STEP: Safe Transportation for Every Pedestrian




On-Ramp to Innovation
every day counts

U.S. Department of Transportation
Federal Highway Administration

Speakers

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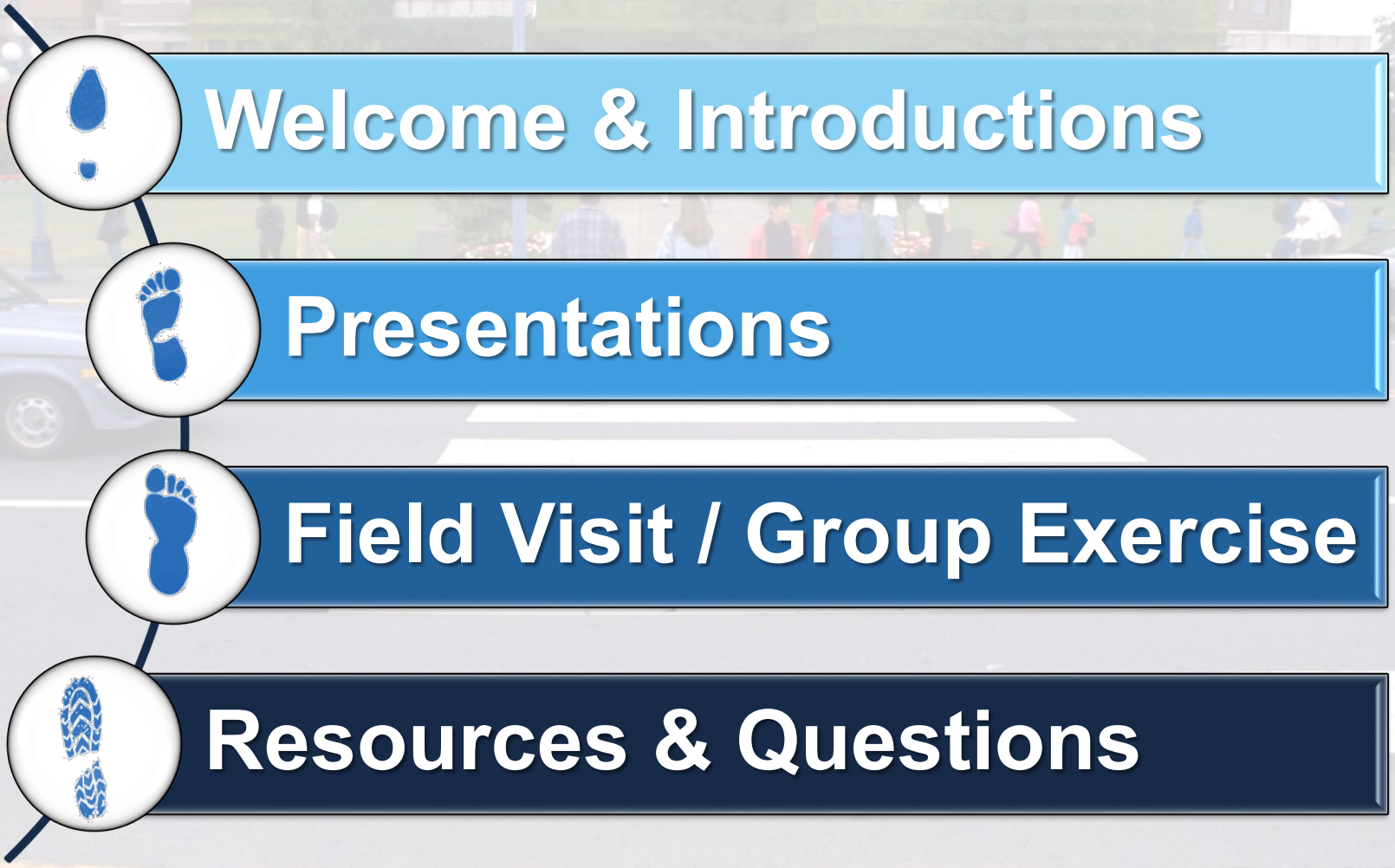
Participant Introductions

- Name
- Agency and Position
- Why did you decide to attend this workshop?

Agenda

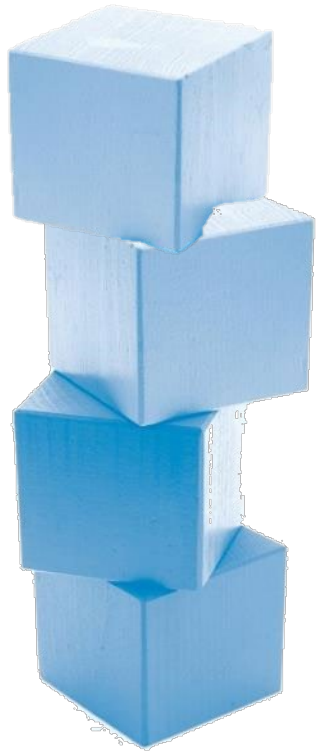

Welcome & Introductions
Presentations
Field Visit / Group Exercise
Resources & Questions

What is *"Every Day Counts"*(EDC)?

State-based model to identify and rapidly deploy proven but underutilized innovations to:

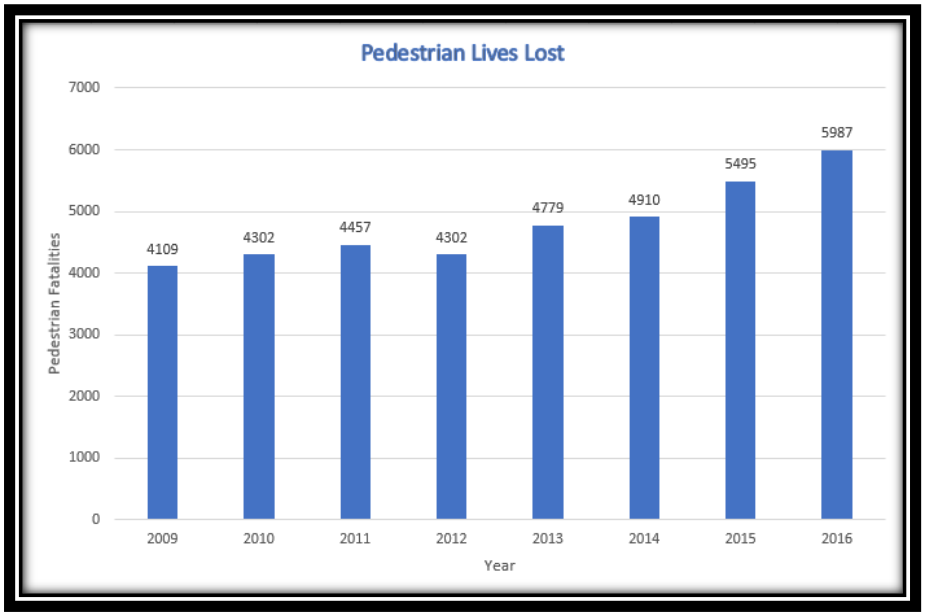
- ✓shorten the project delivery process
- ✓enhance roadway safety
- ✓reduce congestion
- ✓improve environmental sustainability

- EDC Rounds: two year cycles
- Initiating 5th Round (2019-2020)



Why is pedestrian safety and accessibility important?

Too many people dying on our roadways



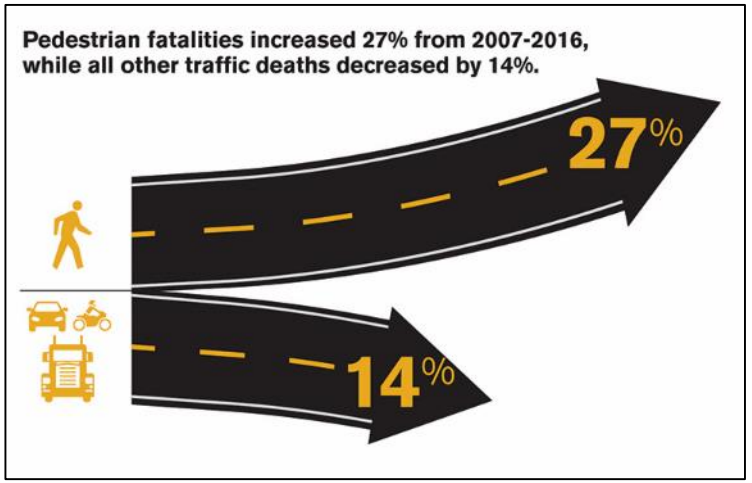
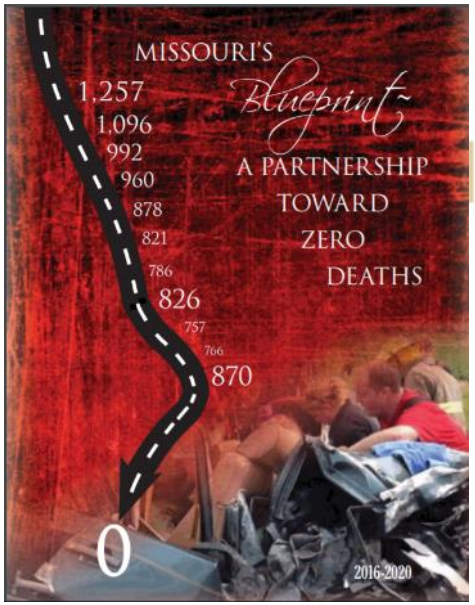


Photo Credit: GHSA

Pedestrians now account for a larger proportion of traffic fatalities (16%) than they have in the past 33 years



Fatalities				Serious Injuries			
2012	2013	2014	Total	2012	2013	2014	Total
86	75	69	230	229	276	252	757

77% of pedestrian fatalities occurred
AT A LOCATION OTHER THAN AT A SIGNAL OR WITHIN A CROSSWALK

- Improve:
  - lighting in selected urban locations
  - pedestrian signalization (e.g., countdown pedestrian signals, advanced walk phase, all-scramble walk phase, etc.)
- Install/improve pedestrian signs, road markings, and devices (e.g., fluorescent and yellow green signs, rectangular rapid flashing beacons, in-roadway lights at crosswalks, etc.)
- Enhance intersection and roadway design to be more pedestrian friendly including refuge islands and traffic calming designs
- Install:
  - crosswalk signs and pavement markings at all schools
  - pedestrian mid-block crossing signals
- Use pedestrian hybrid beacon - formerly known as HAWK (High Intensity Activated CrossWalK Beacons) on non-signalized major roads, stop sign controlled minor roads and mid-block pedestrian crossings

Why?

Because we are all pedestrians

Why?

Because many people do not drive

Why?

Because other modes depend on walking

Why?

Because it's good for business – people walk into stores

Pedestrian and Bicycle Information Center

Data & Resources | Community Support | Planning & Design | Training & Events | Behavior Change

DATA & RESOURCES

- Library
- Case Studies
- White Paper Series
- Frequently Asked Questions
- State by State Information
- International Information
- Fact Sheets
  - Who's Walking and Bicycling
  - Safety Guide
  - Crash Statistics
  - Health Benefits
  - Economic Benefits
  - Environmental Benefits

Economic Benefits of Walking and Bicycling

Walking and bicycling are affordable forms of transportation. Car ownership is expensive and consumes a major portion of many Americans' income. When safe facilities are provided for pedestrians and bicyclists, people can walk and ride more and spend less on transportation, meaning they have more money to save or spend on other things.

- The cost of operating a sedan for one year in 2013 is approximately $10,374 (AAA, Your Driving Costs).
- According to AAA and the 2008-2012 American Community Survey, ownership of one motor vehicle accounts for 19.5 percent of a typical household's income.
- The cost of operating a bicycle for a year is only $308 (League of American Bicyclists).
- An eight-year study of Atlanta communities suggests that a two person household in a walkable community saves over 260 gallons of gas annually. If gas is $3.25 per gallon, that is over $850 in savings.

http://www.pedbikeinfo.org/data/factsheet_economic.cfm

Why?

Because walking is healthy exercise

Do you agree?

- ✓ Pedestrians are legitimate users of the transportation system and should be included as design users for all roads where peds are legally permissible.
- ✓ Transportation agencies should consider pedestrian safety needs when designing roads.
- ✓ Transportation agencies should consider pedestrian convenience (such as delay, travel distance, etc.) when designing and operating intersections and pedestrian crossing locations so that pedestrians may travel to their intended destinations without unreasonable delay.

So Therefore …

All roads should be designed with the premise that there will be pedestrians, that they must be able to cross the street, and that they must be able to do it safely.

For transportation professionals, the question then becomes, "*How can this task best be accomplished?*"

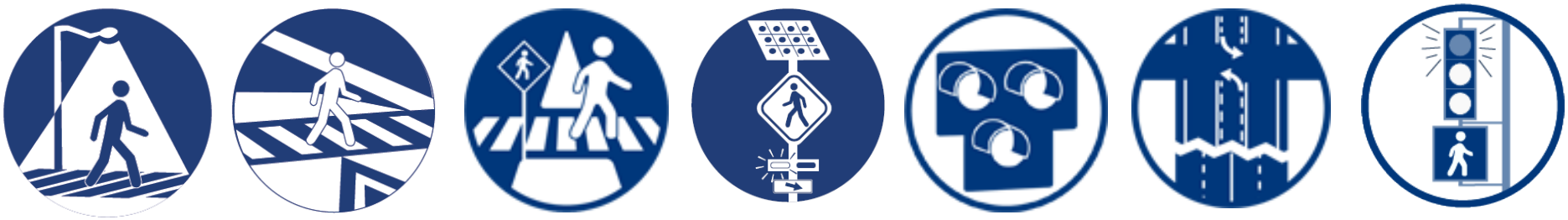




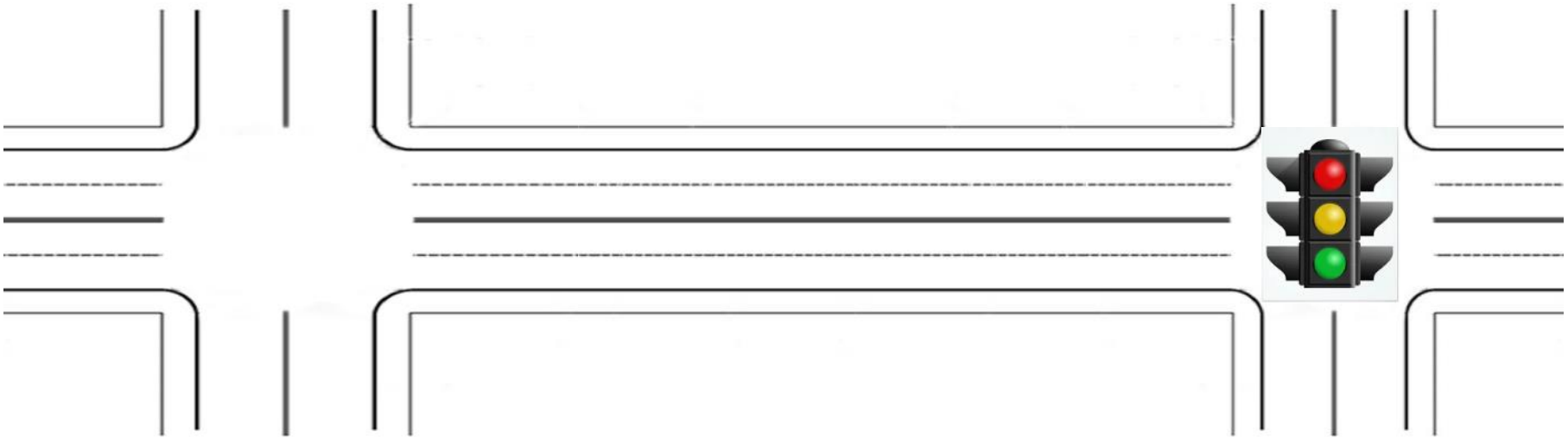
Why STEP?

- Over 72% of pedestrian fatalities occur at non-intersection locations
- Roughly 27% of pedestrian fatalities occur at intersections

every day counts



What is the STEP innovation?
Enhanced Crossings at Crossing Locations



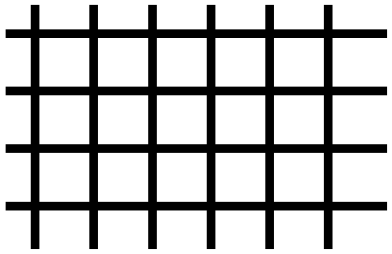
How many grew up as Free Range Children?

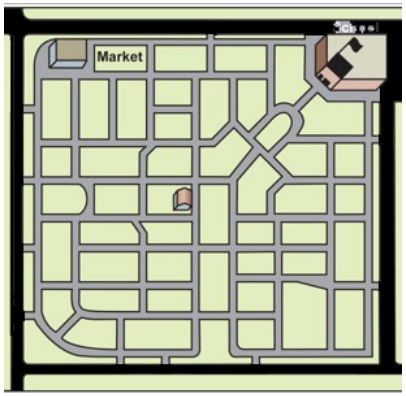
Are your kids Free Range?

MiniCooped

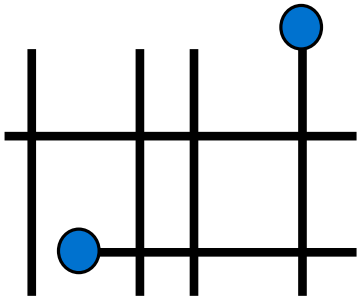

McDonald's
DISCOUNT TIRE CO.

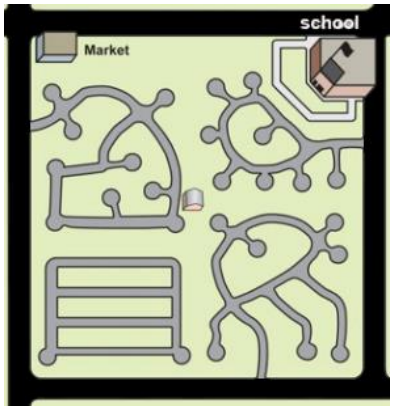
High Connectivity



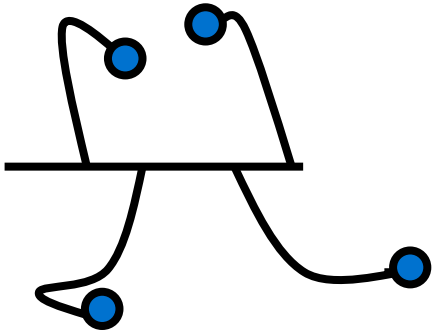


Moderate Connectivity

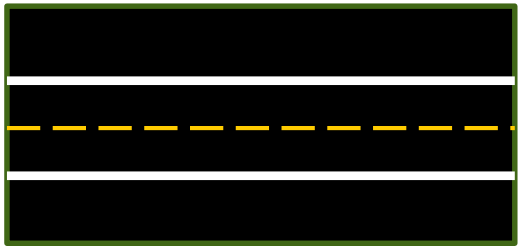




Low Connectivity



Travel Lanes Required



Pedestrians cross where it's most convenient

How far are you willing to walk out of your way to a controlled crossing? 45 mph 4 lanes w/TWLTL

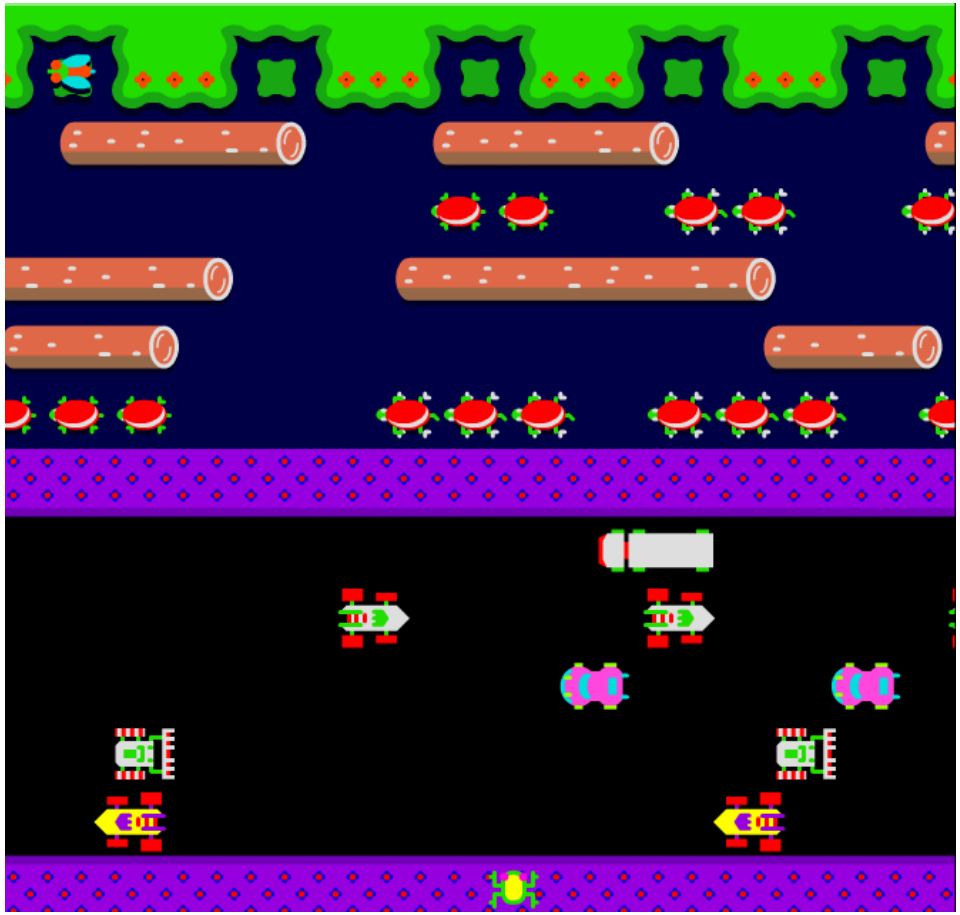
How far are you willing to walk out of your way to a controlled crossing? 45 mph 4 lanes w/TWLTL

A. 50 ft
B. 100 ft
C. 500 ft
D. 1300 ft

Learning from Frogger

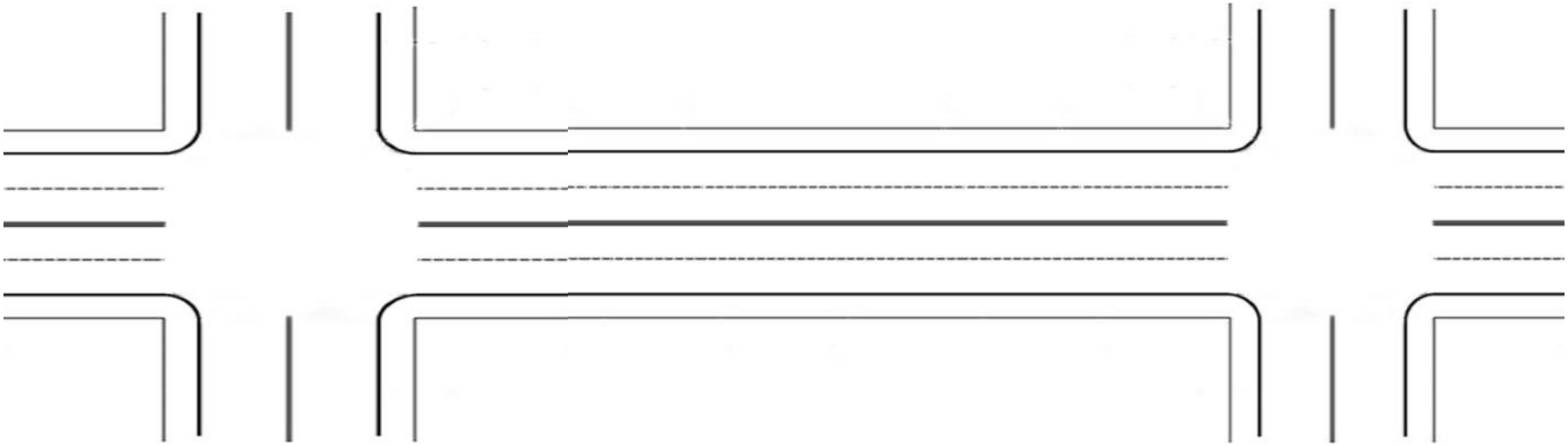
As volunteers play try for top score, audience observe and write down what are some contributing factors for getting squished.

