

Report No. UT-19.29

GUIDANCE FOR ENHANCED PEDESTRIAN TREATMENTS WITHIN REDUCED-SPEED SCHOOL ZONES (RSSZS)

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Final Report
August 2019

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ACKNOWLEDGMENTS

The authors acknowledge the Utah Department of Transportation (UDOT) for funding this research, and the following individuals from UDOT on the Technical Advisory Committee for helping to guide the research:

- Jesse Sweeten
- Travis Evans
- Mark Taylor

TECHNICAL REPORT ABSTRACT

1. Report No. UT-19.29		2. Government Accession No. N/A		3. Recipient's Catalog No. N/A	
4. Title and Subtitle GUIDANCE FOR ENHANCED PEDESTRIAN TREATMENTS WITHIN REDUCED-SPEED SCHOOL ZONES (RSSZS)				5. Report Date August 2019	
				6. Performing Organization Code	
7. Author(s) Robert Chamberlin, Jem Locquaio, Susie Petheram, Sarah Orton				8. Performing Organization Report No.	
9. Performing Organization Name and Address RSG, Inc. 307 W 200 S, Suite 2004 Salt Lake City, UT 84101				10. Work Unit No. 5503301D	
				11. Contract or Grant No. 19-8274	
12. Sponsoring Agency Name and Address Utah Department of Transportation 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410				13. Type of Report & Period Covered Final Feb 2018 to Aug 2019	
				14. Sponsoring Agency Code UT18.308	
15. Supplementary Notes Prepared in cooperation with the Utah Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration					
16. Abstract <p>UDOT receives requests from Regional Traffic Engineers, counties, school districts and municipalities to assist in providing safe pedestrian crossings at crosswalks within Reduced-Speed School Zones (RSSZs) that have significant pedestrian crossing demand outside of school crossing periods. Guidance is necessary for traffic engineers to select appropriate treatments.</p> <p>This research was focused on developing appropriate treatments to enhance pedestrian crossing safety for those situations where there is significant pedestrian crossing demand outside of normal school crossing hours. In developing guidance, the research team conducted interviews with nine state DOTs who expressed interest in this topic. A review of recent relevant literature was also conducted to understand how the research community and practitioners are managing this specific situation.</p> <p>The research recommends a Guidance Table which incorporates the optional implementation of Rectangular Rapid-Flashing Beacons (RRFBs) as a treatment to ensure safe pedestrian crossings after school crossing hours. A full range of cross-sections, speed limits and cross-street traffic (AADT) are considered. A related recommendation is to eliminate the interlocking provision currently within the Utah MUTCD (Section 7B.15.13a) which prohibits the operation of alternative devices such as an OSPA or an RRFB during school crossing times when the RSSZ is active. Based on the research conducted for this project, pedestrian safety will not be compromised with both device types operating simultaneously during school crossing hours.</p>					
17. Key Words Reduced-Speed School Zones, Enhanced pedestrian treatments, rectangular rapid flashing beacons, RRFBs, Utah DOT MUTCD			18. Distribution Statement: UDOT Research Division 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410 www.udot.utah.gov/go/research		23. Registrant's Seal N/A
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 22	22. Price N/A		

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LIST OF ACRONYMS

FHWA	Federal Highway Administration
MUTCD	Manual on Uniform Traffic Control Devices
OSPA	Overhead School-Pedestrian Assembly
OSSLA	Overhead School Speed Limit Assembly
PHB	Pedestrian Hybrid Beacon
RRFB	Rectangular Rapid-Flashing Beacon
RSSZ	Reduced Speed School Zone
TAC	Technical Advisory Committee
UDOT	Utah Department of Transportation

EXECUTIVE SUMMARY

UDOT receives requests for considering additional pedestrian crossing safety treatments within Reduced-Speed School Zones (RSSZs) where there is significant pedestrian crossing demand outside of the normal school crossing hours. This situation occurs whenever a school or a building adjacent to the school is an activity center outside of normal school crossing times, such as a place for civic meetings or for general civic gatherings or recreation.

The existence of these dual pedestrian crossing demands – during normal school crossing times and during times outside of those hours – creates the need for guidance to the engineering community on what additional pedestrian crossing treatments are appropriate for ensuring safe pedestrian crossing outside of normal school crossing hours.

The Utah MUTCD currently provides guidance for the application of one device that can be used in such cases, the Overhead School-Pedestrian Assembly (OSPA), which is described with a warranting process in Section 7B.26n of the Utah MUTCD. To date, only two of these devices have been installed in Utah and, in sponsoring this research, UDOT is seeking to develop guidance for what other types of devices might be installed to ensure pedestrian safety in these situations, covering a broader range of cross-sectional, speed and traffic characteristics.

This research conducted outreach to nine state DOTs and a search of recent literature and relevant guidance to develop an understanding of the state of the practice in the United States for this specific situation. Based on this outreach and literature review, the research team, in consultation with the UDOT Technical Advisory Committee (TAC), is recommending guidance for eventual inclusion within the Utah MUTCD.

Key among the guidance recommendations is the application of Rectangular Rapid-Flashing Beacons (RRFBs) as an option within RSSZs. In addition, an important recommendation that would require modifying the UDOT MUTCD is to eliminate interlocking of the RSSZ and other active pedestrian-activated devices enabling the two devices to operate simultaneously during school crossing times. Currently, interlocking of the RSSZ with the OSPA (currently the only other active device recognized by the Utah MUTCD) is required so that both devices may not operate simultaneously.

