U.S. Department of Transportation
Federal Highway Administration

EDC

Oklahoma Department of Transportation

ACTION PLAN FOR IMPLEMENTING PEDESTRIAN CROSSING COUNTERMEASURES AT UNCONTROLLED LOCATIONS

Photo: Toole Design Group

ODOT
Oklahoma Department of Transportation

Acknowledgments

This Plan was developed by a group of dedicated individuals that are committed to reducing the number of lives taken prematurely on our nation's roadways.

Contributing Agencies:
ODOT
OHSO
ACOG
INCOG
Seminole Nation
FHWA

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AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	average daily traffic
CMF	crash modification factor
CRF	crash reduction factor
EDC	Every Day Counts
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GIS	geographic information system
HSIP	Highway Safety Improvement Program
HSP	Highway Safety Plan
MUTCD	Manual on Uniform Traffic Control Devices
NHTSA	National Highway Traffic Safety Administration
PHB	Pedestrian Hybrid Beacon
RSA	Road Safety Audit
SHSP	Strategic Highway Safety Plan
STBG	Surface Transportation Block Grant
STEP	Safe Transportation for Every Pedestrian
TZD	Toward Zero Deaths
VZ	Vision Zero

Executive Summary

State Participation in STEP Planning Initiative

This Plan has been developed as part of the Safe Transportation for Every Pedestrian (STEP) initiative and targets specific countermeasures for improving pedestrian safety at uncontrolled intersections. STEP is a Federal Highway Administration (FHWA) effort which is part of the Every Day Counts (EDC) Initiative. The Oklahoma Department of Transportation (ODOT) is leading this initiative in the state in coordination with the FHWA Division Office.

STEP has five stages: Not implementing; Development Phase, Demonstration Stage; Assessment Stage; and Institutionalized. States self-assess to determine their stage, and then decide if they would like to move up to the next stage. Oklahoma is currently in the Demonstration Stage (3rd) with an intent of moving to the Assessment Stage (4th) through the implementation of the recommendations of this plan.

The plan was developed as a collaborative effort between the FHWA Division Office and ODOT. A full day work session was held with ODOT staff to review existing practices and policies impacting crossings, and to develop the recommended actions reflected in this Plan. This was proceeded by a thorough review of their current use of the countermeasures and pedestrian safety processes.

Recommendations

This Plan recommends actions that when implemented may reduce the number and rate of pedestrian crashes, fatalities, and injuries on Oklahoma and the nation's highways. If emulated by local transportation agencies, these benefits may also be realized on local roads. ODOT has taken actions in the past several years to not only raise awareness of pedestrian travel, but to improve pedestrian safety. More importantly, ODOT is poised to take additional steps to implement the following STEP recommendations in this plan:

RECOMMENDATION: The commitment to safety as articulated in ODOT's Vision should be reflected in all ODOT policies, projects and programs. This includes giving priority to funding safety projects and using best design practices when making improvements. The commitment to safety should continue to be reflected in Strategic Highway Safety Plan (SHSP) which is currently being updated.

RECOMMENDATION: Include guidance, using the Manual on Uniform Traffic Control Devices (MUTCD) as a reference, for installing marked crosswalks at uncontrolled locations in the ODOT Roadway Design Manual. The guidelines should represent 'best practices' as found in FHWAs Guide for improving Pedestrian Safety at Uncontrolled Crossing Locations (2018).

RECOMMENDATION: The ODOT Americans with Disabilities Act (ADA) inventory of conditions at existing marked crosswalks at uncontrolled locations should be used as a basis for making pedestrian safety improvements. This includes ADA and other improvements that may be identified through the inventory process.

RECOMMENDATION: Building on the ADA Program, ODOT will select countermeasures and prioritize locations for improving pedestrian facilities at uncontrolled locations. Consideration will be given to dividing recommended improvements into three types of interventions: simple measures, moderately complex measures, and complex measures.

RECOMMENDATIONS: The Federal ADA prioritization system is well established and should be thought of as an entry point to talk about pedestrian safety issues in general. The ODOT ADA prioritization system should be expanded to prioritize all ODOT pedestrian safety projects.

RECOMMENDATION: For each of the documents listed below, ODOT will review for opportunities to include design guidance for improving pedestrian safety, with the intent of reducing pedestrian injuries and fatalities. It is anticipated that the following documents will be revised at some point within the next five to ten years:

- Roadway Design Standards & Specifications[1]
- Traffic Engineering Standards & Specifications[2]
- 2009 Special Provisions[3]
- Roadway Design Manual (currently under revision)

RECOMMENDATION: Continue to look for opportunities to bring in training courses; and look for opportunities to provide training at state-wide conferences and traffic safety forums.

1 Oklahoma Department of Transportation. (n.d.). Roadway Design Standards and Specifications. Retrieved from http://www.okladot.state.ok.us/roadway/standards.htm

2 Oklahoma Department of Transportation. (n.d.). Traffic Engineering and Standard Specifications. Retrieved from http://www.odot.org/traffic/standards.htm

3 Oklahoma Department of Transportation. (n.d.). 2009 Special Provisions. Retrieved from http://www.odot.org/c_manuals/specprov2009/index.php

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Introduction and Background

Pedestrians are among the most vulnerable road users, accounting for approximately 16 percent of all roadway fatalities nationally in 2016, per the Fatality Analysis Reporting System (FARS)[1]. Pedestrians are especially vulnerable at non-intersection locations where 72 percent of pedestrian fatalities occur. In the State of Oklahoma, pedestrians account for approximately 13% of all roadway fatalities.

What is STEP

This Plan has been developed as part of the Safe Transportation for Every Pedestrian (STEP) initiative and targets five specific countermeasures (described later in this guide) for improving pedestrian safety at uncontrolled intersections. STEP is an Federal Highway Administration (FHWA) initiative which is part of the Every Day Counts (EDC) effort. EDC is an FHWA-State DOT collaboration which focuses on underutilized innovations. Every two years a new set of initiatives is identified. STEP was identified as part of the fourth round of EDC innovations because of the cost-effectiveness of the countermeasures its offers with known safety benefits

Why Create this Pedestrian Safety Action Plan?

The purpose of this pedestrian safety action plan is to provide specific recommendations for improving

Every Day Counts (EDC)

The STEP initiative is part of EDC. In 2009, the Federal Highway Administration (FHWA) launched Every Day Counts (EDC) in cooperation with the American Association of State Highway and Transportation Officials (AASHTO) to speed up the delivery of highway projects and to address the challenges presented by limited budgets. EDC is a state-based model to identify and rapidly deploy proven but underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion and improve environmental sustainability.

Proven innovations through EDC facilitate greater efficiency at the state and local levels, saving time and resources that can be used to deliver more projects for the same money. By advancing 21st century solutions, the highway community is making every day count to ensure our roads and bridges are built better, faster and smarter.

HOW IT WORKS

Through the EDC model, FHWA works with state and local transportation agencies and industry stakeholders to identify a new collection of innovations to champion every two years. Innovations are selected collaboratively by stakeholders, taking into consideration market readiness, impacts, benefits and ease of adoption of the innovation. After selecting the EDC technologies for deployment, transportation leaders from across the country gather at regional summits to discuss the innovations and share best practices. These summits begin the process for states, local public agencies and Federal Lands Highway Divisions to focus on the innovations that make the most sense for their unique program needs, establish performance goals and commit to finding opportunities to get those innovations into practice over the next two years.

Throughout the two-year deployment cycle, specifications, best practices, lessons learned and relevant data are shared among stakeholders through case studies, webinars and demonstration projects. The result is rapid technology transfer and accelerated deployment of innovation across the nation.

1 National Highway Traffic Safety Administration. (2017). Fatality Analysis Reporting System (FARS) Encyclopedia. Retrieved from https://www-fars.nhtsa.dot.gov/QueryTool/QuerySection/SelectYear.aspx

conditions for walking at uncontrolled pedestrian crossing locations, which occur where sidewalks or designated walkways cross a roadway at a location where no traffic control (e.g., traffic signal or stop sign) is present. These common crossing types occur at intersections (where crosswalks may be marked or unmarked) and at non-intersection or midblock locations (where crosswalks must be marked). Overall, uncontrolled pedestrian crossing locations correspond to higher pedestrian crash rates than controlled locations, often due to inadequate pedestrian crossing accommodations.

