The Spectacular Seven

STEP

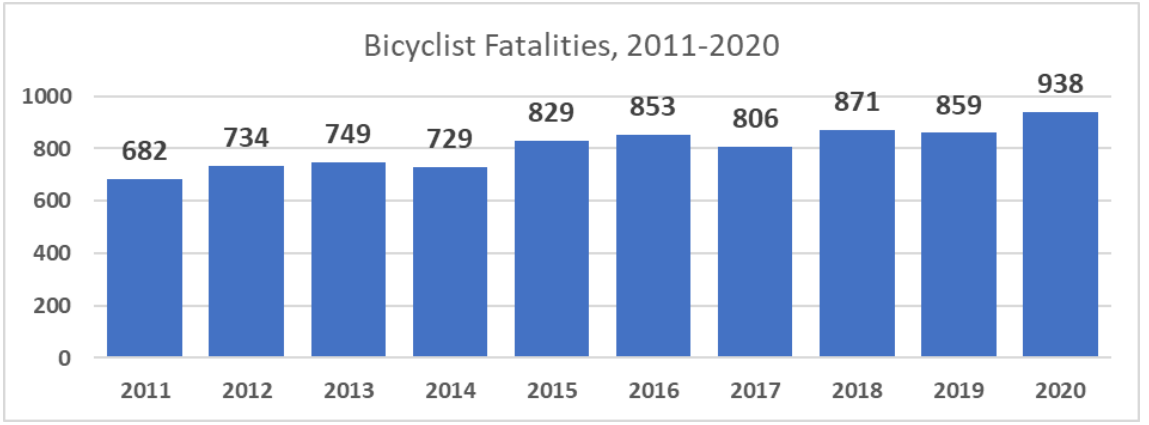
Safe Transportation for Every Pedestrian

Paul LaFleur, FHWA – Office of Safety

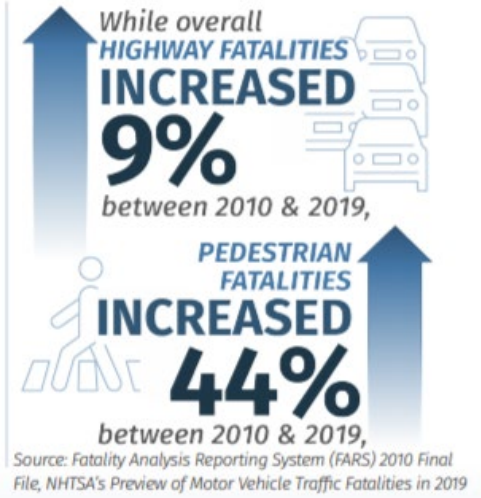
Iowa Bicycle Summit April 6, 2023

EDC

ZERO IS OUR GOAL



Source: NHTSA's Traffic Safety Facts, DOT HS 813 322, 2020 Data



ZERO IS OUR GOAL

Why STEP?

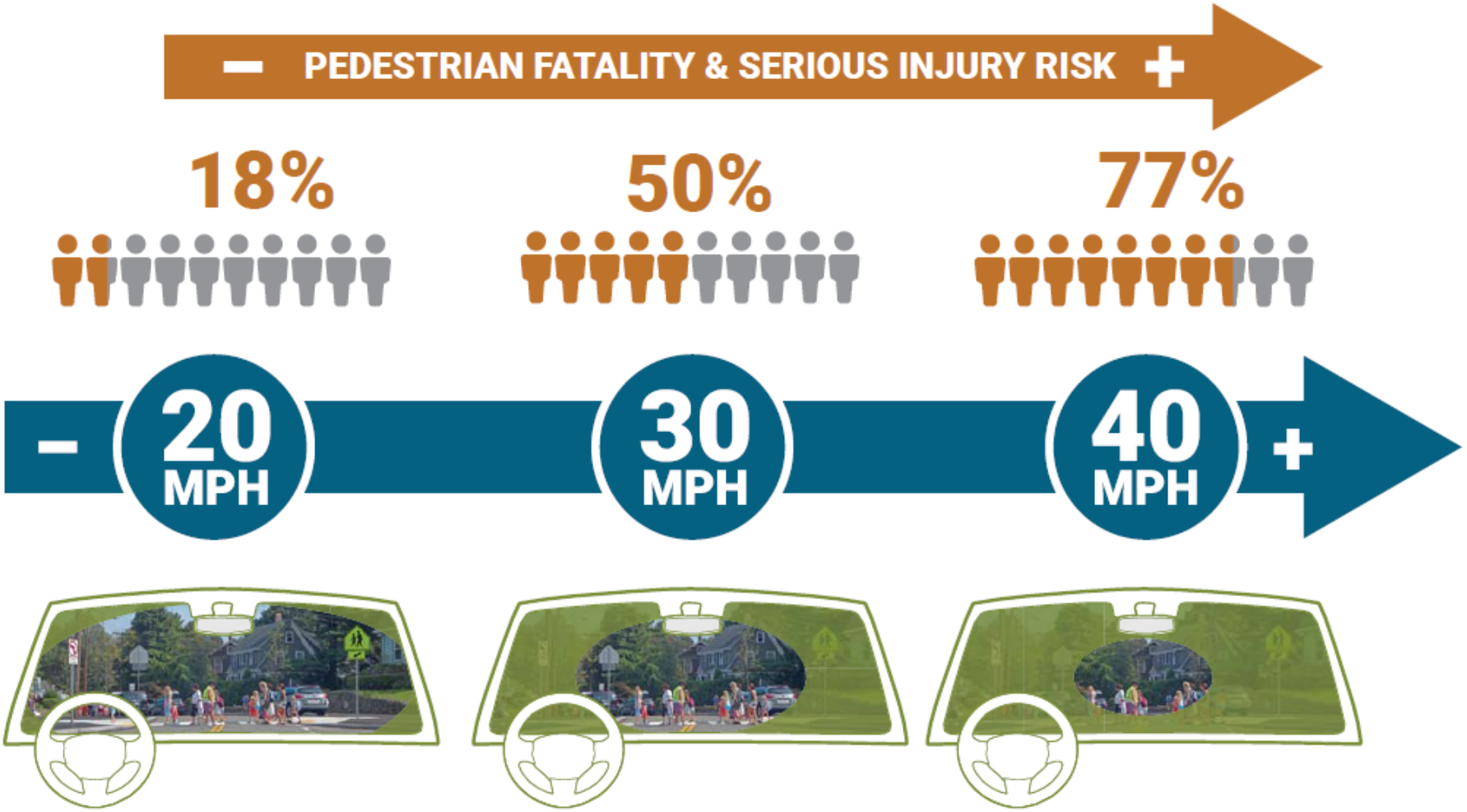
- Over 72% of pedestrian fatalities occur at non-intersection locations
- 26% of bicycle fatalities occur at intersections
- 79% of bicycle fatalities occurred inurban areas

Safe System Approach what is it?

"Safe System is the management and design of the road system such that impact energy on the human body is **firstly avoided or secondly managed at tolerable levels** by manipulating speed, mass and crash angles to reduce crash injury severity."

ZERO IS OUR GOAL
A SAFE SYSTEM is how we get there

https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm



CONE OF VISION

As motor vehicle speeds increase, the risk of serious injury or fatality for a pedestrian also increases (AARP Impact Speed and a Pedestrian's Risk of Severe Injury or Death 2011, p. 1). Also, motorist visual field and peripheral vision is reduced at higher speeds.

Australian PSA on Speed

60 kph (37 mph)

vs.

65 kph (40 mph)

Spectacular Seven

- Crosswalk Visibility Enhancements
- Raised Crosswalks
- Pedestrian Refuge Island
- Rectangular Rapid Flashing Beacon (RRFB)
- Pedestrian Hybrid Beacon (PHB)
- Road Diets
- Leading Pedestrian Interval (LPI)

