

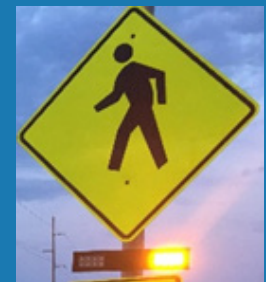
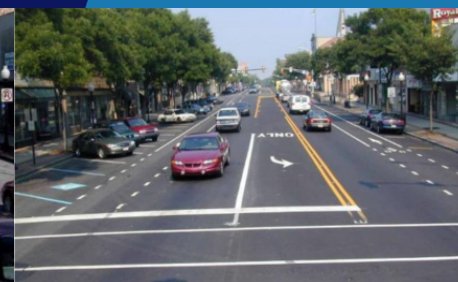
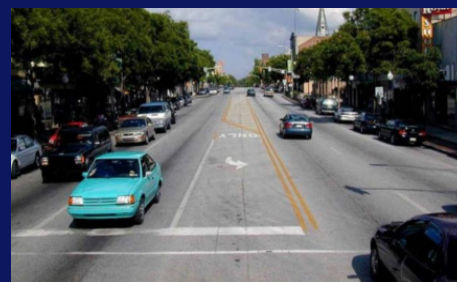


U.S. Department of Transportation  
Federal Highway Administration



# Safe Transportation for Every Pedestrian (STEP)

Keith J. Harrison, PE  
Senior Safety & Design Engineer  
FHWA Resource Center



# Every Day Counts (EDC-5) >> “STEP”

Identify and rapidly deploy  
*proven, but underutilized* innovations



Mobility · Safety · Quality · Environment · Shortening Project Delivery



U.S. Department of Transportation  
Federal Highway Administration



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Leading Pedestrian Interval (LPI)



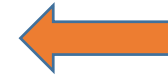
Road Diets



# STEP's "Spectacular Seven"



## Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Leading Pedestrian Interval (LPI)



Road Diets





# Crosswalk Visibility Enhancements

- Indicate preferred locations for people to cross
- Reinforce driver requirement to yield the right-of-way

**23 - 48%**  
Reduction in  
Pedestrian Crashes





# Crosswalk Visibility Enhancements

- High Visibility markings
- Parking restrictions on approaches
- Advance Yield/Stop signs and markings
- Curb extensions (bulb-outs)
- Improved placement of overhead lighting
- In-Street signs

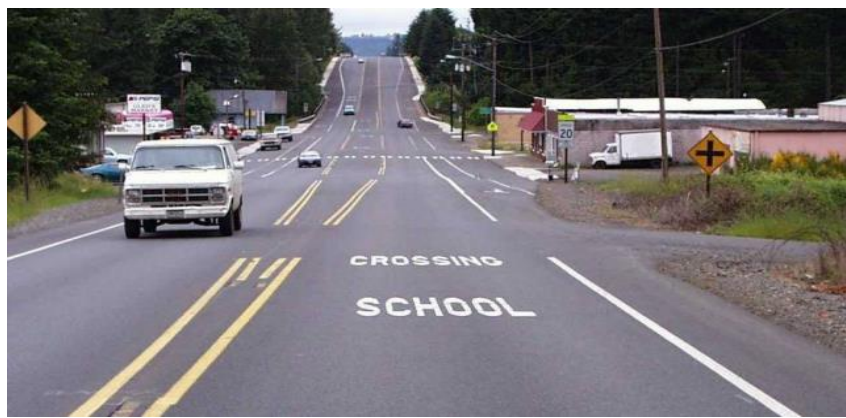
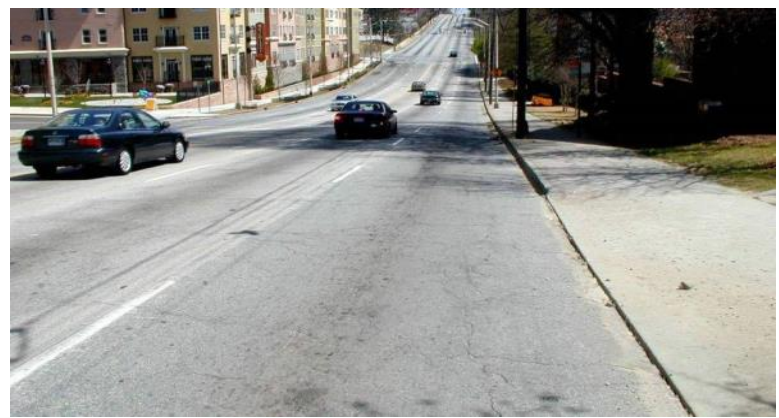






