



ASSESSMENT OF THE HAWK CROSSWALK TRAFFIC SIGNAL

Ian Anderson, Research Engineer
Vermont Agency of Transportation
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Abstract

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1. Introduction

According to the National Highway Traffic Safety Administration (NHTSA), pedestrians represent a significant portion of traffic-related injuries and fatalities in the United States. In 2008 there were 4,378 pedestrian fatalities and 69,000 pedestrian injuries. This translates to a pedestrian was killed every 120 minutes and injured every 8 minutes on average (1). In an effort to reduce these alarming totals, numerous design guidelines and electronic traffic control devices have been developed.

In accordance with the 2009 Manual on Uniform Traffic Control (MUTCD), Section 4F.01, Pedestrian Hybrid Beacons (PHB), "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" (2). In an effort to increase pedestrian safety and driver awareness the Vermont Agency of Transportation installed two PHB signals at a newly constructed crosswalk along Vermont Route 15 in the town of Colchester, VT. The particular PHB signals used are referred to as High Intensity Activated Crosswalk, or HAWK signals.

The new crosswalk was located at the Fanny Allen Hospital entrance which allows for pedestrian traffic from the hospital to easily reach destination points across VT Route 15 without risking their safety by illegally crossing. Although there was a learning curve for drivers because this is the first installation of a Pedestrian Hybrid Beacon (PHB) in Vermont, the HAWK allows both vehicular and pedestrian traffic to flow smoothly through the area with limited stopping by allowing pedestrians to cross the street and then permitting drivers to proceed as soon as the pedestrians have passed. Confusion was a concern as expected with any new traffic light or disruption in traffic flow as noted in a Federal Highway Administration (FHWA) report, "Safety Effectiveness of the HAWK Pedestrian Crossing Treatment" (FHWA-HRT-10-042), "Concerns have been expressed regarding confusion that may result from the dark beacon display, as some drivers may interpret it as a power outage. However, anecdotal experiences in Tucson, AZ have indicated that the dark display does not create such a problem" (3).

The purpose of this study is to examine and evaluate the overall effectiveness of a pedestrian hybrid beacon crosswalk system.

2. Project Location and Summary

2.1. Project Location Description

The HAWK was installed as part of the Colchester TCSP TSCE (009) improvement project at mile marker 0.8 along Vermont Route 15, a principle arterial route in the town of Colchester, VT. The crosswalk is in front of the Fanny Allen Medical complex, and provides pedestrian access to the neighboring area. The crosswalk traverses 5 lanes of traffic, and is adjacent to bus stops on both sides of the road and several driveways for local businesses. Figure 1 below shows the plan view of the improvement. Figure 2 shows the location and preconstruction of the crosswalk.

According to the contract plans, this project includes installing the HAWK pedestrian hybrid beacon system, traffic signs, pavement markings, and other related items. The average annual daily traffic (AADT) is 26,900.

2.2. System Description

According to the FHWA report FHWA-HRT-10-042, the HAWK was developed by the city of Tucson, AZ in the late 1990s with the intention of decreasing pedestrian-vehicular traffic delay time (3). MUTCD section, 4F.02, Design of Pedestrian Hybrid Beacons (PHB), requires that, "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" (4). The standard further states that when a PHB is warranted then, "At least two pedestrian hybrid beacon faces shall be installed for each approach of the major street, a stop line shall be installed for each approach to the crosswalk, a pedestrian signal head conforming to the provisions set forth in Chapter 4E shall be installed at each end of the marked crosswalk, and the pedestrian hybrid beacon shall be pedestrian actuated" (5). The sequence of the PHB as shown in the MUTCD is shown below in Figure 3.

