72	-	-	-	-	-	23	-	-	-	-	-	29	-	-
% Pedestrians	-	-	-	-	95.0	-	-	-	-	-	98.6	-	-	-	-	-	82.1	-	-	-	-	-	85.3	-	-

Unit Number:

DLZ
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Chicago, Illinois, United States 60631
(773) 283-2600

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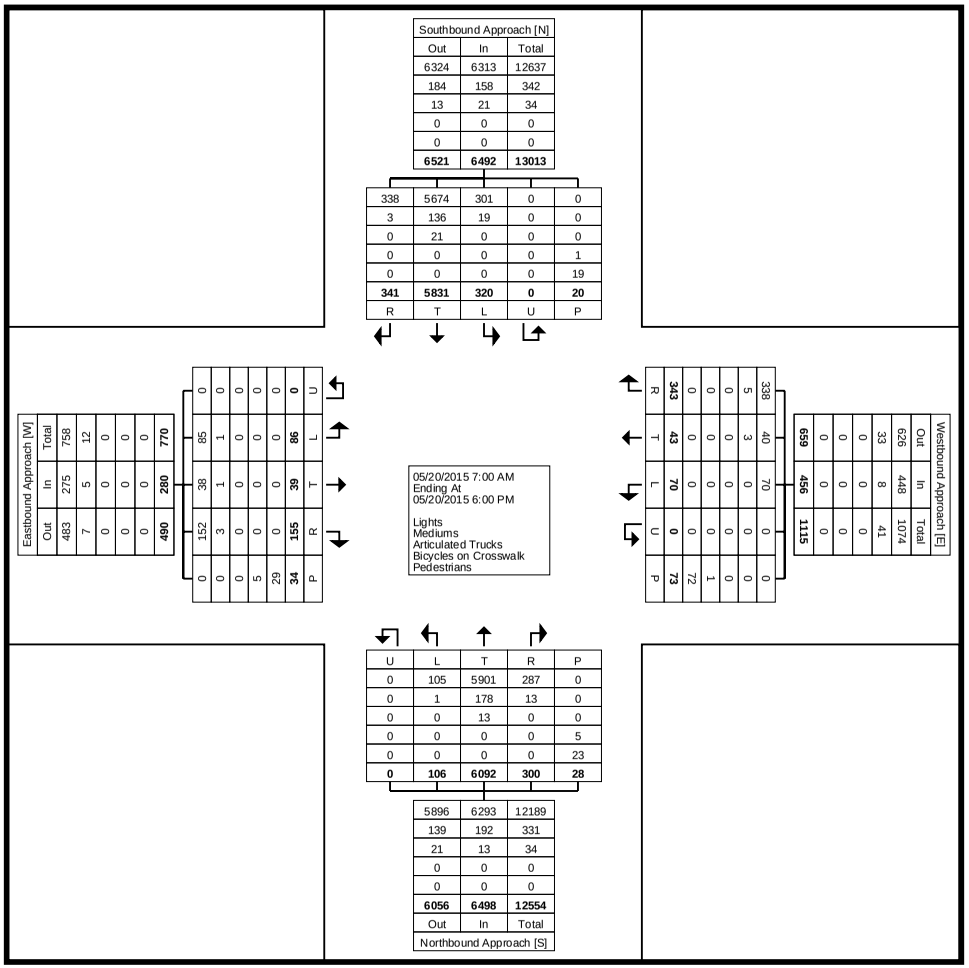

Turning Movement Data Plot

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015
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Turning Movement Peak Hour Data (7:30 AM)

Start Time	Southbound Approach						Westbound Approach						Northbound Approach						Eastbound Approach						
	Southbound						Westbound						Northbound						Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
7:30 AM	52	148	2	0	3	202	6	3	1	0	2	10	2	163	4	0	0	169	2	1	5	0	0	8	389
7:45 AM	10	144	17	0	0	171	6	0	0	0	1	6	7	225	7	0	0	239	7	3	1	0	1	11	427
8:00 AM	6	151	8	0	0	165	6	1	3	0	1	10	6	186	9	0	1	201	9	2	4	0	2	15	391
8:15 AM	12	157	14	0	0	183	12	2	2	0	2	16	9	181	9	0	0	199	9	3	4	0	1	16	414
Total	80	600	41	0	3	721	30	6	6	0	6	42	24	755	29	0	1	808	27	9	14	0	4	50	1621
Approach %	11.1	83.2	5.7	0.0	-	-	71.4	14.3	14.3	0.0	-	-	3.0	93.4	3.6	0.0	-	-	54.0	18.0	28.0	0.0	-	-	-
Total %	4.9	37.0	2.5	0.0	-	44.5	1.9	0.4	0.4	0.0	-	2.6	1.5	46.6	1.8	0.0	-	49.8	1.7	0.6	0.9	0.0	-	3.1	-
PHF	0.385	0.955	0.603	0.000	-	0.892	0.625	0.500	0.500	0.000	-	0.656	0.667	0.839	0.806	0.000	-	0.845	0.750	0.750	0.700	0.000	-	0.781	0.949
Lights	80	578	39	0	-	697	30	5	6	0	-	41	20	715	28	0	-	763	25	9	13	0	-	47	1548
% Lights	100.0	96.3	95.1	-	-	96.7	100.0	83.3	100.0	-	-	97.6	83.3	94.7	96.6	-	-	94.4	92.6	100.0	92.9	-	-	94.0	95.5
Mediums	0	21	2	0	-	23	0	1	0	0	-	1	4	38	1	0	-	43	2	0	1	0	-	3	70
% Mediums	0.0	3.5	4.9	-	-	3.2	0.0	16.7	0.0	-	-	2.4	16.7	5.0	3.4	-	-	5.3	7.4	0.0	7.1	-	-	6.0	4.3
Articulated Trucks	0	1	0	0	-	1	0	0	0	0	-	0	0	2	0	0	-	2	0	0	0	0	-	0	3
% Articulated Trucks	0.0	0.2	0.0	-	-	0.1	0.0	0.0	0.0	-	-	0.0	0.0	0.3	0.0	-	-	0.2	0.0	0.0	0.0	-	-	0.0	0.2
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	3	-	-	-	-	-	6	-	-	-	-	-	1	-	-	-	-	-	4	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

Unit Number:

DLZ
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Southbound Approach [N]		
Out	In	Total
758	697	1455
39	23	62
2	1	3
0	0	0
0	0	0
799	**721**	**1520**

80	578	39	0	0
0	21	2	0	0
0	1	0	0	0
0	0	0	0	0
0	0	0	0	3
80	**600**	**41**	**0**	**3**
R	T	L	U	P

Eastbound Approach [W]		
Out	In	Total
113	47	160
2	3	5
0	0	0
0	0	0
0	0	0
115	**50**	**165**

0	0	0	0	0
25	9	13	0	0
2	0	1	0	0
0	0	0	0	0
0	0	0	0	0
4	0	0	0	0
4	**27**	**9**	**14**	**0**
P	R	T	L	U

Peak Hour Data

05/20/2015 7:30 AM
Ending At
05/20/2015 8:30 AM

Lights
Mediums
Articulated Trucks
Bicycles on Crosswalk
Pedestrians

30	0	0	0	0
5	1	0	0	0
6	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
30	**6**	**0**	**6**	**6**
R	T	L	U	P

Westbound Approach [E]		
Out	In	Total
68	41	109
6	1	7
0	0	0
0	0	0
0	0	0
74	**42**	**116**

U	L	T	R	P
0	28	715	20	0
0	1	38	4	0
0	0	2	0	0
0	0	0	0	0
0	0	0	0	1
0	**29**	**755**	**24**	**1**

Northbound Approach [S]		
Out	In	Total
609	763	1372
23	43	66
1	2	3
0	0	0
0	0	0
633	**808**	**1441**

Turning Movement Peak Hour Data Plot (7:30 AM)

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015
Page No: 6

Turning Movement Peak Hour Data (11:00 AM)

Start Time	Southbound Approach						Westbound Approach						Northbound Approach						Eastbound Approach						
	Southbound						Westbound						Northbound						Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
11:00 AM	8	138	11	0	0	157	7	0	0	0	0	7	7	131	0	0	0	138	2	0	0	0	2	2	304
11:15 AM	1	154	10	0	0	165	11	1	1	0	4	13	11	155	2	0	0	168	2	0	3	0	0	5	351
11:30 AM	2	178	13	0	0	193	12	0	3	0	1	15	12	162	1	0	0	175	6	2	5	0	0	13	396
11:45 AM	2	173	10	0	0	185	12	1	2	0	3	15	4	166	0	0	1	170	8	1	4	0	2	13	383
Total	13	643	44	0	0	700	42	2	6	0	8	50	34	614	3	0	1	651	18	3	12	0	4	33	1434
Approach %	1.9	91.9	6.3	0.0	-	-	84.0	4.0	12.0	0.0	-	-	5.2	94.3	0.5	0.0	-	-	54.5	9.1	36.4	0.0	-	-	-
Total %	0.9	44.8	3.1	0.0	-	48.8	2.9	0.1	0.4	0.0	-	3.5	2.4	42.8	0.2	0.0	-	45.4	1.3	0.2	0.8	0.0	-	2.3	-
PHF	0.406	0.903	0.846	0.000	-	0.907	0.875	0.500	0.500	0.000	-	0.833	0.708	0.925	0.375	0.000	-	0.930	0.563	0.375	0.600	0.000	-	0.635	0.905
Lights	13	616	42	0	-	671	41	2	6	0	-	49	32	590	3	0	-	625	18	3	12	0	-	33	1378
% Lights	100.0	95.8	95.5	-	-	95.9	97.6	100.0	100.0	-	-	98.0	94.1	96.1	100.0	-	-	96.0	100.0	100.0	100.0	-	-	100.0	96.1
Mediums	0	24	2	0	-	26	1	0	0	0	-	1	2	22	0	0	-	24	0	0	0	0	-	0	51
% Mediums	0.0	3.7	4.5	-	-	3.7	2.4	0.0	0.0	-	-	2.0	5.9	3.6	0.0	-	-	3.7	0.0	0.0	0.0	-	-	0.0	3.6
Articulated Trucks	0	3	0	0	-	3	0	0	0	0	-	0	0	2	0	0	-	2	0	0	0	0	-	0	5
% Articulated Trucks	0.0	0.5	0.0	-	-	0.4	0.0	0.0	0.0	-	-	0.0	0.0	0.3	0.0	-	-	0.3	0.0	0.0	0.0	-	-	0.0	0.3
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	1	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	-	-	-	-	12.5	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	0	-	-	-	-	-	7	-	-	-	-	-	1	-	-	-	-	-	4	-	-
% Pedestrians	-	-	-	-	-	-	-	-	-	-	87.5	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

Unit Number:

DLZ
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Southbound Approach [N]		
Out	In	Total
643	671	1314
23	26	49
2	3	5
0	0	0
0	0	0
668	**700**	**1368**

13	616	42	0	0
0	24	2	0	0
0	3	0	0	0
0	0	0	0	0
0	0	0	0	0
13	**643**	**44**	**0**	**0**
R	T	L	U	P

Eastbound Approach [W]		
Out	In	Total
18	33	51
0	0	0
0	0	0
0	0	0
0	0	0
18	**33**	**51**

0	0	0	0	0	U
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
4	0	0	0	0	0
4	**18**	**3**	**12**	**0**	**0**
P	R	T	L	U	

Peak Hour Data

05/20/2015 11:00 AM
Ending At
05/20/2015 12:00 PM

Lights
Mediums
Articulated Trucks
Bicycles on Crosswalk
Pedestrians

R	41	0	0	0	0
T	1	0	0	0	0
L	2	6	0	0	0
U	0	0	0	0	0
0	0	0	0	1	0
0	0	0	0	0	0
7	0	0	0	0	0
8	**0**	**0**	**6**	**2**	**42**
P	U	L	T	R	

Westbound Approach [E]		
Out	In	Total
77	49	126
4	1	5
0	0	0
0	0	0
0	0	0
81	**50**	**131**

U	L	T	R	P
0	3	590	32	0
0	0	22	2	0
0	0	2	0	0
0	0	0	0	0
0	0	0	0	1
0	**3**	**614**	**34**	**1**

640	625	1265
24	24	48
3	2	5
0	0	0
0	0	0
667	**651**	**1318**
Out	In	Total
Northbound Approach [S]		

Turning Movement Peak Hour Data Plot (11:00 AM)

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015
Page No: 8

Turning Movement Peak Hour Data (12:15 PM)

Start Time	Southbound Approach						Westbound Approach						Northbound Approach						Eastbound Approach						
	Southbound						Westbound						Northbound						Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
12:15 PM	3	179	13	0	1	195	8	2	2	0	1	12	9	153	3	0	4	165	5	1	3	0	3	9	381
12:30 PM	6	165	5	0	0	176	4	1	0	0	3	5	3	186	0	0	0	189	0	0	4	0	0	4	374
12:45 PM	5	176	4	0	0	185	7	0	7	0	2	14	11	183	3	0	0	197	6	1	2	0	0	9	405
1:00 PM	5	172	7	0	1	184	8	2	1	0	1	11	7	183	1	0	0	191	5	0	1	0	3	6	392
Total	19	692	29	0	2	740	27	5	10	0	7	42	30	705	7	0	4	742	16	2	10	0	6	28	1552
Approach %	2.6	93.5	3.9	0.0	-	-	64.3	11.9	23.8	0.0	-	-	4.0	95.0	0.9	0.0	-	-	57.1	7.1	35.7	0.0	-	-	-
Total %	1.2	44.6	1.9	0.0	-	47.7	1.7	0.3	0.6	0.0	-	2.7	1.9	45.4	0.5	0.0	-	47.8	1.0	0.1	0.6	0.0	-	1.8	-
PHF	0.792	0.966	0.558	0.000	-	0.949	0.844	0.625	0.357	0.000	-	0.750	0.682	0.948	0.583	0.000	-	0.942	0.667	0.500	0.625	0.000	-	0.778	0.958
Lights	18	671	27	0	-	716	26	5	10	0	-	41	29	684	7	0	-	720	16	2	10	0	-	28	1505
% Lights	94.7	97.0	93.1	-	-	96.8	96.3	100.0	100.0	-	-	97.6	96.7	97.0	100.0	-	-	97.0	100.0	100.0	100.0	-	-	100.0	97.0
Mediums	1	14	2	0	-	17	1	0	0	0	-	1	1	19	0	0	-	20	0	0	0	0	-	0	38
% Mediums	5.3	2.0	6.9	-	-	2.3	3.7	0.0	0.0	-	-	2.4	3.3	2.7	0.0	-	-	2.7	0.0	0.0	0.0	-	-	0.0	2.4
Articulated Trucks	0	7	0	0	-	7	0	0	0	0	-	0	0	2	0	0	-	2	0	0	0	0	-	0	9
% Articulated Trucks	0.0	1.0	0.0	-	-	0.9	0.0	0.0	0.0	-	-	0.0	0.0	0.3	0.0	-	-	0.3	0.0	0.0	0.0	-	-	0.0	0.6
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	2	-	-	-	-	-	1	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	50.0	-	-	-	-	-	16.7	-	-
Pedestrians	-	-	-	-	2	-	-	-	-	-	7	-	-	-	-	-	2	-	-	-	-	-	5	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	50.0	-	-	-	-	-	83.3	-	-

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015
Page No: 9

Southbound Approach [N]		
Out	In	Total
720	716	1436
20	17	37
2	7	9
0	0	0
0	0	0
742	**740**	**1482**

18	671	27	0	0
1	14	2	0	0
0	7	0	0	0
0	0	0	0	0
0	0	0	0	2
19	**692**	**29**	**0**	**2**
R	T	L	U	P

Eastbound Approach [W]		
Out	In	Total
30	28	58
1	0	1
0	0	0
0	0	0
0	0	0
0	0	0
31	**28**	**59**

0	0	0	0	0
0	0	0	0	0
16	2	0	0	0
0	0	0	0	0
0	0	0	0	0
1	0	0	0	0
5	0	0	0	0
6	**16**	**2**	**10**	**0**
P	R	T	L	U

Peak Hour Data

05/20/2015 12:15 PM
Ending At
05/20/2015 1:15 PM

Lights
Mediums
Articulated Trucks
Bicycles on Crosswalk
Pedestrians

26	5	10	0	0
1	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
27	**5**	**10**	**0**	**7**
R	T	L	U	P

Westbound Approach [E]		
Out	In	Total
58	41	99
3	1	4
0	0	0
0	0	0
0	0	0
0	0	0
61	**42**	**103**

U	L	T	R	P
0	7	684	29	0
0	0	19	1	0
0	0	2	0	0
0	0	0	0	2
0	0	0	0	2
0	**7**	**705**	**30**	**4**

697	720	1417
14	20	34
7	2	9
0	0	0
0	0	0
718	**742**	**1460**
Out	In	Total
Northbound Approach [S]		

Turning Movement Peak Hour Data Plot (12:15 PM)

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015

Turning Movement Peak Hour Data (4:45 PM)

Start Time	Southbound Approach						Westbound Approach						Northbound Approach						Eastbound Approach						
	Southbound						Westbound						Northbound						Eastbound						
	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Right	Thru	Left	U-Turn	Peds	App. Total	Int. Total
4:45 PM	12	229	6	0	0	247	15	0	5	0	4	20	14	173	0	0	1	187	4	2	3	0	0	9	463
5:00 PM	7	232	12	0	0	251	14	1	1	0	6	16	7	180	3	0	0	190	4	0	1	0	2	5	462
5:15 PM	9	219	5	0	0	233	10	0	1	0	2	11	12	191	1	0	0	204	4	0	1	0	0	5	453
5:30 PM	7	195	10	0	2	212	11	3	2	0	1	16	9	189	5	0	0	203	5	2	0	0	0	7	438
Total	35	875	33	0	2	943	50	4	9	0	13	63	42	733	9	0	1	784	17	4	5	0	2	26	1816
Approach %	3.7	92.8	3.5	0.0	-	-	79.4	6.3	14.3	0.0	-	-	5.4	93.5	1.1	0.0	-	-	65.4	15.4	19.2	0.0	-	-	-
Total %	1.9	48.2	1.8	0.0	-	51.9	2.8	0.2	0.5	0.0	-	3.5	2.3	40.4	0.5	0.0	-	43.2	0.9	0.2	0.3	0.0	-	1.4	-
PHF	0.729	0.943	0.688	0.000	-	0.939	0.833	0.333	0.450	0.000	-	0.788	0.750	0.959	0.450	0.000	-	0.961	0.850	0.500	0.417	0.000	-	0.722	0.981
Lights	35	868	33	0	-	936	49	4	9	0	-	62	41	724	9	0	-	774	17	4	5	0	-	26	1798
% Lights	100.0	99.2	100.0	-	-	99.3	98.0	100.0	100.0	-	-	98.4	97.6	98.8	100.0	-	-	98.7	100.0	100.0	100.0	-	-	100.0	99.0
Mediums	0	6	0	0	-	6	1	0	0	0	-	1	1	8	0	0	-	9	0	0	0	0	-	0	16
% Mediums	0.0	0.7	0.0	-	-	0.6	2.0	0.0	0.0	-	-	1.6	2.4	1.1	0.0	-	-	1.1	0.0	0.0	0.0	-	-	0.0	0.9
Articulated Trucks	0	1	0	0	-	1	0	0	0	0	-	0	0	1	0	0	-	1	0	0	0	0	-	0	2
% Articulated Trucks	0.0	0.1	0.0	-	-	0.1	0.0	0.0	0.0	-	-	0.0	0.0	0.1	0.0	-	-	0.1	0.0	0.0	0.0	-	-	0.0	0.1
Bicycles on Crosswalk	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-	-	-	-	0.0	-	-
Pedestrians	-	-	-	-	2	-	-	-	-	-	13	-	-	-	-	-	1	-	-	-	-	-	2	-	-
% Pedestrians	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-	-	-	-	100.0	-	-

Unit Number:

DLZ
8169 West Bryn Mawr Ave

Chicago, Illinois, United States 60631
(773) 283-2600

Count Name: High St & Stafford Ave TMC
Site Code:
Start Date: 05/20/2015
Page No: 11

Southbound Approach [N]		
Out	In	Total
778	936	1714
9	6	15
1	1	2
0	0	0
0	0	0
788	**943**	**1731**

35	868	33	0	0
0	6	0	0	0
0	1	0	0	0
0	0	0	0	0
0	0	0	0	2
35	**875**	**33**	**0**	**2**
R	T	L	U	P

Eastbound Approach [W]		
Out	In	Total
48	26	74
0	0	0
0	0	0
0	0	0
0	0	0
48	**26**	**74**

0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
2	0	0	0	0
2	**17**	**4**	**5**	**0**
P	R	T	L	U

0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	**0**	**9**	**4**	**50**
P	U	L	T	R

Westbound Approach [E]		
Out	In	Total
78	62	140
1	1	2
0	0	0
0	0	0
0	0	0
79	**63**	**142**

1	49	0	0	0
0	4	0	0	0
0	9	0	0	0
0	0	0	0	0
0	0	0	0	0
0	**0**	**13**	**0**	**0**
U	L	T	R	P

0	9	724	41	0
0	0	8	1	0
0	0	1	0	0
0	0	0	0	0
0	0	0	0	1
0	**9**	**733**	**42**	**1**

894	774	1668
6	9	15
1	1	2
0	0	0
0	0	0
901	**784**	**1685**
Out	In	Total
Northbound Approach [S]		

Peak Hour Data

05/20/2015 4:45 PM
Ending At
05/20/2015 5:45 PM

Lights
Mediums
Articulated Trucks
Bicycles on Crosswalk
Pedestrians

Turning Movement Peak Hour Data Plot (4:45 PM)

Appendix B: Observation Notes & Photos

High Street & Stafford Avenue Observation Report

- AM Observation (7:35 – 7:55 AM)
  - 0 pedestrians crossed High Street
- Mid-Day Observations (12:40 – 12:55 PM)
  - 1 pedestrian waited over 2 minutes to cross High Street due to traffic
  - 1 pedestrian crossed at 12:45 with no issue
  - 1 pedestrian crossed at 12:47 after waiting 1 minute and 15 seconds.
  - Drivers did not yield to pedestrians crossing High Street while the pedestrian was in the middle of the street (in the left-turn lane)
  - 2 pedestrians crossed High Street at 12:55 PM, waited around 30 seconds to cross. Vehicles yielded to these two pedestrians; however these pedestrians were more aggressive in crossing.
- PM Observations (3:00 – 3:30 PM)
  - At 3:00 PM the southbound queue from SR-161 backed up past Stafford Avenue (both southbound lanes).
  - 1 pedestrian crossed High Street EB at 3:06 PM after waiting 30 seconds. Vehicles did not yield to this pedestrian; pedestrian darted through traffic.
  - 1 pedestrian crossed High Street EB at 3:07 PM after waiting 30 seconds. Pedestrian waited 1 minute for a gap in traffic on High Street to cross, and a westbound left-turning vehicle did yield to the pedestrian. Pedestrian was high-school aged.
  - 3 pedestrians crossed High Street EB at 3:08 PM after waiting 1 minute. A northbound vehicle in the inside travel lane yielded to the pedestrians, but a northbound vehicle in the outside travel lane did not. The pedestrians were high-school aged.
  - 2 pedestrians crossed High Street EB at 3:10 PM after waiting 45 seconds for a gap in traffic on High Street. An eastbound vehicle turning right did yield to the pedestrians. The pedestrians were high-school aged.
  - 1 pedestrian crossed High Street at 3:13 PM after waiting 30 seconds. Northbound vehicles did not yield to this pedestrian, and the pedestrian waited in the left-turn lane for 20 seconds before finishing crossing High Street with a gap in northbound traffic.
  - 2 pedestrians crossed High Street at 3:14 PM after waiting 50 seconds for a gap in traffic on High Street. The pedestrians were high-school aged.