http://www.frogger.net/

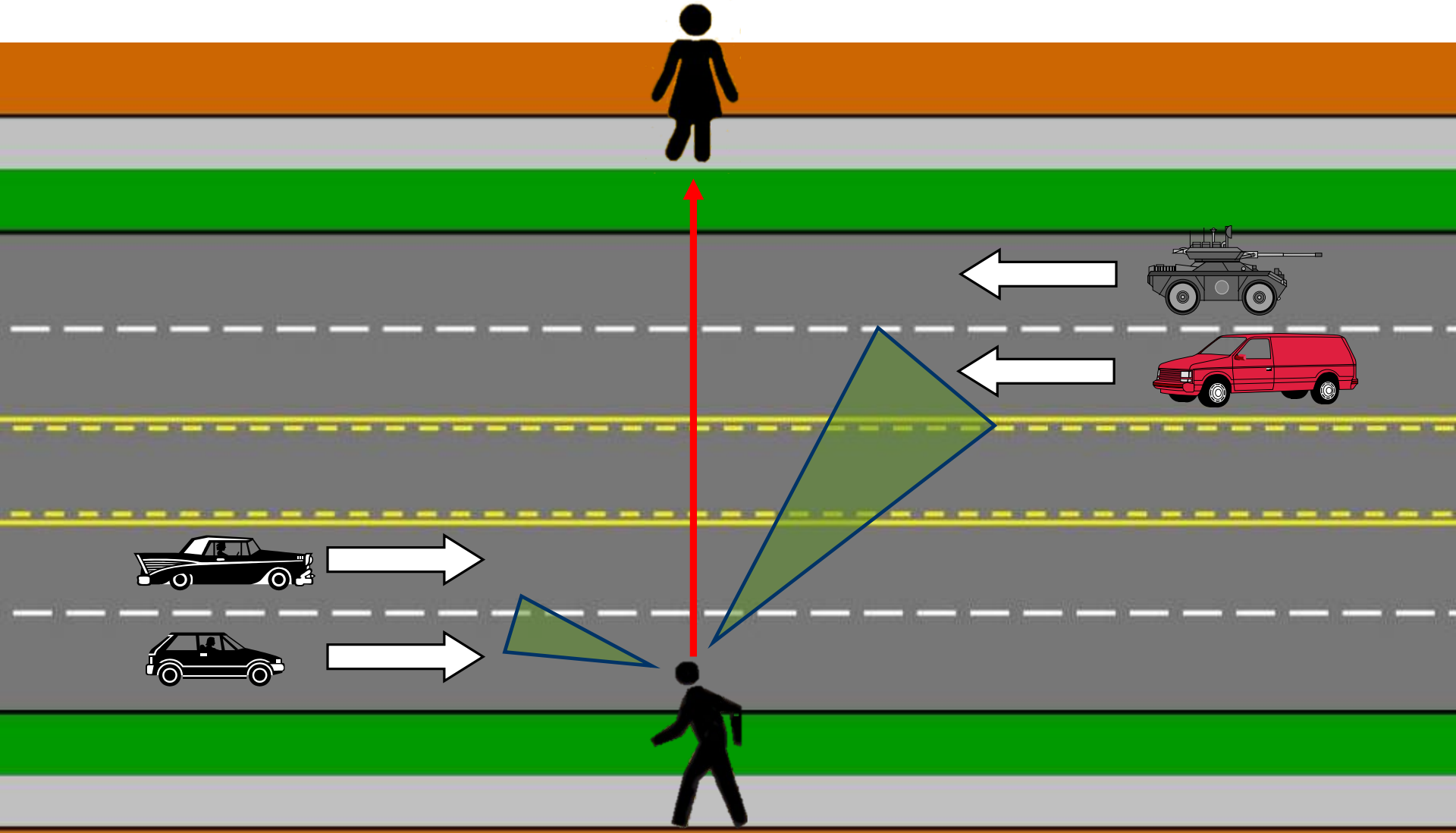


Midblock vs. Intersection

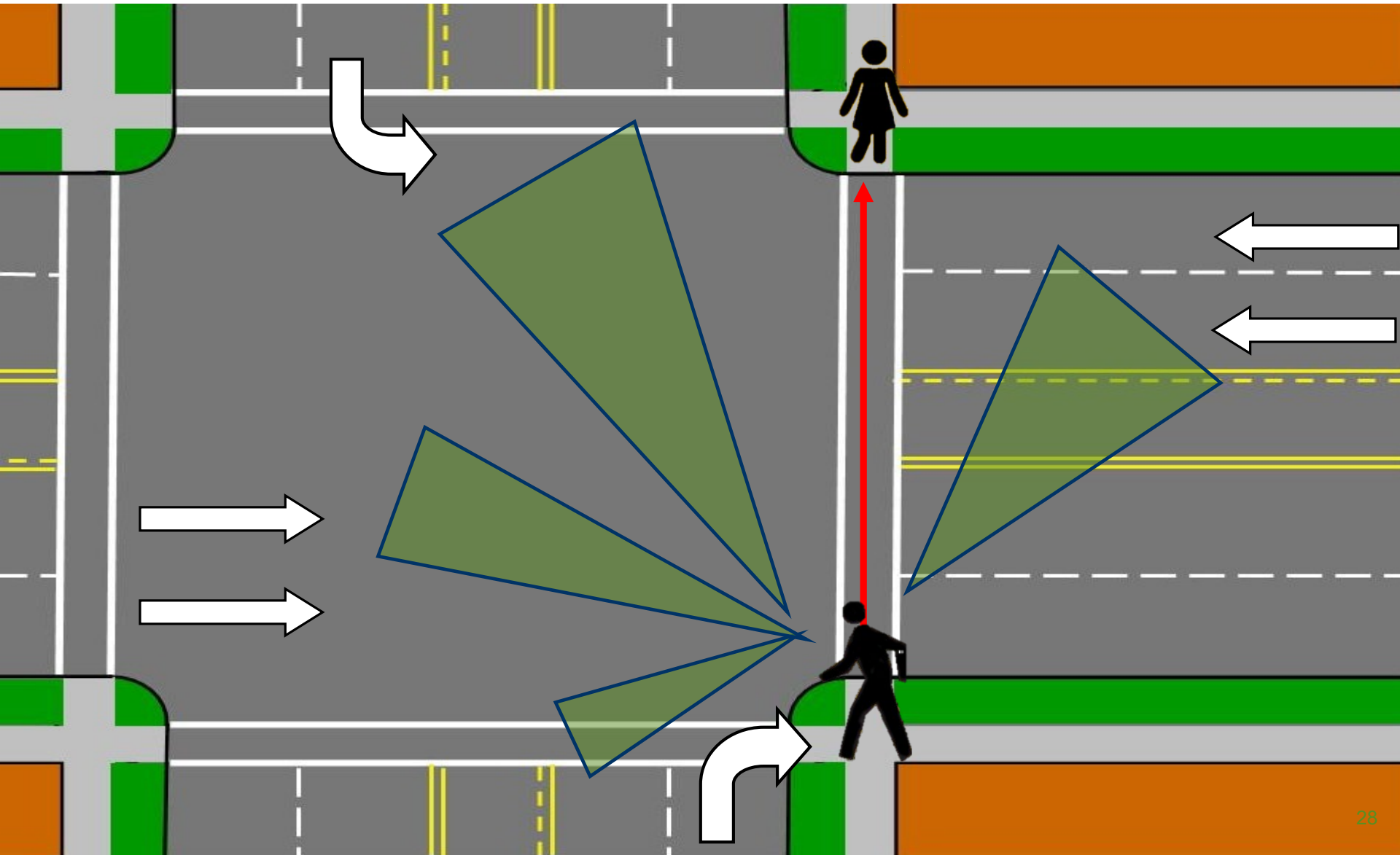
What is the relative risk of crossing midblock vs. crossing at an intersection?



Midblock: Pedestrian faces 2 directions of traffic



Intersection: pedestrian faces other conflicts



Mid-Block or Intersection?

~300 ft from Signalized Intersection to Mid-block Crossing

Street View





Crosswalk Laws

State laws: 7/7/16 http://www.ncsl.org/research/transportation/pedestrian-crossing-50-state-summary.aspx

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What is a crosswalk?

The 2000 *Uniform Vehicle Code* (Section 1-112) defines a crosswalk as:

(a) *"That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs, or in the absence of curbs, from the edges of the traversable roadway; and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the existing sidewalk at right angles to the centerline.*

(b) *Any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface."*

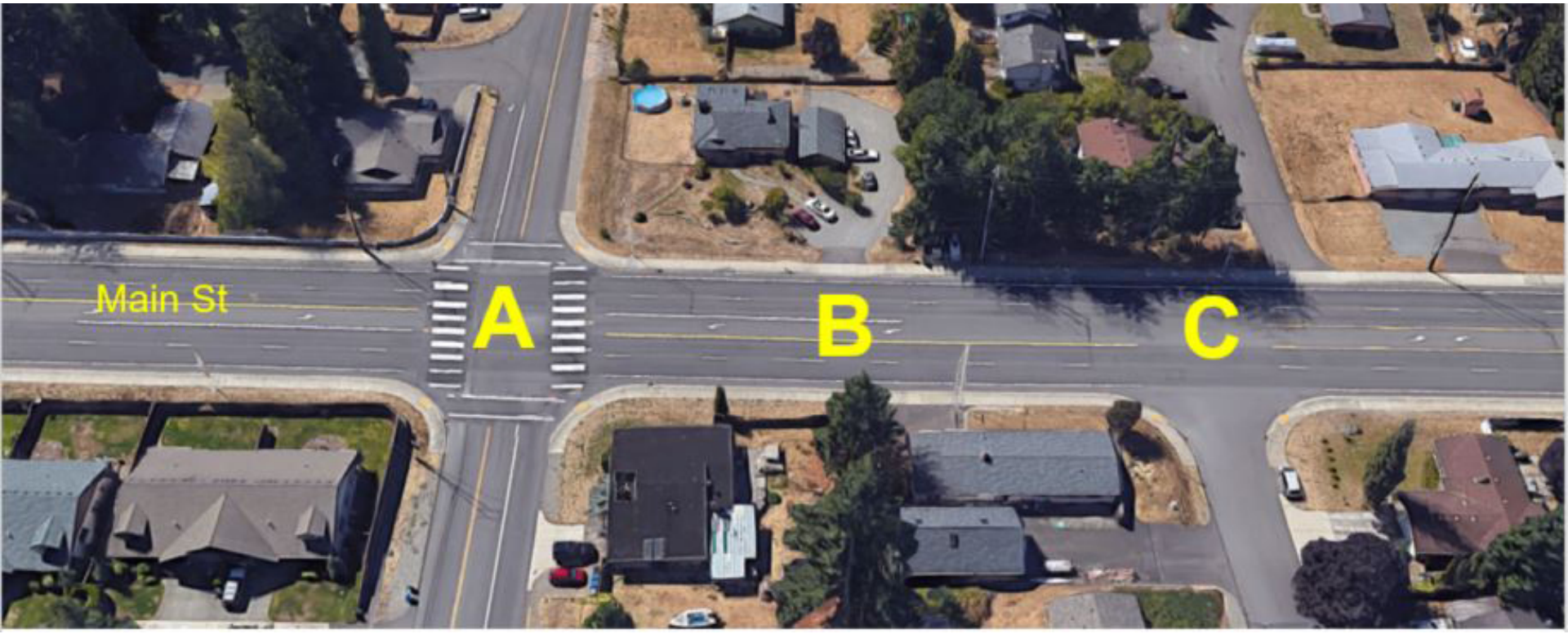
In simpler words:

- At an intersection, a crosswalk is defined as the extension of the sidewalk (or the shoulder) across the intersection, regardless of whether it is marked or not.
  - In most places it is legal for pedestrians to cross the street at any intersection (whether marked or not), unless the pedestrian crossing is specifically prohibited.

- The only way a crosswalk can exist at a midblock location is if it is marked.

Can you cross legally at A or B?

Who has the Right of Way at A, B, C crossing Main St?







Missouri Pedestrian Crossing Laws

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Missouri Laws 300.375
Pedestrians' right-of-way in crosswalks

1. When traffic control signals are not in place or not in operation the driver of a vehicle **shall yield** the right-of-way, slowing down or stopping if need be to so yield, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.

Missouri Laws 300.375
Pedestrians' right-of-way in crosswalks

2. No pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close that it is impossible for the driver to yield.

4. Whenever any vehicle is stopped at a marked crosswalk or at any unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle.

Missouri Laws 300.390
When pedestrian shall yield

1. Every pedestrian crossing a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to all vehicles upon the roadway.

2. Any pedestrian crossing a roadway at a point where a pedestrian tunnel or overhead pedestrian crossing has been provided shall yield the right-of-way to all vehicles upon the roadway.

Missouri Laws 300.395 – Prohibited crossing

1. . **Between adjacent intersections at which traffic control signals are in operation, pedestrians shall not cross at any place except in a crosswalk**
2. No pedestrian shall cross a roadway other than in a crosswalk in any business district.
3. No pedestrian shall cross a roadway other than in a crosswalk upon any street designated by ordinance.

Illinois Sec. 11-1002.
Pedestrians' right-of-way at crosswalks.

(a) When traffic control signals are not in place or not in operation the driver of a vehicle **shall stop and yield the right-of-way to a pedestrian crossing the roadway within a crosswalk** when the pedestrian is upon the half of the roadway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger.

(b) No pedestrian shall suddenly leave a curb or other place of safety and walk or run into the path of a moving vehicle which is so close as to constitute an immediate hazard.

(d) Whenever any vehicle is stopped at a marked crosswalk or at any unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle.

(e) Whenever stop signs or flashing red signals are in place at an intersection or at a plainly marked crosswalk between intersections, drivers shall yield right-of-way to pedestrians as set forth in Section 11-904 of this Chapter.

Sec. 11-1003.
Crossing at other than crosswalks.

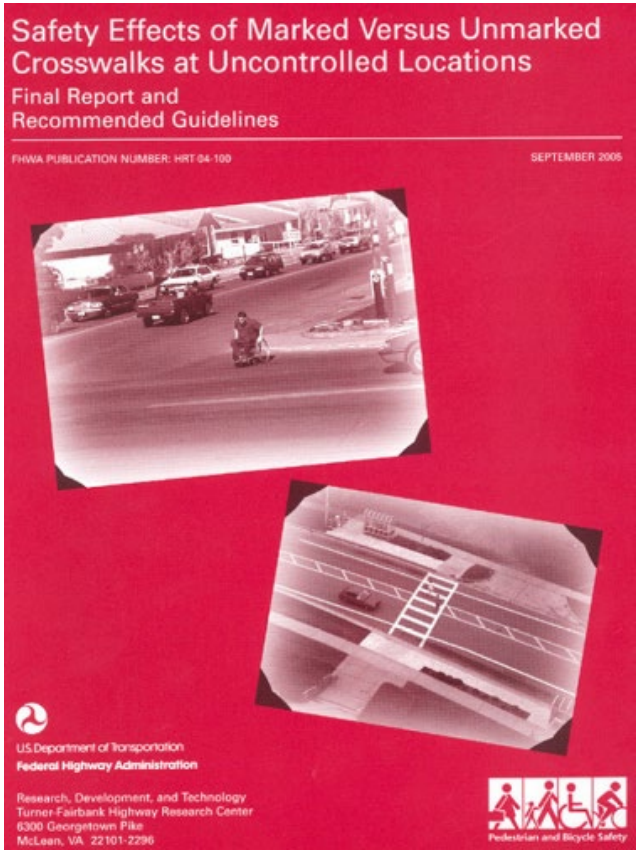
(a) Every pedestrian crossing a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to all vehicles upon the roadway.
(b) Any pedestrian crossing a roadway at a point where a pedestrian tunnel or overhead pedestrian crossing has been provided shall yield the right-of-way to all vehicles upon the roadway.
(c) Between adjacent intersections at which traffic-control signals are in operation pedestrians shall not cross at any place except in a marked crosswalk.
(d) No pedestrian shall cross a roadway intersection diagonally unless authorized by official traffic-control devices; and, when authorized to cross diagonally, pedestrians shall cross only in accordance with the official traffic-control devices pertaining to such crossing movements.
(e) Pedestrians with disabilities may cross a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk where the intersection is physically inaccessible to them but they shall yield the right-of-way to all vehicles upon the roadway.

Marked vs. Unmarked Crosswalks at Uncontrolled Locations

Marked vs. Unmarked Analysis

Speeds < or = to 40 mph

- Two-lane roads: No significant difference in crash rate
- Multilane roads (3 or more lanes)
  - Under 12,000 ADT: no significant difference in crash rate
  - Over 12,000 ADT w/ no median: crashes marked > crashes unmarked
  - Over 15,000 ADT & w/ median: crashes marked > crashes unmarked



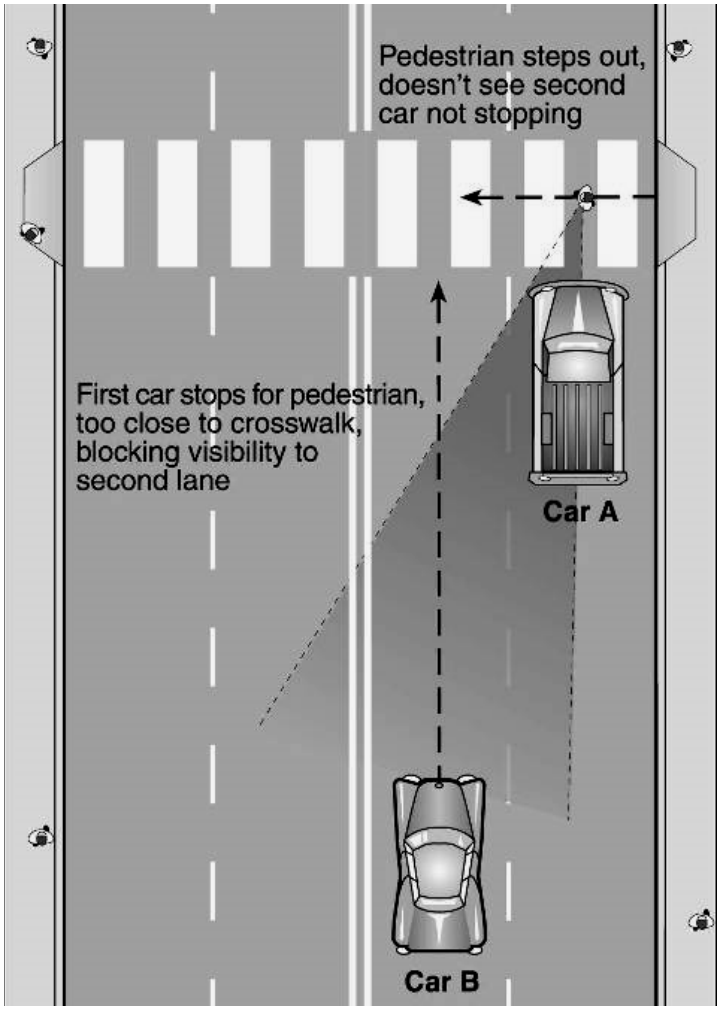
https://www.fhwa.dot.gov/publications/research/safety/04100/

One explanation of higher crash rate at marked crosswalks: multiple-threat crash

1st vehicle stops and "masks" visibility for driver in 2nd lane
Solution: advance stop bar (we'll discuss later…)

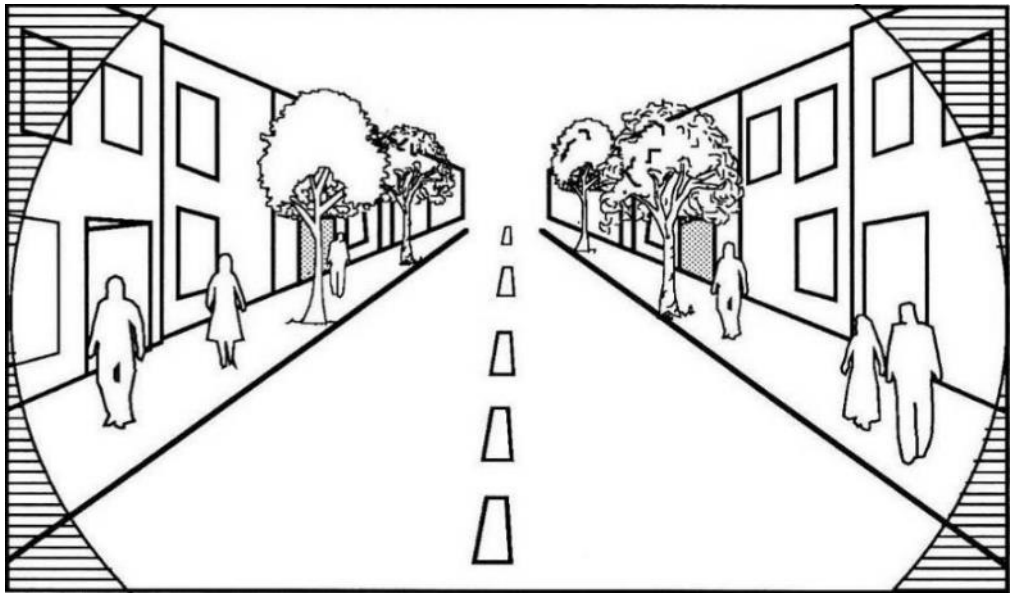
Multiple Threat Crash Problem

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

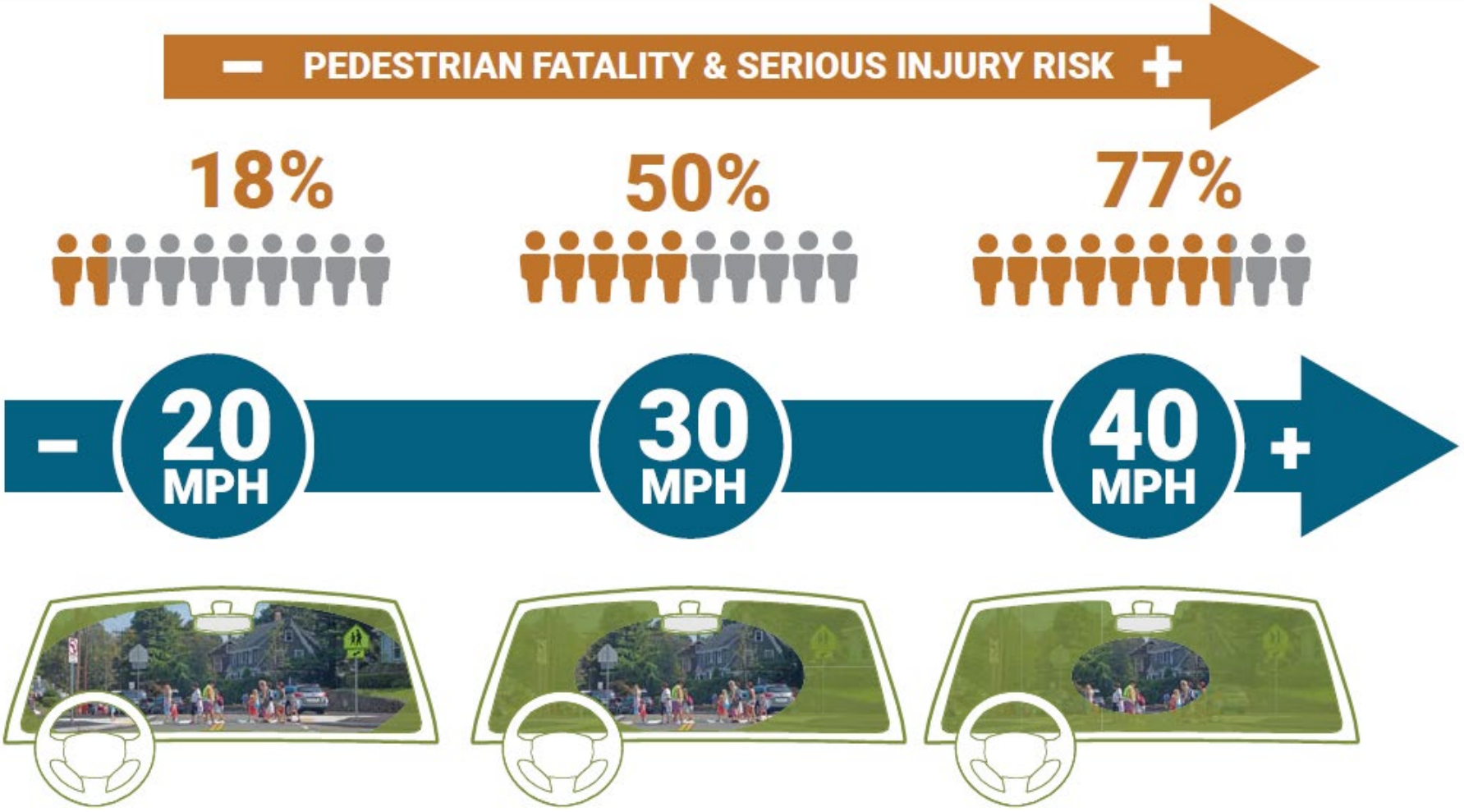


Speed Matters

- Drivers' field of vision to see pedestrians
- Drivers' ability to react and avoid a crash
- Crash Severity



15 MPH



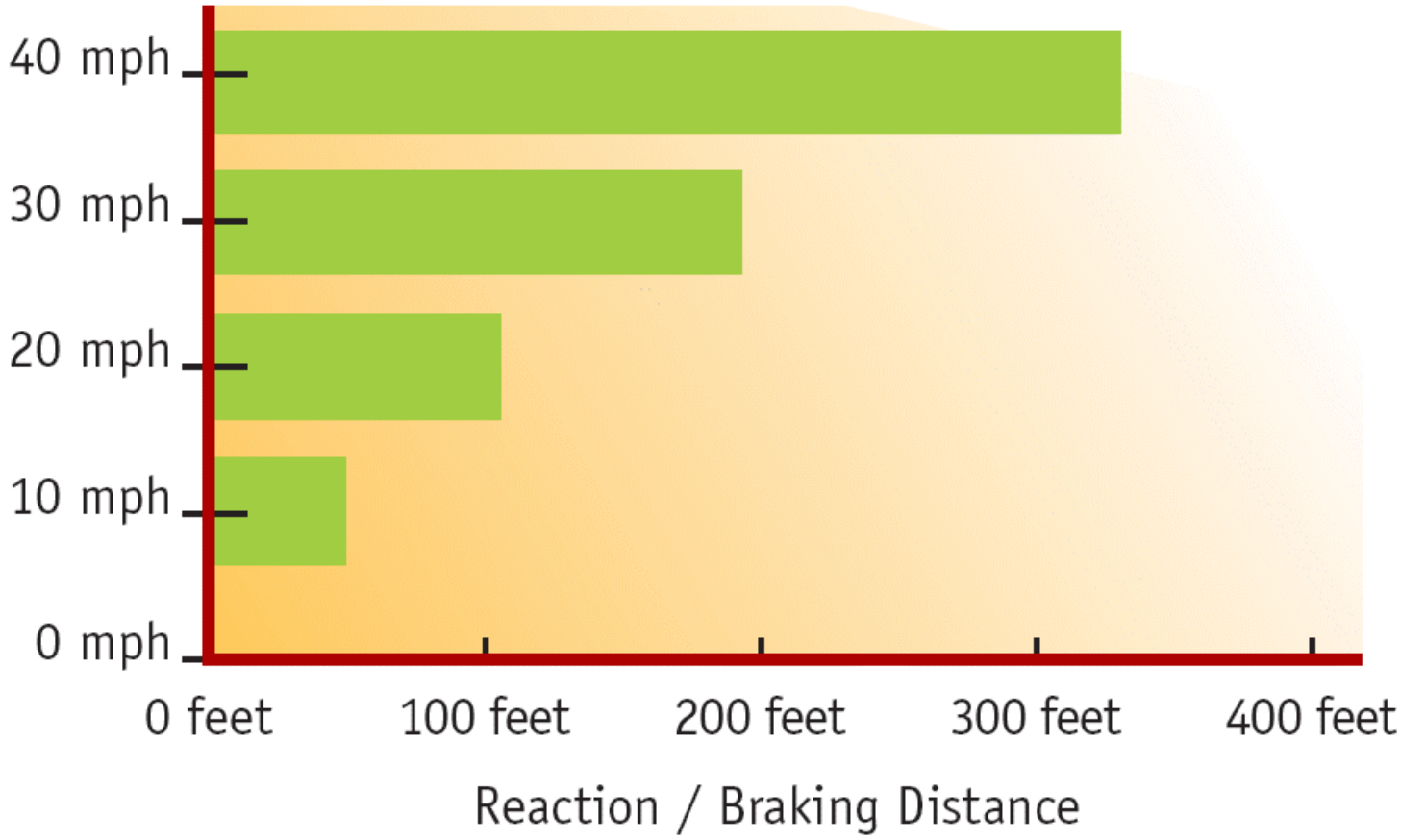
As motor vehicle speeds increase, the risk of serious injury or fatality for a pedestrian also increases (AARP Impact Speed and a Pedestrian's Risk of Severe Injury or Death 2011, p. 1). Also, motorist visual field and peripheral vision is reduced at higher speeds.

Ability to React and Avoid

60 kph (37 mph)
vs.
65 kph (40 mph)

Australian PSA on Speed

Speed Affects Crash Avoidance



High speeds equate to greater reaction and stopping distance

German Speed Management

MUTCD Section 3B.18 Crosswalk Markings

New marked crosswalks **alone**, **without other measures** designed to reduce traffic speeds, shorten crossing distances, enhance driver awareness of the crossing, and/or provide active warning of pedestrian presence, should not be installed across uncontrolled roadways where the speed limit exceeds 40 mph and /or either:

- Has 4 or more lanes without a raised median or island and ADT of 12,000 or more, or
- 4 or more lanes with raised median island and ADT of 15,000 or more

How to determine where to mark a crosswalk?

- Crosswalk markings provide guidance for pedestrians by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops.
- In conjunction with signs and other measures, crosswalk markings help to alert road users of a designated pedestrian crossing point across roadways at locations that are not controlled by traffic control signals or STOP or YIELD signs.
- At non-intersection locations, crosswalk markings legally establish the crosswalk.

MUTCD Guidance 3B.18 paragraph 8

Crosswalk lines should not be used indiscriminately. An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign. The engineering study should consider the number of lanes, the presence of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic (ADT), the posted or statutory speed limit or 85th-percentile speed, the geometry of the location, the consolidation of multiple crossing points, the availability of street lighting, and other appropriate factors.

https://mutcd.fhwa.dot.gov/htm/2009/part3/part3b.htm#section3B18

How to determine where to mark a crosswalk?