# Crosswalk Visibility Enhancements

✓ High visibility markings to enhance conspicuity/awareness



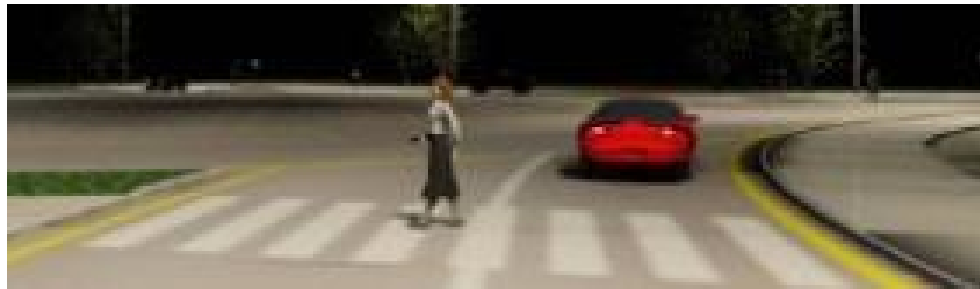
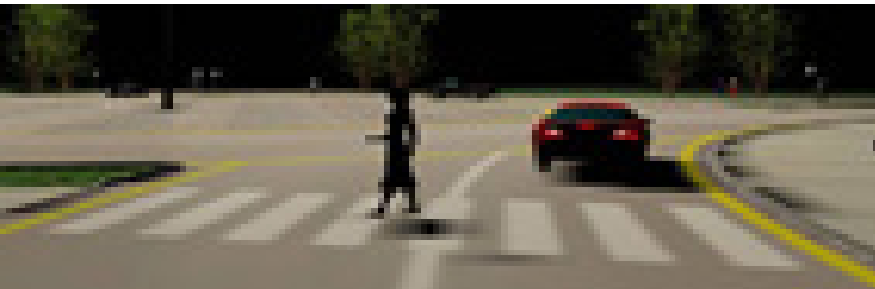
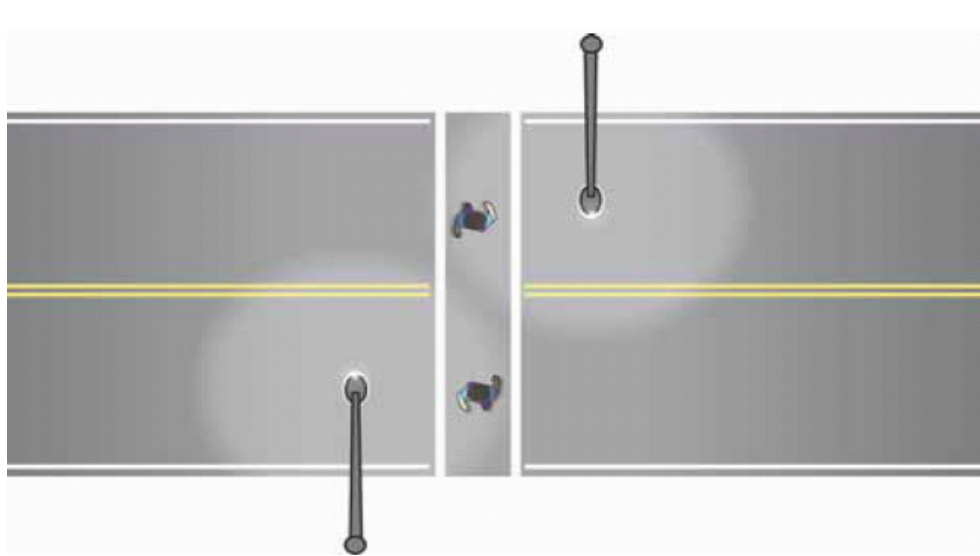
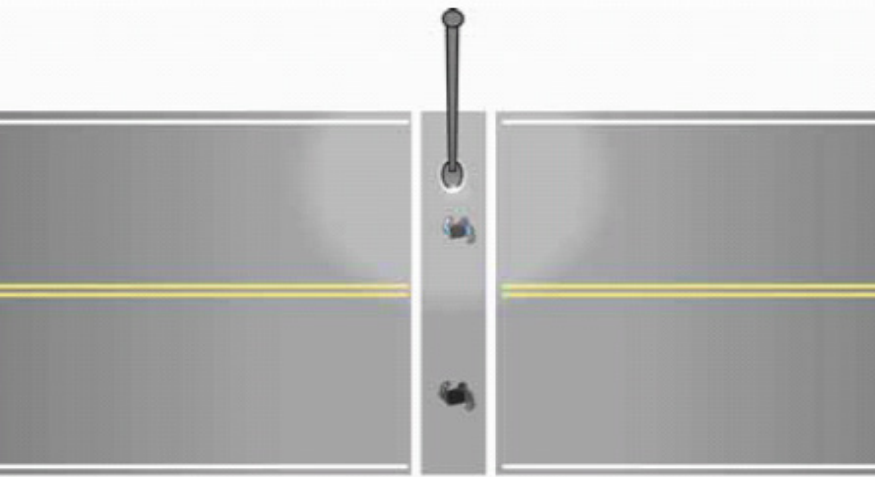
U.S. Department of Transportation  
Federal Highway Administration





# Crosswalk Visibility Enhancements

✓ Position luminaires upstream of crosswalk, not overhead



U.S. Department of Transportation  
Federal Highway Administration







# Crosswalk Visibility Enhancements

✓ In-street signs to reinforce pedestrian right-of-way

Gateway Treatment, Three-Lane Configuration Without Refuge Island	
Travel Lanes	2
Passing/Turn Lanes	1
R1-6 Signs	4
Flexible Delineators	0
Yielding Compliance	Between 60% and 90% compliance rate if speed limit is 30mph or less for ADT up to 25,000.  If the speed limit is 35 mph expect similar results if ADT is 12,000 or less. UNKNOWN above 12,000 ADT.