- 1 pedestrian crossed High Street WB at 3:18 PM with no wait as there was a gap in traffic on High Street.
- 2 pedestrians crossed High Street at 3:19 PM after waiting 1 minute for a gap in traffic on High Street. The pedestrians were high-school aged.
- 3 pedestrians crossed High Street at 3:23 PM after waiting 30 seconds for a gap in traffic on High Street. A northbound vehicle in the inside travel lane yielded to the pedestrians, but a northbound vehicle in the outside travel lane did not. The pedestrians were high-school aged.

DLZ

ARCHITECTURE • ENGINEERING • PLANNING
SURVEYING • CONSTRUCTION SERVICES

OLD WORTHINGTON MOBILITY STUDY

Phase 1 – High Street at Stafford Avenue Photo Log

06/26/2015

LOOKING EAST ON STAFFORD AVENUE

LOOKING EAST ON STAFFORD AVENUE

LOOKING SOUTH ON HIGH STREET

LOOKING WEST ON STAFFORD AVENUE

LOOKING WEST ON STAFFORD AVENUE

LOOKING EAST ON STAFFORD AVENUE

LOOKING WEST ON STAFFORD AVENUE

LOOKING NORTH ON HIGH STREET

LOOKING NORTH ON HIGH STREET

LOOKING AT SOUTHBOUND QUEUE FROM SR-161 FROM THE GRISWOLD CENTER PARKING LOT (SOUTHBOUND QUEUE HAD BACKED UP FROM SR-161 PAST STAFFORD AVENUE

LOOKING EAST ON STAFFORD AVENUE

LOOKING EAST ON STAFFORD AVENUE

LOOKING EAST ON STAFFORD AVENUE

LOOKING AT THE NORTHEAST CORNER

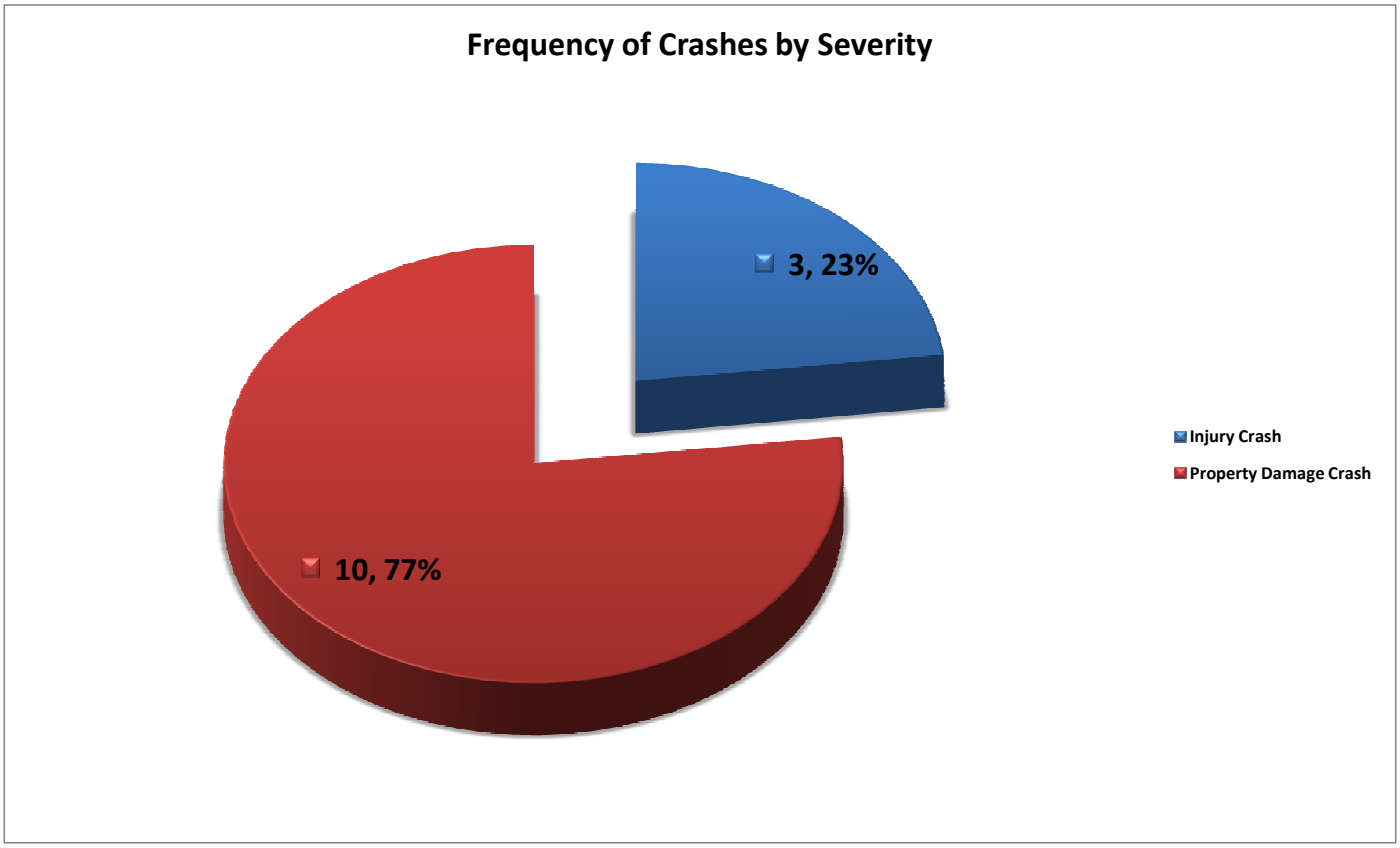
LOOKING AT THE SOUTHEAST CORNER (OLD WORTHINGTON LIBRARY)

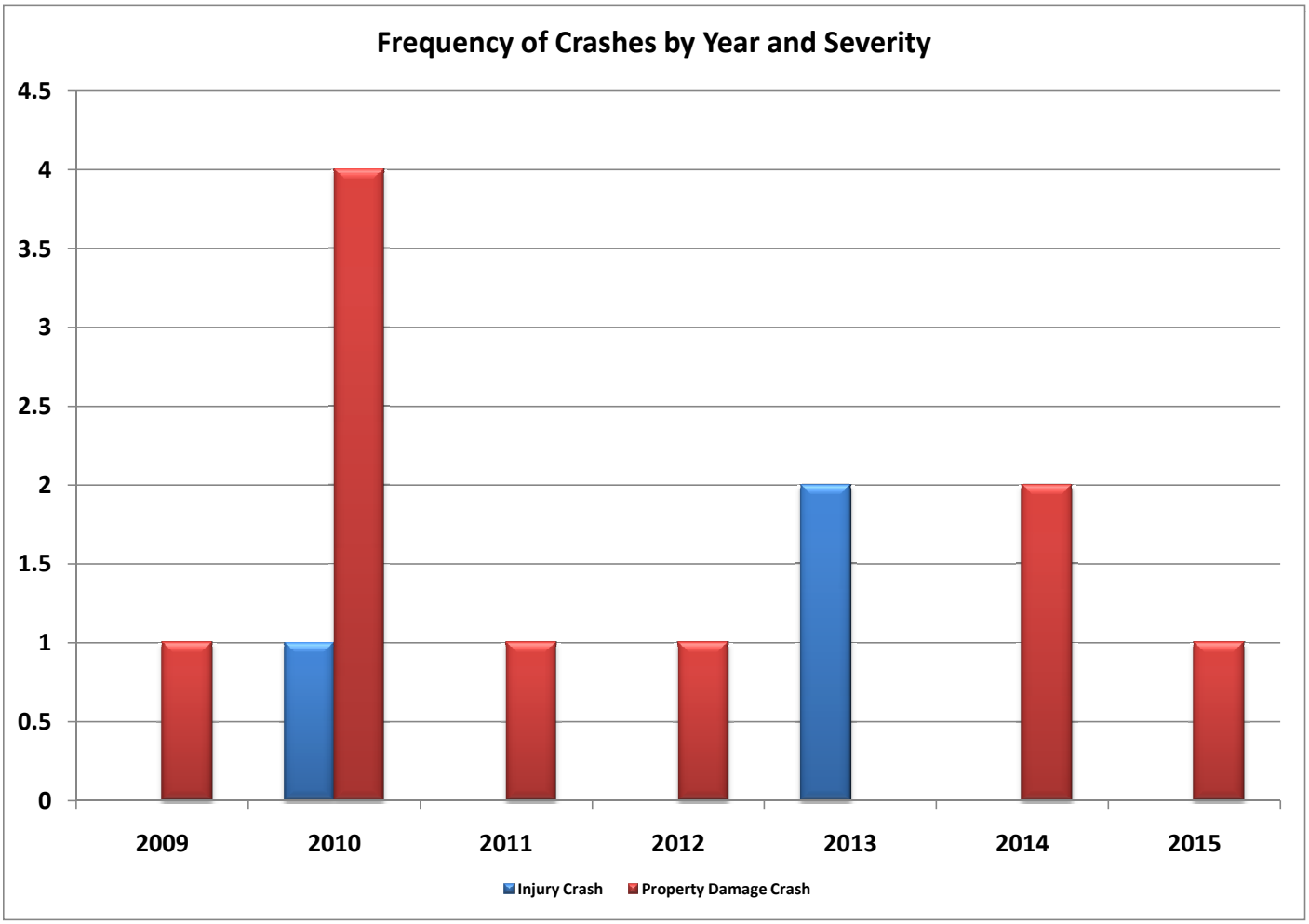
LOOKING AT THE SOUTHEAST CORNER (OLD WORTHINGTON LIBRARY)

LOOKING AT THE SOUTHEAST CORNER (OLD WORTHINGTON LIBRARY)

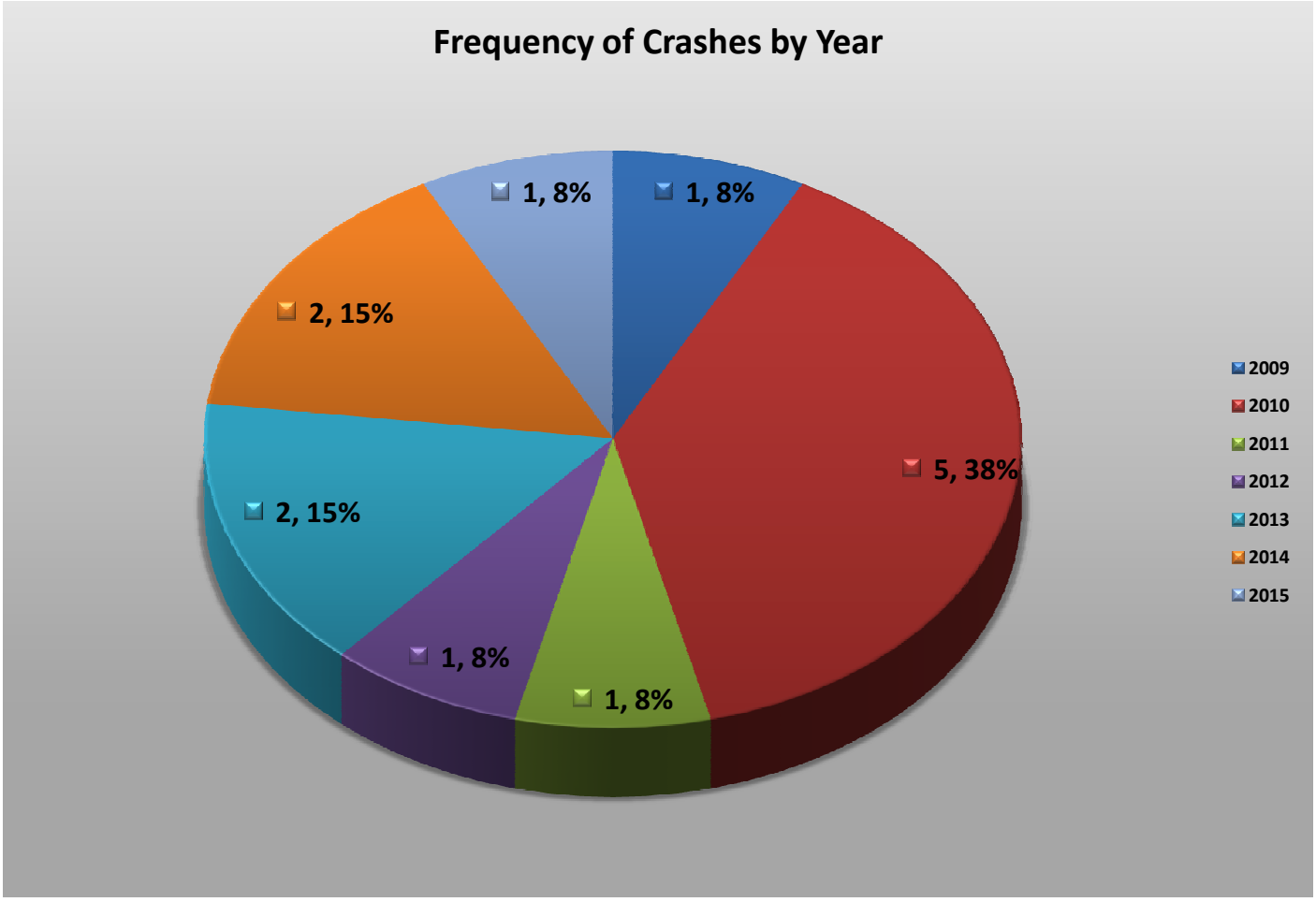
Appendix C: Crash Data

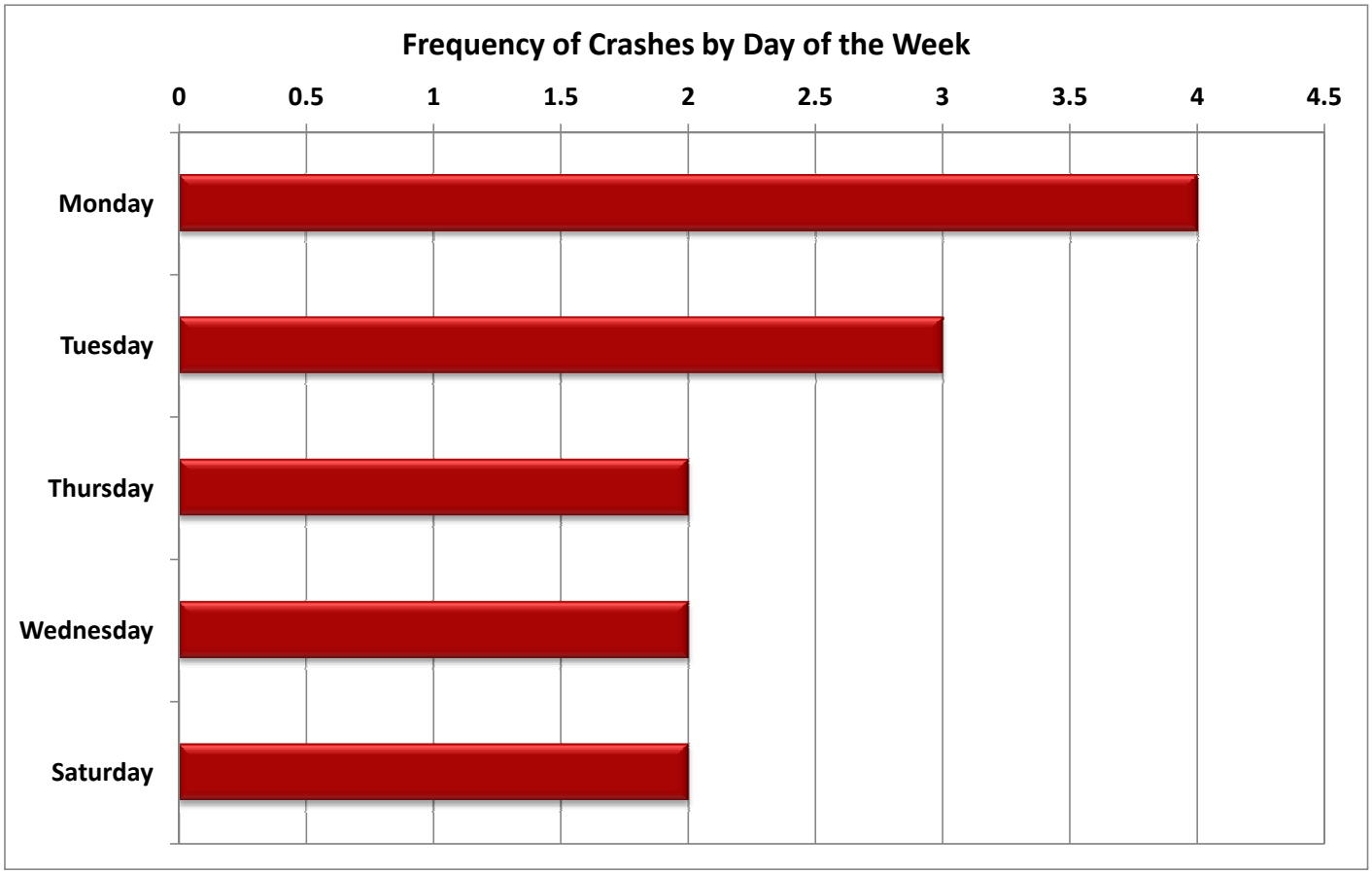
- - (-) From // to //


Frequency of Crashes by Severity
3, 23%
10, 77%
Injury Crash
Property Damage Crash

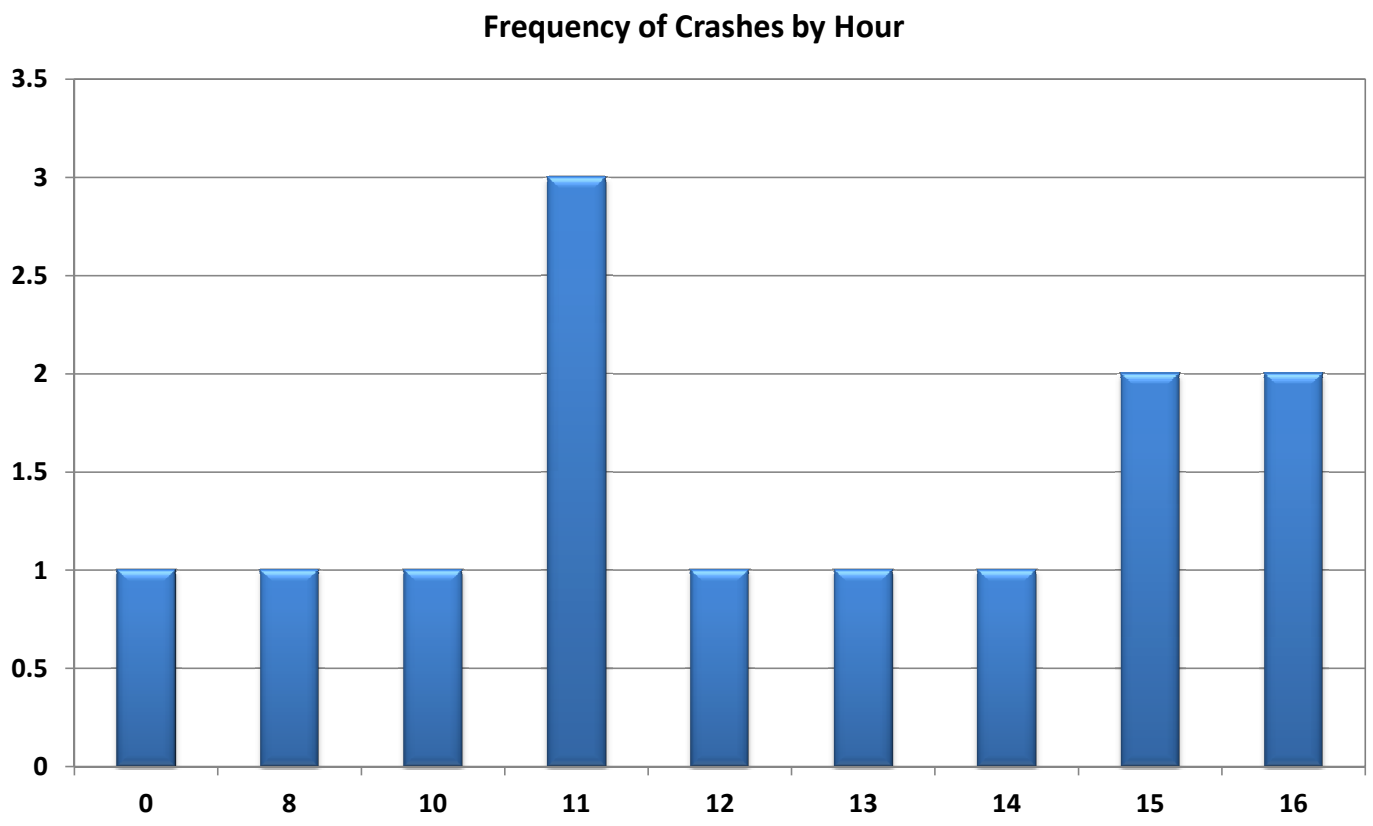

Frequency of Crashes by Year and Severity
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2009
2010
2011
2012
2013
2014
2015
Injury Crash
Property Damage Crash

