2010

Pedestrian Crosswalk Research Study

Identifying Innovative & Feasible Pedestrian Crosswalk Technologies for Two Study Corridors in Volusia County

Prepared for

Volusia County

GMB Engineers & Planners, Inc

2/23/2010

PEDESTRIAN CROSSWALK RESEARCH STUDY

For
S Atlantic Avenue from Dunlawton Avenue to Beach Street
&
CR A1A from E 6th Avenue to Canaveral National Seashore Entrance

Prepared for

Volusia County
FLORIDA

GMB ENGINEERS AND PLANNERS, INC.

February 2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. OVERVIEW

1.1 INTRODUCTION

Volusia County has retained GMB Engineers & Planners, Inc. to conduct a pedestrian crosswalk research study along two roadway sections within the Volusia County, Florida. The first section, approximately a 5.32 mile long roadway is along S Atlantic Avenue and stretches from Dunlawton Avenue (located in Daytona Beach Shores) till Beach Street (located in Ponce Inlet). The other section, approximately a 7.40 mile long roadway is along County Road (CR) A1A and extends between 6th Avenue (located in New Smyrna Beach) and Canaveral National Seashore Park Entrance (located in Bethune Beach). For future references in this report, the study section along S Atlantic Avenue shall be referred to as Study Area 1 and the study section along CR A1A shall be referred to as Study Area 2. The two study roadway sections (Study Area 1 and Study Area 2) are shown in Figures 1 and 2, respectively.

1.2 PROBLEM IDENTIFICATION & STUDY GOALS

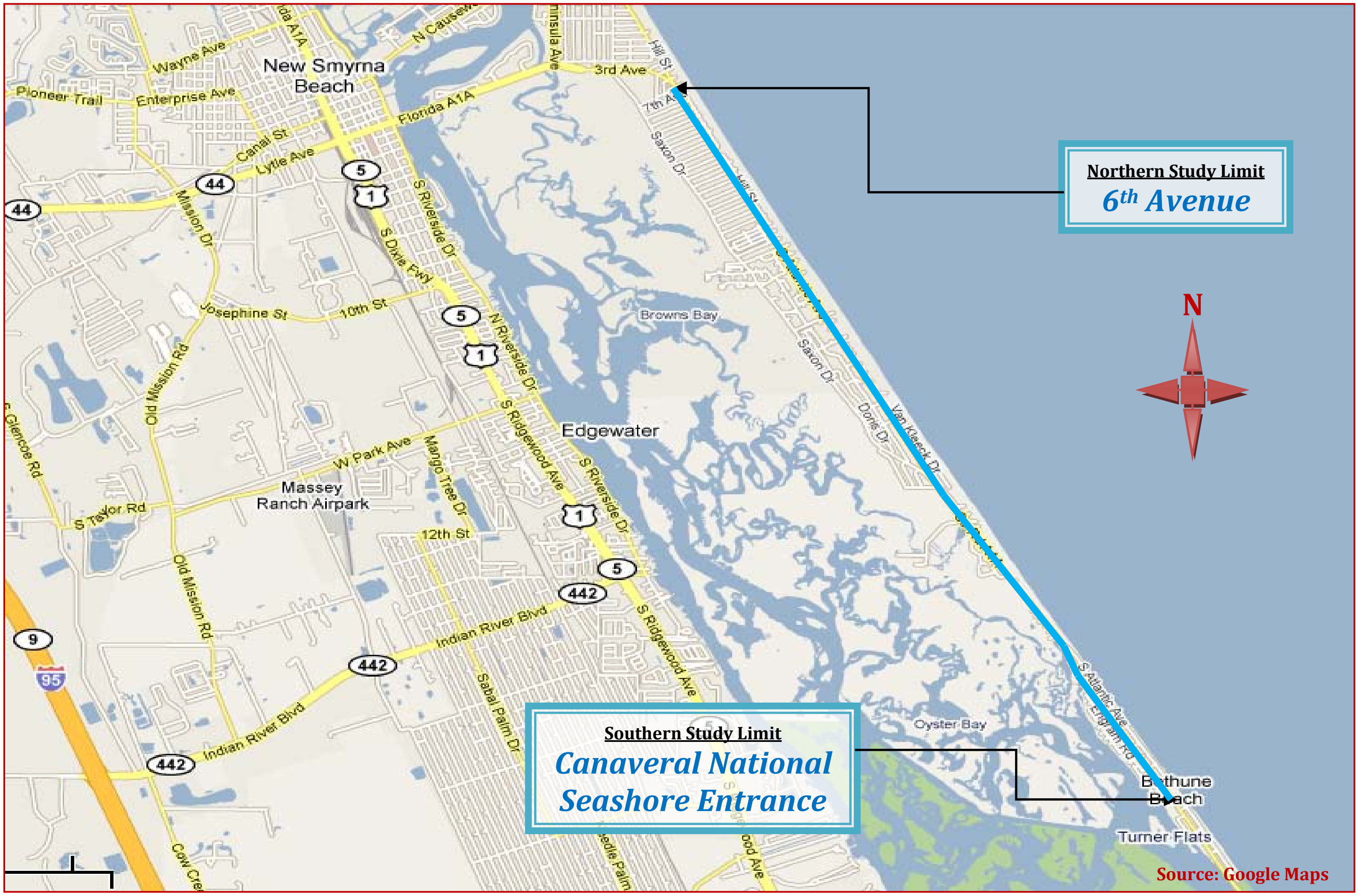
Based on the input given by the Volusia County, pedestrians utilizing the existing crosswalks in Study Areas 1 and 2 have been experiencing difficulty in crossing the roadway along S Atlantic Avenue and CR A1A. The two study roadways being beach front roadways in a famous tourist place, a high number of pedestrians from the nearby hotels, resorts, residential areas, restaurants and elsewhere in the country visiting the beach are believed to utilize the existing crosswalks on the study roadways to access the beach (located on the eastside of the study roadways) especially during the holiday season and weekends. The following paragraphs explain the concerns specific to the study areas and the goals that have to be met to address these concerns.