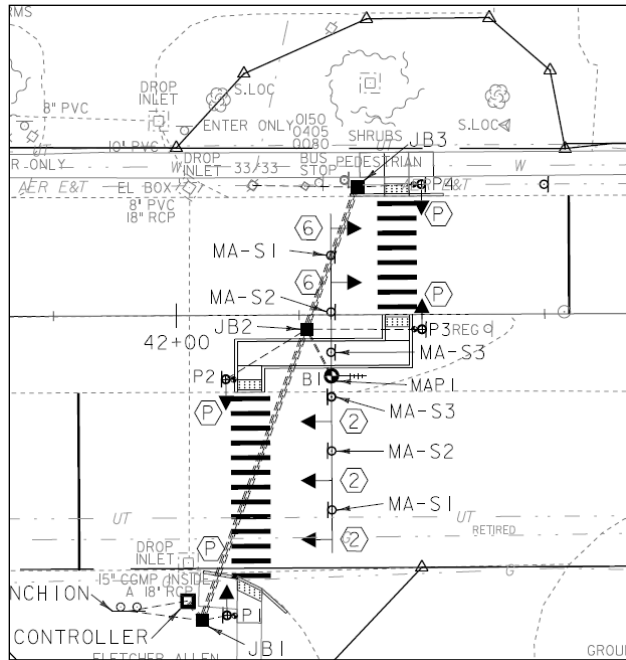


Figure 1: Plan view of the improvement

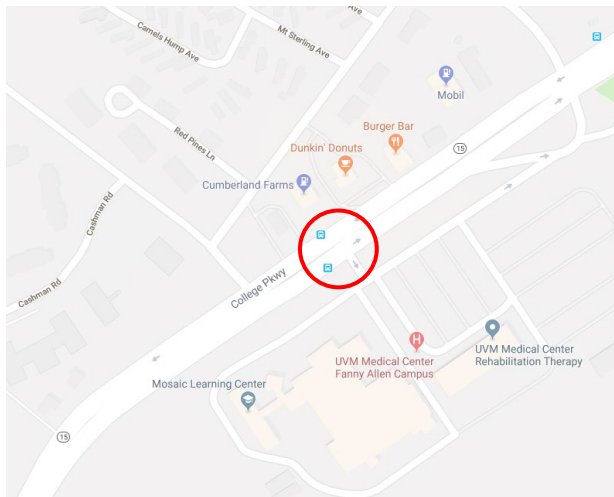


Figure 2: Location of HAWK System, and preconstruction crosswalk

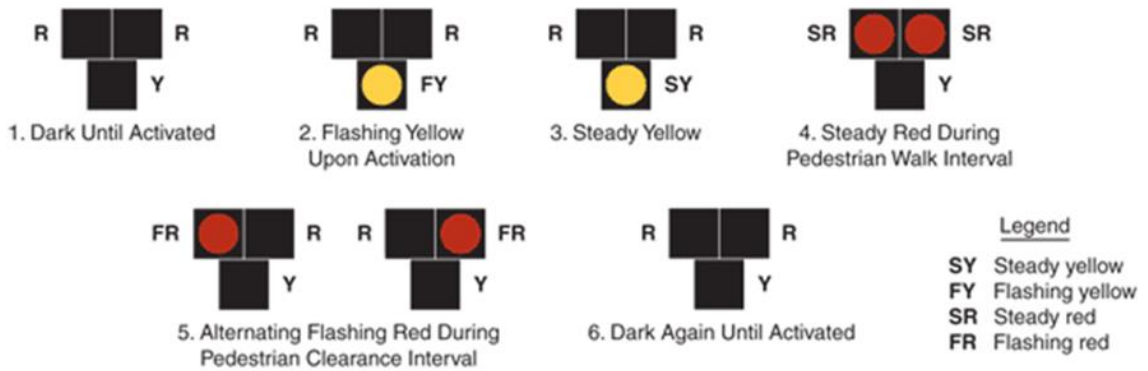


Figure 3: HAWK signal sequence (6).

The system will remain inactive and stay dark until a pedestrian pushes the button to cross. Once the system is activated, the sequence will begin. First the vehicles will see flashing yellow, then steady yellow, and then steady double red. At this phase in the sequence the vehicles should stop. The signal will then flash or “wig-wag” in an alternating red flashing pattern during the pedestrian clearance interval. At this point, vehicles should proceed once pedestrians have cleared the roadway. The signal will then revert to dark until the button is pushed again (7).

3. Performance and Observations

3.1. Pedestrian Study Overview

This pedestrian crossing study was modeled after an evaluation completed by the City of San Rafael, CA (8). The study assessed changes in driver behavior attributed to the crosswalk enhancement system. “Before” and “after” studies evaluated differences in vehicle behavior pre- and post-installation of the Pedestrian Hybrid Beacon Crosswalk System. Each study incorporated an agency member dressed in typical pedestrian clothing with two crossing scenarios. In scenario 1, the decoy pedestrian provided the impression that they were about to step in the crosswalk by looking both directions. In scenario 2, the decoy pedestrian looked in both directions and placed one foot into the crosswalk. Oncoming traffic was visually monitored during these events in order to assess driver behavior. Each scenario was completed 200 times (100 times per lane direction).