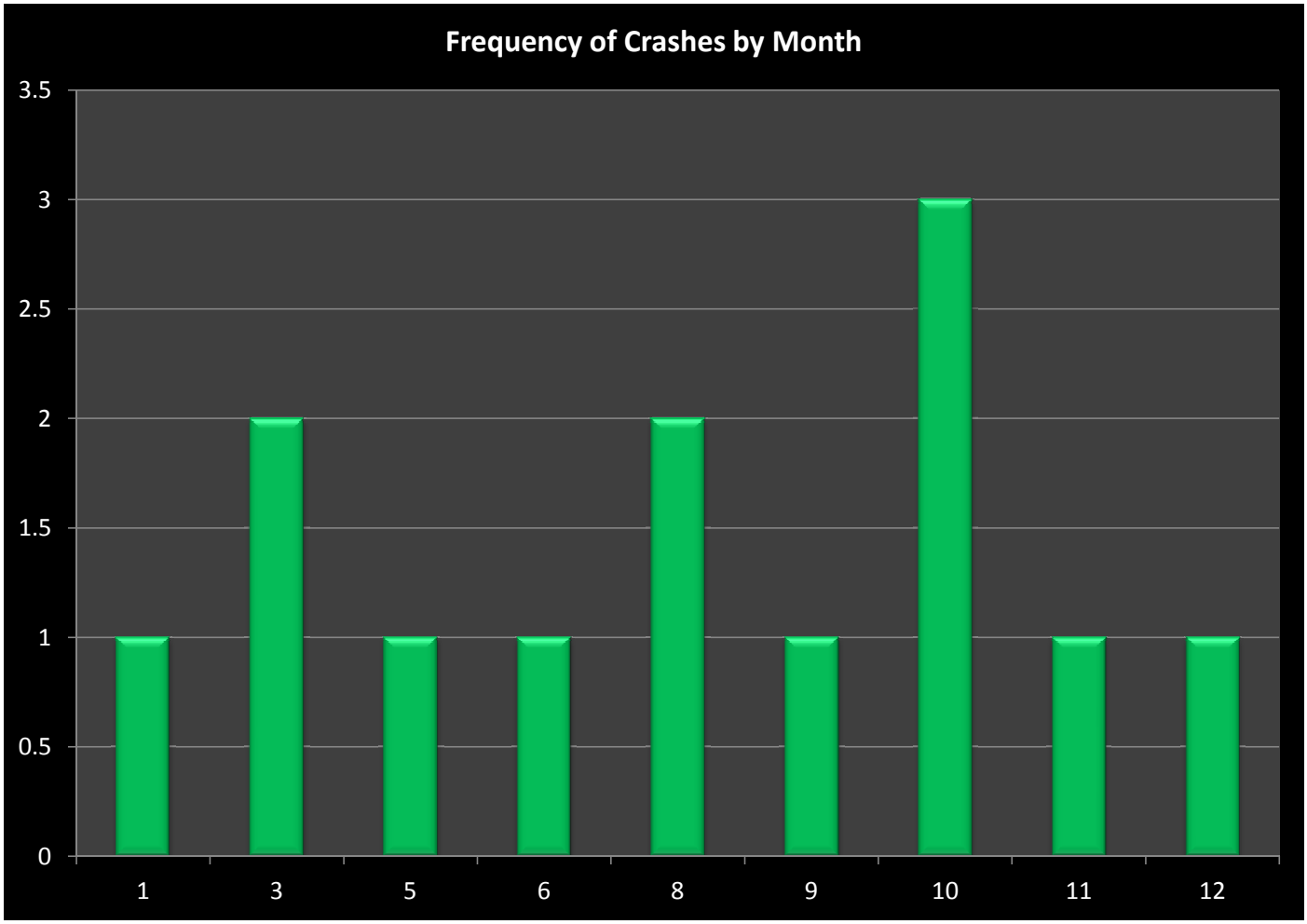
- - (-) From // to //


Frequency of Crashes by Year
1, 8%
1, 8%
2, 15%
5, 38%
2, 15%
1, 8%
1, 8%
2009
2010
2011
2012
2013
2014
2015

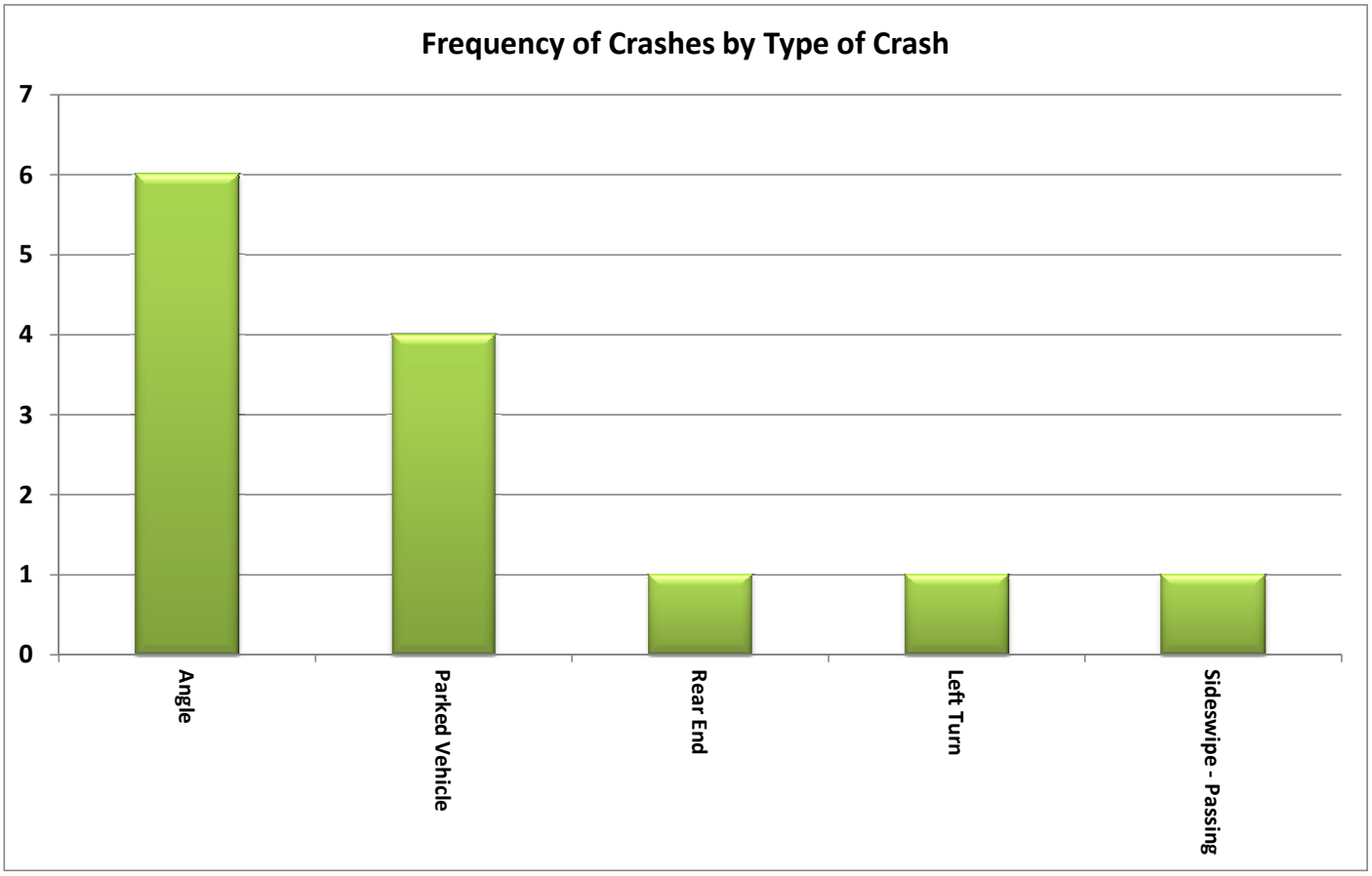

Frequency of Crashes by Day of the Week
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Monday
Tuesday
Thursday
Wednesday
Saturday

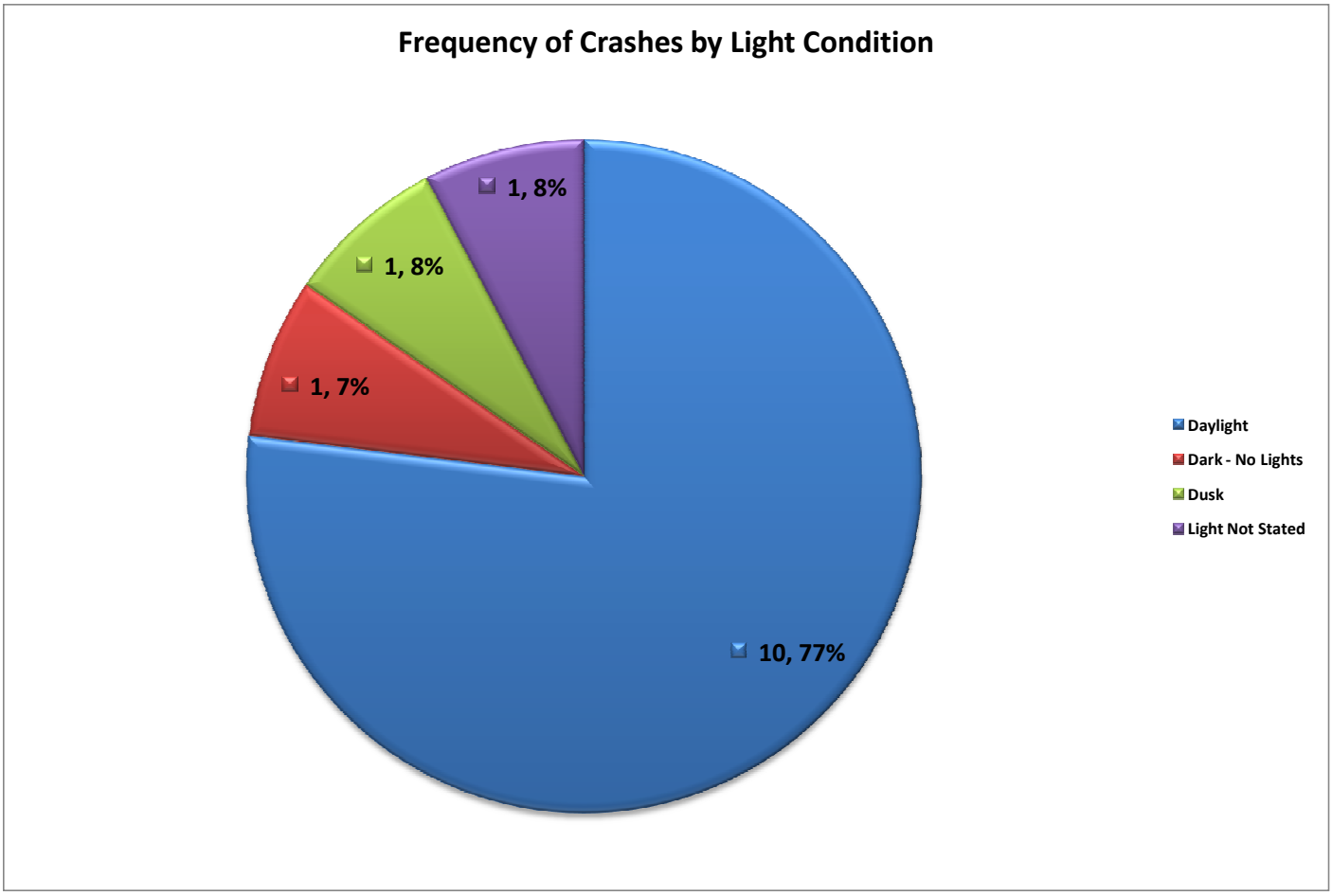
- - (-) From // to //


Frequency of Crashes by Hour
3.5
3
2.5
2
1.5
1
0.5
0
0
8
10
11
12
13
14
15
16

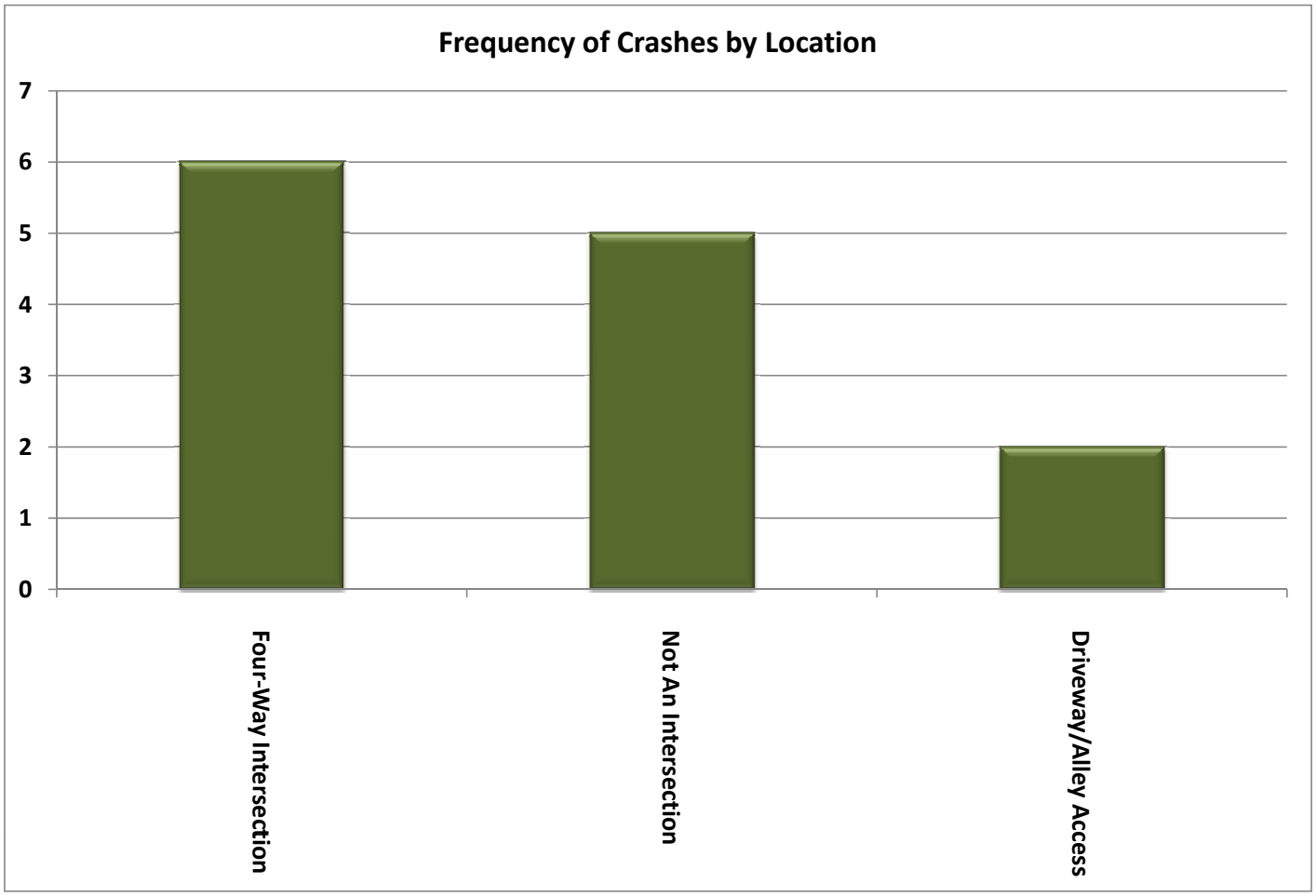

Frequency of Crashes by Month
3.5
3
2.5
2
1.5
1
0.5
0
1
3
5
6
8
9
10
11
12

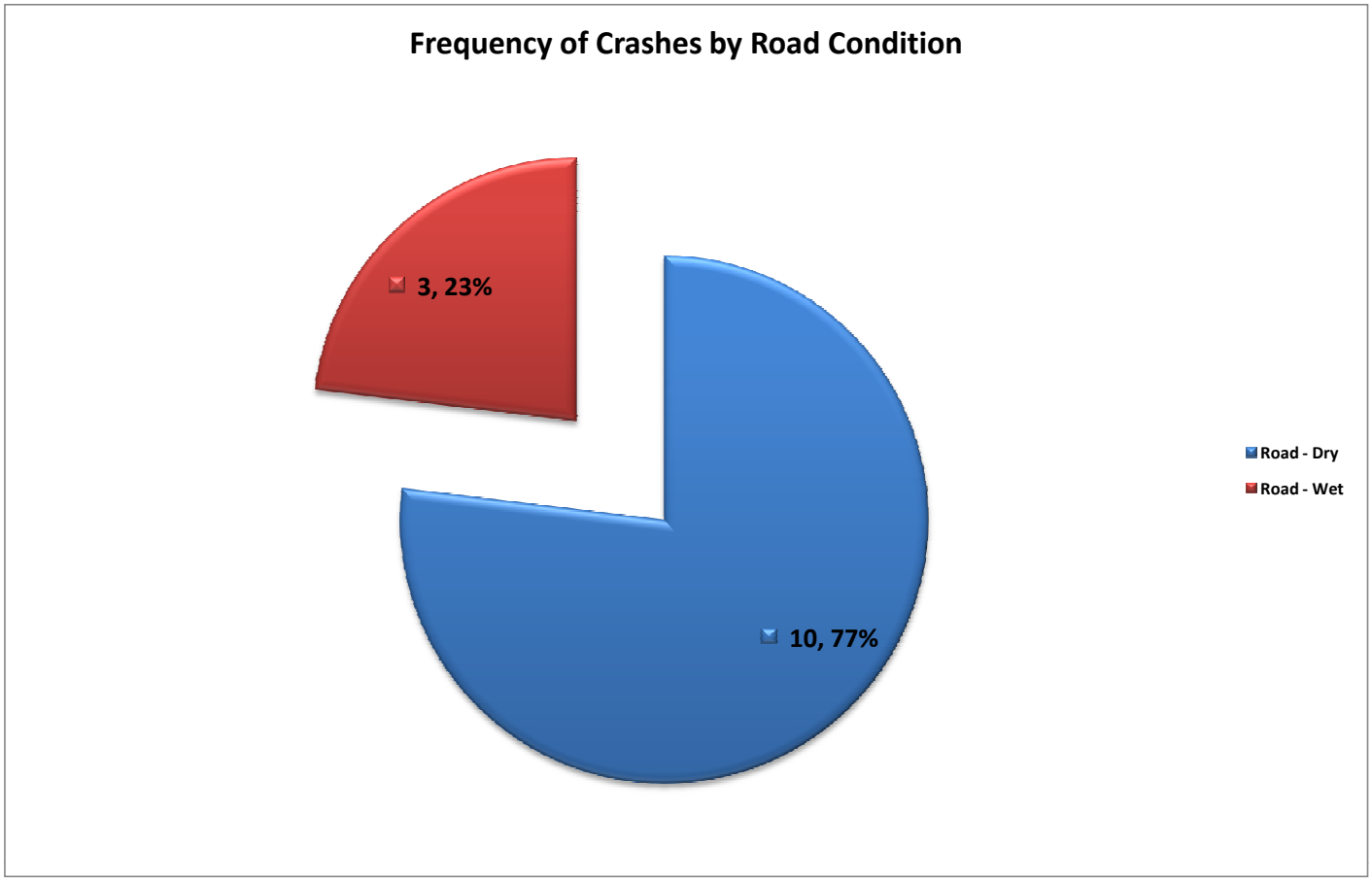
- - (-) From // to //


Frequency of Crashes by Type of Crash
7
6
5
4
3
2
1
0
Angle
Parked Vehicle
Rear End
Left Turn
Sideswipe - Passing