1.0 INTRODUCTION

1.1 Problem Statement

The UDOT Traffic and Safety Division receives requests to evaluate situations where crosswalks in Reduced-Speed School Zones (RSSZs) may also experience significant pedestrian demand outside of school arrival and/or departure times, warranting the use of additional pedestrian crosswalk enhancements. The Utah MUTCD currently addresses this situation with a warranting process for the Overhead School-Pedestrian Assembly (OSPA). However, there is an interest in identifying appropriate measures and best practices to serve as alternatives to the current standard provided in the Utah MUTCD, particularly regarding the provision of pedestrian-activated crossing treatments within RSSZs. Further, there is a wide range of cross-sections, speed and traffic levels that are not currently addressed in the warranting process for the OSPA.

The research team for this project was RSG, Inc. and CRSA, Inc.

1.2 Objectives

This research investigates best practices for the provision of pedestrian-activated enhancements to crosswalks within RSSZs with significant pedestrian demand outside of MUTCD-defined before-school and after-school hours. Findings aim to inform the development of guidance for UDOT and municipalities within the State of Utah which include proposed modifications to pertinent Utah MUTCD standards.

1.3 Scope

Task 1: Project Management

A kick-off meeting with the research team and members of the UDOT Technical Committee assembled for the project was held on Monday, July 2, 2018. The objective of the meeting was to review expectations for the project, including research methods, deliverables, and the timeline for the project. A second meeting with the TAC occurred on Tuesday, February 19,

2019 to discuss the findings from outreach and research. A final meeting with the project TAC to confirm the research team's findings was conducted on Wednesday, August 21, 2019.

The research team periodically provided updates to Jesse Sweeten, the UDOT project champion, over the course of the project.

Task 2: Research Synthesis and DOT Outreach

A meeting was held on Tuesday, February 19, 2019 to update the UDOT Technical Committee on project progress including a summary of interviews with other State DOTs as well as findings from ongoing literature review.

Task 3: Final Deliverables

Based on the DOT outreach and research synthesis, and on collaboration with UDOT professional staff, a guidance table describing the treatment options under different cross-sectional situations, different speed limits and different traffic levels was developed. The project TAC convened to review and modify the guidance table, which is presented in this report as a key recommendation to UDOT (Appendix C).

1.4 Outline of Report

This report documents the findings of the research and includes the following chapters:

- Introduction
- Background
- Research Methods
- Research Summary
- Recommendations and Implementation

3.0 Background

3.1 Overview

Research began with an investigation into current UDOT policies and practices for the provision of marked crosswalks and enhancements within RSSZs. The primary sources of information from which to identify potential gaps, challenges, and opportunities for refining such warranting processes are the Utah Manual on Uniform Traffic Control Devices (Utah MUTCD) and UDOT Policy 06C-27: Marked Pedestrian Crosswalks.

3.2 Existing Standards in the Utah MUTCD

Part 7 of the 2009 Utah MUTCD, titled “Utah Traffic Controls for School Zones”, published in 2015, is a supplement to the 2009 Utah MUTCD and a modification which takes precedence over standards in Part 7 of the 2009 National MUTCD in jurisdictions within the State of Utah.

Section 7A.03 of the Utah MUTCD defines a school zone as a school crosswalk zone, a reduced-speed school zone, a narrow school route, an abutting school zone, or as a school bus loading zone. The section also provides the standards by which each school zone type may be warranted at a study location. Section 7A.03 defines a reduced-speed school zone as the area of a roadway associated with a school crosswalk where the speed limit is reduced to 20 MPH, including the approach to the crosswalk and associated signing. A School Speed Limit Assembly (S5-1) with Speed Limit Sign Beacons indicates the speed limit within an RSSZ. The section then indicates that a reduced-speed school zone may only be warranted given that the warrant for a school crosswalk zone is met (Appendix B1r), that the posted speed limit is less than or equal to 50 MPH, and that Part 7 Appendix B2r titled “Warranting Process for a Reduced-Speed School Zone” of the Utah MUTCD is met. The option is also presented to warrant an RSSZ for an elementary school so long as the study location does not exist at a traffic signal, stop sign, or roundabout, and where the posted speed limit is greater than or equal to 30 MPH.

Per Section 7B.15 of the Utah MUTCD, the enforcement periods for the reduced speed limit within an RSSZ are as follows:

1. 45 minutes earlier than before school starts until 15 minutes after school begins (before-school period);
2. 15 minutes prior to the end of the school day until 45 minutes after school ends (after-school period);
3. Other time periods throughout the day when minimum conditions for an RSSZ exist.

Some states, including Utah, prohibit use of the RSSZ outside of these school walking hours (Fitzpatrick et al. 2009; Utah Code), as exemplified by Section 7B.14 of the Utah MUTCD which specifies that School Speed-Limit Sign Beacons shall not flash continuously throughout the school day and that such beacons must be interlocked with any other flashing beacons within an RSSZ.

Two additional warranting processes related to RSSZs currently exist in the Utah MUTCD. One is for consideration of an Overhead School-Speed Limit Assembly (SS5-1a) in an RSSZ (Appendix B3r); the other is for the warranting of an Overhead School-Pedestrian Assembly (OSPA) (RS1-9b, Appendix B6n). This last option is currently the only provision warranted in the Utah MUTCD for additional treatments to RSSZ crosswalks to facilitate safe use outside of school walking hours.

3.2.1 Warranting Process for an Overhead School-Pedestrian Assembly

Section 7A.03 provides the option to consider an Overhead School-Pedestrian Assembly within an RSSZ given that the associated warranting process for the device in Appendix B6n is met. Per Section 7B.26n, the Overhead School-Pedestrian Assembly consists of a Yield to Pedestrian Blank-Out (RS1-9b) sign on a mast arm signal pole actuated via push button. As with other flashing beacons within Reduced-Speed School Zones, this section specifies that the assembly must be interlocked with School Speed Limit assemblies to not operate during the MUTCD before-school and after-school periods of operation for an RSSZ.