By focusing on uncontrolled crossing locations, the Ohio Department of Transportation (ODOT) will address a significant safety problem and improve crossing potential for pedestrians of all ages and abilities. Recommendations in this Plan follow STEP guidance for implementing lower-cost countermeasures that can be deployed based on specific needs. They have a proven record of reducing crashes and represent underutilized innovations that can have an immediate impact.

This Plan also builds on existing State goals for improving safety, examining existing conditions, and using a data-driven approach to match countermeasures with demonstrated problem locations. Plan recommendations are structured to allow for immediate implementation.

State Participation in STEP

ODOT is leading this initiative in coordination with the FHWA Division Office, the State of Oklahoma Highway Safety Office (OHSO), Native American Tribes and Metropolitan Planning Organizations (MPO). This Plan recommends actions that when implemented may reduce the number and rate of pedestrian crashes, fatalities, and injuries on the Oklahoma state highway system. If emulated by local transportation agencies, these benefits may also be realized on county and city roads.

How this Safety Action Plan was Developed

This Plan is intended to be used in conjunction with two US DOT, FHWA publications:

EDC GUIDE FOR IMPROVING PEDESTRIAN SAFETY AT UNCONTROLLED CROSSING LOCATIONS (2018) (EDC GUIDE)

This guide assists State or local transportation or traffic safety departments that are considering developing a policy or guide to support the installation of countermeasures at uncontrolled pedestrian crossing locations. This document provides guidance to agencies, including best practices for each step involved in selecting countermeasures. By focusing on uncontrolled crossing locations, agencies can address a significant national safety problem and improve quality of life for pedestrians of all ages and abilities. Agencies may use this guide to develop a customized policy or to supplement existing local decision-making guidelines.

FHWA HOW TO DEVELOP A PEDESTRIAN AND BICYCLE SAFETY ACTION PLAN (2017) (FHWA HOW TO)

The purpose of this guide is to assist agencies in developing and implementing a safety action plan to improve conditions for bicycling and walking. The plan lays out a vision for improving safety, examining existing conditions, and using a data-driven approach to match safety programs and improvements with demonstrated safety concerns. This guide will help agencies enhance their existing safety programs and activities, including identifying safety concerns and selecting optimal solutions. It will also serve as a reference for improving pedestrian and bicycle safety through a multidisciplinary and collaborative approach to safety, including street designs and countermeasures, policies, and behavioral programs.

Some language in this Plan is borrowed directly from the above guides. In other cases, the text in this Plan points to these guides for additional information. The text also references other FHWA publications, American Association of State Highway and Transportation Officials (AASHTO) guides, the Manual on Uniform Traffic Control Devices (MUTCD), and relevant State publications for additional information. A complete list of referenced documents and other resources can be found in Appendix C.

The three-part process used to develop this Plan helps ensure that recommended actions represent the best use of agency resources:

1. Discovery: Current policies, plans, design guidance, prioritization methodologies, crash data and implementation strategies were identified and assembled with the assistance of ODOT staff.
2. One-day Work Session: ODOT staff, OHSO staff, Association of Central Oklahoma Governments (ACOG), Indian Nations Council of Governments (INCOG), Seminole Nation, and FHWA met to review materials assembled during the Discovery phase, and to develop the recommended actions reflected in this Plan.
3. Draft and Final Plan: Based on the one-day work session, a draft Action Plan was developed, reviewed by ODOT, revised and finalized.

This Plan will allow for consideration of pedestrian safety improvements to be incorporated in other ODOT plans; the Strategic Highway Safety Plan (SHSP), the Long Range Transportation Plan (LRTP), and the Oklahoma Highway Safety Improvement Program (HSIP).

The recommendations in this Plan provide a roadmap for reducing the number and rate of pedestrian crashes, fatalities and injuries. The recommendations identify current policies and practices that should be continued, as well as others that should be modified or added to better facilitate implementation.

Building a safe and connected pedestrian network requires consideration of topics beyond what is included in this Plan. There are other engineering-based countermeasures that exist for unsignalized and signalized intersections and for walking along streets and highways. Pedestrian crossings near schools are not specifically addressed in the Plan and will be subject to other State guidance. Although ADA requirements must be addressed as part of any pedestrian crossing improvements project, crossing requirements per the ADA are not specifically addressed in this Plan.

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Mission, Goals, and Recommendations

Mission

"The mission of the Oklahoma Department of Transportation is to provide a safe, economical and effective transportation network for the people, commerce and communities of Oklahoma."

Vision

ODOT is committed to improving safety for all travel modes, including pedestrians. This commitment is reflected in the agency mission statement.

The transportation system should accommodate people of all ages and abilities. Walking is an important element of a multimodal transportation system that supports a wide variety of users. Well-designed, well-maintained facilities, with low crash frequencies and severities, are important to creating safe walking conditions.

RECOMMENDATION: The commitment to safety as articulated in the Vision of this plan should be reflected in all ODOT policies, projects and programs. This includes strongly considering pedestrian safety project funding and using best design practices when making improvements.

The commitment to safety should continue to be reflected in the SHSP which is currently being updated.

ODOT recognizes the importance of setting clear, measurable goals for improving pedestrian safety as a way of monitoring progress in reducing fatalities, injuries, and crashes. This is reflected in the State's LRTP. "Safe and Secure Travel – Improve infrastructure safety and security of system users."[1] The Oklahoma Strategic Highway Safety Plan 2013-2014 includes a modest goal to reduce the number of pedestrian fatalities from 43 in 2011 to 42 in 2016[2]. This is based on a goal of reducing fatalities by ten percent using a five-year rolling average. The current goal is not being met.

RECOMMENDATION: The commitment to this goal should be reiterated in SHSP which is currently being updated. Strategies for meeting this goal should be reviewed and updated.

Performance measures are a way to measure the effectiveness of agency policies, projects and

1 Oklahoma Department of Transportation. Moving Oklahoma Forward: Oklahoma Long Range Transportation Plan 2015-2040. (Oklahoma City: Oklahoma Department of Transportation, August 2015), 2-2

2 Oklahoma Department of Transportation. Oklahoma Strategic Highway Safety Plan 2013-2014. (Oklahoma City: Oklahoma Department of Transportation, July 2015), Appendix A-1, p.23.

programs. They can be a measurement of outcomes (e.g., reduction in number of pedestrian injuries and fatalities), or they can be a measurement of production items (e.g., the number of curb ramps installed). They serve as a tool for building agency accountability. Deciding what to measure is important since it will guide the allocation of resources as agencies strive to meet performance measure objectives.

ODOT works with FHWA to establish and track safety performance measures as part of the Oklahoma Highway Safety Plan (HSP). The following performance measures are used to track and measure safety performance as five-year rolling averages:

- Number of fatalities
- Rate of Fatalities per 100 million VMT
- Number of serious injuries
- Rate of serious injuries per 100 million VMT

The University of Oklahoma is recognized as having one of the best safety programs in the state. The City of Shawnee and Pottawatomie County are participating in the Blue Zones, a program that focusses on improving public health using multiple strategies, including the creation of a safer walking environment.

RECOMMENDATION: ODOT will continue to work to reduce pedestrian fatalities and injuries as outlined in the HSP. Additionally, ODOT will continue to implement and expand current education programs. Coordination between ODOT, OSHO, MPOs, individual communities and Tribal Nations will be necessary for implementation. This includes, but is not limited to: funding a 'Watch for Me' pedestrian campaign; promoting safety messages on buses and law enforcement vehicles; bringing safety messages to other events; linking

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Prioritizing Pedestrian Crossing Improvements

Data Collection and Analysis

Individual Crash Location Analysis

Pedestrian crashes, especially those involving fatalities, are relatively rare at any given individual location. Improving pedestrian safety requires identification of problem roadway segments as well as intersection and mid-block locations. A simple mapping of crash locations involving pedestrians will quickly identify high crash locations and corridors. Five years of crash data is appropriate, though in rapidly changing areas, three years might be sufficient.