SOURCE: Michigan DOT



U.S. Department of Transportation  
Federal Highway Administration



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



**Raised Crosswalks** ←



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Leading Pedestrian Interval (LPI)



Road Diets



# Raised Crosswalks

- Makes pedestrian more prominent in driver's field of view
- Acts as traffic calming measure
- Allow pedestrians to cross at grade with sidewalk



**45%** Reduction  
in Pedestrian  
Crashes



# Raised Crosswalks

- Most suitable for
  - 2 to 3 Lanes
  - Speed limit  $\leq 30$
  - AADT  $< 9000$
- Least suitable for
  - Bus/truck routes
  - Primary route for emergency vehicles
  - Poor drainage



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



Raised Crosswalks



**Pedestrian Refuge Island** ←



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Leading Pedestrian Interval (LPI)



Road Diets





# Pedestrian Refuge Island

- Crossing in two stages reduces pedestrian exposure
- Place to rest and wait for gap
- May enhance visibility and reduce vehicle speeds





# Pedestrian Refuge Island

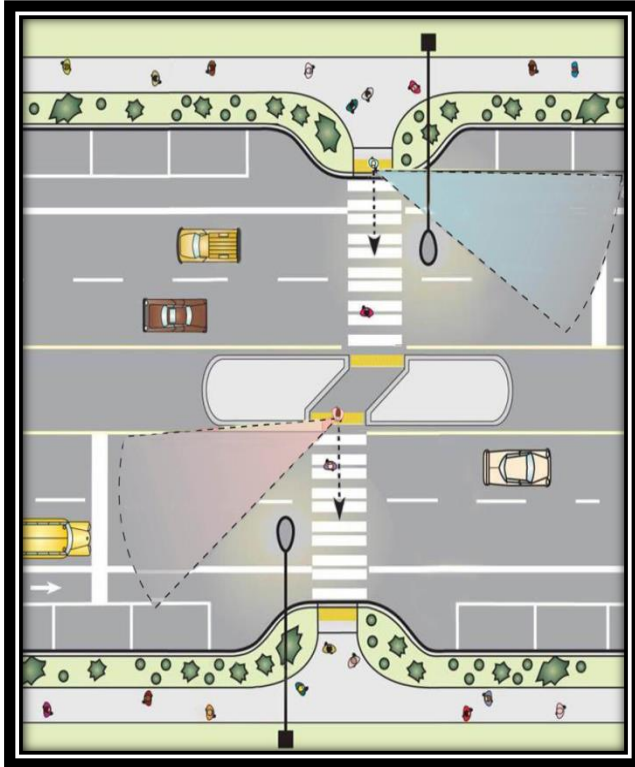


Image Credit:  
UNC Highway Safety Research Center



U.S. Department of Transportation  
Federal Highway Administration



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



**Rectangular Rapid Flashing Beacon (RRFB)**



Pedestrian Hybrid Beacon (PHB)



Leading Pedestrian Interval (LPI)