Warranting processes for School Zones in Section 7 of the Utah MUTCD are provided in Appendix A.

3.2.2 Pedestrian Demand Outside of School Hours

For clarity, pedestrian demand outside of school hours is generally associated with the use of the school for community or athletic events and is thus dependent on the surrounding context of the school that generates pedestrian activity. UDOT Policy 06C-27 expands on this concept by providing a list of pedestrian demand generators proximate to non-school crosswalks which include transit centers, parks, hospitals, libraries, senior centers, shopping centers, employment centers, or other large pedestrian generators. Regardless of the contexts and types of pedestrian generators proximate to school, the common factor is the need for uncontrolled RSSZ crosswalks to function safely and effectively for significant pedestrian demand outside of the enforcement periods for an RSSZ.

4.0 RESEARCH METHODS

4.1 Overview

Research was comprised of a literature review in tandem with an outreach interview process. Findings and discussion from interviews occasionally informed the direction of the literature review search where appropriate. In general, the research process found minimal literature about pedestrian-activated flashers specifically within RSSZs. The interview process also made apparent that few of the agencies interviewed use specific guidelines, warranting processes, and/or best practices related to the subject. The research team encountered no formal guidance currently in use governing this situation during the DOT outreach.

4.2 Literature Review

The literature review aimed to investigate the use of pedestrian-activated flashers within RSSZs. As minimal literature exists on the subject of pedestrian-activated flashers specifically within RSSZs, research focused more broadly on literature relating to the application of pedestrian-activated flashers at marked crosswalks as well as literature on school zone-area traffic control to derive contexts for appropriate application of pedestrian-activated flashers within RSSZs.

4.3 Outreach Interview Process

To supplement the traditional literature review, an outreach process was initiated with transportation agencies in the United States. The effort helped gain insight on current policies, best practices, and specifications related to crosswalks within RSSZs at other DOTs or municipal agencies. These agencies were interviewed to gather details about their experience with issues related to these locations and to learn about the design, guidance, and engineering considerations, if any, that have proven to be important in their decision-making process.

4.3.1 Outreach Development

Interest for participation by the transportation entities was solicited by UDOT's research team via the AASHTO Research Advisory Committee (RAC) listserv. A total of seventeen agencies responded to the solicitation request indicating interest in the research topic. The research team sent an e-mail invitation for a phone interview to each agency that sent a response via the listserv. From these, nine agencies then responded to a follow-up request for a phone interview. The research team developed a list of questions and key concepts to discuss during phone interviews (see below).

Of the nine agencies interviewed, one represented a municipality (Phoenix, AZ), while the other eight respondents represented their respective state Department of Transportation (DOT). Interviews were conducted from December 2018 to February 2019 and ranged in length from 10 to 45 minutes. The nine respondents included:

- Arkansas DOT
- Illinois DOT
- Indiana DOT
- Massachusetts DOT
- New Hampshire DOT
- Oklahoma DOT
- Wisconsin DOT
- Wyoming DOT
- City of Phoenix, Arizona

The eight agencies that indicated interest in the topic via the AASHTO Research Advisory Committee (RAC), but did not respond to interview requests included:

- Alaska DOT

- Arizona DOT
- District DOT (Washington, DC)
- Florida DOT
- Georgia DOT
- Michigan DOT
- Missouri DOT
- New Mexico DOT

The following list of interview questions were used to understand each agency/agency representative's familiarity with the situational context and experiences with processes to provide safer pedestrian crossing experiences within RSSZs.

1. Are there school crosswalk locations in RSSZs (or otherwise) which serve significant pedestrian demand outside of MUTCD before-school and after-school periods?
2. Are there specific issues which arise during these time periods?
3. Are there specific treatments implemented at these crossing locations to serve both school-related demand and non-school-related demand (outside of MUTCD school hours?)
4. What user groups do you observe at school zone/RSSZ locations during non-school periods?
5. If you do have specific treatments, what are they?
6. What operational or safety concerns do you have with additional treatments?
7. What observations can you share on the effects of these pedestrian-activated treatments?

8. What is your warranting process for specific treatments? Or what guidelines do you have?
 - a. Is there an existing Pedestrian Manual, State MUTCD, and/or Policy which outlines these warranting processes?

Additional literature to review resulted from the agency interview process, providing a more robust set of findings, insights, and best practices.

5.0 RESEARCH SUMMARY

5.1 Summary

In summary, there are no formal processes across the DOTs interviewed for establishing treatment preferences for pedestrian crossing demand outside of school crossing hours within RSSZs. DOTs are dealing with this issue largely on an ad hoc basis and, as of yet, no changes to each respective state's MUTCD have been initiated. The literature review revealed that some municipalities, such as Phoenix, AZ and Boulder, CO have advanced the issue in ways that are specific to their needs.

Based on guidance provided by FHWA that is more generally focused on pedestrian crosswalk enhancements and the safety experience associated with Rectangular Rapid-Flashing Beacons (RRFBs), there is a consensus emerging around the use of this specific technology to address the research problem statement.

5.2 Themes

Five key themes emerged from the DOT outreach and associated literature review which support the conclusions and address the stated objectives of this research.

5.2.1 Minimal Policies and Research Regarding Pedestrian-Actuated Enhancements in RSSZs

No formal policies exist for the provision of pedestrian-activated enhancements in Reduced-Speed School Zones among all the agencies interviewed. However, most agencies expressed a desire to create a formal policy or framework to aid the current practice of dealing with this situation on a "case-by-case" basis. The Wyoming and Illinois DOTs were the only agencies interviewed with a policy/manual or draft policy/manual that specifically allows or alludes to the use of RRFBs in school zones.