ODOT currently maintains a database of all motor vehicle crashes, including those involving pedestrians. ODOT has the capacity to map the location of crashes involving pedestrians showing high crash locations and roadway segments (see Appendix B).

Recommendation: ODOT will continue to collect and map pedestrian crashes to identify high crash locations and segments on state roads. Crash analysis completed by local and regional transportation agencies should also be considered. Maps will be created and made available, on a yearly basis, to all ODOT field divisions.

System-wide Crash Analysis

To conduct more sophisticated analyses of pedestrian crashes, additional data are needed. Detailed data such as including crash location, time, demographic information about the individuals involved in the crash, and whether drugs or alcohol were involved, can be extremely useful to determine whether there are patterns to pedestrian crashes. If so, the next step is to select the best countermeasures to address the identified issues. Analysis of detailed data can provide information on where crashes occur, when they occur, and characteristics of the victims.

It can also be helpful to categorize crashes by type. While there are over 60 specific pedestrian crash types, pedestrian crashes can generally be sorted into 12 crash type groupings for selecting countermeasures. Crash typing categorizes all crashes based on situational and behavioral circumstances and is a way to target countermeasures in engineering, education and enforcement programs at very specific types of crashes.

In 2017, ODOT created two maps reflecting pedestrian crashes on state roads: Highway Pedestrian Related Crashes – Uncontrolled 2013-2017" and "Highway Pedestrian Related Crashes – All 2013-2017." (see Appendix B) Based on the crashes information shown on these two maps, it appears that most of pedestrian crashes occurred at uncontrolled locations.

ODOT is considering evaluating pedestrian crashes for time of day, lighting, and day of week, using

Google Street View. ODOT is also working on making improvements to Geocoding pedestrian crash locations.

RECOMMENDATIONS: Continue to create maps which identify pedestrian crashes and high crash locations on state roads. Consider best practices for collecting and analyzing pedestrian crashes if state crash data collection and geo-coding procedures are revised.

Pedestrian Volume and Behavior Analysis

Pedestrian counts, along with field observations (e.g., driver yielding, conflicts, and pedestrian assertiveness), can be very useful in understanding pedestrian behavior and in considering the need for facilities. Counts and behavior studies, when combined with crash data, can provide insights into specific crash causes and potential countermeasures, and allow the determination of crash rates. On-site observations will often reveal behavior patterns that lead to design changes. Before and after counts can be used to measure success which in turn can be used to help secure funding for additional improvements at other locations. Pedestrian counts are also important to assess when and where signals, stop signs and marked crosswalks should be installed.

ODOT does not currently conduct pedestrian counts unless requested. However, ODOT recently purchased four pedestrian/bicycle counters that will be deployed in the future.

RECOMMENDATIONS: ODOT will continue to develop new pedestrian count and observation procedures along with policies for using the information.

Engineering Studies

There are many factors which affect crossing opportunities. These could include motorist approach speeds and volumes, motorist yielding, roadway configuration (width or roadway, number of travel lanes, etc.), and classification of vehicles, the volume and assertiveness of pedestrians and bicyclists.

As part of the engineering studies, sight distances are typically evaluated. Motorists must be provided sufficient stopping sight distance to be able to see, react, and yield to crossing pedestrians. Likewise, pedestrians require sufficient sight distance to identify and judge gaps in traffic. Where sight distance is limited, efforts should be made to increase it by removing parking or other sight obstructions, or to install curb extensions to allow pedestrians to wait closer to the edge of the roadway. Where sight distance cannot be provided, active warning devices should be provided in advance of the intersection, in conjunction with a Pedestrian Hybrid Beacon (PHB) or traffic signal.

ODOT currently uses the guidance in the MUTCD when conducting an engineering study to evaluate the safety of an uncontrolled crossing. It is ODOT policy to conduct an engineering study when evaluating whether or not to install a marked crosswalk.

RECOMMENDATIONS: Continue with current policy

Prioritizing Pedestrian Crossing Improvements

A pre-defined methodology for prioritizing pedestrian improvements ensures that resources are allocated in a way that best meets goals to reduce pedestrian injuries and fatalities. A prioritization methodology should be:

- Responsive to ODOT and community values: Decisions should be based on ODOT mission statement and goals.
- Flexible: Rather than being a rigid, “one-size-fits-all” tool, a prioritization methodology should be flexible and allow practitioners to choose the most appropriate approach that reflects ODOT goals and resource availability.

- Transparent: A prioritization process should be broken down into a series of discrete steps, each of which can be easily documented and explained to the public.

ODOT currently requires some local prioritization of projects through the Surface Transportation Block Grant Program, administered by the Local Government Division. Transportation Alternative Program (TAP) funds are also prioritized using 'safety' as one of the criteria. The ODOT ADA program has a prioritization system for prioritizing ADA related projects at crossing locations.

RECOMMENDATIONS: The ODOT ADA prioritization system is well established and should be thought of as an entry point to talk about pedestrian safety issues in general. The ODOT ADA prioritization system should be expanded to prioritize all ODOT pedestrian safety projects.

Systemic Analysis Approach to Prioritization

Many areas may have low pedestrian crash rates, but still have a high potential for pedestrian crashes. Emerging methodologies identify these sites based on roadway characteristics combined with land use features of the area. In some cases, it may be possible to select countermeasures to address these high potential factors before pedestrian crashes occur. Systemic analysis considers factors such as roadway design characteristics and traffic control devices, lighting conditions, vehicle speeds, and nearby pedestrian destinations. Combinations of these factors will also help identify countermeasures to address and prevent pedestrian crashes.

RECOMMENDATION: ODOT will continue to monitor emerging methodologies for completing a systemic analysis approach to prioritization. Adoption will depend on effectiveness of the methodology, available resources and data.

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Marked Crosswalks at Uncontrolled Locations

Marked Crosswalk Policy

Marked crosswalks delineate optimal or preferred location for a pedestrian to cross a street, and indicate to motorists where to expect pedestrians. Pavement markings must follow one of the types as shown in the MUTCD. New marked crosswalk installations at uncontrolled locations require an engineering study.

Marked crosswalks help to improve pedestrian safety and the connectivity of the pedestrian network. A marked crosswalk policy creates a consistent approach for the evaluation and installation of marked crosswalks. Uniform and consistent application of marked crosswalks can help increase predictability for both pedestrians and drivers. A marked crosswalk policy should:

- Identify what factors are taken into consideration during evaluation (e.g., traffic volume, traffic speeds, crashes, destinations, roadway design, etc.)
- Establish the primary types of crossing treatments to be considered for any marked crosswalk location (including high visibility crosswalks)
- Determine a prioritization process for how crosswalk marking is implemented. Inputs to this prioritization may include locational data such as transit stops, school walking routes, senior walking routes, high collision locations, and midblock locations with high numbers of pedestrians crossing the street.

FHWA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018) provides guidance for installing marked crosswalks.

ODOT follows guidelines in the MUTCD (Section 3B.18) for installing sidewalks.

> ***RECOMMENDATION:*** Include guidance, using the MUTCD as a reference, for installing marked crosswalks at uncontrolled locations in the ODOT Roadway Design Manual. The guidelines should represent 'best practices' as found in FHWAs Guide for improving Pedestrian Safety at Uncontrolled Crossing Locations (2018).

Inventory and Evaluation of Marked Crosswalks at Uncontrolled Locations

A systematic inventory of conditions at existing marked crosswalks, and potential locations, is necessary for prioritizing locations and selecting countermeasures. This also will eventually require a complete list of existing marked crosswalk locations. The review of existing marked crosswalks should be based on the guidelines in the marked crosswalk policy. The results can be used to create a plan for making improvements

at marked crosswalks at uncontrolled locations.

The ODOT ADA program has a detailed inventory of conditions at existing marked crosswalks at uncontrolled locations on state highways. Through the ODOT ADA program, deficiencies are being addressed and more than ten million dollars have been dedicated to making improvements over the next thirty-seven years.

> ***RECOMMENDATION:*** The ODOT ADA inventory of conditions at existing marked crosswalks at uncontrolled locations should be used as a basis for making pedestrian safety improvements. This includes any ADA and other improvements that may be identified through the inventory process.

