EVALUATION OF INNOVATIVE SAFETY TREATMENTS

Volume 5: A Study of the Effectiveness of Countdown Pedestrian Signals

Prepared for

Florida Department of Transportation
State Safety Office

Contract Number B-D500
Financial Project I.D. 406865-1-B2-04
Evaluation of Innovative Safety Treatments
HNTB Project Number 40502-PL-009

Prepared by

HNTB Corporation
6363 NW 6th Way, Suite 420
Fort Lauderdale, Florida 33309

Wayne State University
Transportation Research Group
Detroit, Michigan 48202

January 2008

DISCLAIMER

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle EVALUATION OF INNOVATIVE SAFETY TREATMENTS A Study of the Effectiveness of Countdown Pedestrian Signals		5. Report Date January 2008 6. Performing Organization Code
7. Author(s) Vivek Reddy, Tapan Datta, Peter Savolainen, Satya Pinapaka		8. Performing Organization Report No. 40502-PL-009-001
9. Performing Organization Name and Address HNTB Corporation 6363 NW 6th Way, Suite 420 Fort Lauderdale, Florida 33309		10. Work Unit No. (TRAIS) 11. Contract or Grant No. B-D500
12. Sponsoring Agency Name and Address Florida Department of Transportation 605 Suwannee Street, MS 30 Tallahassee, FL 32399		13. Type of Report and Period Covered Final June 2006-January 2008 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The Florida Department of Transportation (FDOT), the Broward County Traffic Engineering Division and the City of Boca Raton replaced traditional pedestrian signals at eight intersections located in the South Florida area with countdown pedestrian signals. The countdown pedestrian signal is comprised of the same three indications as the conventional pedestrian signal. The flashing “Don’t Walk” indication, however, is complemented by an illuminated number indicating the number of seconds before the steady “Don’t Walk” indication will be illuminated and thus provides feedback to pedestrians on the time remaining in their crossing. By advising the pedestrian of the remaining seconds before the “Don’t Walk” indication will be illuminated, the pedestrian can make a decision on his or her ability to safely cross the street in the available time. As such, the countdown signals are expected to improve compliance with pedestrian indications and enhance pedestrian safety.

A before and after evaluation methodology was utilized to determine the effectiveness of countdown pedestrian signals by comparing pedestrian behavior data collected before and after the installation of countdown pedestrian signals. Several measures of effectiveness (percentage of pedestrians initiating crossing during “Walk,” flashing “Don’t Walk” and steady “Don’t Walk” indications, and the percentage of successful crossings) were evaluated. The results of this evaluation indicated that the pedestrian countdown signals were effective in increasing the percentage of successful crossings and decreasing the percentage of pedestrians who initiate crossing during the flashing “Don’t Walk” indication. However, the percentage of pedestrians entering during the steady “Don’t Walk” indication increased at some locations. Since the results are based on only eight intersections, further research is recommended to confirm the findings from this study. In addition, it is recommended that pedestrian crash data at the study intersections be compared once sufficient crash data for the after period become available to quantify the impacts of countdown signals on pedestrian safety.

17. Key Word	18. Distribution Statement
Safety, Pedestrian, Countdown signal	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	35	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized.

ACKNOWLEDGMENTS

This research project was sponsored by the Florida Department of Transportation (FDOT). The research was conducted by Mr. Vivek Reddy of HNTB Corporation and Dr. Tapan Datta of the Transportation Research Group, Wayne State University. The researchers would like to acknowledge the support and guidance provided by the FDOT project manager, Mr. Patrick Brady. The researchers would also like to acknowledge the assistance of Mr. John Klienedler of the Broward County Traffic Engineering Division, Mr. Rick Mitinger of the FDOT District 4 Traffic Operations Office, and Mr. Emmanuel Posadas of the City of Boca Raton Traffic Engineering Division.

Executive Summary

Approximately 500 pedestrians are killed and 8,000 are injured in traffic crashes every year in Florida. A combination of pedestrian and driver actions contribute to pedestrian crashes. Common driver actions associated with pedestrian crashes include failure to yield to pedestrians, inattention, and speeding. Such pedestrian actions include crossing the street at inappropriate locations or violating the flashing “Don’t Walk” and steady “Don’t Walk” indications.

The various indications on traditional pedestrian signal heads (“Walk,” flashing “Don’t Walk,” and steady “Don’t Walk”) are not universally understood. While the “Walk” indication is straightforward, the flashing “Don’t Walk” is misinterpreted by a significant portion of the pedestrian population. The steady “Don’t Walk” and flashing “Don’t Walk” are frequently confused. Some pedestrians think that the flashing “Don’t Walk” indication means that they should quickly complete their crossing or even return to the sidewalk. Given that the flashing and steady “Don’t Walk” intervals dominate the typical cycle, pedestrians who are unclear on what each indication means may become impatient and cross contrary to the pedestrian indication, thus increasing the potential for pedestrian-vehicular conflicts and crashes.

In recent years, several innovative pedestrian safety treatments have been developed and implemented in various cities throughout the United States to improve pedestrian safety by raising motorist awareness and providing feedback to pedestrians. Such treatments include illuminated pushbuttons, animated eye displays, in-pavement lighting and countdown pedestrian signals.

The countdown pedestrian signal is comprised of the same three indications as the conventional pedestrian signal. The flashing “Don’t Walk” indication, however, is complemented by an illuminated number indicating the number of seconds before the steady “Don’t Walk” indication will be illuminated. The signal head counts down the seconds of what would traditionally be the flashing “Don’t Walk” interval and thus provides feedback to pedestrians on the time remaining in their crossing. By advising the pedestrian of the remaining seconds before the “Don’t Walk” indication will be illuminated, the pedestrian can make a decision on his or her ability to safely cross the street in the available time. As such, the countdown signals are expected to improve compliance with pedestrian indications and enhance pedestrian safety.

The Florida Department of Transportation (FDOT), the Broward County Traffic Engineering Division and the City of Boca Raton replaced traditional pedestrian signals at several intersections located in the South Florida area (Broward and Palm Beach Counties) with countdown pedestrian signals. The study intersections represent a variety of land use characteristics, traffic circulation patterns and levels of pedestrian activities. A majority of the study locations are large intersections with multi-lane approaches and the average daily traffic volumes range from 19,000 to 65,000 vehicles/day. The pedestrian crossing distances range from 38 feet to 131 feet.

The primary purpose of this study was to determine the effectiveness of countdown pedestrian signals by comparing crash data and pedestrian behavior data collected at each of the study intersections before and after the installation of countdown pedestrian signals.

Since sufficient crash data for the after period were not available, several surrogate measures (percentage of pedestrians initiating crossing during "Walk," flashing "Don't Walk" and steady "Don't Walk" indications, and the percentage of successful crossings) were utilized to quantify the impacts of the countdown pedestrian signals. Pedestrian behavior data were collected before and after the installation of countdown signals at the study intersections between June 2006 and October 2007 at different times of the day and for various days of the week. A total of 58 studies were conducted, of which 36 were conducted before the installation of countdown signals and 22 were conducted after the installation of countdown signals. A total of 3,734 pedestrian movements (2,479 in the before period and 1,255 in the after period) were observed at the study intersections.

Several statistical tests were conducted to determine whether the changes observed in the measures of effectiveness are attributable to the installation of the countdown signals. A summary of the findings is as follows:

- Overall, the results of the study show that there was a slight increase in the percentage of pedestrian compliance with the "Walk" indication from 55.03% to 56.33%. However, the increase was not statistically significant. The analysis by intersection indicates that the percentage of pedestrian compliance at three of the study intersections significantly increased, while three of the study intersections experienced reduced compliance rates.
- The countdown signals significantly reduced the proportion of pedestrians crossing during the flashing "Don't Walk" indication from 13.70% during the before period to 8.13% during the after period. The countdown pedestrian signals provide feedback to pedestrians on the time remaining to cross. Pedestrians appear to use this information to assess their ability to cross the street and consequently, appeared to make better decisions on whether or not to

initiate crossing, as indicated by the smaller proportion of pedestrians crossing during the "Don't Walk" phase.