Problem:

The issue common to both the study areas is the concern that pedestrians are not able to cross the study roadways quickly (longer wait periods to cross the road) and safely. To identify any evident pedestrian crash patterns within the two (2) study areas, a three (3) year historical crash data was thoroughly analyzed.

Figure 1: Project Location Map illustrating the study limits on S Atlantic Avenue in Study Area 1

Figure 2: Project Location Map illustrating the study limits on CR A1A in Study Area 2



To quantify the number of gaps available in the traffic stream in the two study areas, vehicle gap size studies were conducted at two representative locations, one each in the two (2) study areas. Since, the majority of the crosswalks in the two study areas are uncontrolled crosswalks either at unsignalized intersections or at mid-blocks, crossing could be unsafe for pedestrians at an inconspicuous crosswalk or during nighttime conditions with insufficient lighting. Moreover, the posted speed limit in Study Area 2 is 45 MPH for the majority of the study corridor. The combinations of several uncontrolled crosswalks with a high approach speed often can create difficult crossing conditions.

Goals:

- *Make pedestrians more visible on the crosswalks.*
- *Increase driver alertness of the approaching crosswalk, especially when the crosswalk is inconspicuous or during nighttime conditions.*
- *Make more motorists yield to the pedestrians.*
- *Address the problem of pedestrian failure to yield to the vehicles.*
- *Achieve highest level of pedestrian and vehicular safety by minimizing the conflicts between the two entities.*

To achieve the above goals, this study gathered information on the latest state of the art and innovative crosswalk technologies used elsewhere in the state of Florida and United States of America that are being successfully implemented not only to improve pedestrian crossing convenience but also achieve highest levels of vehicular and pedestrian safety. Existing and emerging technologies specifically utilized to improve pedestrian visibility and crosswalk usability are studied. As such, this study provided the advantages and disadvantages, expected cost, applicability and maintenance factors of the potential technologies for use in the two study areas.

2. EXISTING CONDITONS

This chapter provides a detailed explanation of the two study roadway sections, field inventory of the existing crosswalks on the two study roadways, three (3) year crash data analysis within the study limits emphasizing on pedestrian related crashes and Vehicle Gap Size Study results conducted at two (one in each of the study roadways) representative locations to assess the existing available gaps for pedestrians.

2.1 FIELD INVENTORY

The crosswalk information for the two study areas was gathered during the field visits.

2.1.1 Study Area 1

The limits for Study Area 1 along S Atlantic Avenue extend from Dunlawton Avenue till Beach Street in Volusia County for a total distance of approximately 5.32 miles. The northern study limit is located in Daytona Beach Shores area, while the southern study limit falls within the Ponce Inlet area. Study Area 1 comprises of a combination of 5 lane section, 4 lane section, a 3 lane section with a continuous left turn lane and a 2 lane undivided section. The posted speed limit within the study limits is 35 miles per hour (MPH). Table 1 provides field inventory of the existing crosswalks in this study area.

Pedestrian crosswalk signs (W11-2) are generally provided at all the crosswalks. Flashing beacons are provided at Marcelle Avenue, Toronita Avenue and Hiles Boulevard. In-street pedestrian crosswalk signs which are used to remind motorists of the right-of-way or the word message “FAILURE TO STOP $141.00 FINE” were provided in addition to the pedestrian crosswalk signs at some locations.

Table 1: Crosswalk Inventory for S Atlantic Ave from Dunlawton Ave to Beach St

SL No	Location	Crosswalk @	Traffic Control	Crossing Number of Lanes	Posted Speed Limit (MPH)	Ped Crosswalk Signs (W11-2)	In-street Ped Crosswalk Sign (R1-6)	Lighting[2]
1	Dunlawton Ave	Intersection	Signal	4	35	Yes		Yes
2	In front of Sand Castle Hotel (south of Demotte St)	Mid Block	None	4	35	Yes		Yes (just south of the crosswalk)
3	S. of Dahlia Ave	Mid Block	None	4	35	Yes		No
4	S. of Phyllis Ave (in front of Royal Holiday Beach Motel)	Mid Block	None	4	35	Yes		No
5	North of Emilia Ave	Mid Block	None	3	35			No
6	Emilia Ave	Intersection	2 Way Stop	3	35	Yes		No
7	Marcelle Ave[1]	Intersection	2 Way Stop	3	35	No		Yes
8	Mallard St	Intersection	2 Way Stop	2	35	Yes		No
9	Heron St	Intersection	2 Way Stop	2	35	Yes		Yes
10	Egret Ave	Intersection	2 Way Stop	2	35	Yes		Yes (just south of the crosswalk)
11	Toronita Ave	Intersection	2 Way Stop	2	35	Yes		Yes
12	Seagull St	Intersection	2 Way Stop	2	35	Yes		Yes
13	Curlew St	Intersection	2 Way Stop	2	35	Yes		Yes
14	Major St	Intersection	2 Way Stop	2	35	Yes		Yes
15	Old Carriage Rd	Intersection	2 Way Stop	2	35	Yes		Yes
16	South of Seahaven Dr (in front of Southpoint Condominiums)	Mid Block	None	2	35	Yes		No
17	In front of North Turn Restaurant	Intersection	2 Way Stop	2	35	Yes	Yes	Yes (just south of the crosswalk)
18	In front of Winterhaven Park	Mid Block	None	4	35	Yes		No
19	Harbor Village Blvd	Intersection	2 Way Stop	4	35	Yes		No
20	North of Cindy Lane	Mid Block	None	4	35	No		No
21	Oceanview Ave	Intersection	2 Way Stop	2	35	Yes		No
22	Glenview Ave	Intersection	2 Way Stop	2	35	Yes		Yes
23	Calumet Ave	Intersection	2 Way Stop	2	35	Yes		No
24	Inlet Harbor Rd	Intersection	2 Way Stop	2	35	Yes		Yes
25	Beach St	Intersection	4 Way Stop	2	35	No		Yes

