STEP STUDIO

Tools for selecting and implementing countermeasures for improving pedestrian crossing safety

U.S. Department of Transportation
Federal Highway Administration

EDC

INSTRUCTIONS

STEP Studio is a comprehensive compilation of resources, design guidance, research, and best practices for practitioners to identify appropriate countermeasures for improved pedestrian safety. To navigate to its resources, click the desired step (e.g. Inventory, Systemic Analysis, Countermeasures) on the visual table of contents on the **Step Studio Home page.**

To return to the homepage at any time, click **STEP Studio Home** button at the top of each sheet.

DISCLAIMER

STEP Studio's contents are subject to advances in safety and behavioral research and updates to standards and relevant guidance documents. Consult with the FHWA Office of Safety for the most current notices that may affect recommendations. STEP Studio does not describe pedestrian crossing requirements per the Americans with Disabilities Act (ADA), although ADA requirements should be addressed as part of any pedestrian crossing improvement project. STEP Studio is a resource through the FHWA's Every Day Counts Round 5 (EDC-5) Safe Transportation for Every Pedestrian (STEP) Initiative.

STEP Studio Home: Selection Process

1 COLLECT DATA AND ENGAGE THE PUBLIC

- Collect pedestrian crash and safety data
- Review existing highway safety plans
- Initiate a pedestrian safety action plan
- Pedestrian safety policy analysis
- Request and receive public input
- Conduct a walkability audit

2 INVENTORY CONDITIONS AND PRIORITIZE LOCATIONS

- Inventory roadway characteristics and pedestrian crossings
- Conduct crash cluster analysis
- Conduct systemic analysis

3 ANALYZE CRASH TYPES AND SAFETY ISSUES

- Create crash diagrams
- Identify crash factors
- Conduct an RSA

4 SELECT COUNTERMEASURES

- Review Table 1 (roadway features)
- Review Table 2 (safety issues)
- Review Table 3 (implementation & operations considerations)

5 CONSULT DESIGN AND INSTALLATION RESOURCES

- MUTCD Guidance
- AASHTO & State Guidance
- Local and Other Guidance

6 IDENTIFY OPPORTUNITIES AND MONITOR OUTCOMES

- Identify implementation opportunities
- Consider funding options
- Construct improvements
- Monitor results of implementation

Click a topic to learn more

STEP 1
Collect Data and Engage the Public

This section of the Studio describes methods for capturing and understanding existing pedestrian safety trends and engaging stakeholders.

Studio Sections

Pedestrian Crash Data Collection	Review Existing Highway Safety Plans	Initiate a Pedestrian Safety Action Plan	Pedestrian Safety Policy Analysis
Request and Receive Public Input	Conduct a Walkability Audit		

Collect Pedestrian Crash and Safety Data

One of the foundational steps to improving pedestrian safety is understanding where and when pedestrian crashes are occurring. Doing so requires collecting and maintaining pedestrian crash data. Crash reports completed by law enforcement agencies may include information about driver and pedestrian actions, as well as environmental conditions when and where the crash occurred.

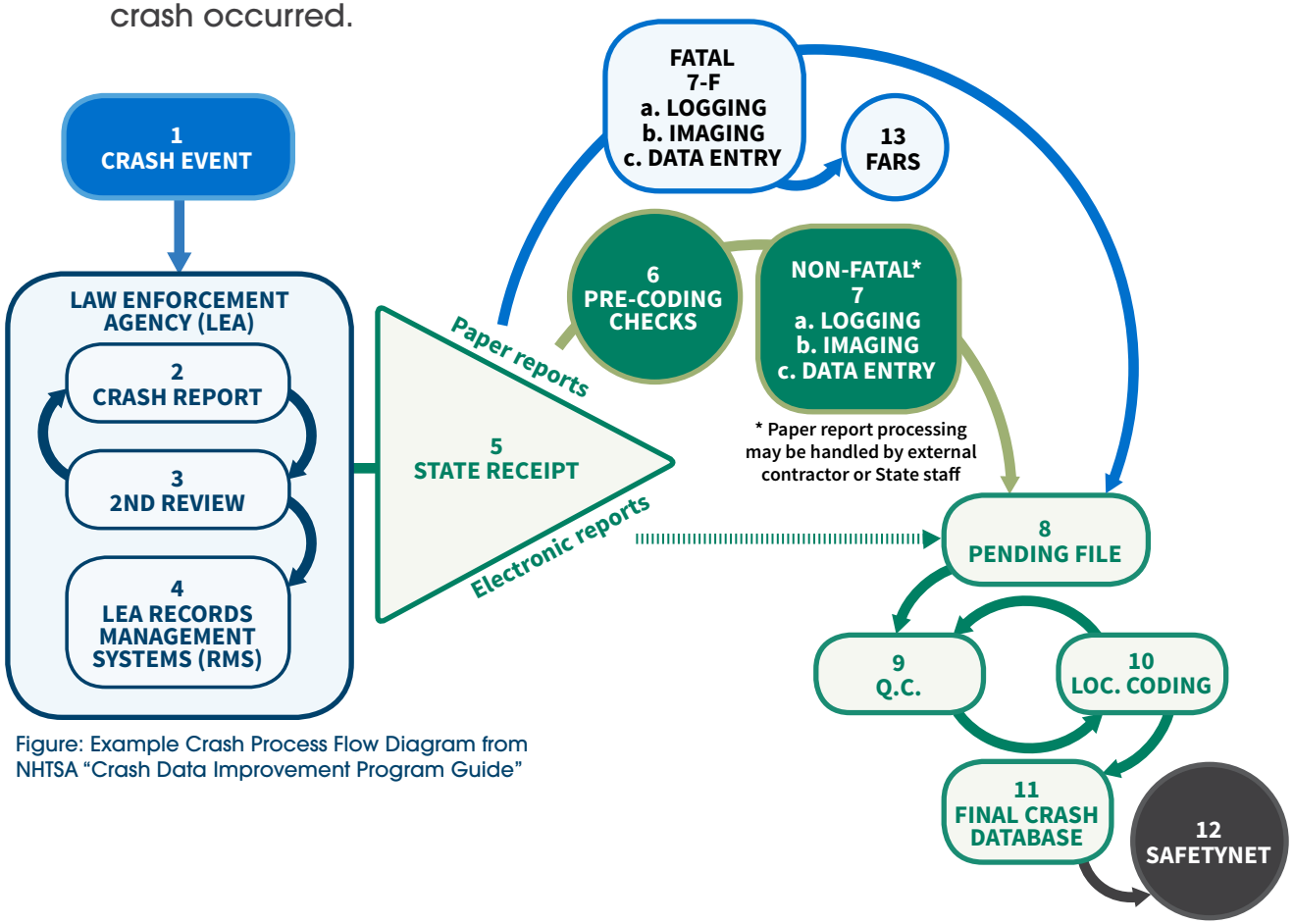


Figure: Example Crash Process Flow Diagram from NHTSA "Crash Data Improvement Program Guide"

Data Collection Considerations

- Train law enforcement in uniform crash report documentation
- Record and share crash data in database that allows crash mapping and data sharing
- Consider inclusion of public-facing online crash database
- Consider incorporating public health information and hospital data to account for unreported incidents

Additional Resources

NHTSA, Crash Data Improvement Program Guide

Review Existing Highway Safety Plans

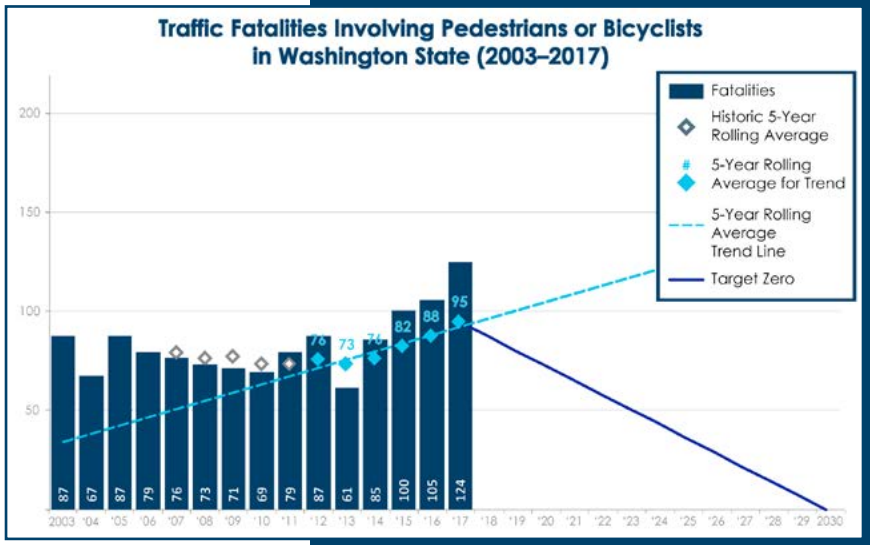
Existing safety plans are a valuable resource in understanding statewide trends in pedestrian crashes, the extent of the problem, and how it is being addressed through planned infrastructure projects, education campaigns, or law enforcement activities. When addressing pedestrian safety, an agency should review the three primary Federal safety plans described below to understand its respective State's efforts in addressing pedestrian safety, the data used in analyses, and identifying the diverse stakeholders involved—which can lead to partnerships.

Key Highway Safety Plans

Strategic Highway Safety Plan (SHSP)
Statewide-coordinated safety plan updated every five years and provides a comprehensive data-driven framework for reducing fatalities and serious injuries on all public roads. Pedestrian safety is included in the emphasis areas of 39 of 52 SHSPs.

Highway Safety Improvement Program (HSIP) The HSIP is the collection of projects, activities, plans, and reports to reduce fatalities and serious injuries on public roads.

Highway Safety Plan (HSP) A State document, coordinated with its Strategic Highway Safety Plan, that the State submits each fiscal year as its application for highway safety grants, which describes the strategies, projects, and resources necessary to achieve its highway safety performance targets.



Pedestrian and Bicyclist Road Users. Source: Washington State Strategic Highway Safety Plan 2019

Additional Resources

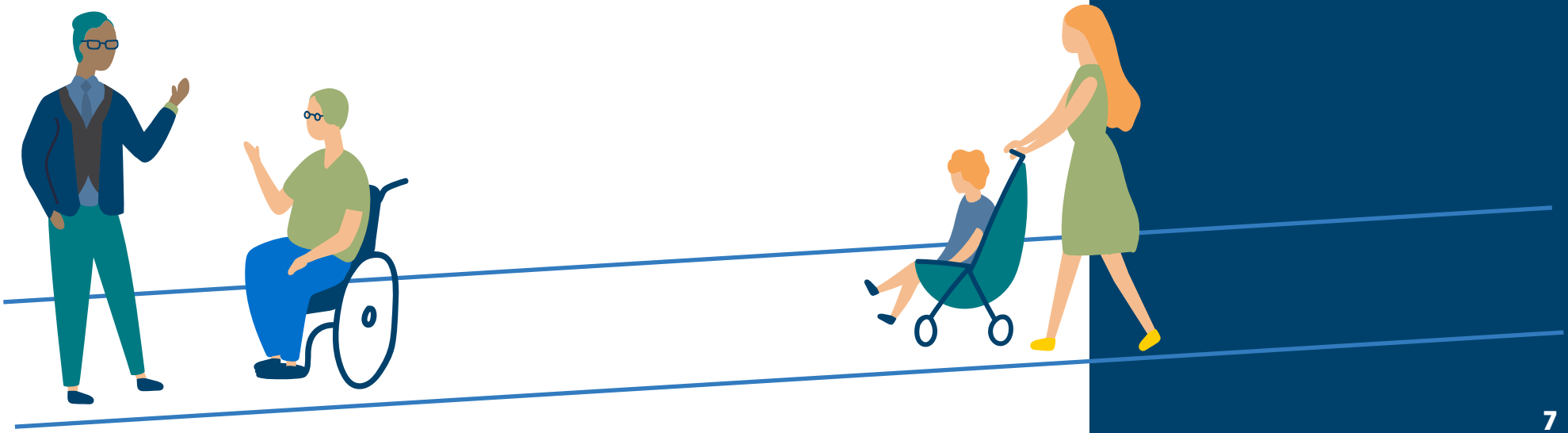
- Strategic Highway Safety Plan Database
- Highway Safety Improvement Program Reports
- State Highway Safety Plans
- Example – Washington State 2019 SHSP

Initiate a Pedestrian Safety Action Plan (PSAP)

A PSAP is a step-by-step action plan to address pedestrian safety within a geographic area such as a state, MPO, county, or city. The plan starts by setting goals, collecting data, and working with community stakeholders to identify pedestrian safety issues. Once goals, data, and issues have been determined, problem sites are evaluated to inform policy, design, or infrastructure recommendations.

Critical Steps

- Establish Goals and Objectives to Improve Pedestrian Safety
- Analyze Pedestrian Safety Data
- Gather Stakeholder Input through Organized Collection Channels
- Identify Pedestrian Improvements
- Implement and Evaluate Safety Programs

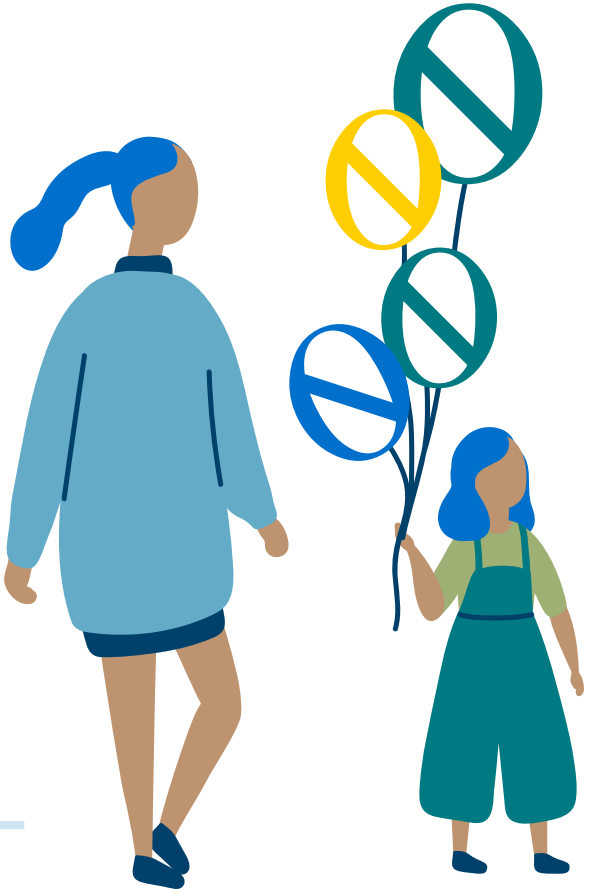


Additional Resources

- FHWA Guide "How to Develop a Pedestrian and Bicycle Safety Action Plan"
- Example - New Jersey Pedestrian Safety Action Plan
- Example - Virginia Department of Transportation Pedestrian Safety Action Plan
- Example - San Antonio-Bexar County Pedestrian Safety Action Plan
- Case Study - Broward MPO Plans for Pedestrian Safety

Pedestrian Safety Policy Analysis

Agencies may have policies or guidance that support incorporating pedestrian projects in other projects or eliminating traffic-related deaths, such as Complete Streets or Vision Zero/Toward Zero Deaths policies, respectively. A Complete Streets policy explains how sidewalks and crossing treatments are integrated into routine street maintenance activities and large-scale highway projects. Vision Zero and Towards Zero Deaths initiatives focus on eliminating or significantly reducing traffic fatalities and prioritize strategies for the most vulnerable roadway users, such as pedestrians. Agencies should review their policies for metrics that establish the need for safety at uncontrolled crossing locations and opportunities to better integrate pedestrian crossing improvements.