Road Diets

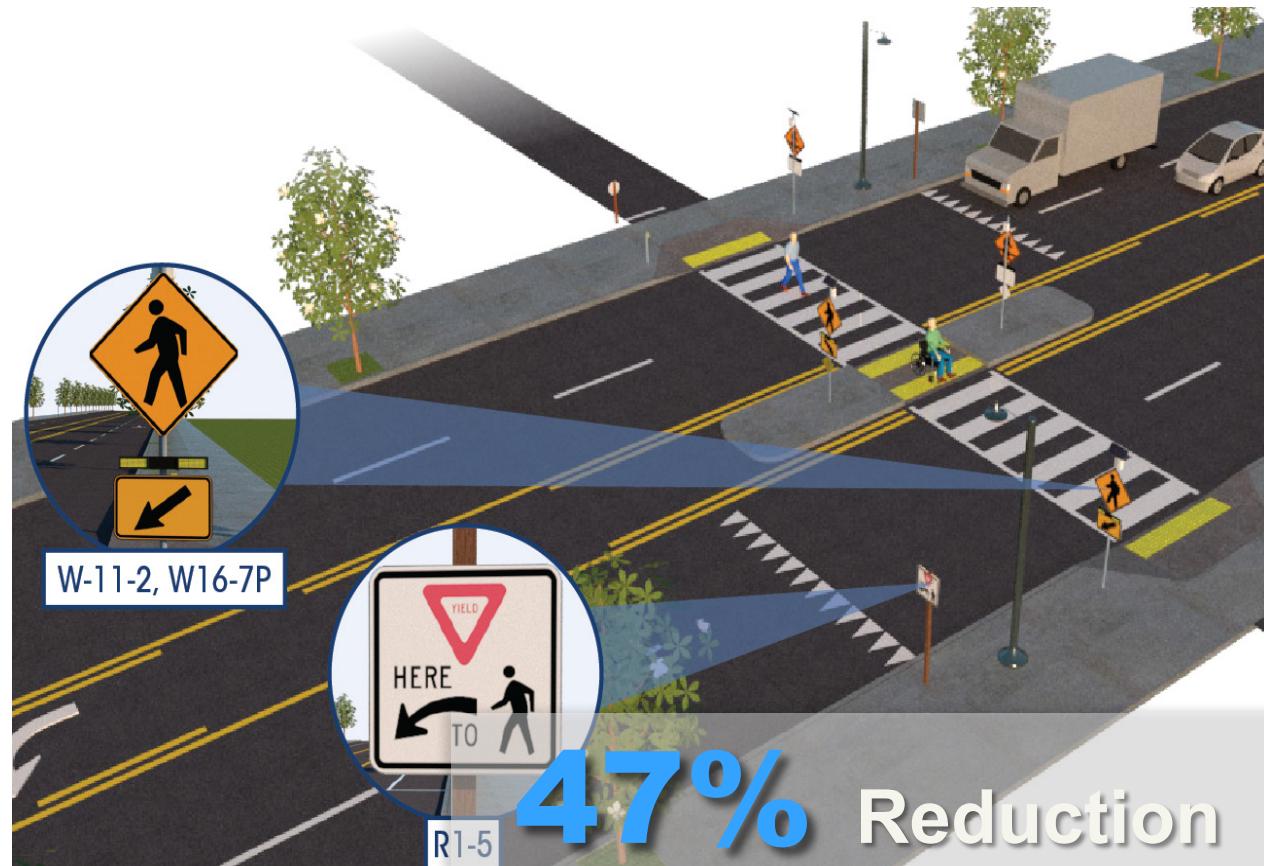






# Rectangular Rapid Flashing Beacon (RRFB)

- Multiple lanes create challenges crossing at unsignalized locations
- Can make pedestrians more visible at a marked crosswalk





# Rectangular Rapid Flashing Beacon (RRFB)

“a pedestrian-actuated conspicuity enhancement to supplement standard pedestrian, school, and trail crossing warning signs at uncontrolled, marked crosswalks” [MUTCD]



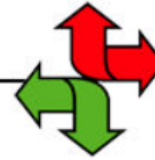




# Rectangular Rapid Flashing Beacon (RRFB)

FHWA Policy Memorandums

Manual on Uniform Traffic Control Devices (MUTCD)



[Resources](#) > [Interim Approvals Issued by FHWA](#)

## Interim Approval 21 – Rectangular Rapid-Flashing Beacons at Crosswalks



 [mutcd.fhwa.dot.gov](http://mutcd.fhwa.dot.gov)



U.S. Department of Transportation  
Federal Highway Administration



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



**Pedestrian Hybrid Beacon (PHB)** ←



Leading Pedestrian Interval (LPI)

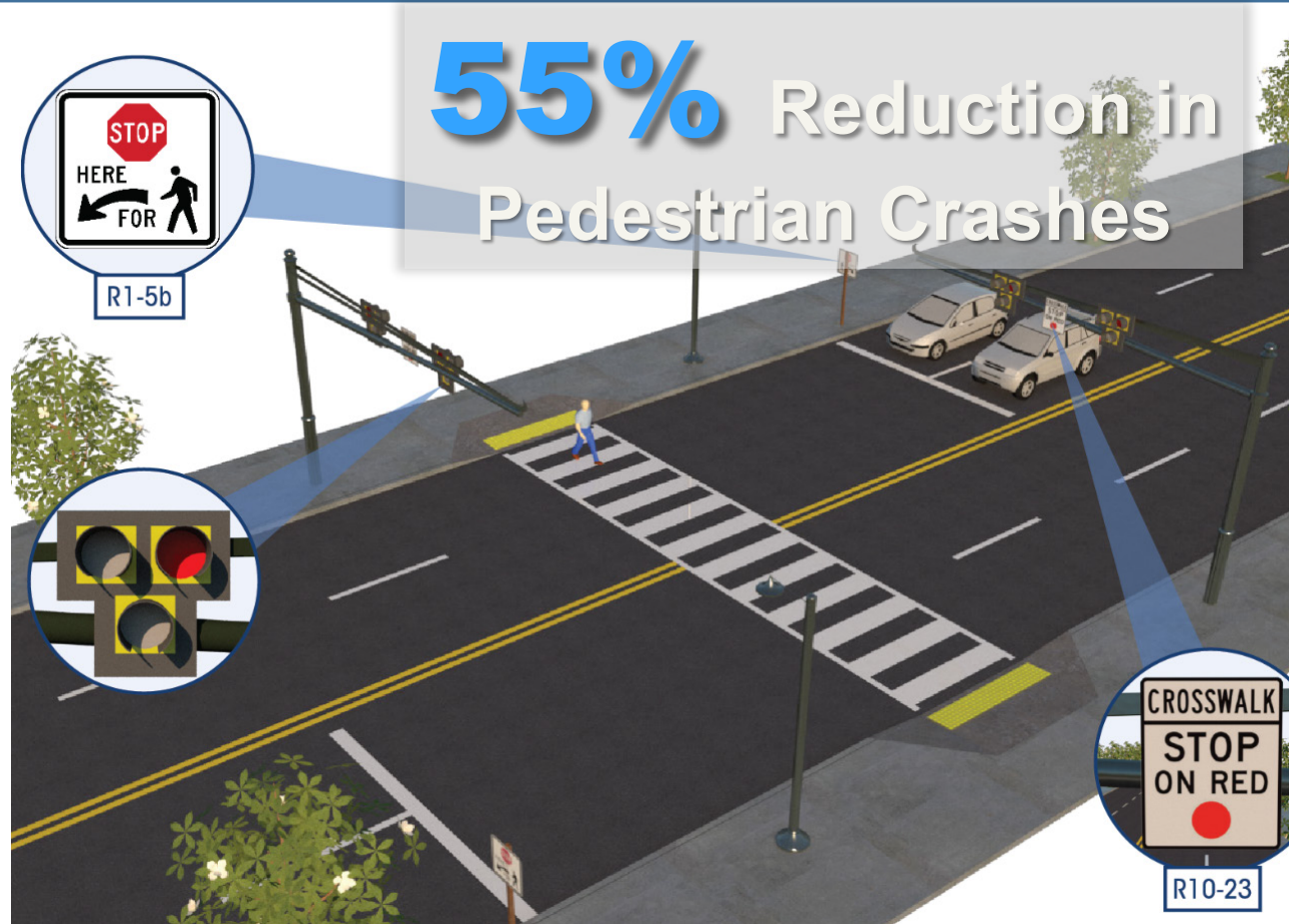


Road Diets



# Pedestrian Hybrid Beacon (PHB)

- Best suited for multilane crossings on high-volume high-speed facilities where signal warrants not met