*Notes:
1. A W11-2 combined with W16-9p is placed before the crosswalk in the NB direction.
2. The presence of lighting listed in Table 2 does not refer to a particular location and can be present at or in the vicinity of the crosswalk. Moreover, this study did not determine whether the lighting provided is sufficient for the crosswalk.
3. The conditions listed in Table 1 reflect the field conditions noted on the day of the field visit.

2.1.3 Study Area 2

The limits for Study Area 1 along CR A1A extend from 6th Avenue till Canaveral National Seashore Park Entrance in Volusia County for a total distance of approximately 7.40 miles. The northern study limit is located in New Smyrna Beach, while the southern study limit falls within the Bethune Beach area. Study Area 2 comprises of a combination of 5 lane section with a continuous left turn lane, a 3 lane section with a continuous left turn lane and a 2 lane undivided section. The posted speed limit for majority of the study corridor is 45 MPH. The posted speed limit from 6th Ave till Sheepshead Avenue is 45 MPH which forms majority of the study corridor. The posted speed limit for the remaining portion of the study corridor (from Sheepshead Avenue till the Park entrance) is 35 MPH. Table 2 provides field inventory of the existing crosswalks in this study area.

Pedestrian crosswalk signs (W11-2) are generally provided at all the crosswalks. Flashing beacons are provided at Hiles Boulevard. In-street pedestrian crosswalk signs which are used to remind motorists of the right-of-way were provided in addition to the pedestrian crosswalk signs in some locations.

Table 2: Crosswalk Inventory for CR A1A - 6th Ave to Canaveral National Seashore Ent

SL No	Location	Crosswalk Type	Traffic Control	Crossing Number of Lanes	Posted Speed Limit (MPH)	Ped Crosswalk Signs (W11-2)	In-street Ped Crosswalk Sign (R1-6)	Lighting[2]
1	B/w 6th Ave & 7th Ave	Mid Block	None	5	45	Yes		Yes (north & south of the crosswalk)
2	7th Ave[1]	Intersection	2 Way Stop	5	45	No		Yes
3	8th Ave	Intersection	2 Way Stop	5	45	Yes		Yes
4	15th Ave	Intersection	2 Way Stop	5	45	Yes		Yes
5	18th Ave	Intersection	2 Way Stop	5	45	Yes	Yes	Yes
6	20th Ave	Intersection	2 Way Stop	5	45	Yes		Yes
7	24th Ave	Intersection	2 Way Stop	5	45	Yes		Yes
8	26th Ave	Intersection	2 Way Stop	5	45	Yes		Yes
9	27th Ave[1]	Intersection	Signal	5	45	No		Yes
10	South of Bahama Dr (in front of Sea Coast Condominiums)	Mid Block	None	3	45	Yes		No
11	Matthews Ave	Intersection	Signal	3	45	Yes		Yes
12	Oyster Quay	Intersection	2 Way Stop	3	45	Yes		Yes
13	South of Sea Woods Blvd	Mid Block	None	3	45	Yes		No
14	Hiles Blvd	Intersection	2 Way Stop	3	45	Yes	Yes	Yes
15	Watts Dr	Intersection	2 Way Stop	3	45	Yes		Yes
16	In front of Tradewinds Condominiums	Mid Block	None	3	45	Yes		Yes (just south of the crosswalk)
17	Blue Fish Ave	Intersection	2 Way Stop	2	45	Yes		Yes
18	Bullhead Ave	Intersection	2 Way Stop	2	45	Yes		Yes
19	Drum Ave	Intersection	2 Way Stop	2	45	Yes		Yes
20	Flounder Ave	Intersection	2 Way Stop	2	45	Yes		Yes
21	South of Lady Fish Ave in front of Bethune Beach Park	Mid Block	None	2	45	Yes		Yes (just south of the crosswalk)
22	Pompano Ave	Intersection	2 Way Stop	2	45	Yes		Yes
23	Sheepshead Ave	Intersection	2 Way Stop	2	45	Yes		Yes
24	Starfish Ave	Intersection	2 Way Stop	2	35	Yes		Yes

*Notes:
1. A W11-2 combined with W16-9p is placed before the crosswalk in the NB direction for 7th Ave and in the NB & SB directions for 27th Ave.
2. The presence of lighting listed in Table 2 does not refer to a particular location and can be present at or in the vicinity of the crosswalk. Moreover, this study did not determine whether the lighting provided is sufficient for the crosswalk.
3. The conditions listed in Table 1 reflect the field conditions noted on the day of the field visit.