Spectacular Seven

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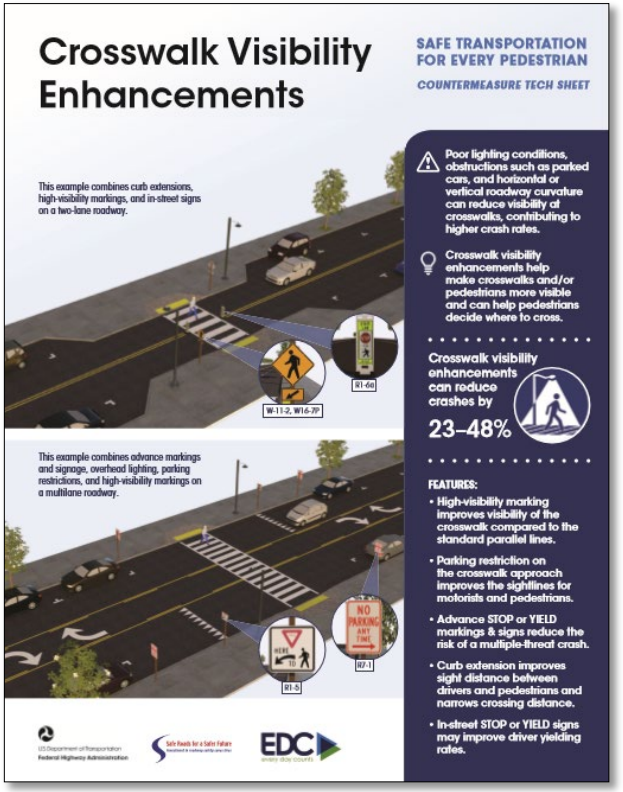
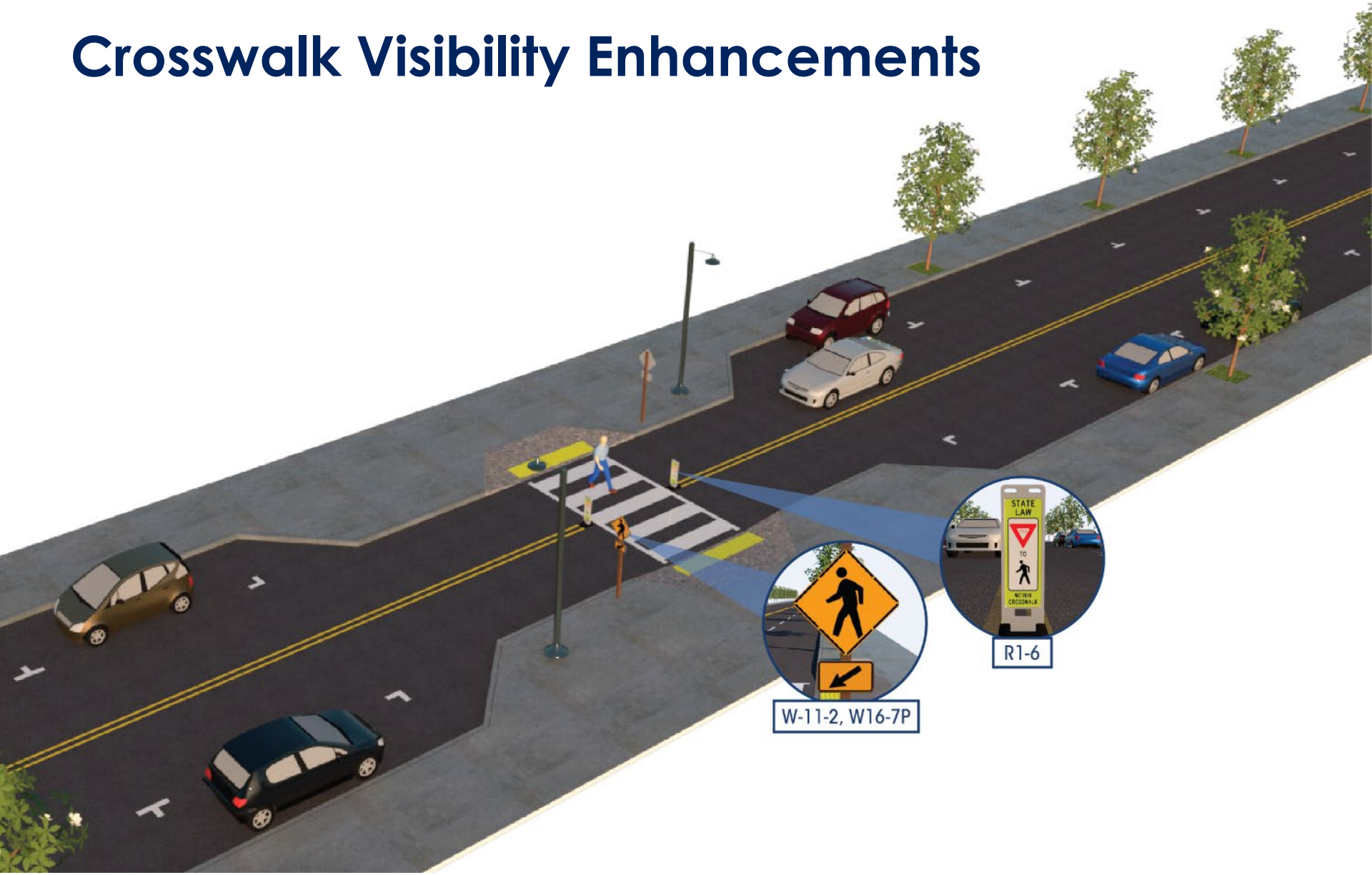


Crosswalk Visibility Enhancements



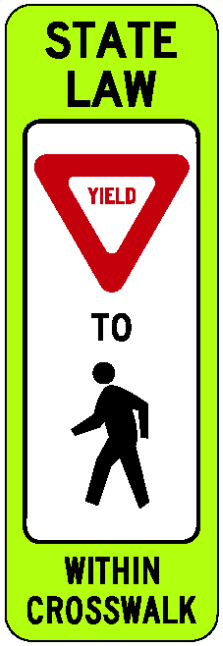
Crosswalk Visibility Enhancements
High Visibility Crosswalk

What Pedestrians See

Photo Source all 4: Michael Ronkin

What Drivers See

In-street pedestrian crossing signs



R1-6

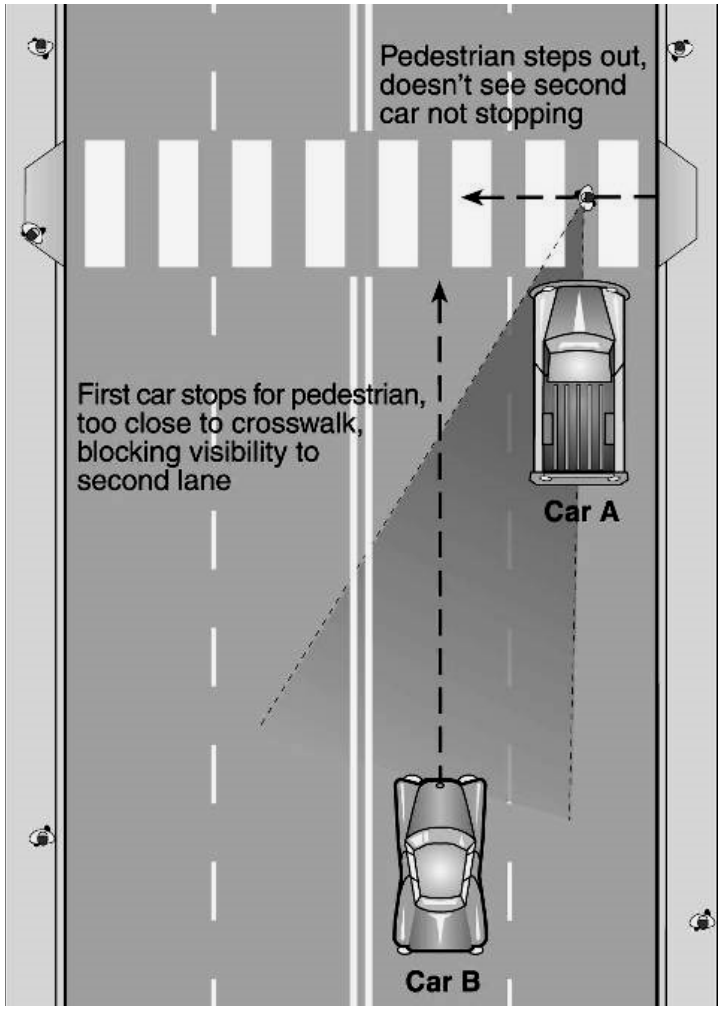
R1-6a

MUTCD signs

Yield or Stop depends on state law

Multiple Threat Crash Problem

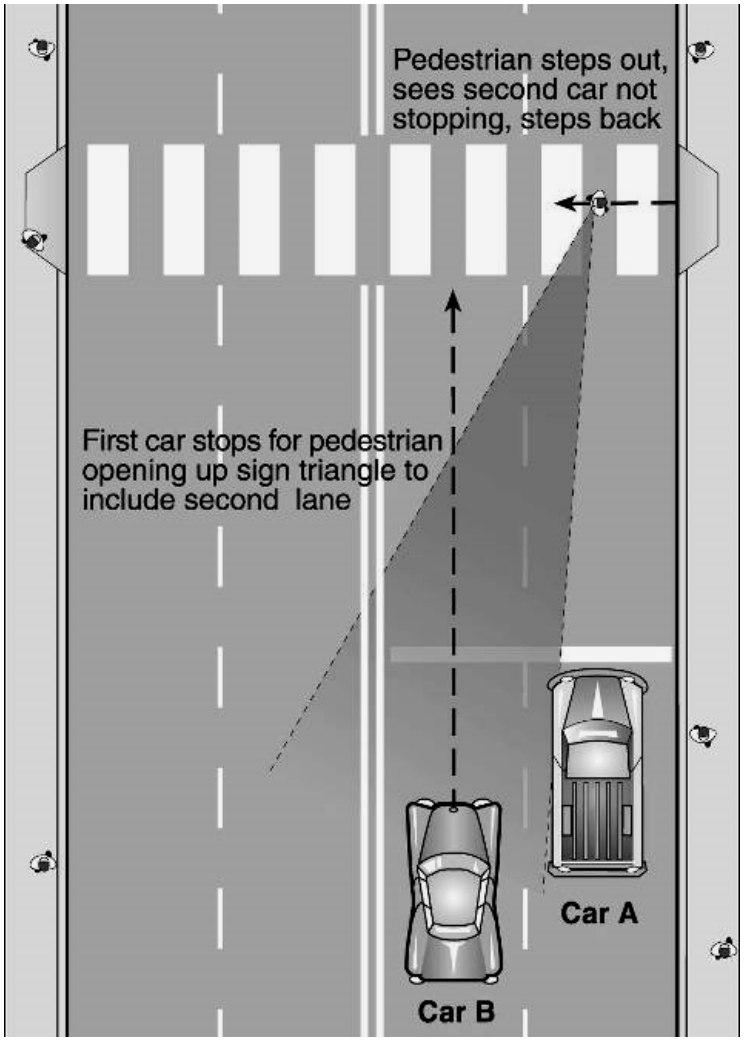
- 1st car stops to let pedestrian cross, blocking sight lines
- 2nd car doesn't stop, hits pedestrian at high speed



Multiple Threat Crash Solution

Advance stop or yield line

- 1st car stops further back, opening up sight lines
- 2nd car can be seen by pedestrian