One study regarding the explicit examination of pedestrian-actuated enhancements in an RSSZ was identified (Brewer, et al. 2012). The study was conducted in Garland, Texas at a marked school crosswalk over a four-lane arterial with a posted speed limit of 35 MPH. The

roadway consists of a center two-way left-turn lane (TWLTL) within an RSSZ with a speed limit of 20 MPH. Data on pedestrian crossings were collected via video during periods of operation for the RSSZ, coincident with periods when a crossing guard was present at the site. A staged pedestrian study was conducted where the RSSZ was no longer in operation and where the school crossing guard was not present. As a before-and-after study, data were collected before the installation of an RRFB and after the installation of an RRFB. The installed RRFB consisted of one RRFB over the roadway center TWLTL for both travel directions and additional RRFBs mounted on posts for each travel direction. Furthermore, the RRFBs were installed with School Crosswalk Warning Assembly Signs (S1-1 and W16-7L).

Results of the study found that the rate of yielding to pedestrians among drivers outside of school hours increased with the installation and use of the RRFB. For example, compliance during the PM peak and mid-afternoon peaks increased from less than 1% during the before period to 81% and 78%, respectively. During school hours, however, the study found decreased or minimal increase to driver compliance over school hours during which the RSSZ was operating and a school crossing guard was present. The decrease or lack of improvement in compliance observed at the site over periods during which the RSSZ was active and a school crossing guard was present is not further explored in the study.

5.2.1.1 Wyoming DOT (WYDOT) Pedestrian and School Traffic Control Manual

Chapter 2 and Chapter 3 of WYDOT's *Pedestrian and School Traffic Control Manual* (WYDOT 2014) contain information on the use of pedestrian-activated treatments at marked crosswalks and note specifically use of such treatments at school-related crosswalks. Chapter 2 relates to Pedestrian Traffic Control and Chapter 3 relates to School Traffic Control. Chapter 2 provides information on warranting processes and operational requirements for pedestrian-activated flashing beacons, traffic control signals, RRFBs, and for pedestrian hybrid beacons. No specific volume-based warrants or considerations are described for RRFBs. However, the chapter does explicitly include language to allow RRFBs as supplements to School Crossing Sign Assemblies and thus, useable within school zones. In the context of school-related and non-school-related crosswalks, the manual recommends that RRFBs be placed on the right-hand and left-hand sides of a roadway.

Chapter 3 of the manual states that a minimum of 20 student crossings per hour in addition to engineering judgment require extra emphasis at a crosswalk for an RRFB to be warranted at a school crosswalk. Additionally, the chapter states that an adult crossing guard must be present for elementary school and junior high school children using the RRFB at a school crosswalk.

WYDOT practices were revealed as semi-formal given that a policy outlines warranting processes and operational requirements for pedestrian-activated enhancements in school crosswalks but note that the minimum pedestrian volume of 20 pedestrians an hour is difficult to attain. Subsequently, the WYDOT representative interviewed shared that general safety considerations determined on a case-by-case basis become a more significant factor in determining the appropriateness of installing pedestrian-activated enhancements in school zones.

5.2.1.2 Illinois Draft Policy

An Illinois Draft Policy with a matrix guide for determining the installation of a marked crosswalk with or without pedestrian enhancements was shared following the interview. The matrix guide is not specific to school zones or crosswalks within RSSZs. However, the guide contains language acknowledging the need to use School Signs (S1-1) instead of Pedestrian Signs (W11-2) for enhancements at school crossing locations. The draft policy includes recommendations for warranting the following pedestrian-activated enhancements at a marked crosswalk: pedestrian-actuated warning beacons, RRFBs, and PHBs (Hawk).

5.2.2 Crosswalk Enhancements for Uncontrolled Locations

Despite a lack of formal policies, agencies interviewed expressed the value of existing guides in their deliberations over the provision of pedestrian-activated enhancements at uncontrolled marked crosswalk locations in general. For example, FHWA has prepared a guide to help practitioners determine the eligibility of a location for a marked crosswalk and/or the most appropriate treatment for the marked crosswalk based on its context (FHWA). In addition, some provide specific information regarding crosswalk locations and/or treatments related to school crosswalks (Boulder 2011, Figure 1; Georgia DOT 2018).

Figure 2a. City of Boulder Guidelines for the Installation of Pedestrian Hybrid (HAWK) Beacons, Pedestrian Signals, or Rectangular Rapid Flash Beacon (RRFB) Signs on Low-Speed Roadways