# Pedestrian Hybrid Beacon (PHB)

1



1

Blank for drivers



2

Flashing yellow



3

Steady yellow



4

Steady red



5

Wig-Wag



Return to 1



Photo Credit Peter Eun



U.S. Department of Transportation  
Federal Highway Administration



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



**Leading Pedestrian Interval (LPI)** ←



Road Diets





# Leading Pedestrian Interval (LPI)

- Intended to help enforce pedestrian right-of-way
- Pedestrians given head start to establish presence in crosswalk

**59%** Reduction  
in Pedestrian Crashes



U.S. Department of Transportation  
Federal Highway Administration



# Leading Pedestrian Interval (LPI)



- Particularly effective in reducing conflicts with Left turning vehicles
- RTOR restrictions may be appropriate at locations with high volume of Right turns



# STEP's "Spectacular Seven"



Crosswalk Visibility Enhancements



Raised Crosswalks



Pedestrian Refuge Island



Rectangular Rapid Flashing Beacon (RRFB)



Pedestrian Hybrid Beacon (PHB)



Leading Pedestrian Interval (LPI)



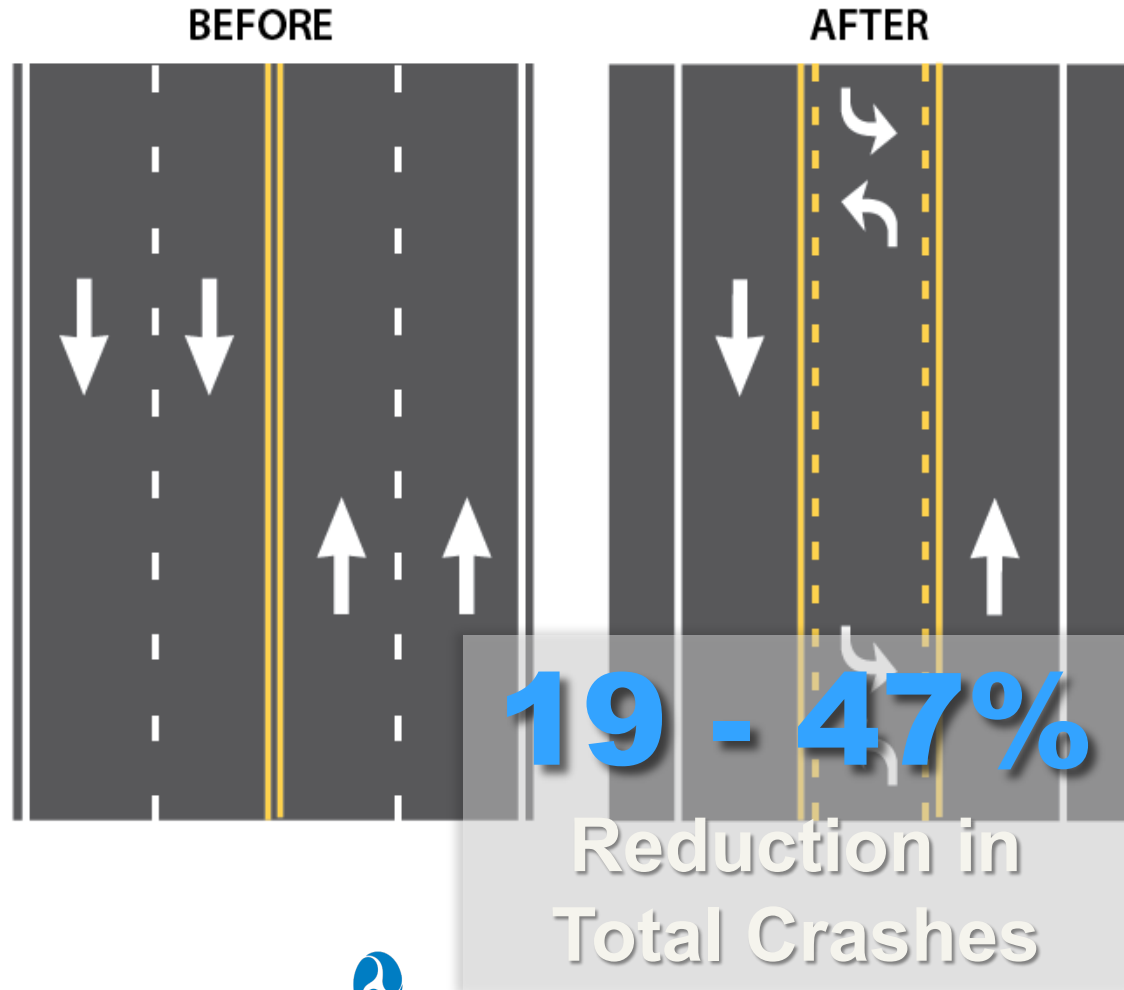
**Road Diets** ←





# Road Diets

- Reconfiguration of roadway cross-section to better serve all modes
- Can incorporate some of the STEP treatments already discussed