Additional Resources

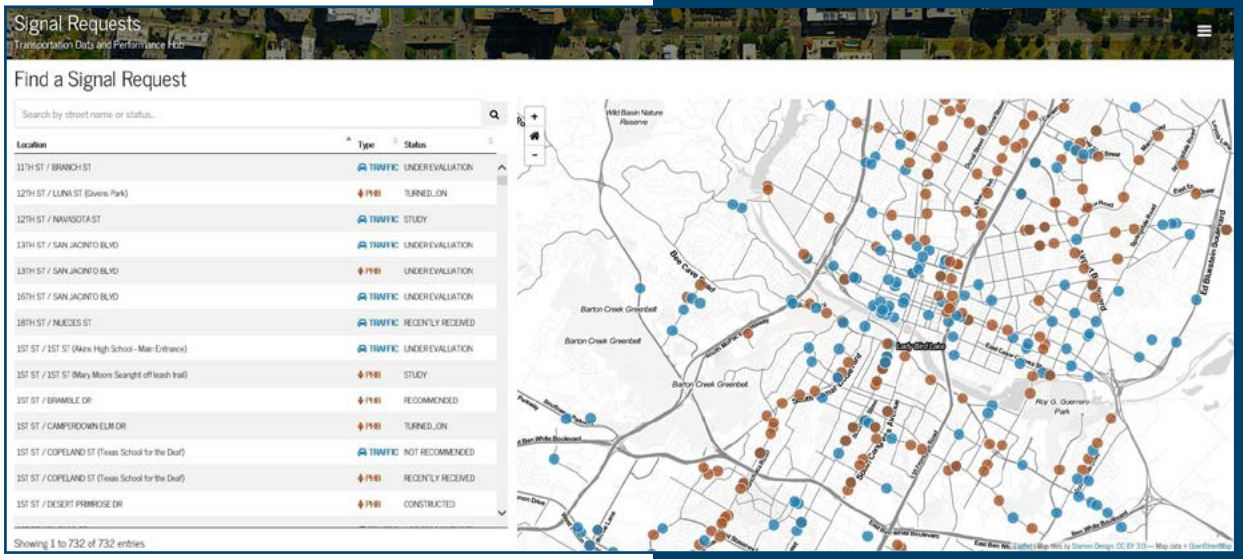
- FHWA Guide – "Transportation Safety Planning and the Zero Deaths Vision: A Guide for Metropolitan Planning Organizations and Local Communities"
- FHWA - Safety Culture and the Zero Deaths Vision
- Example - Massachusetts Department of Transportation Complete Streets Program
- Example - Florida Department of Transportation Complete Streets Program

Request and Receive Public Input

Public input is an essential component of transportation safety improvements. Agencies should set up a process for receiving, tracking, and responding to input from residents and visitors. Many local governments respond with traffic calming request applications or online forms for residents with concerns about pedestrian safety on high-speed arterials or collector streets. Agencies may also consider forming a committee or work group devoted to considering pedestrian safety and mobility, such as a pedestrian advisory committee.

Considerations for Gathering Public Input

- Avoid complex terminology
- Create a public outreach plan that works with existing safety champions, communicates safety benefits, and dispels myths
- Encourage community driven requests
- Consider demonstration projects



City of Austin Signal Request Dashboard

Additional Resources

- FHWA Guide, "Public Involvement Techniques for Transportation Decision-making"
- Case Study – City of Austin Texas Online PHB Request Portal
- Case Study – Publicly Supported Road Diet Reduces Speeds in Alexandria
- FHWA - Virtual Public Engagement

Conduct a Walkability Audit

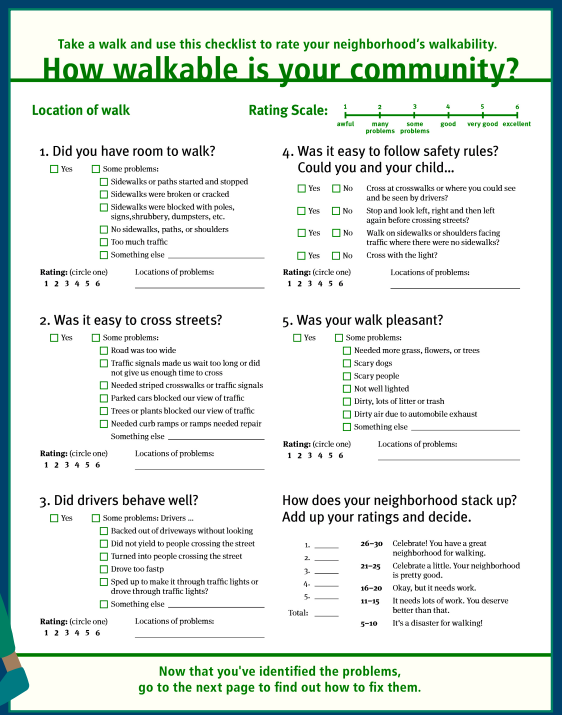
A Walkability Audit is an informal method for engaging stakeholders and raising awareness about pedestrian safety. Community leaders and neighbors can conduct a walkability audit at priority locations or corridors to identify deficiencies in the pedestrian network at a small area or neighborhood scale. Leaders can organize an event and ask participants to follow a simple checklist to assess neighborhood streets. The audit's questions should include questions on driver behavior, ease of walking, quality of the sidewalk, and safety.

Core Walkability Audit Steps

1. Identify the area or corridor (street, neighborhood, etc.)
2. Compare the checklist prompts with area under evaluation
3. Add up audit points
4. Consider area improvements

Additional Resources

- Pedestrian and Bicycle Information Center (PBIC) Walkability Checklist
- Case Study - Broward MPO Plans for Pedestrian Safety



Take a walk and use this checklist to rate your neighborhood's walkability.

How walkable is your community?

Location of walk

Rating Scale: 1 awful, 2 many problems, 3 some problems, 4 good, 5 very good, 6 excellent

1. Did you have room to walk?
   - ☐ Yes ☐ Some problems:
     - ☐ Sidewalks or paths started and stopped
     - ☐ Sidewalks were broken or cracked
     - ☐ Sidewalks were blocked with poles, signs, shrubbery, dumpsters, etc.
     - ☐ No sidewalks, paths, or shoulders
     - ☐ Too much traffic
     - ☐ Something else _____

   Rating: (circle one) 1 2 3 4 5 6 — Locations of problems: _____

2. Was it easy to cross streets?
   - ☐ Yes ☐ Some problems:
     - ☐ Road was too wide
     - ☐ Traffic signals made us wait too long or did not give us enough time to cross
     - ☐ Needed striped crosswalks or traffic signals
     - ☐ Parked cars blocked our view of traffic
     - ☐ Trees or plants blocked our view of traffic
     - ☐ Needed curb ramps or ramps needed repair
     - Something else _____

   Rating: (circle one) 1 2 3 4 5 6 — Locations of problems: _____

3. Did drivers behave well?
   - ☐ Yes ☐ Some problems: Drivers ...
     - ☐ Backed out of driveways without looking
     - ☐ Did not yield to people crossing the street
     - ☐ Turned into people crossing the street
     - ☐ Drove too fast
     - ☐ Sped up to make it through traffic lights or drove through traffic lights?
     - ☐ Something else _____

   Rating: (circle one) 1 2 3 4 5 6 — Locations of problems: _____

4. Was it easy to follow safety rules? Could you and your child...
   - ☐ Yes ☐ No Cross at crosswalks or where you could see and be seen by drivers?
   - ☐ Yes ☐ No Stop and look left, right and then left again before crossing streets?
   - ☐ Yes ☐ No Walk on sidewalks or shoulders facing traffic where there were no sidewalks?
   - ☐ Yes ☐ No Cross with the light?

   Rating: (circle one) 1 2 3 4 5 6 — Locations of problems: _____

5. Was your walk pleasant?
   - ☐ Yes ☐ Some problems:
     - ☐ Needed more grass, flowers, or trees
     - ☐ Scary dogs
     - ☐ Scary people
     - ☐ Not well lighted
     - ☐ Dirty, lots of litter or trash
     - ☐ Dirty air due to automobile exhaust
     - ☐ Something else _____

   Rating: (circle one) 1 2 3 4 5 6 — Locations of problems: _____

How does your neighborhood stack up? Add up your ratings and decide.

1. _____
2. _____
3. _____
4. _____
5. _____

Totals: _____

26–30	Celebrate! You have a great neighborhood for walking.
21–25	Celebrate a little. Your neighborhood is pretty good.
16–20	Okay, but it needs work.
11–15	It needs lots of work. You deserve better than that.
5–10	It's a disaster for walking!

Now that you've identified the problems, go to the next page to find out how to fix them.

STEP 2

Inventory Conditions and Prioritize Locations

This Studio section describes the options for how an agency can document field conditions (such as roadway characteristics) and screen the transportation network for high-crash and high-risk locations. An agency can perform any or all of these analyses.

Studio Sections

Inventory Roadway Characteristics and Pedestrian Crossings	Conduct a Crash Cluster Analysis	Conduct a Systemic Analysis

Additional Resources

Case Study - Data Drives Pedestrian Safety Projects in Oregon

Inventory Roadway Characteristics and Pedestrian Crossings

The process of collecting roadway characteristics includes compiling geospatial data to create base maps for each of the priority sites. Roadway conditions are key criteria for selecting countermeasures. The agency may document and map the following roadway characteristics for priority sites. The agency can also document pedestrian crossing conditions. Agency staff can visit the sites and record the following crossing site features. Finally, it is important that the agency categorize each crossing as either controlled or uncontrolled.

Potential inventory characteristics

- Roadway characteristics (i.e. speed, number of lanes, turn lanes or median, width, turn lanes, AADT, intersections, signalization)
- Parking
- Signage
- Lighting
- Pedestrian crossings (i.e. controlled, uncontrolled)
- Land use and transit access

Additional Resources

Case Study - Uncontrolled Crossing Inventory Assists Pedestrian Safety in Los Angeles

Case Study – Rhode Island DOT Inventories Crossing Locations to Guide Safety Improvements

Case Study - Pedestrian Facility Inventory Prepares for Future Planning in Lexington

STEP Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations

FHWA Roadway Safety Program, Model Inventory of Roadway Elements (MIRE)

Conduct a Crash Cluster Analysis

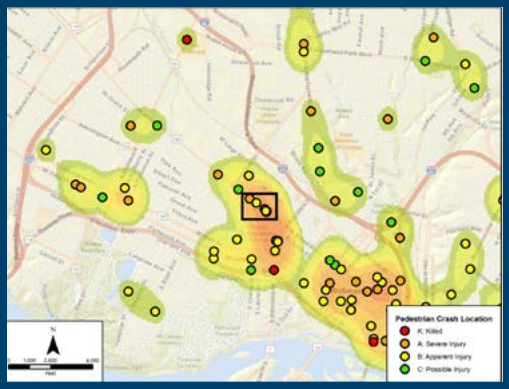
Crash cluster (also known as spot safety) analysis is a reactive approach that maps the concentrations of individual crash locations over a time period, preferably at least 5 years for pedestrian crash data. Mapping these crashes on a geographic information system (GIS) helps to visually reveal clusters, or "hot spots," of pedestrian crashes. The process for conducting crash cluster analysis follows four key steps: gather data; plan the analysis; conduct the analysis; and prioritize locations. For example, the analysis may focus on severity of crashes rather than crash frequency.

Crash cluster analysis steps

- Gather data
- Plan the analysis
- Conduct the analysis
- Prioritize locations

Additional Resources

FHWA Guidebook on Identification of High Pedestrian Crash Locations



Crash cluster analysis map: Richmond, VA. Source: Virginia Department of Transportation (2017).

SPOTLIGHT GDOT Deploys Hot Spot Crash Software to Improve Pedestrian Safety

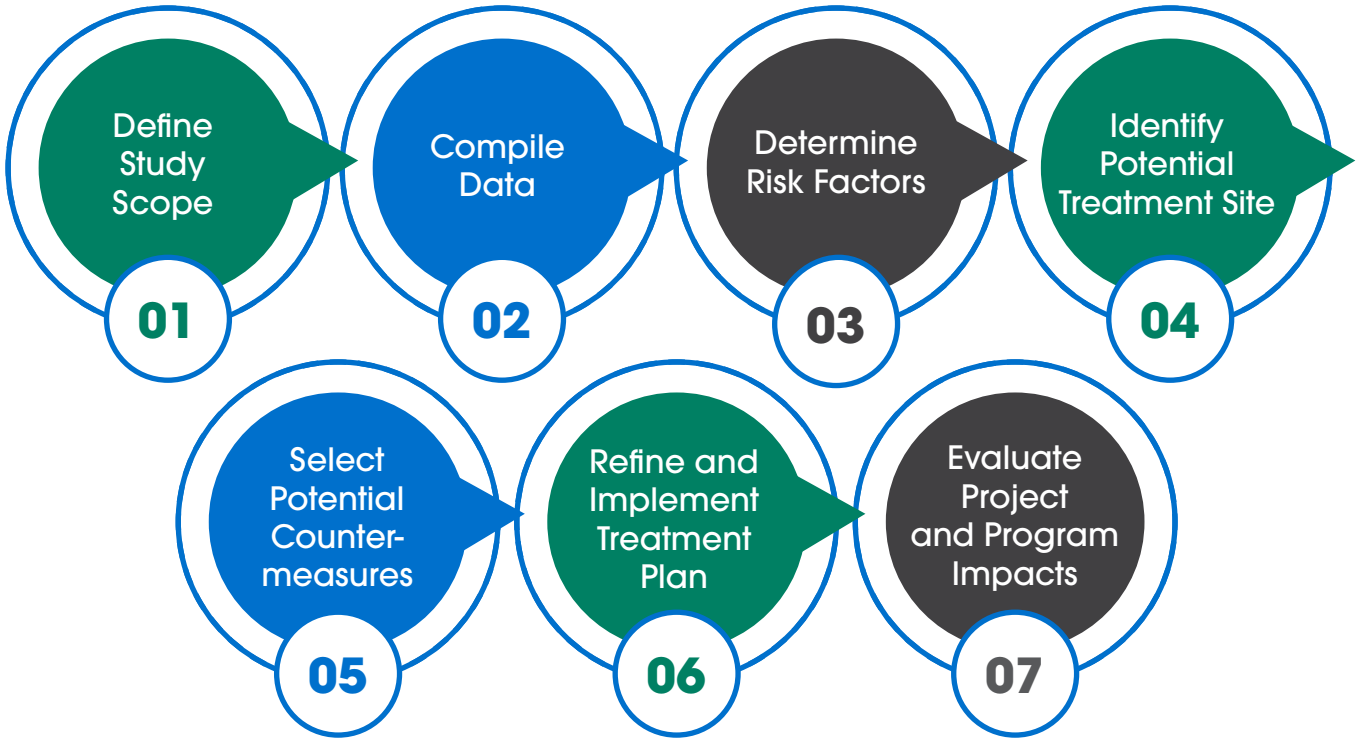
The Georgia Department of Transportation (GDOT) developed a statewide Pedestrian Safety Action Plan in 2018 to reverse the trend of increasing pedestrian fatalities. A key component of the plan was the identification of focus corridors—areas with high levels of pedestrian fatalities and serious injuries—followed by collaboration with regional and local governments to prioritize selection and implement safety improvements. GDOT deployed a software service, called Numetric™, to analyze pedestrian crash data and assist in ranking the most dangerous pedestrian corridors. The software tool allows GDOT to assess seven years of crash data and quickly view factors such as crash location, lighting, roadway conditions, crash grouping, and the crash report itself. This analysis helps GDOT evaluate crash clusters and provides valuable insight to inform decisions about next phase of review and type of safety countermeasures that might be applied at each location.

After GDOT identifies the high crash locations, it may select it for a pedestrian focused Road Safety Assessment (RSA). Once the RSA is completed, GDOT tracks the RSA recommendations and implementation stakeholders in a database, Goasis. This allows GDOT to track the percent of RSA recommendations completed as a performance measure and helps GDOT to easily review past RSAs and work with local and regional agencies to determine where they might need additional help with implementation.

Conduct a Systemic Analysis

Systemic analysis is a 7-step approach to evaluating a network for pedestrian safety improvements that is widely implemented and based on high-risk roadway features that are correlated with particular crash types, rather than crash frequency. It is a proactive, risk-based, and data driven process. The systemic approach may be used in combination with the hot spot or cluster analysis. Research has identified risk factors, some of which are identified below.

Systemic Pedestrian Safety Analysis Process



Prominent Risk Factors

- High vehicle volumes
- Wide roads (pedestrian crossing distance)
- Multiple lanes
- Sidewalk or crosswalk presence
- Higher speed traffic
- Dark or sparsely-lit roads or crossings
- Adjacent land uses
- Type of intersection control

Additional Resources

NCHRP Report 893

Case Study – VDOT Deploys Systemic Analysis to Improve Pedestrian Safety

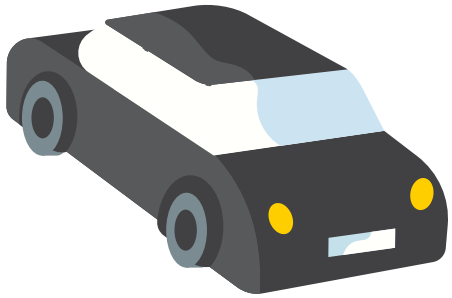
Case Study – Robust Pedestrian Safety Analysis in Seattle

STEP 3
Analyze Crash Types and Safety Issues

This Studio section describes methods for summarizing pedestrian crash types and observed traffic safety issues. This information is important for selecting countermeasures.

Studio Sections

Create crash diagrams	Identify crash factors	Conduct a Pedestrian Road Safety Assessment (RSA)



Create Crash Diagrams

Typing and diagramming pedestrian crashes provides valuable information to transportation professionals trying to identify crash patterns and safety countermeasures. This process should strike a balance between providing enough information and analyzing potentially large amounts of data.