Signing to go along with markings

R1-5

R1-5a

(Use where local law says yield to pedestrians)

R1-5b

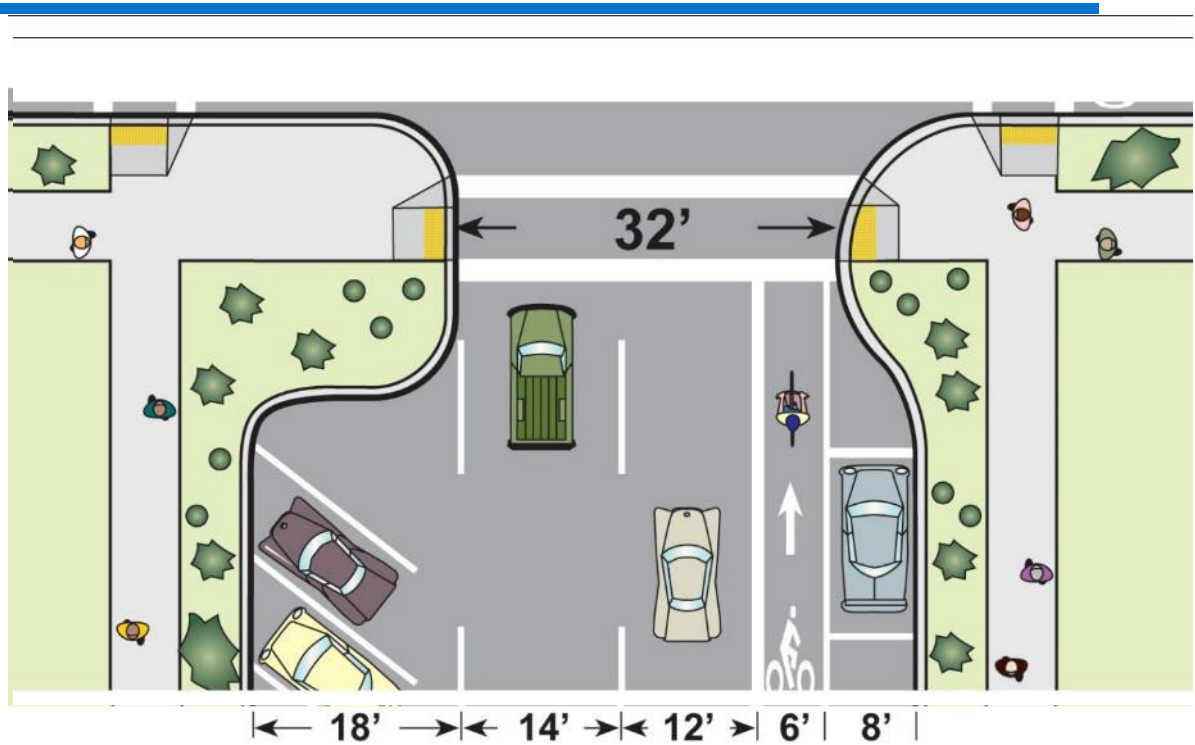
R1-5c

(Use where local law says stop for pedestrians)

- Advance yield line (shark's teeth) & sign
- Consider double white lines for no passing

Curb extensions

Most focus is on reduced crossing distance

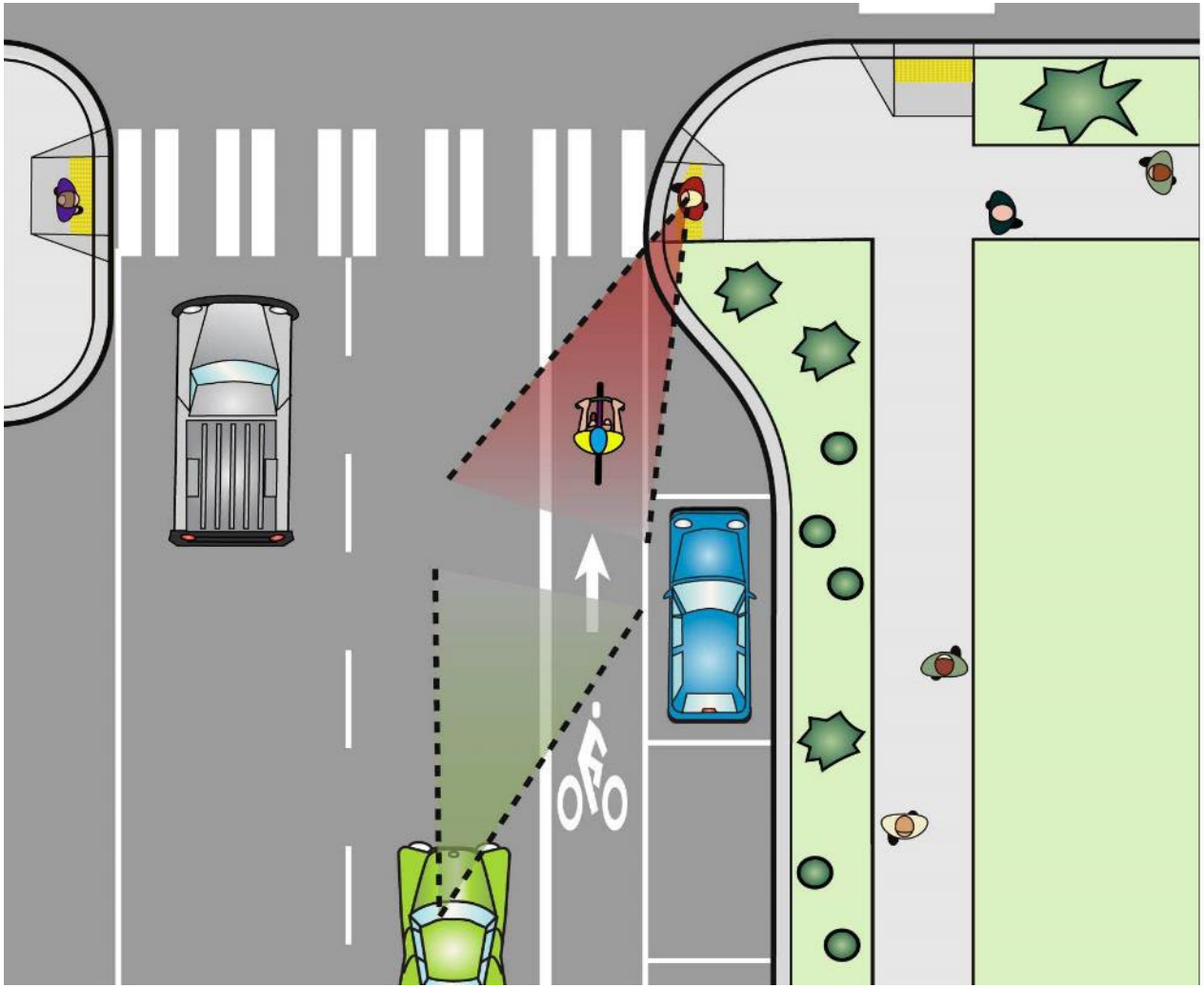


Other advantages:

- Better visibility between peds and motorists
- Traffic calming
- Room for street furniture

Curb extensions should be the width of the parking lane and not encroach on bike lanes or travel lanes

Better Visibility



Before: road looks and feels wide

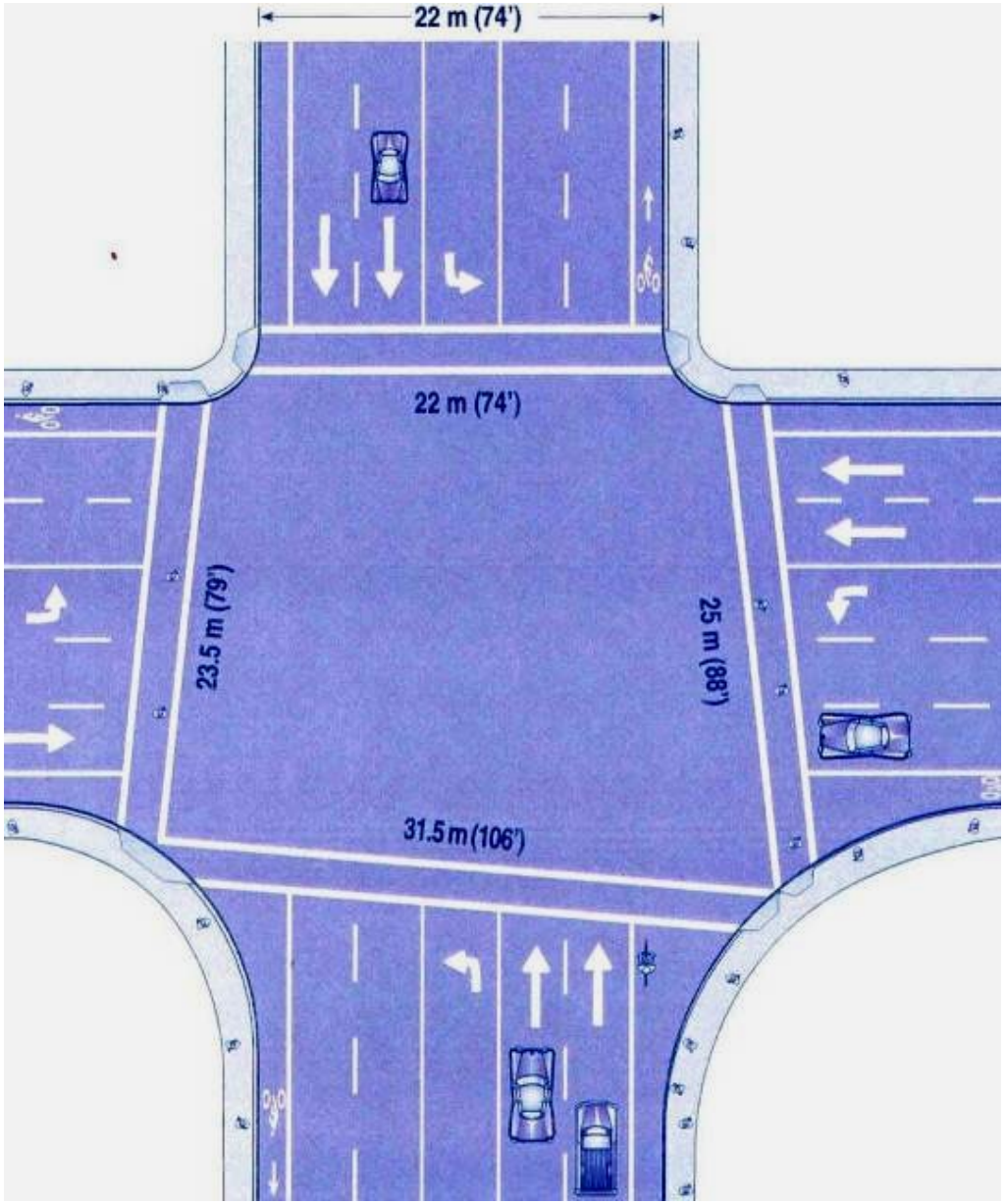
After: Mid-block curb extension and parking material matches sidewalk to make it appear narrower even with no parked cars