It Starts with Origins and Destinations

In this case, apartments across from bus stop & stores

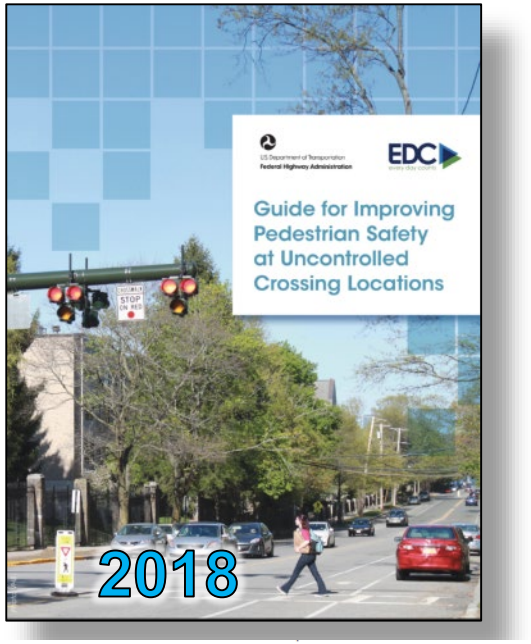


Table 11. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

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

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

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

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

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

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

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

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)	● 2 4 5 6	● 5 6 7 9 ●	○ 5 6 ●	● 4 5 6	● 5 6 7 9 ●	○ 5 6 ●	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 ●
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● ★ ○ 5 7 9 ●	○ ★ 5 ●	○ 3 4 5 7 9	○ ★ ○ 5 7 9 ●	○ ★ 5 ●	○ ★ ○ 4 5 7 9	○ ★ 5 7 9 ●	○ ★ 5 ●
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● ★ ○ 5 6 7 9	○ ★ 5 6 ●	○ 3 4 5 6 7 9	○ ★ ○ 5 6 7 9 ●	○ ★ 5 6 ●	○ ★ ○ 4 5 6 7 9	○ ★ 5 6 7 9 ●	○ ★ 5 6 ●
4+ lanes with raised median (2 or more lanes in each direction)	● ★ 5 7 8 9	● ★ ○ 5 7 8 9	○ ★ 5 8 ●	○ ★ 5 7 8 9	○ ★ ○ 5 7 8 9 ●	○ ★ 5 8 ●	○ ★ ○ 5 7 8 9 ●	○ ★ 5 7 8 9 ●	○ ★ 5 8 ●
4+ lanes w/o raised median (2 or more lanes in each direction)	● ★ 5 6 7 8 9	● ★ ○ 5 6 7 8 9	○ ★ 5 6 ●	○ ★ 5 6 7 8 9	○ ★ ○ 5 6 7 8 9 ●	○ ★ 5 6 ●	○ ★ ○ 5 6 7 8 9	○ ★ 5 6 7 8 9 ●	○ ★ 5 6 ●

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.

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1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning sign
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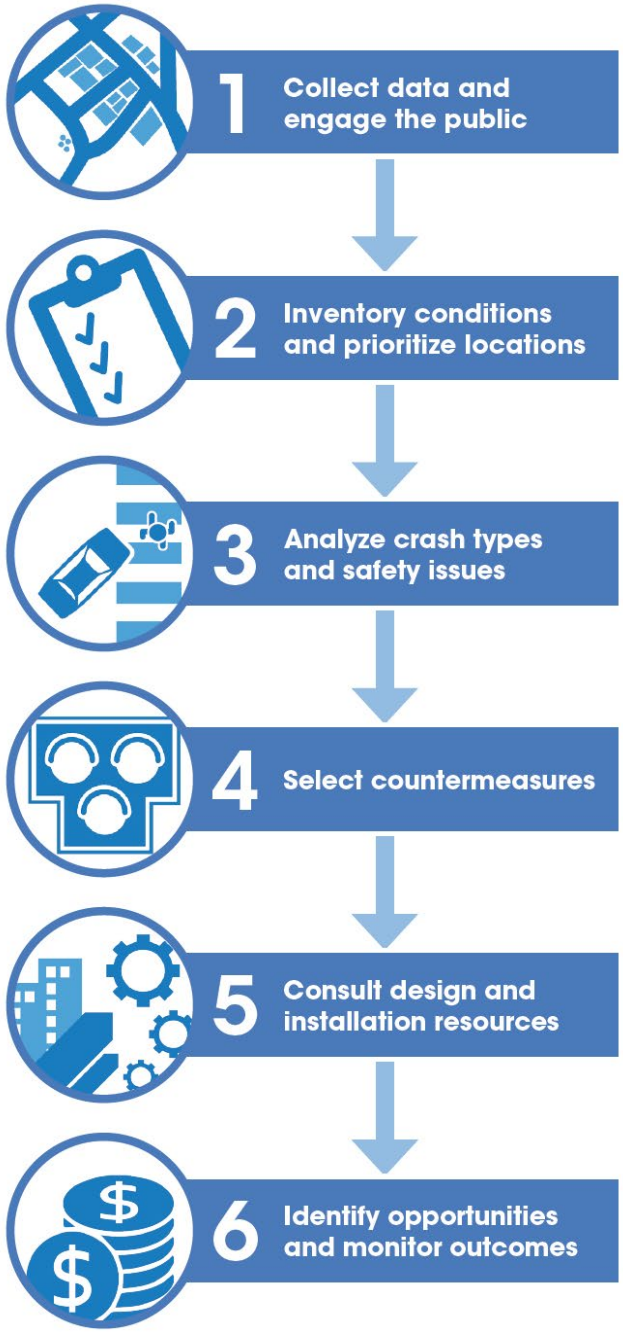
4 In-Street Pedestrian Crossing sign
5 Curb extension
6 Pedestrian refuge island
7 Rectangular Rapid-Flashing Beacon (RRFB)**
8 Road Diet
9 Pedestrian Hybrid Beacon (PHB)**

*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.

https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf

Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations



4 Select countermeasures

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)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 ●
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● ● 5 7 9	○ ● 5 ● 9	○ 3 4 5 7 9	○ ● 5 ● 9	○ ● 5 ● 9	○ ● 4 5 7 9	○ ● 5 ● 9	○ ● 5 ●
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● ● 5 6 7 9	○ ● 5 6 ● 9	○ 3 4 5 6 7 9	○ ● 5 6 ● 9	○ ● 5 6 ● 9	○ ● 4 5 6 7 9	○ ● 5 6 ● 9	○ ● 5 6 ●
4+ lanes with raised median (2 or more lanes in each direction)	● ● 5 7 8 9	● ● 5 7 8 9	○ ● 5 8 ● 9	○ ● 5 7 8 9	○ ● 5 ● 8 ● 9	○ ● 5 8 ● 9	○ ● 5 ● 7 8 9	○ ● 5 8 ● 9	○ ● 5 8 ●
4+ lanes w/o raised median (2 or more lanes in each direction)	● ● 5 6 7 8 9	○ ● 5 ● 6 7 8 9	○ ● 5 ● 6 8 ● 9	○ ● 5 ● 6 7 8 9	○ ● 5 ● 6 ● 8 ● 9	○ ● 5 ● 6 8 ● 9	○ ● 5 ● 6 ● 8 ● 9	○ ● 5 ● 6 8 ● 9	○ ● 5 ● 6 8 ●

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*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.

Table 2. Safety issues addressed per countermeasure.

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	✓		✓	✓	✓

What STEP treatment(s) would you install?
35 mph speed limit
4 lanes w/TWLTL
ADT: 14,500

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)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 9
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● 3 5 7 9	○ 3 5 ● 9	○ 3 4 5 7 9	○ 3 5 ● 9	○ 3 5 ● 9	○ 3 4 5 7 9	○ 3 5 ● 9	○ 3 5 9
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● 3 5 6 7 9	○ 3 5 6 9	○ 3 4 5 6 7 9	○ 3 5 6 ● 9	○ 3 5 6 9	○ 3 4 5 6 7 9	○ 3 5 6 9	○ 3 5 6 9
4+ lanes with raised median (2 or more lanes in each direction)	● 3 5 7 8 9	● 3 5 7 8 9	○ 3 5 8 ● 9	○ 3 5 7 8 9	○ 3 5 ● 8 9	○ 3 5 8 ● 9	○ 3 5 ● 7 8 9	○ 3 5 8 ● 9	○ 3 5 8 9
4+ lanes w/o raised median (2 or more lanes in each direction)	● 3 5 6 7 8 9	○ 3 5 6 7 8 9	○ 3 5 6 8 ● 9	○ 3 5 6 7 8 9	○ 3 5 6 ● 8 9	○ 3 5 6 8 ● 9	○ 3 5 6 ● 7 8 9	○ 3 5 6 8 ● 9	○ 3 5 6 8 9

Given the set of conditions in a cell,

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	≤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)	❶ 2 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6 7 9	① 5 6 7 9	① 5 6 ❾
3 lanes with raised median (1 lane in each direction)	❶ 2 3 4 5	❶ ❸ 5 7 9	① ❸ 5 ❼ ❾	① 3 4 5	① ❸ 5 7 9	① ❸ 5 ❼ ❾	① ❸ 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❾
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	❶ 2 3 4 5 6 7 9	❶ ❸ 5 6 7 9	① ❸ 5 6 ❾	① 3 4 5 6 7 9	① ❸ 5 6 ❼ ❾	① ❸ 5 6 ❾	① ❸ 4 5 6 7 9	① ❸ 5 6 ❾	① ❸ 5 6 ❾
4+ lanes with raised median (2 or more lanes in each direction)	❶ ❸ 5 7 8 9	❶ ❸ 5 7 8 9	① ❸ 5 8 ❾	① ❸ 5 7 8 9	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 8 ❾
4+ lanes w/o raised median (2 or more lanes in each direction)	❶ ❸ 5 6 7 8 9	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾

Given the set of conditions in a cell,

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Pedestrian Safety Countermeasures for Uncontrolled Crossing Locations

On-Ramp to Innovation
every day counts




The Spectacular Seven

STEP

Safe Transportation for Every Pedestrian



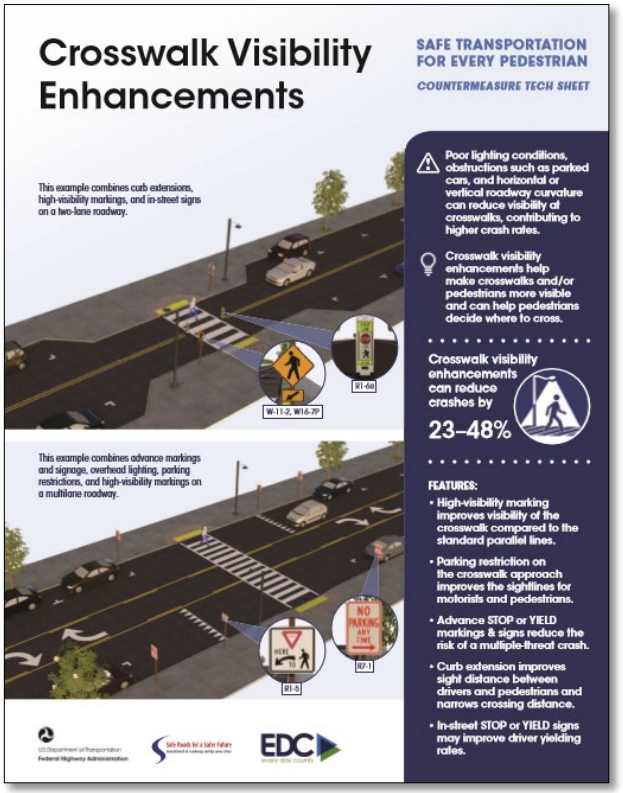
EDC

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

- **Crosswalk Visibility Enhancements**
- Raised Crosswalks
- Pedestrian Refuge Island
- RRFB
- PHB
- Road Diets
- LPI

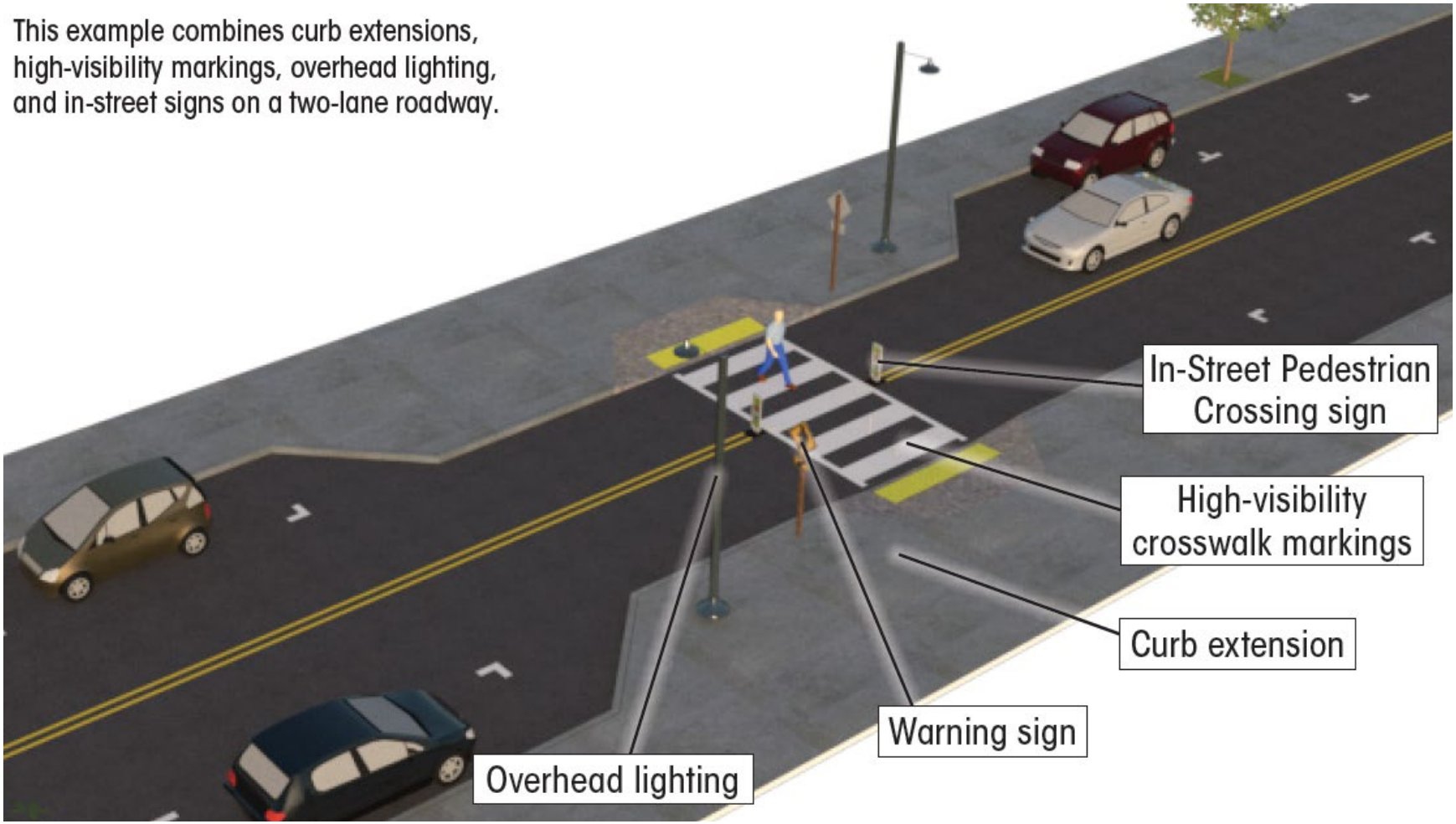


Crosswalk Visibility Enhancements

- Crosswalk Marking Style
- Pedestrian Warning Signs on Approach and at Crosswalk
  - Size and Placement
  - Enhanced Conspicuity (flashing beacons, embedded LEDs)
- Advance Stop or Yield Lines with Signs (e.g., "Stop Here for Crosswalk")
- In-Street Pedestrian Crossing Signs
- Curb Extensions
- Parking Restrictions on Crosswalk Approach
- In-roadway Warning Lights
- Lighting

Crosswalk Visibility Enhancements

This example combines curb extensions, high-visibility markings, overhead lighting, and in-street signs on a two-lane roadway.



Crosswalk Markings - MUTCD

Section 3B.18 Crosswalk Markings

Standard:

When crosswalk lines are used, they shall consist of solid white lines that mark the crosswalk. They shall not be less than 6 inches or greater than 24 inches in width.

Guidance:

If transverse lines are used to mark a crosswalk, the gap between the lines should not be less than 6 feet. If diagonal or longitudinal lines are used without transverse lines to mark a crosswalk, the crosswalk should be not less than 6 feet wide.

Option:

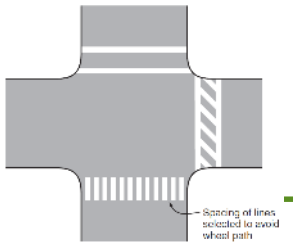
For added visibility, the area of the crosswalk may be marked with white diagonal lines at a 45-degree angle to the line of the crosswalk or with white longitudinal lines parallel to traffic flow as shown in Figure 3B-19.

When diagonal or longitudinal lines are used to mark a crosswalk, the transverse crosswalk lines may be omitted. This type of marking may be used at locations where substantial numbers of pedestrians cross without any other traffic control device, at locations where physical conditions are such that added visibility of the crosswalk is desired, or at places where a pedestrian crosswalk might not be expected.

Guidance:

If used, the diagonal or longitudinal lines should be 12 to 24 inches wide and separated by gaps of 12 to 60 inches. The design of the lines and gaps should avoid the wheel paths if possible, and the gap between the lines should not exceed 2.5 times the width of the diagonal or longitudinal lines.

Figure 3B-19. Examples of Crosswalk Markings



Crosswalk Visibility Enhancements
High Visibility Crosswalk

What Pedestrians See

Photo Source all 4: Michael Ronkin

What Drivers See

Crosswalk Visibility Study

Objective: Investigate relative daytime and nighttime visibility of 3 crosswalk patterns

- Transverse lines
- Continental
- Bar Pairs

https://www.fhwa.dot.gov/publications/research/safety/pedbike/10067/

Crosswalk Visibility Study

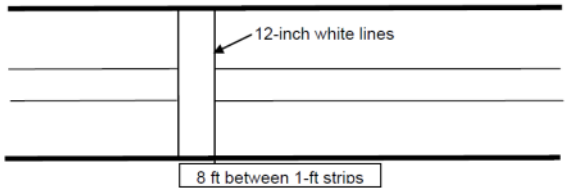


Figure 21. Graphic. Dimensions used for installed transverse markings.

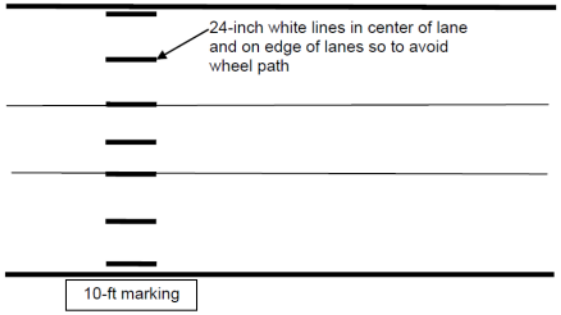


Figure 20. Graphic. Dimensions used for installed continental markings.

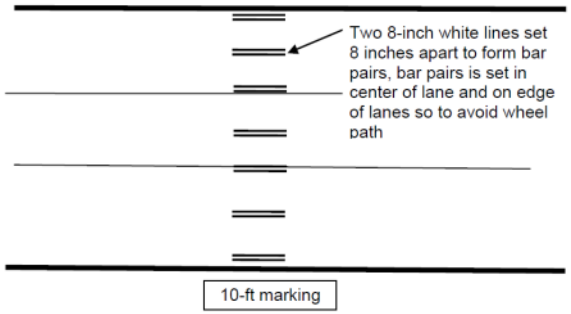


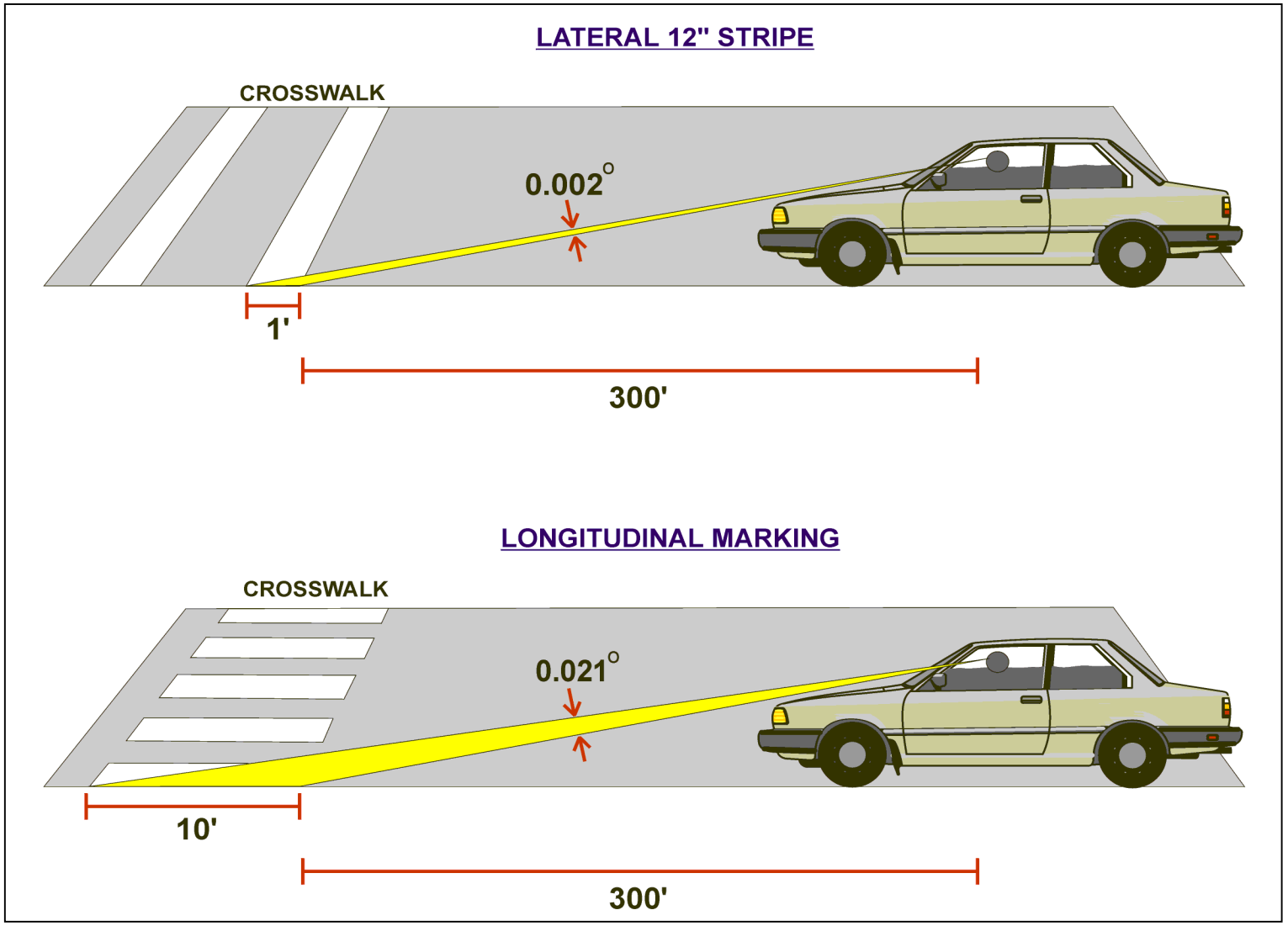
Figure 19. Graphic. Dimensions used for installed bar pair markings.

Photo and images from Crosswalk Visibility Study

Crosswalk Visibility Study Conclusions

- Detection distances Continental & Bar Pairs statistically different from Transverse
- Existing midblock locations: General observation Continental detected about **twice** the distance upstream as transverse during daytime conditions.
  - Increase in distance reflects **8 s** of increased awareness of the presence of the crossing at a 30-mi/h operating speed.
- Participants preferred Continental & Bar Pairs over Transverse
  - Participants gave Continental & Bar Pairs similar ratings during both the day and night
  - Transverse ratings differed based on the light level

Crosswalk Visibility Study

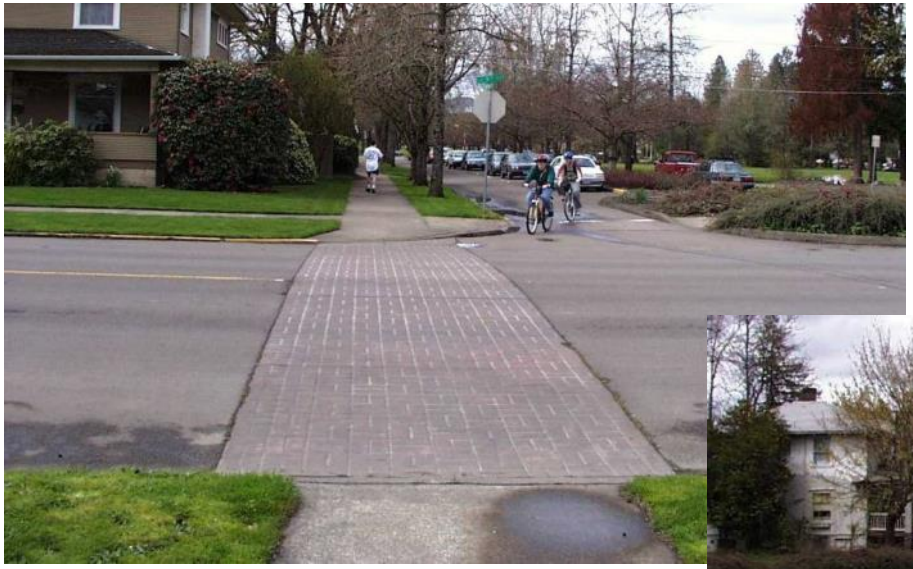


Textured crosswalks: How effective are they?

In theory, more visible.

Reality (after a period of time)

What the pedestrian sees



What the driver sees

Brick crosswalks: prone to failure
Difficult for wheelchair users

Supplement textured crosswalks with white lines to increase visibility

National MUTCD Compliant?

https://mutcd.fhwa.dot.gov/resources/interpretations/index.htm

https://mutcd.fhwa.dot.gov/team.htm

MUTCD – Official Ruling 3(09)-24(I) – Application of Colored Pavement Date: August 15, 2013

- … subdued-colored aesthetic treatments between the legally marked transverse crosswalk lines are permissible provided that they are devoid of retroreflective properties and that they do not diminish the effectiveness of the legally required white transverse pavement markings used to establish the crosswalk.
    - Acceptable examples: brick lattice patterns, paving bricks, paving stones, setts, cobbles, or other resources designed to simulate such paving.
    - Acceptable colors: red, rust, brown, burgundy, clay, tan or similar earth tone equivalents.
    - All elements of pattern and color for these treatments are to be uniform, consistent, repetitive, and expected so as not to be a source of distraction.
- No element of the aesthetic interior treatment is to be random or unsystematic.
- No element of the aesthetic interior treatment can implement pictographs, symbols, multiple color arrangements, etc., or can otherwise attempt to communicate with any roadway user.

Pedestrian Warning Signs – MUTCD 2C.50

"… may be used to alert road users in advance of locations where unexpected entries into the roadway might occur or where shared use of the roadway by pedestrians, animals, or equestrians might occur."

Guidance:

If used in advance of a pedestrian, snowmobile, or equestrian crossing, the W11-2, W11-6, W11-7, and W11-9 signs should be supplemented with plaques (see Section 2C.55) with the legend AHEAD or XX FEET to inform road users that they are approaching a point where crossing activity might occur.

W11-2★

★ A fluorescent yellow-green background color may be used for this sign or plaque.

Guidance:

When a fluorescent yellow-green background is used, a systematic approach featuring one background color within a zone or area should be used. The mixing of standard yellow and fluorescent yellow-green backgrounds within a selected site area should be avoided.