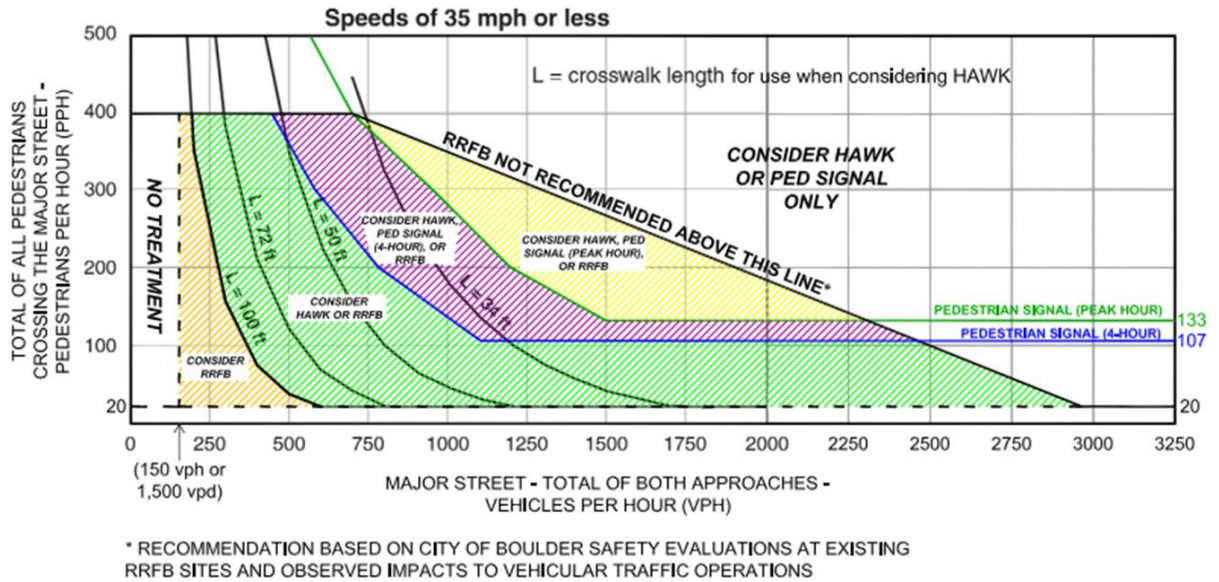


Figure 1 City of Boulder, CO Guidelines for Installation of Pedestrian Enhancements

The safety enhancements for pedestrian crosswalks at uncontrolled locations recommended in such guides range from low-level enhancements such as high-visibility crosswalks, bulb-outs, and yield/stop signs, to high-level enhancements such as Pedestrian Hybrid Beacons (HAWK, W11-2), Rectangular Rapid-Flashing Beacons, and Overhead School-Pedestrian Assemblies (RS1-9b). What to use and where is a common component of state or municipal pedestrian crossing guidelines (Boulder 2011; Washington State DOT 2018, Georgia DOT 2018).

Several agencies and cities provide guides to help practitioners determine the eligibility of locations for a marked crosswalk and/or the most appropriate treatment for the marked crosswalk based on its context (Boulder 2011; FHWA 2017a; FHWA 2017b). Of these, some provide information regarding crosswalk locations and/or treatments related to school crosswalks (Boulder 2011).

A 2005 study published by FHWA (FHWA 2005) conducted research to inform decision making among state agencies, municipalities, and practitioners related to the installation of marked pedestrian crosswalks at uncontrolled locations. The study identified 1,000 marked and

1,000 unmarked crosswalk comparison sites, totaling to 2,000 study sites from which data including crash history, AADT, and roadway geometries were obtained, and crash safety analysis was employed to understand pedestrian crash risks associated with site characteristics. The results of this study recommended a framework for installing marked crosswalks at uncontrolled locations based on AADT, roadway cross-section, and posted speed limit with degrees of caution for practitioners to consider additional pedestrian enhancements in lieu of a marked crosswalk alone. Appendix B depicts the resulting matrix with recommendations for the installation of marked crosswalks at uncontrolled locations.

FHWA published a guide in January 2018 as part of the Safe Transportation for Every Pedestrian (STEP) program with best practices to assist transportation agencies in developing policies for determining appropriate crosswalk enhancements at uncontrolled locations to improve safety. The guide provides a methodology for relevant data collection and analysis to identify locations of concern for pedestrian safety. Moreover, the guide builds on the FHWA 2005 matrix for recommending a marked crosswalk by adding recommendations for selecting additional pedestrian enhancements and countermeasures at marked crosswalk locations including raised crosswalks, pedestrian hybrid beacons (PHBs), road diets, and RRFBs. As in the 2005 FHWA study, recommendations for the application of pedestrian treatments are based on roadway cross-sections, AADT, and posted speed limits.

The aforementioned guides include criteria to identify when marked crosswalks alone are insufficient and not recommended (e.g. speeds over 40 and/or high-traffic counts, and/or wide roadway configuration/# of lanes), as the pedestrian crash risk may be increased if the marked crosswalks are used without additional treatments. Some marked crosswalks in RSSZs would meet these criteria if used outside of school walking hours with no additional treatment.

The Massachusetts DOT representative interviewed cited the 2018 FHWA publication as a useful guide in determining the installation of marked crosswalks in need of additional pedestrian enhancements. Representatives from both Illinois and Arkansas DOT cited the former 2005 FHWA guide as a useful guide in their practice, acknowledging, however, the lack of specificity in the guide regarding pedestrian-activated enhancements at marked crosswalks.

5.2.3 Use of the Guides and Practices among Agencies Regarding School Zones/RSSZs

Requests for safety improvements to crosswalks in school zones for use outside of school hours are common for both state DOTs and municipalities. Based on insights from agency interviews, municipalities generally appear to have more project experience with implementing pedestrian enhancements in RSSZs than DOT agencies in the states contacted. All agencies that participated or were cited by DOTs in the phone-interview process have fielded requests for and helped facilitate the implementation of a range of pedestrian-activated enhancements to crosswalks. Many of these requests occur in school zones and some of these are crosswalks within an RSSZ.

Like Utah, many states consider the location and best configuration for school-zone crosswalks in a process separate from the consideration for non-school crosswalks. None of the agencies interviewed had established formal processes for considering and responding to these school-specific requests. However, most of the agencies interviewed, in general, expressed a desire to create such formal processes. Massachusetts DOT's representative expressed the opposite, however, purporting that considerations for pedestrian-activated enhancements should not be constrained by whether a crosswalk is school related. Rather, the interviewee expressed that, given that it's been observed that schools serve purposes well beyond the typical MUTCD school hours of operation and that certain land uses adjacent to schools may be pedestrian generators, all crosswalks should be evaluated similarly for appropriateness of pedestrian-activated enhancements.