Selecting Countermeasures and Prioritizing Locations for Improvements

The goal of this Plan is to improve pedestrian crossing facilities at uncontrolled marked crosswalks so that they will operate as they are designed to work, with drivers yielding to pedestrians and pedestrians getting across the road safely. Rather than just deciding whether marked crosswalks should or should not be provided, the improvement plan asks what are the most effective measures that can be used to help pedestrians safely cross the street. Improvement plans are typically divided into three types of interventions: simple measures, moderately complex measures, and complex measures. The more complex the measure the more time, money, and coordination among different divisions may be required.

Simple measures include sign replacement and enhancement, high visibility crosswalk remarking, advance stop bars, curb ramps, and lighting adjustments. Moderately complex measures include pedestrian refuge islands (where no rechannelization is required), curb extensions, lighting additions, and changes in pedestrian circulation. Complex measures include pedestrian hybrid beacons, road diets, crossing islands (where re-channelization is required), raised crosswalks, and intersection redesign. After prioritizing locations using the methodology as described in Chapter 3, they should be further organized according to complexity.

Through the ADA program, ODOT has prioritized locations for improving pedestrian crossing facilities at uncontrolled locations. However, ODOT has not selected countermeasures beyond ADA improvements at these locations.

> ***RECOMMENDATION:*** Building on the ADA Program, ODOT will select countermeasures and prioritize locations for improving pedestrian facilities at uncontrolled locations. Consideration will be given dividing recommended improvements into three types of interventions: simple measures, moderately complex measures, and complex measures.

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Toolbox: Pedestrian Crossing Countermeasures at Uncontrolled Locations

Selecting Countermeasures

The results of the crash analysis, road safety audit, and/or stakeholder input can provide a better understanding of the risk factors at uncontrolled crossing locations. The countermeasures listed in this guide can improve the visibility of crossing locations and reduce crashes, and they each address at least one additional safety concern associated with a higher risk of collision and/or severe injury. The countermeasures, when implemented, should follow MUTCD and other relevant AASHTO, FHWA and State guidance.

Table 1 shows a comprehensive matrix and list of STEP recommended pedestrian crash countermeasures suggested for application at uncontrolled crossing locations per roadway and traffic features. The countermeasures are assigned to specific matrix cells based on safety research, best practices, and established national guidelines. When a pedestrian crossing is established, the countermeasure options in the cells should be reviewed before selecting the optimal group of crossing treatments. Previously obtained characteristics such as pedestrian volume, operational speeds, land use context, and other site features should also be considered when selecting countermeasures. ODOT will reference the MUTCD and other national, State, and local guidelines when making the final selection of countermeasures.

Table 2 shows the specific safety issues that each countermeasure may address. The results of the crash analysis, road safety audit, and/or stakeholder input provide ODOT with a better understanding of the risk factors at uncontrolled crossing locations. Some additional safety issues to be considered include excessive vehicle speed, inadequate sight lines/visibility, drivers not yielding to pedestrians in crosswalks, and/or insufficient separation from traffic.

1. Crosswalk Visibility Enhancement

Marked crosswalks on their own do not necessarily increase or decrease the security of a pedestrian crossing the roadway. However, their safety can be increased with high visibility pavement markings, advanced stop bars and warning signs, in-street pedestrian crossing signs, illumination, curb extensions and tighter curb radii.

High Visibility Crosswalk Markings

High visibility crosswalk markings ensure that drivers see the crosswalk, not just the pedestrian. Two parallel lines indicating a marked crosswalk can be almost invisible to the motorist at uncontrolled locations. When a decision has been made to use crosswalk markings, high visibility markings such as ladder style or continental markings should be used at locations without positive traffic control, and are advised at locations with positive traffic control (signals, stop signs).

ODOT design standards for marked crosswalks include an option for continental markings which are considered high-visibility.

RECOMMENDATION: ODOT will consider crosswalk marking options to develop guidelines for when and where to install different types of markings. Consideration will be given to establishing a 10-foot minimum width for marked crosswalks.

Advance Yield Bar and Yield Here to Pedestrians sign

A multiple threat crash results when a car in one lane stops to let the pedestrian cross, blocking the sight lines of the vehicle in the other lane of a multi-lane approach, which advances through the crosswalk and hits the crossing pedestrian. If advance yield lines and R1-5a or signs are used in advance of a crosswalk, they should be placed together and 20 to 50 feet before the nearest crosswalk line; parking should be

Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Speed Limit								
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
2 lanes*	● 2 3 4 5 6	● ● 5 6 7	● ● 5 6 ●	● 3 4 5 6	● ● 5 6 7	● ● 5 6 ●	● 3 4 5 6 7	● ● 5 6 7	● ● 5 6 ●
3 lanes with raised median*	● 2 3 4 5	● ● 5 7	● ● 5 ●	● 3 4 5 7	● ● 5 ●	● ● 5 ●	● ● 4 5 7	● ● 5 ●	● ● 5 ●
3 lanes w/o raised median†	● 2 3 4 5 6 7	● ● 5 6 7	● ● 5 6 ●	● 3 4 5 6 7	● ● 5 6 ●	● ● 5 6 ●	● ● 4 5 6 7	● ● 5 6 ●	● ● 5 6 ●
4+ lanes with raised median‡	● ● 5	● ● 5 7	● ● 5 ●	● ● 5 7	● ● 5 ●	● ● 5 ●	● ● 5 ●	● ● 5 ●	● ● 5 ●
4+ lanes w/o raised median‡	● ● 5 6 7 8	● ● 5 ● 7 8	● ● 5 ● ● 8	● ● 5 ● 7 8	● ● 5 ● ● 8	● ● 5 ● ● 8	● ● 5 ● ● 8	● ● 5 ● ● 8	● ● 5 ● ● 8

*One lane in each direction †One lane in each direction with two-way left-turn lane ‡Two or more lanes in each direction

Given the set of conditions in a cell,

- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1 High-visibility crosswalk markings, parking restriction on crosswalk approach, adequate nighttime lighting levels
2 Raised crosswalk
3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Pedestrian Hybrid Beacon
8 Road Diet

This table was developed using information from: Zegeer, C. V., Stewart, J. R., Huang, H. H., Lagerwey, P. A., Feaganes, J., & Campbell, B. J. (2005), Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines (No. FHWA-HRT-04-100); Manual on Uniform Traffic Control Devices, 2009 Edition, Chapter 4F. Pedestrian Hybrid Beacons; the Crash Modification Factors (CMF) Clearinghouse website (http://www.cmfclearinghouse.org/); and the Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE) website (http://www.pedbikesafe.org/PEDSAFE/).

prohibited in the area between the yield line and the crosswalk. The MUTCD requires R1-5a signs when yield lines are used in advance of a crosswalk with an uncontrolled multi-lane approach.

ODOT uses advance stop and/or yield bars on a project by project basis. Consultants usually do an engineering study that would recommend and install per MUTCD. However, ODOT typically does not install Yield here to pedestrian signs at the vehicle stop location.

RECOMMENDATION: Update current design plans to include a stop and/or yield bar and the 'Yield Here to Pedestrian' signs at the vehicle stop location, consistent with the MUTCD.

In-street Pedestrian Crossing sign

In-street signs are placed in the middle of the road at a crossing and are often used in conjunction with refuge islands. These signs may be appropriate on 2-lane or 3-lane roads with speed limits of 30 mph or less. MUTCD Section 2B.12—In- Street and Overhead Pedestrian Crossing Signs contains additional information about these signs.

Table 2. Safety issues addressed per countermeasure.

	Safety Issue Addressed				
Pedestrian Crash Countermeasure for Uncontrolled Crossings	**Conflicts at crossing locations**	**Excessive vehicle speed**	**Inadequate conspicuity/ visibility**	**Drivers not yielding to pedestrians in crosswalks**	**Insufficient separation from traffic**
Crosswalk visibility enhancement	✓	✓	✓	✓	✓
High-visibility crosswalk markings*	✓		✓	✓	
Parking restriction on crosswalk approach*	✓		✓	✓	
Improved nighttime lighting*	✓		✓		
Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line*	✓		✓	✓	✓
In-Street Pedestrian Crossing sign*	✓	✓	✓	✓	
Curb extension*	✓	✓	✓		✓
Raised crosswalk	✓	✓	✓	✓	
Pedestrian refuge island	✓	✓	✓		✓
Pedestrian Hybrid Beacon	✓			✓	
Road Diet	✓	✓	✓		✓

*These countermeasures make up the STEP countermeasure "crosswalk visibility enhancements." Multiple countermeasures may be implemented at a location as part of crosswalk visibility enhancements.