Crash Mapping and Diagramming

- **Determine appropriate level detail** - The method used for mapping pedestrian crashes depends on the intended level of detail. A smaller data set can be visualized with specific details: exact location, direction the vehicle and pedestrian were traveling, and contributing circumstances. A larger data set might depict fewer details in order to clearly communicate information.
- **Map or diagram pedestrian crashes** - Consider ways to symbolize or label crashes that will clearly and effectively convey crash type and/or other desired information. Online mapping provides several advantages, including allowing viewers to see additional information through pop-up windows.

Additional Resources

- PedBikeData – National Pedestrian and Bicycle Safety Data Clearinghouse
- Pedestrian and Bicycle Crash Analysis Tool (PBCAT)
- Pedestrian Crash Types
- PEDSAFE- Pedestrian Safety Guide and Countermeasure Selection System
- SafeTREC

Identify Crash Factors

The identification and categorization of pedestrian crash factors can help agencies address safety issues through countermeasures or other modifications. Factors can include vehicle speed, pedestrian behavior, pedestrian crossing distance, vehicle yielding and regulation compliance, transit stops, alcohol, built environment, and more.

Additional Resources

NCRHP Report 500 -A Guide for Reducing Collisions Involving Pedestrians

Conduct a Pedestrian Road Safety Assessment

A Pedestrian Road Safety Assessment (RSA) is a formal review of a roadway by an independent multidisciplinary team that is focused on pedestrian safety. RSAs enhance safety by identifying potential safety issues affecting road users under all conditions. The final RSA report can also identify locations for further exploration, consideration of STEP countermeasures, and create a more complete picture of design considerations that may impact countermeasures selection.

The FHWA's RSA process follows eight steps (seen right) from identification of the study area through implementation. The RSA process focuses on data collection, analysis, field work, and collaboration that builds trust and reaches broadly acceptable recommendations.

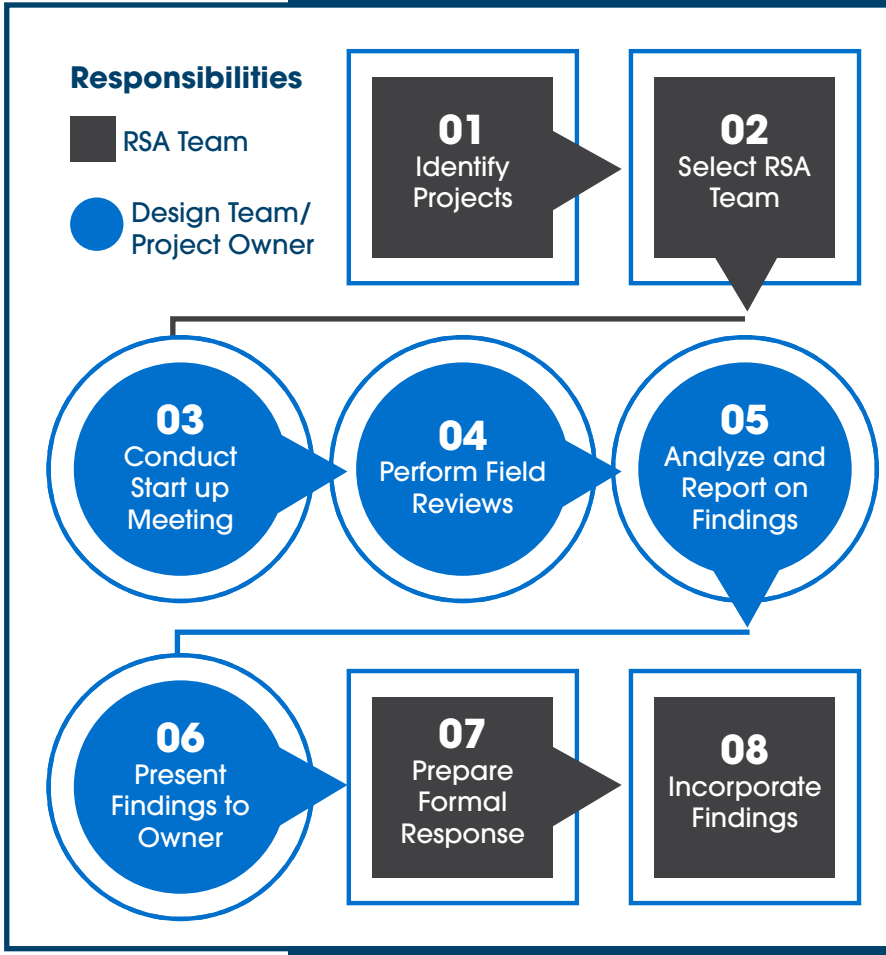
Key data inputs

- 3 to 10 years of pedestrian crash data
- Vehicle volumes and traffic speeds
- Roadway characteristics
- Transportation, development, and related plans
- Locations of pedestrian generators and attractors

Additional Resources

FHWA Pedestrian RSA Case Studies

FHWA Guide - Pedestrian Road Safety Audit Guidelines and Prompts List



STEP 4
Countermeasure Selection

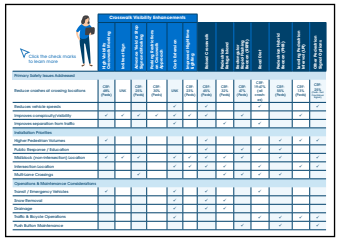
Instructions

Resources for both selecting countermeasures and learning more about the countermeasures are below. Click through each item to access recommendations, case studies, and links to additional information.

Tools for selecting countermeasures

Table 1
Roadway Features

Table 2
Safety Features



NEW Table 3
Implementation & Operations Considerations

Countermeasure information

- Marked Crosswalk
- Crosswalk Lighting
- In-street Pedestrian Signage
- Advance Yield and Stop Markings
- Curb Extensions & Parking Restriction
- Raised Crosswalk
- Pedestrian Refuge Island
- Rectangular Rapid Flashing Beacon (RRFB)
- Pedestrian Hybrid Beacon (PHB)
- Road Diet
- Leading Pedestrian Interval
- Additional Signalized Intersection Pedestrian Safety Improvements

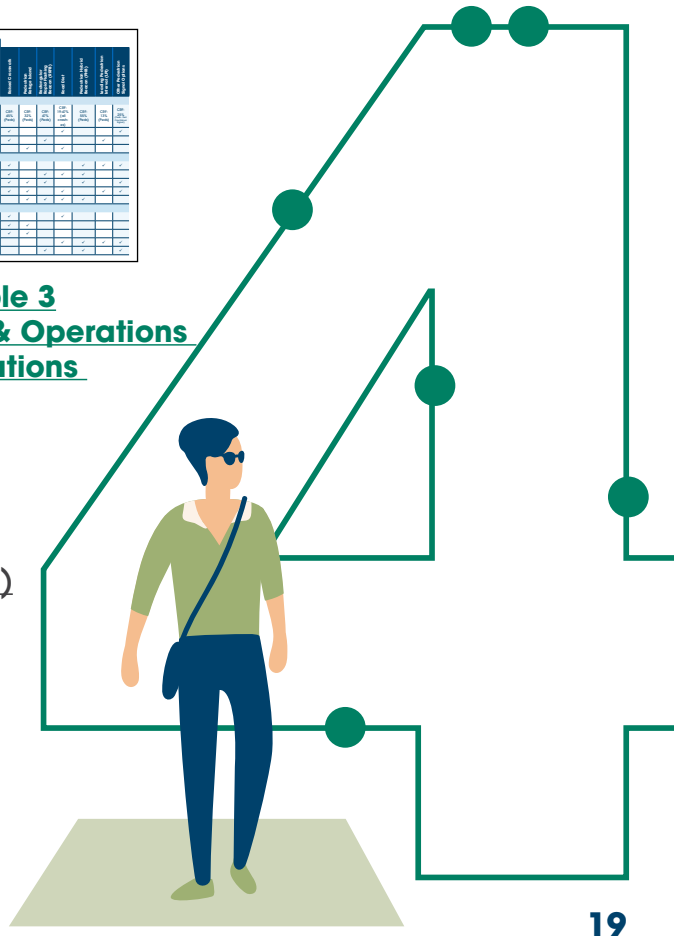


Table 1 Roadway Features

Roadway Configuration	Posted Speed Limit and AADT																	
	Vehicle AADT <9,000						Vehicle AADT 9,000–15,000						Vehicle AADT >15,000					
	≤30 mph			35 mph			≥40 mph			≤30 mph			35 mph			≥40 mph		
2 lanes (1 lane in each direction)	❶	2		❶			①			❶			❶			①		
	4	5	6		5	6		5	6	4	5	6		5	6		5	6
				7		9	❼		❾				7		9	❼		❾
3 lanes with raised median (1 lane in each direction)	❶	2	3	❶		❸	①		❸	①		3	①		❸	①		❸
	4	5			5			5		4	5			5			5	
				7		9	❼		❾	7		9	❼		❾	❼		❾
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	❶	2	3	❶		❸	①		❸	①		3	①		❸	①		❸
	4	5	6		5	6		5	6	4	5	6		5	6		5	6
	7		9	7		9			❾	7		9	❼		❾			❾
4+ lanes with raised median (2 or more lanes in each direction)	❶		❸	❶		❸	①		❸	①		❸	①		❸	①		❸
		5			5			5			5			5			5	
	7	8	9	7	8	9		8	❾	7	8	9	❼	8	❾		8	❾
4+ lanes w/o raised median (2 or more lanes in each direction)	❶		❸	①		❸	①		❸	①		❸	①		❸	①		❸
		5	6		5	❻		5	❻		5	❻		5	❻		5	❻
	7	8	9	7	8	9		8	❾	7	8	9	❼	8	❾		8	❾

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● 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 crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

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 restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
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. Rectangular Rapid-Flashing Beacon (RRFB)*
8. Road Diet
9. Pedestrian Hybrid Beacon (PHB)*

**It should be noted that the PHB and RRFB are not both installed at the same crossing location.*

This table was developed using information from: Zegeer, C.V., J.R. Stewart, H.H. Huang, P.A. Lagerwey, J. Feaganes, and B.J. Campbell. (2005). Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines. FHWA, No. FHWA-HRT-04-100, Washington, D.C.; FHWA. Manual on Uniform Traffic Control Devices, 2009 Edition. (revised 2012). Chapter 4F, Pedestrian Hybrid Beacons. FHWA, Washington, D.C.; FHWA. Crash Modification Factors (CMF) Clearinghouse. http://www.cmfclearinghouse.org/; FHWA. Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE). http://www.pedbikesafe.org/PEDSAFE/; Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Transportation Research Board, Washington, D.C.; Thomas, Thirsk, and Zegeer. (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Transportation Research Board, Washington, D.C.; and personal interviews with selected pedestrian safety practitioners.

Table 2 Safety Features

Pedestrian Crash Countermeasure for Uncontrolled Crossings	Safety Issue Addressed				
	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	✓	✓	✓		✓
Rectangular Rapid-Flashing Beacon	✓		✓	✓	✓

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

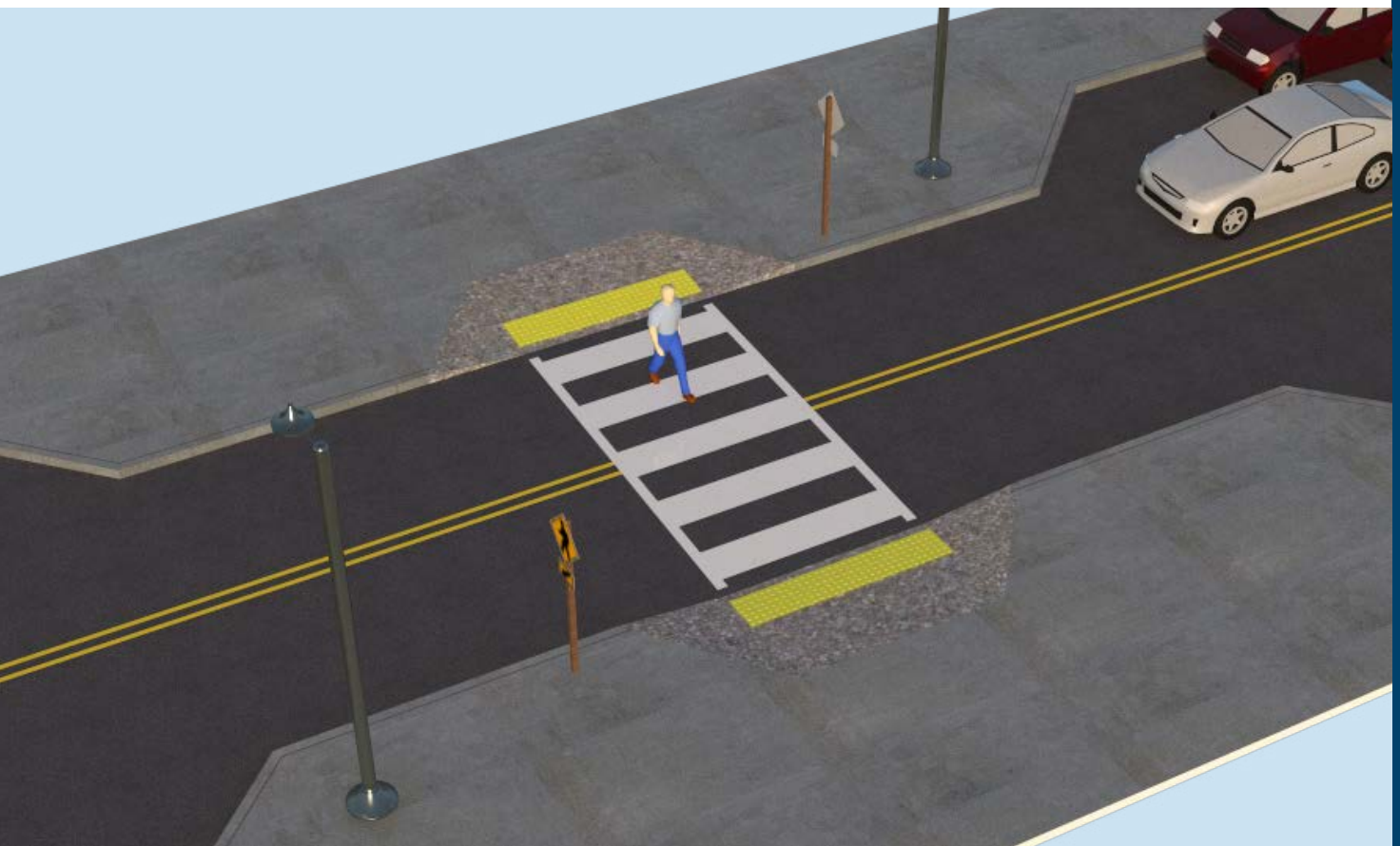
Table 3 Implementation & Operations Considerations

Click the check marks to learn more

	High Visibility Crosswalk Marking	In-Street Sign	Advance Yield or Stop Sign and Marking	Parking Restrictions on Crosswalk Approach	Curb Extension	Improved Nighttime Lighting	Raised Crosswalk	Pedestrian Refuge Island	Rectangular Rapid-Flashing Beacon (RRFB)	Road Diet	Pedestrian Hybrid Beacon (PHB)	Leading Pedestrian Interval (LPI)	Other Pedestrian Signal Options
Primary Safety Issues Addressed													
Reduce crashes at crossing locations	CRF: 48% (Peds)	UNK	CRF: 25% (Peds)	CRF: 30% (Peds)	UNK	CRF: 23% (Peds)	CRF: 45% (Peds)	CRF: 32% (Peds)	CRF: 47% (Peds)	CRF: 19-47% (all crashes)	CRF: 55% (Peds)	CRF: 13% (Peds)	CRF: 25% (Peds - Ped Countdown Signal)
Reduces vehicle speeds					✓		✓			✓			✓
Improves conspicuity/visibility	✓	✓	✓	✓	✓	✓	✓		✓			✓	
Improves separation from traffic					✓			✓		✓			
Installation Priorities													
Higher Pedestrian Volumes	✓						✓				✓	✓	✓
Public Response / Education							✓		✓	✓	✓		
Midblock (non-intersection) Location	✓	✓	✓		✓	✓	✓	✓	✓		✓		✓
Intersection Location					✓	✓	✓	✓		✓		✓	✓
Multi-Lane Crossings			✓					✓	✓	✓	✓		
Operations & Maintenance Considerations													
Transit / Emergency Vehicles	✓				✓		✓			✓			
Snow Removal					✓		✓	✓					
Drainage					✓		✓	✓					
Traffic & Bicycle Operations					✓					✓	✓	✓	✓
Push Button Maintenance									✓		✓		✓
MUTCD Reference	3B.18 2C.50	2B.12	3B.16 2B.11	2B.46 3B.19 3B.23			3B.25	3B.10 3B.23 3B.18	2C.50 7B.08 IA-21		Figure 4F-1 Figure 4F-2 Part 4F	4E.06	

Marked Crosswalk

The marked crosswalk is the foundational countermeasure for uncontrolled crossing locations and is utilized in combination with the other proven safety countermeasures. Marked midblock crosswalks serve to legally establish pedestrian crossings outside of intersection locations, according to the Manual on Uniform Traffic Control Devices (MUTCD). There are four primary considerations for determining the location of a marked crosswalk. These considerations are intended to assist agencies and practitioners at placing crosswalks at optimal locations for pedestrian activity, safety, operations, and visibility.