Testing dates for the Colchester, VT installation were roughly predetermined. The first study took place 5 months prior to the Hybrid Beacon Crosswalk System installation on December 7, 2012. Approximately 5 months after installation, the PHB System “after” study was conducted. During both studies, weather conditions were sunny and clear, and the same agency member was used as the decoy pedestrian.

Methodology used in Colchester was parallel in both studies. The first task was to delineate observation stations. This was done with painted stakes, marked out within a 500-foot stretch from the crosswalk in both the east and westbound directions. Observation stations are shown in Figure 4 below, which details the test area. After stations were set, the decoy pedestrian carried out the two crossing scenarios for both traffic directions. During this time, agency workers were taking observations 500 and 300 feet back from the crosswalk.

Numerical data was collected using a stopwatch. The time in seconds for the leading car to travel from the 500’- 300’ from the crosswalk was recorded. This data was used to calculate the leading car’s approach speed, in mph. The advance speed was calculated similarly, using the time to travel from the stakes marked off at 500 and 100 feet. Additional observations included the vehicle’s first braking distance, its compliance to the crosswalk system, and state of licensure.

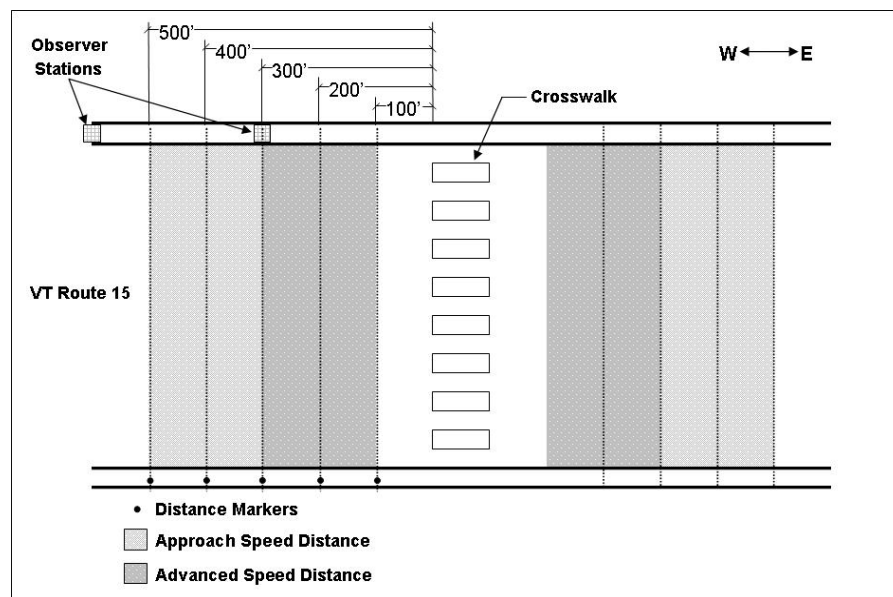


Figure 4: PHB Study Test Area, for both pre- and post-installation experiments

3.2. Data Analysis

All data was entered into a spreadsheet to be analyzed. Average speeds (miles per hour) were calculated by dividing the travel distance (feet) by travel time (seconds). All values were subsequently converted into miles per hour. Pre- and post-installation data was pooled together to develop a final summary, composed of roughly 800 data points. Results compared the test site before and after installation of the High-Intensity Activated Crosswalk. Data analysis yielded the system's performance success through percent increase/decrease of vehicles yielding, and percent increase/decrease of approach and advance speeds. All definitions and data analysis are summarized below. Please note that all raw data is available upon request.

3.2.1. Approach Speed

The approach speed is the speed of the vehicle while approaching the crosswalk within a range of 300 to 500 feet. This value represents the travel speed when the vehicle is first able to see the pedestrian. At this point, the driver should recognize the need to start slowing down in preparation to stop at the crosswalk. It is calculated by dividing the distance travelled, (300 to 500 feet=200 feet) by the time in seconds, it took the vehicle to travel the distance.

A graphical representation for the system exhibiting the average approach speeds for both east and westbound travel directions are showing below in Figure 5. It should be noted that this figure includes speeds of all vehicles whether they yielded to the decoy pedestrian or not. Please note that all averages and associated standard deviation results are summarized in Table 1, just below Figure 5. A breakdown of each scenario for the two directions is provided following Table 1. Conclusively, it is apparent that no trend can be applied to this data. The change in approach speed varied greatly, and is not dependent on the presence of the Pedestrian Hybrid Beacon Crosswalk System. The standard deviation for all systems in both directions and crossing scenarios are comparable and reasonable as to suggest a small amount of variability within the data sets or in this case driver response.