- The percentage of pedestrians entering the crosswalk during the steady "Don't Walk" interval increased from 31.26% to 35.54% (all intersections combined). The analysis by intersection indicates that the proportion of pedestrians crossing during the steady "Don't Walk" phase decreased at one intersection and increased at three intersections. Field observations revealed that pedestrians generally crossed during the steady "Don't Walk" indication when gaps were present in the oncoming traffic or began crossing early, often during the side street left-turn phase, especially at major intersections. In addition, other factors such as the size of intersection, the availability of gaps in oncoming traffic, whether or not the clearance intervals are adequate, and type of pedestrian activity may influence pedestrian behavior related to crossing during the steady "Don't Walk" indication. Further research is warranted to verify the reasons for this pedestrian behavior.
- The percentage of successful crossings (all intersections combined) increased significantly, from 56.15% to 63.27%. The analysis by intersection indicates that the proportion of successful crossings significantly increased at three intersections and decreased at one intersection. It appears that pedestrians are able to more easily assess their likelihood of a successful crossing due to the countdown timers and it is likely that pedestrians might have quickened their steps as they saw the remaining time winding down.
- Sufficient data was not available at the time of this report that would allow for an assessment of the impact of the countdown signals on driver behavior, specifically in regard to red light running and associated crashes. As crash data for the after period becomes available, these particular issues can be addressed by comparing crash rates between the before and after periods. Previous research has shown that countdown signals had no significant impacts on vehicular traffic.

Overall, the pedestrian countdown signals seem to be effective in increasing the percentage of successful crossings and decreasing the percentage of pedestrians who initiate crossing during the flashing "Don't Walk" indication. However, the percentage of pedestrians entering during the steady "Don't Walk" indication increased at some locations. Since the results are based on only eight intersections, further research is recommended to confirm the findings from this study. In addition, it is recommended that the frequency and rate of pedestrian crashes at the study intersections be examined once sufficient crash data for the after period become available to quantify the impacts of countdown signals on pedestrian safety.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

In 2006, a total of 8,346 pedestrian crashes occurred in the State of Florida, resulting in 7,754 injuries and 546 fatalities (1). A combination of pedestrian and driver actions contribute to these crashes. Common driver actions associated with pedestrian crashes include failure to yield to pedestrians, inattention, and speeding. Such pedestrian actions include crossing the street at inappropriate locations or violating the flashing “Don’t Walk” and steady “Don’t Walk” indications.

The various indications on traditional pedestrian signal heads (“Walk,” flashing “Don’t Walk,” and steady “Don’t Walk”) are not universally understood. While the “Walk” indication is straightforward, the flashing “Don’t Walk” is misinterpreted by a significant portion of the pedestrian population. The steady “Don’t Walk” and flashing “Don’t Walk” are frequently confused. Some pedestrians think that the flashing “Don’t Walk” indication means that they should quickly complete their crossing or even return to the sidewalk. Given that the flashing and steady “Don’t Walk” intervals dominate the typical cycle, pedestrians who are unclear on what each indication means may become impatient and cross contrary to the pedestrian indication, thus increasing the potential for pedestrian-vehicular conflicts and crashes.

In recent years, several innovative pedestrian safety treatments have been developed and implemented in various cities throughout the United States to improve pedestrian safety by raising motorist awareness and providing feedback to pedestrians. Such treatments include illuminated pushbuttons, animated eye displays, in-pavement lighting and countdown pedestrian signals.

The countdown pedestrian signal is comprised of the same three indications as the conventional pedestrian signal. The flashing “Don’t Walk” indication, however, is complemented by an illuminated number indicating the number of seconds before the steady “Don’t Walk” indication will be illuminated. The signal head counts down the seconds of what would traditionally be the flashing “Don’t Walk” interval. The purpose of the countdown pedestrian signal is to provide feedback to pedestrians on the time remaining in their crossing. By advising the pedestrian of the remaining seconds before the “Don’t Walk” indication will be illuminated, the pedestrian can make a decision on his or her ability to safely cross the street in the available time. As such, the countdown signals are expected to improve compliance with pedestrian indications and enhance pedestrian safety.

2.0 LITERATURE REVIEW

Several studies investigated the impact of countdown pedestrian signals on pedestrian and motorist behavior. Many of these studies are based on relatively small sample sizes, and some of the findings are not supported by appropriate statistical analysis. The following is a brief summary of the findings from past studies on countdown pedestrian signals.

The results of a before and after observational study performed by Eccles, Tao and Mangum (2) in Montgomery County, Maryland indicated that countdown pedestrian signals had no effect on vehicle approach speeds during the pedestrian clearance interval, increased the number of pedestrians who entered on the "Walk" indication, and significantly decreased pedestrian-vehicle conflicts. Additionally, the authors stated that the pedestrians interviewed were aware of and understood the countdown pedestrian signals correctly.

An evaluation of countdown signals conducted by Leonard and Jukes (3) using the data only for after period, which does not allow for a comparative analysis, found that countdown signals discourage pedestrians from crossing at the end of the indication, encourage pedestrians to cross at faster speeds, and did not encourage motorists to use the countdown signals to anticipate signal changes. However, documentation of the statistical significance of these findings was not provided in the published paper.

A comparative parallel study by Huang and Zegeer (4) was conducted in Lake Buena Vista, Florida at two test intersections with countdown pedestrian signals and three control intersections with traditional pedestrian signals. This study found a reduction in the number of pedestrians who started running when the flashing "Don't Walk" signal appeared, reduction in compliance with the "Walk" indication, and no effect on the number of pedestrians who ran out of time while crossing.

A before and after study was conducted by Markowitz, Sciortino, Fleck and Bond (5) in San Francisco, California to assess the effectiveness of 14 intersections with countdown pedestrian signals. This study found that countdown signals reduced pedestrian crashes and injuries, reduced the proportion of pedestrians finishing crossing on the red signal, and were viewed favorably by pedestrians.

A study by the Minnesota Department of Transportation (6) found that crosswalk modifications at five sites that included pedestrian countdown signals increased "successful crossings" from 67 % to 75 %. Furthermore, the incidence of pedestrians starting on the flashing "Don't Walk" or steady "Don't

Walk” indication and finishing after the “Don’t Walk” display, increased from 6 to 12 %. The study stated that a majority of pedestrians indicated that they understood the meaning of the countdown signals.

An evaluation study conducted in San Francisco (7) indicated that the number of pedestrians clearing the intersection after the flashing “Don’t Walk” phase decreased significantly after the installation of countdown signals. The report suggests that the higher incidence of successful crossings is mostly attributed to pedestrians quickening their pace in response to the countdown display. The study reports a slight decrease in the incidence of pedestrians entering on the flashing “Don’t Walk”, as well as decreases in pedestrian/vehicle conflicts and erratic pedestrian behavior in the crosswalk.

A study conducted in Quebec indicates that the presence of countdown signals reduced pedestrian/traffic conflicts (8). Specific data supporting this conclusion was not included in the report. As such, the actual significance of the reduction is unclear.

A research study conducted by Huang and Zegeer for the Federal Highway Administration (9) indicates that pedestrian countdown signals installed at test sites in Sacramento County, California had a negative rather than positive impact on pedestrian safety. The study found that the proportion of pedestrians who complied with the “Walk” phase decreased for 82 % to 68 %, and the proportion of pedestrians finishing after time ran out increased from 11 % to 17 %. The study also stated that the signal might be inducing pedestrians to enter the crossing on the flashing “Don’t Walk” indication. The study concludes that the percentage of pedestrians conflicting with oncoming traffic increased significantly, pedestrian countdown signals need further testing to ascertain their effects, and that alternatives other than countdown signals can be more effective in improving pedestrian safety.

Botha, Zabyshny and Day (10) conducted a study of four test intersections (with countdown pedestrian signals) and two control intersections in San Jose, California. The authors found a significant increase in the proportion of pedestrians crossing during the flashing “Don’t Walk” indication, a significant decrease in the proportion of pedestrians that arrived during the flashing “Don’t Walk” and waited for the “Walk” indication to cross, a negligible difference in pedestrian walking speeds, and relatively small differences in pedestrian-vehicle conflicts.

A study conducted by Schattler and Datta (11) assessed the effects of countdown signals on pedestrian and motorist behavior at five test intersections equipped with countdown pedestrian signals, and five control intersections equipped with traditional pedestrian signals in Peoria, Illinois. The results of the study indicated that the use of countdown signal increased compliance with pedestrian signals. This study also showed that a very small percentage of pedestrians were observed running and the difference between test and control locations was not significant. The red and yellow light running characteristics were not different at the test and control intersections.

In terms of pedestrian behavior there seems to be mixed results among the studies, while in terms of motorist behavior the general consensus is that no negative impacts were observed.