Embedded LED's in Signs

- STOP Sign
  - 28.9% reduction number of vehicles not fully stopping
  - 52.9% reduction number of vehicles moving through intersection w/o significantly slowing

https://safety.fhwa.dot.gov/intersection/conventional/unsignalized/tech_sum/fhwasa09006/

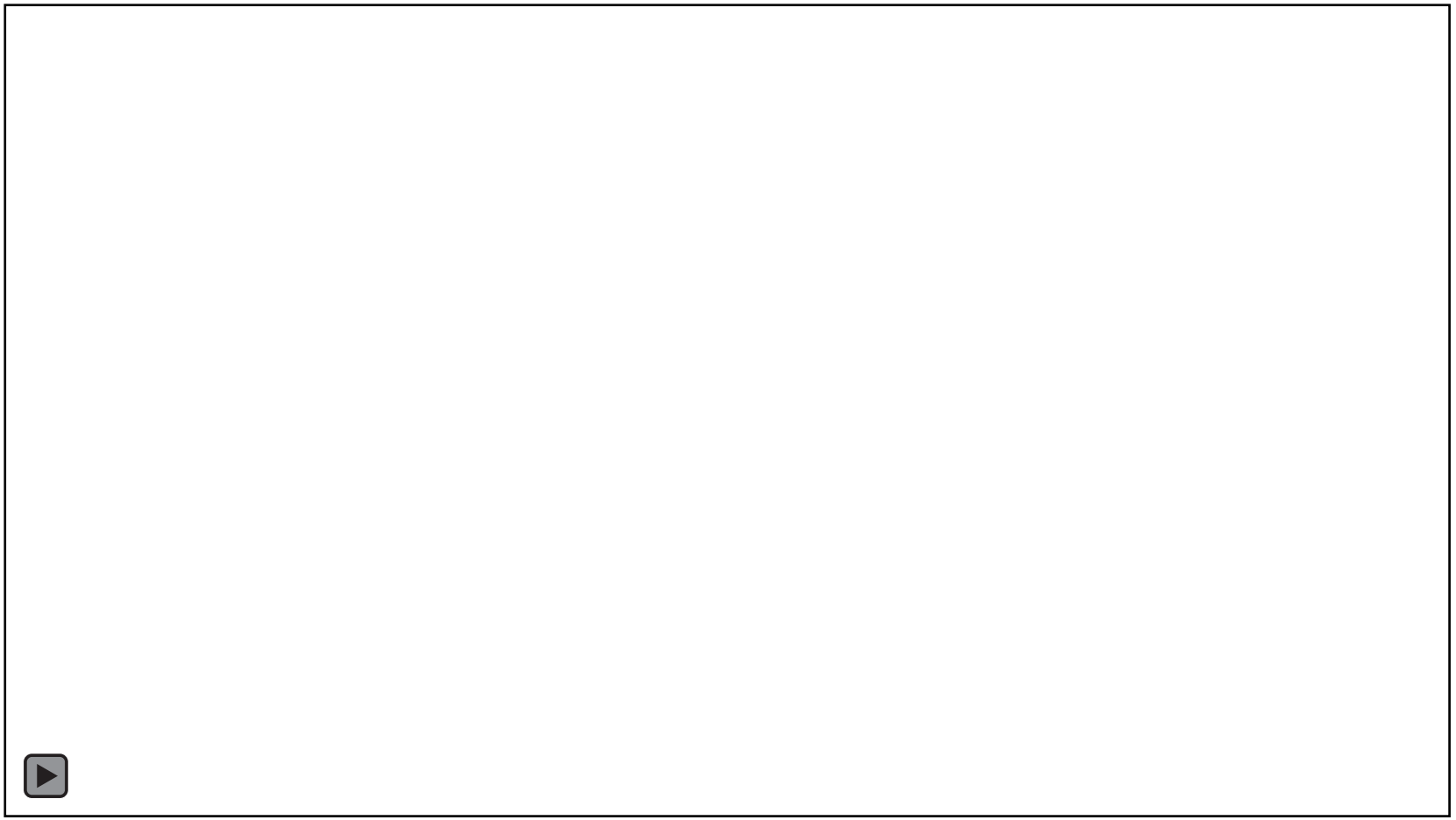
Figure 3: Example of pedestrian crossing warning sign with embedded LEDs and solar unit.

Figure 1: Example of stop sign with embedded LEDs and solar unit.

Figure 2: LEDs are embaded in the symbols and lettering on this truck warning sign.

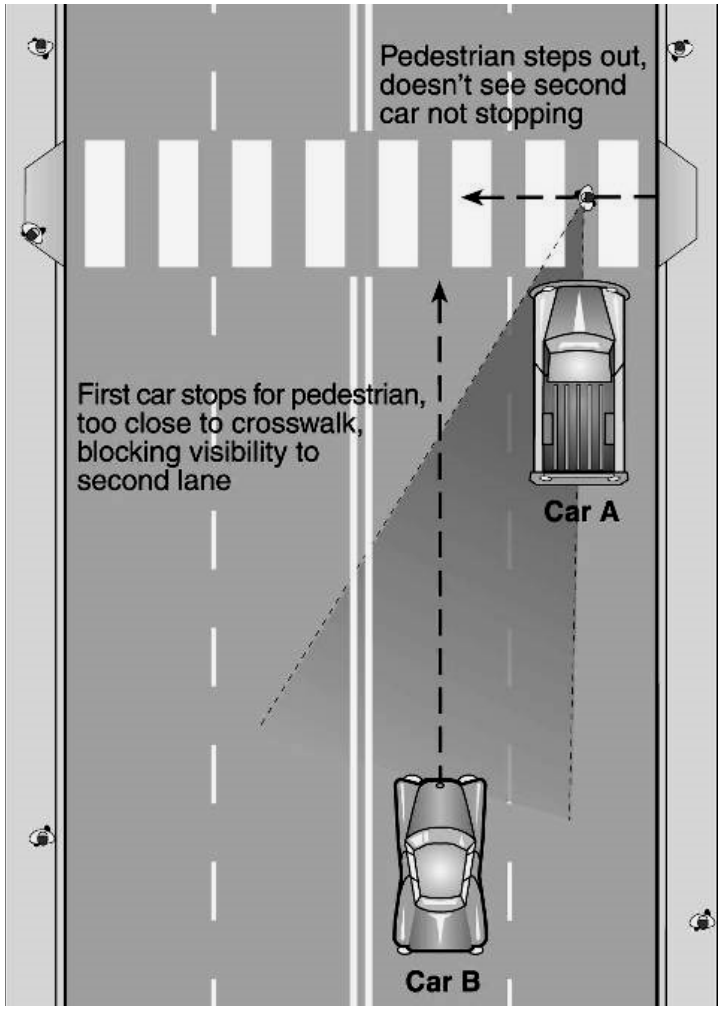
2009 MUTCD Section 2A.07 Retroreflectivity and Illumination
https://mutcd.fhwa.dot.gov/htm/2009r1r2/part2/part2a.htm#section2A07

LED Pedestrian Sign



Multiple Threat Crash Problem

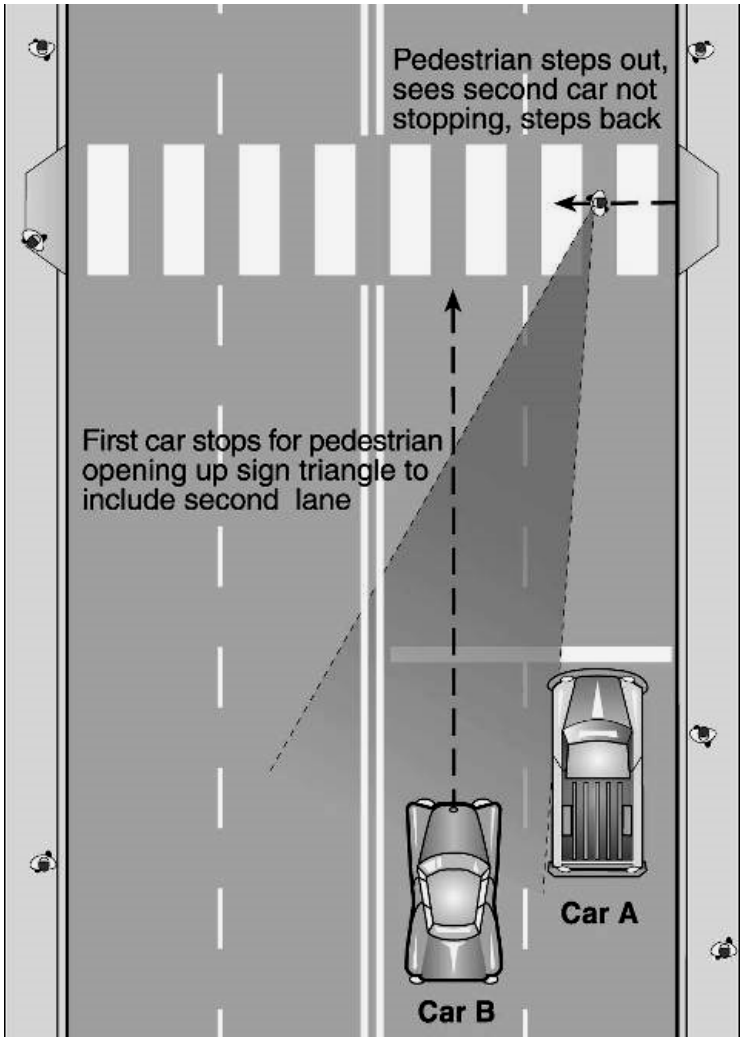
- 1st car stops to let pedestrian cross, blocking sight lines
- 2nd car doesn't stop, hits pedestrian at high speed



Multiple Threat Crash Solution

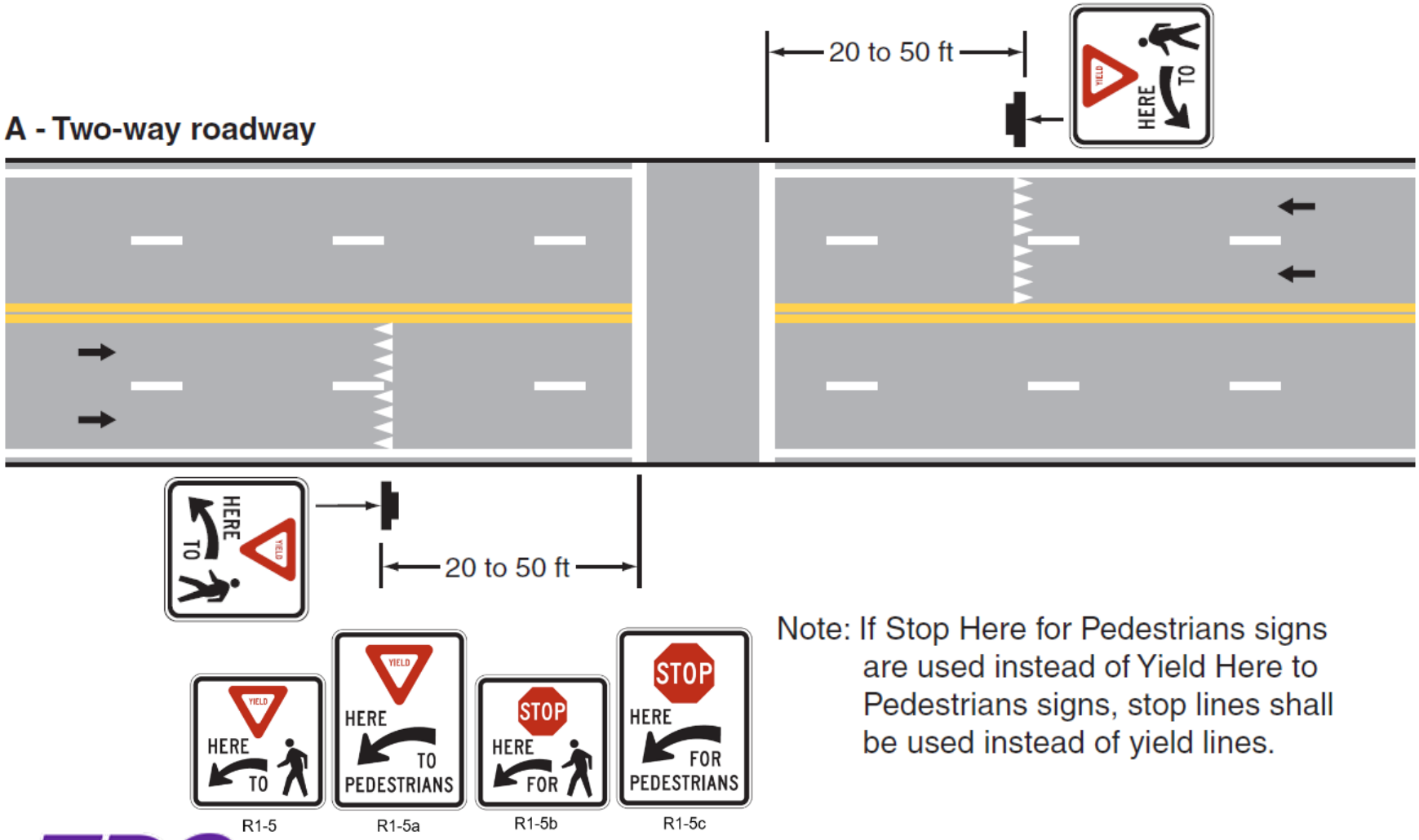
Advance stop or yield line

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



MUTCD Figure 3B-17

Figure 3B-17. Examples of Yield Lines at Unsignalized Midblock Crosswalks



Note: If Stop Here for Pedestrians signs are used instead of Yield Here to Pedestrians signs, stop lines shall be used instead of yield lines.

Signing to go along with markings

Section 2B.11 Yield Here To Pedestrians Signs and Stop Here For Pedestrians Signs (R1-5 Series)

Standard:

01 **Yield Here To (Stop Here For) Pedestrians (R1-5, R1-5a, R1-5b, or R1-5c) signs (see Figure 2B-2) shall be used if yield (stop) lines are used in advance of a marked crosswalk that crosses an uncontrolled multi-lane approach. The Stop Here for Pedestrians signs shall only be used where the law specifically requires that a driver must stop for a pedestrian in a crosswalk. The legend STATE LAW may be displayed at the top of the R1-5, R1-5a, R1-5b, and R1-5c signs, if applicable.**

Guidance:

02 *If yield (stop) lines and Yield Here To (Stop Here For) Pedestrians signs are used in advance of a crosswalk that crosses an uncontrolled multi-lane approach, they should be placed 20 to 50 feet in advance of the nearest crosswalk line (see Section 3B.16 and Figure 3B-17), and parking should be prohibited in the area between the yield (stop) line and the crosswalk.*

03 *Yield (stop) lines and Yield Here To (Stop Here For) Pedestrians signs should not be used in advance of crosswalks that cross an approach to or departure from a roundabout.*

Option:

04 Yield Here To (Stop Here For) Pedestrians signs may be used in advance of a crosswalk that crosses an uncontrolled multi-lane approach to indicate to road users where to yield (stop) even if yield (stop) lines are not used.

(Use where local law says yield to pedestrians)

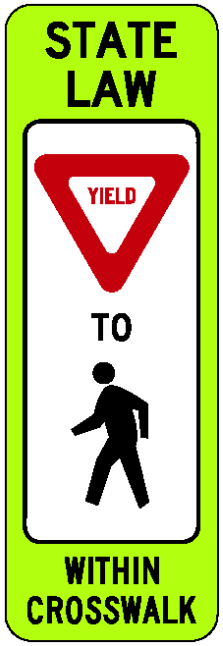
R1-5 R1-5a R1-5b R1-5c

(Use where local law says stop for pedestrians)

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

Advance stop line and sign

In-street pedestrian crossing signs



R1-6

R1-6a

MUTCD signs

Yield or Stop depends on state law

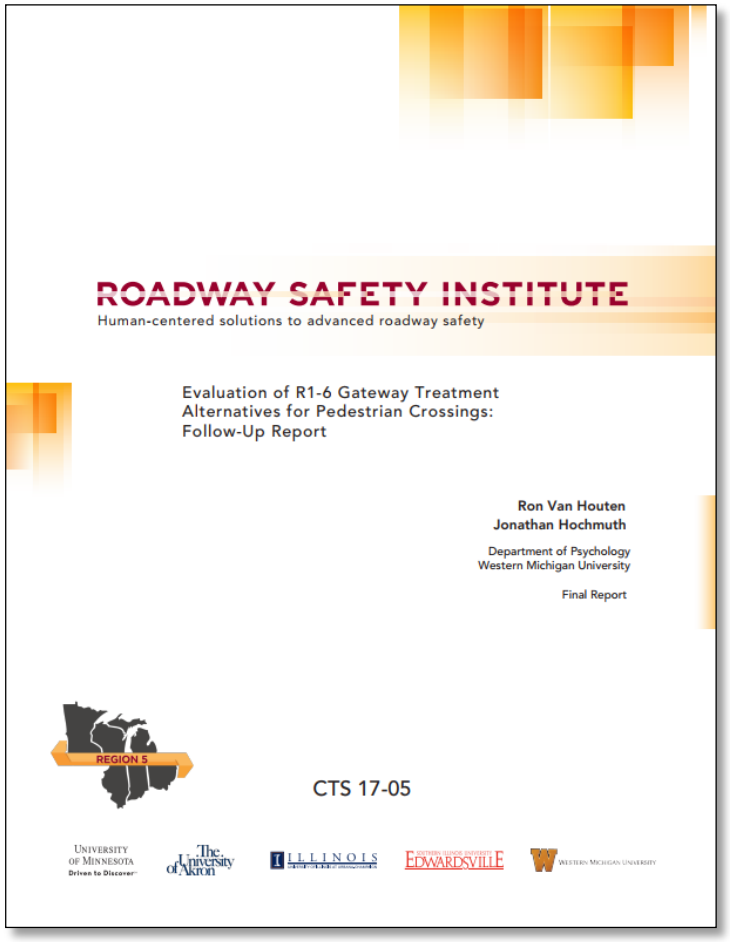
2009 MUTCD Section 2B.12 and Figure 2B-2

In-Street Pedestrian Sign - MUTCD Standards

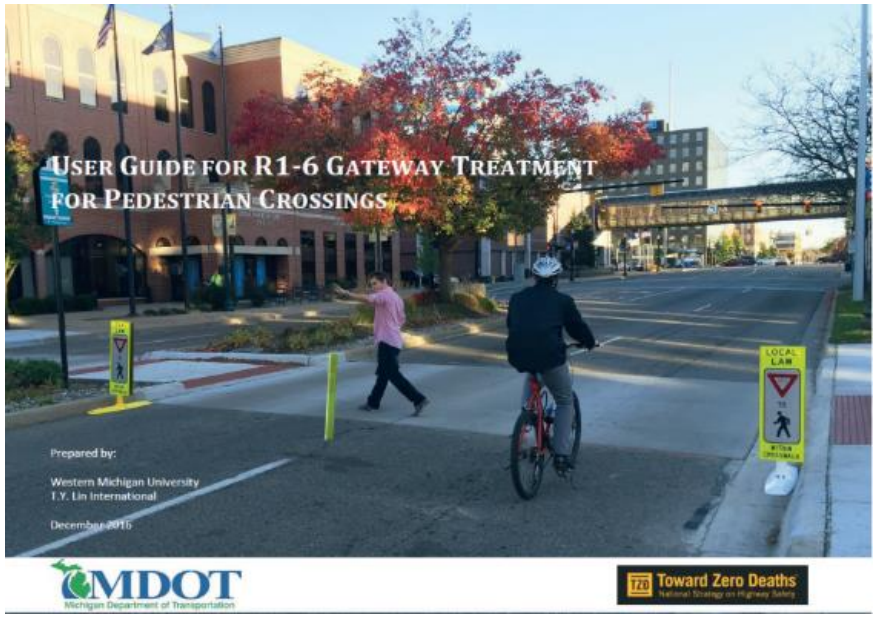
- Shall be placed in the roadway at the crosswalk location on the center line, on a lane line, or on a median island
- Shall not be post-mounted on the left-hand or right-hand side of the roadway
- Unless placed on a physical island, the sign support shall be designed to bend over and then bounce back to its normal vertical position when struck by a vehicle
- Top of sign placed in an island shall be a maximum of 4 feet above the island surface

https://mutcd.fhwa.dot.gov/htm/2009r1r2/part2/part2b.htm#section2B12

In Street Gateway Treatment



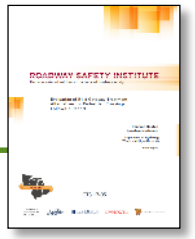
https://conservancy.umn.edu/bitstream/handle/11299/189957/CTS%2017-05.pdf?sequence=1&isAllowed=y



https://mdotcf.state.mi.us/public/tands/Details_Web/mdot_user_guide_gateway_treatment.pdf

Research Abstract key points

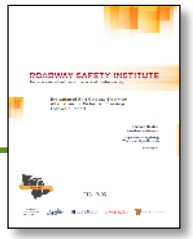
- **Increase** in the percentage of **drivers yielding** to pedestrians at midblock and multilane urban and suburban locations **from 15% to 70%** and that these increases endured **without** any **decrement** over the spring, summer and fall of **2016**.
- Speed data collected at each site showed 4 to 5 mph reduction in mean when motorists traversed the crosswalk when pedestrians were absent. These speed changes persisted over time.
- An additional study showed that placing the signs between 5, 10, 20, 30, and 50 ft in advance of the crosswalk were equally effective and they enticed drivers to yield further ahead of the crosswalk.



Research Abstract key points cont.

Signs mounted on a curb type mount with a flexible rubber attachment all survived while only 58% of the flush mounted signs with a pivoting base survived.

None of the signs mounted on top of the edge of a curb on a refuge island or median island, curb extension, or the curb on the edge of the roadway under FHWA permission to experiment were destroyed or damaged.



Gateway Treatment, Three–Lane Configuration Without Refuge Island	
Travel Lanes **Passing/Turn Lanes**	2 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.
Approximate Cost	$1,200 for materials 20-minute installation 8 minutes to remove for winter 8 minutes to reinstall in spring

Figure 6a

General Description:

Note: By installing the gateway on the near side of the intersection, both crosswalks are covered with only four signs. Data show that a gateway at the near side crosswalk continues to be effective for the far side of the intersection, as the motorist on the far side has already passed through a gateway on the near side.

The signs on the curb side in the gutter pan would have a better chance of survival if they are moved placed between 3 and 50 feet in Advance of the crosswalk markings. This would reduce the chance of the sign being struck by a turning vehicle. Figure 6b shows a typical installation.

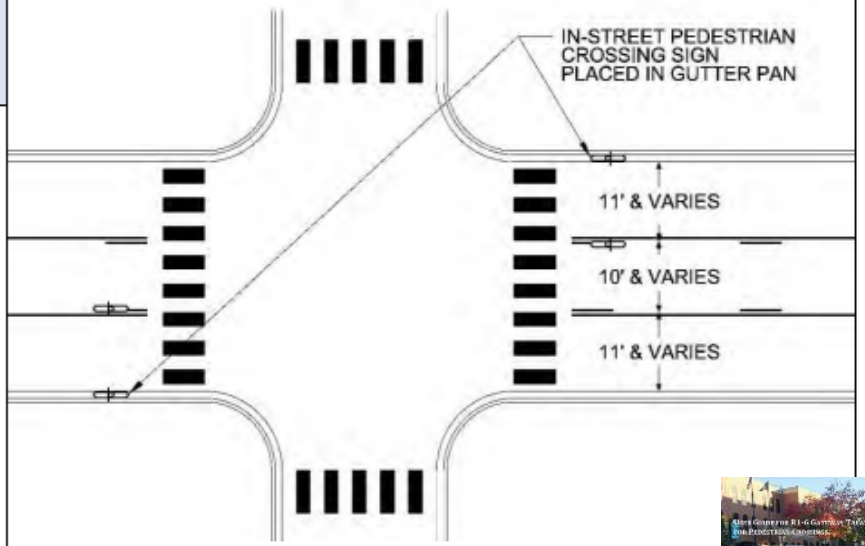
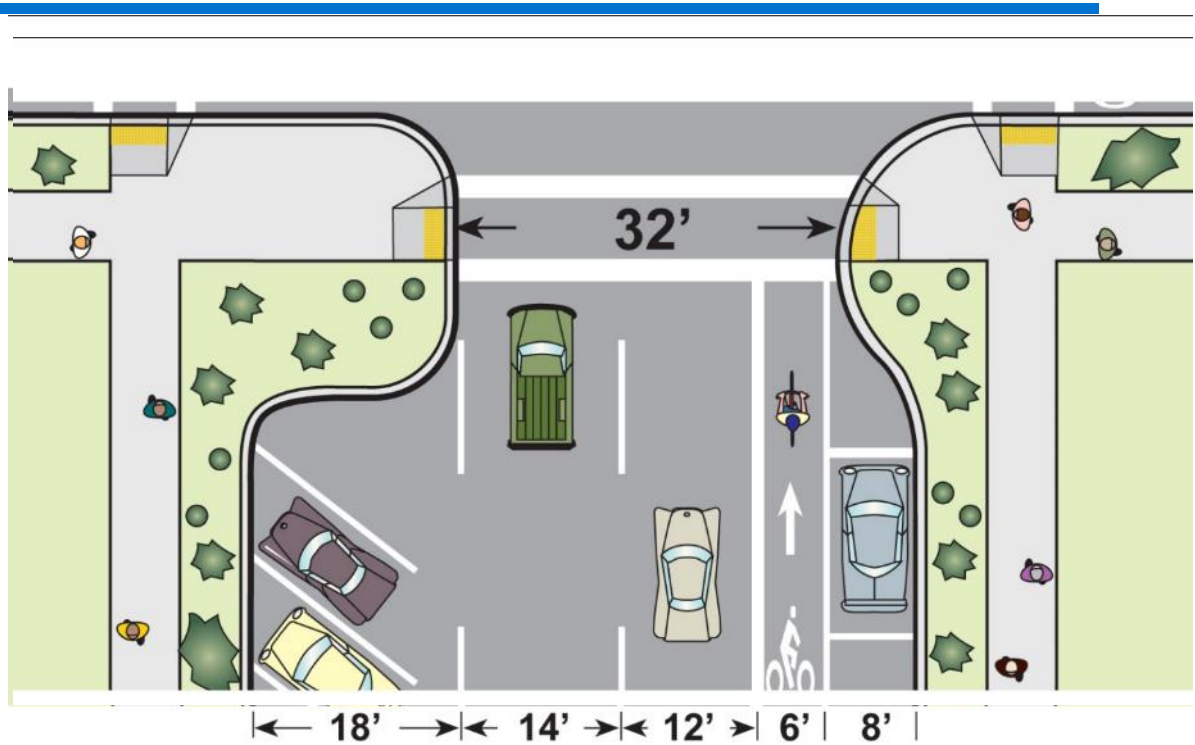