ODOT does not currently have a policy for when and where to install in-street pedestrian crossing signs at uncontrolled locations.

RECOMMENDATION: ODOT will consider inclusion in the Traffic Design Standards and Specifications for in-street pedestrian crossing sign, consistent with the MUTCD.

Illumination

Up to half of pedestrian crashes nationwide occur at night. Lighting greatly increases the driver's ability to see pedestrians crossing the road.

ODOT adds additional illumination at marked crosswalks on a project by project basis.

RECOMMENDATION: ODOT will initiate a meeting internally to review basis of current lighting policy and discuss potential changes.

Curb Extensions

Curb extensions extend the sidewalk or curb face into the parking lane or shoulder at an intersection, thus improving sight distance between the driver and pedestrian. They are typically designed to extend no further than the edge of a parking lane or shoulder. They are also known as neckdowns, bumpouts or bulbouts. They are most commonly applied at intersections where they are intended to reduce the pedestrian crossing distance, slow right-turning vehicles, improve visibility between motorists and pedestrians, and provide more space for landscaping or storm water management, among other features. When trees are planted on curb extensions, they can be an effective treatment to visually narrow a street and thus create traffic calming effects.

ODOT does not have policy or guidance for the installation of curb extensions at established pedestrian crossings at uncontrolled locations.

RECOMMENDATION: ODOT will consider inclusion of curb extensions in the Traffic Design Standards and Specifications.

Tighter Curb Radii

Tighter curb radii can improve sight lines between driver and pedestrian, shorten the crossing distance, bring crosswalks closer to the intersection, and slow right-turning vehicles. Intersection design will determine whether best practices for meeting ADA requirements can be applied. The appropriate radius should be calculated for each corner on a case by case basis, taking into account the design vehicle.

The Traffic Design Standards and Specifications includes guidance on curb radii. Typically, the default is a larger radius to accommodate truck turning movements.

RECOMMENDATION: ODOT will consider reevaluating its current guidelines to develop a more nuanced approach that reflects the design vehicle, desired turning speed, and context. The goal would be to create tighter curb radii where appropriate. Consideration could also be given to truck aprons in lieu of a barrier curb.

2. Raised Crosswalks

Raised crosswalks function as an extension of the sidewalk and allow a pedestrian to cross the street without stepping down to street level. A raised crosswalk is typically a candidate treatment on 2-lane or 3-lane roads with speed limits of 30 mph or less and AADTs below 9,000. Raised crossings are generally avoided on truck routes, emergency routes, and arterial streets. For retrofit projects, drainage needs to be evaluated and revised as necessary. See MUTCD Section 3B.25—Speed Hump Markings for additional information about markings that can be used alongside raised crosswalks.

ODOT does not have a policy regarding raised crosswalks at established pedestrian crossings at uncontrolled locations.

Recommendation: Raised crosswalks might be acceptable on roadways with speeds under 30 mph. Refer to PEDSAFE (www.pedbikesafe.org) for further guidance if there is a situation where a raised crosswalk is being considered.

3. Pedestrian Refuge Islands

A pedestrian refuge island is typically constructed in the middle of a 2-way street and provides a place for pedestrians to stand and wait for motorists to stop or yield. This countermeasure is highly desirable for midblock pedestrian crossings on roads with four or more lanes, and should be considered especially for undivided crossings of four or more lanes with speed limits of 35 mph or greater and/or AADTs of 9,000 or greater. Median islands may also be a candidate treatment for uncontrolled pedestrian crossings on 3-lane or 2-lane roads, especially where the street is wide and/or where vehicle speed or volumes are moderate to high. Consideration should be given to creating a two-stage crossing with the island to encourage pedestrians to cross one direction of traffic at a time and look towards oncoming traffic before completing the second part of the crossing. The minimum pedestrian refuge island width is approximately 6 feet. MUTCD Sections 3B.10—Approach Markings for Obstructions, 3B.18—Crosswalk Markings, and 3B.23—Curb Markings provide additional information.

ODOT does not currently have a policy regarding pedestrian refuge islands at established pedestrian crossings at uncontrolled locations.

> ***RECOMMENDATION:*** Evaluate existing system to determine if there is a need. Develop policy guidance on when and where to install refuge islands, using best practices as found in PEDSAFE and the new AASHTO Pedestrian Guide (when it becomes available – likely in 2019).

4. Pedestrian Hybrid Beacons (PHBs)

PHBs are a candidate treatment, especially for roads with three or more lanes that generally have AADT above 9,000. PHBs should be strongly considered for midblock and intersection crossings where the roadway speed limits are equal to or greater than 40 mph. Refer to Table 1 for other conditions where PHBs should be strongly considered. Application guidelines for the PHB are provided in Figure 4F-1 (for speeds of 35 mph or less) and Figure 4F-2 (for speeds greater than 35 mph) of the MUTCD. Chapter 4F—Pedestrian Hybrid Beacons provides additional requirements and information about the use of this device. Figure 6 shows a rendering of a PHB.

PHBs are still relatively new to Oklahoma with only two on the state highway system and only one on a local road. By the end of 2014, the state highway system will have two more.

> ***RECOMMENDATION:*** ODOT will review current practices, standards, and specifications and will consider developing more detailed guidance on locating and installing PHBs consistent with MUTCD guidance.

5. Road Diet

A Road Diet, also called a lane reduction or road rechannelization, is a technique in transportation planning whereby the number of travel lanes and/or effective width of the road is reduced in order to achieve systemic improvements. A common Road Diet involves converting a 4-lane, undivided roadway into a 3-lane roadway with a center turn lane. This is a candidate treatment for any undivided road with wide travel lanes or multiple lanes that can be narrowed or repurposed to improve pedestrian crossing safety.

By reducing the width of the roadway, pedestrians benefit from shorter crossing distances and often bike lanes or streetscape features can be added. Road Diets are often effectively accomplished during

pavement resurfacing and enable the implementation of many of the other countermeasures discussed above.

ODOT does not have a formal policy regarding road diets. However, ODOT, working with local jurisdictions and using FHWA guidance, will consider road diets.

RECOMMENDATION: ODOT will consider developing formal road diet installation policies. ODOT will consider developing a maintenance agreement template for local agencies who are proposing to do a road diet on a state road.

6

Policy Recommendations

The following implementation strategies provide a roadmap for implementation of this Plan through institutionalization, with the intent of making pedestrian safety a key part of all ODOT activities.

Policy and Planning Documents

At any given time, one or more policy, planning and other agency documents are undergoing revisions and updates. This is the ideal time to make changes that begin to make pedestrian considerations the norm.

Recommendation: For each of the documents listed below, ODOT will review for opportunities to include policy and planning guidance for improving pedestrian safety, with the intent of reducing pedestrian injuries and fatalities. It is anticipated that the following documents will be revised at some point within the next five to ten years:

- "Moving Oklahoma Forward: Oklahoma Long Range Transportation Plan 2015-2040"[1] – revision in 2020
- "Oklahoma Strategic Highway Safety Plan 2018" [2]
- Oklahoma Highway Safety Plan – annually updated (Federal Fiscal Year)
- Statewide Pedestrian Bicycle Plan – by 2025
- Roadway Design Manual
- ADA design directives along pedestrian facilities

ODOT Design and Traffic Manuals

In addition to FHWA, AASHTO and MUTCD guidance, ODOT has developed agency policy and planning guidance regarding transportation related topics. This guidance defines approaches to solving safety problems, setting priorities and providing decision making procedures. Policy and planning documents provide a means to increase awareness of pedestrian safety issues while also providing specific objectives for reducing injuries and fatalities. These manuals are the most used resources for engineers within Departments of Transportation and incorporating countermeasure considerations into these manuals is one of the key steps to ensuring their routine use.