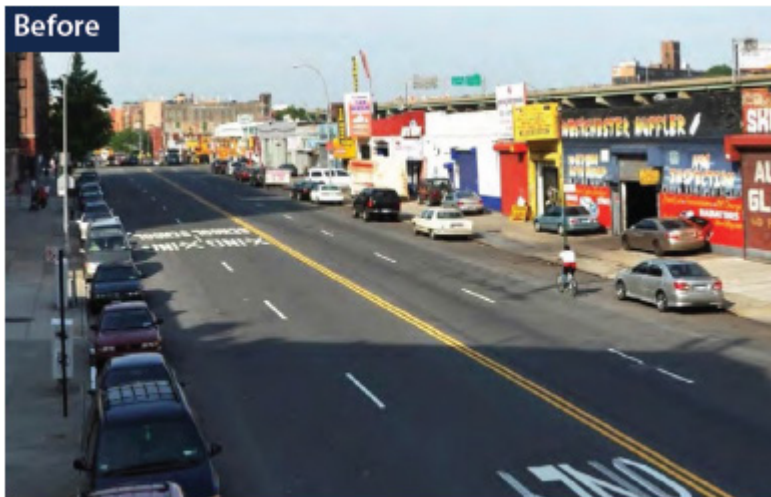






# Road Diets

- Utilize existing footprint
- Rebalance allocation of street space
- TWLTL (need not be continuous)



Source: NYCDOT

Example of a Road Diet on Southern Blvd., Bronx, New York



U.S. Department of Transportation  
Federal Highway Administration

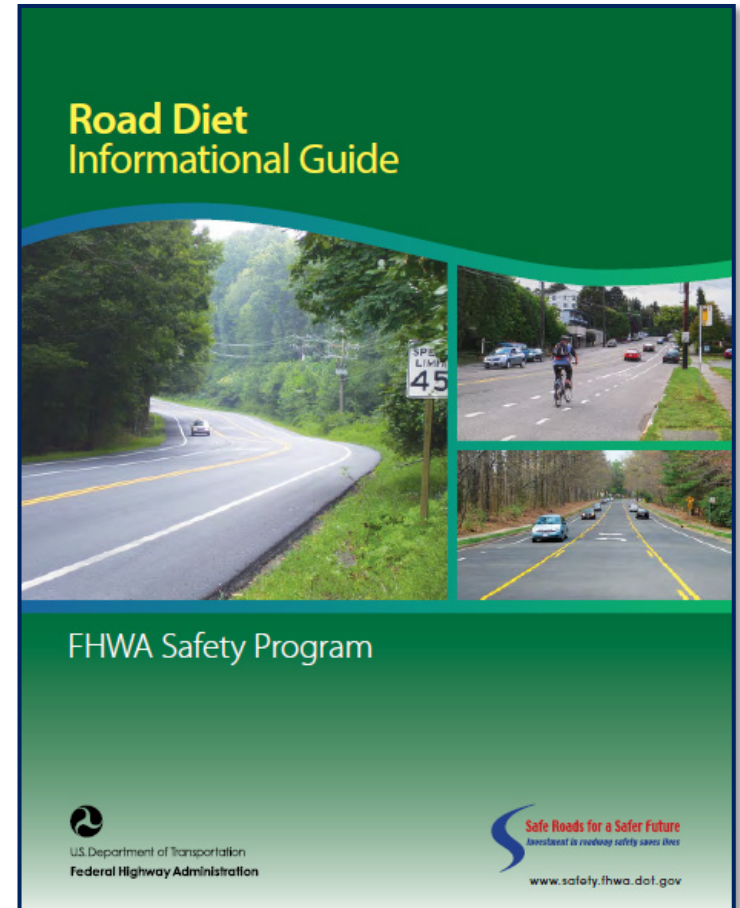
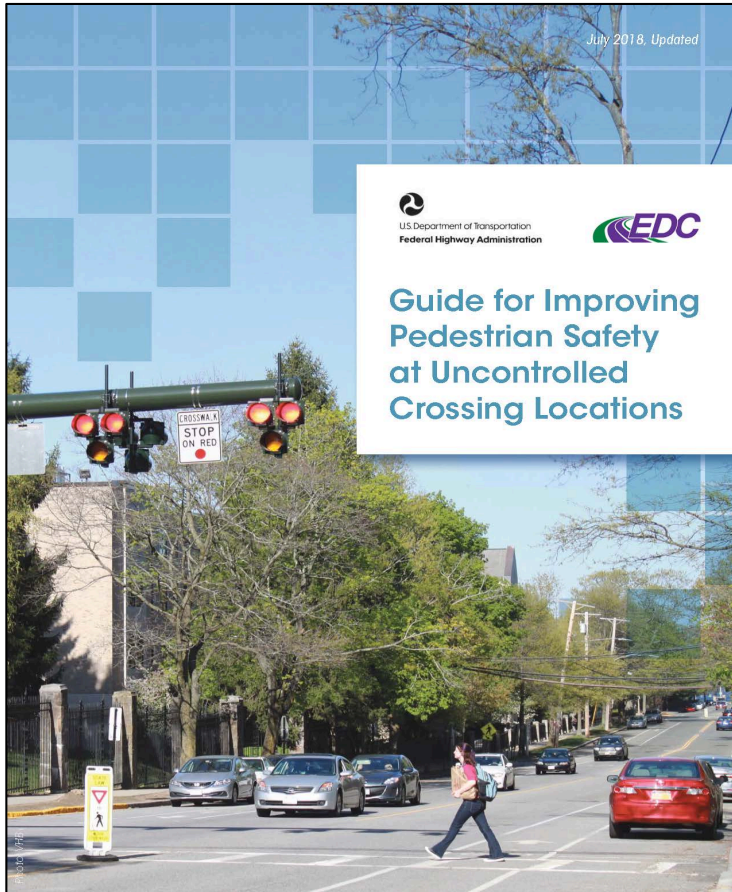