2.2 CRASH ANALYSIS

Crash records along the two study areas were reviewed in the period between August 1, 2006 and July 31, 2009. Information relating to the crash occurrences within the study areas was provided by the Volusia County Traffic Engineering Department. Emphasis was given on pedestrian crashes to identify potential pedestrian related crash patterns. The crash data was analyzed using the procedures outlined in the **FDOT Topic Number 500-000-100-C, Section 1 pages 21 to 24**. Tables 3 and 4 provide the crash summaries for Study Area 1 and Study Area 2, respectively.

Table 3: Pedestrian Crash Summary for Study Area 1

Along S Atlantic Avenue for Crash Period between August 1, 2006 and July 31, 2009									
Crash Ref. No.	Date	Time	Location	Fatal	Injury	Property Damage	Lighting Condition	Wet/ Dry	Contributing Cause
1	05/12/07	0:52 AM	Glenview Ave	0	1	$0	Night; Street Light	Dry	Careless Driving
2	06/19/07	11:08 PM	Dunlawton Ave	0	1	$1,000	Night; Street Light	Wet	No Improper Driving

Table 4: Pedestrian Crash Summary for Study Area 2

Along CR A1A for Crash Period between August 1, 2006 and July 31, 2009									
Crash Ref. No.	Date	Time	Location	Fatal	Injury	Property Damage	Lighting Condition	Wet/ Dry	Contributing Cause
3	01/10/09	7:29 PM	Hiles Blvd	1	0	$3,000	Night; Street Light	Dry	Failed to Yield Right-of-way

The three (3) year period crash analysis for the two study areas revealed that only two (2) pedestrian related crashes occurred in Study Area 1 and only one (1) pedestrian related crash occurred in Study Area 2. The crash analysis did not reveal any crash patterns at specific locations. The pedestrian crash at S Atlantic Avenue and Glenview Avenue (ref. no 1) occurred when a pedestrian crossing Glenview Avenue was hit by a vehicle turning onto southbound S Atlantic Avenue. The crash at S Atlantic Avenue and Dunlawton Avenue (ref. no 2) occurred when a pedestrian crossing Dunlawton Avenue in the eastbound direction was hit by a northbound traveling vehicle. No citations were issued in this case.

The fatal crash at CR A1A and Hiles Boulevard (ref. no 3) occurred when a pedestrian crossing CR A1A was hit by vehicle traveling north on CR A1A.

The three (3) crashes occurred during night-time conditions. However, street light is present at all the crash locations. In crashes (ref. no's 1 and 3), vehicle driver was found at fault. Citations were not issued in the crash that occurred at Dunlawton Avenue and S Atlantic Avenue.

Out of the three (3) crashes, the crash that occurred at Hiles Boulevard and CR A1A revealed that sometimes drivers do not yield to pedestrians, despite the presence of all the relevant traffic signs and a flashing beacon. The pedestrian related signs installed at this location include a Pedestrian Crosswalk Sign (MUTCD code W11-2 combined with MUTCD code W16-7p) and In-street Pedestrian Crosswalk sign (MUTCD code R1-6). The In-street Pedestrian Crosswalk sign is generally used to remind road users of laws regarding right-of-way at unsignalized intersections.

2.3 VEHICLE GAP SIZE STUDY

Vehicle gap size studies were conducted in the study areas in two representative locations; one along S Atlantic Avenue near Toronita Avenue and the other along CR A1A near 18th Avenue. The two gap studies were conducted on November 28, 2009 (Saturday) from 9 a.m. to 1: p.m. and from 2:00 p.m. to 6:00 p.m., when pedestrian activity is expected to be high. Gap studies are generally conducted to determine the size and the number of gaps in the vehicular traffic stream along a subject roadway. The gap studies were conducted in accordance with the procedures set forth in **Chapter 8 of the MUTS Topic No 750-020-007.**

Based on a walking speed (s) of 2.5 feet per second (fps) to account for elderly pedestrians and based on the width of S. Atlantic Avenue (w = 22 feet, northbound and southbound lanes combined width), the adequate gap time required to cross Atlantic Avenue was found to be 11.8 seconds (adequate gap time G = (w/s) + 3). To obtain conservative results, a gap greater than or equal to 12 seconds is assumed to give enough time for pedestrians to cross

S Atlantic Avenue at Toronita Avenue. A summary of gaps greater than or equal to 12 seconds is provided in Table 5.

Table 5: Gap Summary for S Atlantic Avenue at Toronita Avenue

Time Period	Total Gaps >= 12 Seconds
9:00 - 10:00 AM	90
10:00 - 11:00 AM	77
11:00 - 12:00 AM	61
12:00 - 1:00 PM	72
2:00 - 3:00 PM	71
3:00 - 4:00 PM	72
4:00 - 5:00 PM	74
5:00 - 6:00 PM	92

Since pedestrians crossing CR A1A at 18th Street can take refuge in the continuous left-turn lane, gap summary is provided for northbound and southbound directions separately. Based on a walking speed of 2.5 fps, the adequate gap time required to cross CR A1A at 18th Avenue (approximately 30 feet in each direction) is found to be 15 seconds. A summary of gaps greater than or equal to 15 seconds at 18th Avenue on CR A1A is provided in Table 6.