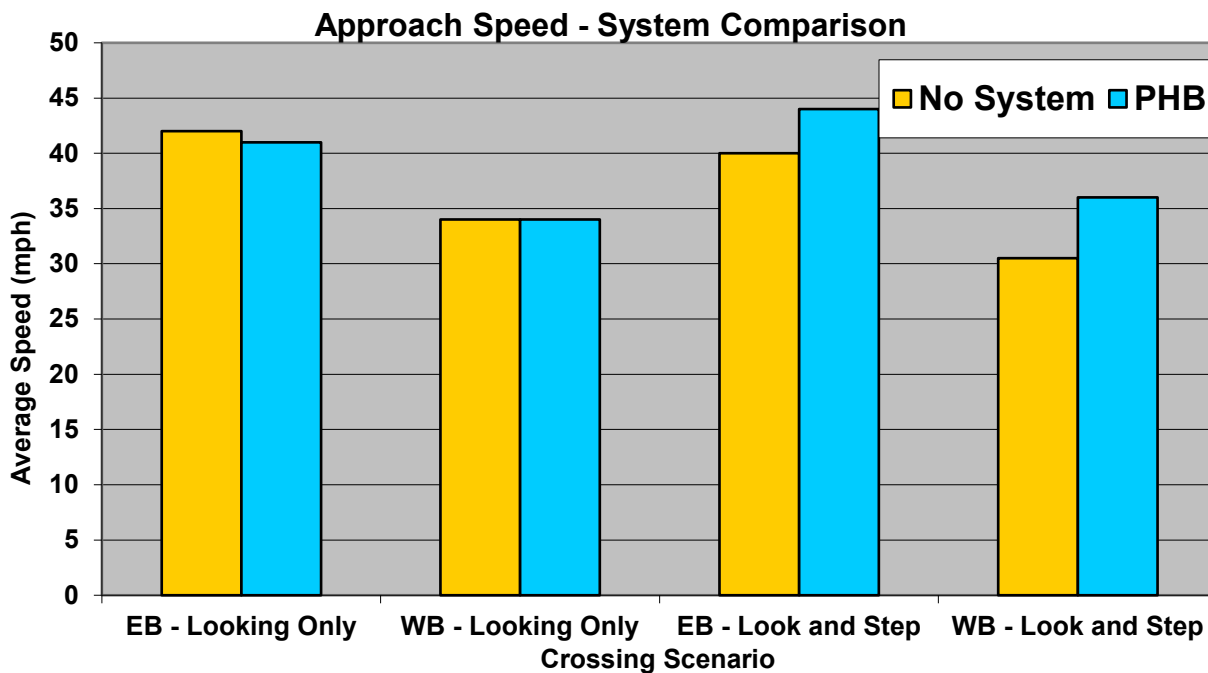


Figure 5: Average Approach Speed

Table 1: Average Approach Speeds and Associated Standard Deviation Results

Approach Speeds (mph)								
System	EB Look only		WB Look Only		EB Look Step		WB Look Step	
	Average	Std Dev	Average	Std Dev	Average	Std Dev	Average	Std Dev
None	42	6	34	6	40	4	30.5	6
PHB	41	6	34	7	44	5	36	8
Percent Change	-2.4%		0%		10%		18%	

3.2.2. Advance Speed

The advance speed is the speed of the vehicle within the distance of 100 to 500 feet in the advance of the crosswalk. This value represents the average speed that vehicles travel over the 400-foot distance. It is calculated by dividing the distance traveled, (400 feet) by the time in seconds it took the vehicle to travel that distance.

A graphical representation for the three systems exhibiting the average advance speeds for both east and westbound travel directions are shown below in Figure 6. It should be noted that the figure below includes speeds of all vehicles whether they yielded to the decoy pedestrian or not. The averages and associated standard deviation results are shown in Table 2.