# Implementation Considerations

- Suitability of countermeasures depends on context
  - Volumes
  - Speeds
  - Cross-section
  - Land use
- Compliance with MUTCD and State/local policies
- Stakeholder involvement (outreach and education)
  - Understanding
  - Acceptance
  - “Ownership”



# Implementation Tools



U.S. Department of Transportation  
Federal Highway Administration



# Implementation Tools

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

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	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	① 2 4 5 6	① 7 5 6 7 9	① 5 6 ⑦ ⑨	① 4 5 6	① 7 5 6 7 9	① 5 6 ⑦ ⑨	① 4 5 6 7 9	① 7 5 6 7 9	① 5 6 ⑦ ⑨
3 lanes with raised median (1 lane in each direction)	① 2 3 4 5	① ③ 7 5 7 9	① ③ 5 6 ⑦ ⑨	① 3 4 5 6	① ③ 7 5 7 9	① ③ 5 6 ⑦ ⑨	① ③ 4 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	① 2 3 4 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨	① 3 4 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨	① ③ 4 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨
4+ lanes with raised median (2 or more lanes in each direction)	① ③ 7 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨	① ③ 7 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨	① ③ 4 5 6 7 9	① ③ 7 5 6 7 9	① ③ 5 6 ⑦ ⑨
4+ lanes w/o raised median (2 or more lanes in each direction)	① ③ 7 5 6 7 8 9	① ③ 7 5 6 7 8 9	① ③ 8 5 6 ⑧ ⑨	① ③ 7 5 6 7 8 9	① ③ 7 5 6 7 8 9	① ③ 8 5 6 ⑧ ⑨	① ③ 7 5 6 7 8 9	① ③ 7 5 6 7 8 9	① ③ 8 5 6 ⑧ ⑨

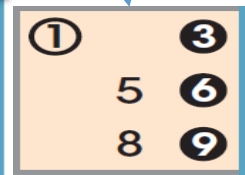
Given the set of conditions in a cell,

- # 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 sign
- 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)\*\*

\*Refer to Chapter 4, "Using Table 1 and Table 2 to Select Countermeasures," for more information about using multiple countermeasures.  
 \*\*The PHB and RRFB are not both installed at the same crossing location.





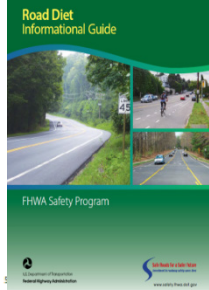
# Implementation Tools

## Appendix B – Feasibility Determination Factors, Characteristics, and Sample Evaluative Questions

Factor	Characteristics	Sample Evaluative Questions
Roadway Function and Environment	<ul style="list-style-type: none"> <li>Actual, Expected, and Desired Primary Function (Access, Mobility, or a Combination of the Two)</li> <li>Community Objectives or Goals for the Roadway</li> <li>Available Right-of-Way</li> <li>Current and Expected Adjacent Land Use</li> <li>Jurisdictional Plan or Policy for Conversions</li> <li>Jurisdictional Context Sensitive or Complete Street Policy</li> </ul>	<ul style="list-style-type: none"> <li>What is the primary current, expected, and desired function of the roadway?</li> <li>Is the roadway primarily a collector or minor arterial roadway?</li> <li>Does the current roadway primarily operate as a "de facto" three-lane cross section?</li> <li>Is the goal for the roadway improvement increased safety with somewhat lower mobility?</li> <li>Is the right-of-way limited?</li> <li>Will the adjacent land use remain relatively stable throughout the design period?</li> <li>Will the proposed cross section match the desired function of the roadway?</li> <li>Will the answers to the above questions remain the same throughout the design period of the project?</li> <li>Does the jurisdiction have a plan or policy related to these types of conversions?</li> <li>Does the jurisdiction have a context sensitive or Complete Streets policy that may apply?</li> </ul>
Crash Types and Patterns	<ul style="list-style-type: none"> <li>Type of Crashes</li> <li>Location of Crashes</li> <li>Number and Location of Pedestrians and Bicyclists</li> <li>Parallel Parking Needs</li> </ul>	<ul style="list-style-type: none"> <li>Can the crashes that are occurring be reduced with a conversion?</li> <li>Will a reduction in speed and speed variability increase safety?</li> <li>Are there safety concerns related to parallel parking maneuvers?</li> <li>Do pedestrians and bicyclists have safety concerns?</li> </ul>
Pedestrian and Bike	<ul style="list-style-type: none"> <li>Number and Location of Pedestrians</li> <li>Number and Location of Bicyclist Use</li> <li>Characteristics of Pedestrians and Bicyclists (Age)</li> <li>Speed and Pedestrian Friendliness of Roadway</li> <li>Section Width</li> <li>Parallel Parking Need</li> <li>Stop Locations</li> </ul>	<ul style="list-style-type: none"> <li>What is the pedestrian and bicyclist friendliness of the roadway?</li> <li>Do pedestrians and bicyclists have safety concerns?</li> <li>Will the addition of a TWLTL assist pedestrians and bicyclists?</li> <li>How will conversions, pedestrian and bicyclist intersect with parallel parking maneuvers be addressed with the conversion?</li> </ul>