Table 6: Gap Summary for CR A1A at 18th Avenue

Time Period	Total Gaps >= 15 Seconds	
	Northbound	Southbound
9:00 - 10:00 AM	46	45
10:00 - 11:00 AM	58	63
11:00 - 12:00 AM	57	61
12:00 - 1:00 PM	50	61
2:00 - 3:00 PM	48	50
3:00 - 4:00 PM	42	36
4:00 - 5:00 PM	52	56
5:00 - 6:00 PM	72	54

In addition, results from the gap study that was conducted by GMB in July 2006 are also reported in this study. The study was conducted between 10:00 a.m. and 6:00 p.m. Similar to the afore-mentioned gap size analysis for Toronita Avenue, a minimum walking speed (s) of 2.5 fps and a roadway width of 22 feet were assumed to calculate the number of gaps available in the traffic stream at Hiles Boulevard. A summary of gaps greater than or equal to 12 seconds is provided in Table 7.

Table 7: Gap Summary for CR A1A at Hiles Boulevard

Time Period	Total Gaps >= 12 Seconds
10:00 - 10:00 AM	83
11:00 - 12:00 AM	87
12:00 - 1:00 PM	79
1:00 - 2:00 PM	49
2:00 - 3:00 PM	37
3:00 - 4:00 PM	16
4:00 - 5:00 PM	5
5:00 - 6:00 PM	13

In conclusion, results from the gap size studies at Toronita Avenue and 18th Avenue show that significant number of gaps was available at these two locations. Nonetheless, the number of pedestrians crossing the study roadways at these locations during these study hours will reveal whether required number of gaps is available.

3. INNOVATIVE & EFFECTIVE TECHNOLOGIES

Based on the understanding of the pedestrian concerns in the two (2) study areas, the type and location of the technologies that are currently utilized in the two (2) study areas, crash analysis for three years, gap studies at representative locations, a total of ten (10) different countermeasures are discussed that could potentially be used in the two study areas. Out of the proposed ten (10) countermeasures, six (6) are engineering and the remaining four (4) are Intelligent Transportation Systems (ITS) based technologies. The discussion for these technologies was based on the seven (7) sources as mentioned below. As such, the relevant technologies discussed in this chapter are consistent with the latest 2009 Manual on Uniform Traffic Control Devices (MUTCD) and Section 3.8: Mid-Block Pedestrian Crosswalks of the Topic No. 750-000-005, Traffic Engineering Manual, revised in January of 2010.

1. "Pedestrian Safety Engineering and ITS-Based Countermeasures Program for Reducing Pedestrian Fatalities, Injury Conflicts, and Other Surrogate Measures - Final System Impact Report". The technologies discussed in this report were based on three individual studies conducted in

   1-A. Las Vegas, Nevada;

   1-B. Miami-Dade, Florida and

   1-C. San Francisco, California.

2. http://www.walkinginfo.org/pedsmart

3. Technologies specifically used in Albany, New York.

4. http://www.spotdevices.com/index.html

5. MUTCD – 2009 Edition.

6. Section 3.8 of the Topic No. 750-000-005, Traffic Engineering Manual, revised in January 2010 (Section 3.8 of the Topic No. 750-000-005).

7. Selecting the most effective ITS application for pedestrian safety in Florida (http://www.dot.state.fl.us/researchcenter/Completed_Proj/Summary_TE/FDOT_BC353_50_rpt.pdf)

Since, the majority of the crosswalks are at unsignalized intersections and some at mid-block sections, the technologies explored and provided in this study are specifically relevant to unsignalized intersections. Based on the historical crash analysis for a three (3) year period and concerns of the pedestrians in the two study areas, the technologies discussed in this study aimed at addressing the pedestrian visibility issues and vehicle yield behavior. As such, these technologies were mainly developed to focus on improving the pedestrian visibility in the crosswalk and increasing the yield rate of the vehicles at the crosswalks.

3.1 ENGINEERING TECHNOLGIES

A total of six (6) technologies were discussed as part of this study.

3.1.1 In-Street Pedestrian Crosswalk Signs

MUTCD R1-6 In-Street Pedestrian Crosswalk Signs are intended for use at uncontrolled (unsignalized) crosswalks to remind drivers of laws regarding pedestrians' right-of-way. The legend "State Law" may be shown on the top of the sign if applicable.

Figure 3: Picture of In-Street Pedestrian Crosswalk Signs

This technology has the following advantages:

- These signs are expected to increase the number of vehicles that stop for pedestrians at uncontrolled intersections or mid-block pedestrian crossings.
- These are especially useful on high speed or high traffic volume roadways.
- They are more noticeable than roadside pedestrian crosswalk signs and may also wield a minor traffic-calming effect by narrowing the inside lanes slightly.
- These could help the safety of both the pedestrians and vehicles in locations where pedestrian and/or vehicle failure to yield is a concern.

The general concerns with this technology:

- These signs are susceptible to damage when not installed on a raised median.
- The maintenance costs could be excessive if these are knocked down frequently.

Technology in the Study Areas Setting

This technology is currently used in both the study areas. However, the size and number of signs used at an individual location are the two areas where improvements could be considered to improve the effectiveness of these signs. For instance, instead of one sign, a group of at-least three signs could be used to improve the effectiveness. The size of the sign could be increased for better visibility. Refer to the MUTCD – 2009 Edition and Section 3.8 of the Topic No. 750-000-005 on selection guidance and additional information on this treatment.

Estimated Cost

The total cost for an installed sign is expected at $275.00 (source: 1-B)

3.1.2 Median Refuge Island

These are raised barriers in the center of the roadway (either in the median or center lane) that serve as a place of refuge for pedestrians who cross a street at mid-block or at an intersection. However, the turning movements have to be carefully planned so that motorists are not forced to travel on inappropriate routes, such as residential streets, or make unsafe U-turns.