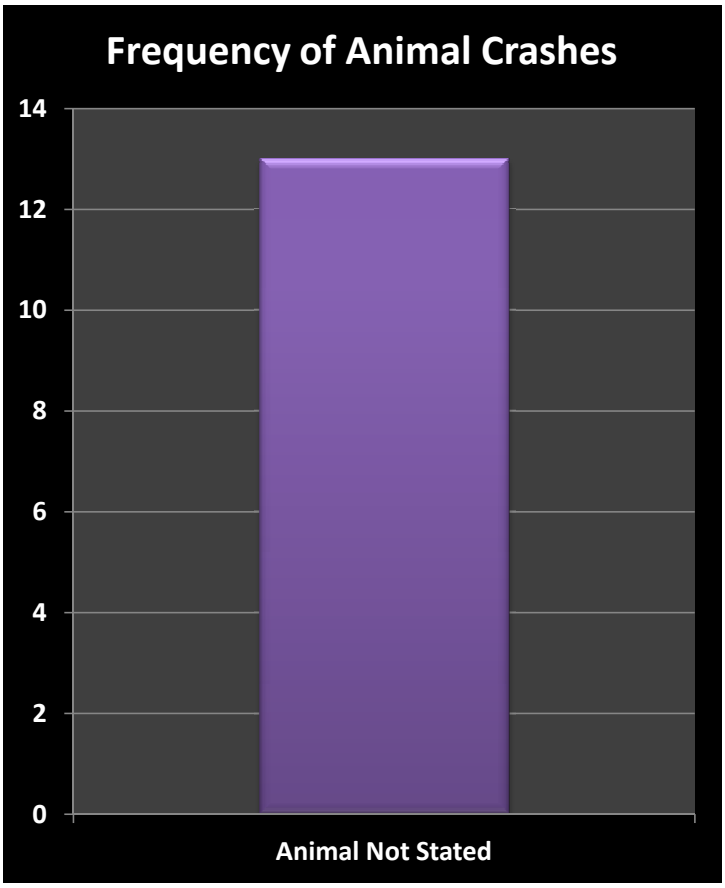

Frequency of Crashes by Light Condition
1, 8%
1, 8%
1, 7%
10, 77%
Daylight
Dark - No Lights
Dusk
Light Not Stated

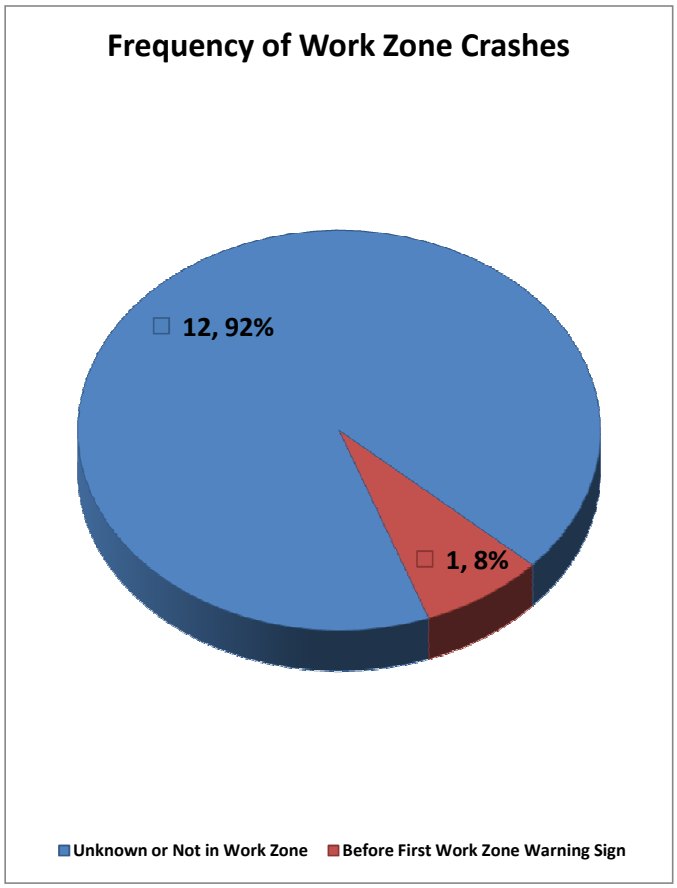
- - (-) From // to //

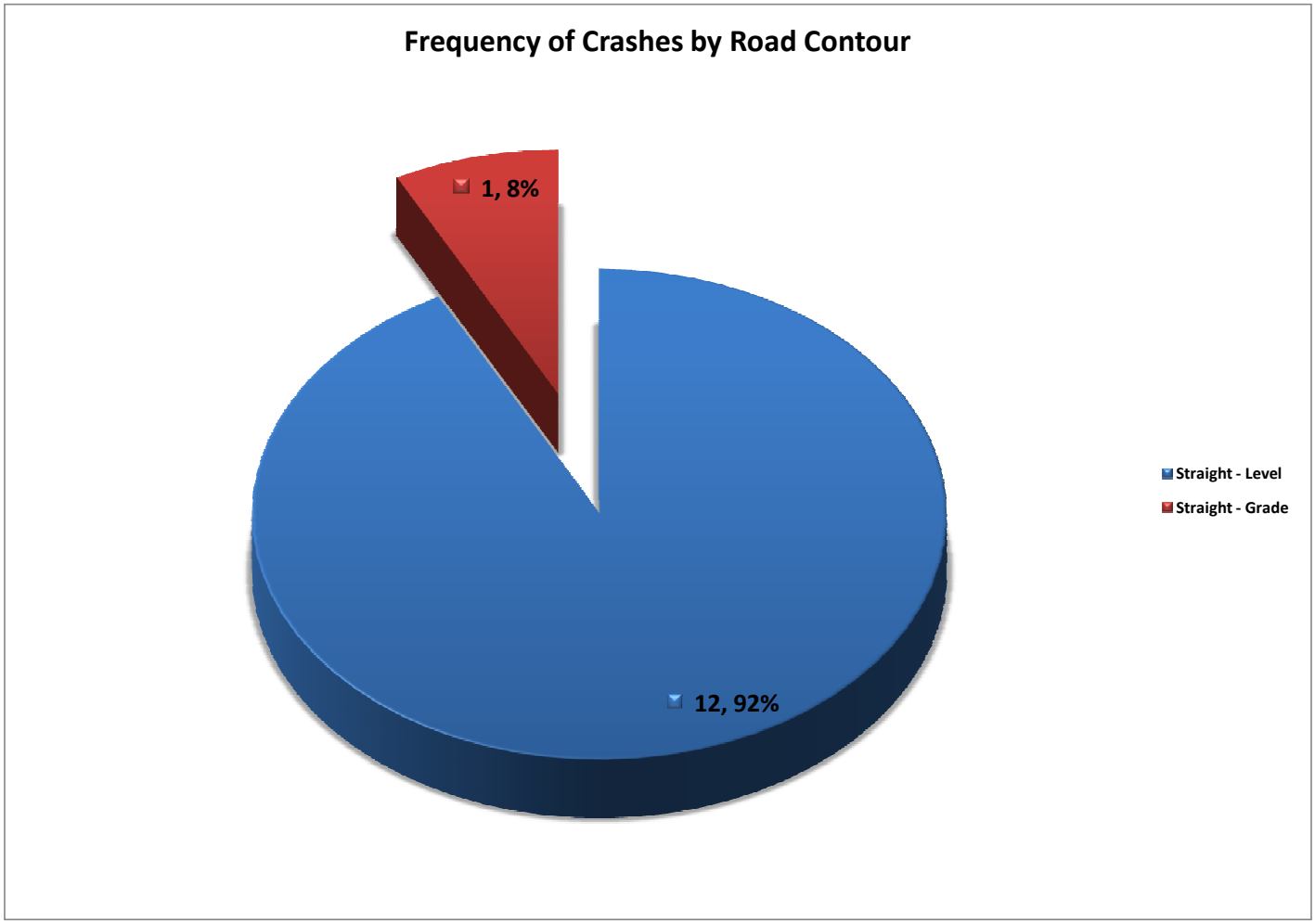

Frequency of Crashes by Location
7
6
5
4
3
2
1
0
Four-Way Intersection
Not An Intersection
Driveway/Alley Access


Frequency of Crashes by Road Condition
3, 23%
10, 77%
Road - Dry
Road - Wet

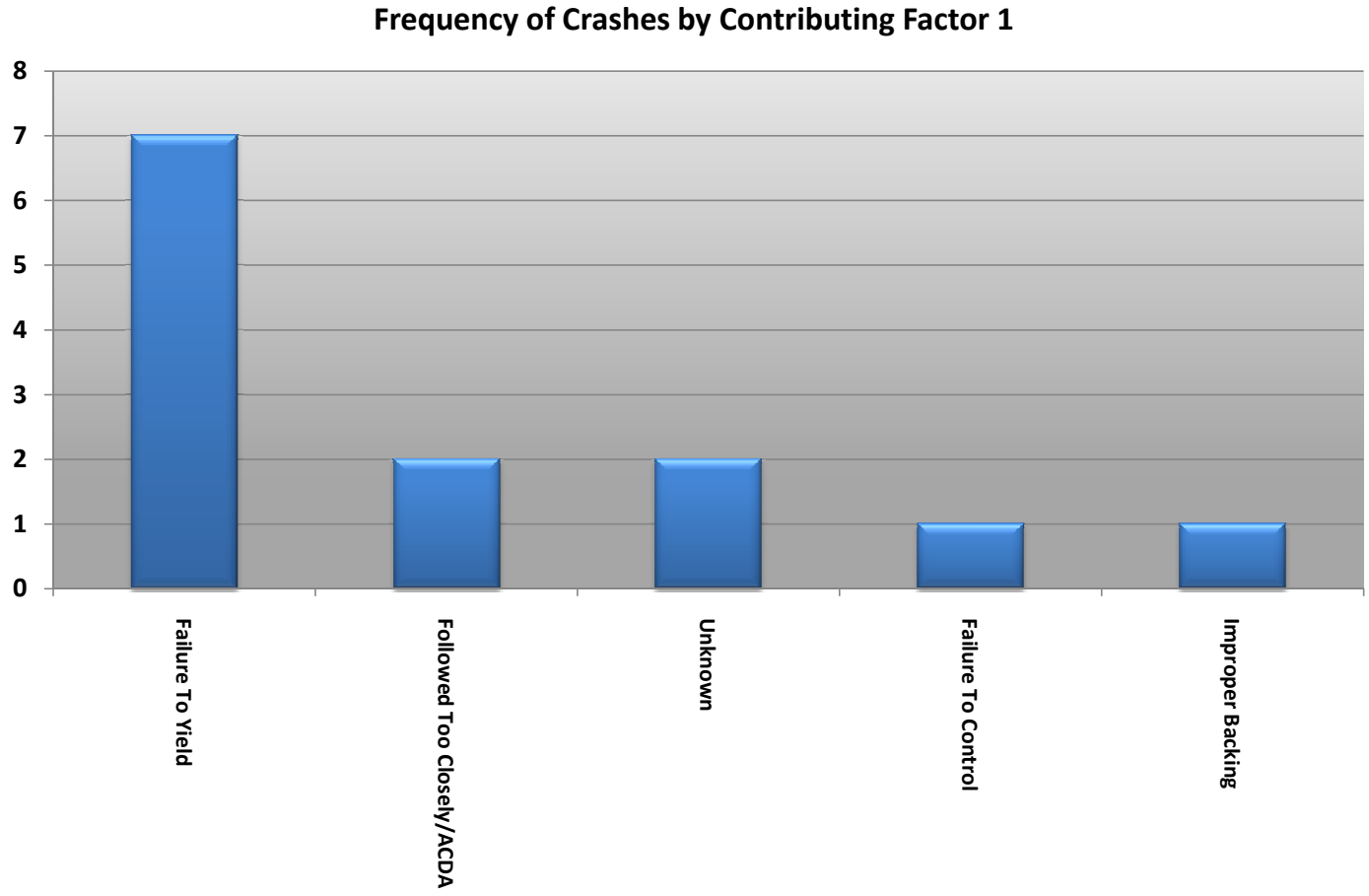
- - (-) From // to //

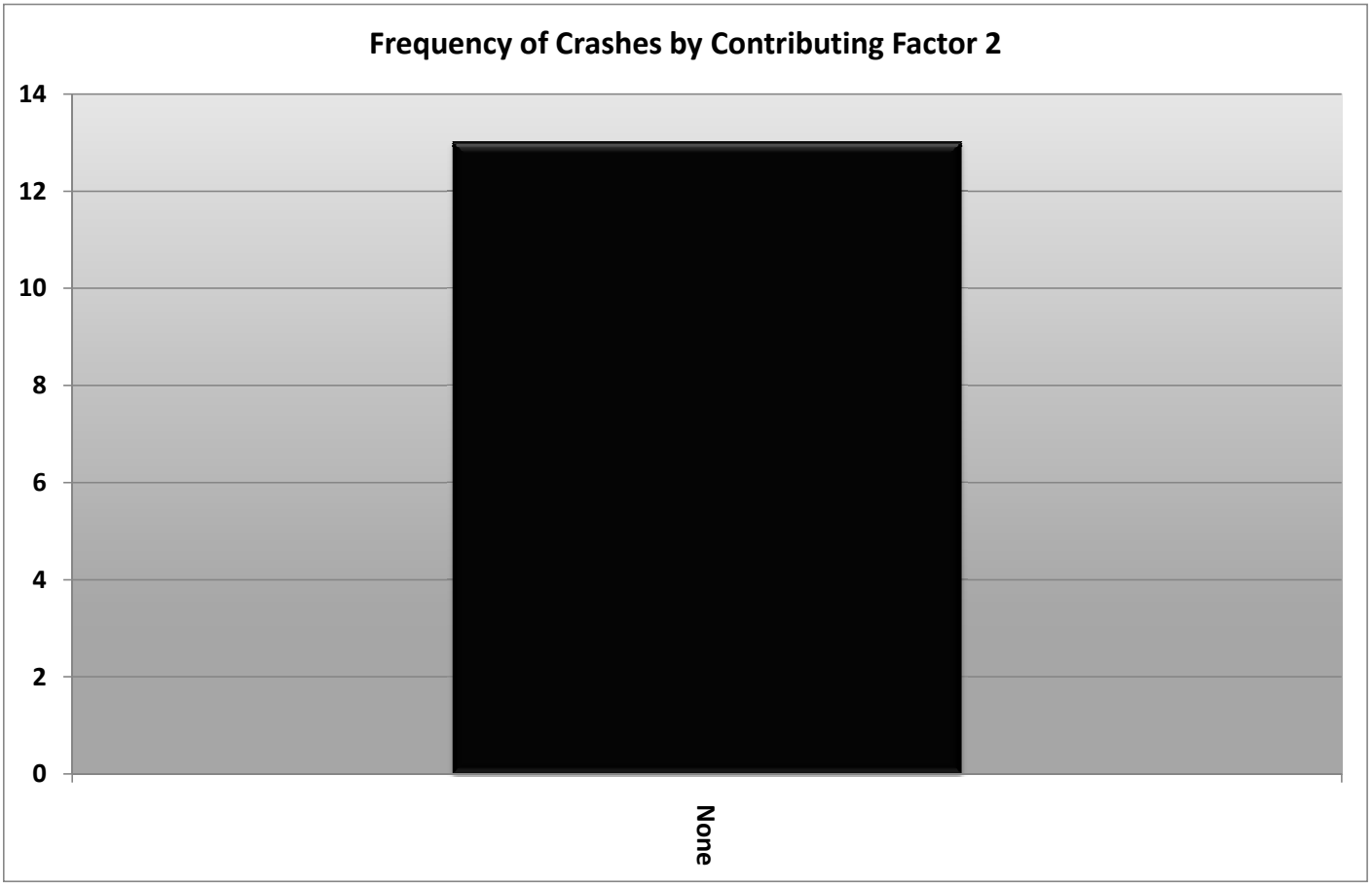

Frequency of Animal Crashes
14
12
10
8
6
4
2
0
Animal Not Stated


Frequency of Work Zone Crashes
12, 92%
1, 8%
Unknown or Not in Work Zone
Before First Work Zone Warning Sign

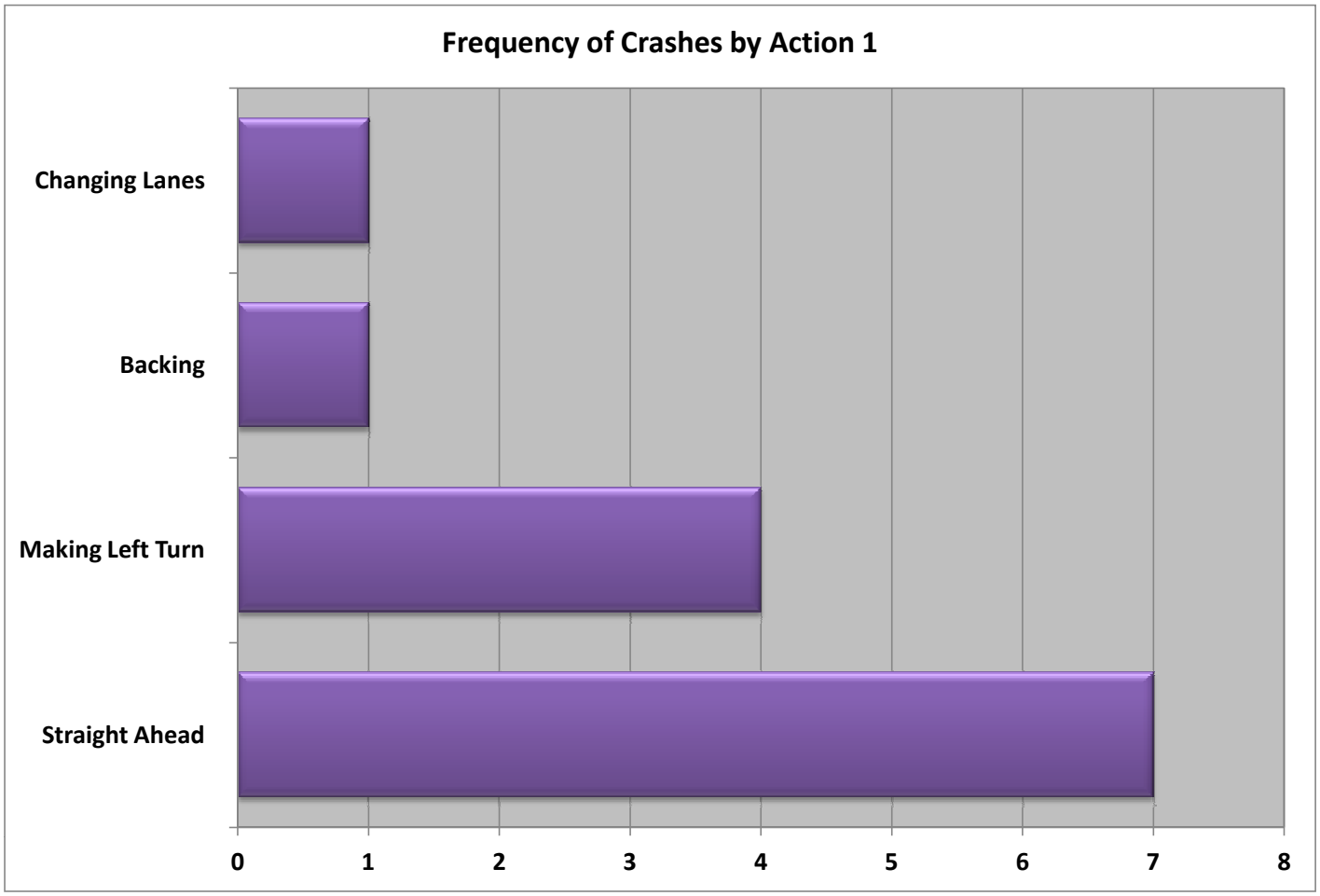

Frequency of Crashes by Road Contour
1, 8%
12, 92%
Straight - Level
Straight - Grade