## Feasibility Determination Factors

- Roadway Function and Environment
- Crash Types and Patterns
- Pedestrian and Bike Activity
- Overall Traffic Volume and LOS
- Turning Volumes and Patterns
- Frequent Stop /Slow-Moving Vehicles
- Weaving, Speed, and Queues
- ROW Availability, Cost, Impacts
- General Characteristics



# Countermeasure Fact Sheets

## 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.

Refuge islands are highly desirable for midblock pedestrian crossings on roads with four or more travel lanes, especially where speed limits are 35 mph or greater and/or where annual average daily traffic (AADT) is 9,000 or higher. They are also a candidate treatment option for uncontrolled pedestrian crossings on 3-lane or 2-lane roads that have high vehicle speeds or volumes. When installed at a midblock crossing, the island should be supplemented with a marked high-visibility crosswalk.



### SAFE TRANSPORTATION

## Rectangular Rapid-Flashing Beacon (RRFB)



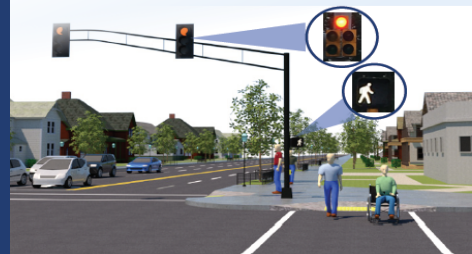
An RRFB is a pedestrian-actuated conspicuity enhancement used in combination with a pedestrian crossing warning sign to improve safety at uncontrolled crossing locations. The device includes two rectangular-shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated.

The RRFB is a treatment option of many types of established pedestrian crossings. For example, an RRFB may be a consideration for crossings of 2 or more lanes with speed limits of 35 mph or above and/or at crossings of 3 or more lanes with any speed limits. However, for high-speed roads (40 mph or greater) combined with high vehicle volumes (annual average daily traffic of 15,000 and above) and/or certain combinations of high-volume and high-speed, the RRFB may not be sufficient, and a Pedestrian Hybrid Beacon is likely a better option.



### SAFE TRANSPORTATION

## Leading Pedestrian Interval (LPI)



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. Agencies will often consider restricting Right Turns on Red (RTOR) in association with LPIs to better control for conflicts with right-turning vehicles.

The Manual on Uniform Traffic Control Devices (MUTCD) offers guidance on signal timing when LPI is used. The MUTCD says an LPI "should be at least 3 seconds in duration and should 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." Using Accessible Pedestrian Signals (APS) with LPI provides indications for persons with disabilities. MUTCD guidance also offers considerations for accessible pedestrian signals when LPIs are used.<sup>2</sup>



### SAFE TRANSPORTATION FOR EVERY PEDESTRIAN COUNTERMEASURE TECH SHEET

▲ LPIs reduce conflicts between pedestrians and vehicles.

💡 LPIs improve visibility of pedestrians in the crosswalk.

.....  
LPIs can reduce pedestrian crashes by!  
**13%**  
.....



#### FEATURES:

- Increased likelihood of driver yielding.
- Enhanced safety for slower moving pedestrians.

#### COMPLIMENTARY TREATMENTS:

- Right Turn on Red (RTOR) Restrictions.
- Accessible Pedestrian Signals.
- Parallel Vehicular Green Extension Interval.<sup>2</sup>

October 2019 | FHWA-SA-19-040



U.S. Department of Transportation  
Federal Highway Administration



# Targeted Assistance

- In-person training
  - Designing for Pedestrian Safety
  - Designing for Bicyclist Safety
  - Road Safety Assessment (RSA)
- Webinars
- Peer Exchanges
- Custom solutions



# Additional Resources

## Safety

About Office of Safety Programs Initiatives Resources Contact

Search Safety



FHWA Home / Safety / Pedestrian & Bicycle / Safe Transportation for Every Pedestrian (STEP)

eSubscribe

Resources

Webinars/Links

Every Day Counts (EDC)

Videos

### Program Contact

Becky Crowe  
[rebecca.crowe@dot.gov](mailto:rebecca.crowe@dot.gov)  
(202) 507-3699

Peter Eun  
[peter.eun@dot.gov](mailto:peter.eun@dot.gov)  
(804) 775-3381



Safe Transportation for Every Pedestrian (STEP)

[https://safety.fhwa.dot.gov/ped\\_bike/step/](https://safety.fhwa.dot.gov/ped_bike/step/)



U.S. Department of Transportation  
Federal Highway Administration







U.S. Department of Transportation

**Federal Highway Administration**



# Thank You!

Keith J. Harrison, PE  
keith.harrison@dot.gov  
(415) 748-8393