Figure 6b

Crosswalk Visibility Enhancements
Curb Extensions

Curb extensions

Most focus is on reduced crossing distance

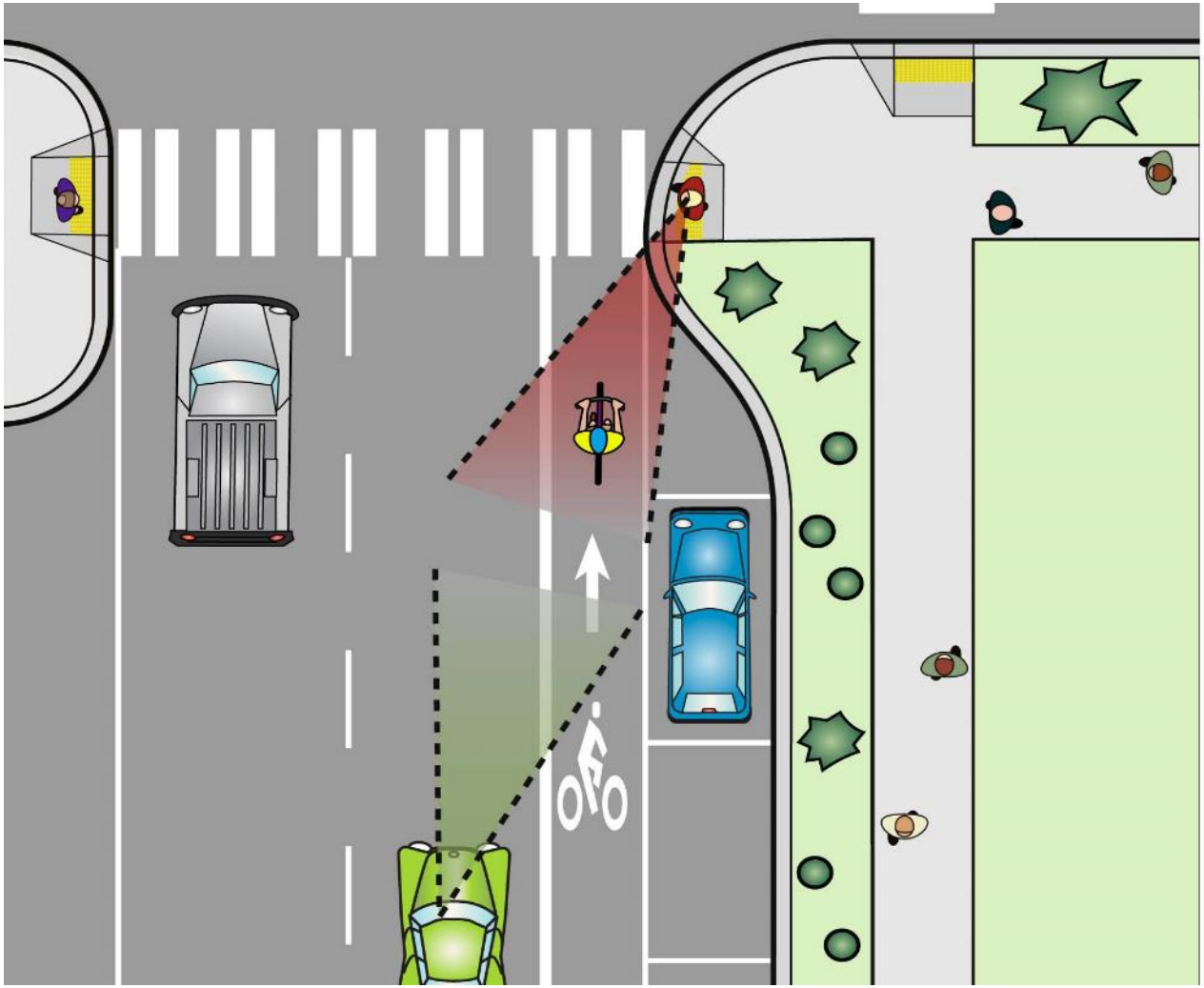


Other advantages:

- 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



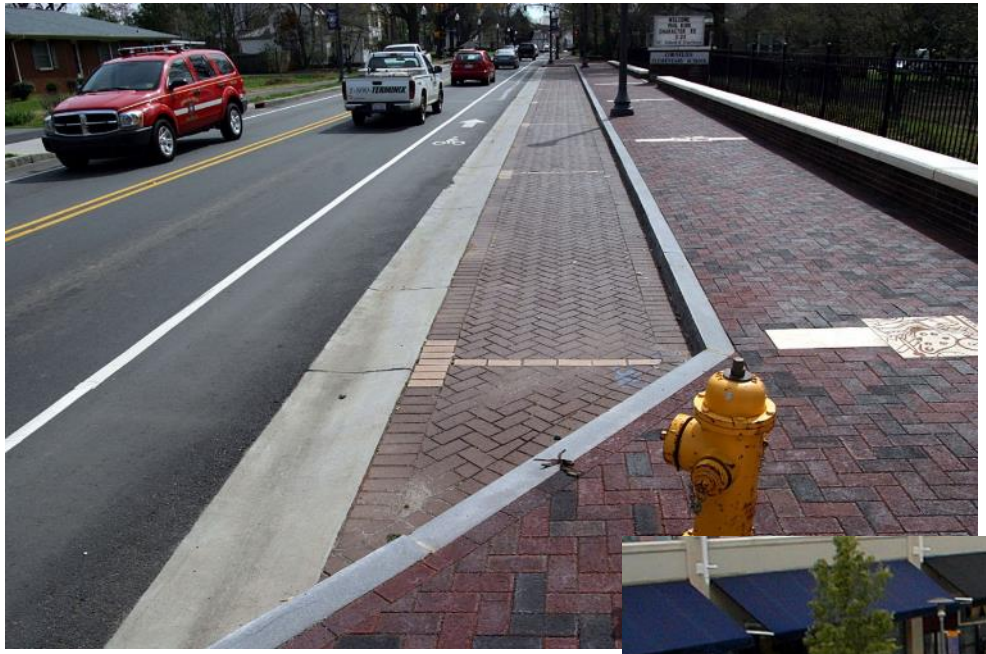
Curb extensions enable signs to be moved in

Drainage solutions: Additional inlet

Drainage solutions: Same as before, plus plate

Before: road looks and feels wide

After: curb extension integral to sidewalk
Street looks narrow even with no parked cars



Curb extension integrated into sidewalk

Fixed objects

Warren & Smith Streets, Brooklyn DOT

Bollards, planters, & other fixed objects may be placed at the back of curb to protect pedestrians and prevent vehicles from driving onto the sidewalk.

Paint & delineator posts

No Curb Extension?
Limit Parking Near Crosswalk

On-street parking should be restricted at least 20 feet in advance of the crosswalk to allow for good visibility of pedestrians

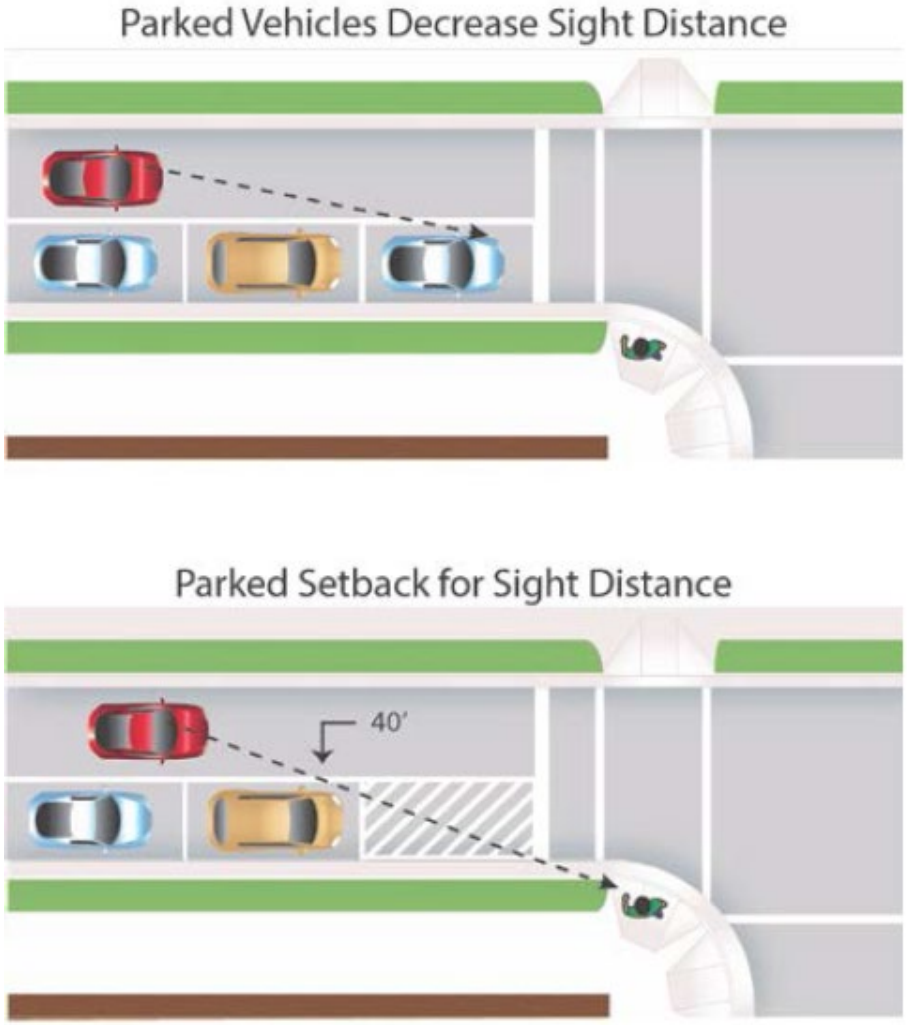


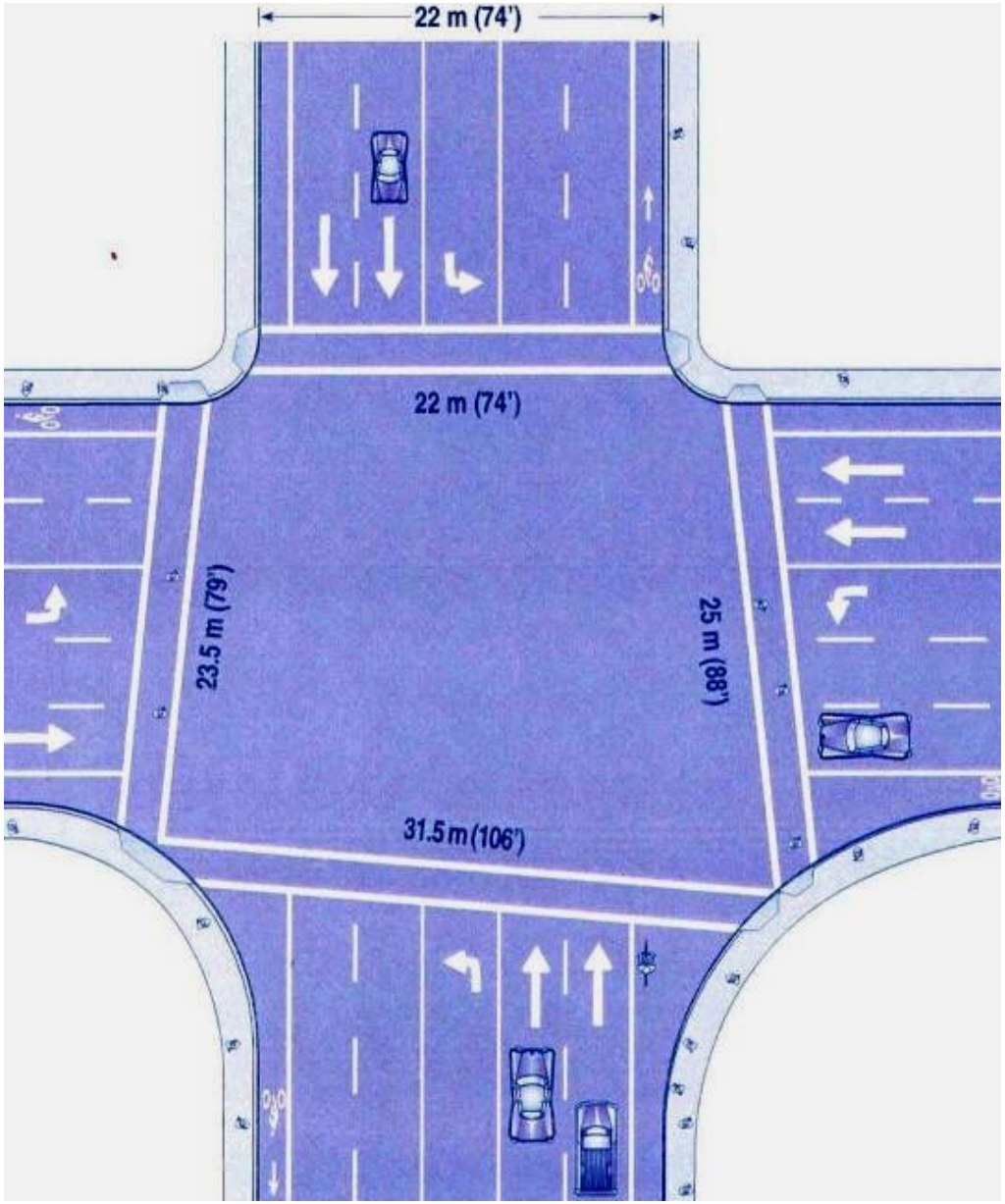
Figure Source: City of Honolulu Complete Streets Manual

Curb radius – small radii are safer for pedestrians

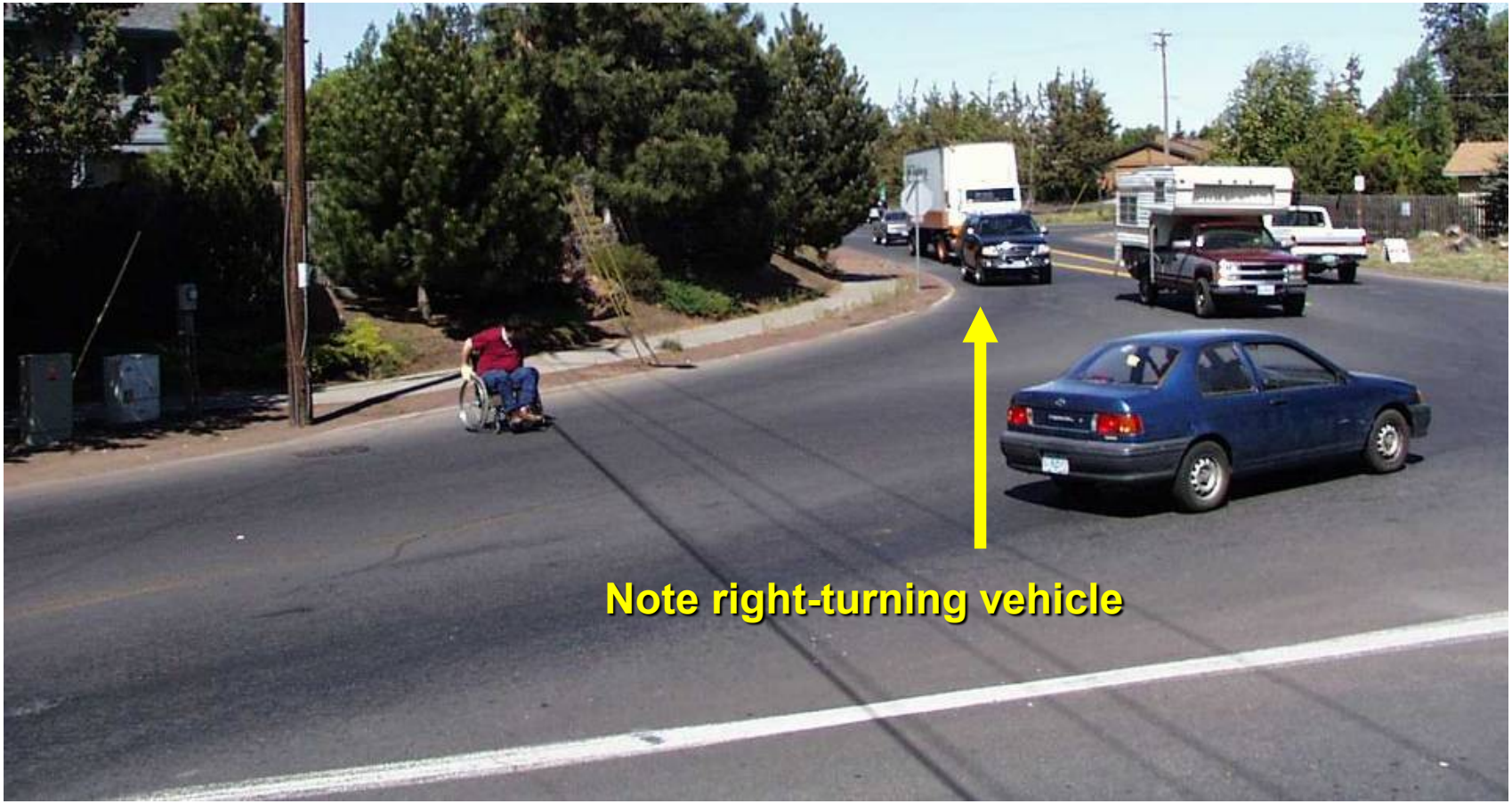
Large radii:

Increases crossing distance

Makes crosswalk & ram placement more difficult



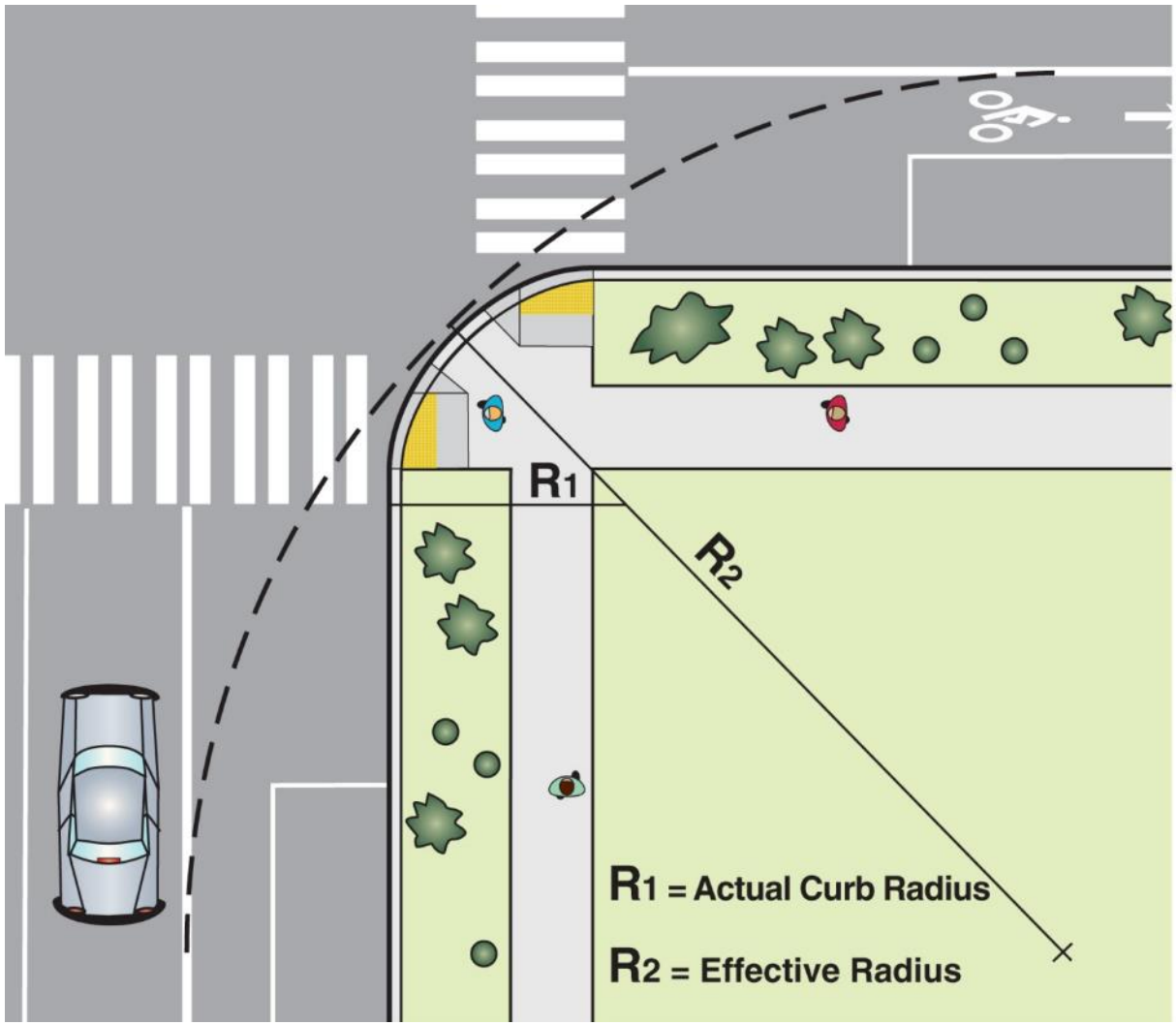
Effect of large radius on crosswalk:



… and makes it hard to figure out where to cross

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

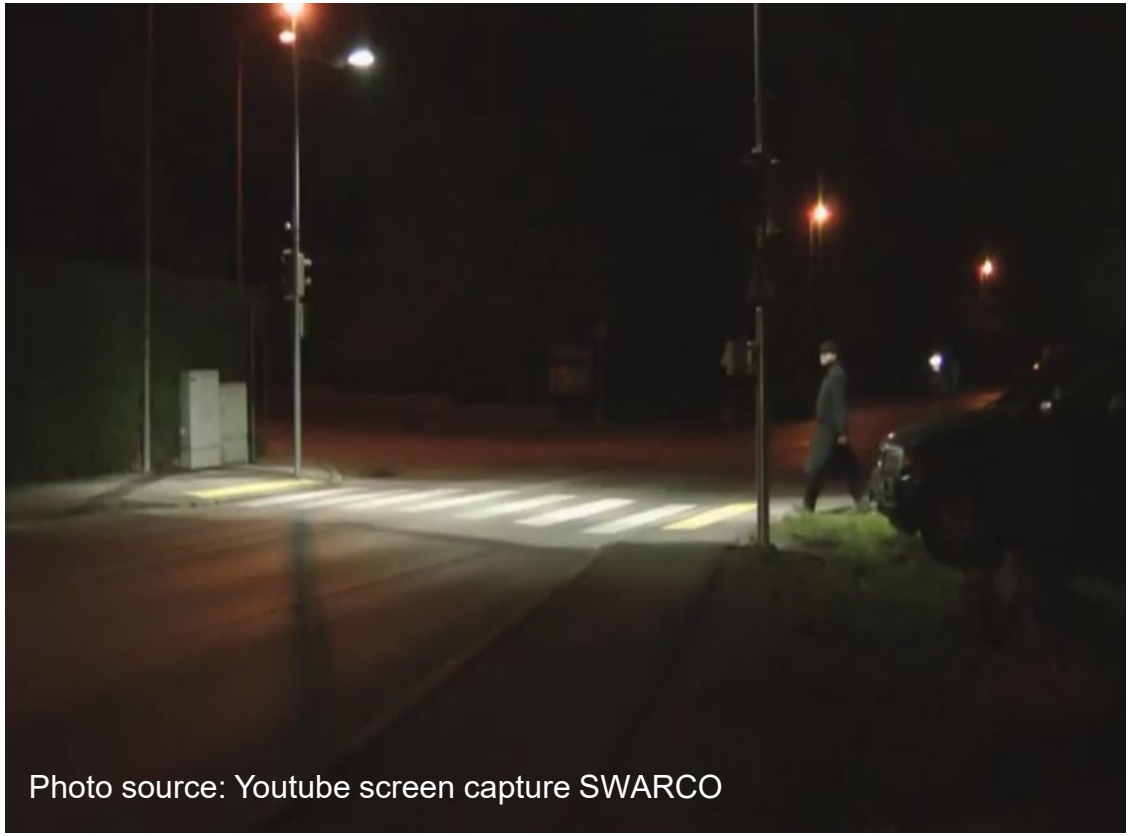
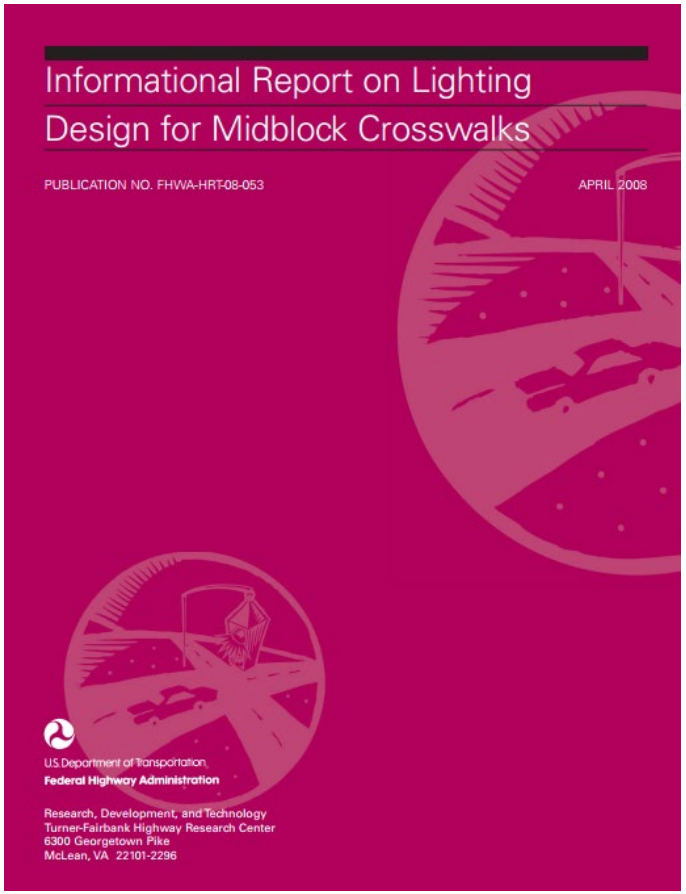


Photo source: Youtube screen capture SWARCO

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

Informational Report on Lighting Design for Midblock Crosswalks



https://www.fhwa.dot.gov/publications/research/safety/08053/

Vertical illuminance of 20 Lx in the crosswalk, measured at a height 5 ft from the road surface, provided adequate detection distances in most circumstances

Lighting Over Crosswalks

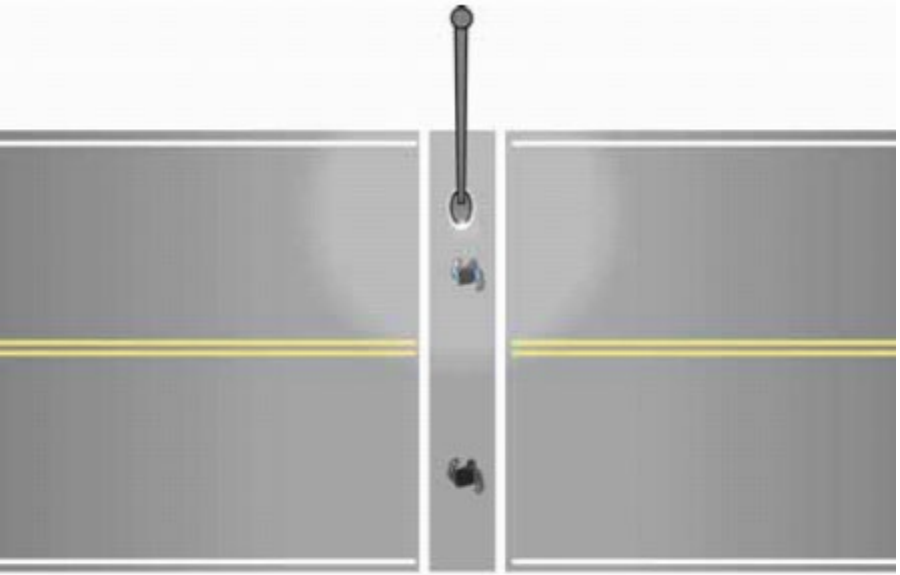


Fig 11. Traditional midblock crosswalk lighting layout

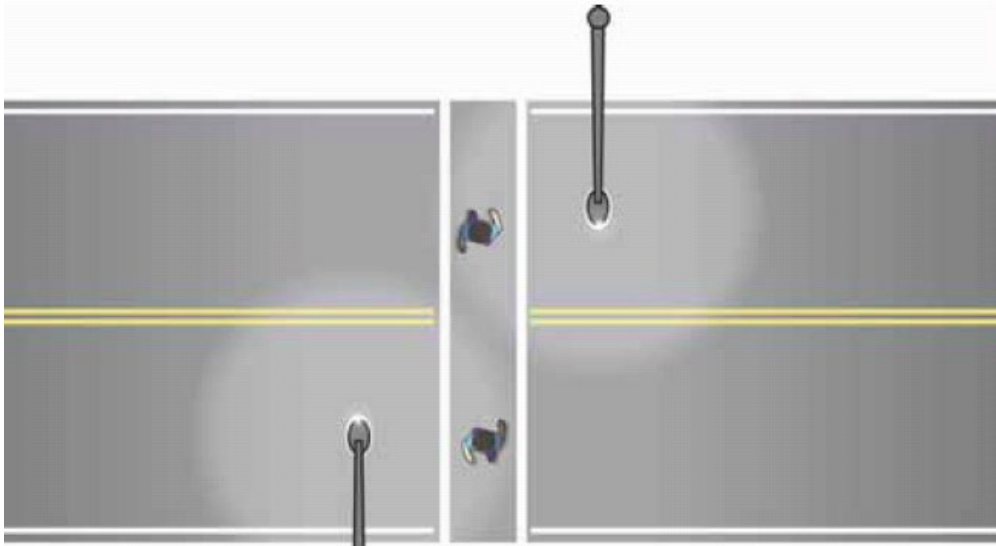
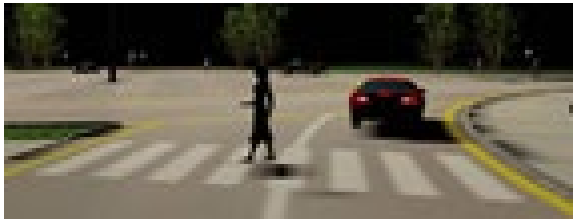