This technology has the following advantages:

- The refuge is especially useful on multilane highways and could help pedestrians trapped in the middle of a roadway while crossing.
- The refuge also helps pedestrians to quickly get to a safe waiting place if motorists fail to yield to pedestrians.
- The refuge can help in convenient crossing on high volume roadways and where gaps are not sufficient to cross the roadway in a single stretch.

Figure 4: Picture of a Median Refuge Island

The general concerns with this technology:

- The refuges can only be provided at limited locations due to the inconvenience caused to the motorist.
- The refuge cannot be provided at undivided multilane roadways without expanding the roadway.

Technology in the Study Areas Setting

This technology is currently used in Study Area 1 near Dunlawton Avenue on S Atlantic Avenue as shown in Figure 5. However, the technology could be tested at other multilane crosswalk locations in the two study areas, as recommended for consideration in Section 3.8 of the Topic No. 750-000-005.

Estimated Cost

The total typical cost for an installed median refuge island is expected at $8,567.00 (source: 1-C)

Figure 5: Picture of a Median Refuge Island on S Atlantic Avenue between Dahlia Avenue and Phyllis Avenue (source: Google Maps)

3.1.3 Danish Offset

A Danish offset is an offset at the middle of a multilane crossing that provides refuge for pedestrians in terms of physical separation from traffic and ensures they are facing the traffic before crossing the second half of the roadway.

Figure 6: Picture of Danish Offset and Median Refuge Island Combination

The offset is a type of channelization that encourages pedestrians to turn and walk parallel to the traffic they are crossing.

This technology has all the advantages of a median refuge including:

- Increases the number of pedestrians who look before crossing.
- Decreases the number of pedestrians trapped in the roadway, especially on high-volume roadways.
- Increases the number of pedestrians yielding to the vehicles.

The general concerns are same as that of the median refuge island. In addition, this technology can only be used at limited number of locations in the study areas.

Technology in the Study Areas Setting

This technology is currently not used in the two (2) study areas. However, the technology could be tested at other appropriate multilane crosswalk locations in the two study areas.

Estimated Cost

The total cost of implementing this technology varies with the cost of raw materials and labor costs. However, this technology is widely believed to be a cost-effective countermeasure to reduce pedestrian crashes and enhance pedestrian safety.

3.1.4 Retro-Reflective Materials

These low cost retro-reflective materials could be distributed to pedestrians that frequently use the study area crosswalks. These materials are especially helpful to children and senior citizens. Various materials were identified to be effective including clipsters, zipper pulls, badges and armbands.

These items are embroidered with retro-reflective material and printed with slogans as "Be Safe", Be Seen" or "Look, Slow Down, Focus." This technology is tested at multiplied locations in San Francisco, California and slowly gaining publicity as a low cost alternative for improving the safety of pedestrians.

Figure 7: Picture of a Retro-reflective Material used by School Children

This technology has the following advantages:

- This is a low cost alternative to increase the motorist awareness of the pedestrians in the crosswalk.
- Increases the visibility of the pedestrians, especially in locations where the crosswalks are inconspicuous and have insufficient lighting during night time conditions.

- Increases the number of vehicles yielding to pedestrians.
- Addresses the problem of pedestrians failing to yield to vehicles.

The general concerns with this technology:

- Difficult to organize, conduct and publicize meetings to explain about these materials.
- Challenging to recruit volunteers to help distribute the material.

Technology in the Study Areas Setting

This technology is currently not used in the two study areas. Appropriate test locations could be selected to implement this technology. However, public meetings have to be organized as part of the safety outreach project and explain the advantages of this technology.

Estimated Cost

The cost is generally low and can range between $6.00 to $20.00 per item based on the type and category (armband, wristband, etc.) of the material used and vendor (source: www.breflective.com). However, a bulk retail purchase of these items can reduce the cost per item.

3.1.5 Pedestrian Self-Serve Crosswalk Flags

These low cost crosswalk flags are provided to pedestrians at the crossing. This technology is currently used in Hudson Falls, New York. This technology has all the advantages of the retro-reflective material.

The concerns with this technology are 1) to encourage pedestrians to use the flags for crossing and 2) to replace the stolen flags at crossing locations at regular intervals. Collector bins are generally provided at either end of the crosswalks as a storage space for the flags.

Figure 8: Picture of a Crossing Flag (Hudson Falls, New York)

<u>Estimated Cost</u>

The estimated cost of each flag generally varies from region to region and the type of flag used (plain or retro-reflective). The cost could vary between $2.00 to $3.00 per flag depending on the region and type of flag used (source: http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2001/05/10/MN200520.DTL).

3.1.6 Yield Here To Pedestrians and Stop Here For Pedestrians Signs (R1-5 Series)

Another low cost and effective crosswalk technology is the use of R1-5 series crosswalk signs at uncontrolled crosswalks on multi-lane approaches. The MUTCD – 2009 Edition and Section 3.8 of the Topic No. 750-000-005 provides additional information on the use of R1-5 series crosswalk signs.

The MUTCD states that these signs shall be used if yield or stop lines are used in advance of a marked crosswalk that crosses an uncontrolled multi-lane approach. These signs should be placed 20 to 50 feet in advance of the nearest crosswalk. According to the Section 3.8 of the Topic No. 750-000-005, R1-5 series shall not be used in combination with Rectangular Rapid Flashing Beacons (RRFB) Assembly or flashing beacons, In-Roadway Lighting, a Pedestrian Hybrid Beacon or traffic signal.