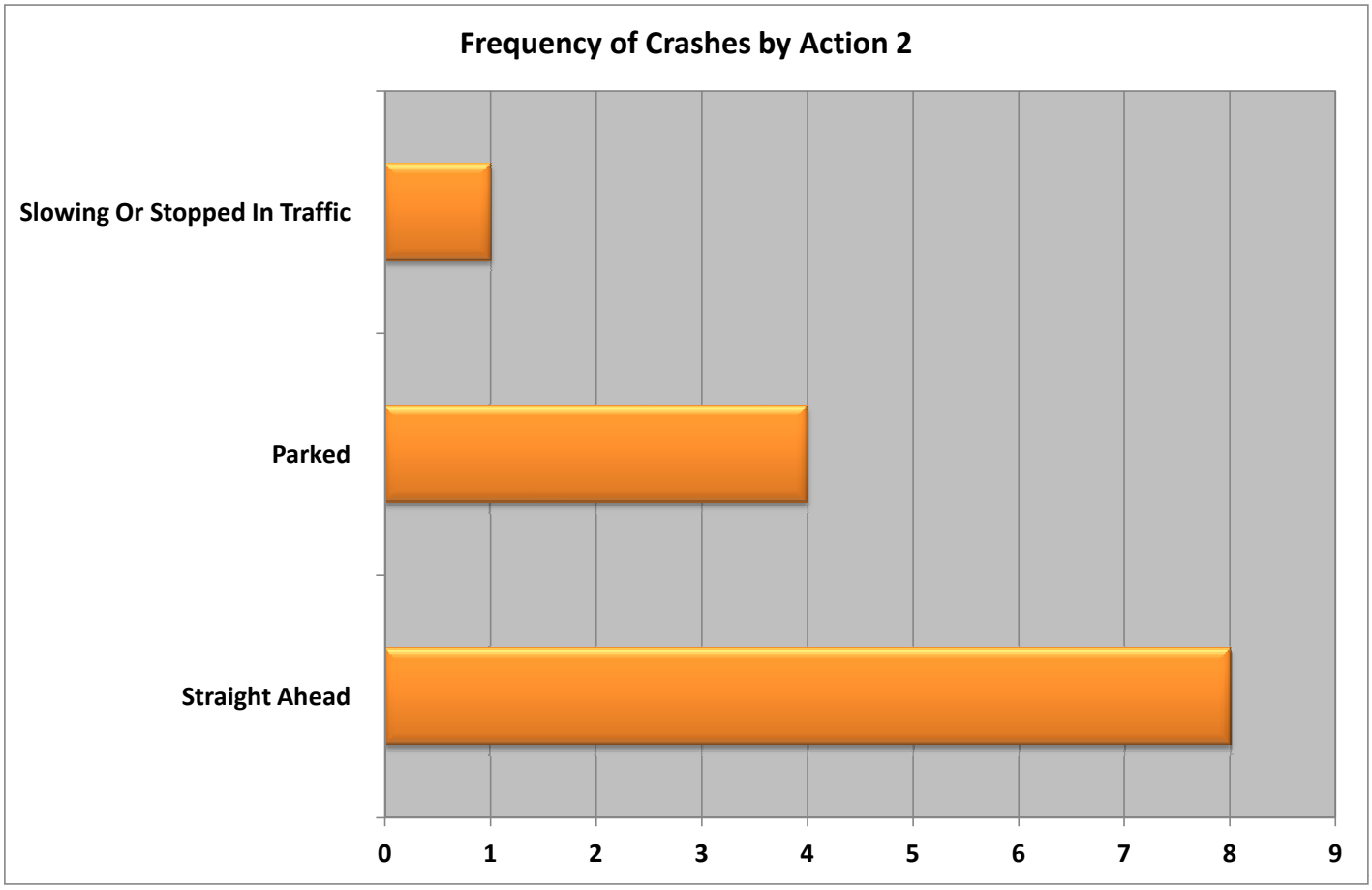
- - (-) From // to //


Frequency of Crashes by Contributing Factor 1
8
7
6
5
4
3
2
1
0
Failure To Yield
Followed Too Closely/ACDA
Unknown
Failure To Control
Improper Backing

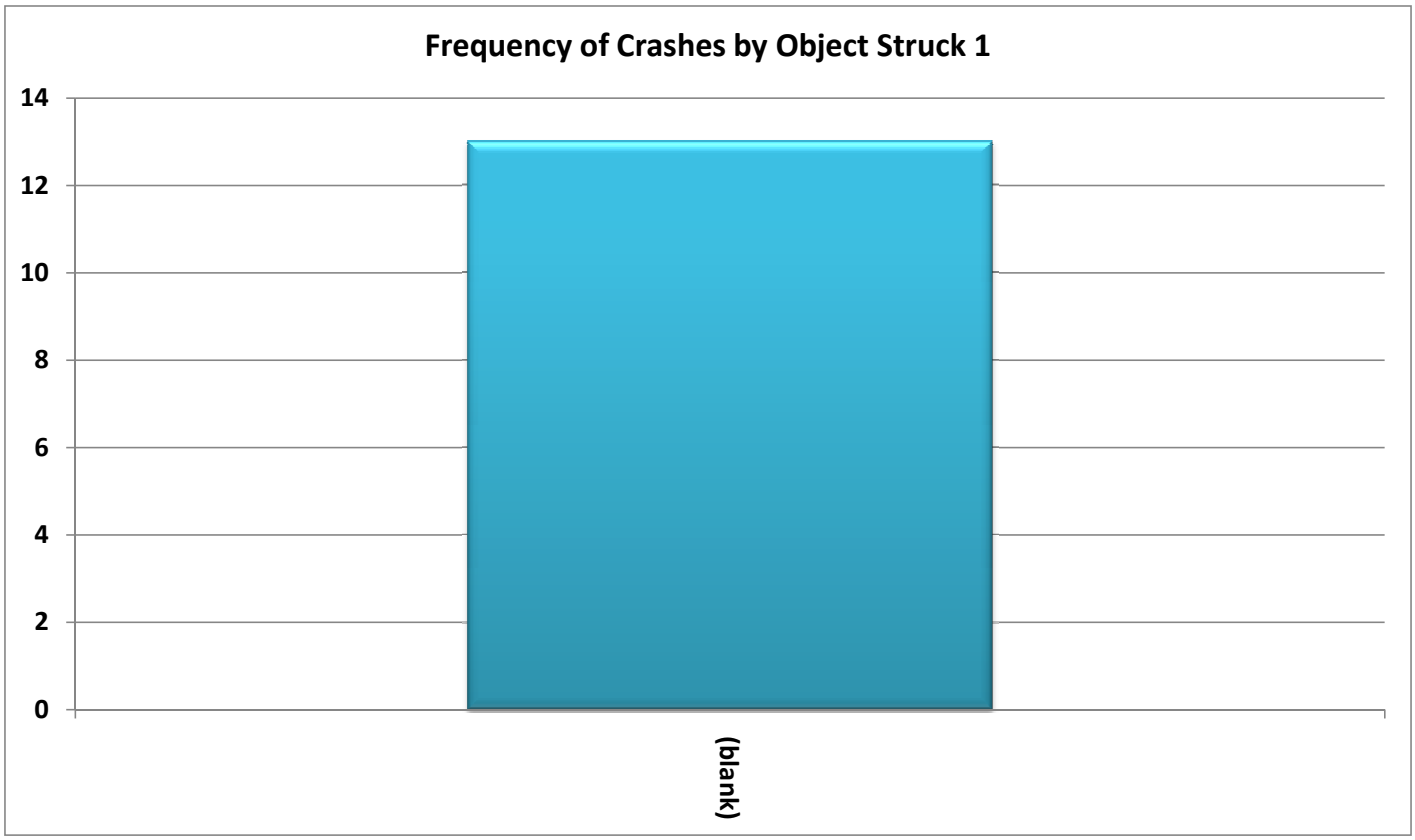

Frequency of Crashes by Contributing Factor 2
14
12
10
8
6
4
2
0
None

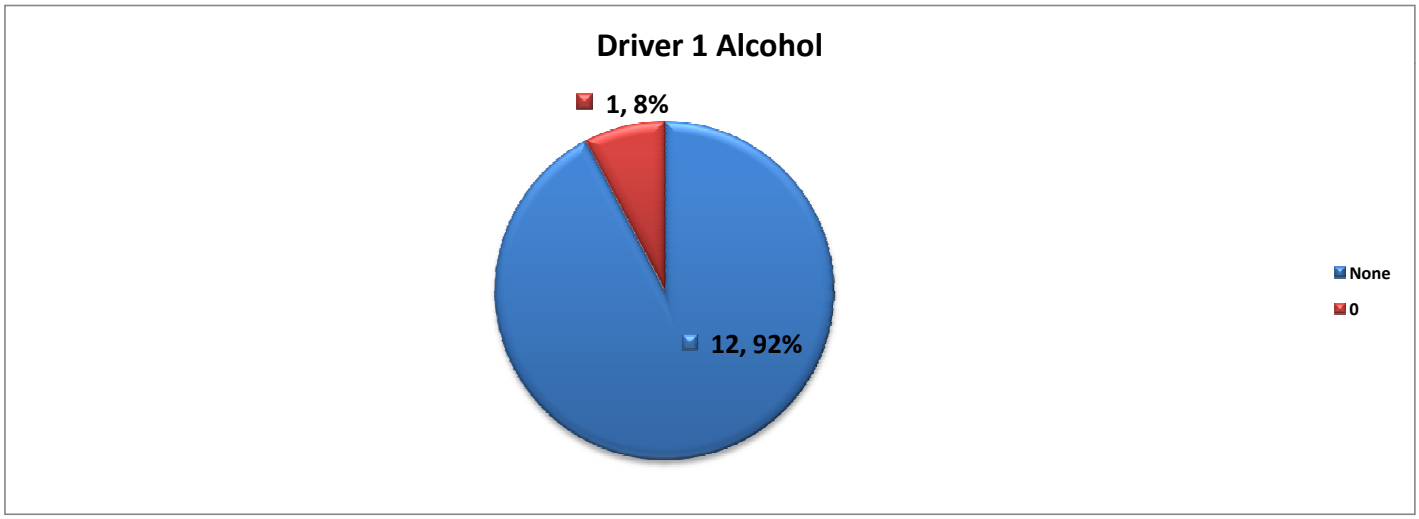
- - (-) From // to //

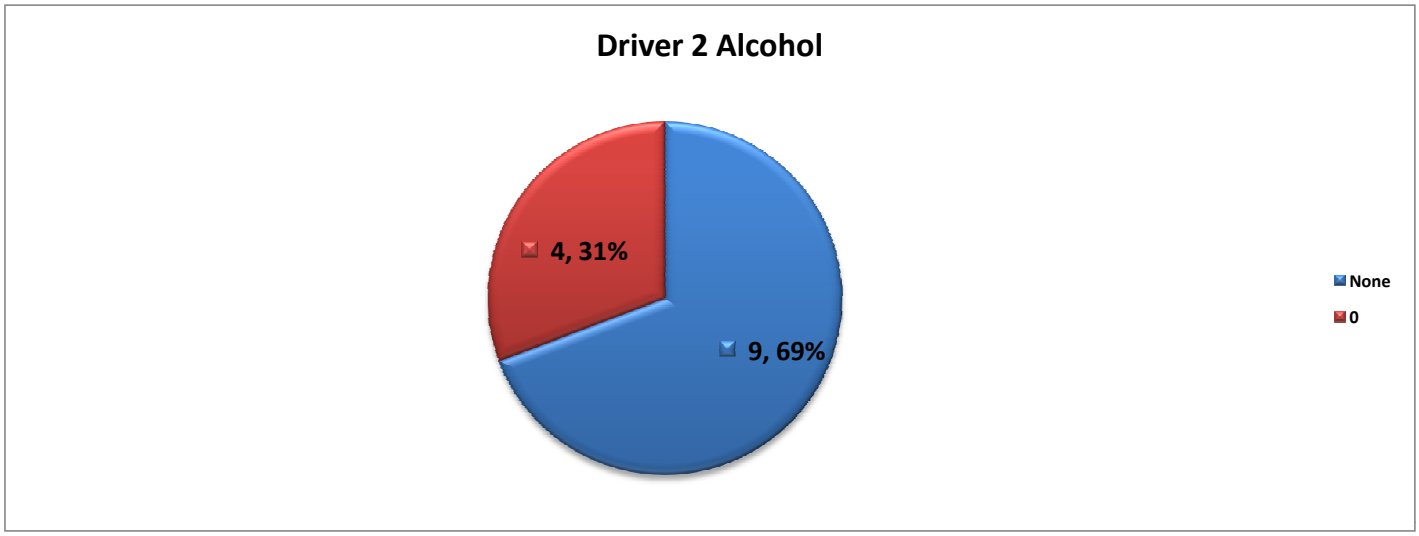

Frequency of Crashes by Action 1
Changing Lanes
Backing
Making Left Turn
Straight Ahead
0
1
2
3
4
5
6
7
8


Frequency of Crashes by Action 2
Slowing Or Stopped In Traffic
Parked
Straight Ahead
0
1
2
3
4
5
6
7
8
9

- - (-) From // to //


Frequency of Crashes by Object Struck 1
14
12
10
8
6
4
2
0
(blank)


Driver 1 Alcohol
1, 8%
12, 92%
None
0


Driver 2 Alcohol
4, 31%
9, 69%
None
0

- - (-) From // to //

	Number
Total	**13**

CRASH_SEVERITY	Number	%
Injury Crash	**3**	23.1%
Property Damage Crash	**10**	76.9%
Grand Total	**13**	**100.0%**

TRAFFIC_CRASH_YEAR	Number	%
2009	**1**	7.7%
2010	**5**	38.5%
2011	**1**	7.7%
2012	**1**	7.7%
2013	**2**	15.4%
2014	**2**	15.4%
2015	**1**	7.7%
Grand Total	**13**	**100.0%**

DAY_OF_WEEK	Number	%
Monday	**4**	30.8%
Tuesday	**3**	23.1%
Thursday	**2**	15.4%
Wednesday	**2**	15.4%
Saturday	**2**	15.4%
Grand Total	**13**	**100.0%**

HOUR_OF_DAY	Number	%
0	**1**	7.7%
8	**1**	7.7%
10	**1**	7.7%
11	**3**	23.1%
12	**1**	7.7%
13	**1**	7.7%
14	**1**	7.7%
15	**2**	15.4%
16	**2**	15.4%
Grand Total	**13**	**100.0%**

TYPE_OF_CRASH	Number	%
Angle	**6**	46.2%
Parked Vehicle	**4**	30.8%
Rear End	**1**	7.7%
Left Turn	**1**	7.7%
Sideswipe - Passing	**1**	7.7%
Grand Total	**13**	**100.0%**

- - (-) From // to //

WEATHER_CONDITION	Number	%
Cloudy	**7**	53.8%
Clear	**5**	38.5%
Rain	**1**	7.7%
Grand Total	**13**	**100.0%**

ROAD_CONDITION	Number	%
Road - Dry	**10**	76.9%
Road - Wet	**3**	23.1%
Grand Total	**13**	**100.0%**

LIGHT_CONDITION	Number	%
Daylight	**10**	76.9%
Dark - No Lights	**1**	7.7%
Dusk	**1**	7.7%
Light Not Stated	**1**	7.7%
Grand Total	**13**	**100.0%**

NUMBER_OF_VEHICLES	Number	%
(blank)	**13**	100.0%
Grand Total	**13**	**100.0%**

LOCATION	Number	%
Four-Way Intersection	**6**	46.2%
Not An Intersection	**5**	38.5%
Driveway/Alley Access	**2**	15.4%
Grand Total	**13**	**100.0%**

CRASH_MONTH_NBR	Number	%
1	**1**	7.7%
3	**2**	15.4%
5	**1**	7.7%
6	**1**	7.7%
8	**2**	15.4%
9	**1**	7.7%
10	**3**	23.1%
11	**1**	7.7%
12	**1**	7.7%
Grand Total	**13**	**100.0%**

ROAD_CONTOUR	Number	%
Straight - Level	**12**	92.3%
Straight - Grade	**1**	7.7%
Grand Total	**13**	**100.0%**

SPECIAL_AREA	Number	%
Unknown or Not in Work Zone	**12**	92.3%
Before First Work Zone Warning Sign	**1**	7.7%
Grand Total	**13**	**100.0%**

ANIMAL_TYPE	Number	%
Animal Not Stated	**13**	100.0%
Grand Total	**13**	**100.0%**

- - (-) From // to //

ACTION1	Number	%
Straight Ahead	**7**	53.8%
Making Left Turn	**4**	30.8%
Backing	**1**	7.7%
Changing Lanes	**1**	7.7%
Grand Total	**13**	**100.0%**

CONTRIBUTING_FACTOR1	Number	%
Failure To Yield	**7**	53.8%
Followed Too Closely/ACDA	**2**	15.4%
Unknown	**2**	15.4%
Failure To Control	**1**	7.7%
Improper Backing	**1**	7.7%
Grand Total	**13**	**100.0%**

OBJECT_STRUCK1	Number	%
(blank)	**13**	100.0%
Grand Total	**13**	**100.0%**

TRAFFIC_CONTROL1	Number	%
Stop Sign	**5**	38.5%
No Controls	**4**	30.8%
Pavement Markings	**3**	23.1%
Not Reported	**1**	7.7%
Grand Total	**13**	**100.0%**

DRIVER_ALCOHOL1	Number	%
None	**12**	92.3%
0	**1**	7.7%
Grand Total	**13**	**100.0%**

DRIVER_DRUGS1	Number	%
(blank)	**13**	100.0%
Grand Total	**13**	**100.0%**

- - (-) From // to //

DIRECTION_FROM1	Number	%
West	5	38.5%
East	4	30.8%
South	2	15.4%
North	2	15.4%
Grand Total	**13**	**100.0%**

DIRECTION_TO1	Number	%
East	4	30.8%
West	3	23.1%
South	3	23.1%
North	2	15.4%
Southeast	1	7.7%
Grand Total	**13**	**100.0%**

POSTED_SPEED1	Number	%
Posted Speed 21-25	13	100.0%
Grand Total	**13**	**100.0%**

ESTIMATED_SPEED1	Number	%
Unit Speed 20 and Under	10	76.9%
Unit Speed 21-25	2	15.4%
Unit Speed Not Stated	1	7.7%
Grand Total	**13**	**100.0%**

VEHICLE_TYPE1	Number	%
Mid Size	6	46.2%
Compact	4	30.8%
Sport Utility Vehicle	2	15.4%
Minivan	1	7.7%
Grand Total	**13**	**100.0%**

VEHICLE_TYPE2	Number	%
Mid Size	3	23.1%
Sport Utility Vehicle	3	23.1%
Minivan	2	15.4%
Compact	2	15.4%
Bus (16+ Seats, Inc Driver)	1	7.7%
Pickup	1	7.7%
Sub-Compact	1	7.7%
Grand Total	**13**	**100.0%**

- - (-) From // to //

ACTION2	Number	%
Straight Ahead	**8**	61.5%
Parked	**4**	30.8%
Slowing Or Stopped In Traffic	**1**	7.7%
Grand Total	**13**	**100.0%**

CONTRIBUTING_FACTOR2	Number	%
None	**13**	100.0%
Grand Total	**13**	**100.0%**

DIRECTION_FROM2	Number	%
South	**5**	38.5%
West	**4**	30.8%
North	**4**	30.8%
Grand Total	**13**	**100.0%**

DIRECTION_TO2	Number	%
North	**5**	38.5%
East	**4**	30.8%
South	**4**	30.8%
Grand Total	**13**	**100.0%**

DRIVER_ALCOHOL2	Number	%
None	**9**	69.2%
0	**4**	30.8%
Grand Total	**13**	**100.0%**

DRIVER_DRUGS2	Number	%
(blank)	**13**	100.0%
Grand Total	**13**	**100.0%**

- - (-) From // to //

SEVERITY	CRASH_SEVERITY	
TRAFFIC_CRASH_YEAR	Injury Crash	Property Damage Crash
2009	0	1
2010	1	4
2011	0	1
2012	0	1
2013	2	0
2014	0	2
2015	0	1
Grand Total	**3**	**10**

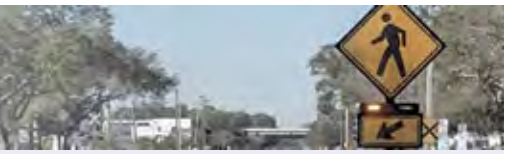
TRAFFIC_CRASH_YEAR	Fatalities	Incapacitating Injuries
2009	0	0
2010	0	0
2011	0	0
2012	0	0
2013	0	0
2014	0	0
2015	0	0
Grand Total	**0**	**0**

TRAFFIC_CRASH_YEAR	INJ_TYPE2_SERIOUS_VISIBLE	INJ_TYPE3_MINOR_VISIBLE	INJ_TYPE4_NO_VISIBLE
2009	0	0	0
2010	0	1	0
2011	0	0	0
2012	0	0	0
2013	0	0	2
2014	0	0	0
2015	0	0	0
Grand Total	**0**	**1**	**2**

Appendix D: Rectangular Rabid Flashing Beacon (RRFB) Information

U.S.Department of Transportation
Federal Highway Administration

Rectangular Rapid Flash Beacon (RRFB)



This summary is one in a series describing Innovative Intersection Safety Treatments. The summaries identify new technologies and techniques to improve intersection safety developed since NCHRP Report 500, Volumes 5 and 12, were published in 2003 and 2004, respectively. These treatments show promise for improving safety but comprehensive effectiveness evaluations are not yet available.

Purpose

According to the National Highway Traffic Safety Administration, there were a total of 14,340 pedestrian fatalities and 193,000 pedestrian injuries resulting from pedestrian-vehicle crashes nationwide during the 2004-2006 period. Rectangular Rapid Flash Beacons (RRFB) can enhance safety by reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings by increasing driver awareness of potential pedestrian conflicts.

Alternative Names

Light Emitting Diode (LED) Rapid-Flash System, Stutter Flash or LED Beacons.

Operation

- RRFBs are user-actuated amber LEDs that supplement warning signs at unsignalized intersections or mid-block crosswalks. They can be activated by pedestrians manually by a push button or passively by a pedestrian detection system.
- RRFBs use an irregular flash pattern that is similar to emergency flashers on police vehicles.
- RRFBs may be installed on either two-lane or multi-lane roadways.

Potential Benefits

- RRFBs are a lower cost alternative to traffic signals and hybrid signals that are shown to increase driver yielding behavior at crosswalks significantly when supplementing standard pedestrian crossing warning signs and markings.
- An official FHWA-sponsored experimental implementation and evaluation conducted in St. Petersburg, Florida found that RRFBs at pedestrian crosswalks are dramatically more effective at increasing driver yielding rates to pedestrians than traditional overhead beacons.
- The novelty and unique nature of the stutter flash may elicit a greater response from drivers than traditional methods.
- The addition of RRFB may also increase the safety effectiveness of other treatments, such as the use of advance yield markings with YIELD (or STOP) HERE FOR PEDESTRIANS signs. These signs and markings are used to reduce the incidence of multiple-threat crashes at crosswalks on multi-lane roads (i.e., crashes where a vehicle in one lane stops to allow a pedestrian to cross the street while a vehicle in an adjacent lane, traveling in the same direction, strikes the pedestrian), but alone they only have a small effect on overall driver yielding rates.