ODOT Design and Traffic Manuals provide design guidance and standards that, among other things,

1 Oklahoma Department of Transportation. (2015). "Moving Oklahoma Forward", Oklahoma Long Range Transportation Pan 2015-2040. Retrieved from http://www.okladot.state.ok.us/p-r-div/lrp_2015_2040/2040_LRTP_Full_Document.pdf

2 Oklahoma Department of Transportation. (2018). Oklahoma 2018 Highway Safety Plan. Retrieved from https://ohso.publishpath.com/Websites/ohso/images/Publications/2018%20HSP%20Revised.pdf

ensures roadway crossings at uncontrolled locations are designed to maximize pedestrian safety and access.

RECOMMENDATION: For each of the documents listed below, ODOT will review for opportunities to include design guidance for improving pedestrian safety, with the intent of reducing pedestrian injuries and fatalities. It is anticipated that the following documents will be revised at some point within the next five to ten years:

- Roadway Design Standards & Specifications[3]
- Traffic Engineering Standards & Specifications[4]
- 2009 Special Provisions[5]
- Roadway Design Manual (currently under revision)

Annual Project Priorities

Integrating pedestrian facilities into routine reconstruction and resurfacing projects as part of ODOT's 8-year Construction Work Plan using Road Diets and other repurposing of roadway space, is a cost-effective way to integrate pedestrian facilities into resurfacing projects.

ODOT reviews resurfacing projects for opportunities to include pedestrian improvements at marked crosswalks at uncontrolled locations. ODOT also makes required ADA improvements as part of all resurfacing projects.

RECOMMENDATION: ODOT will review current practices and consider the need to develop a more formal policy and agency procedures on including pedestrian improvements (beyond ADA) in resurfacing projects.

American Disabilities Act (ADA) Transition Plan

The ODOT ADA Transition Plans ensure that all pedestrian facilities will become accessible over time. Implementation of the ADA Transition Plan also provides an opportunity to make safety improvements that benefit all pedestrians. According to ADA, whenever streets are resurfaced, ramps and other accessibility improvements must be made which open opportunities for crosswalk countermeasures. The current ADA Transition Plan was approved in 2017 and is updated every six months.

RECOMMENDATION: ODOT will continue to update the ADA Transition Plan every six months, exploring opportunities to make safety improvements that benefit all pedestrians.

Public Involvement as an Implementation Strategy

ODOT recognizes that public involvement is another excellent way to get a better product. It also builds public support for programs and policies to reduce pedestrian crashes. To be effective, stakeholders must feel listened to and heard.

ODOT routinely solicits public comment on upcoming roadway projects. ODOT does not have a policy for public involvement in pedestrian projects.

RECOMMENDATION: ODOT will explore revising the Public Participation Plan to be proactive, using non-traditional types of outreach such as social media, online surveys, online interactive maps, meeting in a box (going to other meetings and bringing up issues).

3 Oklahoma Department of Transportation. (n.d.). Roadway Design Standards and Specifications. Retrieved from http://www.okladot.state.ok.us/roadway/standards.htm

4 Oklahoma Department of Transportation. (n.d.). Traffic Engineering Standards and Specifications. Retrieved from http://www.odot.org/traffic/standards.htm

5 Oklahoma Department of Transportation. (n.d.). 2009 Special Provisions. Retrieved from http://www.odot.org/c_manuals/specprov2009/index.php

Request for Proposals (RFP)

Including experts in pedestrian transportation planning on consulting teams for major public works ensures that opportunities for making pedestrian improvements are maximized. This can be accomplished by making sure the requests for proposals or qualifications RFP that are issued by ODOT include this requirement.

Currently, applications for TAP and Safe Routes to Schools (SRTS) funds receive extra points (10) if a pedestrian safety issue is being addressed. ODOT has 'prequalified' consultant lists of which one category is 'Pedestrian Expertise'. 'Pedestrian Expertise' is included in RFPs on an as-needed basis.

RECOMMENDATION: Continue current practice.

Ongoing Training

ODOT recognizes that the field of pedestrian transportation planning and design is changing rapidly as new research is completed and innovative approaches are implemented.

ODOT provides training as often as possible for a variety of transportation topics. Recent trainings included Designing for Pedestrian Facilities and Accessibility, STEP workshops; Designing for Pedestrian Safety, and NACTO pedestrian planning and design.

RECOMMENDATION: Continue to look for opportunities to bring in training courses; and look for opportunities to provide training at state-wide conferences and traffic safety forums.

Glossary

AVERAGE ANNUAL DAILY TRAFFIC (AADT)
The total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year.

AVERAGE DAILY TRAFFIC (ADT)
The average 24-hour volume of traffic passing a point or segment of a highway in both directions.

COMPLETE STREETS
Complete Streets are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities. (Smart Growth America, National Complete Streets Coalition.)

CONTROLLED PEDESTRIAN CROSSING
A pedestrian crossing where motorists are required to stop by either a STOP sign, traffic signal, or other traffic control device.

CRASH MODIFICATION FACTOR (CMF)
A multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure. If available, calibrated or locally developed State estimates may provide a better estimate of effects for the State. (Crash Modification Factors Clearinghouse.)

CRASH REDUCTION FACTOR (CRF)
The percentage crash reduction that might be expected after implementing a given countermeasure at a specific site.

CURB EXTENSIONS
A roadway edge treatment where a curb line is bulbed out toward the middle of the roadway to narrow the width of the street. Curb extensions are sometimes called "neckdowns."

HIGHWAY SAFETY IMPROVEMENT PROGRAM (HSIP)
A Federal-aid program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned roads and roads on tribal land. The HSIP requires a data-driven, strategic approach to improving highway safety on all public roads with a focus on performance. (FHWA.)

HIGH VISIBILITY CROSSWALK
A pedestrian crossing location marked by patterns such as zebra, ladder, or continental markings as described by the MUTCD.

MARKED CROSSWALK
A pedestrian crossing that is delineated by white crosswalk pavement markings.

PARKING RESTRICTION
Parking restriction can include the removal of parking space markings, installation of new "parking prohibition" pavement markings or curb paint, and signs.

PEDESTRIAN HYBRID BEACON (PHB)

A traffic control device with a face that consists of two red lenses above a single yellow lens. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection.

RAISED CROSSWALK

Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at midblock crossing locations.

REFUGE ISLAND

A median with a refuge area that is intended to help protect pedestrians who are crossing the road. This countermeasure is sometimes referred to as a crossing island or pedestrian island.

ROAD DIET

A roadway reconfiguration resulting in a reduction in the number of travel lanes. The space gained by eliminating lanes is typically used for other uses and travel modes. (FHWA.)

ROAD SAFETY AUDIT (RSA)

A formal examination of an existing or future road or intersection by a multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users. (FHWA.)

TOWARD ZERO DEATHS (TZD)

TZD is a traffic safety framework that seeks to eliminate highway fatalities by engaging diverse safety partners and technology to address traffic safety culture. (See also: Vision Zero.)

UNCONTROLLED PEDESTRIAN CROSSING

An established pedestrian crossing that does not include a traffic signal, beacon, or STOP sign to require that motor vehicles stop before entering the crosswalk.

VEHICLE QUEUE

A line of stopped vehicles in a single travel lane, commonly caused by traffic control at an intersection.

VISION ZERO (VZ)

Similar to TZD, Vision Zero is a vision to eliminate traffic fatalities and serious injuries within the transportation system. VZ employs comprehensive strategies to address roadway design, traffic behavior, and law enforcement.

Appendix: CRF and CMF Summary Table

Table 3. CRFs and CMFs by countermeasure.