Figure 9: Picture of R1-5 Series Crosswalk Signs (source: MUTCD 2009 Edition)

Figure 10: Picture of R1-5a Crosswalk Sign in combination with Yield Lines (source: http://www.bouldercolorado.gov/index.php?option=com_content&view=article&id=963&Itemid=3625**)**

This technology has all the advantages of In-street Pedestrian Crosswalk Signs in addition to the following added advantage.

1. This low cost technology in combination with advance yield or stop lines can be effectively used to address the ***multiple threat crashes*** on milt-lane approaches. Multiple threat crashes involve a vehicle in one lane stopping to allow a pedestrian to cross the street while the driver of an oncoming vehicle travelling in the same direction, in an adjacent lane, strikes the pedestrian.

Technology in the Study Areas Setting

This technology is currently not used in both the study areas. However, appropriate test locations could be selected to implement and track the effectiveness of this technology. Refer to the MUTCD – 2009 Edition and Section 3.8 of the Topic No. 750-000-005 on selection guidance and additional information on this treatment.

Estimated Cost

The cost of this technology will vary with vendor and region. An estimated typical cost for a single sign is between $30.00 and $60.00 (source: www.ricesigns.com), based on the reflective material use. It should be noted that installation costs are not included in the above cost estimate.

3.2 ITS BASED TECHNOLGIES

A total of four (4) technologies were discussed as part of this study. The technologies described in the following paragraphs are tested at limited locations in the country. These technologies could be tested at appropriate locations in the two study areas, since the two (2) study areas consist of a mix of roadway and pedestrian characteristics that are suitable for testing these ITS based technologies. As such, a separate study should be conducted to determine if and where these ITS based technologies could be successfully implemented in the two (2) study areas.

3.2.1 In-Pavement Lighting

In-pavement lights are being used at crosswalks to alert motorists to the presence of a pedestrian crossing or pedestrians preparing to cross the street. The amber lights are embedded in the pavement on both sides of the crosswalk and oriented to face oncoming traffic.

When the pedestrian activates the system, either by using a push-button or through detection from an automated device, the lights begin to flash at a constant rate, warning the motorist that a pedestrian is in the vicinity of the crosswalk ahead.

Figure 11: Picture of In-Pavement Lighting on Livingston Street in Orlando (source: Google Maps)

The amber LED lights flash in unison at a rate designed for maximum motorist recognition and are visible during the daylight as well as at night. The flashing lights are only activated when a pedestrian wants to cross and are automatically shut off after a set period of time, i.e., the time required for a pedestrian to safely cross the street. If installed in conjunction with the means to detect the presence of pedestrians while in the crosswalk, the crossing interval can be extended, in which case the lights would continue to flash and allow slower pedestrians to safely cross.

This technology has the following advantages:

- Increases the visibility of the pedestrians, especially in locations where the crosswalks are inconspicuous and have insufficient lighting during night time conditions.
- Increases the number of vehicles yielding to pedestrians.
- Addresses the problem of pedestrians failing to yield to vehicles.

The primary concern with this technology is that the approaching motorist should have enough decision sight distance for the illuminated crosswalk. This technology is not suited for high speed high volume roadways because of this concern.

Technology in the Study Areas Setting

This technology is currently not used in the two study areas. Refer to Section 3.8 of the Topic No. 750-000-005 on selection guidance and additional information on this treatment. For guidance on installation and operation of this technology, refer to Section 4N of the MUTCD – 2009 Edition.

Estimated Cost

The total cost for this technology ranges from $15,000 to $40,000 (source: 3). The estimated costs depends on the width of the roadway and whether automatic detection is needed.

3.2.2 Activated Beacons

Flashing beacons could be installed on roadside poles and mast arms and only flash when a pedestrian activates the system, either by push button or automatic detection, as to obtain more effective response from motorists compared to continuously flashing beacons.

Once the system is activated, the flashing amber beacons provide a bright warning to motorists. Optional audible announcements could be provided to assist vision-impaired pedestrians.

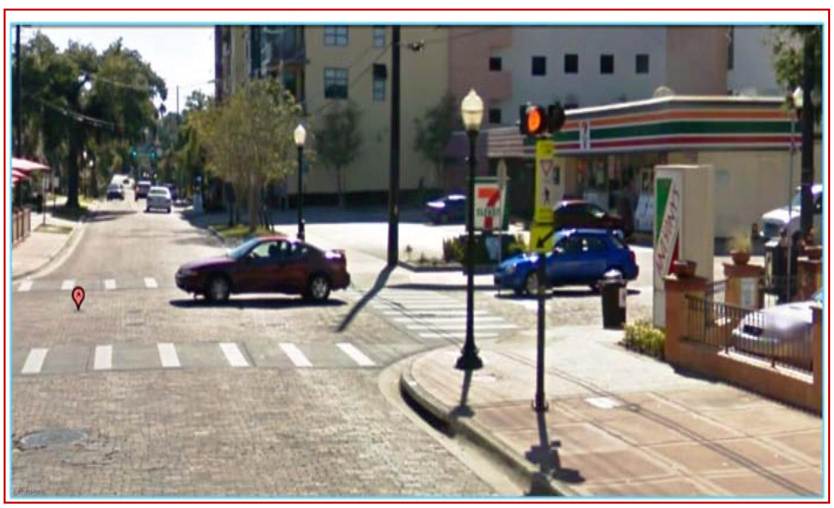


Figure 12: Picture of an Activated Beacon in combination with unsignalized pedestrian crosswalk sign (R1-6) (source: Google Maps)

This technology has the following advantages:

- Increases the driver alertness, especially at inconspicuous crosswalks.
- Increases the number of vehicles yielding to pedestrians.
- Addresses the problem of pedestrians failing to yield to vehicles.
- Could be solar powered to save energy costs.