Safe Roads for a Safer Future
Investment in roadway safety saves lives

May 2009
FHWA-SA-09-009

Figure 1: Activated, solar-powered RRFB on a center island at an unsignalized intersection–beacons flash using an irregular flash pattern that is similar to emergency flashers on police vehicles

Figure 2: Activated, solar-powered, roadside RRFB at a mid-block crosswalk

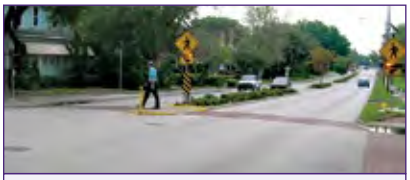


Figure 3: Combined roadside and median system of solar-powered RRFB

Learn More

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FHWA Office of Safety

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See Also:
http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgrpt/intro.htm
http://www.stpete.org/pdf/ite_paper_07.pdf

Agency Experience

"An Analysis of the Effects of Stutter Flash LED Beacons to Increase Yielding to Pedestrians Using Multilane Crosswalks," along with "The Use of Stutter Flash LED Beacons to Increase Yielding to Pedestrians at Crosswalks," presented at the Transportation Research Board Annual Meeting in 2008, summarized the results of two studies on the effects of RRFBs when used to supplement standard pedestrian crossing warning signs at crosswalks[1].

The former found that going from a no-beacon arrangement to a two-beacon system, mounted on the supplementary warning sign on the right side of the crossing, increased yielding from 18 percent to 81 percent. There was a further increase in yielding behavior, with a four-beacon system (with two beacons on both the right and left side of the crossing) to 88 percent. "An Analysis of the Effects of Stutter Flash LED Beacons to Increase Yielding to Pedestrians Using Multilane Crosswalks" also evaluated the sites over a 1-year period, and found that there was little to no decrease in yielding behavior over time.

Implementation Considerations

- Including RRFBs on the roadside increases driver yielding behavior significantly. Including RRFBs on a center island or median as well can further increase driver yielding behavior, although with a lower marginal benefit than roadside beacons.
- RRFBs can use manual push-buttons or automated passive (e.g., video or infrared) pedestrian detection, and should be unlit when not activated.
- RRFBs typically receive power by standalone solar panel units, but may also be wired to a traditional power source.

Manual on Uniform Traffic Control Devices (MUTCD) Specifications

- The MUTCD gave interim approval to RRFBs for optional use in limited circumstances in July 2008. The interim approval allows for usage as a warning beacon to supplement standard pedestrian crossing warning signs and markings at either a pedestrian or school crossing; where the crosswalk approach is not controlled by a yield sign, stop sign, or traffic-control signal; or at a crosswalk at a roundabout.
- The MUTCD interim approval memo also contains other provisions for the implementation of the device and should be reviewed (*http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/fhwamemo.htm*).

Costs

- Cost is approximately $10,000 to $15,000 for purchase and installation of two units (one on either side of a street). This includes solar panels for powering the units, pad lighting, indication units (for both sides of street) with RRFBs in the back and front of each unit, signage on both approaches, all posts, and either passive infrared detection or push buttons with audio instructions.
- Costs would be proportionately higher for additional units placed on a median island, etc.

[1]The two known studies of stutter flash were both conducted in Florida—one in Miami Beach and one in St. Petersburg. They are:

Sherbutt, J., R. Van Houten, and S. Turner. "An Analysis of the Effects of Stutter Flash LED Beacons to Increase Yielding to Pedestrians Using Multilane Crosswalks." Presented at the Transportation Research Board Annual Meeting, Washington, DC, 2008.

Van Houten, R., R. Ellis, and E. Marmolejo. "The Use of Stutter Flash LED Beacons to Increase Yielding to Pedestrians at Crosswalks." Presented at the Transportation Research Board Annual Meeting, Washington, DC, 2008.

Rectangular Rapid Flashing Beacon (RRFB)

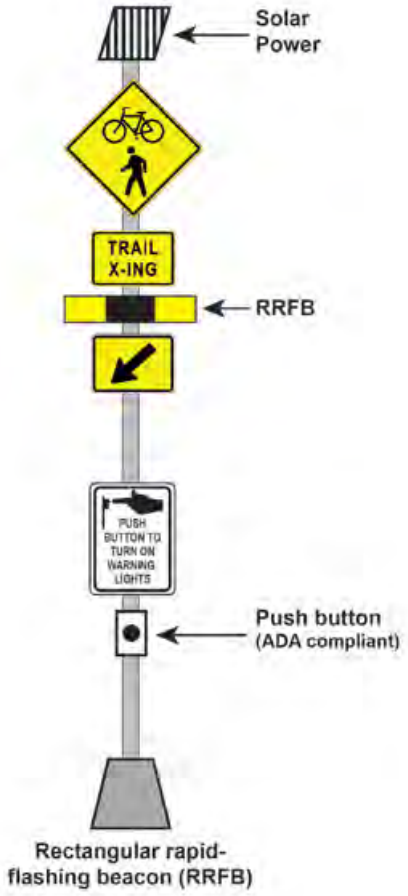
The Rectangular Rapid Flashing Beacon (RRFB) is a special LED flashing device used in conjunction with a pedestrian or bike crossing sign placed at a marked, unsignalized crosswalk.

ADVANTAGES:

- Improves crossing visibility and safety
- Can get a solar powered option and wireless technology or a hard-wired system
- Activated/on-demand flasher increases driver respect for device
- Driver compliance rates greater than 80%
- Lower installation costs than traffic signal pole type flashers- $16,000 to $25,000 to install plus operation and maintenance costs

DISADVANTAGES:

- Device is under FHWA Interim Approval
- Does not provide a “red/stop” condition for drivers
- Wide roadways can make curb/side of road signing more difficult for drivers to see



Appendix E: Pedestrian Hybrid Beacon (PHB) Information

CHAPTER 4F. PEDESTRIAN HYBRID BEACONS

Section 4F.01 Application of Pedestrian Hybrid Beacons

Support:

01 A pedestrian hybrid beacon is a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk.

Option:

02 A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see Chapter 4C), or at a location that meets traffic signal warrants under Sections 4C.05 and/or 4C.06 but a decision is made to not install a traffic control signal.

Standard:

03 **If used, pedestrian hybrid beacons shall be used in conjunction with signs and pavement markings to warn and control traffic at locations where pedestrians enter or cross a street or highway. A pedestrian hybrid beacon shall only be installed at a marked crosswalk.**

Guidance:

04 *If one of the signal warrants of Chapter 4C is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be installed based upon the provisions of Chapters 4D and 4E.*

05 *If a traffic control signal is not justified under the signal warrants of Chapter 4C and if gaps in traffic are not adequate to permit pedestrians to cross, or if the speed for vehicles approaching on the major street is too high to permit pedestrians to cross, or if pedestrian delay is excessive, the need for a pedestrian hybrid beacon should be considered on the basis of an engineering study that considers major-street volumes, speeds, widths, and gaps in conjunction with pedestrian volumes, walking speeds, and delay.*

06 *For a major street where the posted or statutory speed limit or the 85th-percentile speed is 35 mph or less, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-1 for the length of the crosswalk.*

07 *For a major street where the posted or statutory speed limit or the 85th-percentile speed exceeds 35 mph, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-2 for the length of the crosswalk.*

08 *For crosswalks that have lengths other than the four that are specifically shown in Figures 4F-1 and 4F-2, the values should be interpolated between the curves.*

Section 4F.02 Design of Pedestrian Hybrid Beacons

Standard:

01 **Except as otherwise provided in this Section, a pedestrian hybrid beacon shall meet the provisions of Chapters 4D and 4E.**

02 **A pedestrian hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 4F-3).**

03 **When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:**

- **A. At least two pedestrian hybrid beacon faces shall be installed for each approach of the major street,**
- **B. A stop line shall be installed for each approach to the crosswalk,**
- **C. A pedestrian signal head conforming to the provisions set forth in Chapter 4E shall be installed at each end of the marked crosswalk, and**
- **D. The pedestrian hybrid beacon shall be pedestrian actuated.**

Figure 4F-1. Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways

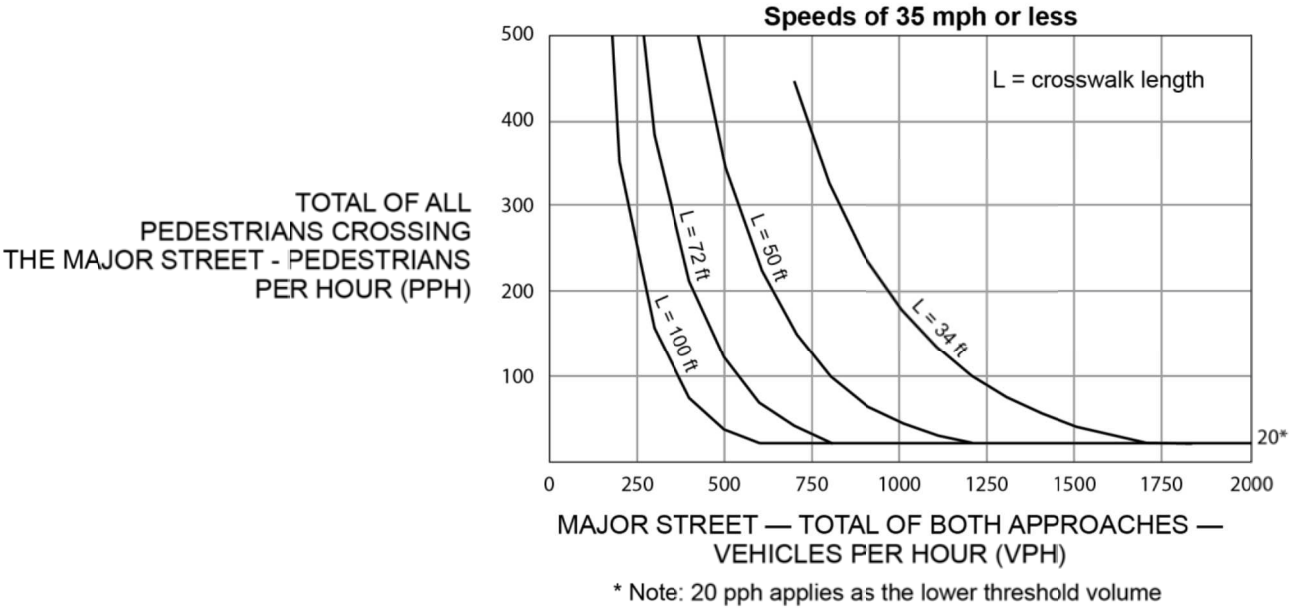


Figure 4F-2. Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways

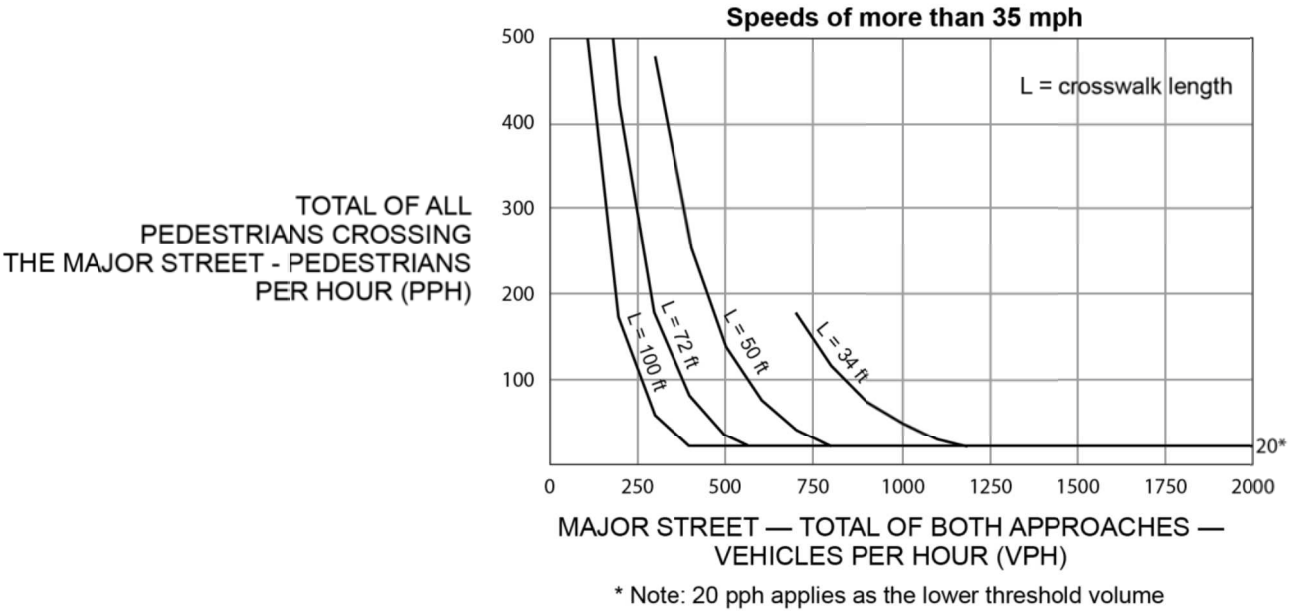
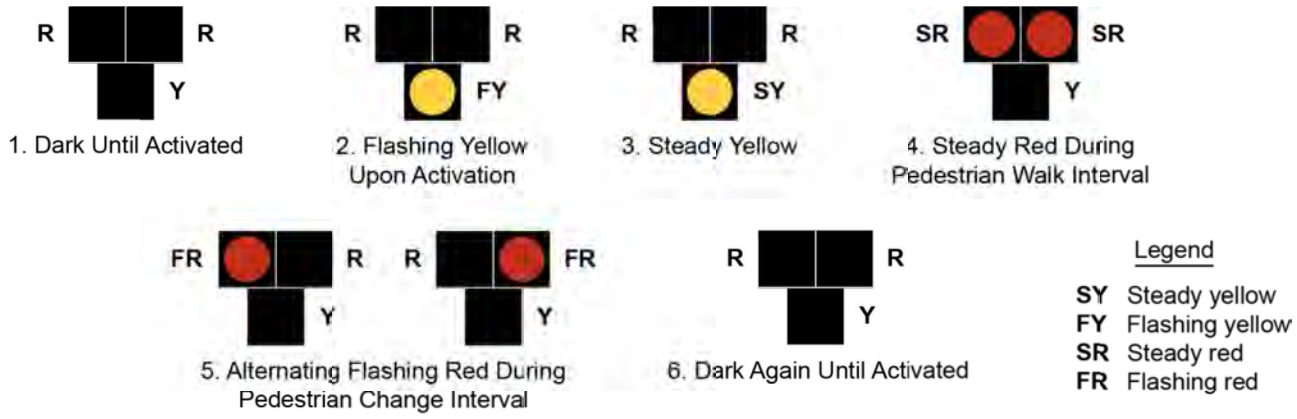


Figure 4F-3. Sequence for a Pedestrian Hybrid Beacon



Guidance:

04 *When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:*

A. The pedestrian hybrid beacon should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs,

B. Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk, or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance,

C. The installation should include suitable standard signs and pavement markings, and

D. If installed within a signal system, the pedestrian hybrid beacon should be coordinated.

05 *On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 35 mph and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside hybrid beacon face locations, both of the minimum of two pedestrian hybrid beacon faces should be installed over the roadway.*

06 *On multi-lane approaches having a posted or statutory speed limits or 85th-percentile speeds of 35 mph or less, either a pedestrian hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the pedestrian hybrid beacon faces should be installed over the roadway.*

07 *A pedestrian hybrid beacon should comply with the signal face location provisions described in Sections 4D.11 through 4D.16.*

Standard:

08 **A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign (see Section 2B.53) shall be mounted adjacent to a pedestrian hybrid beacon face on each major street approach. If an overhead pedestrian hybrid beacon face is provided, the sign shall be mounted adjacent to the overhead signal face.**

Option:

09 A Pedestrian (W11-2) warning sign (see Section 2C.50) with an AHEAD (W16-9P) supplemental plaque may be placed in advance of a pedestrian hybrid beacon. A warning beacon may be installed to supplement the W11-2 sign.

Guidance:

10 *If a warning beacon supplements a W11-2 sign in advance of a pedestrian hybrid beacon, it should be programmed to flash only when the pedestrian hybrid beacon is not in the dark mode.*

Standard:

11 **If a warning beacon is installed to supplement the W11-2 sign, the design and location of the warning beacon shall comply with the provisions of Sections 4L.01 and 4L.03.**

Section 4F.03 Operation of Pedestrian Hybrid Beacons

Standard:

01 **Pedestrian hybrid beacon indications shall be dark (not illuminated) during periods between actuations.**

02 **Upon actuation by a pedestrian, a pedestrian hybrid beacon face shall display a flashing CIRCULAR YELLOW signal indication, followed by a steady CIRCULAR YELLOW signal indication, followed by both steady CIRCULAR RED signal indications during the pedestrian walk interval, followed by alternating flashing CIRCULAR RED signal indications during the pedestrian change interval (see Figure 4F-3). Upon termination of the pedestrian change interval, the pedestrian hybrid beacon faces shall revert to a dark (not illuminated) condition.**

03 **Except as provided in Paragraph 4, the pedestrian signal heads shall continue to display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication when the pedestrian hybrid beacon faces are either dark or displaying flashing or steady CIRCULAR YELLOW signal indications. The pedestrian signal heads shall display a WALKING PERSON (symbolizing WALK) signal indication when the pedestrian hybrid beacon faces are displaying steady CIRCULAR RED signal indications. The pedestrian signal heads shall display a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication when the pedestrian hybrid beacon faces are displaying alternating flashing CIRCULAR RED signal indications. Upon termination of the pedestrian change interval, the pedestrian signal heads shall revert to a steady UPRAISED HAND (symbolizing DONT WALK) signal indication.**

Option:

04 Where the pedestrian hybrid beacon is installed adjacent to a roundabout to facilitate crossings by pedestrians with visual disabilities and an engineering study determines that pedestrians without visual disabilities can be allowed to cross the roadway without actuating the pedestrian hybrid beacon, the pedestrian signal heads may be dark (not illuminated) when the pedestrian hybrid beacon faces are dark.

Guidance:

05 *The duration of the flashing yellow interval should be determined by engineering judgment.*

Standard:

06 **The duration of the steady yellow change interval shall be determined using engineering practices.**

Guidance:

07 *The steady yellow interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds (see Section 4D.26). The longer intervals should be reserved for use on approaches with higher speeds.*

The Pedestrian & Bicyclist Hybrid Beacon is a new tool to help pedestrians and bicyclists cross busy streets. This new beacon is different from a standard traffic signal in that the major street's signal is generally dark, or off, and there is no traffic signal for cross street motorists so cut through traffic is not encouraged on the side street. Pedestrians and bicyclists on the side street each have their own signals.

Here is how it works. This is shown pictorially on the inside of this brochure.

When a pedestrian on the sidewalk or a bicyclist on the street wants to cross, they push a button to activate the beacon to stop the major street traffic.

The beacon on the major street will first flash yellow then display solid yellow and finally solid red indicating the stop requirement.

When the major street traffic is stopped by the red signal, the side street pedestrians will have a walk signal and the bicyclists will have a green bicycle signal.

After an appropriate clearance interval for pedestrians and bicyclists to complete their crossing, the major street signal will flash red, with the usual meaning of stop (or stay stopped) and then go if clear.

Finally, the major street signal will go back to being dark.

For more information about the Pedestrian & Bicyclist Hybrid Beacon, or other traffic issues, contact:

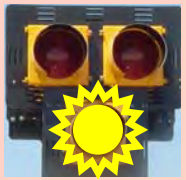
City of Madison
Traffic Engineering
215 Martin Luther King, Jr. Blvd, Suite 100
PO Box 2986
Madison, WI 53701-2986

608-266-4761 (voice)
866-704-3215 (TTY)
608-267-1158 (fax)

http://www.cityofmadison.com/trafficengineering/

Pedestrian & Bicyclist Hybrid Beacon

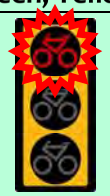
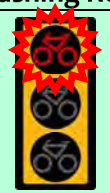
Drivers

See This	Do This
Dark	**Proceed with caution.** Yield to pedestrians in crosswalks
 Flashing Yellow	**Slow down and prepare to Stop** Pedestrian or Bicyclist has activated the signal.
Steady Yellow	**Stop if safe to do so.**
Steady Red	**Stop and stay stopped.** Pedestrian &/or bicyclist crossing.
Flashing Red	**Stop.** Then Proceed with caution if clear.
Dark	**Proceed with caution.** Yield to pedestrians in crosswalks

Pedestrians

See This	Do This
Dark	**Cross in crosswalk normally,** watching to make sure drivers are slowing down to yield or stop, or **Push the button** to activate the pedestrian signal.
Solid Red Hand	**Do not start to cross.** Wait for the white walking person signal before starting to cross.
Solid Red Hand	**Do not start to cross.** Wait for the white walking person signal before starting to cross
Walk, then Countdown	**Start crossing** on the Walk signal, and continue crossing on the countdown signal
Solid Red Hand	**Do not start to cross.** Push button and wait for Walk signal.
Dark	**Cross in crosswalk normally,** watching to make sure drivers are slowing down to yield or stop, or **Push the button** to activate the pedestrian signal.