State DOTs typically address the issue of pedestrian-activated enhancements on a case-by-case basis in response to community desires. Pedestrian demand is consistently cited as the determining factor for most states, except Wyoming, which has insufficient numbers to meet typical demand threshold requirements and instead considers safety as the key factor for installation. Much of the demand for pedestrian-activated enhancements is for existing crosswalks located in school zones (Arkansas; Indiana). Currently, state MUTCDs according to those interviewed generally do not have specific information or guidance on the topic of how to treat these school zone enhancement requests and warranting processes do not typically exist yet. Instead, agencies rely on a range of sources for guidance as noted previously, including those

published by FHWA and policies developed by municipalities. In contrast to the agencies interviewed, Utah's MUTCD already includes a warranting process for placement of one specific type of pedestrian-activated enhancement, the OSPA (MUTCD Section 7 Appendix B6n) for use in RSSZs outside of school hours (as opposed to selecting an enhancement option based on criteria).

Despite not having formal processes, the agencies interviewed use a range of pedestrian enhancements within school zones or RSSZs, including:

- o Use of the RSSZ flashers outside school hours (and/or enabling continual operation);
- o Rectangular Rapid-Flashing Beacons (RRFBs)
- o Pedestrian Hybrid Beacons (PHBs, or HAWKs)
- o Wig-wag flashers
- o Enhanced conspicuity of warning signs (e.g. flashing LEDs in the border)
- o Stutter flash
- o In roadway warning lights (Utah MUTCD Section 4N.02)
- o Portable speed feedback signs

5.2.4 Pedestrian-Activated Enhancements Favored among Interviewed Agencies

Requests for safety improvements to crosswalks in school zones for use outside of school hours are common for both state DOTs and municipalities. Among the top concerns with the current strategies - as stated by the agencies interviewed - are crosswalks where the current implementation strategy entails the RSSZ beacons flashing continuously (24 hours). This continual flashing of the RSSZ beacons may serve to desensitize driver compliance to the RSSZ beacons during their intended, specific use timeframe – that of school walking hours. A shift to pedestrian-activated enhancements is seen as a viable solution for communities that would like to use the flashing RSSZ beacons all day (Massachusetts; Oklahoma). Concerns for safety

throughout the day are cited by agencies that recommend not deactivating devices during RSSZ periods (New Hampshire).

When asked specifically about pedestrian-activated enhancements within RSSZs, the two most commonly referred to were RRFBs and PHBs. The Institute of Traffic Engineers Safe Routes to School Program lists the RRFB as a potential traffic-control device within school areas (ITE undated).

Some agencies are shifting to the implementation of Pedestrian Hybrid Beacons (HAWKs) in their RSSZs when the demand is sufficient to warrant an enhancement/improvement of the crosswalk for use outside of school hours. While the PHB/HAWK option results in high driver compliance, the cost is among the highest for pedestrian-activated beacons (Fayyaz et al 2019). The Utah MUTCD currently prohibits the use of HAWKs in RSSZs:

Section 7A.04, paragraph 09n: A pedestrian hybrid beacon shall not be used within a Reduced Speed School Zone.

5.2.5 Compliance/Effectiveness of Pedestrian Enhancements

While several flashing-beacon configurations exist, the effectiveness of RRFBs has been demonstrated in several studies that examine compliance with yielding at crosswalks (Brewer and Fitzpatrick 2012; Fayyaz et al 2019; Fitzpatrick et al 2016). RRFBs generate a comparable rate of compliance to HAWKs, OSPA, etc., but also are nearly matched with the yielding compliance observed at school-related crossings with a crossing guard (Brewer and Fitzpatrick 2012). Drivers are four times more likely to yield when an RRFB is activated than when it is not (FHWA 2015).

Furthermore, higher rates of compliance with RRFBs are associated with certain conditions of the context, including shorter crossing distance, presence of a median refuge, and only two lanes (vs. four lanes) to cross. Compliance rates were higher at crosswalks with RRFBs that were within 0.5 mile of a school, indicating the potential presence of children leads to a higher level of awareness to crosswalk use. The installation location of the RRFB is also a significant factor regarding yielding compliance. More drivers yielded when the RRFBs were

located on both sides of the roadway AND overhead (90% compliance), compared to when RRFBs were located on both sides of the roadway but NOT overhead (72% compliance), or located on the right side of the roadway only (53% compliance), according to Fitzpatrick et al (2016).

With the interim approval by the FHWA for RRFBs (Interim Approval 21, FHWA), many agencies are utilizing this approach both in and outside of RSSZs and for a range of roadway contexts from two-lane highways to four-lane roadway cross sections (Arkansas; Illinois; Indiana; Oklahoma; Wyoming). In some states, the use of an RRFB is prioritized over HAWKs or is being considered as the primary enhancement moving forward (Illinois; Oklahoma).

Agencies interviewed emphasized the need for community-driven processes, and community involvement and education. Community involvement and support is an integral component of the process for identifying which type of enhancement/implementation strategy is the best fit for the context in question.

Roadway configuration, speed limit, and average daily traffic are all elements commonly used to identify the best enhancement option for a given crosswalk. While many options are available, the compliance with each in a context impacts how effective and useful it will be.

5.3 Limitations and Challenges

The major challenge of this research is that, to date, there have been no formal guidelines established in any state for the specific question of the research, namely, what pedestrian enhancements are most effective and under which circumstances (cross-section, traffic levels, speed limit) to provide safe pedestrian crossings within RSSZs but outside school crossing times?

To the extent that DOTs or municipalities have addressed this question, it has been in an ad hoc fashion or on an as-needed basis. With this research, UDOT is moving toward establishing formal guidance for engineers and planners.

6.0 RECOMMENDATIONS AND IMPLEMENTATION

6.1 Recommendations

This research recommends the adoption of a warranting process, presented as the guidance table (Figure in Appendix C), which can be incorporated into Part 7 of the Utah DOT MUTCD. The matrix features elements commonly used in the evaluation of installing a marked crosswalk at an uncontrolled location as well as elements of warranting processes related to school zones in Section 7 of the Utah MUTCD.