3.0 COUNTDOWN PEDESTRIAN SIGNAL TREATMENT

The Florida Department of Transportation (FDOT), the Broward County Traffic Engineering Division and the City of Boca Raton replaced traditional pedestrian signals at several intersections located in the South Florida area (Broward and Palm Beach Counties) with countdown pedestrian signals. The 14 intersections scheduled for countdown signal installations are shown in Table 1. However, as of today, only eight of these intersections have been upgraded with countdown signals and the last six intersections listed in the table still have traditional pedestrian signals. Therefore, the before/after analyses were conducted using the data from the eight intersections equipped with countdown signals. Aerial photographs of these intersections are shown in Figures 1 to 4. The study intersections represent a variety of land use characteristics, traffic circulation patterns and levels of pedestrian activities. With the exception of the SR A1A/Bayshore Drive intersection, all of the study intersections are four-legged intersections. A majority of the study locations are large intersections with multi-lane approaches and the average daily traffic volumes on major streets range from 19,000 to 65,000 vehicles/day. The pedestrian crossing distances range from 38 feet to 131 feet.

The primary purpose of this study was to determine the effectiveness of countdown pedestrian signals by comparing crash data and pedestrian behavior data collected at each of the study intersections before and after the installation of countdown pedestrian signals.

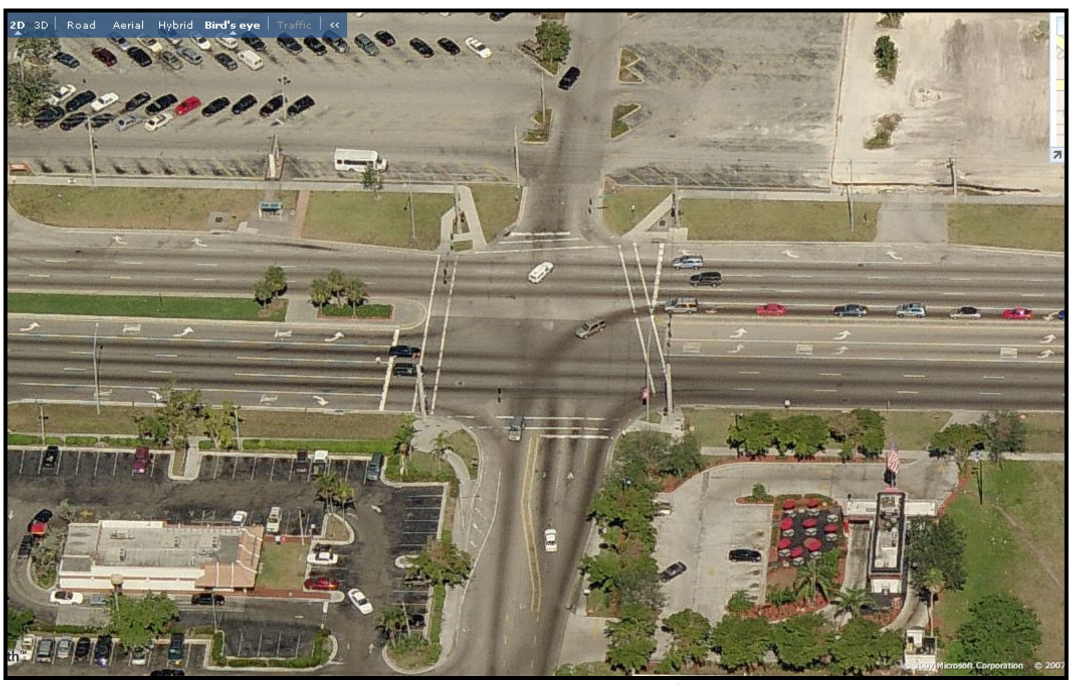
TABLE 1: List of Study Intersections

No.	Intersection	City	Average Daily Traffic (ADT)	Countdown Pedestrian Signal Installation Date
1	Oakland Park Boulevard at Inverrary Boulevard (NW 56 th Avenue)	Lauderhill	47,000*	March 2007
2	Oakland Park Boulevard at NW 55th Avenue	Lauderhill	64,833*	March 2007
3	NW 2nd Avenue at NW 2nd Street	Boca Raton	10,957*	July 2007
4	US 1 at SE 17th Street Causeway	Fort Lauderdale	108,667	March 2007
5	US 1 at Broward Boulevard	Fort Lauderdale	89,667	July 2007
6	Broward Boulevard at NE/SE 3rd Avenue	Fort Lauderdale	36,667*	July 2007
7	SR A1A at Bayshore Drive	Fort Lauderdale	35,000*	July 2007
8	US 1 at Commercial Boulevard	Fort Lauderdale	82,500	October 2007
9	Davie Boulevard at Andrews Avenue	Fort Lauderdale	34,333*	Not Installed
10	Davie Boulevard at SE 3rd Avenue	Fort Lauderdale	18,900*	Not Installed
11	Davie Boulevard at SW 4th Avenue	Fort Lauderdale	34,333*	Not Installed
12	Davie Boulevard at SW 9th Avenue	Fort Lauderdale	34,333*	Not Installed
13	Palmetto Park Road at Dixie Highway	Boca Raton	29,590*	Not Installed
14	US 441 at Commercial Boulevard	Fort Lauderdale	112,500	Not Installed

Notes:

1) * indicates ADT on major street only

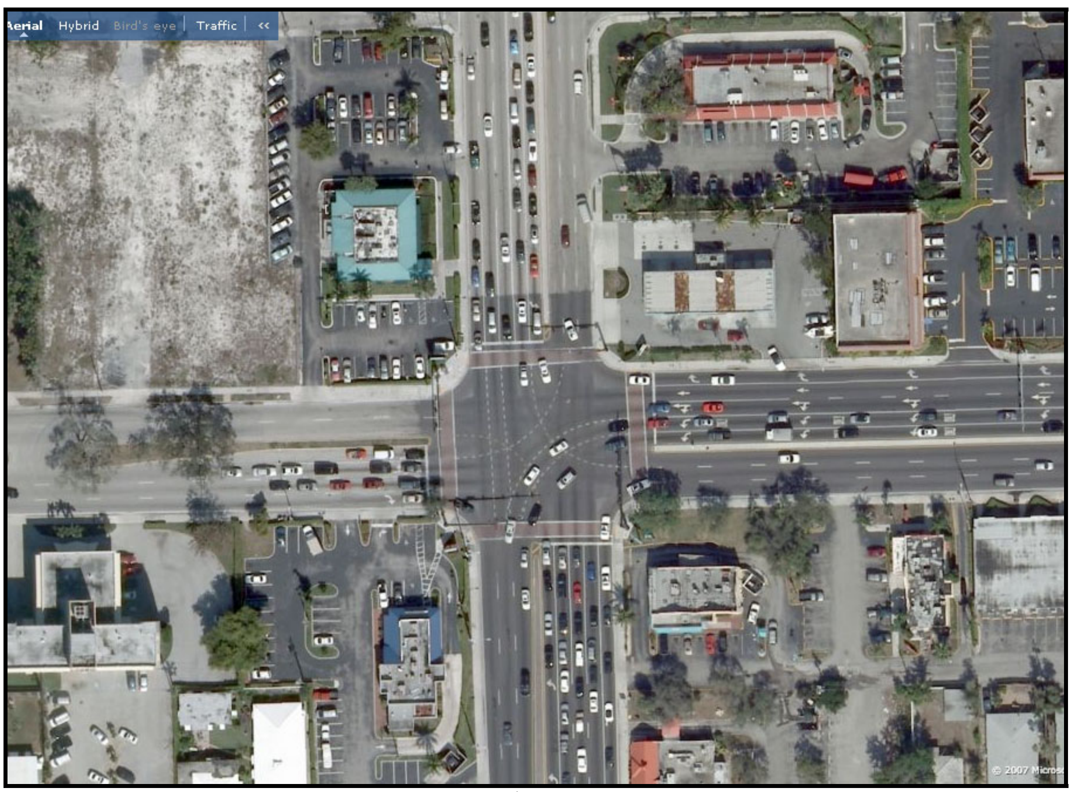
Oakland Park Boulevard at Inverrary Boulevard