Countermeasure	CRF	CMF	Basis	Reference
Crosswalk visibility enhancement[1]	—	—	—	—
Advance STOP/YIELD signs and markings	25%	0.75	Pedestrian crashes[2]	Zegeer, et. al. 2017
Add overhead lighting	23%	0.77	Total injury crashes	Harkey, et. al. 2008
High-visibility marking[3]	48%	0.52	Pedestrian crashes	Chen, et. al., 2012
High-visibility markings (school zone)[3]	37%	0.63	Pedestrian crashes	Feldman, et. al. 2010
Parking restriction on crosswalk approach	30%	0.70	Pedestrian crashes	Gan, et. al., 2005
In-street Pedestrian Crossing sign	UNK	UNK	N/A	N/A
Curb extension	UNK	UNK	N/A	N/A
Raised crosswalk (speed tables)	45%	0.55	Pedestrian crashes	Elvik, et. al., 2004
	30%	0.70	Vehicle crashes	
Pedestrian refuge island	32%	0.68	Pedestrian crashes	Zegeer, et. al., 2017
PHB	55%	0.45	Pedestrian crashes	Zegeer, et. al., 2017
Road Diet – Urban area	19%	0.81	Total crashes	Pawlovich, et. al., 2006
Road Diet – Suburban area	47%	0.53	Total crashes	Persaud, et. al., 2010

[1]This category of countermeasure includes treatments which may improve the visibility between the motorist and the crossing pedestrian.
[2]Refers to pedestrian street crossing crashes, and does not include pedestrians walking along the road crashes or "unusual" crash types.
[3]The effects of high-visibility pavement markings (e.g., ladder, continental crosswalk markings) in the "after" period is compared to pedestrian crashes with parallel line markings in the "before" period.

Appendix B: Locations of Pedestrian Crashes

Figure 1 Highway Pedestrian Related Crashes – Uncontrolled, 2013-2017:

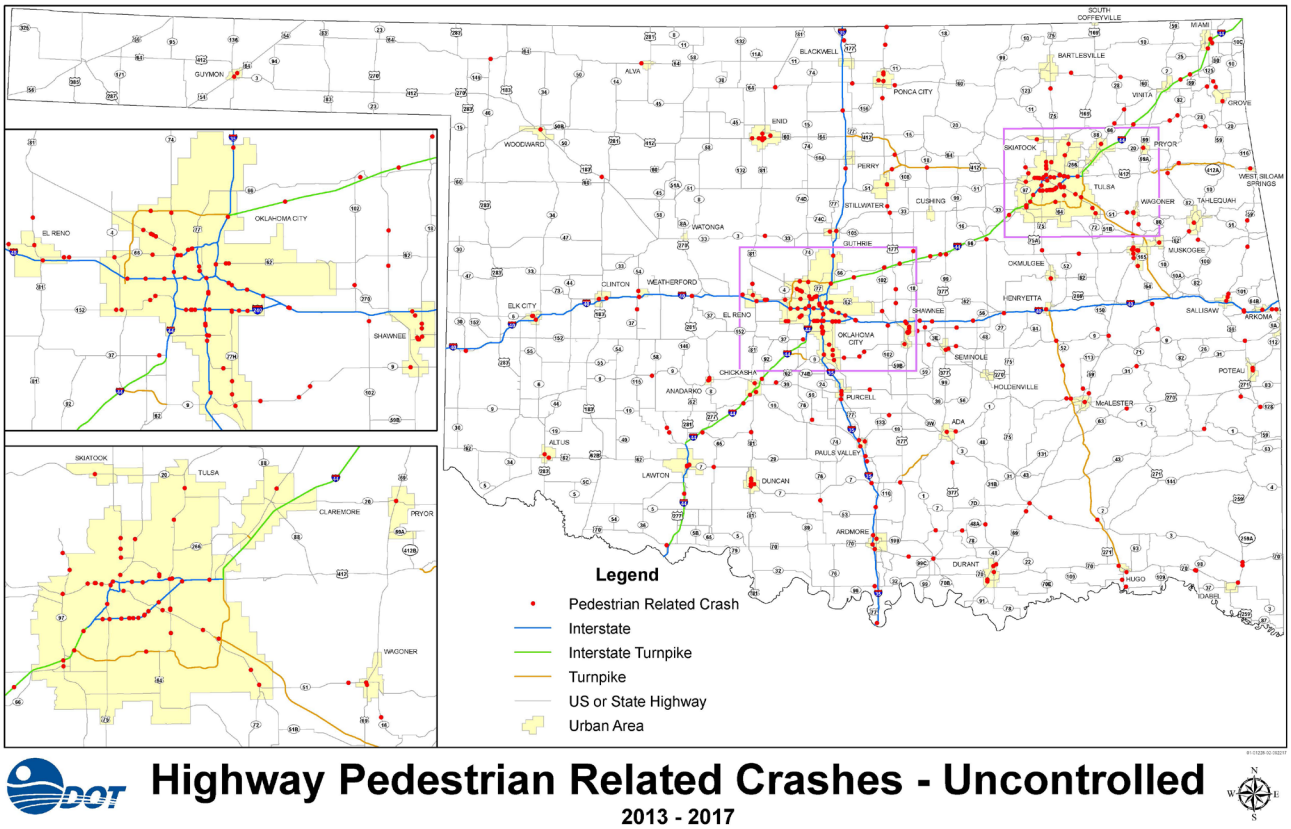
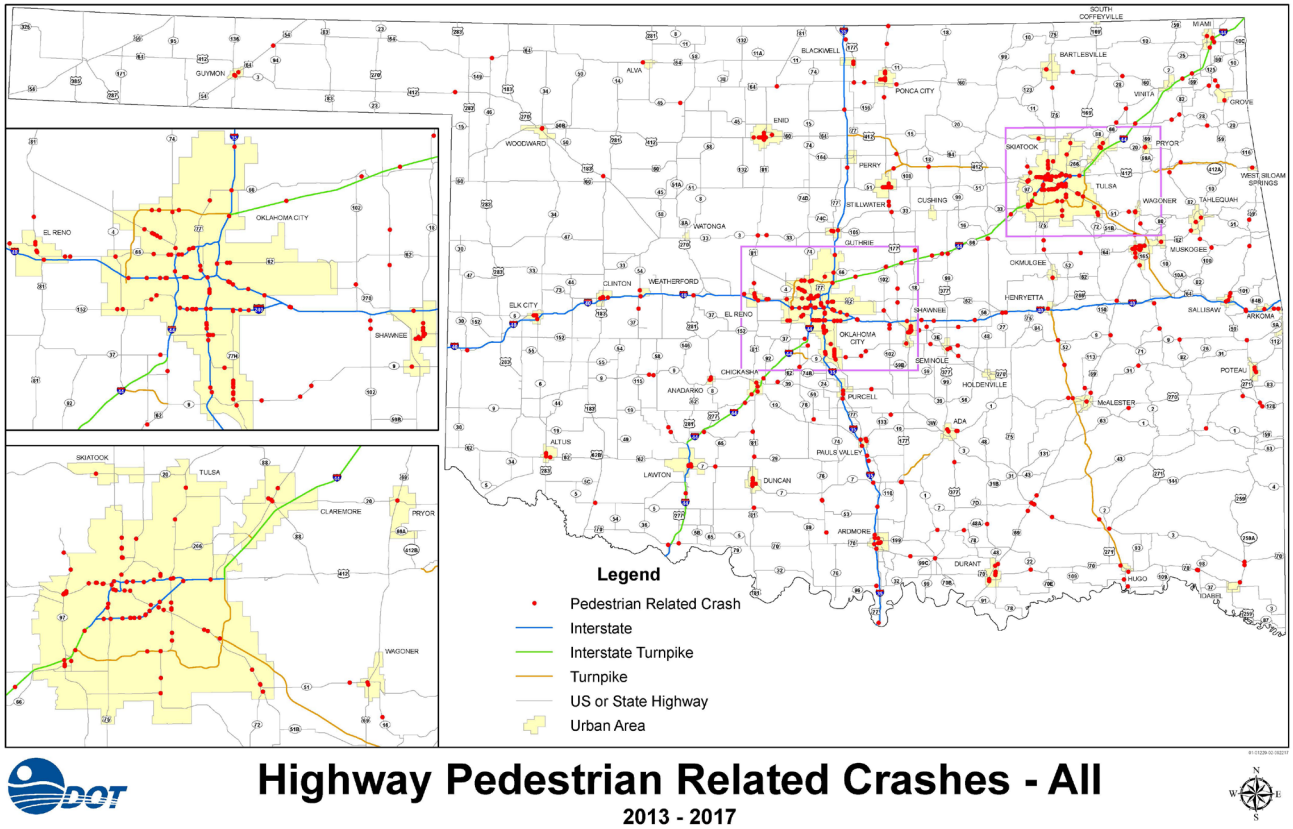