Countermeasure Details

Safety Benefit: 48 percent reduction in pedestrian crashes for high visibility materials.

Cost: $2,540 each

Specific Considerations

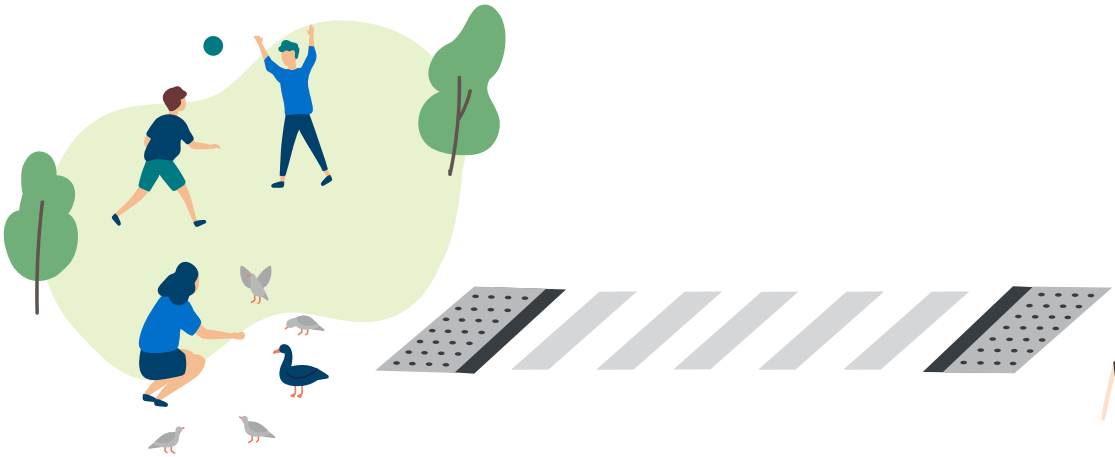
- Analyze the Network
- Stopping Sight Distance
- Crosswalk Spacing
- Markings and Patterns

Additional Resources

- STEP Tech Sheet
- Educational Video – Visibility Improvements
- Literature Review - An Overview and Recommendations of High-Visibility Crosswalk Marking Styles
- STEP Guide
- FAQs

Marked Crosswalk — Analyze Network

Pedestrians are sensitive to the environmental context of the road they are attempting to cross and regularly weigh the trade-offs between crossing a roadway more safely at an intersection or by crossing at the most direct point. The greater the distance between crosswalks, the greater the risks pedestrians tend to be willing to take to get to their destination. The MUTCD guidance for pedestrian walking speed is 3.5 feet per second. The image to the right compares the distance traveled and walking time between crossing at intersections and at a midblock location in an example scenario.



Specific Considerations

- Pedestrians crossing at intersections are exposed to conflicts with turning vehicles
- Evaluate distances between legal crossing opportunities, between marked crosswalks, and signalized crossings
- Look for complementary land uses like schools and parks, parking lot and retail shopping, tourist attractions in a central business district (CBD), and transit stop and pedestrian destinations.

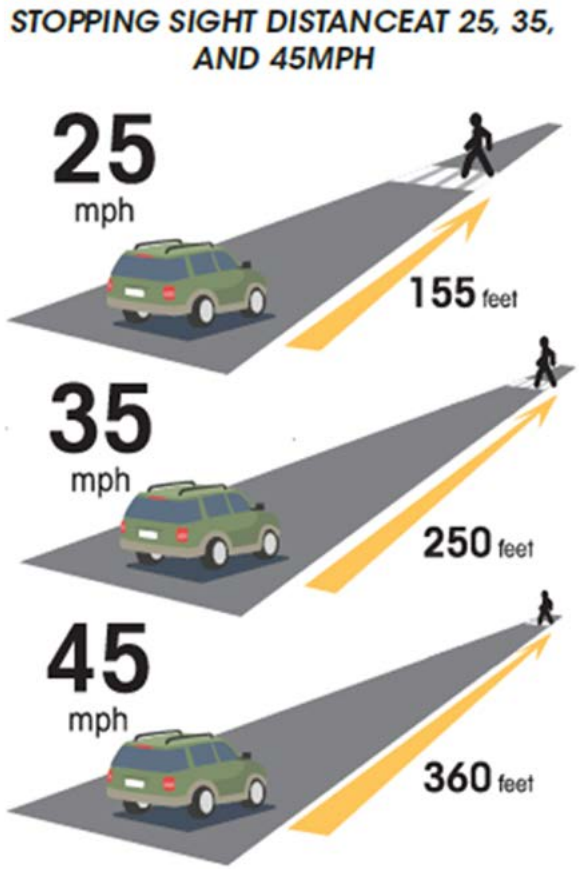
Additional Resources

- FHWA Guide - Guidebook for Developing Pedestrian and Bicycle Performance Measures
- STEP Tech Sheet
- FHWA Guide - Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts
- FHWA Guide - Small Town and Rural Multimodal Networks

Marked Crosswalk — Stopping Sight Distance

Crossings should only be placed in locations where approaching vehicles have adequate time to yield to the pedestrian. Stopping sight distance (SSD) is a consideration used in highway design to provide sufficient available sight distance along the road for a driver to stop before reaching a person in the crosswalk.

SSD is the sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop and applies the brakes, and (2) the distance needed to stop the vehicle after the brakes are applied. As seen in the figure to the right, as travel speed increases, so does the necessary stopping distance.



Stopping Sight Distance for Level Roadways, AASHTO Policy on Geometric Design of Highways and Streets

Additional Resources

- STEP Tech Sheet
- AASHTO Policy on Geometric Design of Highways and Streets (7th Ed.)
- STEP Guide

Marked Crosswalk — Crosswalk Spacing

The agency should consider roadway speeds, turning movements, and queue lengths when determining an appropriate location for a midblock crosswalk. By collecting current traffic counts as part of a crosswalk study, the agency can evaluate if roadway elements, such as the presence or length of a turn lane, can be changed to accommodate a midblock crosswalk. State guidance ranges from 200 feet to 600 feet (table below).

State Agency	Min. Distance to Intersection	Note
Utah DOT	600’	—
Arizona DOT	400’	From nearest intersection
California DOT	300’	From a controlled intersection
North Carolina DOT	300’	From next crossing opportunity
Florida DOT	300’	—
Oregon DOT	250-550’	Target spacing for Urban Mix context
Michigan DOT	200’	Distance for urban conditions

If the midblock crossing and existing signalized intersection are too close, vehicle queues may extend across the crosswalk, or motorists may not anticipate stopping for the crossing. Additional consideration should be made for frequent midblock crosswalks near key destinations such as schools. The ultimate distance from a signalized intersection—given the roadway elements noted above—is context dependent.

SPOTLIGHT Portland Pedestrian Plan 2019 Crossing Spacing Guidelines

Portland, Oregon’s 2019 Pedestrian Master Plan created new crossing spacing guidelines to address the City’s significant pedestrian network gaps. An assessment of City’s pedestrian crashes found that approximately 50 percent of all pedestrian crashes from 2006 through 2015 occurred at mid-block or unsignalized intersections, as well as 63 percent of all fatal and serious injury crashes. The new crossing spacing guidelines and accompanying recommended countermeasures were intended to increase pedestrian visibility, improve driver yielding rates, and decrease crashes.

When the City assessed its pedestrian network against the new crossing guidelines, it found it would need over 3,000 new crossings. The City intends to incorporate the crossing spacing guidelines as part of new capital projects and the existing Pedestrian Network Completion Program. The Oregon Department of Transportation has integrated an adapted version of the Portland spacing guidelines into its “ODOT Blueprint for Urban Design.”

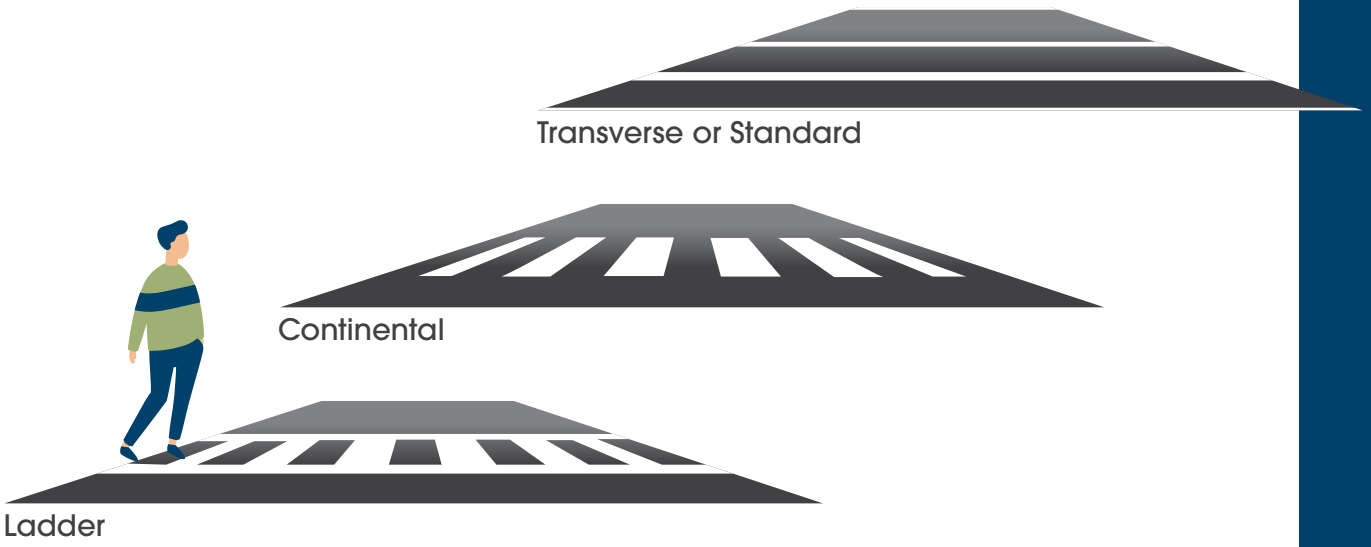
Graphic excerpt from Portland Pedestrian Plan

Walkways Inside of Pedestrian Districts: Desired Crossing Frequency	Walkways Outside of Pedestrian Districts: Desired Crossing Frequency	Transit Stops: Desired distance from transit stop
530 feet	**800 feet**	**100 feet**

Marked Crosswalk — Markings and Patterns

High visibility crosswalk materials and patterns are commonly used at midblock crosswalks. Continental and ladder are considered high visibility crosswalk marking patterns, as these crosswalk patterns are visible from farther away compared to a transverse crosswalk for both the driver and pedestrian (figure to the right). Research has shown that for existing midblock locations, continental markings are detected at about twice the distance upstream as the transverse markings during daytime conditions, or about 8 seconds of increased awareness of the crossing at 30 MPH (Crosswalk Marking Field Study, 2010).

High visibility markings increase motorist detection of a crosswalk. Agencies should also use materials such as inlay tape or thermoplastic tape, instead of paint or brick, for highly reflective crosswalk markings.



Additional Resources

- STEP Tech Sheet
- Literature Review - An Overview and Recommendations of High-Visibility Crosswalk Marking Styles
- FHWA Report - Crosswalk Marking Field Visibility Study

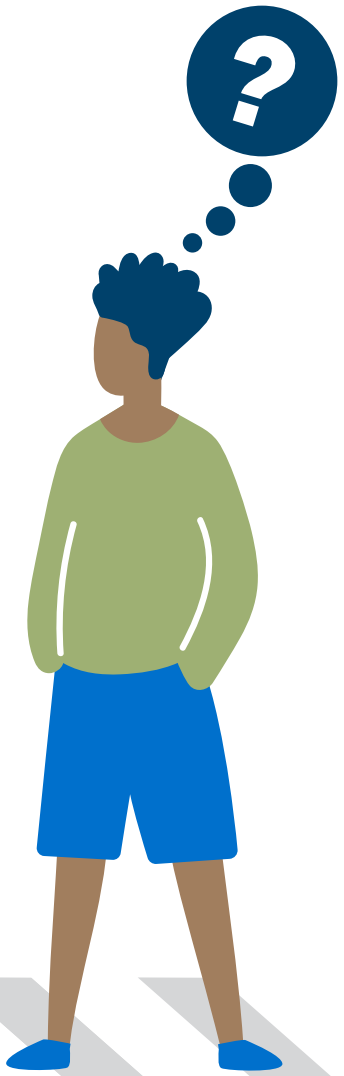
Marked Crosswalk FAQs

Q: Is there a MUTCD pedestrian volume warrant to mark a crosswalk?

A: There is no warrant or pedestrian volume requirement to mark a crosswalk. Section 3B.18 of the 2009 MUTCD says "Crosswalk lines should not be used indiscriminately. An engineering study should be performed before they are installed at locations away from a traffic control signal or an approach controlled by a STOP or YIELD sign." The MUTCD goes on to reference the 2005 Zegeer study, "Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations". This study recommended that priority for marking crosswalks be placed at locations with 20 or more pedestrians per peak hour (or 15 or more elderly and/or child pedestrians per peak hour). This threshold has been misconstrued as a minimum requirement for marking crosswalks.

Q: Does research support the removal of midblock crosswalks?

A: Midblock crosswalks should not be removed without a plan for improving safety. Simply removing an existing midblock crosswalk without assessing the pedestrian safety needs at a location can be problematic. The Zegeer study identified conditions where a crosswalk alone is not sufficient to reduce risk for pedestrian crashes. However, it did not recommend removing existing crosswalks without a plan for improving crossing safety, such as through the addition of countermeasures.

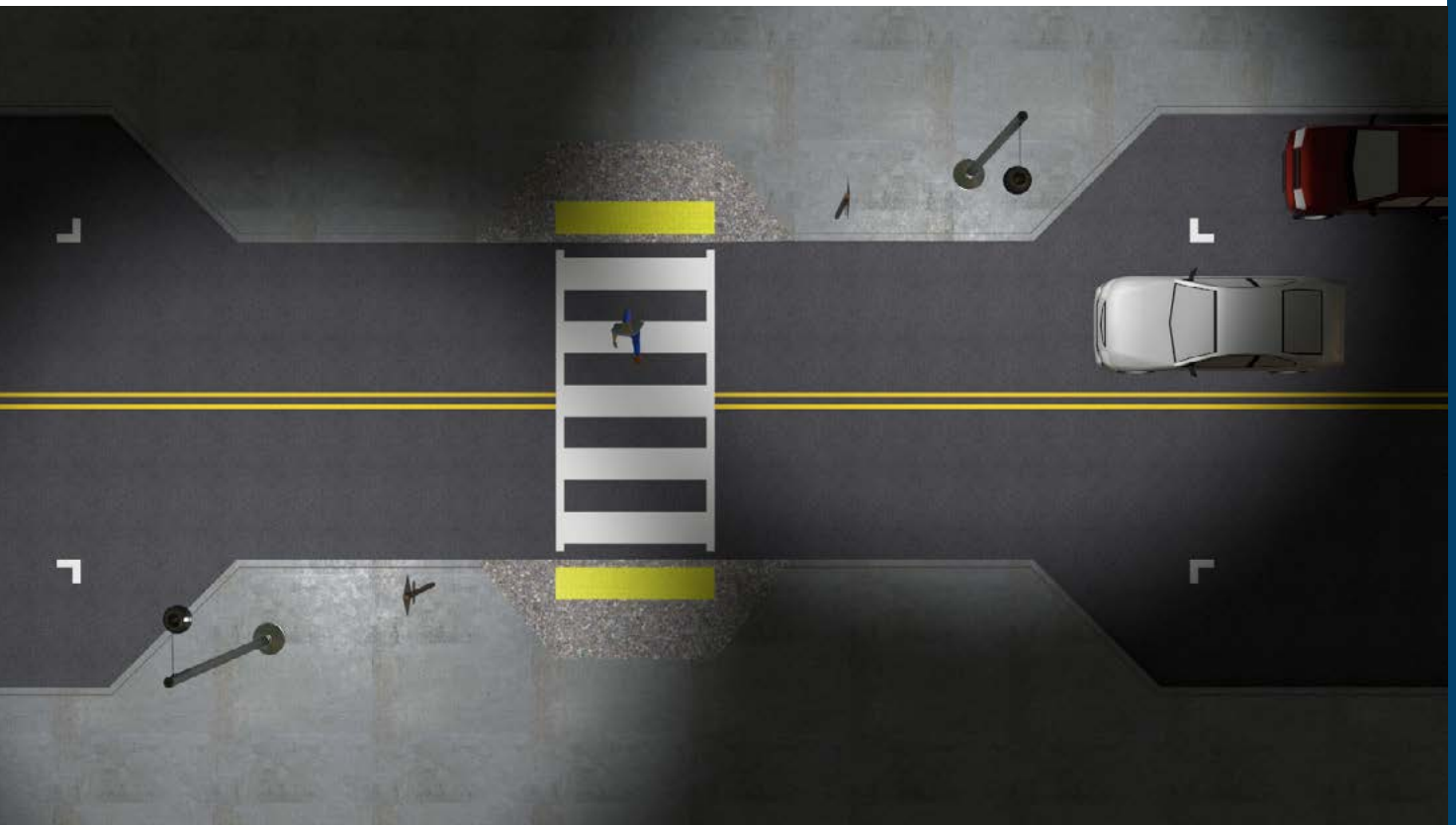


Crosswalk Lighting

Consideration should be given **to placing lights in advance** of midblock and intersection crosswalks on both approaches to illuminate the **front of the pedestrian** and avoid creating a silhouette.