Fig 12. New design for midblock crosswalk lighting layout



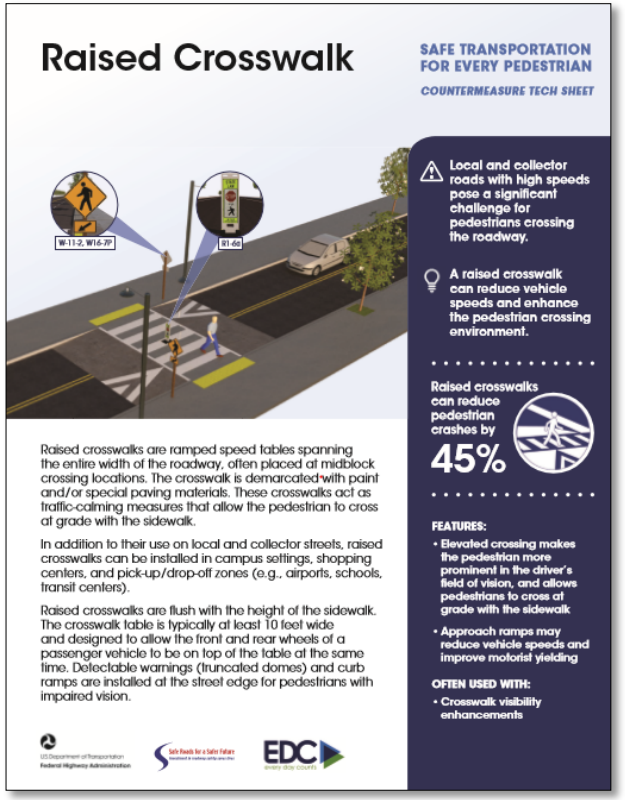
Recommended lighting level: 20 lux at 5’ above pavement

Lummi Nation Haxton Way Pedestrian Pathway Adaptive Solar Lighting WSDOT

https://www.youtube.com/watch?v=ltR2oiQ3R9Q

Spectacular Seven

- Crosswalk Visibility Enhancements
- **Raised Crosswalks**
- Pedestrian Refuge Island
- RRFB
- PHB
- Road Diets
- LPI



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

May be appropriate for roads with:

- Two or three lanes
- Speed limits of 30 mph or less
- AADT below 9,000

Photo Source: SRTS Guide

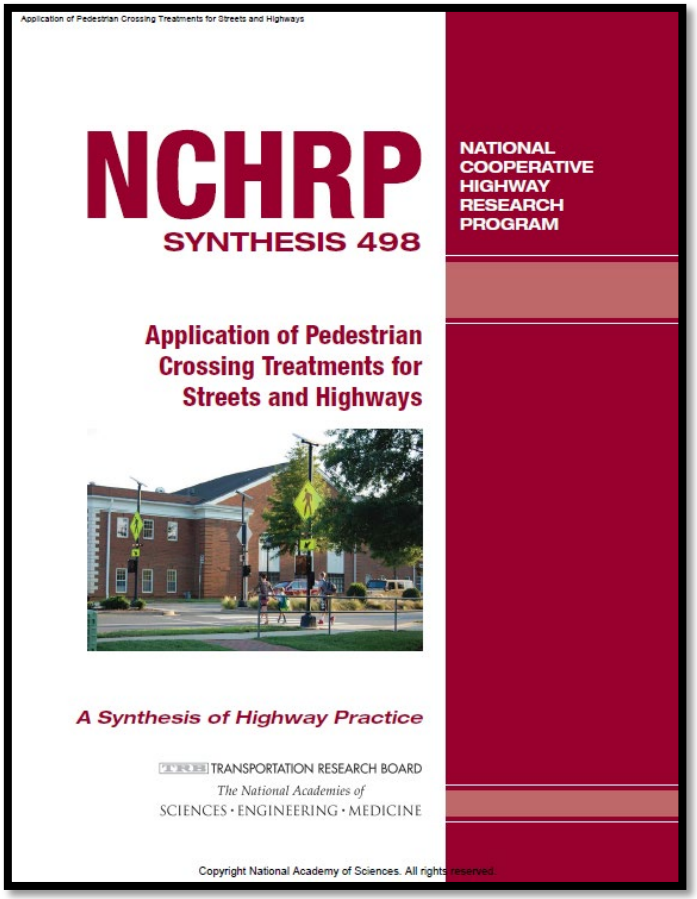
Raised Crosswalk

NCHRP 674 Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities

Raised Crosswalks
NCHRP Synthesis 498 (December 2016)

Key Measured Effects

- Lower speeds
- Improved motorist yielding at some locations
- 30% CRF for all crashes
- 36% CRF for all fatal injury crashes



http://www.trb.org/Publications/Blurbs/175419.aspx

Considerations

- May not be appropriate if street is a bus route or emergency route
  - Emergency services consulted
  - Snow plowing public works consulted
- ADA – Truncated domes for visually impaired
- Drainage
- May be inappropriate for crossings on curves or steep roadway grades
- Several raised crossings in succession may be disruptive

Raised Crosswalk

Traffic Calming ePrimer

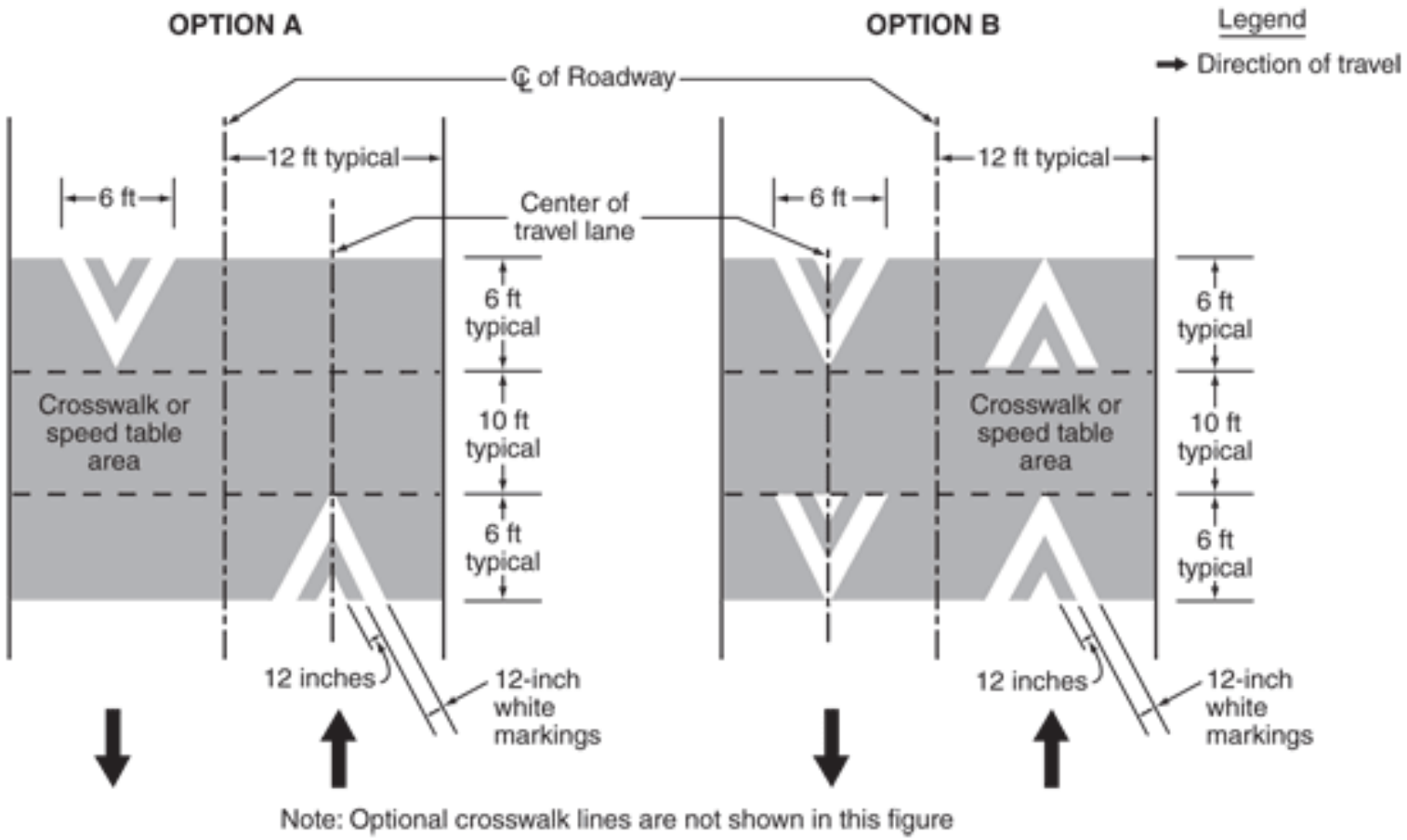
- https://safety.fhwa.dot.gov/speedmgt/traffic_calm.cfm

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)

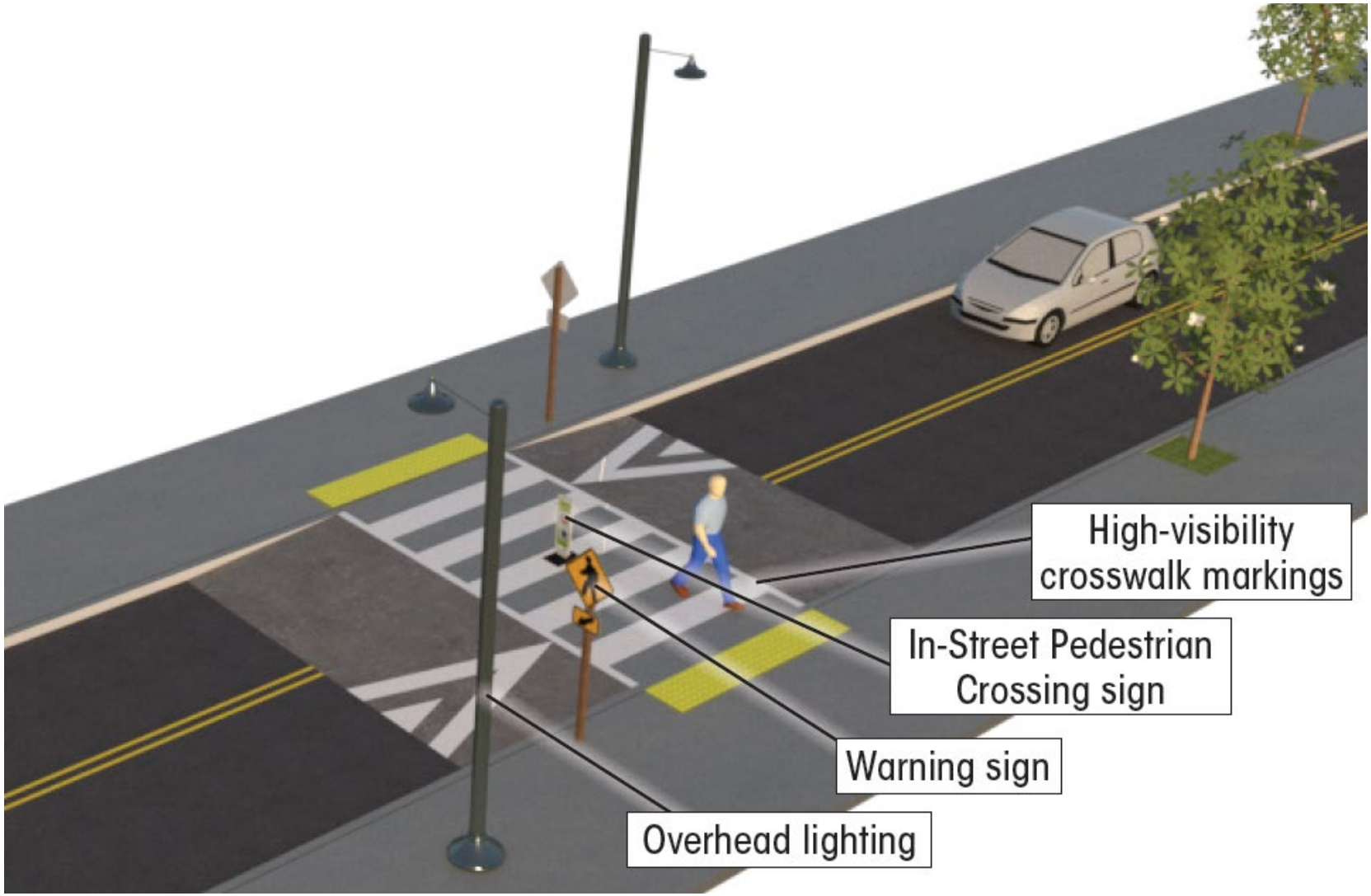
Raised Crosswalk - MUTCD

Figure 3B-30. Pavement Markings for Speed Tables or Speed Humps with Crosswalks



https://mutcd.fhwa.dot.gov/htm/2009/part3/fig3b_30_longdesc.htm

Raised Crosswalks



Spectacular Seven

- Crosswalk Visibility Enhancements
- Raised Crosswalks
- **Pedestrian Refuge Island**
- RRFB
- PHB
- Road Diets
- LPI

Pedestrian Refuge Island

SAFE TRANSPORTATION FOR EVERY PEDESTRIAN

COUNTERMEASURE TECH SHEET

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%

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.

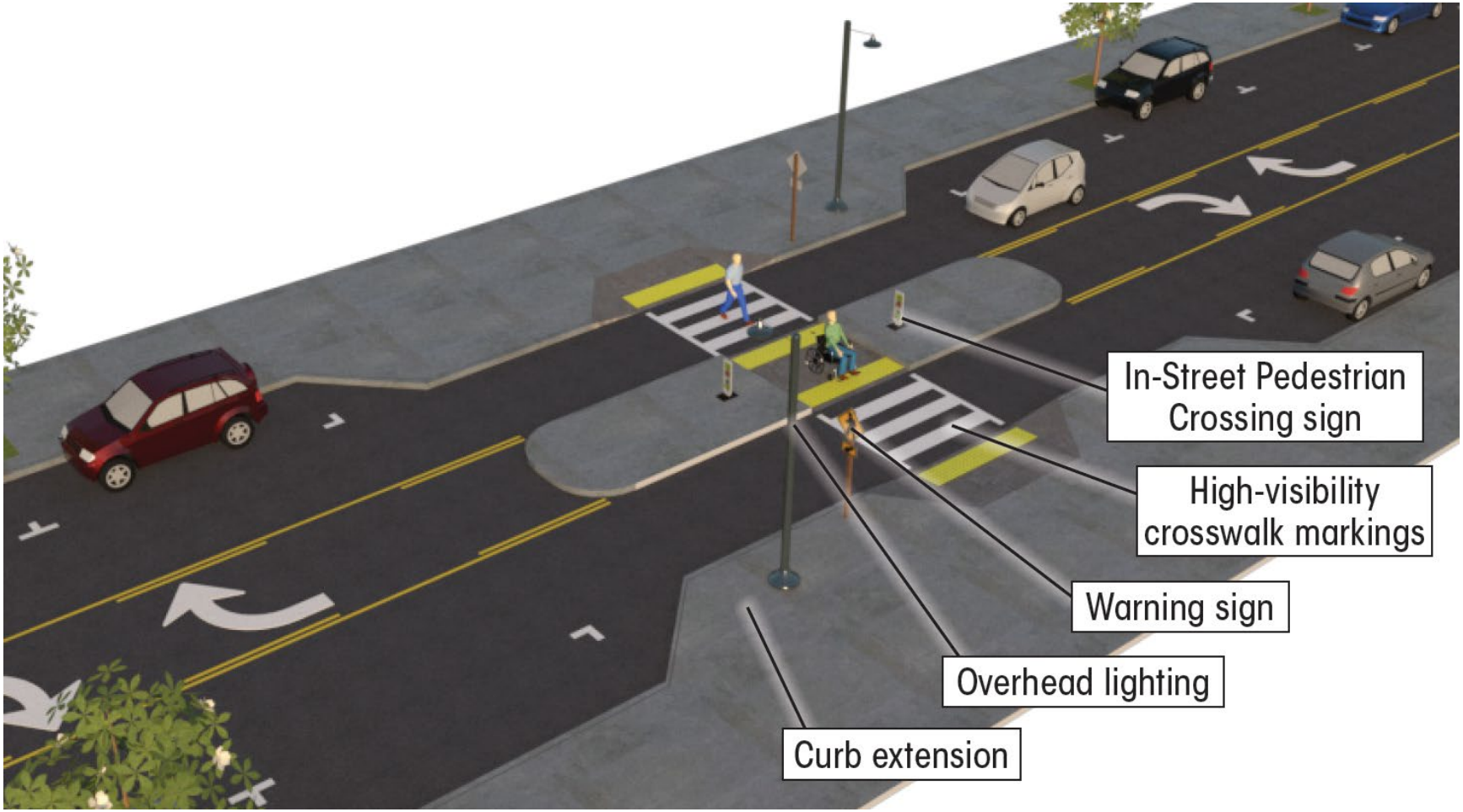
FEATURES:

- 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

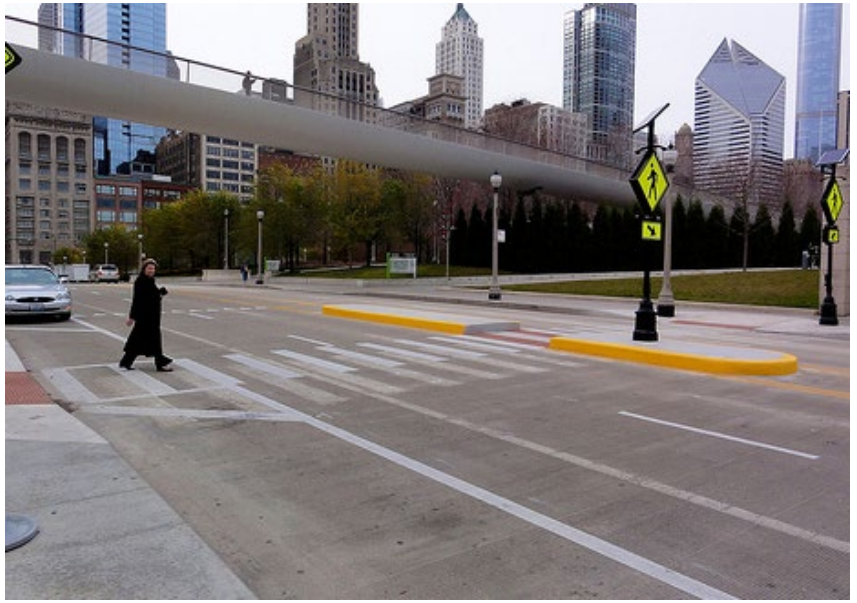
OFTEN USED WITH:

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

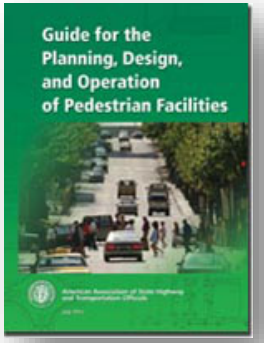
Pedestrian Refuge Islands



Pedestrian Refuge Islands



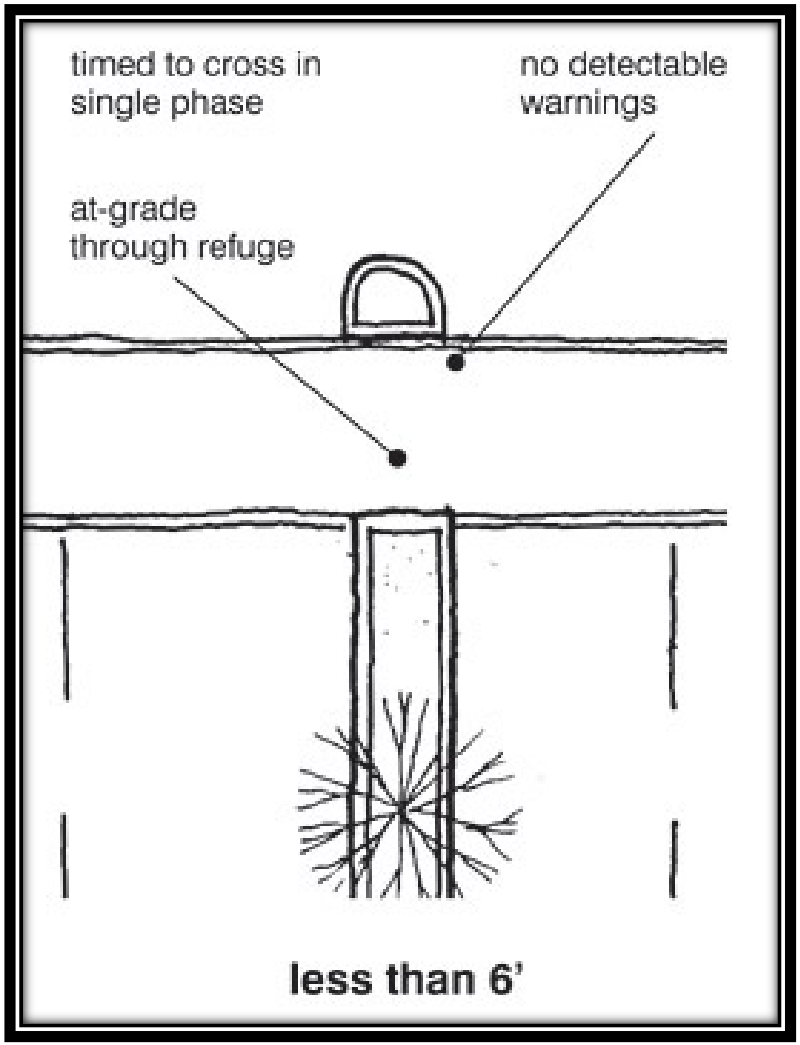
6-inch raised



- Minimum 6 feet wide
- 8 feet to accommodate bicycles, wheelchairs, scooters, and groups of pedestrians
- Length parallel to street 20 feet minimum

Medians less than 6 feet wide

- No detectable warning strips in median
- Need 2ft gap between truncated domes

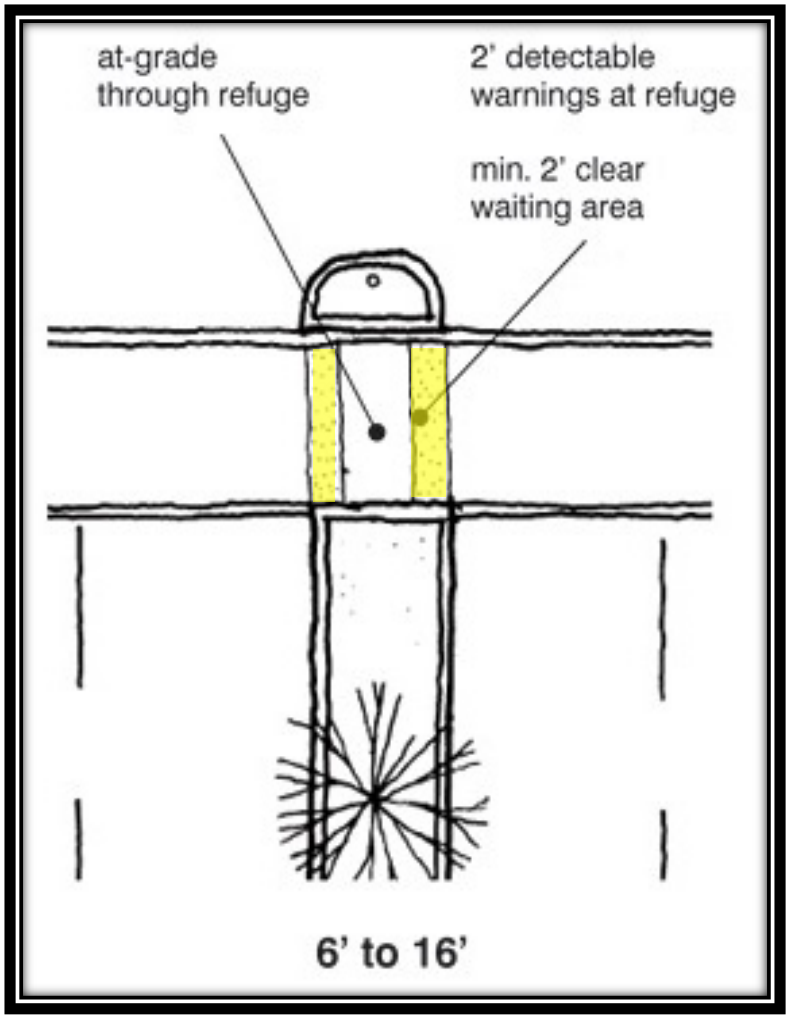


Graphic: San Francisco Better Streets Guide

Less than 6 feet median: no truncated domes

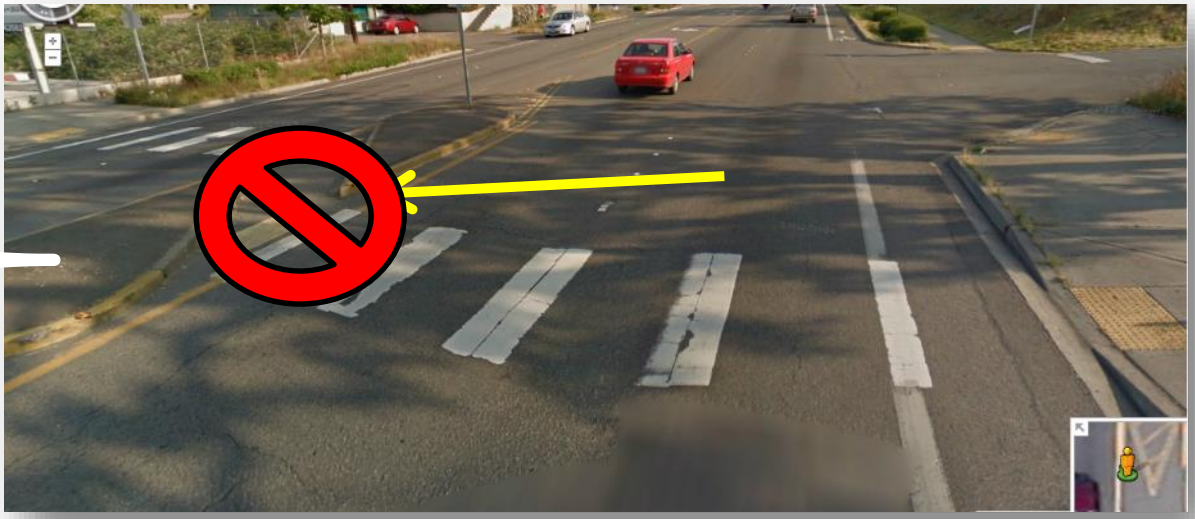
Medians between 6 and 16 feet wide

- Pathway & waiting area should be at street grade
- 2 foot wide detectable warning strips on each end
- 2 foot wide clear zone (min.) in the center



Graphic: San Francisco Better Streets Guide

Angled cut through right or wrong?