Oakland Park Boulevard at NW 55th Avenue

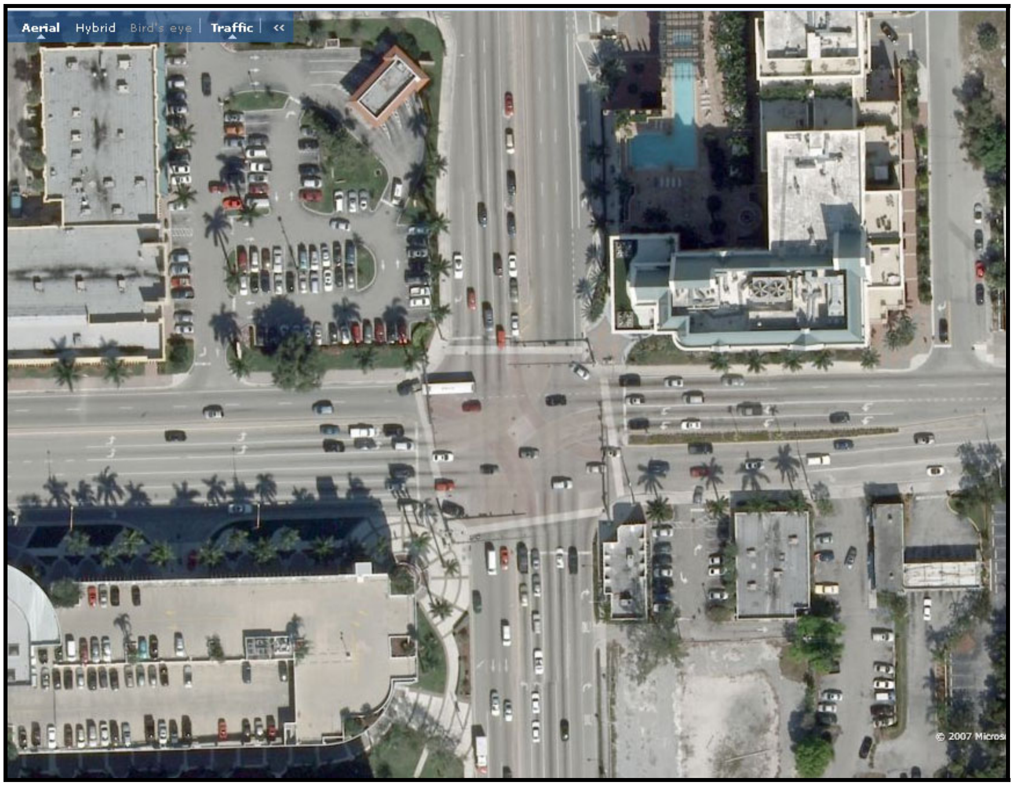
Figure 1. Study Intersection Aerial Photographs (Source: http://maps.live.com)

NW 2nd Avenue at NW 2nd Street

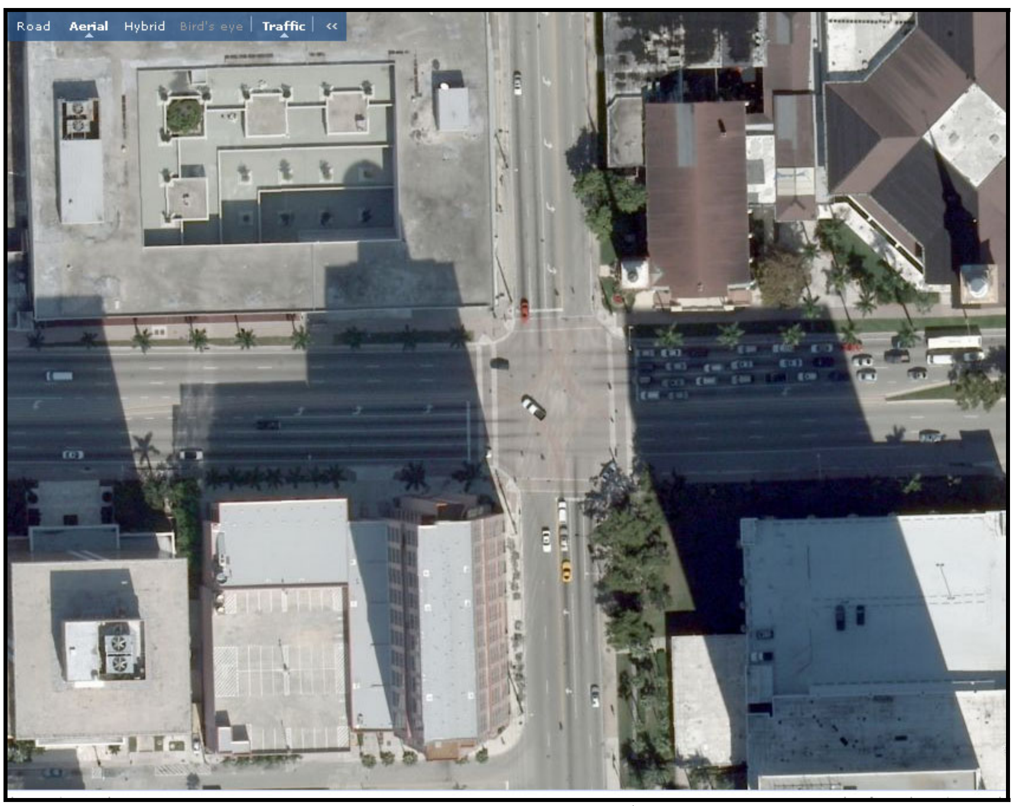


US 1 at SE 17th Street Causeway

Figure 2. Study Intersection Aerial Photographs (Source: http://maps.live.com)

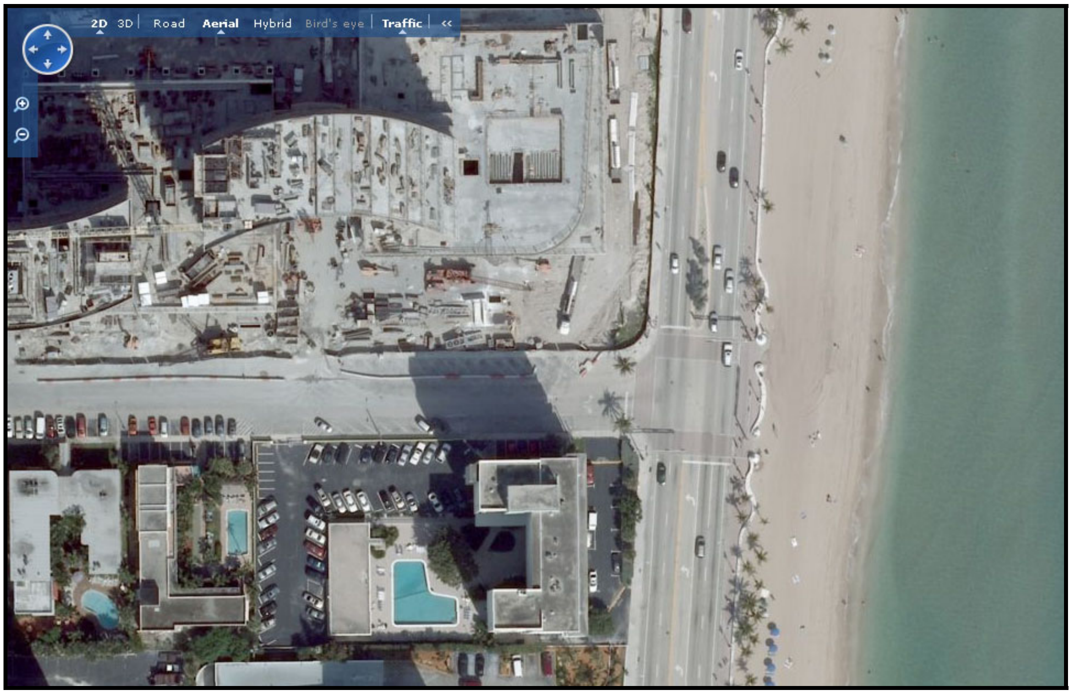


US 1 at Broward Boulevard



Broward Boulevard at NE/SE 3rd Avenue

Figure 3. Study Intersection Aerial Photographs (Source: http://maps.live.com)



SR A1A at Bayshore Drive

US 1 at Commercial Boulevard

Figure 4. Study Intersection Aerial Photographs (Source: http://maps.live.com)

4.0 STUDY METHODOLOGY

In order to evaluate the effectiveness of the countdown pedestrian signals, a before and after evaluation methodology was utilized as illustrated in Figure 5. The before period was defined as the period prior to the installation of the countdown pedestrian signals. The after period was defined as the period after the installation of the countdown signals.