Figure 3: Recommended Guidance for the Installation of Pedestrian Crossing Enhancements within Reduced-Speed School Zones

ROADWAY TYPE (number of lanes and median type)	ADT < 9,000			ADT 9,000 TO 12,000			ADT 12,000 TO 15,000			ADT > 15,000		
	≤ 30 MPH	35 MPH	≥ 40-45 MPH	≤ 30 MPH	35 MPH	≥ 40-45 MPH	≤ 30 MPH	35 MPH	≥ 40-45 MPH	≤ 30 MPH	35 MPH	≥ 40-45 MPH
Two Lanes	1	1 and/or 2	2 or 4	1	1 and/or 2	2 or 4	2	2	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
Three Lanes with Raised Median	1	1 and/or 2	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
Three Lane without Raised Median	1 and/or 2	2 or 4	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
>=Four Lanes with Raised Median	1 and/or 2	2 or 4	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
>=Four Lanes without Raised Median	1 and/or 2	2 or 4	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4

1 = Low-Level Treatments (Refer to UDOT Policy 06C-27 *Low-Level Treatments at Uncontrolled Locations*)

2 = Rapid Rectangular Flashing Beacon (RRFB)^{2,3}

3 = RRFB and Advance RRFB^{2,3}

4 = Pedestrian Activated Overhead School Pedestrian Assembly (RS1-9B)⁴

¹For application at crosswalks with significant pedestrian crossing demand outside school crossing hours.

²Overhead mounting of RRFBs should be considered based on engineering judgment, including the adequacy of visibility achievable by roadside signs

³If a median is present, provide an RRFB on the median instead of left of the crosswalk

⁴Additional or different treatments will be required at speeds greater than 45mph

⁵Interlocking of recommended pedestrian crossing treatments with RSSZ devices, making one or the other device non-activatable, is *not* recommended.

In addition, the research recommends that the guidance prohibit interlocking of the RSSZ with other active devices (RRFBs or OSPAs) which would enable simultaneous use of both devices during school crossing times. Activation of the RSSZ devices outside school crossing times would not be enabled.

Furthermore, if a pedestrian-activated enhancement is warranted within an RSSZ, recommendations for overhead mounting of RRFBs in RSSZs may be considered using existing requirements for consideration of Overhead School Speed Limit Assembly (OSSLA) per Appendix B3r of the Utah MUTCD which are intended to address sight-visibility constraints associated with side-mounted beacons and signage.

REFERENCES

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- FHWA (2017b) “*Guide for Improving Pedestrian Safety at Uncontrolled Locations.*” FHWA-SA-17-072, authors: Blackburn, L; Zegeer, C.; Brookshire, K.

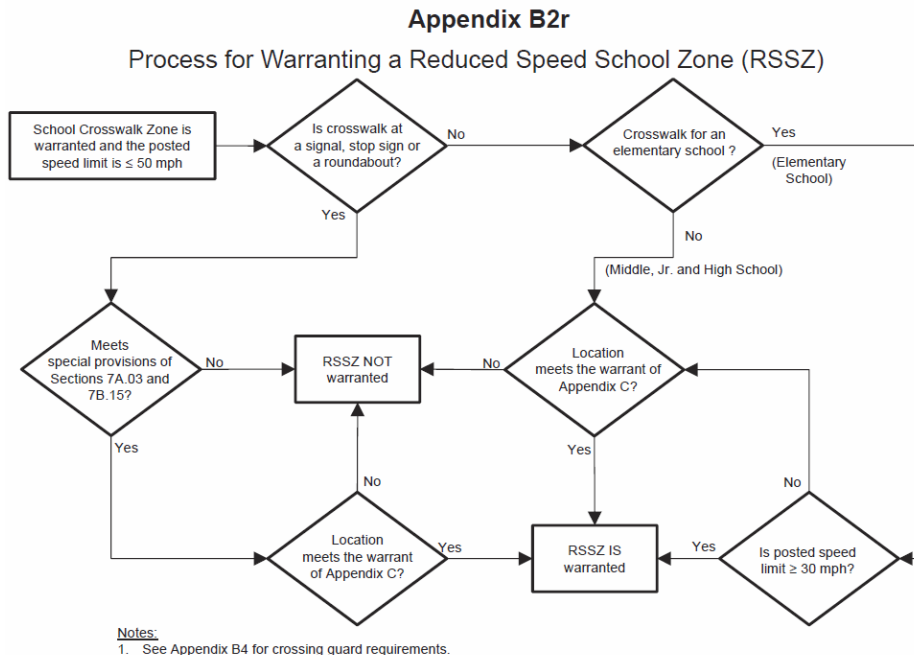
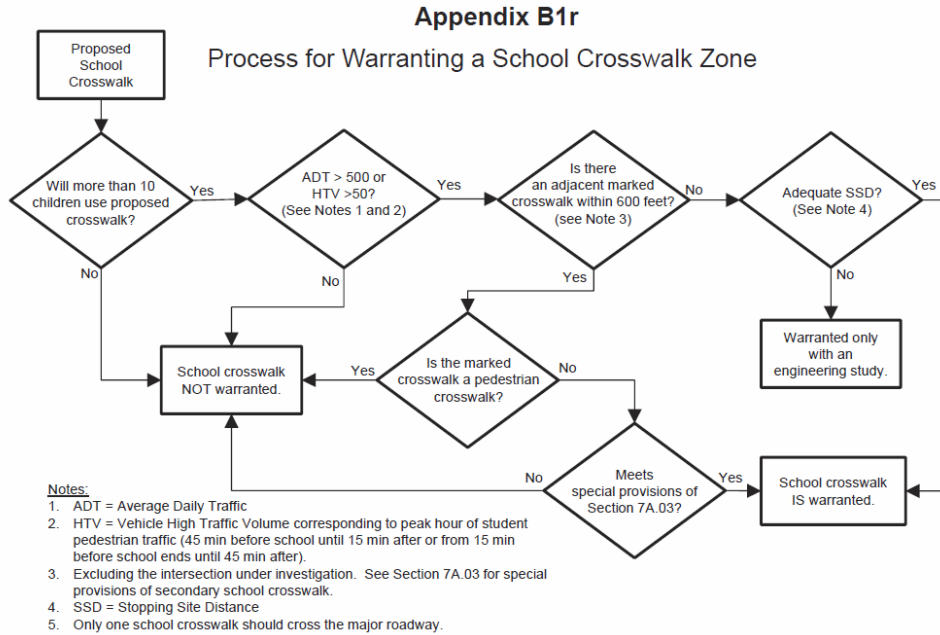
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FHWA (2018) “Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations”
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APPENDIX A: UTAH MUTCD SCHOOL ZONE WARRANTS