Installation and design guidelines

- Overhead lights placed in advance of uncontrolled crossings on both approaches illuminate the front of the pedestrian and avoid creating a silhouette.
- Consider placing the light fixtures 10 to 15 feet in advance of the crosswalk on both sides of the street.



Countermeasure Details

Safety Benefit: 23 percent reduction in total injury crashes

Dimensions: Dependent on application

Cost: Varies based on fixture type and utility service agreement

Additional Resources

- STEP Tech Sheet
- Educational Video - Visibility Improvements
- FHWA report – "Informational Report on Lighting Design for Midblock Crosswalks"
- STEP Guide
- FAQ
- FHWA - Roadway Lighting Resources

Crosswalk Lighting FAQs

Q: What is "smart lighting", and how does it differ from traditional lighting?

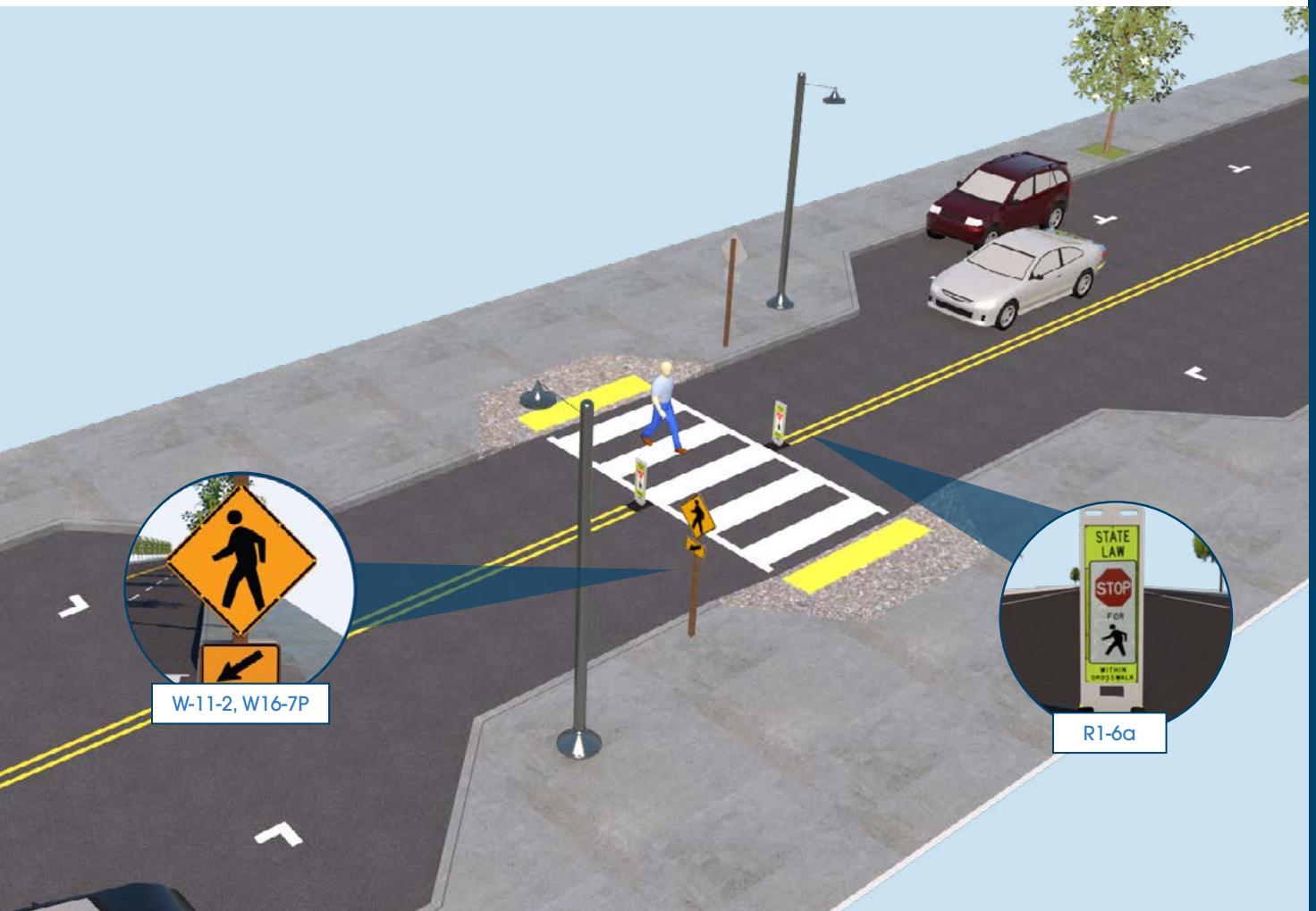
A: Smart lighting refers to lighting that makes use of detectors placed along a corridor which are sensitive to movement by pedestrians who approach a roadway, which activates the overhead lighting. When no pedestrian movement is detected along the corridor, the overhead lights turn off automatically.

Q: What is the preferred quality of pedestrian-focused lighting?

A: Overhead LED lighting with a temperature of 4700° kelvin has been observed as the most similar to the moon and may be preferred for illuminating pedestrians. (Source: City of Seattle).

In-Street Pedestrian Signage

These signs serve to **remind road users of laws** regarding right-of-way, and they may be appropriate on **2-lane or 3-lane roads** where speed limits are 30 mph or less. The sign can be placed in between travel lanes or in a median. The R1-6 is intended for states where motorists must yield to pedestrians when in the crosswalk, and the R1-6a is for states where motorists must stop for pedestrians.



Countermeasure Details

Safety Benefit: Unknown CMF at this time. However, in-street signage has been observed with increased vehicle yielding rates (near 75 percent) and decreased vehicle speeds

Dimensions: Approximately 36" x 12"

Cost: $240 per sign

Specific Considerations

Addressing Low Yielding Rates with Low-Cost Signage Case Study, Michigan

Additional Resources

STEP Tech Sheet

Educational Video - Visibility Enhancements

STEP Guide

Advance Yield and Stop Markings

The stop bar or yield markings (sometimes referred to as "sharks teeth") are placed 20 to 50 feet in **advance of a marked crosswalk** to indicate where vehicles are **required to stop or yield** in compliance with the accompanying "STOP Here for Pedestrians" or "YIELD Here to Pedestrians" sign.

Countermeasure Details

Safety Benefit: 25 percent reduction of pedestrian crashes.

Dimensions: The MUTCD recommended minimum base width of 12" with a height of 18" and a maximum width of 24" and height of 36" for Yield markings (MUTCD Part 3 Figure 3B-16)

Cost: $300 ea. (sign)/ $320 ea. (line)

Specific Considerations

Stop Here for Pedestrians signs should only be used where the law specifically requires that a driver must stop for a pedestrian in a crosswalk. Otherwise, Yield Here for Pedestrians signs should be used with yield line pavement markings.

Additional Resources

STEP Tech Sheet

Educational Video

STEP Guide

Curb Extension and Parking Restriction

A curb extension, also referred to as bulb-outs, **extends the sidewalk** or curb line out into the parking lane, which **reduces the effective street width**. Curb extensions must not extend into travel lanes and should not extend across bicycle lanes.

Parking restriction can include the removal of parking space markings, installation of new "parking prohibition" pavement markings or curb paint, and signs. The minimum setback is 20 feet in advance of the crosswalk where speeds are 25 mph or less, and 30 feet where speeds are between 26 and 35 mph.

Countermeasure Details

Safety Benefit: The CMF safety effects of curb extensions are unknown at this time, but they are often combined with other countermeasures like refuge islands that have proven safety effects. Parking restriction on the crosswalk approach can reduce pedestrian crashes by 30 percent.

Dimensions: Highly variable by context

Cost: $13,000 average cost (each) for curb extensions. Parking restriction cost varies by required signs and pavement markings.

Additional Resources

- STEP Tech Sheet
- Educational Video
- NCHRP Report 498 - "Application of Pedestrian Crossing Treatments for Streets and Highways"
- STEP Guide
- FAQs

Curb Extension and Parking Restriction FAQs

Q: What are the known safety effects of curb extensions?

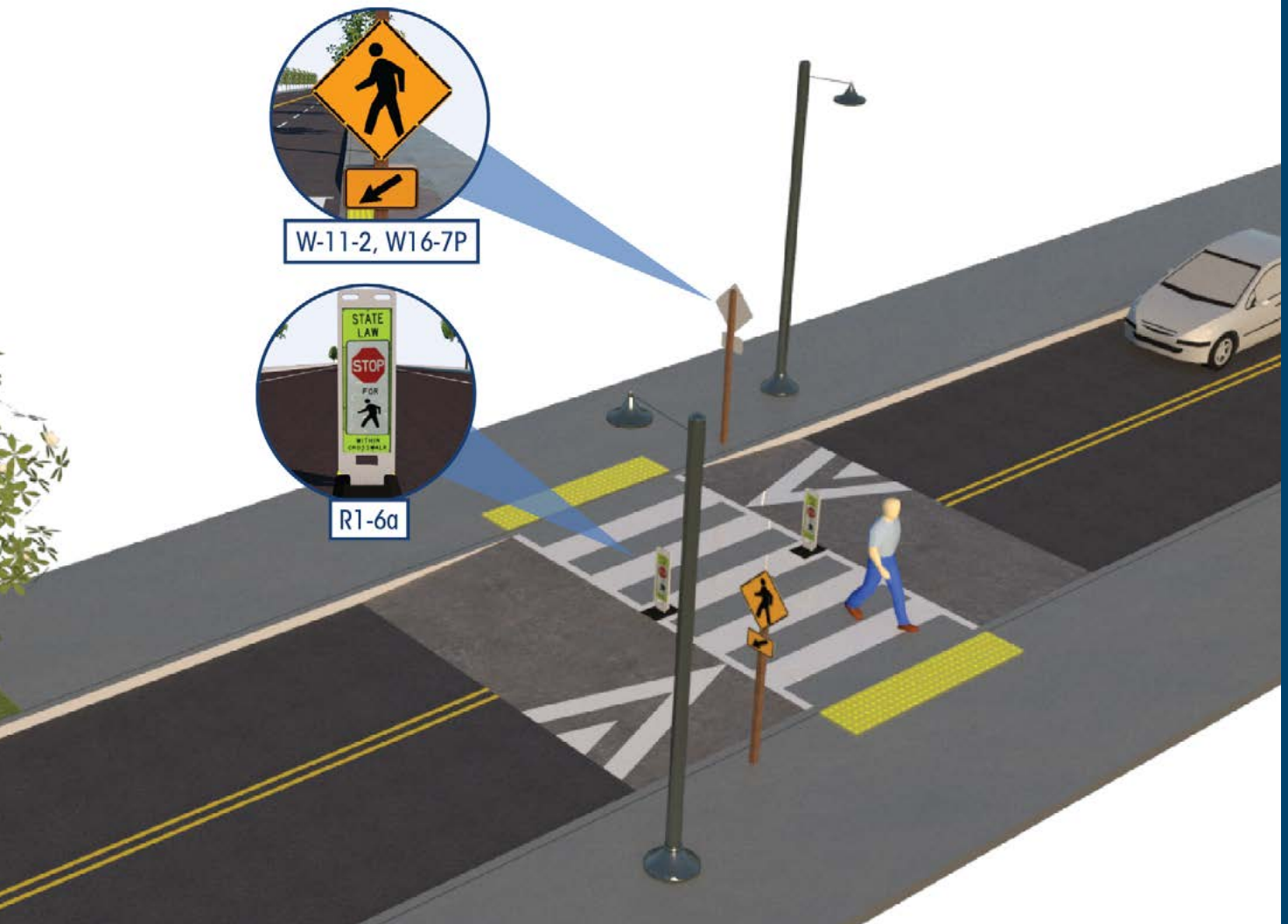
A: The crash reduction factor of curb extensions is unknown at this time. Curb extensions are often combined with other countermeasures such as pedestrian refuge islands, parking restrictions, and advance stop markings that do have proven safety effects. Some safety studies have indicated that curb extensions may reduce pedestrian crossing delay, and improve vehicle yielding in the far lane in multilane roads.

Q: How is a parking restriction designated?

A: Parking restriction sign and marking requirements vary by state. Consult the MUTCD for signs (Section 2B.46) and markings (Sections 3B.19 and 3B.23) that designate parking spaces and restrictions.

Raised Crosswalk

Raised crosswalks are **ramped speed tables** spanning the entire width of the roadway, often placed at **midblock crossing locations**. The crosswalk is demarcated with paint and/or special paving materials. These crosswalks act as **traffic-calming measures** that allow the pedestrian to cross at grade with the sidewalk.



Countermeasure Details

Safety Benefit: 45 percent reduction in pedestrian crashes and 30 percent reduction in vehicle crashes.

Dimensions: Typically 10' wide

Cost: $8,170 each (average)

Specific Considerations

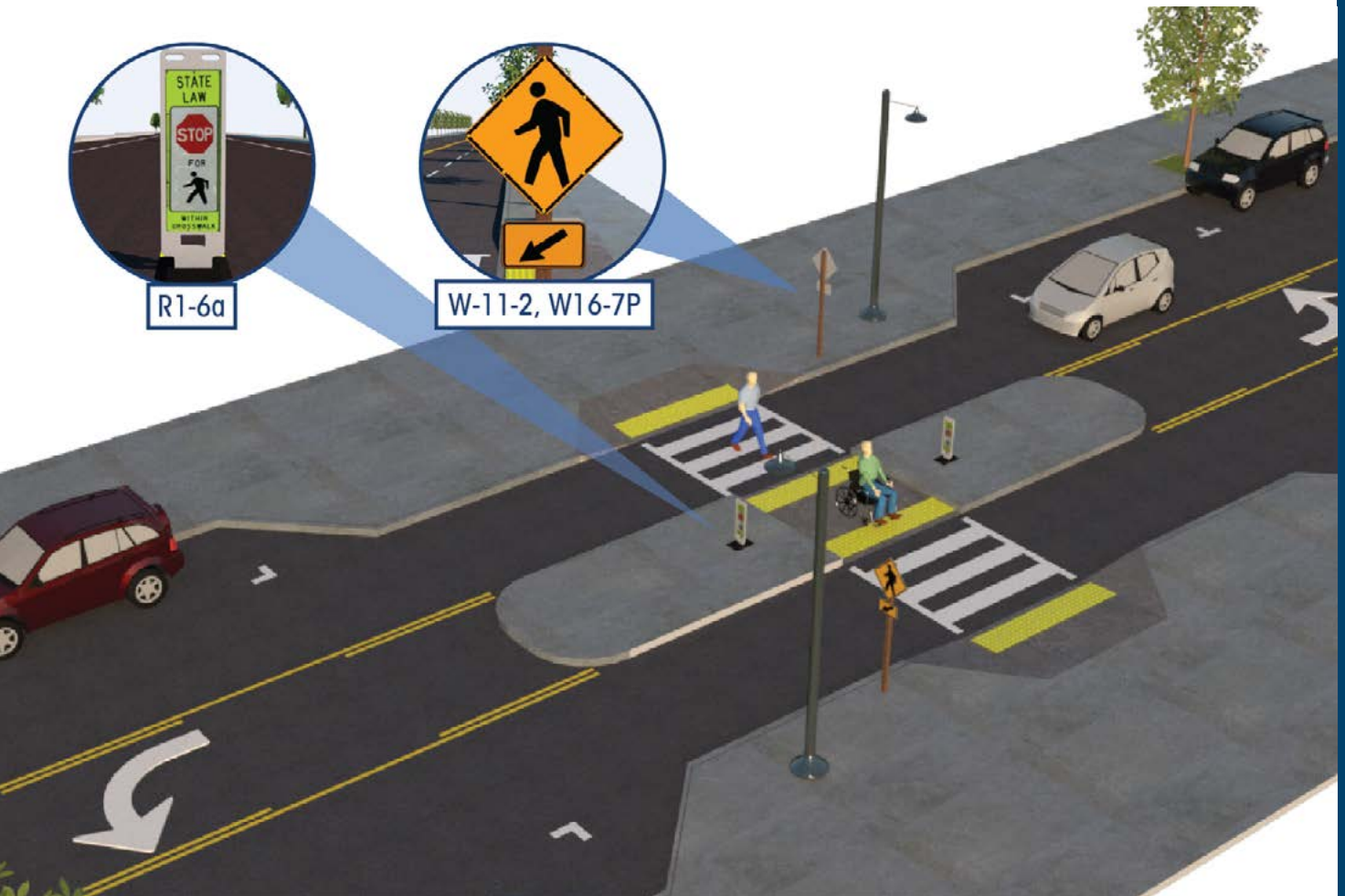
- Pedestrian Supportive Land Uses Case Study, Harrisburg, PA
- Emergency Response Best Practices
- Winter Maintenance Best Practices

Additional Resources

- STEP Tech Sheet
- Educational Video
- STEP Guide
- FHWA Guide - Traffic Calming ePrimer - Module 3

Pedestrian Refuge Island

A pedestrian refuge island is a median with a refuge area that is intended to help protect pedestrians who are crossing a multilane road. This countermeasure is sometimes referred to as a crossing island, refuge island, or pedestrian island. The presence of a pedestrian refuge island at a midblock location or intersection allows pedestrians to focus on one direction of traffic at a time as they cross, and gives them a place to wait for an adequate gap in oncoming traffic before finishing the second phase of a crossing.