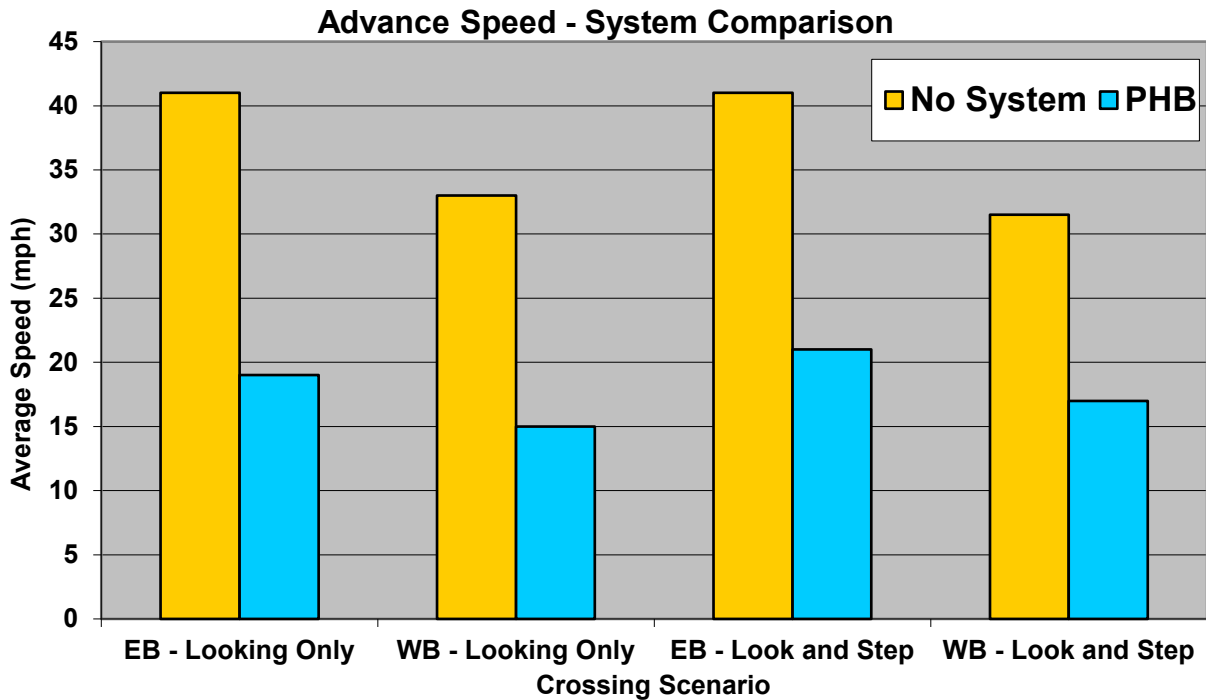


Figure 6: Average Advance Speed

Table 2: Average Advance Speeds and Associated Standard Deviation Results

Advance Speeds (mph)								
System	EB Look only		WB Look Only		EB Look Step		WB Look Step	
	Average	Std Dev	Average	Std Dev	Average	Std Dev	Average	Std Dev
None	41	5	33	4	41	4	31.5	5
PHB	19	3	15	3	21	3	17	4
Percent Change	-54%		-54%		-49%		-46%	

The standard deviation for all systems in both directions and crossing scenarios are comparable results based on the average speed results. Once again standard deviations are relatively small indicating consistent driver behavior. Similarly, for the approach speed assessment, while the average speeds are below the posted speed limit, the standard deviations imply that some portion of the study population is traveling well above the speed limit of 35 mph assuming normal distribution. This evidence supports the need for an advanced warning system.

3.2.3. Approach and Advance Speed Comparison

Approach and advance speeds suggest an interesting comparison. It was assumed that average approach speeds would be more than average advance speeds. Advance speed examines driver behavior over a larger length, in closer proximity to the crosswalk (100 to 500 feet) as compared to the approach speed, which considers average speeds over a shorter length and farther away from the crosswalk.

However, with no system installed, the average advance speeds were actually greater (~1 mph) in both directions when the pedestrian looked and stepped into the crosswalk. This means that some portion of the driver population actually accelerated within a range of 100 to 500 feet in advance of the crosswalk.

3.2.4. Yielding Compliance

Yielding compliance is the percentage of vehicles approaching the crosswalk during the staged experiment that yielded/stopped for the pedestrian during the yellow phase. The measurements followed the methodology used in the San Rafael, CA study described on Page 3. This data was collected by Research staff in 2012 and 2013. Yielding compliance was measured to capture the impact of the HAWK system during the yellow phase. Table 3 below shows the percentage of vehicles that yielded for the staged pedestrian during each crossing scenario for both lane directions. The percent increase/decrease column represents the percent change in yielding behavior between the advanced warning system and no system in place.

For example, there was a 0% yielding compliance rate before the PHB was installed, in the looking only scenario for the eastbound direction. After the installation of the PHB, 12% of vehicles yielded, however. Overall the percentage of traffic that yielded to pedestrians increased following the installation of the pedestrian hybrid beacon crosswalk system. When no system was in place, overall, 4.5% of traffic yielded. The percent of traffic increased to 22.5% compliance due to the PHB. The overall percentages are comprised of both directions and crossing scenarios. This suggests that the HAWK system has increased safety for this crossing.