Landscaping

- Landscaping can be a positive feature
- Must not block sight lines of pedestrians and motorists at the crossing area
- Use of ground covering, low shrubs, colorful native plants

Landscaping

Hardscape treatments , patterned concrete or paver surface, may be used on splitter islands in lieu of landscaping





Case Studies
Phoenix

On-Ramp to Innovation
every day counts

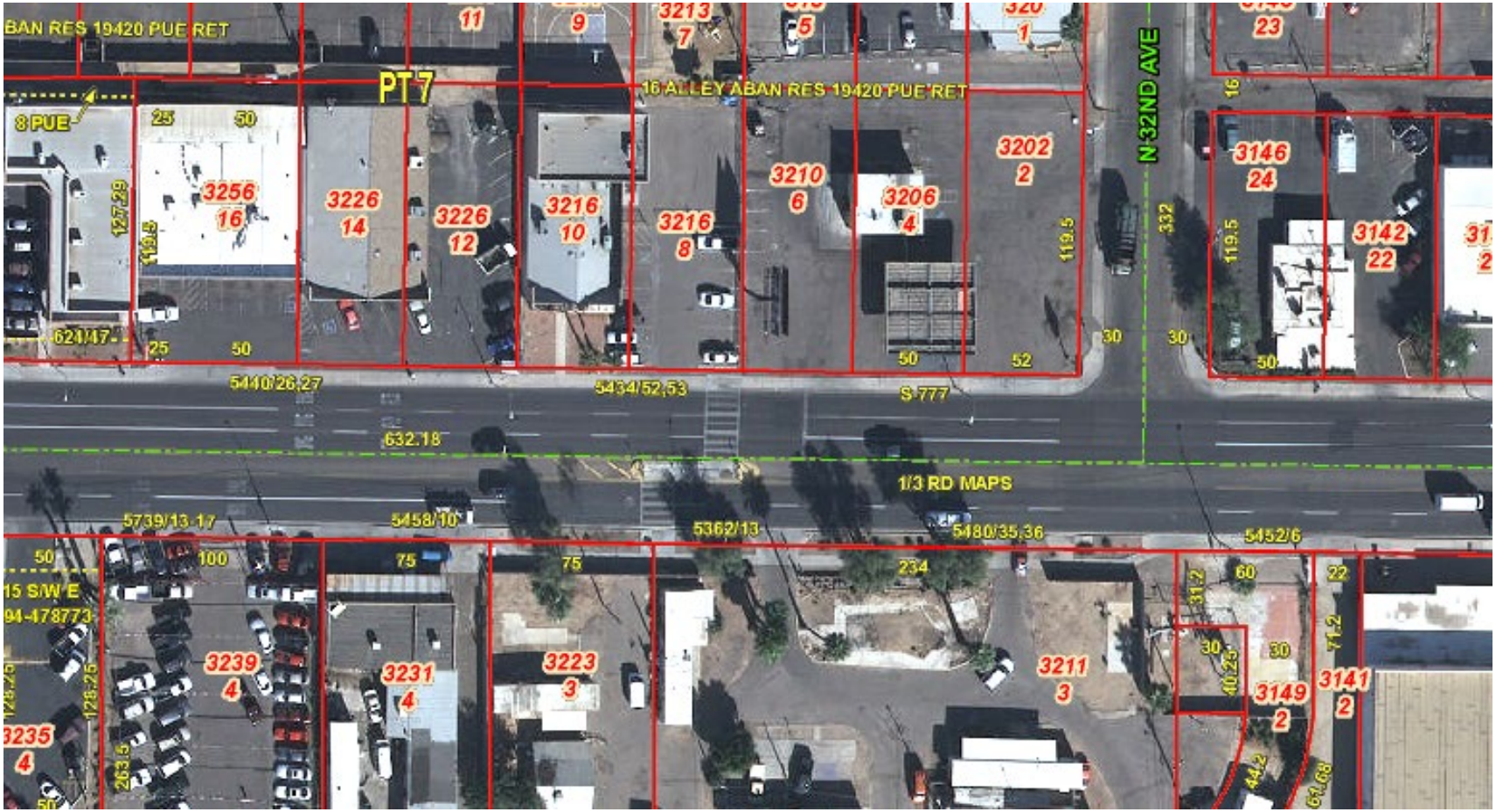
Phoenix, AZ – W. Van Buren Street. Before: 1/2-mile signal spacing; high-volume, high-speed; marked crosswalks at unsignalized intersections

Phoenix, AZ

Before: No frills marked crosswalk at intersection

Phoenix, AZ

Before: Challenging 6-lane crossing at Community Center



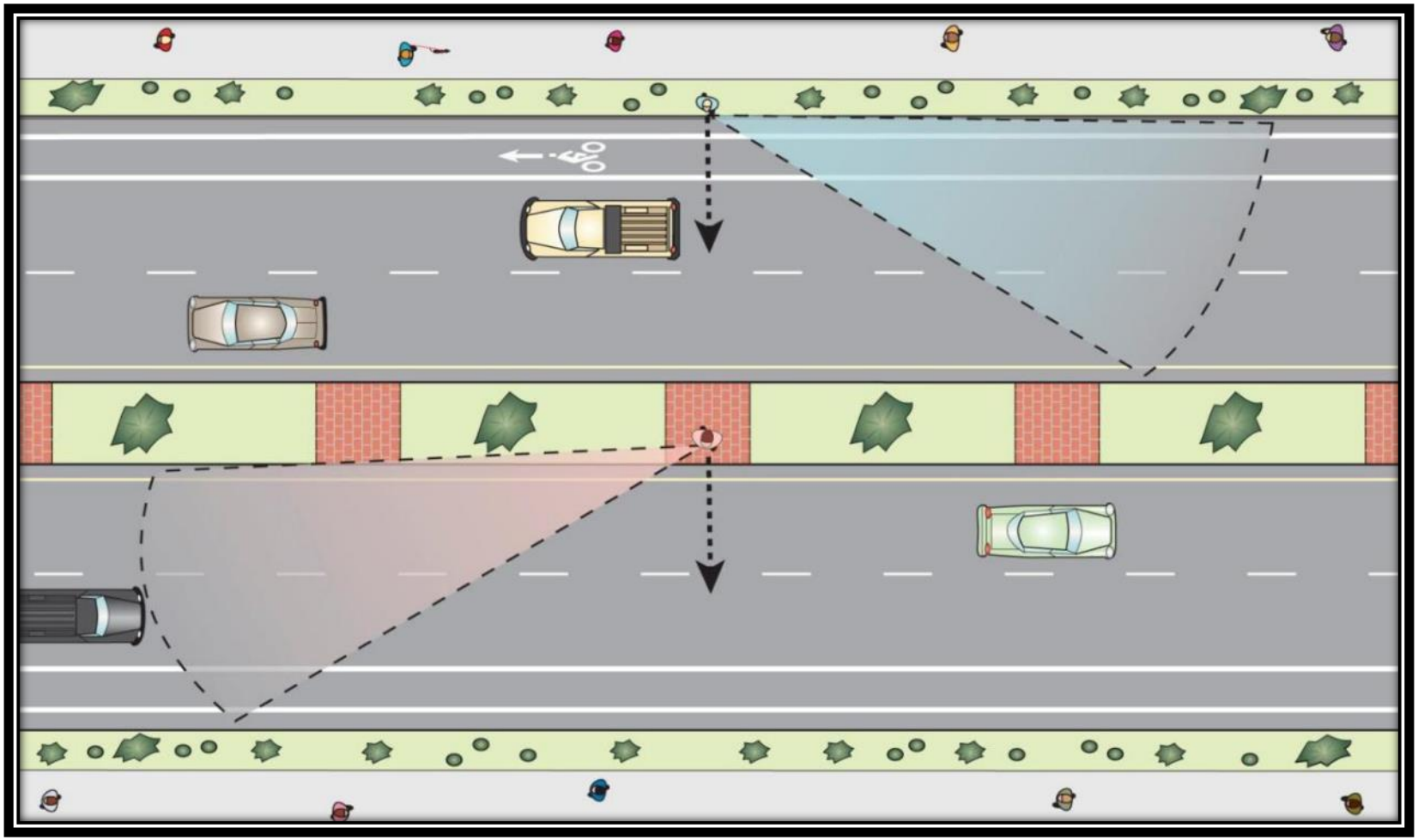
Phoenix, AZ

After: Marked crosswalk moved to midblock location near Community Center; Raised median with stagger; advance stop lines

Phoenix, AZ

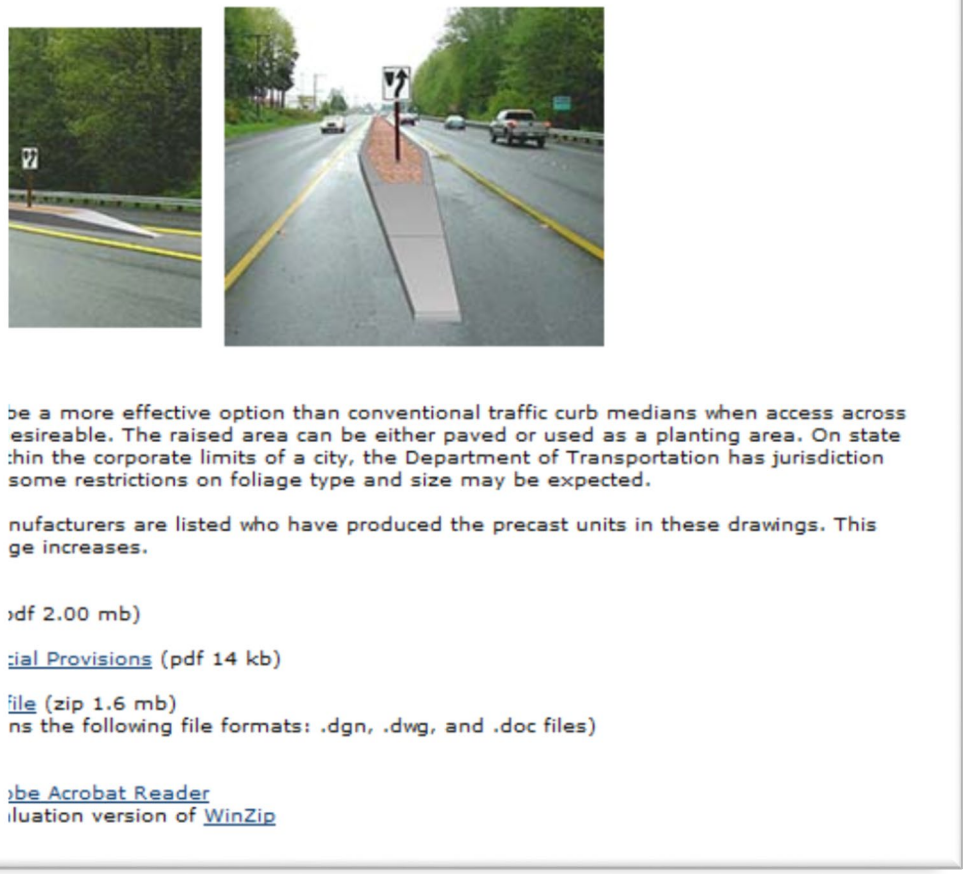
After: Raised median with stagger, Advance stop lines (not visible), Location near destination

Raised median- Breaks complex crossing into two simpler crossings



WSDOT Low profile Barrier

WSDOT standard drawings



be a more effective option than conventional traffic curb medians when access across
esireable. The raised area can be either paved or used as a planting area. On state
:hin the corporate limits of a city, the Department of Transportation has jurisdiction
some restrictions on foliage type and size may be expected.

nufacturers are listed who have produced the precast units in these drawings. This
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ns the following file formats: .dgn, .dwg, and .doc files)

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http://www.wsdot.wa.gov/Design/Standards/PlanSheet/GD-3.htm

Spectacular Seven

- Crosswalk Visibility Enhancements
- Raised Crosswalks
- Pedestrian Refuge Island
- **RRFB**
- PHB
- Road Diets
- LPI

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.

Interim Approval – Allowable Uses

- Function as pedestrian-actuated conspicuity enhancement
- Shall only be used to supplement post-mounted Pedestrian, School, Trail Crossing warning sign with diagonal downward arrow, plaque, or overhead-mounted warning sign located at or immediately adjacent to an uncontrolled marked crosswalk
- If deemed necessary by the engineer, in event of sight distance, additional RRFB may be installed in advance of crosswalk. Shall supplement not replace.

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

IA-21Beacon Operation

6. e. Flash period shall be **immediately initiated each and every time** a pedestrian is detected through passive detection or pushbutton activated, including when pedestrians are detected while RRFB's are already flashing and when pedestrians are detected immediately after the RRFB's have ceased flashing.

6. f. Small pilot light may be installed

Figure 2. View of pilot light to pedestrian at shared-use path crossing with median refuge. Enlargement of pilot light at right.

IA-21 Accessible Pedestrian Features

7. a. - If speech pushbutton information message is used locator tone shall be provided

7. b. - If speech pushbutton information message is used, the audible information device shall not use vibrotactile indications or percussive indications

7. c. - Speech pushbutton message "Yellow lights are flashing". Message should be spoken twice.

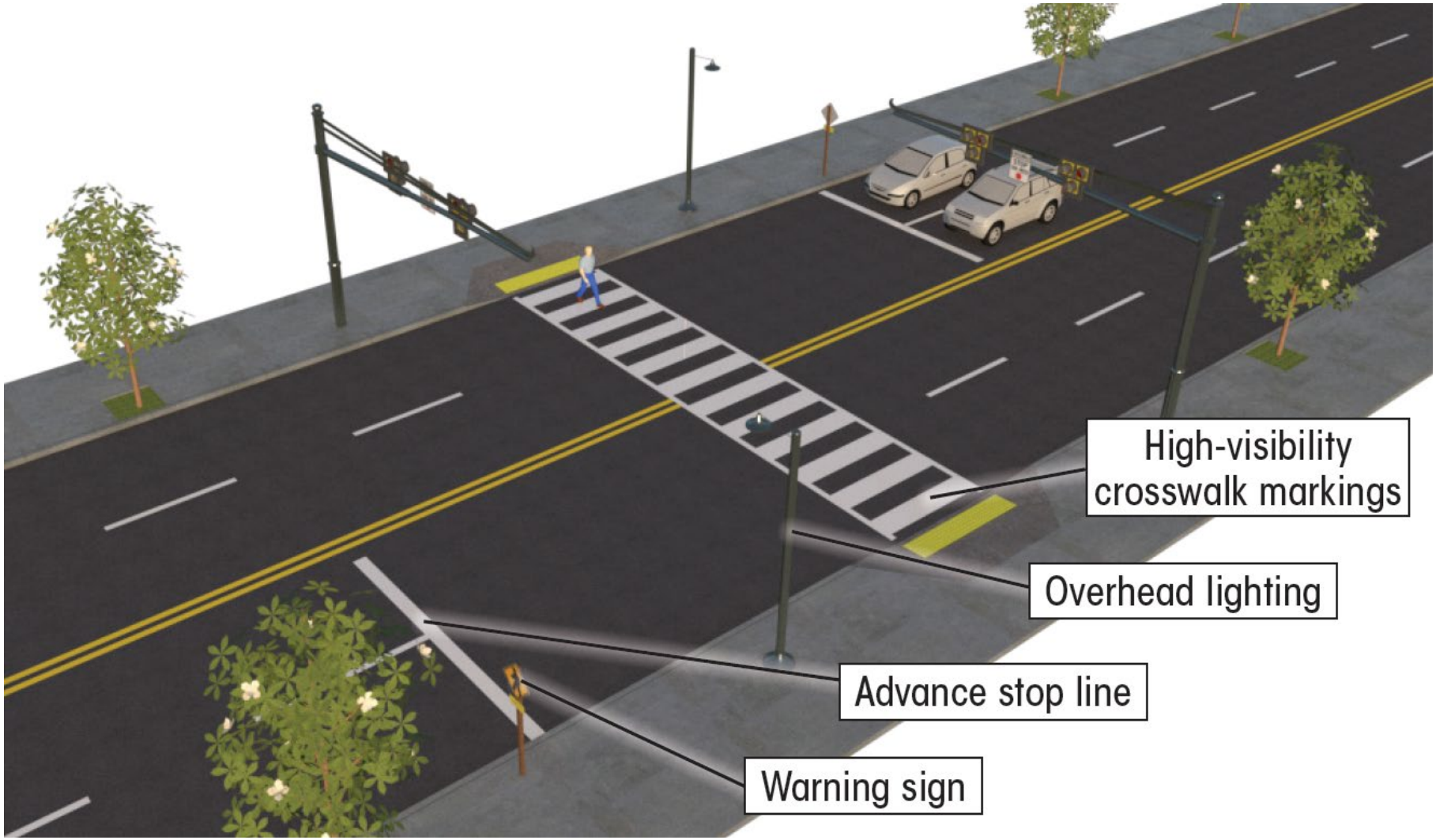
Rectangular Rapid Flash LED Beacon

- Studies indicate motorist yield rates increased from about 20% to 80%
- Higher yielding rates sustained even after two years of operation and no identifiable negative effects
  - St. Petersburg FL research report 2008

Spectacular Seven

- Crosswalk Visibility Enhancements
- Raised Crosswalks
- Pedestrian Refuge Island
- RRFB
- **PHB**
- Road Diets
- LPI

Pedestrian Hybrid Beacon



When to consider a PHB

- Pedestrians want or need to cross the high speed multilane roadways
- Crossing location doesn't meet signal warrants
- Crosswalk markings and signs just won't do
  - if there are any at all
- Pedestrians complain or crash data shows a problem

Pedestrian Hybrid Beacon

Pedestrian Hybrid Beacons (PHB)

CRF: Vehicle/Pedestrian 69%

1

Blank for drivers

2

Flashing yellow

3

Steady yellow

4

Steady red

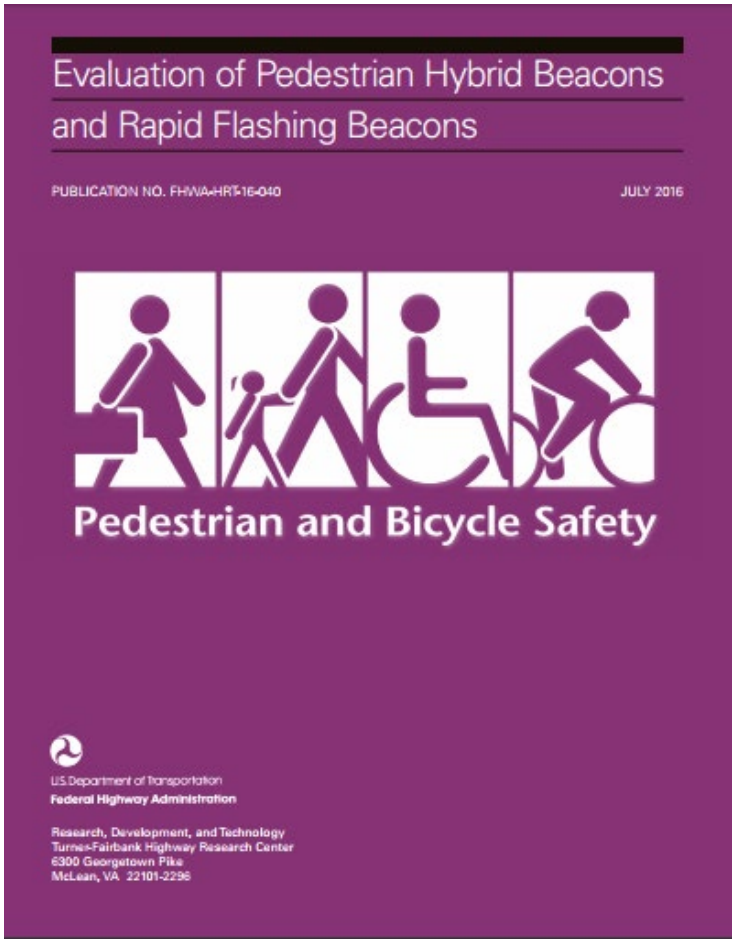
5

Wig-Wag

Return to 1

Research of PHB

- 20 PHB sites open-road study
- Driver yielding to pedestrians avg. 96%
- Overall, 91% pedestrians pushed pushbutton to activate the PHB in the crosswalk
- A greater percentage of pedestrians activated the device when on 45 mph posted speed limit roads as compared to roads with posted speed limits of 40 mph or less



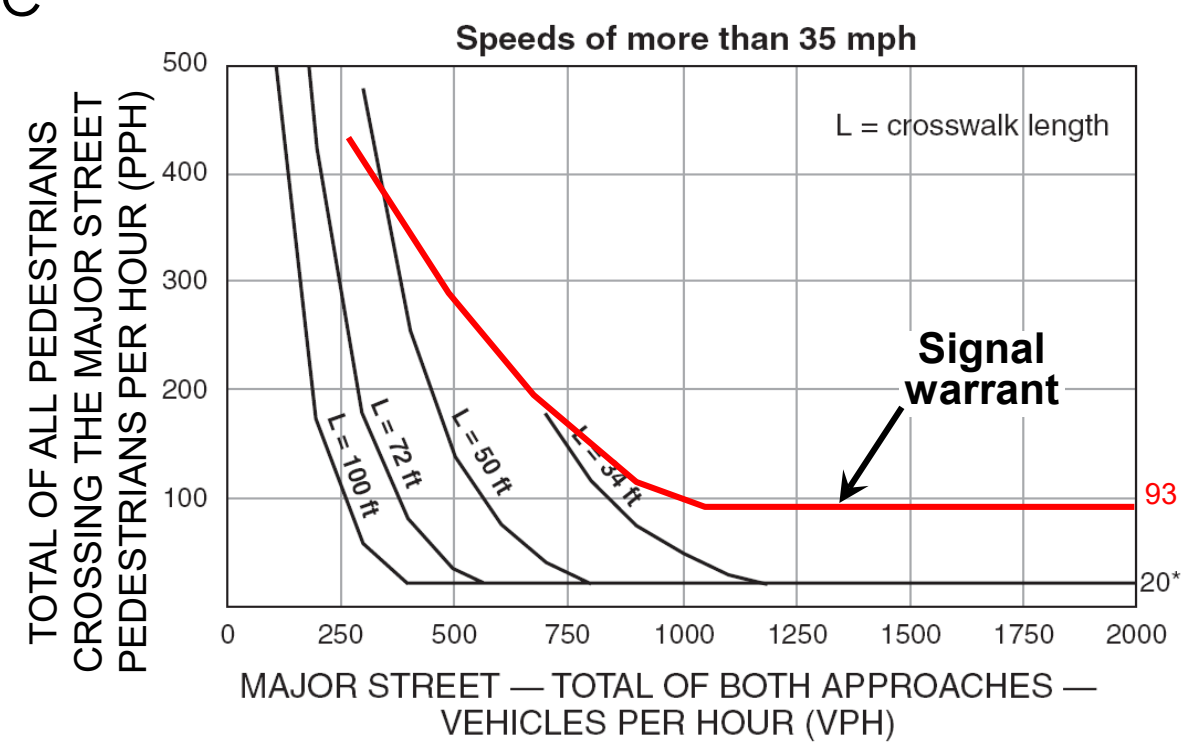
https://www.fhwa.dot.gov/publications/research/safety/16040/16040.pdf

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:

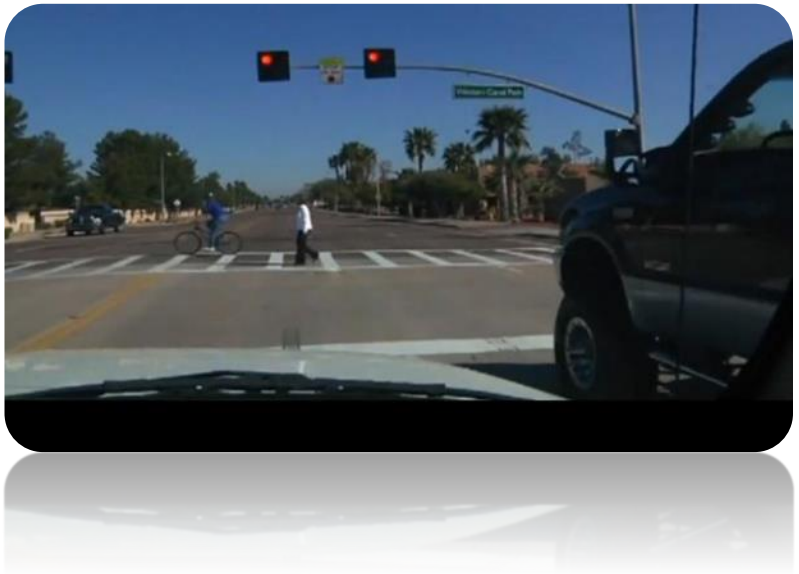
- Pedestrian volume
- Traffic speeds
- Traffic volumes
- Crosswalk length



MUTCD Section 4F.01

Standard:

- If used, PHBs shall be used in conjunction with signs and pavement markings to warn and control traffic.
- A PHB shall only be installed at a marked crosswalk.



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

Optional Signing

MUTCD – PHB & Intersections

Section 4F.02, paragraph 04

Guidance:

- "When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then the PHB should be installed at least 100 feet from side streets or driveways controlled by STOP or YIELD signs."

"Guidance" not a "Standard"

NCUTCD voted to remove that Guidance.

Proposed Standard for next MUTCD:

- "If a pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a side road, vehicular traffic on the side road shall be controlled by STOP signs."

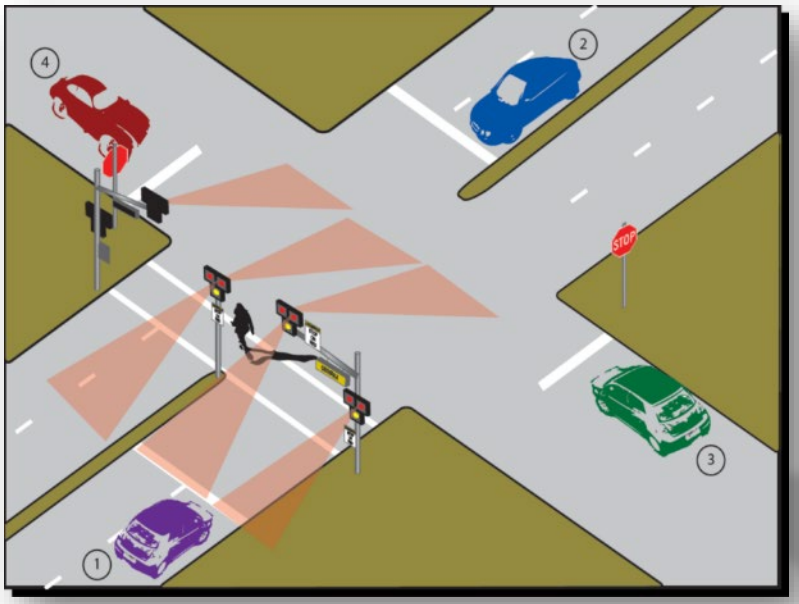
MUTCD - PHB & Intersections

- "Guidance" not based on research from Tucson, AZ where PHB (HAWK) was developed
  - (HAWKs in TTI study were at local street intersections)
- 2009 MUTCD "Guidance" was not a part of the Preliminary Rulemaking
- Some State supplements have eliminated the "Guidance" statement (Arizona)
- Ultimate decision up to FHWA

One or Two crossing(s) at intersections

If used at an intersection or driveway, the PHB crossing and signal equipment should only control one crossing

- ITE Traffic Control Devices Handbook



PHB Florida Success Story

FDOT D7 installed three PHBs along Hillsborough Ave in the Fall of 2015.