Countermeasure Details

Safety Benefit: 32 percent reduction in pedestrian crashes

Dimensions: Minimum 4' wide, though preferable 8' wide.

Cost: $13,520 (average). Costs will be higher for concrete islands versus asphalt islands.

Specific Considerations

Including Medians in Multilane Design Case Study, Florida

Additional Resources

STEP Tech Sheet

Educational Video

STEP Guide

FAQs

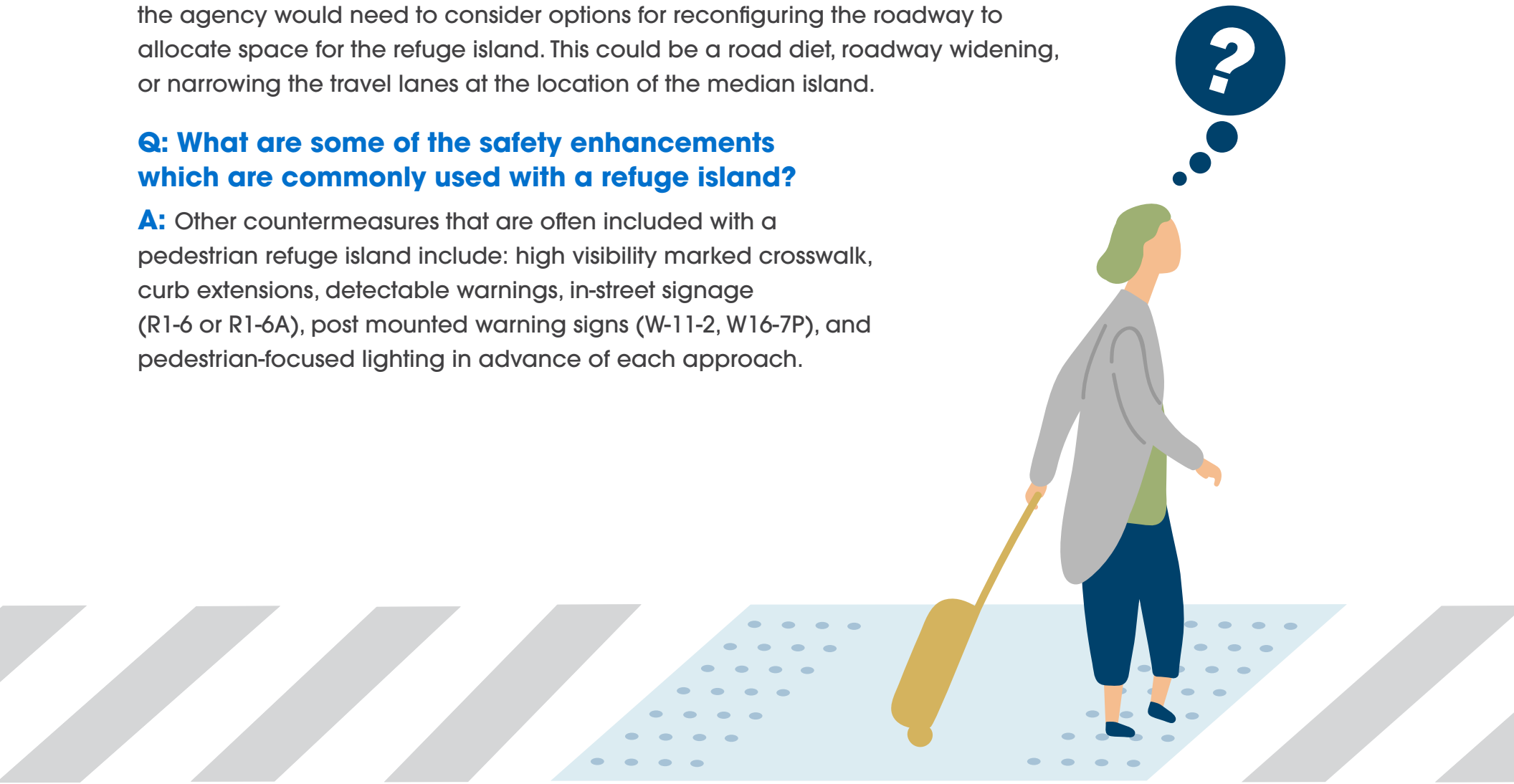
Pedestrian Refuge Island FAQs

Q: Can you use a pedestrian refuge island with a 4 lane undivided roadway? If so, how?

A: To include a pedestrian refuge island within a four lane undivided roadway, the agency would need to consider options for reconfiguring the roadway to allocate space for the refuge island. This could be a road diet, roadway widening, or narrowing the travel lanes at the location of the median island.

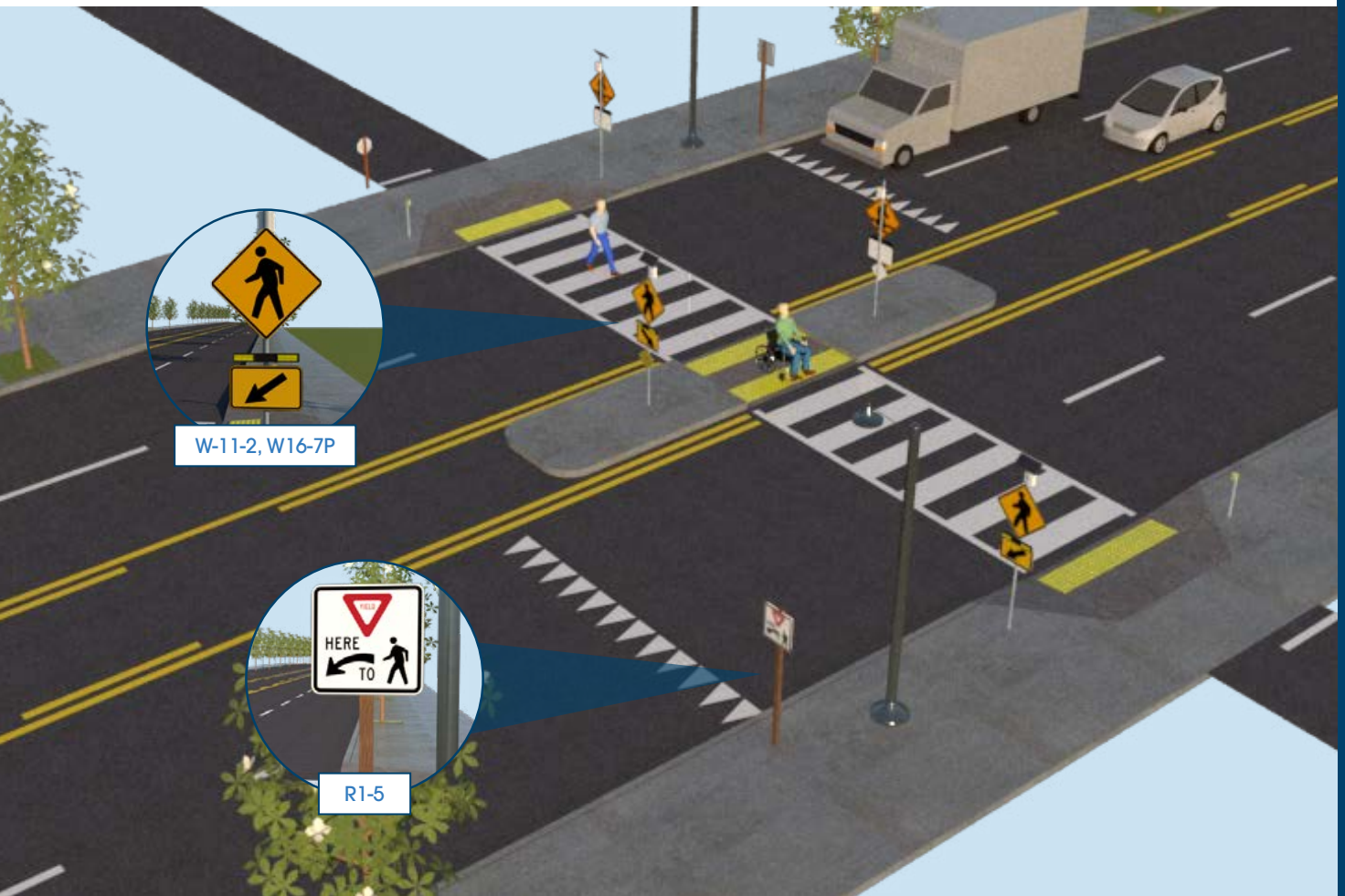
Q: What are some of the safety enhancements which are commonly used with a refuge island?

A: Other countermeasures that are often included with a pedestrian refuge island include: high visibility marked crosswalk, curb extensions, detectable warnings, in-street signage (R1-6 or R1-6A), post mounted warning signs (W-11-2, W16-7P), and pedestrian-focused lighting in advance of each approach.



Rectangular Rapid Flashing Beacons (RRFB)

RRFBs are **pedestrian-actuated conspicuity enhancements** used in combination with a pedestrian, school, or trail crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes **two rectangular shaped yellow indications**, each with an LED-array-based light source, that **flash with high frequency** when activated.



Countermeasure Details

Safety Benefit: 47 percent reduction in pedestrian crashes. Research indicates RRFBs can result in increased motorist yielding rates.

Dimensions: Each RRFB consists of two rectangular-shaped yellow indications, each with an LED-array-based light source

Cost: $22,250 (average)

Specific Considerations

- Identifying Roadways for RRFBs Case Study, Arlington, VA
- Integrating RRFBs into HSIP Planning Case Study, ME

Additional Resources

- STEP Tech Sheet
- FHWA Interim Approval 21 (IA-21)
- Educational Video
- FAQs

RRFB FAQs

Q: When would an RRFB generally be preferable to a pedestrian hybrid beacon at a designated pedestrian crossing?

A: RRFBs tend to be substantially less expensive than pedestrian hybrid beacons, so some agencies prefer installing RRFBs primarily for cost reasons. Other agencies may have begun using RRFBs as a supplemental traffic control device, and may not want to also introduce another device (like a PHB) in the same city, for fear of confusing drivers and pedestrians. Cities which use either RRFBs or pedestrian hybrid beacons (and particularly if both types of devices are used in the same city) should be sure to provide adequate public information and police enforcement. There is evidence that on high-speed, high-volume arterial streets, pedestrian hybrid beacons may be more appropriate than RRFBs in many instances.

Q: Can RRFB's be used without having a push-button activation, for example, using passive detection?

A: It is technically possible to activate an RRFB through passive detection, although most RRFBs make use of push-button activation. If there is passive detection, signage should clearly indicate to pedestrians when they are to enter the roadway (i.e., only after the device begins to flash and all vehicles have stopped). Agencies should also consider the installation of Audible Pedestrian Signals for both RRFBs and PHBs to address the needs of pedestrians with vision impairments.

Q: How is an RRFB situated when there is median?

A: The RRFB is post mounted on the right-hand side of the roadway and the left-hand side of the roadway; if the roadway is divided, the left-hand side assembly should be installed on the median, if practical.

Q: Are RRFB's suitable for use at trail crossings, and if so, under what conditions is this desirable?

A: RRFBs may be suitable for marked trail crossings at 2-lane road crossings and at multilane roads, particularly with AADTs above 9,000 and speeds of 35 MPH or greater. Consult Table 1, "Application of pedestrian crash countermeasures by roadway feature," for more information.

Q: Is the standard flashing beacon a suitable substitution for a RRFB? If no, then why not?

A: Flashing beacons are not a substitute for RRFBs. RRFBs are proven to reduce pedestrian crashes by 47 percent. Consult the MUTCD for information on flashing beacons and IA-21 for RRFBs.

Pedestrian Hybrid Beacon (PHB)

A Pedestrian Hybrid Beacon (PHB, also referred to as a HAWK) head **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**. When activated, the beacon displays a sequence of flashing and solid lights that indicate the pedestrian walk interval and when it is safe for drivers to proceed.

Countermeasure Details

Safety Benefit: 55 percent reduction in pedestrian crashes.

Dimensions: Dependent on installation context. The beacon heads and signage are supported by mounts along the roadway or mast arms above the roadway.

Cost: $57,680 (average)

Specific Considerations

- User and Motorist Education Case Study, Tampa, FL
- Responding and Prioritizing to Resident Requests Case Study, Austin, TX

Additional Resources

- STEP Tech Sheet
- Analysis of Current PHB Installation Policies (Illinois Center for Transportation)
- Educational Video
- STEP Guide
- FAQs

PHB FAQs

Q: What are the warrants or guidelines for installing a PHB? For the MUTCD chart, should it make use of a count during the pedestrian peak hour or vehicle peak hour, or both?

A: There is no warrant for PHBs, and the language in the MUTCD is guidance that should be considered alongside engineering judgment.

Q: In timing a PHB, should there be an immediate response, or should the timing be part of the signal progression of the corridor?

A: A PHB can be coordinated within the signal system, but this can also create a long delay for pedestrians and may encourage crossing prior to the PHB's activation. The PHB may also be coordinated with signals during peak travel times and use an immediate response during off-peak travel times.

Q: When would a PHB be considered to be preferable to a standard traffic signal with pedestrian WALK/DON'T WALK signals?