Curb radius – small radii are safer for pedestrians

Large radii:

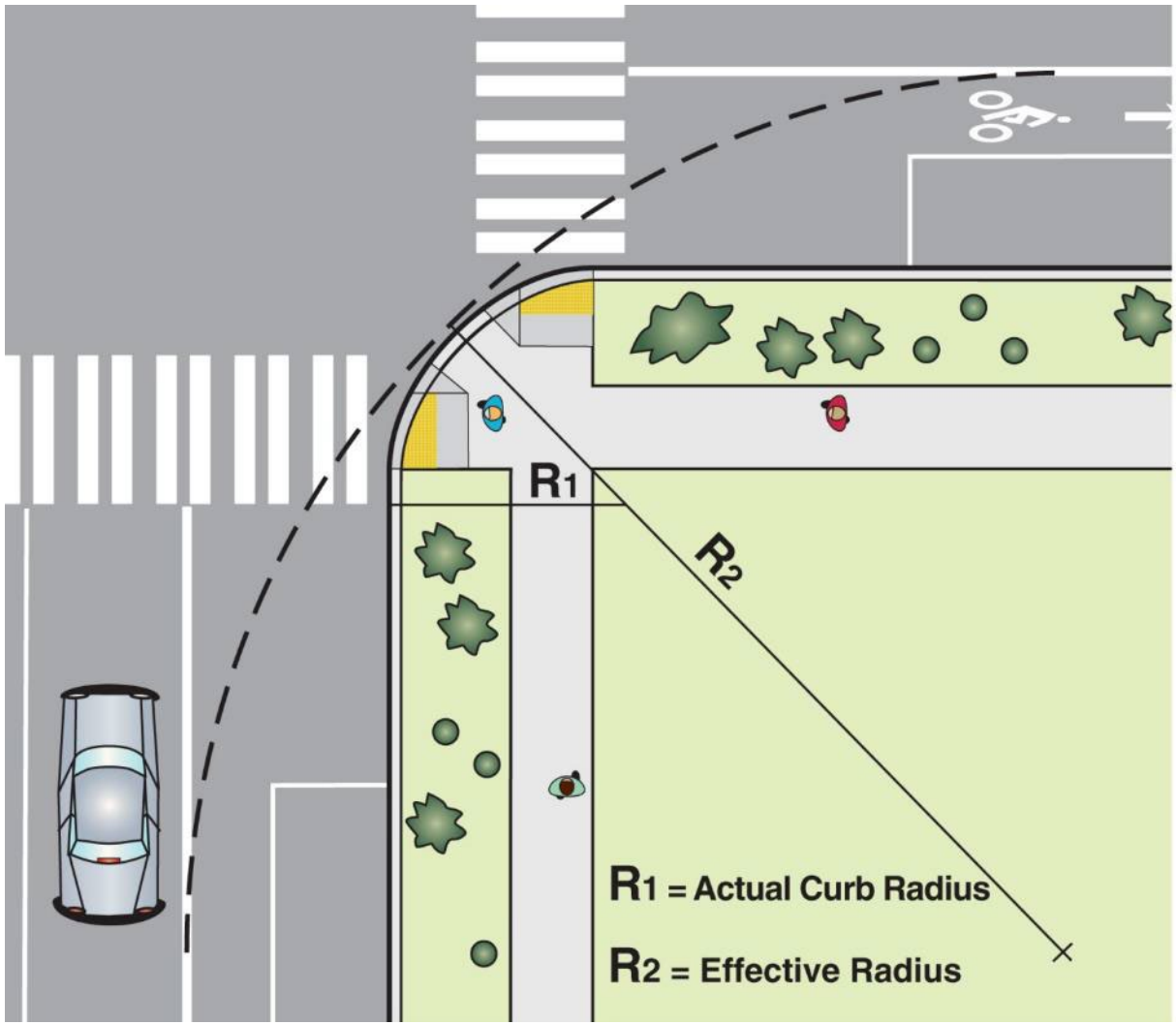
Increases crossing distance

Makes crosswalk & ramp placement more difficult



Minimize curb radius

Calculate effective radius: Larger than built radius if travel lanes offset from curb with parking and/or bike lane



Effective Curb Radius

Minimize Curb Radius w/Truck Apron

Crosswalk Visibility Enhancements
Crosswalk Lighting

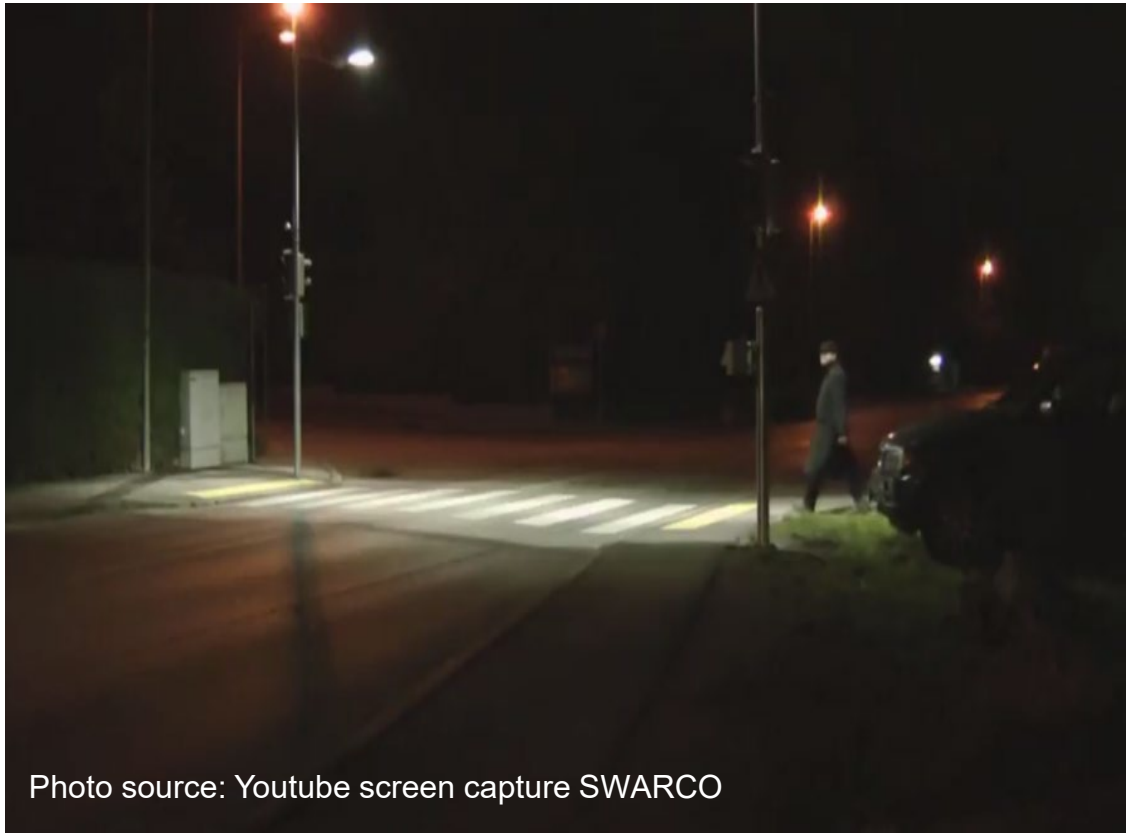


Photo source: Youtube screen capture SWARCO

- CRF 42% to 59%
  - Lighting at intersections
  - 4 star rating
  - Vehicle/ped crashes