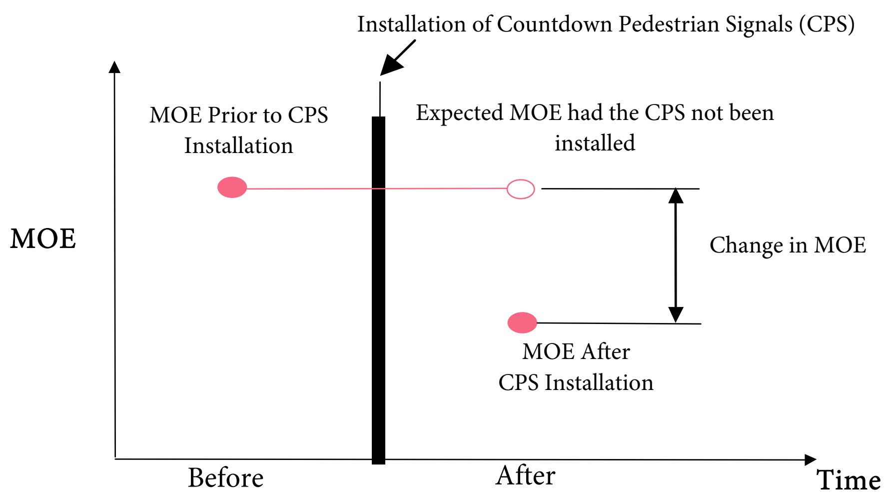


Figure 5. Before and After Evaluation Plan

Comparative analyses of various measures of effectiveness (MOE) were conducted to determine the impact of countdown signals on pedestrian/motorist behavior and crashes.

Crashes

Observed changes in the number of crashes or crash rates are generally used as a direct measure of changes in traffic safety. Crash frequencies of pedestrian crashes for the before and after periods can be compared to determine the impact of countdown pedestrian signals on pedestrian safety. Crash data for the before period (years 2003 to 2005) were obtained from the FDOT Crash Analysis and Reporting System (CARS) for those study intersections that are located on the state highway system. Crash statistics for all crashes and pedestrian crashes are presented in Table 2.

The countdown pedestrian signals were installed at the study intersections between March and October 2007. Consequently, sufficient crash data for the after period is not yet available. Therefore, surrogate measures of safety are instead utilized to quantify the impacts of the countdown pedestrian signals. Specifically, pedestrian compliance and the percentage of successful crossings are examined as explained in the following paragraphs.

TABLE 2: Crash Statistics for Before Period

Number	Study Intersection	All Crashes (2003-2005)	Pedestrian Crashes (2003-2005)
1	Oakland Park Blvd at NW 55th Avenue	87	4
2	Oakland Park. Blvd At Inverrary Blvd.	57	0
3	US 1 at SE 17th Street Causeway	82	4
4	US 1 at Broward Blvd	71	1
5	Broward Blvd at NE/SE 3rd Avenue	40	2
6	SR A1A at Bayshore Drive	13	2
7	US 441 at Commercial Boulevard	118	9
8	Davie Blvd at SW 9th Avenue	36	0
9	Davie Blvd at NW-SW 4th Avenue	29	0
10	Davie Blvd at Andrews Avenue	39	2
11	Davie Blvd at SE 3rd Avenue	13	1
12	Commercial Blvd at US 1	91	1

Pedestrian Compliance

The condition of pedestrian compliance is met if a pedestrian starts crossing on the "Walk" indication and does not start crossing once the flashing "Don't Walk" indication is illuminated. The proportion of pedestrian compliance with the "Walk," flashing "Don't Walk" and steady "Don't Walk" indications before and after the installation of countdown signals were compared.

Successful Crossings

For the purpose of this study, the crossing is considered successful if the pedestrian initiated the crossing in accordance with the signal and reached the opposite side before the steady "Don't Walk" is illuminated. The pedestrian clearance interval is generally set to allow a pedestrian to cross the street walking at speeds of 3 to 4 feet per second. A pedestrian should therefore be able to leave the curb at the end of the "Walk" indication and arrive at the opposite side before the steady "Don't Walk" is illuminated. The countdown timer should enhance a pedestrian's ability to gauge whether or not to initiate the crossing based on his or her own assessment of his or her ability to cross within the remaining time indicated on the countdown timer. It is possible that the pedestrian will modify his or her crossing speed as the ensuing steady "Don't Walk" indication is approaching, and as such, countdown signals may help pedestrians successfully complete the crossing.

Thus, the measures of effectiveness (MOEs) selected for this study were as follows:

- Pedestrian Compliance
    - Percentage of crossings initiated during the steady "Don't Walk" indication
    - Percentage of crossings initiated during the flashing "Don't Walk" indication
    - Percentage of crossing violations (the sum of the two preceding MOEs)
    - Percentage of crossings initiated during the "Walk" indication (i.e., crossings consistent with pedestrian signals)
- Successful Crossings
    - Percentage of successful crossings (i.e., completed prior to the steady "Don't Walk" indication)
    - Percentage of unsuccessful crossings (i.e., completed after onset of the steady "Don't Walk" indication)

5.0 DATA COLLECTION

The data collection team obtained signal-timing data (see Table 3) from the signal maintaining agencies (the Broward County Traffic Engineering Division and the City of Boca Raton) prior to initiating field data collection activities. The Broward County Traffic Engineering Division (BCTED) is in the process of upgrading the clearance intervals in the entire county in accordance with current MUTCD guidance (Page 4E-9, 2003 edition), which states that the pedestrian clearance time should be sufficient to allow a pedestrian who left the curb during the 'Walk" indication to travel at a walking speed of 4 feet/second, to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait. As part of this timing upgrade program, the BCTED increased pedestrian clearance intervals at three of the study intersections (locations 1, 4 and 6, from Table 3) after pedestrian data for the before period were collected at these locations. At the remaining study locations, pedestrian clearance intervals were unchanged during the study period.

TABLE 3: Crossing Distance and Pedestrian Clearance Intervals

Number	Intersection	Crossing Distance (ft)				Existing Pedestrian Clearance Interval (sec)			
		Approach				Approach			
		N	S	E	W	N	S	E	W
1	Oakland Park Boulevard at NW 55th Avenue	62	77	131	121	15	15	27	27
2	Oakland Park Boulevard at Inverrary Boulevard	66	67	118	111	21	21	31	31
3	NW 2nd Avenue at NW 2nd Street	48	54	74	80	20	20	12	10
4	US 1 at SE 17th Street Causeway	99	106	95	99	18	18	17	17
5	US 1 at Broward Boulevard	105	105	93	106	24	24	25	25
6	Broward Boulevard at NE/SE 3rd Avenue	65	71	105	91	15	15	20	20
7	SR A1A at Bayshore Boulevard	71	67	N/A	60	15	15	N/A	15
8	US 1 at Commercial Boulevard	116	115	99	94	24	23	25	25

The data collection team visited each study location to measure crosswalk distances, look for good vantage points for observing pedestrian movements and to determine peak periods for pedestrian activity based on the surrounding developments.

Once the peak pedestrian periods were identified, the data collection team collected pedestrian behavior data during the peak period both before and after the installation of countdown pedestrian signals.

Observations were recorded on a field observation form, a sample of which is shown in Figure 6. After noting the start and end times of the observation period, date of the study, and weather conditions, the field personnel recorded pedestrian activities on the observation form. They also kept track of general observations, such as the presence of construction, occurrence of crashes, and police stops.

In the first row, the field personnel tallied the number of pedestrians who initiated a crossing during the steady “Don’t Walk” indication. This number indicates the number of pedestrians who blatantly violated the signal indication.

In the second row, the field personnel would indicate the number of pedestrians who initiate a crossing during the “Walk” indication. This number represents the number of individuals who are crossing in compliance with the signal indication.

The third row was used to record the number of pedestrians who initiated crossing during the flashing “Don’t Walk” indication. Pedestrians who enter the crosswalk during the flashing “Don’t Walk” indication were also classified as “violators” and the total number of “violating” pedestrians was obtained by summing the values in rows 1 and 3.

In the fourth row, the field personnel recorded the number of pedestrians who reach the opposite side prior to the steady “Don’t Walk” indication. This number indicates the number of successful crossings.

The fifth row was used to record the number of pedestrians who reached the opposite side of the street during the steady “Don’t Walk” indication. This number indicates the number of unsuccessful crossings.

In addition to each of the previously explained data entry fields, the field personnel also recorded, to the extent possible, any other qualitative observations related to pedestrian or driver behavior that was applicable for this evaluation study.