Technology in the Study Areas Setting

This technology is currently not used in the two study areas. Refer to Section 3.8 of the Topic No. 750-000-005 on selection guidance and additional information on this treatment. For guidance on installation and operation of this technology, refer to Section 4L of the MUTCD – 2009 Edition.

Estimated Cost

The total cost for this technology is approximately $21,000.00 (for a push button activated) and $62,600.00 (for an automatic activation) (source: 1-C).

3.2.3 Rectangular Rapid Flashing Beacon (RRFB)

These flashing beacons are generally provided in pairs below the pedestrian crosswalk sign (W11-2) and operate in a wig-wag pattern.

The RRFB remains dark until a pedestrian activates the system by pressing a pushbutton. Once the system is activated, rapidly flashing amber beacon lights provide a bright warning to motorists.

Figure 13: Picture of RRFB (source: 4)

This technology has the following advantages:

- Increases the driver alertness, especially at inconspicuous crosswalks.
- Increases the number of vehicles yielding to pedestrians.
- Addresses the problem of pedestrians failing to yield to vehicles.
- Could be solar powered to save energy costs.
- Low maintenance costs.

Technology in the Study Areas Setting

This technology is currently not used in the two study areas. Section 3.8 of the Topic No. 750-000-005 states that this technology has found promising results from its use in St. Petersburg, Florida and looks promising for the two study areas. Please refer to Section 3.8 of the Topic No. 750-000-005 on selection guidance and additional information on this treatment.

Estimated Cost

The total cost for this technology is approximately $15,000.00 (source: 1-B).

3.2.4 High Intensity Activated Crosswalk (HAWK) Beacon

HAWK beacons could be installed on roadside poles and mast arms and remains dark until a pedestrian activates the system by pressing a pushbutton. Once the system is activated, a sequence of amber and red beacon lights provides a bright warning to motorists.

The system also provides a Pedestrian Signal Head and could be used as mid-block pedestrian signal.

Figure 14: Picture of HAWK Beacon (source: 4)

This technology has the following advantages:

- Increases the driver alertness, especially at inconspicuous crosswalks and at nighttime conditions.
- Increases the number of vehicles yielding to pedestrians.
- Addresses the problem of pedestrians failing to yield to vehicles.
- Optional synchronization with adjacent signalized intersections to maintain traffic flow
- Optional audible announcements assist sight-impaired pedestrians

Technology in the Study Areas Setting

This technology is currently not used in the two study areas. Currently there is no guidance on selection and operation of this technology in Section 3.8 of the Topic No. 750-000-005 or the MUTCD – 2009 Edition. However, a discussion on "Pedestrian Hybrid Beacon" in Section 3.8 of the Topic No. 750-000-005 and Chapter 4F of the MUTCD – 2009 Edition is similar to this technology and could be used for additional information.

Estimated Cost

The total cost for this technology is approximately $85,000.00 to $95,000.00 based on the current costs (source: http://www.kpvi.com/Global/story.asp?S=11606268).

4. CONCLUSIONS

S Atlantic Avenue in Daytona Beach Shores and CR A1A in New Smyrna Beach run directly along the Atlantic Ocean and are famous for their beaches that reside along these two roadway segments. Tourists visiting the beaches and local population extensively use the existing crosswalks that are provided along these two roadway segments. Numerous crosswalks currently exist in the two (2) study areas at major intersections, beach ramps and mid-blocks with potential pedestrian activity. In general, pedestrian crosswalk signs are placed at all the crosswalk locations in the two (2) study areas. Some locations (Hiles Boulevard, Toronita Avenue and Marcelle Avenue) are provided with flashing beacons to enable safe pedestrian crossings. Some locations (example: Hiles Boulevard) have In-street pedestrian crosswalk sings to remind the motorists the right-of-way laws in the crosswalks.

However, the need to make the existing crosswalk locations safe, more pedestrian friendly and eliminate potential pedestrian-vehicle conflicts, this study researched several state of the art pedestrian crosswalk technologies used in other parts of the United States, that can specifically be used in the two study areas. The main focus of this study is to document feasible and innovative crosswalk technologies that can be implemented in the two (2) study areas, with emphasis on improving the visibility of pedestrians in crosswalks and achieve driver yield rate to pedestrians at uncontrolled crosswalk locations.

The study provided a total of ten (10) crosswalk technologies, out of which, six (6) are engineering technologies and the remaining four (4) are ITS based technologies. Some of the engineering technologies, such as In-street Pedestrian Crosswalk Signs and Median Refuge Islands are already used in the two study areas. However, the use of the individual or combination of technologies discussed in this study could enhance the pedestrian safety and help reduce potential pedestrian-vehicle conflicts. Nevertheless, a separate study should be conducted to determine if and where a particular crosswalk technology can be successfully implemented, taking into consideration the study areas setting. The new study should focus on feasible crosswalk technologies that can be implemented in the study areas consistent with the conditions set forth in the MUTCD – 2009 Edition and Section 3.8 of the Topic No. 750-000-005 and that have the potential to address the pedestrian crosswalk related issues specific to the two study areas.