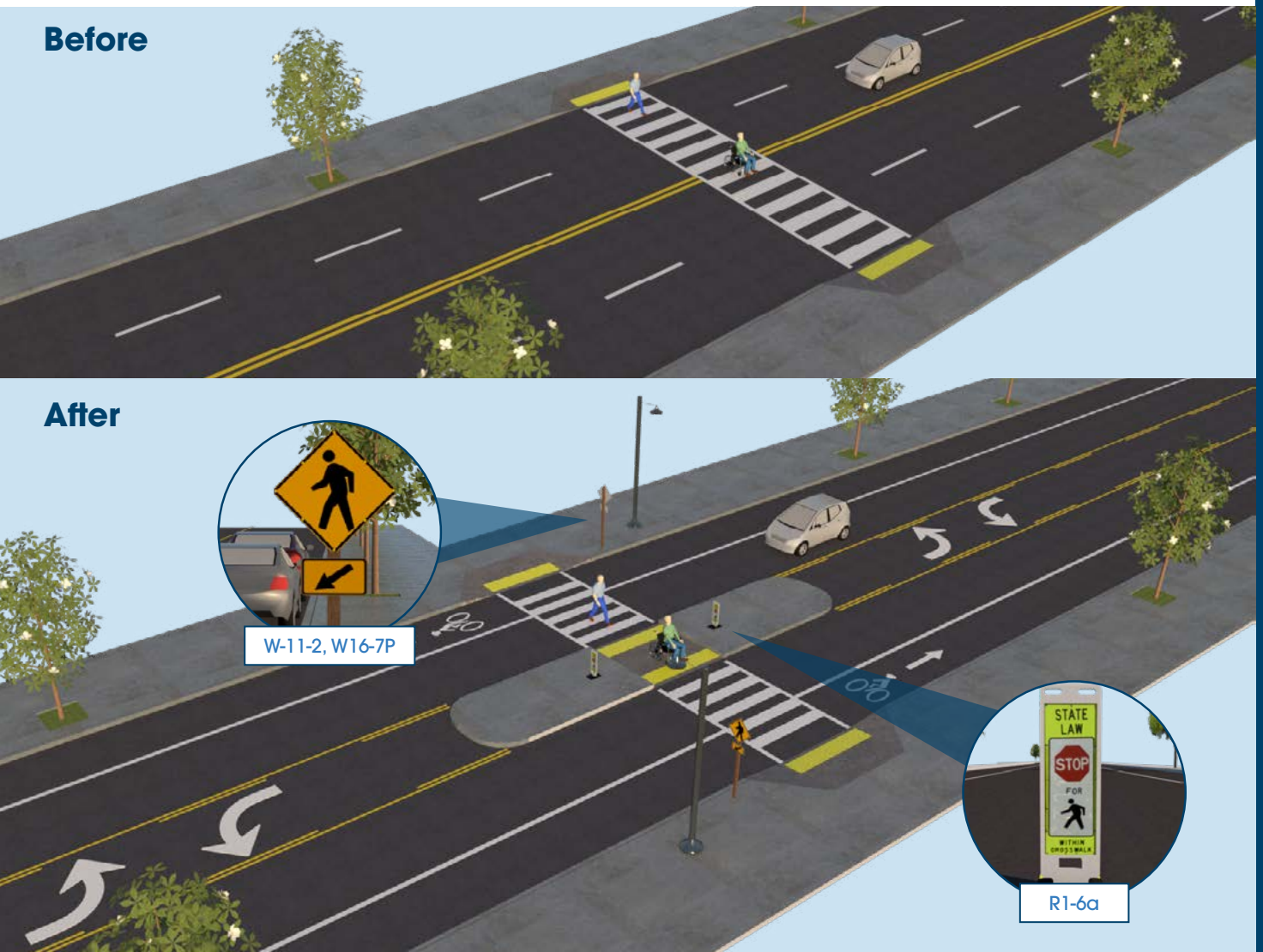
A: The MUTCD states that a "pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see Chapter 4C), or at a location that meets traffic signal warrants under Sections 4C.05 and/or 4C.06 but a decision is made to not install a traffic control signal." A PHB can also create less vehicular delay since it allows vehicles to move once the crosswalk is clear of pedestrians, while a traffic signal holds vehicles until the pedestrian phase ends and the clearance interval timing is completed.

Q: MUTCD Section 4F.02 states, "The pedestrian hybrid beacon should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs." Is it ever acceptable to install a PHB at or closer than 100 feet in this scenario?

A: In the current MUTCD, Item A of Paragraph 4 in Section 4F.02 is a Guidance statement; therefore, if there is a good engineering reason to deviate from this guidance (see Item B in Paragraph 1 of Section 1A.13), the agency is permitted to do so. According to a review of state PHB practices, 43 states maintain a 100' offset from side streets or driveways with STOP or YIELD signs, 6 states have no offset requirement, and one state maintains a 100' offset from side streets or driveways and at least 300 feet from traffic signals or railroad grade crossings with active warning devices.

Road Diet

A Road Diet is **a roadway reconfiguration** resulting in a reduction in the number of travel lanes, which is usually achieved by converting a four-lane undivided road to three lanes. The **space gained** by eliminating lanes is typically used for **other uses and travel modes**.



Countermeasure Details

Safety Benefit: 19 percent reduction in total crashes (urban areas) to 47 percent reduction in total crashes (suburban areas).

Dimensions: Dependent on planned roadway reconfiguration.

Cost: $25,000 to $100,000 per mile, dependent on roadway improvements.

Specific Considerations

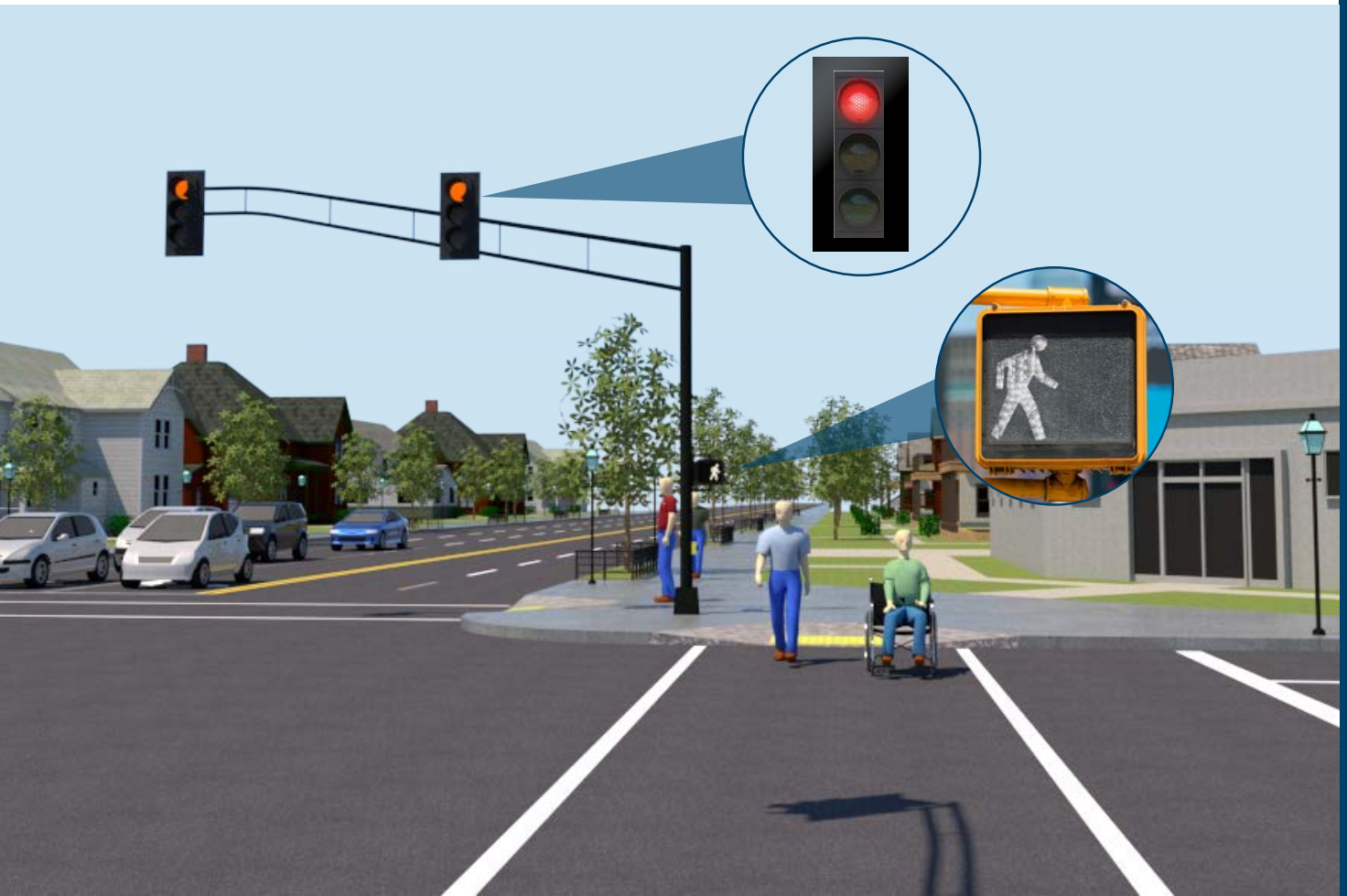
- Integrating with Complete Streets Case Study, Alexandria, VA
- Public Response and Education Case Study, Ramsey County, MN

Additional Resources

- STEP Tech Sheet
- FHWA Road Diet Informational Guide
- Educational Video
- 4-to-3-Lane Conversion Video (Iowa DOT)

Leading Pedestrian Interval

Leading Pedestrian Intervals (LPIs) are **low-cost adjustments** to signal timing to increase pedestrian safety at signalized intersections. An LPI gives pedestrians **a typical 3- to 7-second head start** before vehicles in the parallel direction are given the green signal indication. LPIs can help reduce conflicts between pedestrians and left- or right- turning vehicles. The LPI works to position the pedestrian within the crosswalk thereby **decreasing the likelihood of a conflict** or crash with a left- or right-turning vehicle ahead of the turning traffic.



Countermeasure Details

Safety Benefit: 13 percent reduction in pedestrian crashes.

Dimensions: The LPI should be at least 3 seconds and be timed to allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far enough for pedestrians to establish their position before the turning traffic is released.

Cost: $200 (controller setting changes only) to $1,200 each (pedestrian/vehicle study, retiming analyses, incorporating the formers setting changes).

Specific Considerations

Addressing Vehicle Intersection Delay - Case Study, Austin, TX

Additional Resources

STEP Tech Sheet

Educational Video

Additional Signalized Intersection Pedestrian Safety Improvements

There are many crash countermeasures that can be deployed at signalized intersections to increase pedestrian safety. These countermeasures can provide information to motorists and pedestrians on the permitted interval to walk across the roadway, reduce turning conflicts, increase signal accessibility, improve pedestrian conspicuity, and more. The safety benefits, costs, and appropriate applications vary for these signalized intersection-based improvements.

Potential Intersection Countermeasures

- Advanced Stop Lines
- Pedestrian Signals
- Pedestrian Signal Timing
- Right-Turn-on-Red Restrictions
- Traffic Signal Enhancements (e.g. Audible Pedestrian Signal, countdown timer, pedestrian detector)
- Additional Signing (e.g. Yield to Pedestrian, Turn Sign)

Additional Resources

FHWA Website - Intersection Safety for Vulnerable Road Users

PEDSAFE

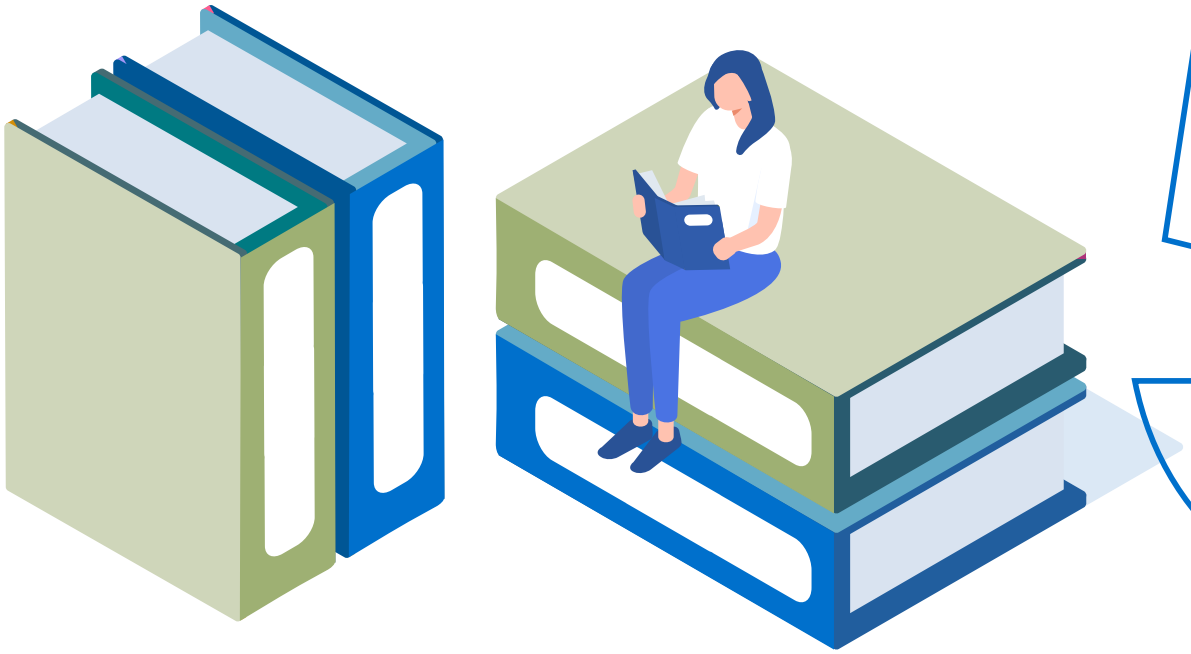
STEP 5

Consult Design and Installation

This Studio section identifies additional resources that refine countermeasure options for priority sites.

Studio Sections

MUTCD Guidance	AASHTO & State Guidance	Local and Other Guidance



MUTCD Guidance

The MUTCD defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public travel. Agencies may focus on three parts of the MUTCD shown below for additional considerations when installing countermeasures. Interim Approvals are those that authorize certain uses while a rulemaking is pending.

Countermeasure	MUTCD Reference
Marked Crosswalk	Crosswalk Markings (3B.18) Non-Vehicular Warning Signs (2C.50)
Advance Yield/ Stop Lines & Signs	Stop/Yield Lines (3B.16) Stop/Yield for Pedestrians Signs (2B.11)
In-Street Pedestrian Signage	In-Street Sign (2B.12)
Parking Restriction	Signage (2B.46) Markings (3B.19 & 3B.23)
Raised Crosswalk	Speed Hump Markings (3B.25)
Pedestrian Refuge Island	Approach Markings and Obstructions (3B.10) Crosswalk Markings (3B.18) Curb Markings (3B.23)
Pedestrian Hybrid Beacon	Speeds ≤ 35MPH (Figure 4F-1) Speeds > 35MPH (Figure 4F-2) Design and Operation (Part 4F)
Rectangular Rapid Flashing Beacon	Non-Vehicular Warning Signs (2C.50) School Sign (7B.08) Dimensions, Placement, and Flashing Conditions (Interim Approval 21)
Leading Pedestrian Interval	Interval and Signal Phases (4E.06)

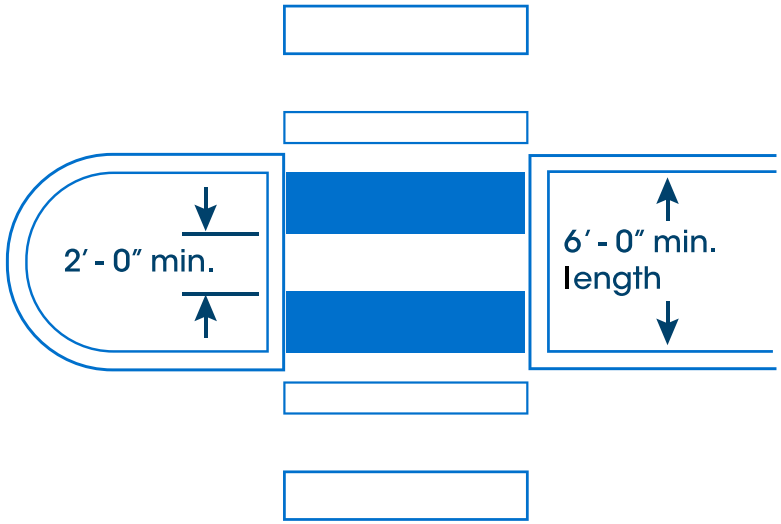
Additional Resources

- Manual on Uniform Traffic Control Devices
- MUTCD Interim Approvals

AASHTO & State Guidance

The American Association of State Highway and Transportation Officials (AASHTO) provides recommendations for the planning, design, and operation of accommodations for pedestrians on public rights-of-way. Two of these documents, the Guide for the Planning, Design, and Operation of Pedestrian Facilities (1st Edition), and the Policy on Geometric Design of Highways and Streets (7th Edition, commonly referred to as the Green Book), describe the relationship of land use and site design to roadway and pedestrian features. They are available for purchase from the organization's website.

States reference AASHTO guidance or create state specific materials to direct the design of pedestrian crossing treatments. For example, the New Mexico Department of Transportation revised its Design Manual to incorporate consideration of the STEP countermeasures during project planning.



Pedestrian Island Cut Through,
NMDOT Design Manual, Pedestrian Facilities

Additional Resources

- AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition (2004)
- AASHTO Policy on Geometric Design of Highways and Streets, 7th Edition (2018)
- Case Study - Maryland DOT Context Guide Illustrates STEP Countermeasures Across Land Uses
- New Mexico State DOT Design Manual

Local and Other Guidance

A local agency can review and, if needed, enhance local guidance for traffic engineers and roadway designers to follow when installing countermeasures. The agency's roadway design manual can include details, such as design and installation guidance, for each of the countermeasure options. The agency may also consider creating additional warrant and threshold guidance for countermeasures such as the Road Diet, considering local conditions.