Provided are the School Zone Warrants in Appendix B1r to Appendix B6n located within Part 7 of the Utah MUTCD.



APPENDIX B: RECOMMENDATIONS FOR MARKED CROSSWALKS AT UNCONTROLLED LOCATIONS

FHWA (2005) provides the recommendations below for determining candidate (C), possible (P) and insufficient locations (N) where marked crosswalks alone would not be sufficient to ensure pedestrian safety.

TABLE 11. RECOMMENDATIONS FOR INSTALLED MARKED CROSSWALKS AND OTHER PEDESTRIAN IMPROVEMENTS AT UNCONTROLLED LOCATIONS.

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT >9,000 to 12,000			Vehicle ADT >12,000–15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)	≤ 48.3 km/h (30 mi/h)	56.4 km/h (35 mi/h)	64.4 km/h (40 mi/h)
Two lanes	C	C	P	C	C	P	C	C	N	C	P	N
Three lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multilane (four or more lanes) with raised median***	C	C	P	C	P	N	P	P	N	N	N	N
Multilane (four or more lanes) without raised median	C	P	N	P	P	N	N	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.

** Where the speed limit exceeds 64.4 km/h (40 mi/h), marked crosswalks alone should not be used at unsignalized locations.

*** The raised median or crossing island must be at least 1.2 m (4 ft) wide and 1.8 m (6 ft) long to serve adequately as a refuge area for pedestrians, in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

C = Candidate sites for marked crosswalks. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, and other factors may be needed at other sites. It is recommended that a minimum utilization of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) be confirmed at a location before placing a high priority on the installation of a marked crosswalk alone.

P = Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements. These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

N = Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased by providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.

**APPENDIX C: RECOMMENDED GUIDANCE FOR THE INSTALLATION OF
PEDESTRIAN CROSSING ENHANCEMENTS WITHIN REDUCED-SPEED SCHOOL
ZONES**

The purpose of this research was in part to develop clear guidance for considering pedestrian-activated enhancements for use in RSSZs. The proposed guidance is based on research of warranting processes for pedestrian-activated enhancements in RSSZs, on outreach to other DOTs and municipalities that are considering this issue on a more ad-hoc basis, and on a review of recent related research.

Of note is that the proposed guidance, presented in the table below, involves incorporating the RRFB into UDOT guidance. As the RRFB is an FHWA-approved device under “Interim Approval”, the UDOT Engineer for Traffic and Safety will need to approve the guidance table prior to implementation.

Also of note is that the current Utah MUTCD Section 7B.15.13a specifies that the beacons associated with RSSZs “shall be interlocked with any other flashing beacons within a Reduced-Speed School Zone such that the other beacons shall not operate when the School Speed Limit beacons are active.” The outreach conducted for this research did not identify any other states where this interlocking provision was in effect, nor did the research suggest that having both devices operate simultaneously would be problematic in any way. For these reasons, it is recommended that the interlocking provision within Section 7B.15.13a be eliminated from the Utah MUTCD. Eliminating this provision would allow, for example, RRFBs to operate at the same time as RSSZ flashers during school crossing periods.

Guidance for Additional Pedestrian Crossing Improvements in Reduced Speed School Zones^{1,4,5}

ROADWAY TYPE (number of lanes and median type)	ADT < 9,000			ADT 9,000 TO 12,000			ADT 12,000 TO 15,000			ADT > 15,000		
	≤ 30 MPH	35 MPH	≥ 40-45 MPH	≤ 30 MPH	35 MPH	≥ 40-45 MPH	≤ 30 MPH	35 MPH	≥ 40-45 MPH	≤ 30 MPH	35 MPH	≥ 40-45 MPH
Two Lanes	1	1 and/or 2	2 or 4	1	1 and/or 2	2 or 4	2	2	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
Three Lanes with Raised Median	1	1 and/or 2	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
Three Lane without Raised Median	1 and/or 2	2 or 4	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
>=Four Lanes with Raised Median	1 and/or 2	2 or 4	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4
>=Four Lanes without Raised Median	1 and/or 2	2 or 4	2 or 4	1 and/or 2	2 or 4	2 or 4	2 or 4	2 or 4	2 or 4	2 or 3 or 4	2 or 3 or 4	2 or 3 or 4

¹ = Low-Level Treatments (Refer to UDOT Policy 06C-27 Low-Level Treatments at Uncontrolled Locations)

² = Rapid Rectangular Flashing Beacon (RRFB)^{2,3}

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⁵Interlocking of recommended pedestrian crossing treatments with RSSZ devices, making one or the other device non-activatable, is **not** recommended.