Lighting Over Crosswalks

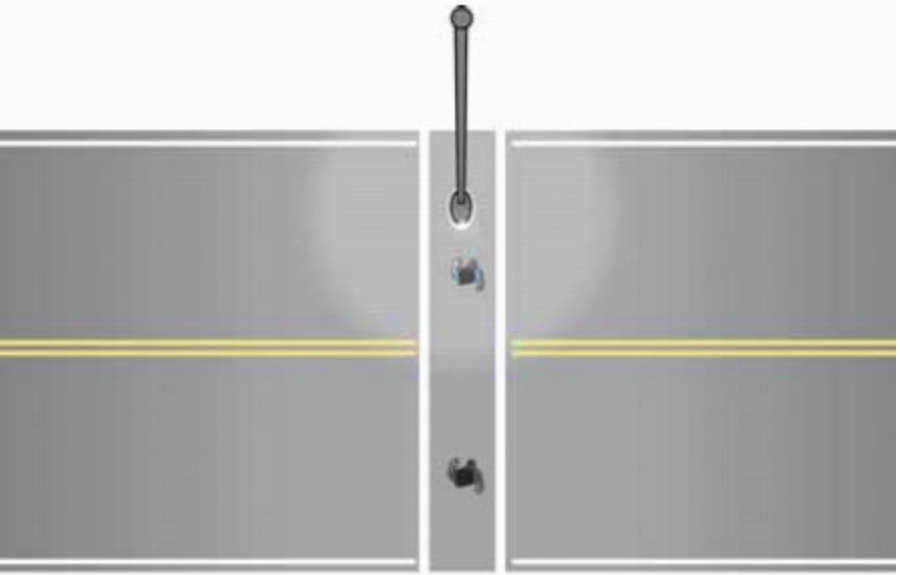


Fig 11. Traditional midblock crosswalk lighting layout

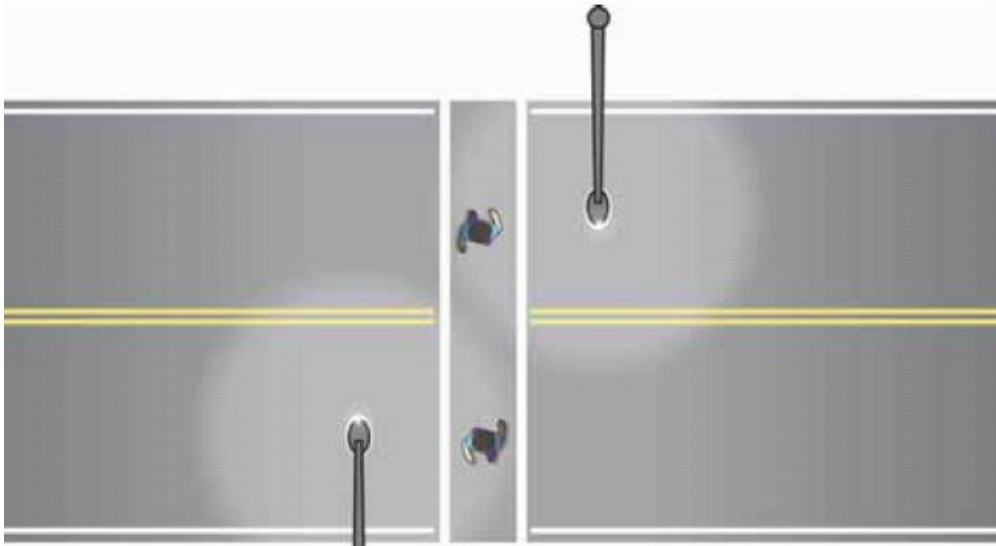
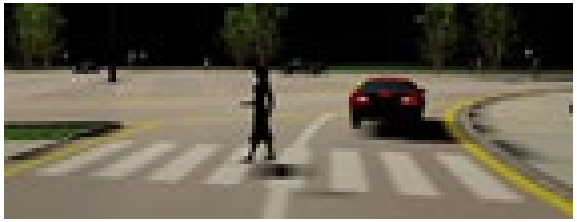


Fig 12. New design for midblock crosswalk lighting layout



Recommended lighting level: 20 lux at 5’ above pavement

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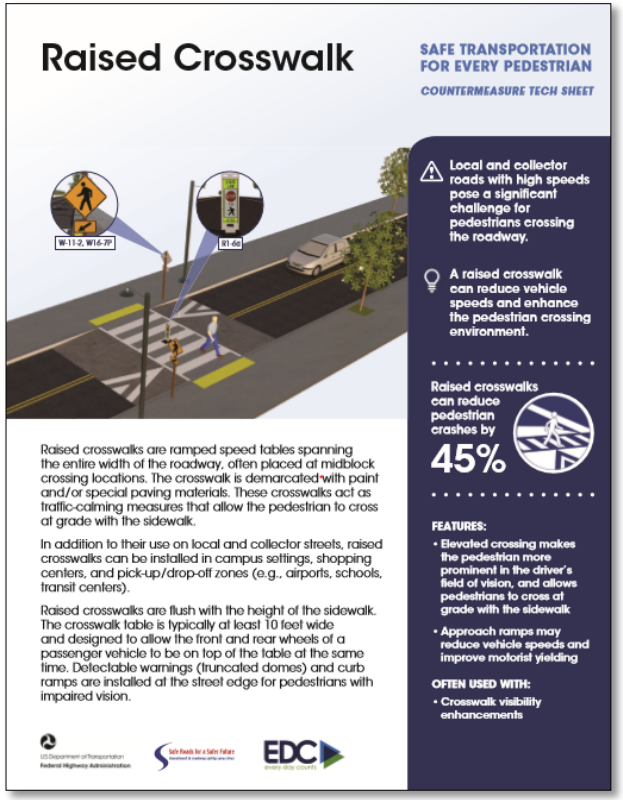

Raised Crosswalk

SAFE TRANSPORTATION FOR EVERY PEDESTRIAN

COUNTERMEASURE TECH SHEET

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.

In addition to their use on local and collector streets, raised crosswalks can be installed in campus settings, shopping centers, and pick-up/drop-off zones (e.g., airports, schools, transit centers).

Raised crosswalks are flush with the height of the sidewalk. The crosswalk table is typically at least 10 feet wide and designed to allow the front and rear wheels of a passenger vehicle to be on top of the table at the same time. Detectable warnings (truncated domes) and curb ramps are installed at the street edge for pedestrians with impaired vision.

Local and collector roads with high speeds pose a significant challenge for pedestrians crossing the roadway.

A raised crosswalk can reduce vehicle speeds and enhance the pedestrian crossing environment.

Raised crosswalks can reduce pedestrian crashes by 45%

FEATURES:

- Elevated crossing makes the pedestrian more prominent in the driver's field of vision, and allows pedestrians to cross at grade with the sidewalk
- Approach ramps may reduce vehicle speeds and improve motorist yielding

OFTEN USED WITH:

- Crosswalk visibility enhancements

Raised Crosswalks

- Typically installed on 2-lane or 3-lane roads
- Speed limits of 30 mph or less
- AADT below about 9,000
- CRF: 45%

Photo Source: SRTS Guide

Raised Crosswalk

Traffic Calming ePrimer

- https://safety.fhwa.dot.gov/speedmgt/traffic_calm.cfm

Figure 3.14.6. Raised Crosswalk with Bicycle Lane
(Source: Scott Batson)

Figure 3.14.4. Raised Crosswalk at Intersection
(Source: City of Cambridge, Massachusetts)

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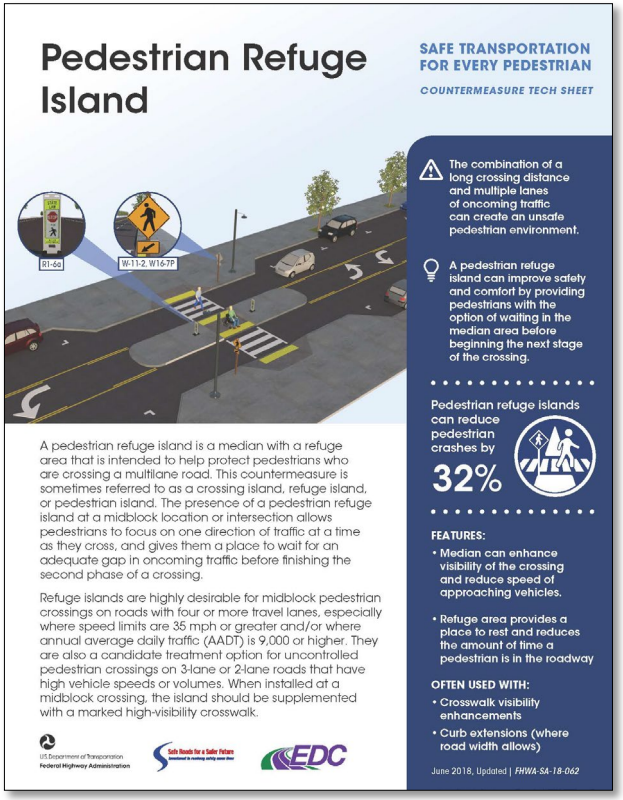


Pedestrian Refuge Island

SAFE TRANSPORTATION FOR EVERY PEDESTRIAN

COUNTERMEASURE TECH SHEET

R1-6a

W-11-2, W16-7P

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.

U.S. Department of Transportation Federal Highway Administration

Safe Roads for a Safer Future

EDC

The combination of a long crossing distance and multiple lanes of oncoming traffic can create an unsafe pedestrian environment.

A pedestrian refuge island can improve safety and comfort by providing pedestrians with the option of waiting in the median area before beginning the next stage of the crossing.