Field Observation Form

Study Intersection: ____

Study Approach: ____

Start Time: ___________ End Time: ____________ Date: __________

Weather Conditions: ____

Notes: ____

No	Pedestrian/Vehicle Action	Cycle				
		1	2	3	4	5
1	No. of pedestrians initiated crossing during steady “Don’t Walk” indication					
2	No. of pedestrians initiated crossing during “Walk” indication					
3	No. of pedestrians initiated crossing during flashing “Don’t Walk” indication					
4	No. of pedestrians reaching opposite side prior to steady “Don’t Walk” indication (successful crossing)					
5	No. of pedestrians reaching opposite side after steady “Don’t Walk” indication (unsuccessful crossing)					

FIGURE 6: Sample Field Observation Form

A total of 58 studies were conducted between June 2006 and October 2007 at different times of the day and for various days of the week to observe pedestrian behavior at each of the study intersections. Thirty six (36) of these studies were conducted before the installation of countdown signals and 22 were conducted after the installation of countdown signals. The dates and times during which field studies were conducted are presented in Table 4 and Table 5 for the before and after periods, respectively. A total of 3,734 pedestrian movements (2,479 in the before period and 1,255 in the after period) were observed at the study intersections.

The data collected is summarized in Tables 6 and 7. As can be seen from these tables, during both the before and after periods, a substantial proportion of pedestrians crossed during the flashing "Don't Walk" and steady "Don't Walk" indications even though it should have been apparent that entering the crosswalk during this time was prohibited.

The results of the studies indicate that after the installation of countdown signals, the percentage of pedestrian compliance with the "Walk" indication increased slightly from 55.03% to 56.33% and the non-compliance (percentage of crossing initiated during the flashing and steady "Don't Walk" indications) was reduced from 44.97% to 43.67%. The percentage of successful crossings increased from 56.15% to 63.27%.

TABLE 4: Data Collection Schedule for Before Period

No	Intersection	Date	Time
1	Davie Boulevard at Andrews Avenue	6/30/2006	4:00-5:30 PM
		7/11/2006	12:00-2:30 PM
2	Davie Boulevard at SE 3rd Avenue	7/5/2006	12:00-2:00 PM
		7/11/2006	4:00-6:45 PM
3	Davie Boulevard at SW 4th Avenue	6/30/2006	2:00-3:00 PM
4	Davie Boulevard at SW 9th Avenue	7/5/2006	4:00-6:15 PM
		7/12/2006	12:00-3:00 PM
		7/12/2006	4:00-6:30 PM
		9/19/2006	4:15-6:15PM
		12/5/2006	11:45 AM-1:30 PM
5	Oakland Park Boulevard at NW 55th Avenue	6/28/2006	4:00-6:25 PM
		6/29/2006	7:11-9:40 AM
		6/29/2006	12:00-2:00 PM
		6/29/2006	4:00-6:20 PM
6	Oakland Park Boulevard at Inverrary Boulevard	6/28/2006	12:40-2:00 PM
		12/11/2006	12:30-2:30 PM
7	NW 2nd Avenue at NW 2nd Street	7/13/2006	4:00-5:25 PM
		7/14/2006	12:00-2:30 PM
8	Palmetto Park Road at Dixie Highway	7/13/2006	12:00-2:30 PM
		4/5/2007	12:00-2:30 PM
9	US 1 at SE 17th Street Causeway	6/28/2006	7:05-7:40 AM
		6/30/2006	12:00-12:30 PM
		9/23/2006	5:00-6:30 PM
		9/18/2006	12:43-2:43 PM
10	US 1 at Broward Boulevard	10/10/2006	12:05-2:05 PM
		12/13/2006	7:45-9:30 AM
11	Broward Blvd. at NE/SE 3rd Avenue	10/17/2006	12:10-2:10 PM
12	SR A1A at Bayshore Drive	10/19/2006	12:30-2:30 PM
		12/12/2006	11:30 AM-1:00 PM
		4/5/2007	10:00-11:30 AM
13	SR 441 at Commercial Boulevard	11/28/2006	7:45-9:45 AM
		11/30/2006	4:15-6:15 PM
		12/7/2006	11:45 AM-1:00 PM
14	US 1 at Commercial Boulevard	12/5/2006	7:30-9:30 AM
		12/13/2006	11:45 AM-1:30 PM
		4/5/2007	7:45 AM-9:30 AM

TABLE 5: Data Collection Schedule for After Period

No	Intersection	Date	Time
1	Oakland Park Boulevard at NW 55th Avenue	8/15/2007	4:30-6:30 PM
		9/20/2007	12:30-1:50 PM
		9/20/2007	4:30-6:30 PM
		10/4/2007	7:30-10:00 AM
2	Oakland Park Blvd. at Inverrary Blvd.	9/20/2007	2:00-3:00 PM
3	NW 2nd Avenue at NW 2nd Street	10/3/2007	3:45-6:30 PM
		10/4/2007	11:45-2:30 PM
		10/5/2007	12:05-2:00 PM
4	US 1 at SE 17th Causeway	8/16/2007	12:30-2:30 PM
		10/3/2007	12:50-2:15 PM
		10/4/2007	7:20-9:30 PM
5	US 1 at Broward Boulevard	8/16/2007	12:30-2:30 PM
		10/4/2007	8:50-10:50 AM
		10/5/2007	7:20-9:30 AM
6	Broward Blvd at NE/SE 3rd Avenue	8/15/2007	1:30-3:30 PM
		11/1/2007	12:35-2:15 PM
7	SR A1A at Bayshore Drive	10/3/2007	11:45-1:45 PM
		10/4/2007	10:30-12:30 PM
		10/4/2007	1:00-3:05 PM
8	US 1 at Commercial Boulevard	10/2/2007	5:20-7:00 PM
		10/3/2007	11:35-1:35 PM
		10/4/2007	7:40-9:40 PM

TABLE 6: Pedestrian Data Summary for Before Period

Intersection Location	No. of Pedestrians Initiating During:			No. of Pedestrians Finished		Total No of Pedestrians
	Steady "Don't Walk"	"Walk"	Flashing "Don't Walk"	Prior to Steady "Don't Walk"	After Steady "Don't Walk"	
Davie Blvd at Andrews Ave	57	35	10	28	74	102
	55.88%	34.31%	9.80%	27.45%	72.55%	
Davie Blvd at SE 3rd Ave	58	44	16	40	78	118
	49.15%	37.29%	13.56%	33.90%	66.10%	
Davie Blvd at SW 4th Ave	2	4	4	2	8	10
	20.00%	40.00%	40.00%	20.00%	80.00%	
Davie Blvd at SW 9th Ave	131	66	31	63	165	228
	57.46%	28.95%	13.60%	27.63%	72.37%	
Oakland Pk Blvd at NW 55th Ave	180	133	87	135	265	400
	45.00%	33.25%	21.75%	33.75%	66.25%	
Oakland Pk Blvd at Inverrary Blvd (NW 56 th Ave)	31	38	13	35	47	82
	37.80%	46.34%	15.85%	42.68%	57.32%	
NW 2nd Ave at NW 2nd St	81	31	9	30	91	121
	66.94%	25.62%	7.44%	24.79%	75.21%	
Palmetto Pk Rd at Dixie Hwy	85	23	9	25	92	117
	72.65%	19.66%	7.69%	21.37%	78.63%	
US 1 at SE 17th Causeway	96	83	34	73	140	213
	45.07%	38.97%	15.96%	34.27%	65.73%	
US 1 at Broward Blvd	21	193	32	201	45	246
	8.54%	78.46%	13.01%	81.71%	18.29%	
Broward Blvd at NE/SE 3rd Ave	32	197	15	199	45	244
	13.11%	80.74%	6.15%	81.56%	18.44%	
SR A1A at Bayshore Dr	81	261	30	283	89	372
	21.77%	70.16%	8.06%	76.08%	23.92%	
SR 441 at Commercial Blvd	31	69	16	69	47	116
	26.72%	59.48%	13.79%	59.48%	40.52%	
US 1 at Commercial Blvd	37	48	25	48	62	110
	33.64%	43.64%	22.73%	43.64%	56.36%	
Total	**923**	**1225**	**331**	**1231**	**1248**	**2479**
Proportions	**37.23%**	**49.42%**	**13.35%**	**49.66%**	**50.34%**	