Anecdotal evidence suggests that there is a far greater compliance (stops) during the red phase—vehicles interpret the HAWK as a traffic signal and they must stop for a pedestrian that has triggered the red light.

Table 3: Percentages of Vehicles Yielding

System Comparison - Vehicles Yielding			
Direction	No System	HAWK	Comparison
	% Vehicles Yielding	% Vehicles Yielding	% Change
Looking Only			
EB	0.00%	12%	12.00%
WB	10.00%	18%	8.00%
Looking and Stepping			
EB	0.00%	28%	28.00%
WB	8.00%	32%	24.00%
Average			
EB	0.00%	20%	20.00%
WB	9.00%	25%	16.00%
Overall Average	4.50%	22.50%	18.00%

3.3. Year 4 Site Visit Observations

A site visit to the HAWK Crosswalk System in Colchester near the UVM Medical Center - Fanny Allen Campus was conducted on Thursday, August 31st, 2017 at 3:00 PM, as part of an investigative check. Observations and photos on the performance and appearance of the HAWK Crosswalk System after installation were collected and can be seen in Figures 7 and 8 below.



Figure 7: HAWK Crosswalk System on the eastbound lane of VT Route 15 across from the Fanny Allen Hospital



Figure 8: HAWK Crosswalk System on the westbound lane of VT Route 15 across from the Fanny Allen Hospital

The video (available here online: [link](#)) of the HAWK Crosswalk system shows the system in action on the eastbound lane and working as detailed by the manufacturer. The video shows that once the crossing button is pushed, the system is activated making the yellow lights start flashing and then after a few seconds they become steady yellow lights. The steady yellow lights then turn into steady red lights during the pedestrian walk interval. After approximately six seconds (programed for this particular crosswalk) the steady red lights turn into alternating red flashing lights, specifying the pedestrian clearance interval lasting approximately 16 seconds before the system goes dark again. The video shows the slight confusion/hesitation of the vehicles after the pedestrian has crossed the street while the red lights are still flashing. The first two cars, the silver Honda SUV and the maroon sedan, were next to each other stopped at the light and it took the Honda approximately three seconds to proceed, while it took the maroon sedan a few seconds longer. We conducted the crossing scenario several times and it was noted that in most instances the cars were hesitant for a few seconds, while the light was flashing red, before they proceeded through the crosswalk. It is good to see that the vehicle drivers are vigilant and careful at this dangerous crosswalk, but the hesitation does periodically build up traffic. Unfortunately, during

our field visit we did not see many pedestrians using the crosswalk and the one person we did see, crossed the crosswalk without activating the HAWK system.

4. Cost

The product material and installation costs were paid for through the construction project. The bid cost of the Pedestrian Hybrid Beacon Crosswalk unit was \$85,000. Bid cost of the entire construction project including mobilization, traffic control, the HAWK installation, related traffic signs, markings, and miscellaneous work totaled \$273,855.30. There have been no reported service calls or issues with the system since installation, which depicts a high reliability for the signal system.

5. Summary and Recommendations

After analyzing the results from the speed study, the Pedestrian Hybrid Beacon Crosswalk was found to be more effective than having no system in place. Following installation of the PHB, yielding compliance increased by 18% on average. However, the data does not accurately portray the complete success of the advanced warning system. During the post-construction study, the majority of observed cars that did not yield were crossing through the intersection on a yellow light. Although approximately 87.5% of the time the drivers did not stop, 75% of the immediately following cars yielded to the pedestrian on red. Advance speeds were affected by this, as vehicles accelerated closer to the crosswalk to pass through the intersection on yellow.

The performance and effectiveness of the HAWK Crosswalk System is supported by the visual inspection and photographic evidence gathered during the 2017 site visit. This study has surpassed its initial (no less than 3 years) study duration detailed in the approved FHWA Work Plan. The field visit documentation suggests that the HAWK Crosswalk System performs as expected and detailed by the manufacturer. Observations from the field verified the initial concerns regarding confusion with the new traffic signal. The confusion was not due to the dark beacon display as initially thought, but after the pedestrian had crossed and the red lights were flashing. Vehicles were uncertain or hesitant to proceed even though signs on the light post dictate that they should proceed after the pedestrian had cleared the roadway. Results from this study will be given to the VTrans Traffic Safety Section for consideration on future crosswalk designs at particularly dangerous locations.

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