Pedestrian refuge islands can reduce pedestrian crashes by

32%

FEATURES:

- Median can enhance visibility of the crossing and reduce speed of approaching vehicles.
- Refuge area provides a place to rest and reduces the amount of time a pedestrian is in the roadway

OFTEN USED WITH:

- Crosswalk visibility enhancements
- Curb extensions (where road width allows)

June 2018, Updated | *FHWA-SA-18-062*

Pedestrian Refuge Islands

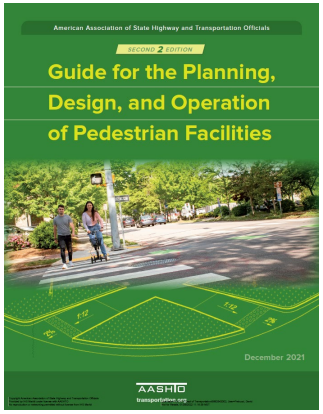
Two-stage island

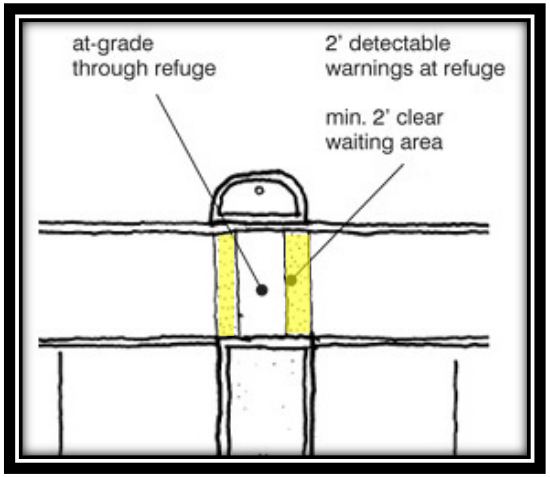
Two-Stage PHB

- Decorative fencing
- Shade in median
- Decorative landscaping – does not block visibility

2021 AASHTO 3.6.2.8 Design of Refuge Median Islands

- Minimum 6 feet wide for raised curb cut through design
  - 2 ft truncated domes 2 ft gap 2 ft truncated domes
- 10 ft recommended: accommodate bicycles, wheelchairs, scooters, and groups of pedestrians
- Length parallel to street 20 feet minimum





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Rectangular Rapid-Flashing Beacon (RRFB)

SAFE TRANSPORTATION FOR EVERY PEDESTRIAN

COUNTERMEASURE TECH SHEET

High speeds and multiple lanes of traffic create challenges for pedestrians crossing at unsignalized locations.

RRFBs can make crosswalks and/or pedestrians more visible at a marked crosswalk.

RRFBs can reduce pedestrian crashes by 47%

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 at 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.

FEATURES:
- Enhanced warning improves motorist yielding

OFTEN USED WITH:
- Crosswalk visibility enhancements
- Pedestrian refuge island
- Advance STOP or YIELD markings and signs

Rectangular Rapid Flashing Beacon New IA-21

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Correction issued 3/21/2018

Subject: **INFORMATION:** MUTCD – Interim Approval for Optional Use of Pedestrian-Actuated Rectangular Rapid-Flashing Beacons at Uncontrolled Marked Crosswalks (IA-21)

Date: MAR 20 2018

From: Martin C. Knopp
Associate Administrator for Operations

In Reply Refer To: HOTO-1

To: Federal Lands Highway Division Directors
Division Administrators

https://mutcd.fhwa.dot.gov/res-interim_approvals.htm#valid09

Figure 1. Example of an RRFB dark (left) and illuminated during the flash period (center and right) mounted with W11-2 sign and W16-7P plaque at an uncontrolled marked crosswalk.

Must request and receive permission to use this new Interim Approval (1A-21) even if prior approval had been given for Interim Approval 1A-11

A State may request Interim Approval for all jurisdictions in that State.

St. Petersburg FL

IA-21 3.a For any approach two RRFB required, One on right-hand and one on left-hand of roadway. If divided highway left-hand should be installed on median if practical rather than far left-hand.

RRFB Video IA-21Flash Pattern

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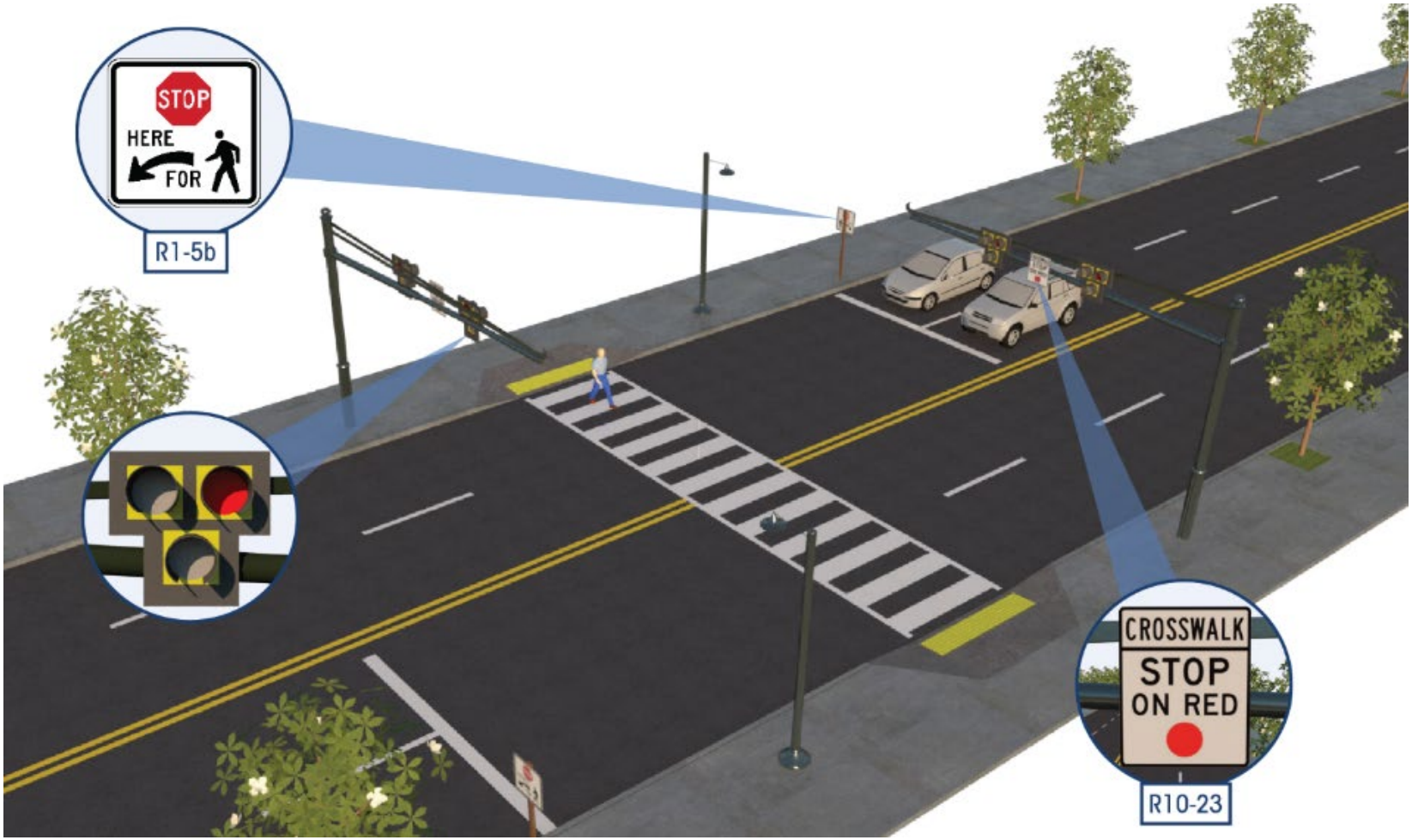
Pedestrian Hybrid Beacons (PHB)



Pedestrian Hybrid Beacons (PHB)

CRF: Vehicle/Pedestrian 69%

1

Blank for drivers

2

Flashing yellow

3

Steady yellow

4

Steady red

5

Wig-Wag

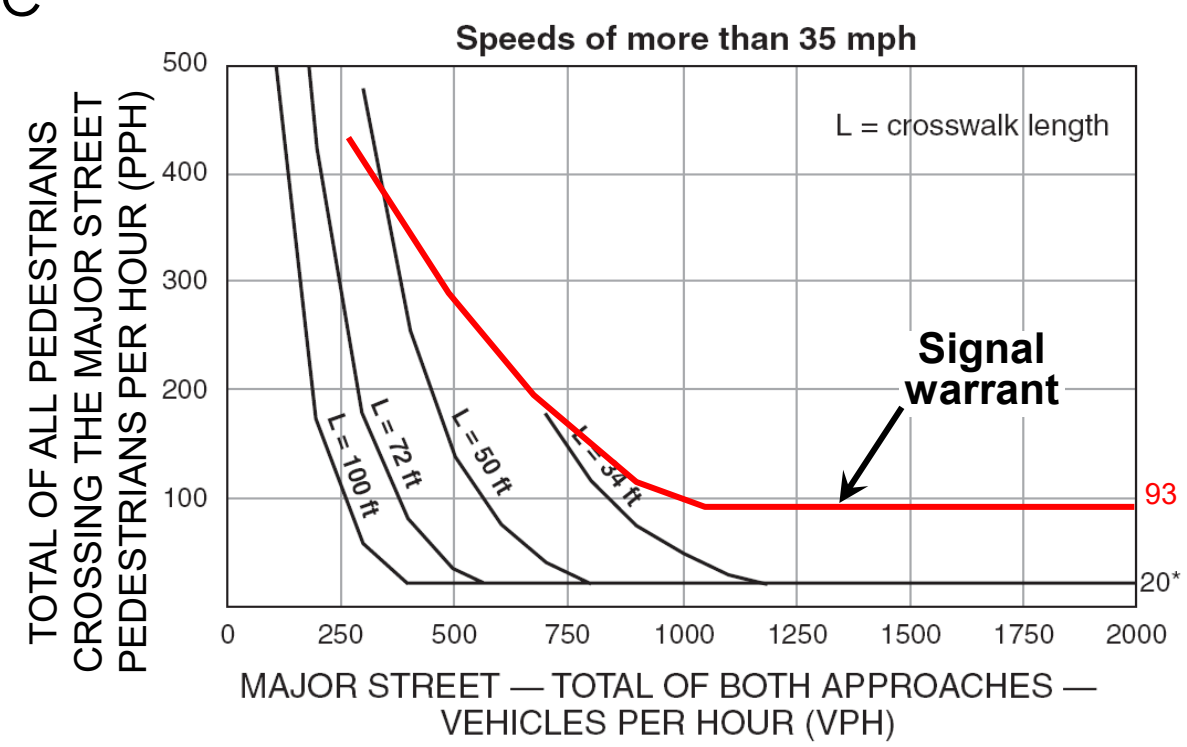
Return to 1

Excerpts from 2009 MUTCD Chapter 4F For Pedestrian Hybrid Beacons

The CROSSWALK STOP ON RED sign shall be used

There are **Guidelines** (similar to signal warrants) for Pedestrian Hybrid Beacons – variables include:

- Pedestrian volume
- Traffic speeds
- Traffic volumes
- Crosswalk length



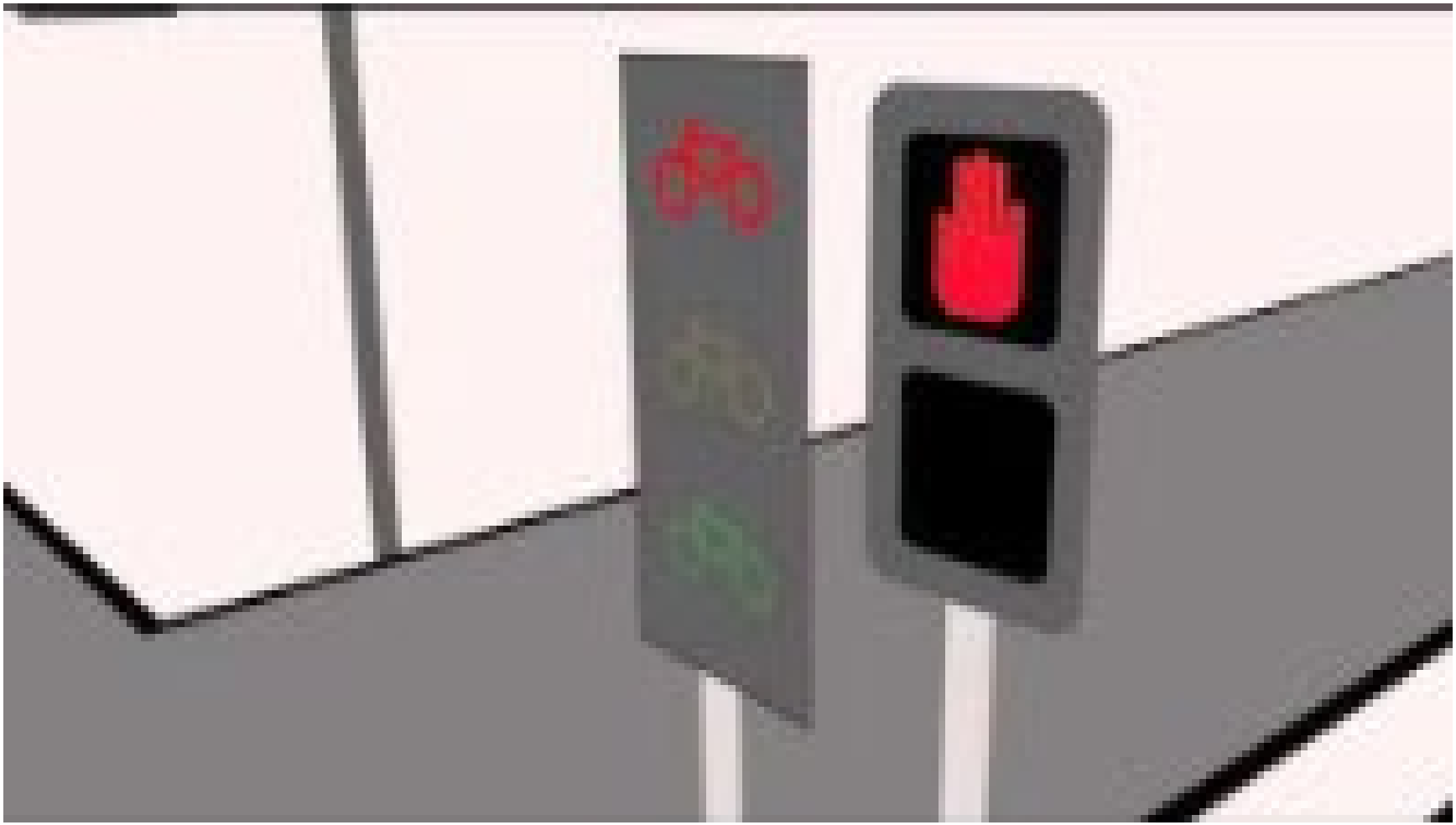
2009 MUTCD mandated sign

Standard:
A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign shall be mounted adjacent to a PHB face on each major street approach.

Option:

- State MUTCD's may allow other appropriate MUTCD approved ped, bike or school crossing signs

PHB and Bike Signal videos



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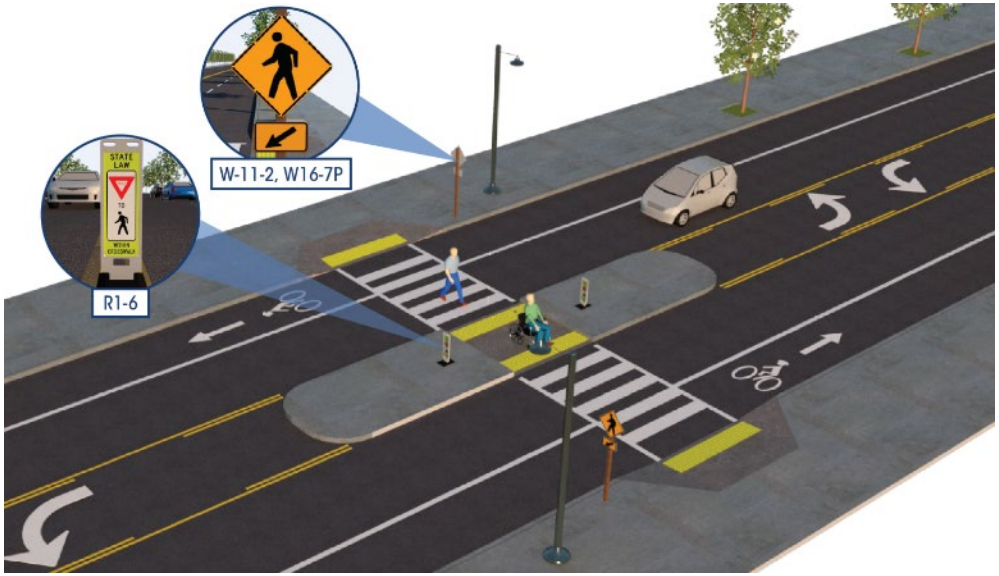
Road Diet:

Before

After



Road Diet / Roadway Reconfiguration

- Reduce crossing distance
- Eliminate /reduce “multiple threat” crash types
- Install crossing island to cross in 2 simple steps

Road Diet / Roadway Reconfiguration

- Reduce top end travel speeds
- Buffer sidewalk from travel lanes (parking or bike lane)
- Reclaim street space for "higher and better use" than moving peak hour traffic

General Guidelines for Traffic Volumes

LESS THAN 10,000 ADT	10,000 – 15,000 ADT	15,000 – 20,000 ADT	GREATER THAN 20,000 ADT
Great candidate for Road Diet	**Very good candidate for Road Diet**	**Good candidate for Road Diet**	**Potential candidate for Road Diet**
In most instances traffic will likely not be negatively affected.	Agencies should conduct intersection analysis to study potential traffic operational effects and consider signal retiming as needed.	Agencies should conduct a corridor analysis since traffic operations may be affected at this volume depending on the "before" condition.	Agencies should complete a feasibility study to determine whether this is a good location for a Road Diet. Operations may be affected at this volume.

There are examples across the country where Road Diets have been successful with ADTs as high as 26,000

EDC

Road Diets

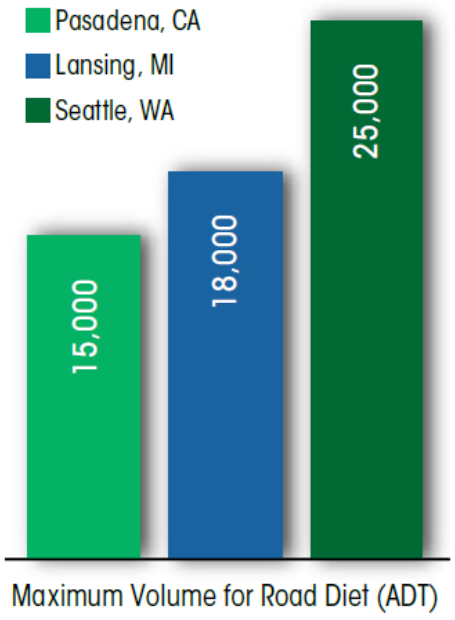
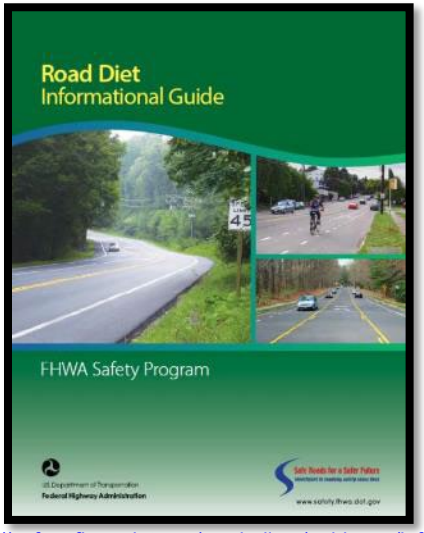