TABLE 7: Pedestrian Data Summary for After Period

Intersection Location	No. of Pedestrians Initiating During:			No. of Pedestrians Finished		Total No of Pedestrians
	Steady "Don't Walk"	"Walk"	Flashing "Don't Walk"	Prior to Steady "Don't Walk"	After Steady "Don't Walk"	
Oakland Pk Blvd at NW 55th Ave	45	70	14	74	55	129
	34.88%	54.26%	10.85%	57.36%	42.64%	
Oakland Pk Blvd at Inverrary Blvd (NW 56 th Ave)	13	6	5	11	13	24
	54.17%	25.00%	20.83%	45.83%	54.17%	
NW 2nd Ave at NW 2nd St	71	50	0	53	68	121
	58.68%	41.32%	0.00%	43.80%	56.20%	
US 1 at SE 17th Causeway	79	92	11	103	79	182
	43.41%	50.55%	6.04%	56.59%	43.41%	
US 1 at Broward Blvd	96	210	25	233	98	331
	29.00%	63.44%	7.55%	70.39%	29.61%	
Broward Blvd at NE/SE 3rd Ave	54	156	22	176	56	232
	23.28%	67.24%	9.48%	75.86%	24.14%	
SR A1A at Bayshore Dr	35	81	17	92	41	133
	26.32%	60.90%	12.78%	69.17%	30.83%	
US 1 at Commercial Blvd	53	42	8	52	51	103
	51.46%	40.78%	7.77%	50.49%	49.51%	
Total	**446**	**707**	**102**	**794**	**461**	**1255**
Proportions	**35.54%**	**56.33%**	**8.13%**	**63.27%**	**36.73%**	

6.0 RESULTS OF THE STATISTICAL ANALYSIS

Pedestrian data collected before and after the installation of countdown signals, as discussed in the previous section, were compared to determine if observed changes are statistically significant. The appropriate measures of effectiveness for this study are represented by percentages or proportions. Consequently, the z-test was used to test if observed differences in these percentages are statistically significant. A two-tailed analysis was used with a null hypothesis that states there are no differences between the two proportions. The alternative hypothesis states that the proportions are not similar.

The following equation is used to calculate the z-statistic. If the calculated z-value is greater than the critical z-value obtained from the standard statistical table, then the difference in proportions is considered statistically significant. The calculated z-value was determined using the following equation [12]:

$$Z = \frac{P_1 - P_2}{\sqrt{P(1-P)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where:
P_1 = the sample proportion for the before condition
P_2 = the sample proportion of the after condition
P = the combined sample proportion between the before and after conditions
n_1 = the sample size (i.e., number of pedestrians) for the before condition
n_2 = the sample size for the after condition

The results of the statistical tests are presented in the following sections.

Pedestrian Compliance

Table 8 presents the results of the z-test for the percentage of compliant and non-compliant pedestrians at each study intersection, as well as for all intersections collectively. The z-value greater than 1.96 indicates a significant difference (at a 95% confidence level) between the before condition (with traditional pedestrian signal) and the after condition (with countdown pedestrian signal). As discussed earlier, pedestrians were classified as compliant if they entered the intersection during the "Walk" indication and they are classified as non-compliant if they entered during either the flashing or steady "Don't Walk" indication.

Overall, the results indicate that the percentage of pedestrian compliance with the "Walk" indication slightly increased, although the increase was not statistically significant at a 95% level of confidence. The analysis by intersection indicates that the percentage of pedestrian compliance with the "Walk" indication at three of the study intersections significantly increased at a 95% confidence level, while three of the study intersections experienced reduced compliance rates at a 95% confidence level (see Table 8).

The percentage of pedestrians entering the crosswalk during the flashing "Don't Walk" phase reduced significantly, from 13.70% during the before period to 8.13% during the after period. The analysis by intersection indicates that the percentage of pedestrians entering during the flashing "Don't Walk" indication at five of the study intersections decreased significantly (at a 95% confidence level), while three of the study intersections experienced no significant change. The pedestrian clearance intervals at three of the study intersections were increased in accordance with the BCTED's Pedestrian Clearance Standard (dated June 23, 2004) to comply with the MUTCD (2003 Edition) guidance on pedestrian clearance intervals. The reduction in the percentage of pedestrians entering during the flashing "Don't Walk" phase occurred at those intersections where the clearance intervals were not changed, which indicates that countdown signals alone had significant impact on the pedestrian behavior associated with crossings initiated during the flashing "Don't Walk" indication. This result may be construed as positive, since it appears that pedestrians are using the additional information provided by the countdown signal (i.e. the feedback to pedestrians on the time remaining in their crossing) to decide whether or not to initiate crossing and were less likely to enter the crosswalk if they felt they did not have enough time to complete their crossing maneuver.

The percentage of pedestrians entering the crosswalk during the steady "Don't Walk" indication increased significantly, from 31.26% in the before period to 35.54% in the after period (see Table 8). The percentage of non-compliant pedestrians (entering during the steady "Don't Walk" phase) substantially decreased at one intersection (location no. 1) and increased at three intersections (locations 5, 6, and 8). Based on the characteristics of the intersections where the proportion of non-compliant pedestrians increased, it appears that several other factors (such as the size of intersection, availability of gaps in oncoming traffic, length of side street left turn phase, and type of pedestrian activity) influence pedestrian's decision on whether or not to cross during the steady "Don't Walk" indication. In addition, although it was not apparent during field observations, it is possible that pedestrians may be observing the countdown signal on the cross street and, upon realizing that they would have a long wait before their turn, they decided to cross early if gaps in traffic were present.

TABLE 8: Z-test for Percentage of Pedestrian Compliance

No.	Intersection Location	Percentage of Pedestrians Initiating Crossing During: "Walk" Indication: Before				Flashing "Don't Walk" Indication				Steady "Don't Walk" Indication			
		Before	After	Z-value	Significant at 95% Confidence Level?	Before	After	Z-value	Significant at 95% Confidence Level?	Before	After	Z-value	Significant at 95% Confidence Level?
1	Oakland Park Blvd. at NW 55th Avenue	33.25%	54.26%	**4.27**	Yes	21.75%	10.85%	**2.74**	Yes	45.00%	34.88%	**2.02**	Yes
2	Oakland Park Blvd atInverrary Blvd.	46.34%	25.00%	1.87	No	15.85%	20.83%	0.57	No	37.80%	54.17%	1.43	No
3	NW 2nd Avenue at NW 2nd Street	25.62%	41.32%	**2.59**	Yes	7.44%	0.00%	**3.06**	Yes	66.94%	58.68%	1.33	No
4	US 1 at SE 17th Street Causeway	38.97%	50.55%	**2.31**	Yes	15.96%	6.04%	**3.09**	Yes	45.07%	43.41%	0.33	No
5	US 1 at Broward Boulevard	78.46%	63.44%	**3.89**	Yes	13.01%	7.55%	**2.17**	Yes	8.54%	29.00%	**6.05**	Yes
6	Broward Blvd at NE/SE 3rd Avenue	80.74%	67.24%	**3.36**	Yes	6.15%	9.48%	1.36	No	13.11%	23.28%	**2.88**	Yes
7	SR A1A at Bayshore Drive	70.16%	60.90%	**1.96**	Yes	8.06%	12.78%	1.61	No	21.77%	26.32%	1.07	No
8	US 1 at Commercial Boulevard	43.64%	40.78%	0.42	No	22.73%	7.77%	**3.02**	Yes	33.64%	51.46%	**2.63**	Yes
	Total	55.03%	56.33%	0.71	No	13.70%	8.13%	**4.76**	Yes	31.26%	35.54%	**2.47**	Yes

The intersections where the proportion of non-compliant pedestrians increased are large intersections with heavy turning volumes. Two of these three intersections are located along Broward Boulevard in downtown Fort Lauderdale. Field observations revealed that pedestrians generally crossed during the steady "Don't Walk" indication when gaps were present in the oncoming traffic or when the cross street left-turn traffic was moving. For example, at major intersections with lead left turn phasing, pedestrians would tend to initiate crossing the first half of the intersection during the side street left turn phase. They would then wait in the median for the left turn phase to end prior to completing their crossing maneuver. This behavior was frequently observed at the intersections located in downtown where the pedestrians consisted primarily of office workers, who possibly use the intersection on a daily basis.

Based on the results of this study, it appears that pedestrians are more cognizant of the time available to cross and, consequently, fewer pedestrians are entering during the flashing "Don't Walk" phase. Although a larger percentage of pedestrians are entering the crosswalk on the steady "Don't Walk" indication, they appear to do so cautiously. A before/after analysis of pedestrian crash data needs to be performed to confirm whether this behavior is contributing to pedestrian crashes.