Bicyclists

See This	Do This
Flashing Red	**Stop.** Yield to any cross street traffic and / or pedestrians before going, or **Push the button** to activate the bicycle signal.
Steady Red	**Stop and stay stopped.** Signal is about to change to green. Cross street traffic does not have Red yet.
Steady Red	**Stop and stay stopped.** Signal is about to change to green. Cross street traffic does not have Red yet.
Green, Yellow, Red	**Standard traffic signal meanings,** for bicyclists only. Motorists still follow the Stop sign.
 Flashing Red	**Stop.** Yield to any cross street traffic and / or pedestrians before going, or **Push the button** to activate the bicycle signal.
 Flashing Red	**Stop.** Yield to any cross street traffic and / or pedestrians before going, or **Push the button** to activate the bicycle signal.

BENEFITS OF PEDESTRIAN HYBRID BEACON SIGNALS

There are several main benefits of Pedestrian Hybrid Beacon (PHB) signals:

- PHB signals have been shown to increase safety by reducing crash rates at pedestrian crossings.
- PHB signals cause a decrease in dangerous driver violations at pedestrian crossings.
- With a typical "Red/Yellow/Green" pedestrian crossing signal, there can be a tendency for the signal to "blend in" to the background. However, PHB signals eliminate this concern, since they only turn on when a pedestrian wishes to cross the street.
- PHB signals can eliminate driver delay and frustration, as they allow drivers to proceed through the crossing once it is clear of pedestrians (rather than having to wait for a green light).

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Public Works Department
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For additional information on Pedestrian Hybrid Beacon signals, or for a copy of this brochure in electronic format, visit the Traffic Engineering Division website at http://bit.ly/NVSKMV
-or-
http://cityofomaha.org/
Keyword Search: PHB

Pedestrian Hybrid Beacon Signal

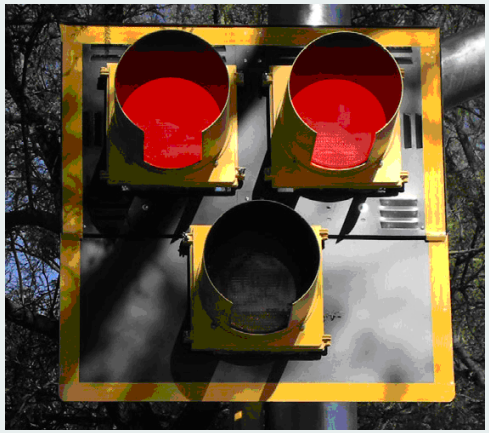
City of Omaha
Public Works Department -
Traffic Engineering

User's Guide

WHAT IS A PEDESTRIAN HYBRID BEACON SIGNAL?

A Pedestrian Hybrid Beacon (PHB) signal is a type of traffic signal which creates a safer and more efficient environment for pedestrians to cross busy streets. PHB signals replace traditional "Red/Yellow/Green" pedestrian crossing signals. PHB signals are in line with Federal standards and have been around since the late 1990s; in fact, they are already in use in many cities around the country.

The first PHB signal to be installed in Omaha will be on 50th Street between "G" Street and "I" Street, where the new South Omaha trail crosses 50th Street. Trail users will be able to cross 50th Street by using the PHB signal, which will help alert drivers to their presence and provide for a safe and efficient crossing. PHB signals will continue to be considered at other locations around the City.



HOW PEDESTRIAN HYBRID BEACON SIGNALS WORK

	DRIVERS		PEDESTRIANS	
	Will See...	Will Do...	Will See...	Will Do...
1		Proceed with caution.		Push the button to activate the system.
2	FLASHING	Slow down, prepare to stop. A pedestrian has activated the system.		Wait.
3		Stop if it is safe to do so.		Continue to wait.
4		**STOP.** A pedestrian is in the crosswalk.		Start crossing when all vehicles are stopped.
5	FLASHING	**STOP.** Proceed with caution if the crosswalk is clear.		Continue crossing; the signal will count down.
6		Proceed with caution.		Push the button to activate the system.

WHAT TO DO AS A DRIVER

When approaching a Pedestrian Hybrid Beacon (PHB) signal in a vehicle, the signals will be dark when not in use. However, if the yellow light begins flashing, then begin to slow down and prepare to stop. When the yellow light changes to a steady indication, stop if it is safe to do so. Once the PHB signal changes from steady yellow to two solid red indications, stop and remain stopped. When the two red lights begin an alternating flash pattern, stop or remain stopped until pedestrians have finished crossing the street. If the crosswalk is clear while the two red signals are still in the alternating flash pattern, then drivers may proceed with caution. The signal will then return to its unlit condition when not in use by pedestrians.

WHAT TO DO AS A PEDESTRIAN

As a pedestrian wishing to use a Pedestrian Hybrid Beacon (PHB) signal, use the signal as you would a normal traffic signal. Push the button on

the signal and watch the pedestrian signal head across the street. When it changes from a Don't Walk symbol (orange solid hand) to a Walk symbol (walking person), begin crossing the street in the crosswalk. When the Walk symbol changes to a Flashing Don't Walk with Countdown Timer, continue crossing if you are already in the crosswalk, but do not begin crossing if you have not already done so.

Appendix F: Synchro Capacity Analysis Results

HCM Unsignalized Intersection Capacity Analysis
152: High St & Stafford Ave

6/25/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	14	8	25	7	4	28	24	717	29	41	596	34
Future Volume (Veh/h)	14	8	25	7	4	28	24	717	29	41	596	34
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	15	9	27	8	4	30	26	779	32	45	648	37
Pedestrians		3			6			1				
Lane Width (ft)		12.0			12.0			12.0				
Walking Speed (ft/s)		4.0			4.0			4.0				
Percent Blockage		0			1			0				
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								771			725	
pX, platoon unblocked	0.88	0.88		0.88	0.88	0.88				0.88		
vC, conflicting volume	1233	1628	346	1300	1631	412	688			817		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	992	1442	346	1068	1445	59	688			520		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	90	92	96	94	96	97	97			95		
cM capacity (veh/h)	154	106	647	129	105	871	900			913		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	51	42	26	519	292	45	432	253
Volume Left	15	8	26	0	0	45	0	0
Volume Right	27	30	0	0	32	0	0	37
cSH	228	313	900	1700	1700	913	1700	1700
Volume to Capacity	0.22	0.13	0.03	0.31	0.17	0.05	0.25	0.15
Queue Length 95th (ft)	21	11	2	0	0	4	0	0
Control Delay (s)	25.3	18.3	9.1	0.0	0.0	9.1	0.0	0.0
Lane LOS	D	C	A			A		
Approach Delay (s)	25.3	18.3	0.3			0.6		
Approach LOS	D	C						

Intersection Summary				
Average Delay	1.6			
Intersection Capacity Utilization	39.0%	ICU Level of Service	A	
Analysis Period (min)	15			

HCM Unsignalized Intersection Capacity Analysis
152: High St & Stafford Ave

6/25/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	10	2	18	11	4	31	15	681	33	28	694	22
Future Volume (Veh/h)	10	2	18	11	4	31	15	681	33	28	694	22
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	11	2	20	12	4	34	16	740	36	30	754	24
Pedestrians		8			3			3			4	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		1			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								769			727	
pX, platoon unblocked	0.89	0.89		0.89	0.89	0.89				0.89		
vC, conflicting volume	1276	1645	400	1254	1639	395	786			779		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1066	1480	400	1042	1473	78	786			509		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	98	97	92	96	96	98			97		
cM capacity (veh/h)	139	104	594	148	105	857	823			936		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	33	50	16	493	283	30	503	275
Volume Left	11	12	16	0	0	30	0	0
Volume Right	20	34	0	0	36	0	0	24
cSH	250	315	823	1700	1700	936	1700	1700
Volume to Capacity	0.13	0.16	0.02	0.29	0.17	0.03	0.30	0.16
Queue Length 95th (ft)	11	14	1	0	0	2	0	0
Control Delay (s)	21.6	18.6	9.5	0.0	0.0	9.0	0.0	0.0
Lane LOS	C	C	A			A		
Approach Delay (s)	21.6	18.6	0.2			0.3		
Approach LOS	C	C						

Intersection Summary			
Average Delay	1.2		
Intersection Capacity Utilization	34.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM Unsignalized Intersection Capacity Analysis
152: High St & Stafford Ave

6/25/2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	5	4	17	9	4	50	9	733	42	33	875	35
Future Volume (Veh/h)	5	4	17	9	4	50	9	733	42	33	875	35
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	5	4	18	10	4	54	10	797	46	36	951	38
Pedestrians		8			13			1			2	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		1			1			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								761			735	
pX, platoon unblocked	0.91	0.91	0.89	0.91	0.91	0.86	0.89			0.86		
vC, conflicting volume	1526	1926	504	1422	1922	436	997			856		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	850	1287	196	735	1282	19	750			506		
tC, single (s)	7.5	6.5	6.9	7.5	6.5	6.9	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	98	97	97	96	97	94	99			96		
cM capacity (veh/h)	201	139	718	251	140	896	756			897		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	NB 3	SB 1	SB 2	SB 3
Volume Total	27	68	10	531	312	36	634	355
Volume Left	5	10	10	0	0	36	0	0
Volume Right	18	54	0	0	46	0	0	38
cSH	342	528	756	1700	1700	897	1700	1700
Volume to Capacity	0.08	0.13	0.01	0.31	0.18	0.04	0.37	0.21
Queue Length 95th (ft)	6	11	1	0	0	3	0	0
Control Delay (s)	16.4	12.8	9.8	0.0	0.0	9.2	0.0	0.0
Lane LOS	C	B	A			A		
Approach Delay (s)	16.4	12.8	0.1			0.3		
Approach LOS	C	B						

Intersection Summary			
Average Delay	0.9		
Intersection Capacity Utilization	39.5%	ICU Level of Service	A
Analysis Period (min)	15		

High St

Direction	NB	SB	All
Control Delay / Veh (s/v)	15	25	20
Total Delay / Veh (s/v)	15	25	20
Total Delay (hr)	37	65	102
Stops (#)	4061	4859	8920
Average Speed (mph)	19	15	17
Total Travel Time (hr)	92	125	217
Distance Traveled (mi)	1740	1873	3613
Performance Index	48.6	78.6	127.2

High St

Direction	NB	SB	All
Control Delay / Veh (s/v)	12	13	12
Total Delay / Veh (s/v)	12	13	12
Total Delay (hr)	28	31	59
Stops (#)	3481	3448	6929
Average Speed (mph)	21	20	20
Total Travel Time (hr)	80	87	167
Distance Traveled (mi)	1670	1728	3398
Performance Index	37.4	40.6	78.0

High St

Direction	NB	SB	All
Control Delay / Veh (s/v)	15	16	16
Total Delay (hr)	41	50	91
Stops / Veh	0.43	0.46	0.45
Stops (#)	4222	5137	9359
Average Speed (mph)	19	18	19
Total Travel Time (hr)	102	124	226
Distance Traveled (mi)	1957	2276	4233
Performance Index	53.1	64.3	117.4

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	14	8	25	7	4	28	24	717	29	41	596	34
Future Volume (vph)	14	8	25	7	4	28	24	717	29	41	596	34
Satd. Flow (prot)	0	1694	0	0	1669	0	1770	3515	0	1770	3507	0
Flt Permitted		0.921			0.954		0.380			0.328		
Satd. Flow (perm)	0	1582	0	0	1606	0	707	3515	0	610	3507	0
Satd. Flow (RTOR)		27			30			9			13	
Lane Group Flow (vph)	0	51	0	0	42	0	26	811	0	45	685	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Total Split (s)	26.5	26.5		26.5	26.5		93.5	93.5		93.5	93.5	
Total Lost Time (s)		5.5			5.5		5.5	5.5		5.5	5.5	
Act Effct Green (s)		21.0			21.0		88.0	88.0		88.0	88.0	
Actuated g/C Ratio		0.18			0.18		0.73	0.73		0.73	0.73	
v/c Ratio		0.17			0.14		0.05	0.31		0.10	0.27	
Control Delay		25.5			20.8		2.6	3.2		1.7	1.9	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		25.5			20.8		2.6	3.2		1.7	1.9	
LOS		C			C		A	A		A	A	
Approach Delay		25.5			20.8			3.2			1.9	
Approach LOS		C			C			A			A	

Intersection Summary	
Cycle Length: 120	
Actuated Cycle Length: 120	
Offset: 7 (6%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.31	
Intersection Signal Delay: 3.7	Intersection LOS: A
Intersection Capacity Utilization 60.4%	ICU Level of Service B
Analysis Period (min) 15	

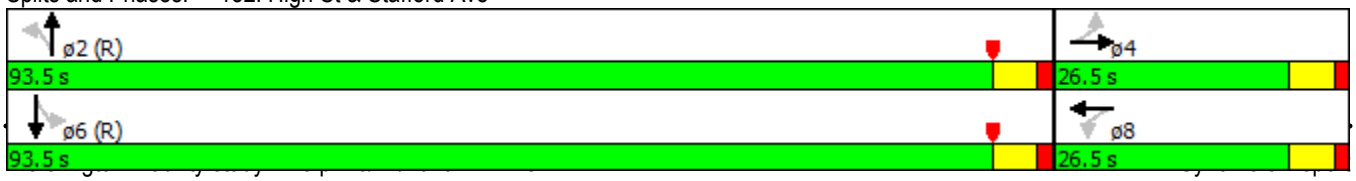
Splits and Phases: 152: High St & Stafford Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	10	2	18	11	4	31	15	681	33	28	694	22
Future Volume (vph)	10	2	18	11	4	31	15	681	33	28	694	22
Satd. Flow (prot)	0	1665	0	0	1650	0	1770	3511	0	1770	3519	0
Flt Permitted		0.918			0.940		0.341			0.342		
Satd. Flow (perm)	0	1550	0	0	1568	0	634	3511	0	637	3519	0
Satd. Flow (RTOR)		20			34			11			7	
Lane Group Flow (vph)	0	33	0	0	50	0	16	776	0	30	778	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phase	4	4		8	8		2	2		6	6	
Switch Phase												
Minimum Initial (s)	7.0	7.0		7.0	7.0		10.0	10.0		10.0	10.0	
Minimum Split (s)	26.5	26.5		26.5	26.5		21.5	21.5		21.5	21.5	
Total Split (s)	26.5	26.5		26.5	26.5		93.5	93.5		93.5	93.5	
Total Split (%)	22.1%	22.1%		22.1%	22.1%		77.9%	77.9%		77.9%	77.9%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)		0.0			0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.5			5.5		5.5	5.5		5.5	5.5	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Ped	Ped		Ped	Ped		C-Max	C-Max		C-Max	C-Max	
Act Effct Green (s)		21.0			21.0		88.0	88.0		88.0	88.0	
Actuated g/C Ratio		0.18			0.18		0.73	0.73		0.73	0.73	
v/c Ratio		0.11			0.17		0.03	0.30		0.06	0.30	
Control Delay		24.2			21.1		3.7	4.1		1.2	1.9	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		24.2			21.1		3.7	4.1		1.2	1.9	
LOS		C			C		A	A		A	A	
Approach Delay		24.2			21.1			4.1			1.9	
Approach LOS		C			C			A			A	

Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 50 (42%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow
Natural Cycle: 50
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.30
Intersection Signal Delay: 3.9 Intersection LOS: A
Intersection Capacity Utilization 49.9% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 152: High St & Stafford Ave



Timings
152: High St & Stafford Ave

6/25/2015

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	5	4	17	9	4	50	9	733	42	33	875	35
Future Volume (vph)	5	4	17	9	4	50	9	733	42	33	875	35
Satd. Flow (prot)	0	1664	0	0	1631	0	1770	3505	0	1770	3515	0
Flt Permitted		0.958			0.964		0.268			0.318		
Satd. Flow (perm)	0	1608	0	0	1583	0	499	3505	0	591	3515	0
Satd. Flow (RTOR)		18			54			13			9	
Lane Group Flow (vph)	0	27	0	0	68	0	10	843	0	36	989	0
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Detector Phase	4	4		8	8		2	2		6	6	
Switch Phase												
Minimum Initial (s)	7.0	7.0		7.0	7.0		10.0	10.0		10.0	10.0	
Minimum Split (s)	26.5	26.5		26.5	26.5		22.0	22.0		20.5	20.5	
Total Split (s)	26.5	26.5		26.5	26.5		103.5	103.5		103.5	103.5	
Total Split (%)	20.4%	20.4%		20.4%	20.4%		79.6%	79.6%		79.6%	79.6%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5	
Lost Time Adjust (s)		0.0			0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.5			5.5		5.5	5.5		5.5	5.5	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Ped	Ped		Ped	Ped		C-Max	C-Max		C-Max	C-Max	
Act Effct Green (s)		21.0			21.0		98.0	98.0		98.0	98.0	
Actuated g/C Ratio		0.16			0.16		0.75	0.75		0.75	0.75	
v/c Ratio		0.10			0.23		0.03	0.32		0.08	0.37	
Control Delay		25.5			18.6		2.1	2.7		1.1	1.5	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		25.5			18.6		2.1	2.7		1.1	1.5	
LOS		C			B		A	A		A	A	
Approach Delay		25.5			18.6			2.7			1.5	
Approach LOS		C			B			A			A	

Intersection Summary

Cycle Length: 130
Actuated Cycle Length: 130
Offset: 52.5 (40%), Referenced to phase 2:NBTL and 6:SBTL, Start of Yellow
Natural Cycle: 50
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.37
Intersection Signal Delay: 2.9 Intersection LOS: A
Intersection Capacity Utilization 54.1% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 152: High St & Stafford Ave

High St

Direction	NB	SB	All
Control Delay / Veh (s/v)	16	25	20
Total Delay / Veh (s/v)	16	25	20
Total Delay (hr)	39	65	104
Stops (#)	4374	4835	9209
Average Speed (mph)	19	15	17
Total Travel Time (hr)	93	125	219
Distance Traveled (mi)	1740	1873	3613
Performance Index	50.9	78.6	129.5

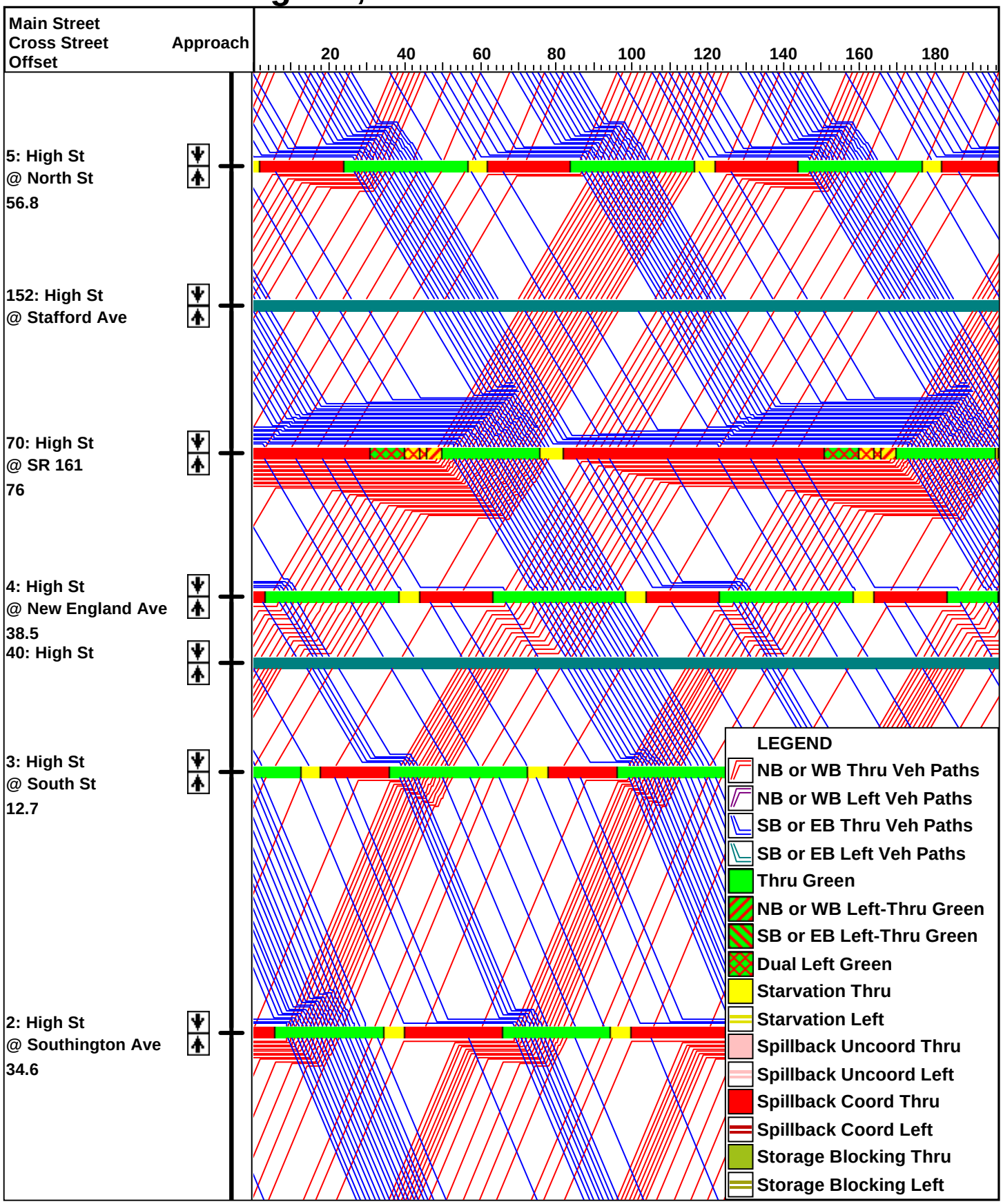
High St

Direction	NB	SB	All
Control Delay / Veh (s/v)	13	13	13
Total Delay / Veh (s/v)	13	13	13
Stops / Veh	0.47	0.40	0.43
Stops (#)	3888	3513	7401
Average Speed (mph)	20	20	20
Total Travel Time (hr)	82	87	169
Distance Traveled (mi)	1670	1728	3398
Performance Index	40.4	40.9	81.3