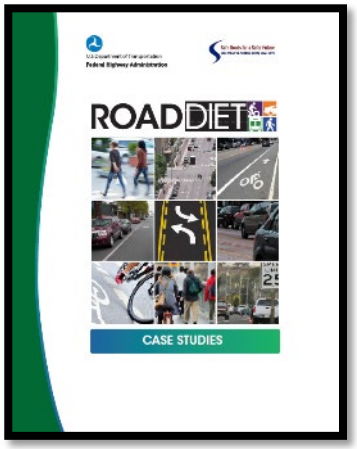
Figure 12. Road Diet Implementation Maximum Volume Thresholds by Agency

Considerations

- Safety
- Operations
  - Peak Hour
- Design
  - Signalized Intersection Adjustments
- Resurfacing
- Context Sensitive Solutions/Complete Streets



https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/



https://safety.fhwa.dot.gov/road_diets/case_studies/

Intersections

- Signal timing or phasing changes at intersections to optimize operations and safety benefits
- Roundabouts Single Lane
  - ~ 20,000 ADT

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Leading Pedestrian Interval

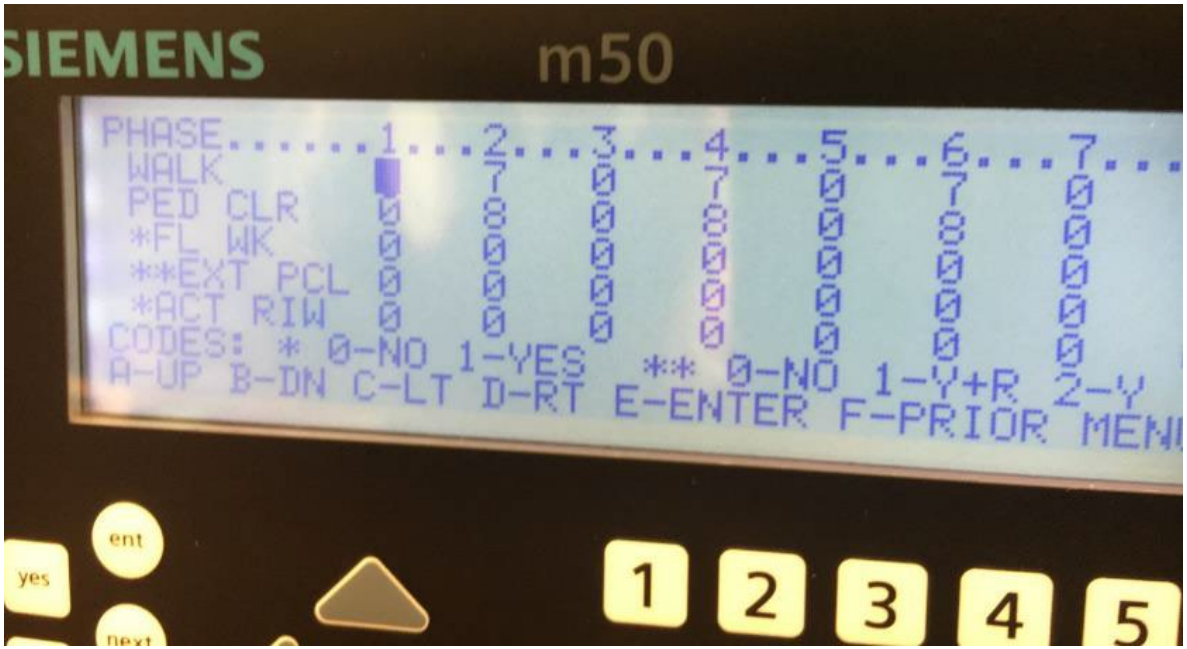
3+ second head start to enter the crosswalk

Source: FHWA

LPI Suitability

- Often used at intersections where drivers make turns with a need to yield to oncoming traffic
- Address visibility concerns
- Accommodate high ped volume and crashes
- Proximity to vulnerable populations

Implementation Considerations Hardware



Controller Requirements

- NEMA TS2 Type 1 or 2
- 2070 or 270

Vision Impairment and APS

- Without APS, pedestrians with vision impairments cross by listening to vehicle movement
- APS important when either LPI or exclusive ped phase used

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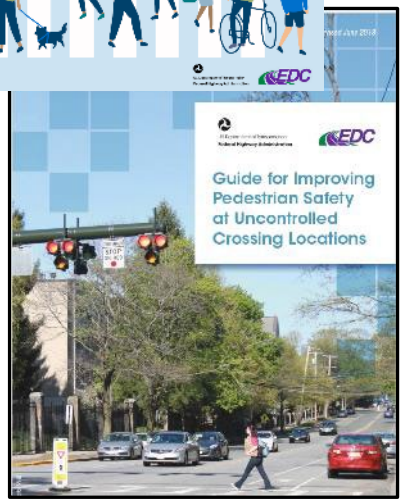
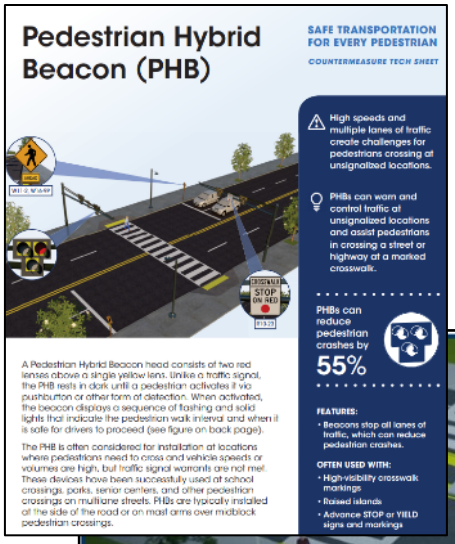
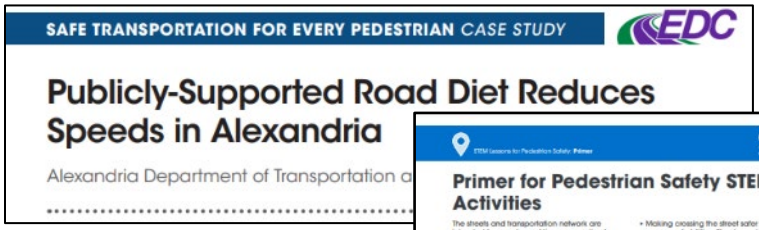
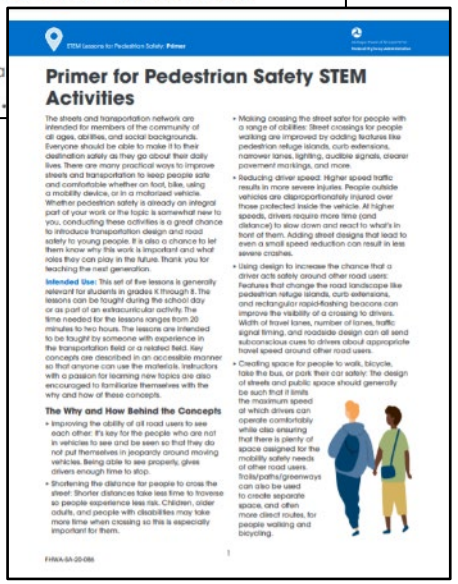
STEP Resources

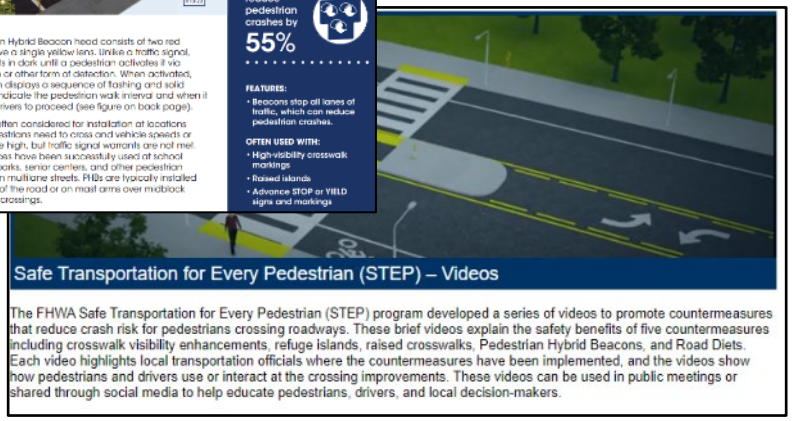
https://safety.fhwa.dot.gov/ped_bike/step/resources/











SS4A Grants

Resources

- STEP
  - https://safety.fhwa.dot.gov/ped_bike/step/resources/
- FHWA Pedestrian Safety
  - https://safety.fhwa.dot.gov/ped_bike/
- Pedestrian Bicycle Information Center
  - http://www.pedbikeinfo.org/
- NHTSA Bicycle Safety
  - https://www.nhtsa.gov/road-safety/bicycle-safety
- US DOT Walking and Bicycling
  - https://www.transportation.gov/pedestrian-bicycle-safety

Resources

PEDSAFE http://www.pedbikesafe.org/PEDSAFE/index.cfm

Links in PEDSAFE to specific countermeasures

- Marked Crosswalks and Enhancements
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=4
- Lighting and Illumination
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=8
- Crossing Islands
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=6
- Raised Pedestrian Crossings/ Raised Crosswalks
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=7
- Raised Medians
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=22
- RRFB
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=54
- Pedestrian Hybrid Beacon
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=53
- Road Diets (Lane Reduction)
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=19
- Leading Pedestrian Interval (LPI)
  - http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=12





Questions

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On-Ramp to Innovation
every day counts