Successful Crossings

The percentage of pedestrians who successfully crossed the intersection (i.e. reached the opposite curb prior to the steady "Don't Walk" indication) was also examined as shown in Table 9. The z-value greater than 1.96 indicates a significant difference (at a 95% confidence level) between the before period (with traditional signals) and the after period (with countdown signals). The percentage of successful crossings increased significantly, from 56.15% in the before period to 63.27% in the after period. The analysis by intersection indicates that the proportion of successful crossings increased significantly at three intersections (locations 1, 3 and 4 from Table 9) and decreased at one intersection (location 5). Pedestrian clearance intervals at two of these three intersections where the percentage of successful crossings increased were modified to comply with the MUTCD (2003 edition) guidance on pedestrian clearance intervals. No changes in clearance intervals were made at the third location. Based on this, it appears that the combination of countdown pedestrian signals and appropriately timed clearance intervals is the most effective means of increasing the number of successful crossings.

TABLE 9: Z-test for Percentage of Successful Crossings

No.	Intersection Location	Percentage of Pedestrians Finished Crossing:							
		Prior to Steady "Don't Walk" Indication				After Steady "Don't Walk" Indication			
		Before	After	Z-statistic	Significant at a 95% Confidence Level?	Before	After	Z-statistic	Significant at a 95% Confidence Level?
1	Oakland Park Blvd. at NW 55th Avenue	33.75%	57.36%	**4.77**	Yes	66.25%	42.64%	**4.77**	Yes
2	Oakland Park Blvd at Inverrary Blvd.	42.68%	57.32%	0.27	No	57.32%	54.17%	0.27	No
3	NW 2nd Avenue at NW 2nd Street	24.79%	43.80%	**3.11**	Yes	75.21%	56.20%	**3.11**	Yes
4	US 1 at SE 17th Causeway	34.27%	56.59%	**4.45**	Yes	65.73%	43.41%	**4.45**	Yes
5	US 1 at Broward Boulevard	81.71%	70.39%	**3.11**	Yes	18.29%	29.61%	**3.11**	Yes
6	Broward Blvd at NE/SE 3rd Avenue	81.56%	75.86%	1.52	No	18.44%	24.14%	1.52	No
7	SR A1Aat Bayshore Drive	76.08%	69.17%	1.56	No	23.92%	30.83%	1.56	No
8	US 1 at Commercial Boulevard	43.64%	50.49%	1.00	No	56.36%	49.51%	1.00	No
	Total	56.15%	63.27%	**3.83**	Yes	43.85	36.73%	**3.93**	Yes

7.0 CONCLUSIONS

The objective of this study was to determine the effectiveness of countdown pedestrian signals on pedestrian compliance and safety. A field experiment was conducted at various intersections located in Broward and Palm Beach Counties to evaluate the effectiveness of countdown pedestrian signals. Since sufficient crash data for the after period was not available, several surrogate measures were utilized instead to quantify the impacts of countdown pedestrian signals. Data on pedestrian behavior were collected before and after the installation of countdown signals at the study intersections between June 2006 and October 2007 at different times of the day and for various days of the week. Several measures of effectiveness related to pedestrian compliance with signal indications (percentage of pedestrians initiating crossing during "Walk", flashing "Don't Walk" and steady "Don't Walk" indications) and the percentage of successful crossings were evaluated. Statistical tests were conducted to determine whether the changes observed in the measures of effectiveness are attributable to the installation of countdown signals. A summary of the findings is as follows:

- Overall, the results of the study show that there was a slight increase in the percentage of pedestrian compliance with the "Walk" indication from 55.03% to 56.33%. However, the increase was not statistically significant. The analysis by intersection indicates that the percentage of pedestrian compliance at three of the study intersections significantly increased, while three of the study intersections experienced reduced compliance rates.
- The countdown signals significantly reduced the proportion of pedestrians crossing during the flashing "Don't Walk" indication from 13.70% during the before period to 8.13% during the after period. The countdown pedestrian signals provide feedback to pedestrians on the time remaining to cross. Pedestrians appear to use this information to assess their ability to cross the street and consequently, appeared to make better decisions on whether or not to initiate crossing, as indicated by the smaller proportion of pedestrians crossing during the "Don't Walk" phase.
- The percentage of pedestrians entering the crosswalk during the steady "Don't Walk" interval increased from 31.26% to 35.54% (all intersections combined). The analysis by intersection indicates that the proportion of pedestrians crossing during the steady "Don't Walk" phase decreased at one intersection and increased at three intersections. Field observations revealed that pedestrians generally crossed during the steady "Don't Walk" indication when gaps were present in the oncoming traffic or began crossing early, often during the side street left-turn

phase, especially at major intersections. In addition, other factors such as the size of intersection, the availability of gaps in oncoming traffic, whether or not the clearance intervals are adequate, and type of pedestrian activity may influence pedestrian behavior related to crossing during the steady “Don’t Walk” indication. Further research is warranted to verify the consistency of the results of this study and the reasons for this pedestrian behavior.

- The percentage of successful crossings (all intersections combined) increased significantly, from 56.15% to 63.27%. The analysis by intersection indicates that the proportion of successful crossings significantly increased at three intersections and decreased at one intersection. It appears that pedestrians are able to more easily assess their likelihood of a successful crossing due to the countdown timers and it is likely that pedestrians might have quickened their steps as they saw the remaining time winding down.
- Sufficient data was not available at the time of this report that would allow for an assessment of the impact of the countdown signals on driver behavior, specifically in regard to red light running and associated crashes. As crash data for the after period becomes available, these particular issues can be addressed by comparing crash rates between the before and after periods. Previous research has shown that countdown signals had no significant impacts on vehicular traffic (11).

Overall, the pedestrian countdown signals seem to be effective in increasing the percentage of successful crossings and decreasing the percentage of pedestrians who initiate crossing during the flashing “Don’t Walk” indication. However, the percentage of pedestrians entering during the steady “Don’t Walk” indication increased at some locations. Since the results are based on only eight intersections, further research is recommended to confirm the findings from this study. Once countdown pedestrian signals have been installed at the remaining six intersections from the before period, similar data can be collected and analyzed to verify the consistency of these results. In addition, it is recommended that the frequency and rate of pedestrian crashes at the study intersections be examined once sufficient crash data for the after period become available to quantify the impacts of countdown signals on pedestrian safety.

8.0 REFERENCES

1. Florida Department of Highway Safety and Motor Vehicles (2006). *Traffic Crash Statistics Report,* http://www.hsmv.state.fl.us/hsmvdocs/CS2006.pdf
2. Eccles, K.A., Tao, R., and Mangum, B.C. *Evaluation of Countdown pedestrian Signals in Montgomery County, Maryland.* Journal of the Transportation Research Board, Record No. 1878, National Research Council, Washington, DC. 2004.
3. Leonard, J. and Jukes, M. *Behavioral Evaluation of Pedestrian and Motorists towards Countdown Pedestrian Signals.* A Report prepared by Dessau-Soprin, Inc. for the City of Monterey, California. March 1999.
4. Huang, H., and Zegeer, C. *The Effects of Countdown pedestrian Signals in Lake Buena Vista.* Florida Department of Transportation, November 2000.
5. Markowitz, F., Sciortino, S, Fleck, J. L., and Bond, M.Y. *Countdown pedestrian Signals: Experience with an Extensive Pilot Installation,* ITE Journal, January 2006.
6. *Countdown Pedestrian Indication Market Research.* A report Prepared by Cook Research & Consulting, Inc. for the City of Minneapolis, Minnesota. June 1999.
7. *San Francisco Pedestrian Countdown Signals: Preliminary Evaluation Summary*. A Report prepared by DKS Associates for the San Francisco Department of Parking and Traffic. September 2001.
8. *Transportation Research and Development Project Page*. Québec Ministère des Transports.
9. Huang, H., and Zegeer, C. *An Evaluation of Pedestrian Countdown Signals.* A Report Prepared by the University of North Carolina at Chapel Hill Highway Safety Research Center for the Federal Highway Administration. February 1999.
10. Botha, J.L., Zabyshny, A.A., and Day, J.E. *Countdown pedestrian Signals: An Experimental Evaluation.* City of San Jose Department of Transportation. May 2002.
11. Schattler, K.L. and T.K. Datta. *Assessment of Pedestrian and Driver Behavior at Signalized intersections with Countdown Pedestrian Signals.* Proceedings of the ITE Technical Conference, San Antonio, TX. March 2006.
12. Montgomery, D.C. and G.C. Runger. *Applied Statistics and Probability for Engineers, Fourth Edition.* John Wiley & Sonc, Inc., Hoboken, N.J., 2007.