Figure 2 Highway Pedestrian Related Crashes – All, 2013-2017:



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4. Oklahoma Strategic Highway Safety Plan (SHSP); Oklahoma Highway Patrol, Oklahoma Highway Safety Office, Oklahoma Department of Transportation, U.S. Department of transportation; 2013-2014.
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Resources

EDC Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018)

This guide assists State or local transportation or traffic safety departments that are considering developing a policy or guide to support the installation of countermeasures at uncontrolled pedestrian crossing locations. This document provides guidance to agencies, including best practices for each step involved in selecting countermeasures. By focusing on uncontrolled crossing locations, agencies can address a significant national safety problem and improve quality of life for pedestrians of all ages and abilities. Agencies may use this guide to develop a customized policy or to supplement existing local decision-making guidelines

FHWA How to Develop a Pedestrian and Bicycle Safety Action Plan (2017)

The purpose of this guide is to assist agencies in developing and implementing a safety action plan to improve conditions for bicycling and walking. The plan lays out a vision for improving safety, examining existing conditions, and using a data-driven approach to match safety programs and improvements with demonstrated safety concerns. This guide will help agencies enhance their existing safety programs and activities, including identifying safety concerns and selecting optimal solutions. It will also serve as a reference for improving pedestrian and bicycle safety through a multidisciplinary and collaborative approach to safety, including street designs and countermeasures, policies, and behavioral programs.

NCHRP Report 803: Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook (2015)

This resource includes an interactive tool and guidance to help agencies prioritize pedestrian and bicycle improvements, including safety projects, either as standalone or incidental to a roadway project.

FHWA Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts (2016)

This resource focuses on flexibility and options for the design of pedestrian and bicycle networks designed to minimize crash conflicts, including case studies to illustrate various design treatments.

FHWA State SHSP Resources

The FHWA Office of Safety posts a link to each State's current SHSP. This website also lists noteworthy practices. Many SHSP plans provide an emphasis on pedestrians and contain goals for reducing traffic fatalities and injuries.

FHWA HSIP Resources

The HSIP includes the projects selected for implementation, an evaluation of past projects, and an annual status report. Projects can include pedestrian safety improvement programs and projects. For example, the 2016 Oregon HSIP Annual Report details how the its All Roads Transportation Safety Program sets aside funding to address systemic pedestrian crash locations.

State HSP Documents

NHTSA posts the States' current HSP outlining non-infrastructure strategies for improving roadway safety. A State HSP is likely to contain a pedestrian fatality and injury reduction goal, an associated performance measure, and describe non-infrastructure initiatives like enforcement and education programs. For example, Colorado DOT's 2017 HSP (called the 2017 Integrated Safety Plan) supports the Denver Police Department's "Decoy Pedestrian Program" to enforce driver yielding compliance at high-crash pedestrian crossings.

Manual on Uniform Traffic Control Devices (MUTCD)

This manual provides transportation engineers and planners with detailed guidance for the design and application of traffic control devices, including signage, roadway markings, and intersection controls. Refer to the specific sections of the MUTCD listed in the countermeasure descriptions and consult State-level supplements for additional information.

PEDSAFE: Pedestrian Crash Typing

PEDSAFE provides definitions for 12 key pedestrian crash types identified by the software package, the Pedestrian and Bicycle Crash Analysis Tool (PBCAT). PBCAT is still used by many agencies but may not be compatible with some current operating systems.

NHTSA Pedestrian Safety Information

NHTSA publishes annual reports summarizing the latest pedestrian fatality statistics. These statistics are based on FARS and the reports describe pedestrian fatality trends per different socioeconomic groups and for each State.

Walkability Checklist

This tool can be used by community leaders during a walkability audit to evaluate pedestrian infrastructure and traffic behavior.

FHWA Model Road Safety Audit Policy (2014)

This resource outlines the steps typically taken to conduct an RSA and the roles of the stakeholders. Identifying safety issues is an element of the RSA that is accompanied by suggestions on how to enhance the specific road's safety.

Vision Zero Network

This collaborative website posts case studies and tracks cities who are implementing Vision Zero plans or goals. The Vision Zero Network website also notes best practices by agencies who are working to eliminate traffic fatalities and serious injuries. Vision Zero goals are accompanied by policies, strategies, and target dates. For example, Columbia, Missouri's Vision Zero Action Plan contains an outreach campaign to educate pedestrians and drivers on new and potentially confusing infrastructure improvements like pedestrian hybrid beacons and enhanced pedestrian crosswalks.

Countermeasure Selection System

This online tool includes links to research studies, crash reduction statistics, and case studies for nearly 70 pedestrian safety countermeasures. Its Countermeasure Selection Tool provides countermeasure recommendations for uncontrolled crossing locations based upon variables such as AADT, vehicle speed, and number of lanes.

Highway Safety Manual

This manual provides detailed guidance for the collection, analysis, and evaluation of roadway crash data, as well as related CMFs and treatment selection guidance.

FHWA Road Diet Desk Reference (2015)

This resource includes sample policy, case studies, and design guidance for agencies and decision-makers considering Road Diets. The benefits of Road Diets include reducing vehicle speeds, reducing number of lanes to cross, and allocating space for pedestrian refuge island.

FHWA Design Resource Index

This resource directs practitioners to the specific location of information about pedestrian and bicycle treatments or countermeasures, across various design guidelines published by organizations such as AASHTO, the Institute of Transportation Engineers, and National Association of City Transportation Officials.

TCRP REPORT 112/NCHRP REPORT 562: Improving Pedestrian Safety at Unsignalized Crossings (2006)

This document recommends treatments to improve safety for pedestrians crossing high-volume, high-speed roadways at unsignalized intersections, with

particular focus on roadways served by public transportation.

AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition (2004)
This guide provides recommendations for the planning, design, and operation of accommodations for pedestrians on public rights-of-way. This guide also discusses the impact of land use and site design on pedestrian safety and connectivity

FHWA Federal-aid Program Administration
This website includes links to guidance for local and State governments administering federally-funded projects, such as those funded by HSIP or STBG.

Pedestrian RSA Guidelines and Prompt Lists (2007)
This resource complements practices for RSAs with additional guidance and a field manual for a pedestrian-focused RSA. An RSA team will use the knowledge of a diverse team, analysis of crash data, and a site visit to identify pedestrian safety issues.

Pedestrian RSA Case Studies (2009)
This website provides links to several examples of RSAs focused on identifying pedestrian safety factors and improvement strategies. For example, the City of Tucson, Arizona conducted an RSA of roadways with PHBs to improve the countermeasures' visibility and usability.

FHWA Pedestrian and Bicycle Funding Opportunities Summary (2016)
This resource includes a matrix comparing eligibility of various federal transportation funding programs for different types of bicycle and pedestrian projects.

FHWA Guidebook for Developing Pedestrian and Bicycle Performance Measures (2016)
This resource identifies a wide variety of potential metrics for setting goals, prioritizing projects and evaluating outcomes of bicycle and pedestrian plans, including plans for pedestrian safety improvements. Performance measures may include pedestrian levels of service or pedestrian fatality rates.

NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments (2017)
This report describes the safety benefits and CMFs for four types of pedestrian crossing treatments—rectangular rapid-flashing beacons, PHBs, pedestrian refuge islands, and advance crosswalk signs and pavement markings.

NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways (2016)
This is a compilation of existing practices regarding the selection and implementation of pedestrian crossing improvements, as well as a literature review of research on more than 25 pedestrian crossing treatments.

NHTSA "A Primer for Highway Safety Professionals" (2016)
This resource outlines a comprehensive approach to improving safety for bicyclists and pedestrians and offers a summary of the most frequently used engineering, enforcement, and education safety measures. The resource identifies how certain treatments may be placed in relation to other treatments, such as the coordinated installation of a pedestrian refuge island and lighting.

U.S. Department of Transportation
Federal Highway Administration