Webpage screenshot from Arizona Department of Transportation.

Additional Resources

- PEDSAFE
- FHWA STEP Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

SPOTLIGHT Arizona DOT Tailors STEP Guidance for Local Agencies

In 2017, the Arizona Department of Transportation (ADOT) formed a STEP Team to advance implementation of the STEP countermeasures. The team included representatives from ADOT, FHWA, the City of Phoenix, City of Tempe, and City of Tucson. The STEP team used the Arizona Statewide Pedestrian Safety Action Plan (2017) to focus on identified corridors and sites for focused improvements. The team also recognized the different challenges that rural and urban areas face with implementing the STEP countermeasures.

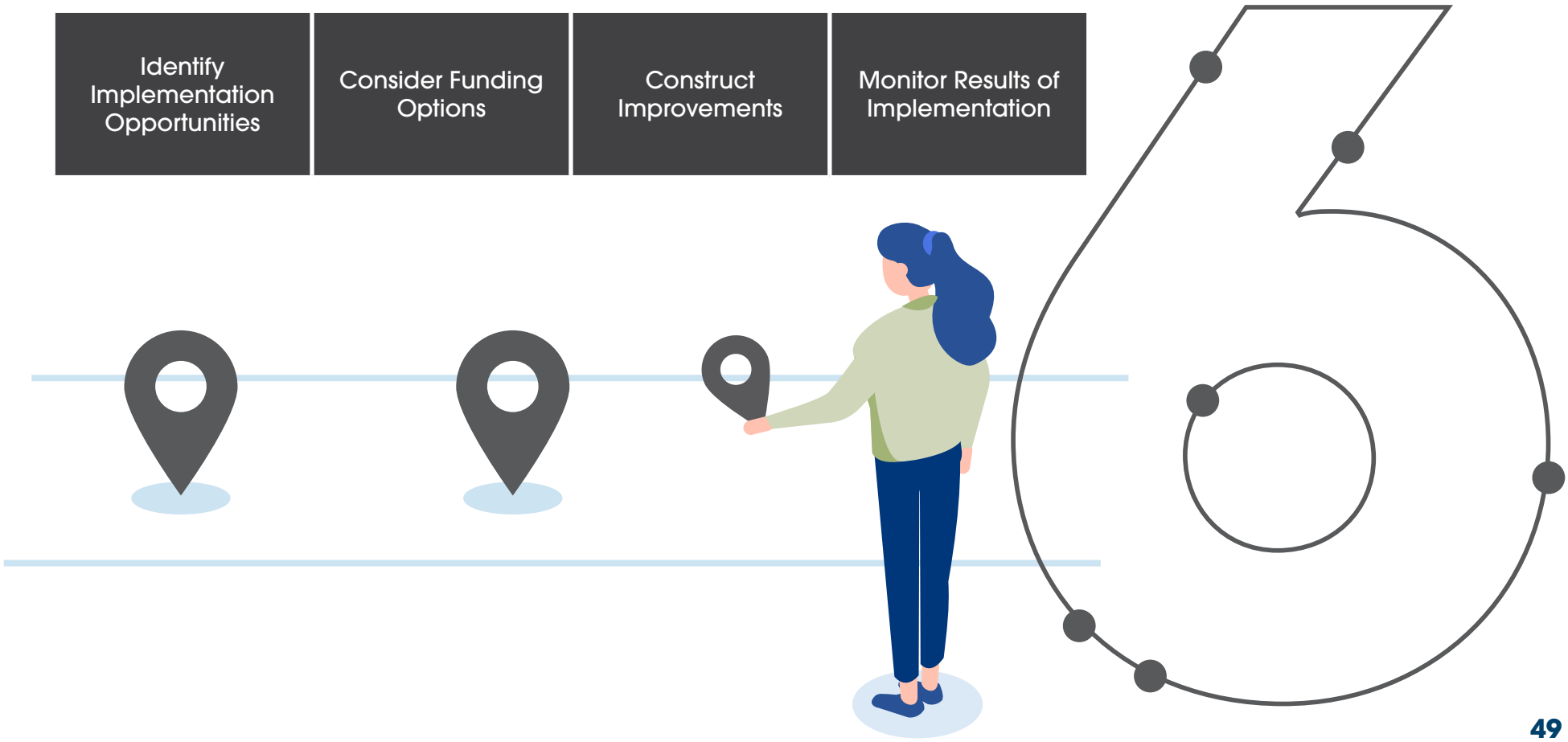
The ADOT STEP Team then developed a website devoted to helping local agencies respond to pedestrian safety challenges. The STEP website included an interactive countermeasure selection tool based on the STEP Guide. The website's interactive tool also provides links to Arizona-specific installation examples, countermeasure illustrations, local case studies, and references to State laws and MUTCD guidance for the design of the treatments.

STEP 6
Identify Opportunities and Monitor

This Studio section describes possible options for funding and implementation of the countermeasures described in the Studio and the Guide.

Studio Sections

Identify Implementation Opportunities	Consider Funding Options	Construct Improvements	Monitor Results of Implementation

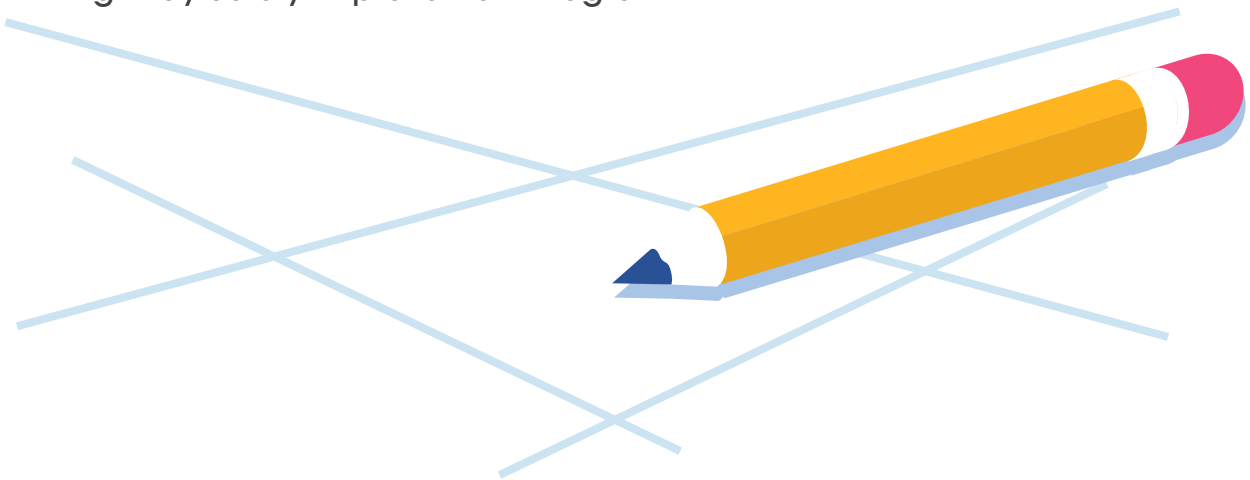


Identify Implementation Opportunities

Agencies can look beyond safety-focused funding programs to help implement countermeasures. By incorporating safety treatments into planned improvements or projects, the agency can realize cost savings. The agency can also engage the community prior to programing or designing the project to identify opportunities for improved pedestrian crossing safety and build support for the project.

Implementation Opportunities

- Roadway resurfacing
- Roadway maintenance
- State Transportation Improvement Projects
- Operational improvements
- Public or private land or site development
- Highway Safety Improvement Program



Additional Resources

- NCHRP Report 803: Pedestrian and Bicycle Transportation Along Existing Roads—ActiveTrans Priority Tool Guidebook (2015)
- FHWA - Road Diet: Systemically Identifying Candidate Road Diet Locations
- Case Study - Ohio DOT Designs Pedestrian Safety Program to Fast-Track Project Construction
- FHWA - Strategies for Accelerating Multimodal Project Delivery
- Case Study - Broward MPO Plans for Pedestrian Safety

Consider Funding Options

A major consideration when selecting a safety project or program is identifying and securing the funding to design, construct, operate, and maintain the project or program. Federal agencies distribute funds to the states and other jurisdictions for safety projects; some projects require a local match to leverage State or Federal funds.

Potential funding steps

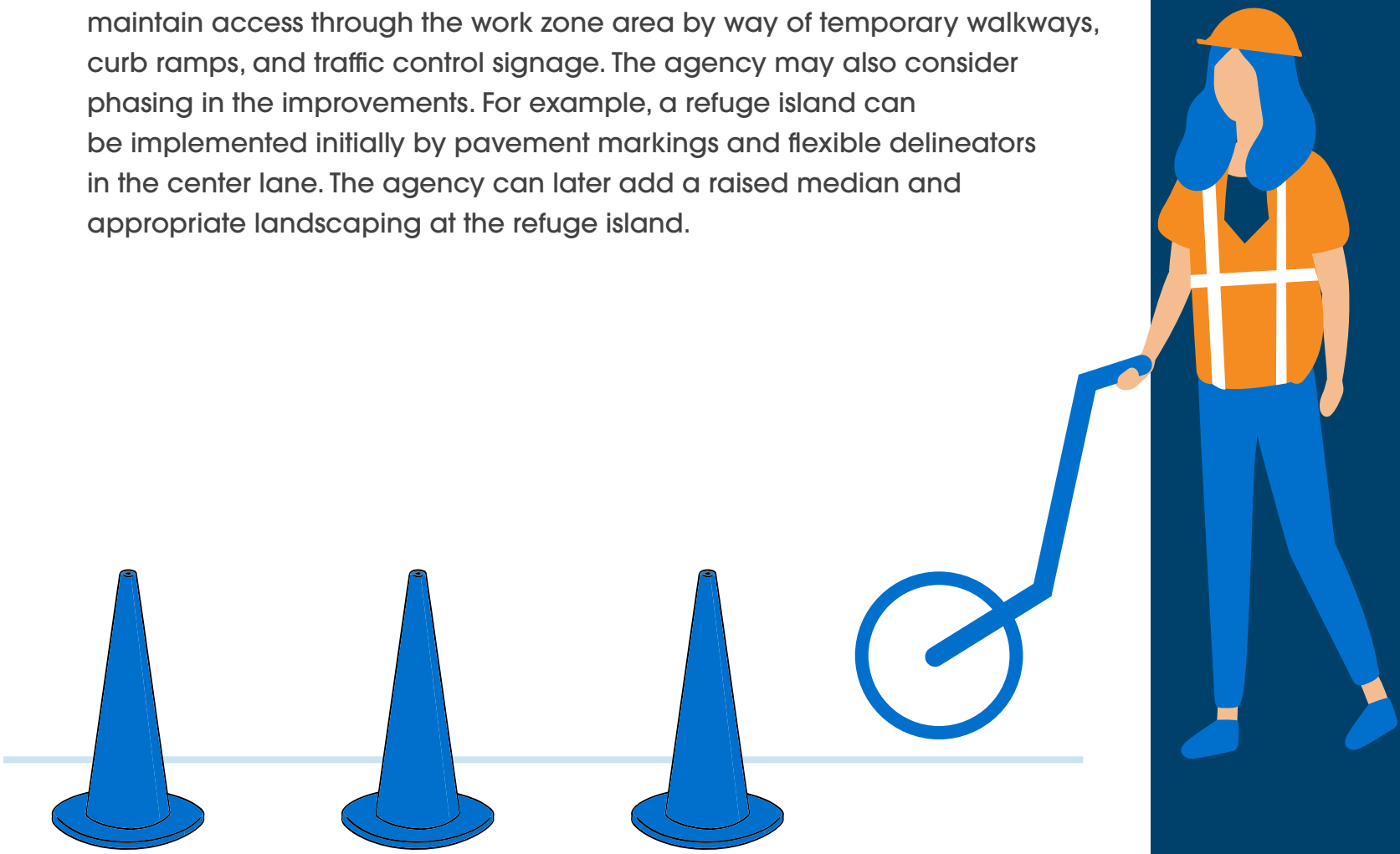
- Submit high-priority pedestrian crash locations as HSIP projects
- Consider other State safety funding programs for low-cost pedestrian safety improvements
- Address gaps in pedestrian accommodations through other State or Federal funding programs

Additional Resources

- FHWA Pedestrian and Bicycle Funding Opportunities Summary
- Federal Highway Improvement Program (HSIP)
- FHWA Federal-aid Program Administration

Construct Improvements

The public may have questions about the improvements as construction activities begin. The agency should post information about the improvements and a timeline for construction to a public-facing website and consider issuing a press release about the project. The agency should also provide detailed information about the project to neighbors and business owners impacted by construction activities. Pedestrians will maintain access through the work zone area by way of temporary walkways, curb ramps, and traffic control signage. The agency may also consider phasing in the improvements. For example, a refuge island can be implemented initially by pavement markings and flexible delineators in the center lane. The agency can later add a raised median and appropriate landscaping at the refuge island.



Additional Resources

Case Study – TNDOT Temporary Pedestrian Refuge Island

Monitor Results of Implementation

The agency should consider monitoring the impacts of countermeasures per defined performance measures. Specific performance measures can be outlined in plans, such as a Pedestrian Safety Action Plan (PSAP) described in Step 1. In addition to the performance of the treatment, the agency should consider assessing the durability and life cycle maintenance needs for in-service devices. As more pedestrian crossing treatments are implemented, State and local agencies can use these data to research the effectiveness of countermeasures and best practices for installation. Evaluation also helps an agency demonstrate the value of the investment in countermeasures to community leaders and the public.

Potential performance measures

- Public support or public outreach events
- Crash rates and severities (minimum 3 years after countermeasure installation)
- Pedestrian volumes
- Traffic speeds

Additional Resources

- FHWA Guidebook for Developing Pedestrian and Bicycle Performance Measures (2016)
- Case Study - NCDOT PHB Evaluation Shows Safety Improvement

References

Summary Table: 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
RRFB	47%	0.53	Pedestrian crashes	Zegeer, et. al. 2017

[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.

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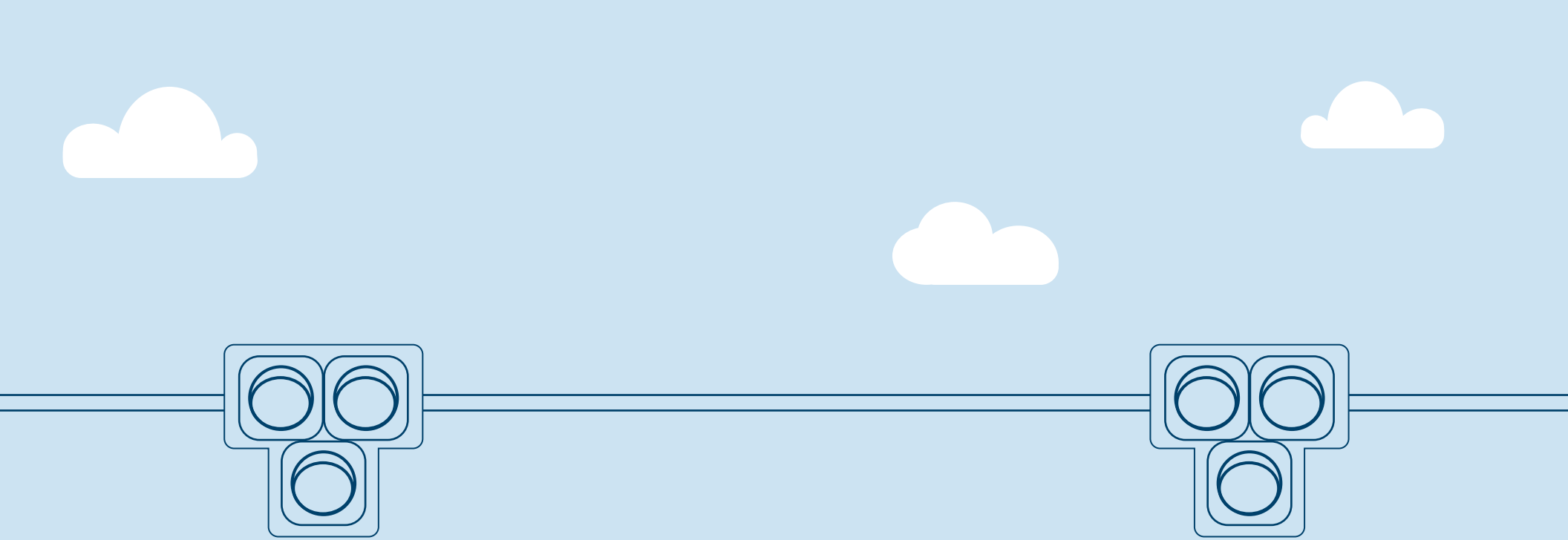

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