High St

Direction	NB	SB	All
Control Delay / Veh (s/v)	16	16	16
Total Delay / Veh (s/v)	16	16	16
Total Delay (hr)	43	51	94
Stops (#)	4523	4913	9436
Average Speed (mph)	19	18	19
Total Travel Time (hr)	104	124	228
Distance Traveled (mi)	1957	2276	4233
Performance Index	55.5	64.3	119.8

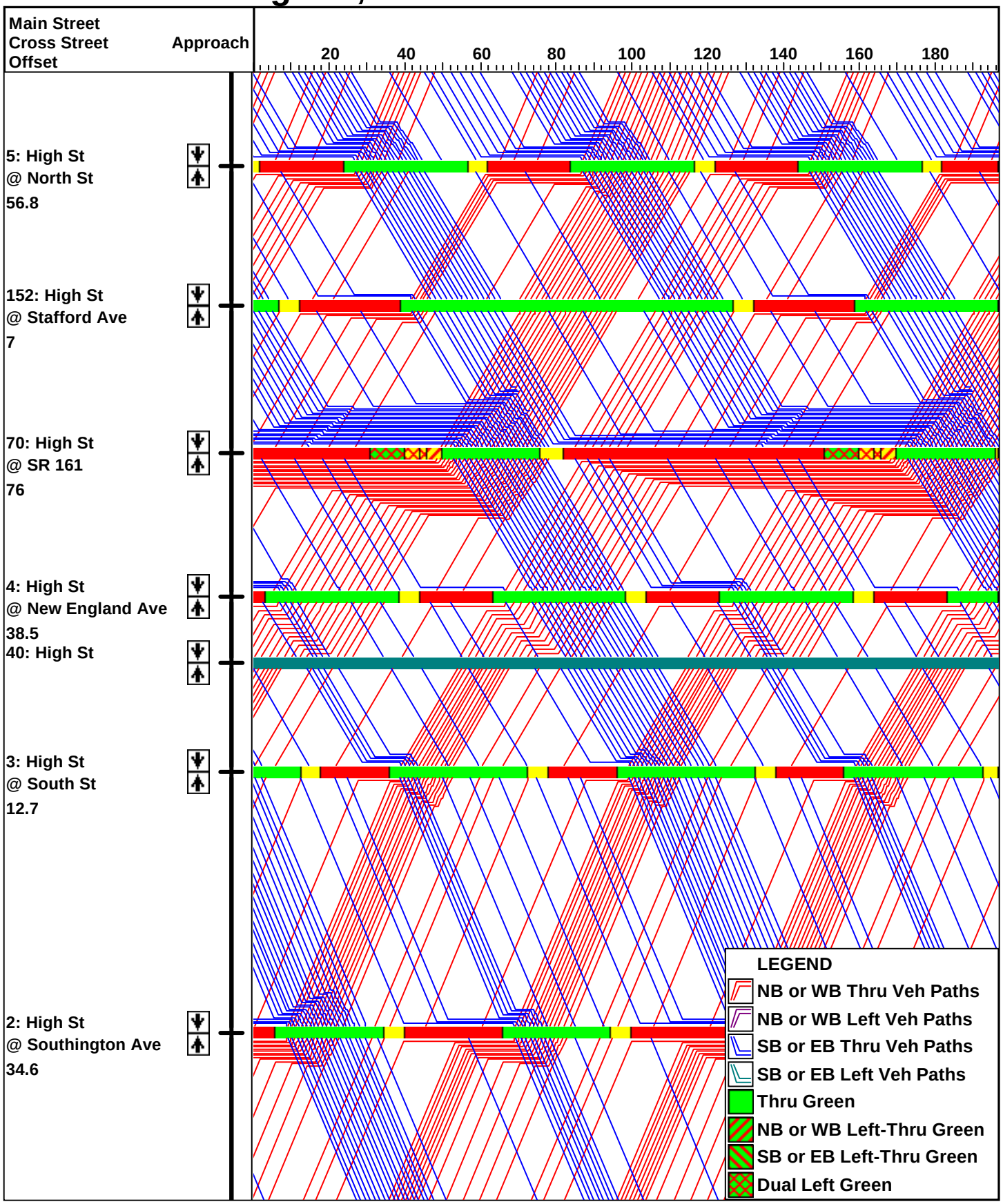
Time-Space Diagram - High St
Traffic Flow Diagram, 90th Percentile Flow and Green Times



Worthington Mobility Study AM Existing

DKA **7/1/2015**

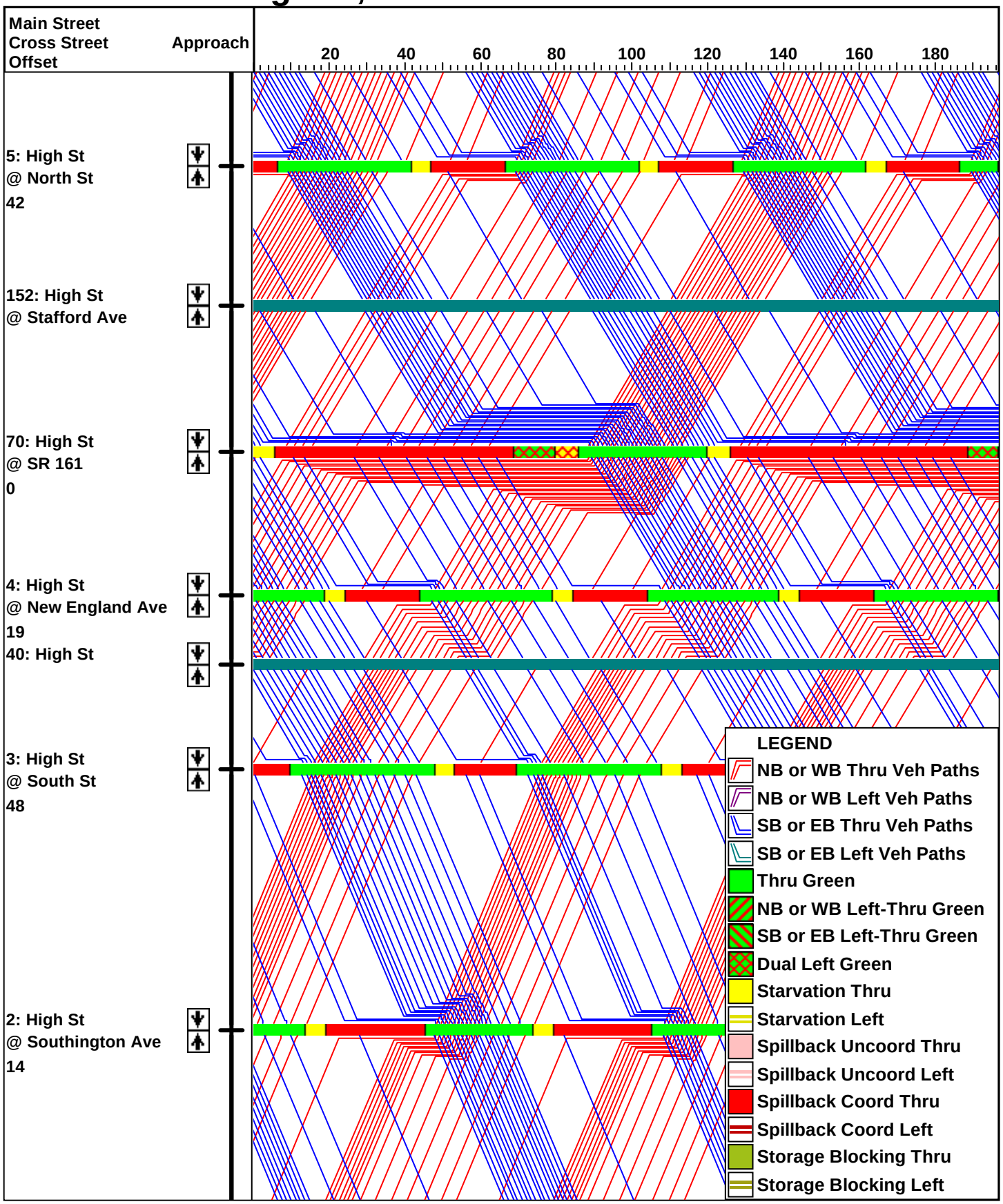
Time-Space Diagram - High St
Traffic Flow Diagram, 90th Percentile Flow and Green Times



Worthington Mobility Study AM Alt 4 - PHB

DKA **7/1/2015**

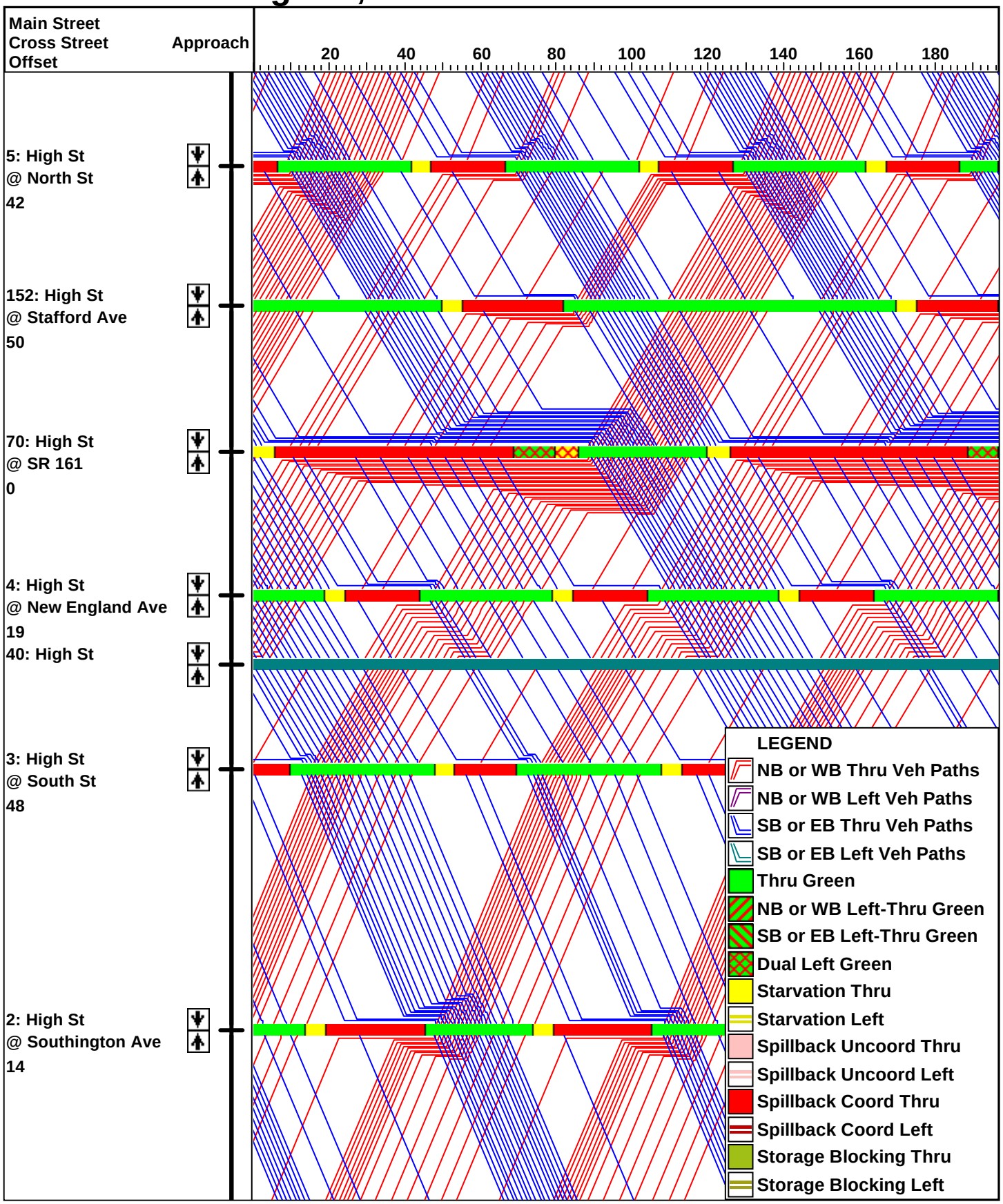
Time-Space Diagram - High St
Traffic Flow Diagram, 90th Percentile Flow and Green Times



Worthington Mobility study MID Existing

DKA **7/1/2015**

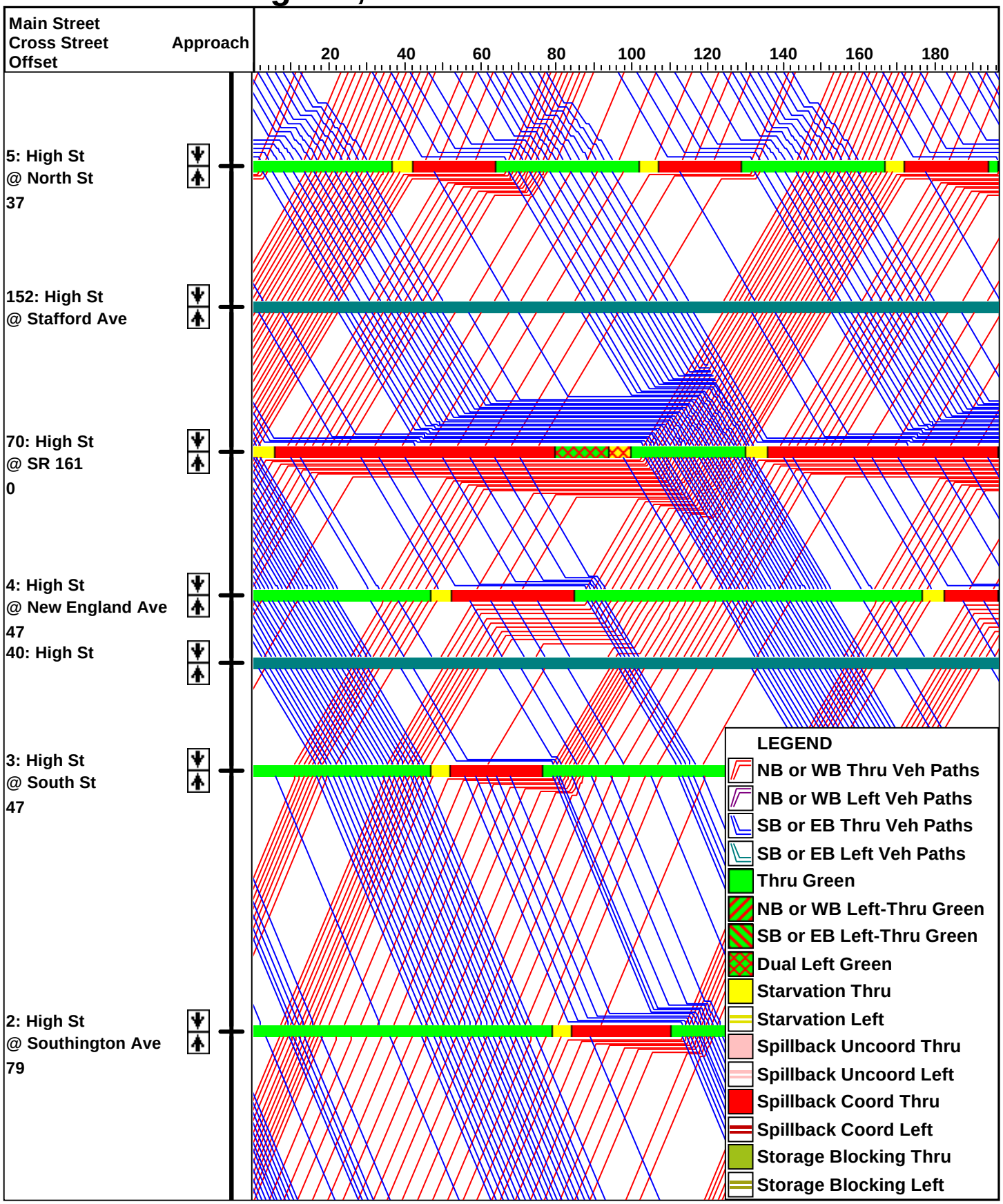
Time-Space Diagram - High St
Traffic Flow Diagram, 90th Percentile Flow and Green Times



Worthington Mobility study MID Alt 4 - PHB

DKA **7/1/2015**

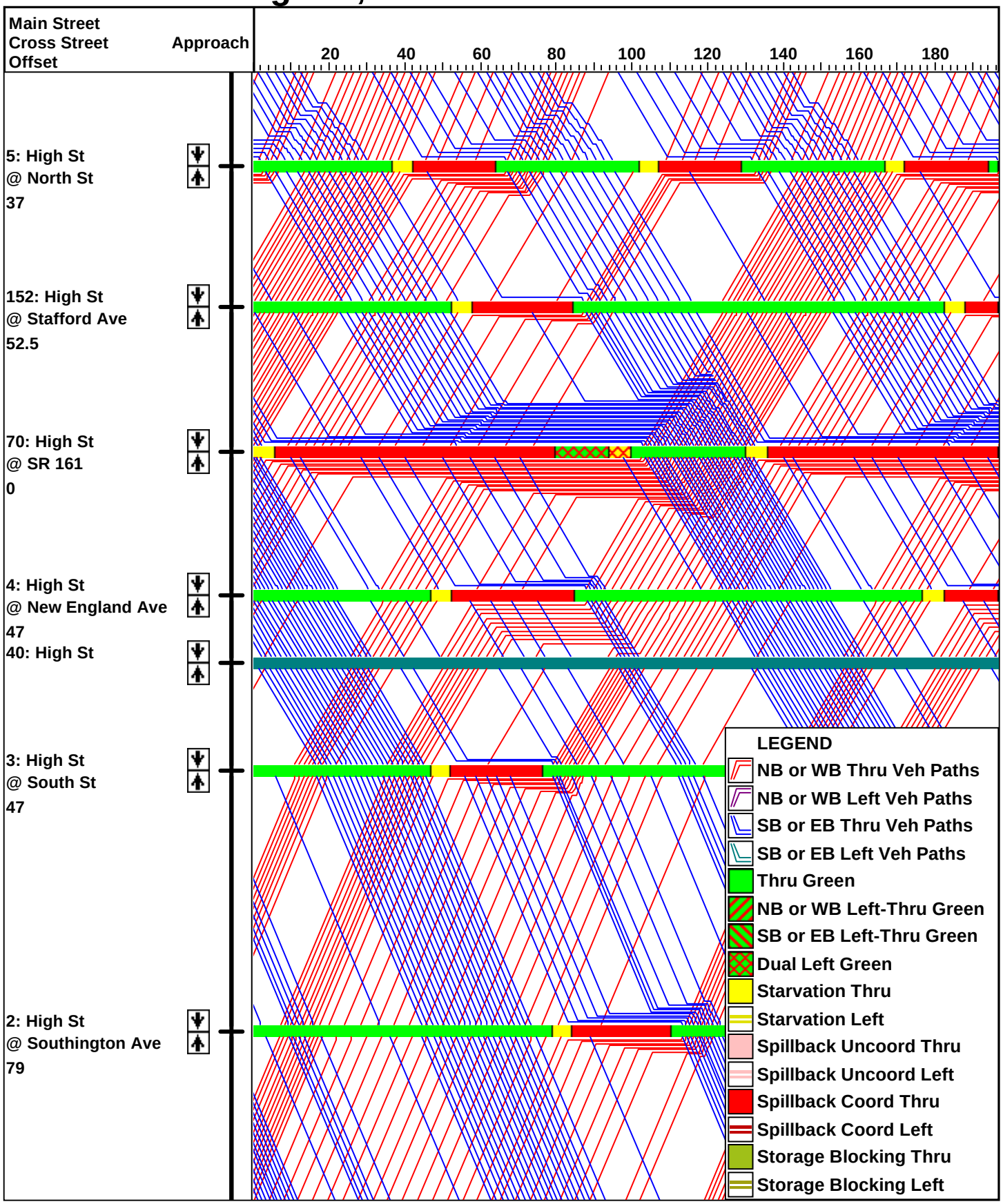
Time-Space Diagram - High St
Traffic Flow Diagram, 90th Percentile Flow and Green Times



Worthington Mobility Study PM Existing

DKA **7/1/2015**

Time-Space Diagram - High St
Traffic Flow Diagram, 90th Percentile Flow and Green Times



Worthington Mobility Study PM Alt 4- PHB

DKA **7/1/2015**

Appendix G: Signal Warrant #5 (School Crossing) Gap Analysis

High Street & Stafford Avenue

Warrant 5 – School Crossing Gap Analysis

TEM Section 402-3.4

PM Peak Hour # pedestrians crossing High Street = 17

gaps = Ve^(-Vt/T)

T-second intervals = (T/t)e^(-Vt/T)

t = 3 + (width/3.5); t = 3 + (50/3.5) = 17.3 seconds

T = length of time V is applied in seconds; T = 3600 seconds

V = 2-way vehicular volume; V = 1515 vehicles

Gaps = (1515) * e ^ ((-1515) * (3 + 50/3.5)/3600)

Gaps = 1515 * e ^ (-1515*17.3/3600)

Gaps = 1.04

T-second Intervals = (3600/17.3) * e ^ (-1515 * 17.3/3600)

T-second intervals = 0.14