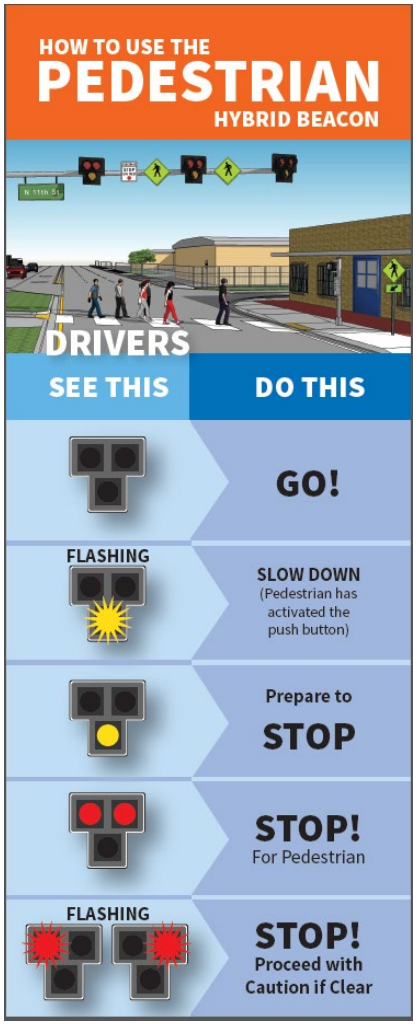
Hillsborough Ave Preliminary Crash Data

Hillsborough Ave Bicycle and Pedestrian Crashes	
Year	Crashes
2010	17
2011	20
2012	27
2013	24
2014	14
2015	19
2016	7

PHB Installed Fall of 2015

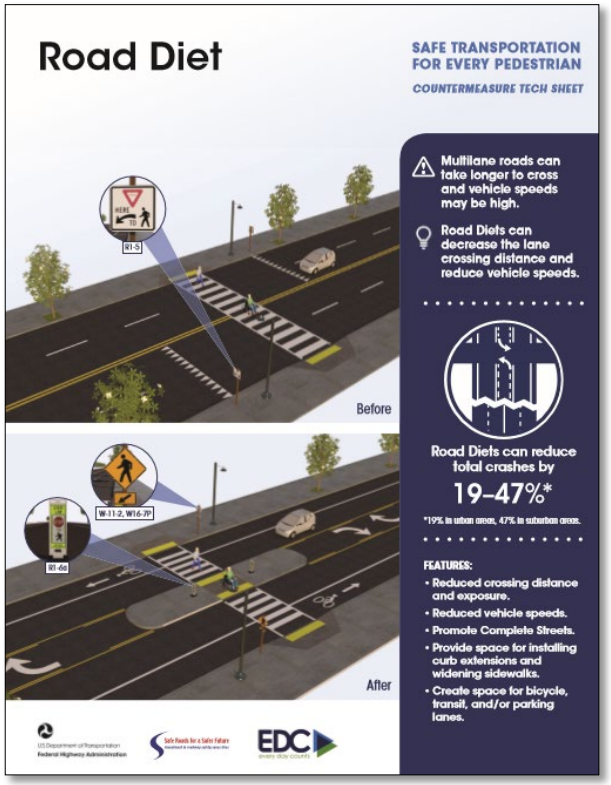
Six year average 20 crashes per year

Education Campaign



Spectacular Seven

- Crosswalk Visibility Enhancements
- Raised Crosswalks
- Pedestrian Refuge Island
- RRFB
- PHB
- **Road Diets**
- LPI



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

Road Diet CMF = 0.47 & 0.71
CRF = 53% & 29%

▼ Countermeasure: Converting four-lane roadways to three-lane roadways with center turn lane (road diet)

CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.47	53	★★★★☆	All	All	Suburban	Persaud et. al, 2010	

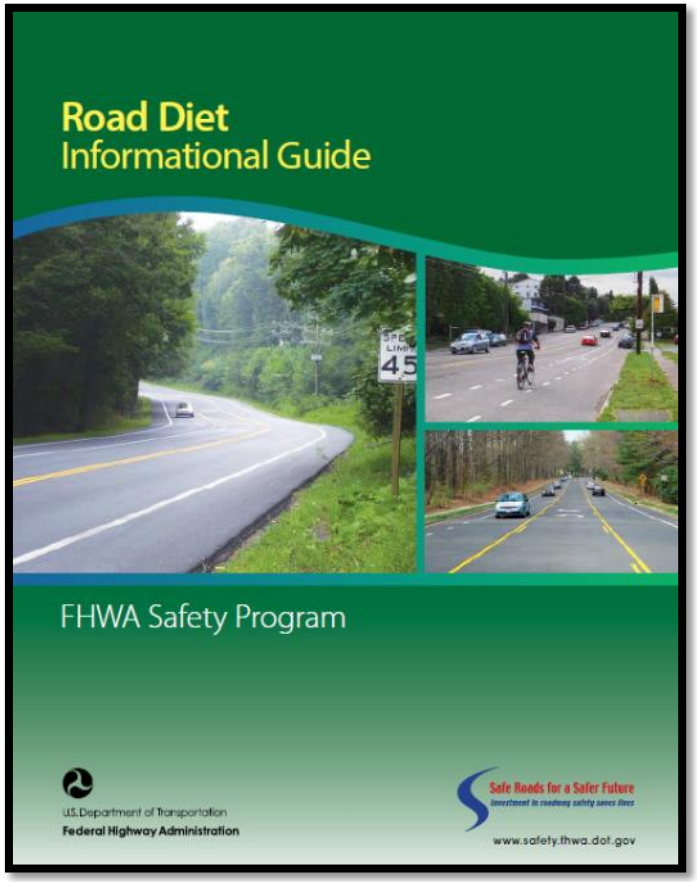
▼ Countermeasure: Road diet (Convert 4-lane undivided road to 2-lanes plus turning lane)

CMF	CRF (%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
0.71 [B]	29	★★★★★	All	All	Urban	Harkey et al., 2008	

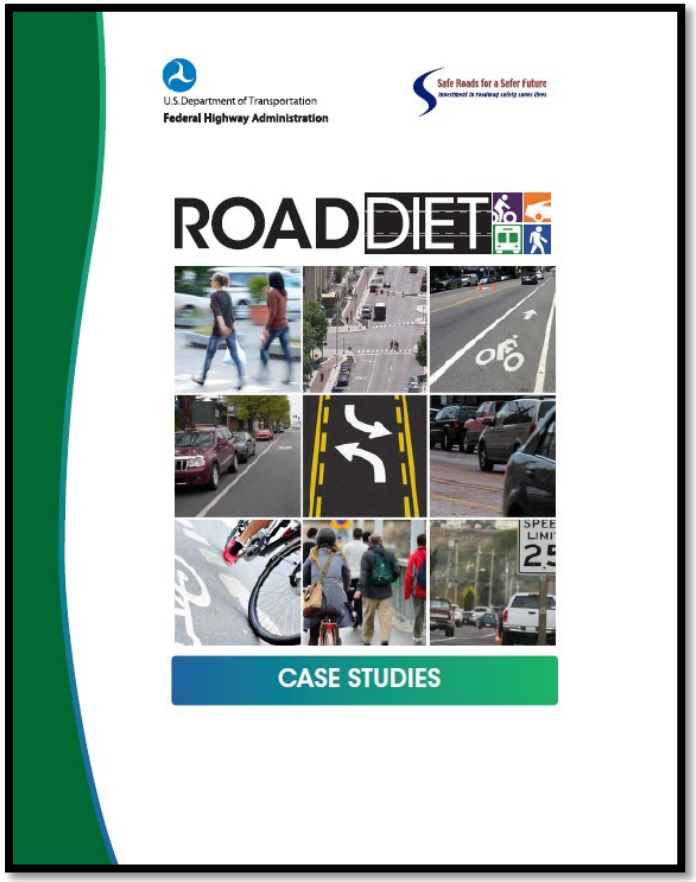
Source: CMF Clearinghouse www.cmfclearinghouse.org

Implementing Road Diets in New Jersey video

Road Diet Informational Guide & Road Diet Case Studies



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



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

New Jersey Road Diet

https://www.youtube.com/watch?v=lm_zrAfRj20

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

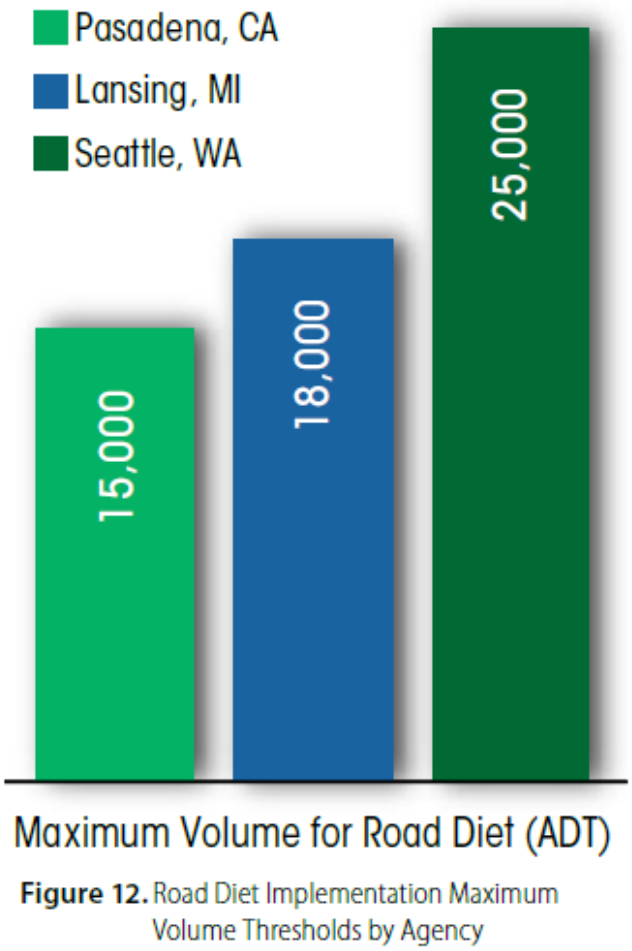


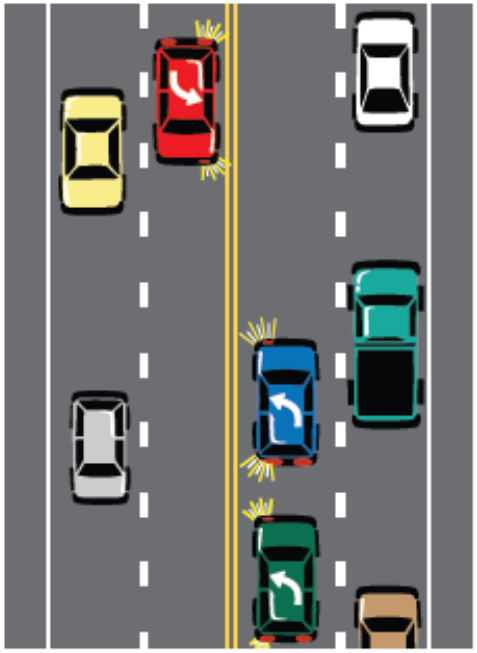
Figure 12. Road Diet Implementation Maximum Volume Thresholds by Agency

Considerations

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

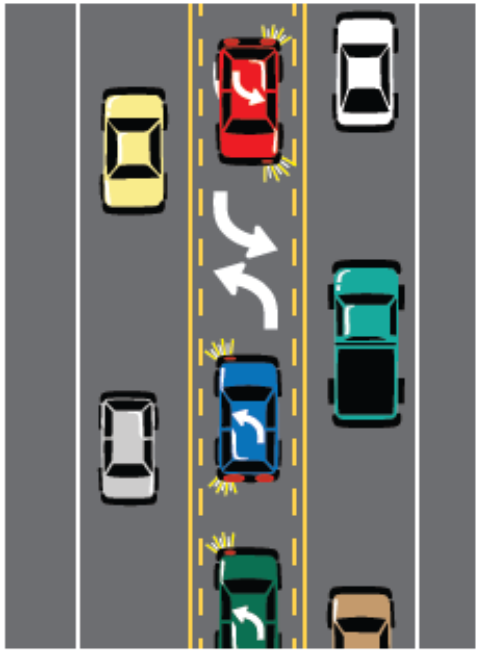
A four-lane roadway may already operate like a three-lane road.

Some four-lane roads operate essentially like a three-lane road (defacto one lane in each direction) and do not experience a reduction in capacity.



Before

A four-lane undivided road operating as a de facto three-lane cross section.



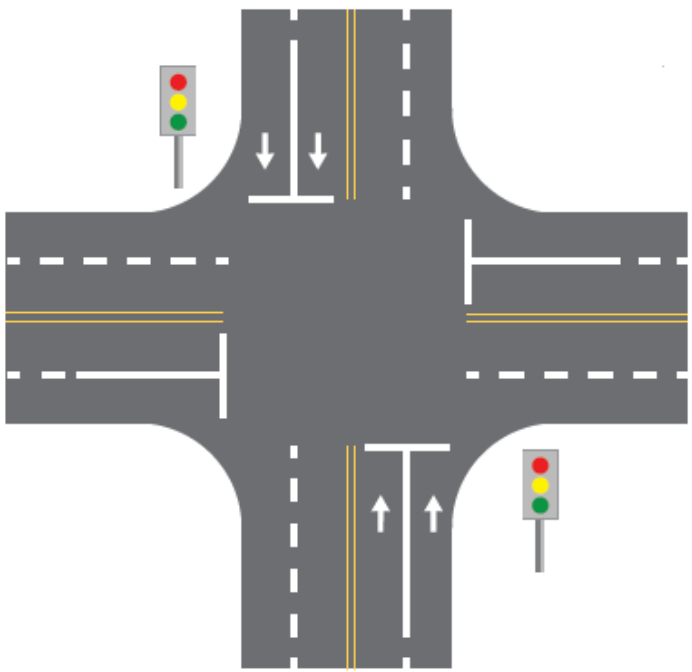
After

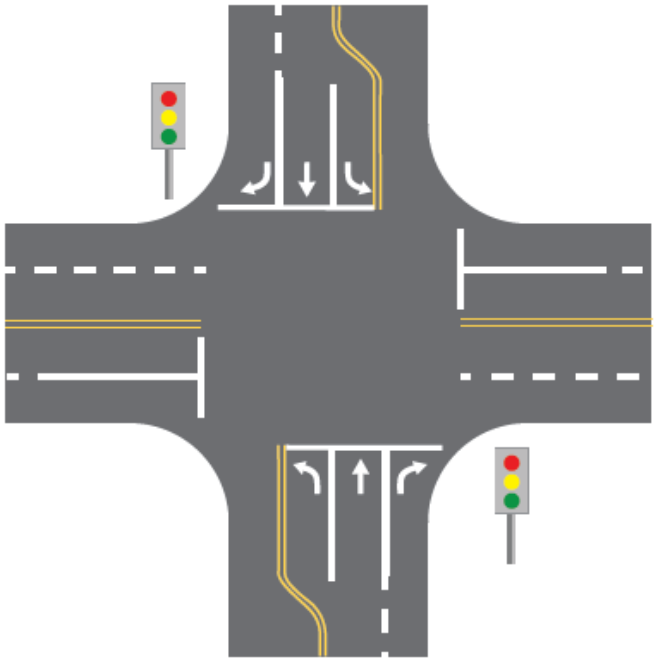
A Road Diet providing a two-way left-turn lane.

When a corridor contains a large number of access points (driveways) the majority of through traffic will tend to utilize the outside lanes to avoid being delayed by left-turning vehicles slowing and stopping in the inside lanes.

Intersections “Control” Capacity

Converting four through lanes to two through lanes may make it possible to install dedicated turn lanes at the intersection





Example of intersection with added turning movements.

Intersections

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

LaJolla Blvd – Bird Rock Community (San Diego, CA)

Prior to 2003, La Jolla Boulevard was a four-lane boulevard moving 20,000 cars per day with average speeds of 38-42 mph.

The roadway configuration and speed of traffic created a setting uninviting for pedestrians and unable to stimulate growth among local businesses.

In response to numerous community members demanding a safer walking environment, the City of San Diego, in partnership with the community, embarked upon a project to improve safety along the boulevard.

Source: Arnold, M., Chui, G., and Lupo, D., P.E. "Roundabout Product Demonstration Showcase" Presentation on December 10, 2008, City of San Diego Engineering & Capital Projects Department

LaJolla Blvd – San Diego, CA

LaJolla Blvd – Bird Rock Community (San Diego, CA)

Narrower travel lanes, five roundabouts, landscaped medians and angled parking have slowed traffic speeds, improved pedestrian safety, and also revitalized the businesses!!!

LaJolla Blvd – Photo Credit: Mark Doctor FHWA



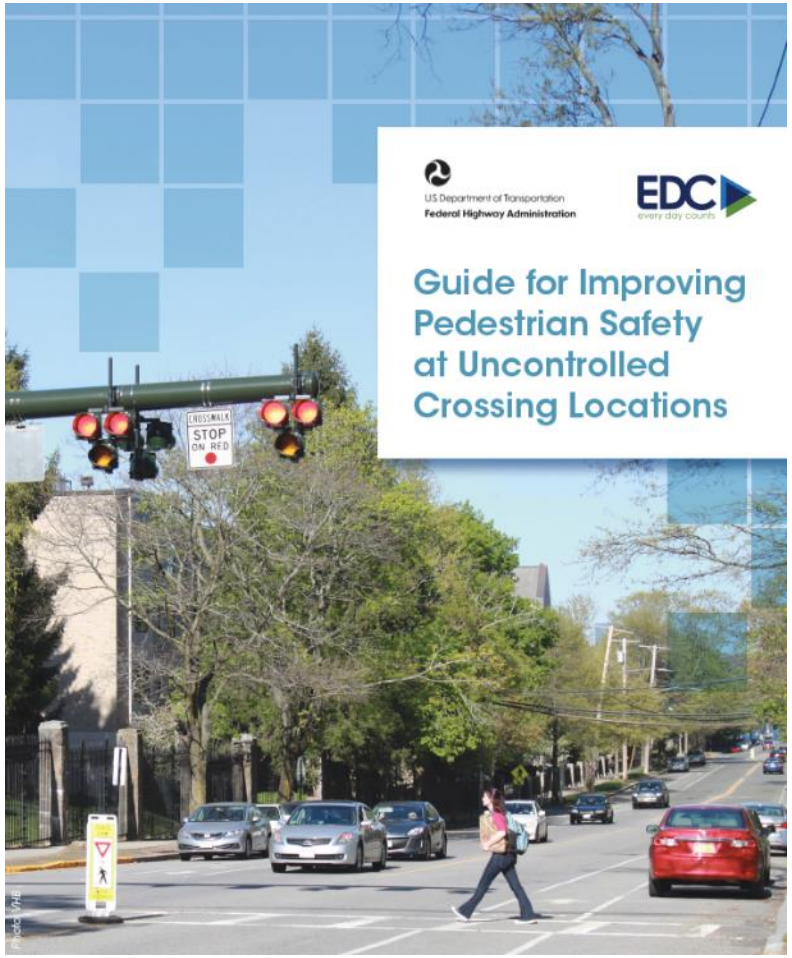


Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

On-Ramp to Innovation
every day counts

FHWA Guide

- Provides guidance and suggested process for selecting countermeasures
- Assists agencies in developing a policy to support the installation of countermeasures at uncontrolled crossing locations



www.fhwa.dot.gov/innovation/everydaycounts/edc_4/guide_to_improve_uncontrolled_crossings.pdf

Countermeasure Selection Process

Following the process suggested in the guide offers countermeasure options based on road conditions, crash causes, and pedestrian safety issues.

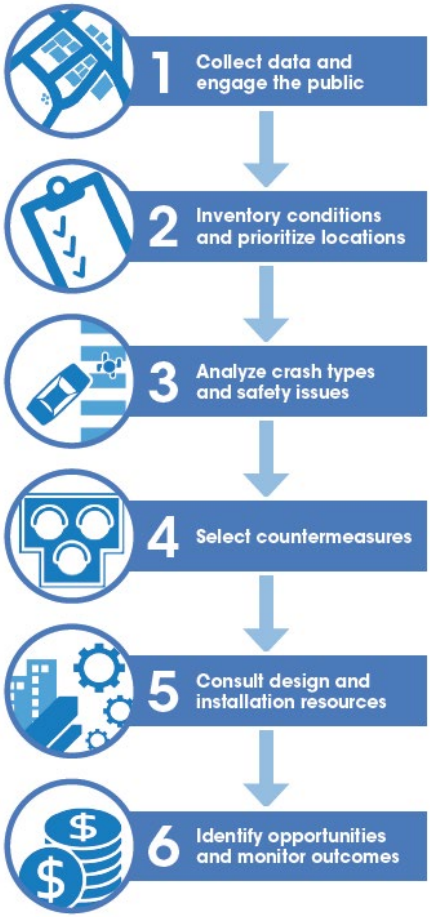


Figure 1. Process diagram for selecting countermeasures at uncontrolled pedestrian crossing locations.

1 Collect data and engage the public

- Collect pedestrian crash and safety data
- Evaluate pedestrian accommodation policies
- Initiate a Pedestrian Safety Action Plan
- Review pedestrian and traffic safety plans
- Conduct a walkability audit

Planning for Crosswalks

Common Crosswalk Myths

MYTH: There is an MUTCD pedestrian volume warrant for marked crosswalks.

REALITY: There is no pedestrian volume requirement to mark a crosswalk in the MUTCD.

MYTH: Research supports the removal of crosswalks.

REALITY: Marked crosswalks should not be removed without a plan for improving safety.

MYTH: Not marking a crosswalk is safer than marking a crosswalk.

REALITY: Pedestrians can be expected to cross most types of roadways, with or without marked crosswalks. Research demonstrates that marked crosswalks alone along high-volume or high-speed roadways are generally not sufficient to improve pedestrian safety.

- Inventory pedestrian crossings and observed traffic behavior
- Classify pedestrian crossings: controlled vs uncontrolled
- Inventory roadway characteristics
- Screen the network for high-crash or high-risk locations

Field Guide

Sample Inventory Form

Worksheets for each countermeasure:

- Definition
- Roadway conditions checklist
- Safety issues checklist
- Installation guidelines and MUTCD references

Roadway Conditions Inventory

Speed Limit

☐ ≤ 30 mph ☐ 35 mph ☐ ≥ 40 mph

Total Vehicles per Day

Annual Average Daily Traffic (AADT): _____

Approximate Vehicles per Hour (VPH): _____

☐ AADT < 9,000
☐ AADT 9,000–15,000
☐ AADT > 15,000

Travel Lane Configuration

☐ 2 lanes without raised median
☐ 3 lanes without raised median
☐ 3 lanes with raised median
☐ 4+ lanes without raised median
☐ 4+ lanes with raised median

Crosswalk Length (feet): _____

Approximate Total Pedestrians per Hour (PPH) Crossing the Roadway: _____

Pedestrian Safety Issues Inventory

Noted conflicts at crossing locations ☐ Yes ☐ No

» History of turning movement crashes
» Observed conflicts at permitted crossings

Excessive vehicle speed ☐ Yes ☐ No

» 85th percentile speeds, per speed study
» History of speed-related crashes

Inadequate conspicuity/visibility ☐ Yes ☐ No

» Dim or dark conditions for pedestrians in the crosswalk
» Limited visibility of crosswalk due to roadway curvature or topography
» Obstructions, such as on-street parking, vegetation, and signage

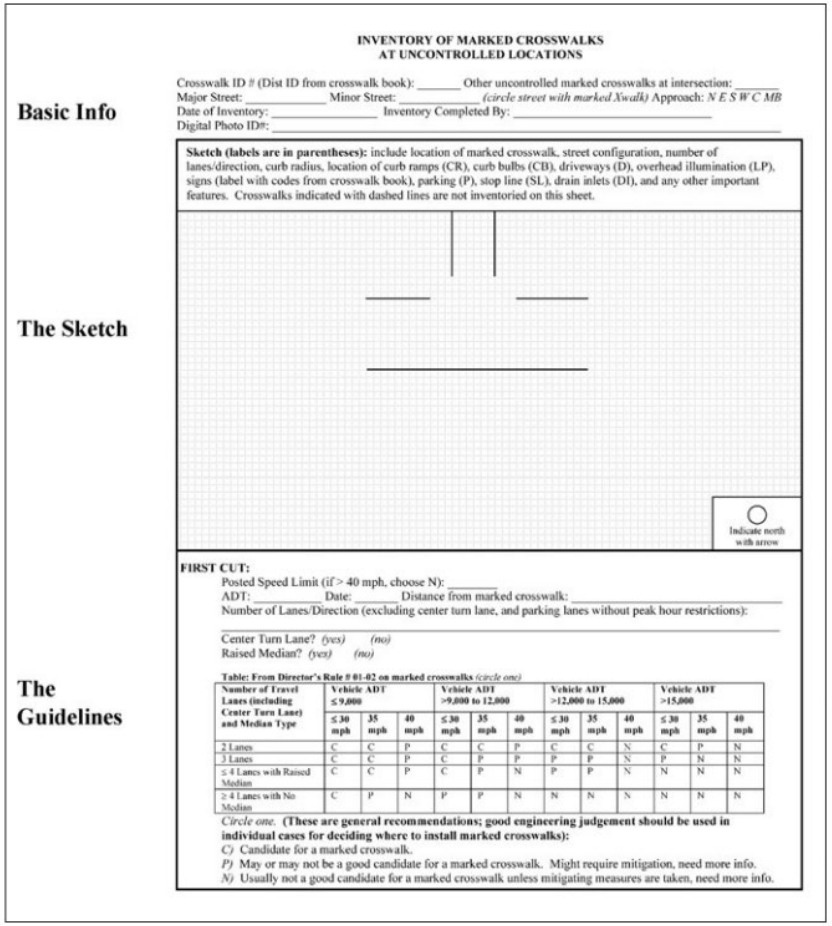
Drivers not yielding to pedestrians in crosswalks ☐ Yes ☐ No

» Crash history in marked crosswalks

Insufficient separation between pedestrians and traffic ☐ Yes ☐ No

» Long crossing distance
» No buffer (e.g., landscape buffer, on-street parking, bike lanes)

Crosswalk Inventory Form Ex. Seattle



INVENTORY OF MARKED CROSSWALKS AT UNCONTROLLED LOCATIONS

Basic Info

Crosswalk ID # (Dist ID from crosswalk book): _____ Other uncontrolled marked crosswalks at intersection: _____
Major Street: _____ Minor Street: _____ *(circle street with marked Xwalk)* Approach: *N E S W C MB*
Date of Inventory: _____ Inventory Completed By: _____
Digital Photo ID#: _____

The Sketch

Sketch (labels are in parentheses): include location of marked crosswalk, street configuration, number of lanes/direction, curb radius, location of curb ramps (CR), curb bulbs (CB), driveways (D), overhead illumination (LP), signs (label with codes from crosswalk book), parking (P), stop line (SL), drain inlets (DI), and any other important features. Crosswalks indicated with dashed lines are not inventoried on this sheet.

Indicate north with arrow

The Guidelines

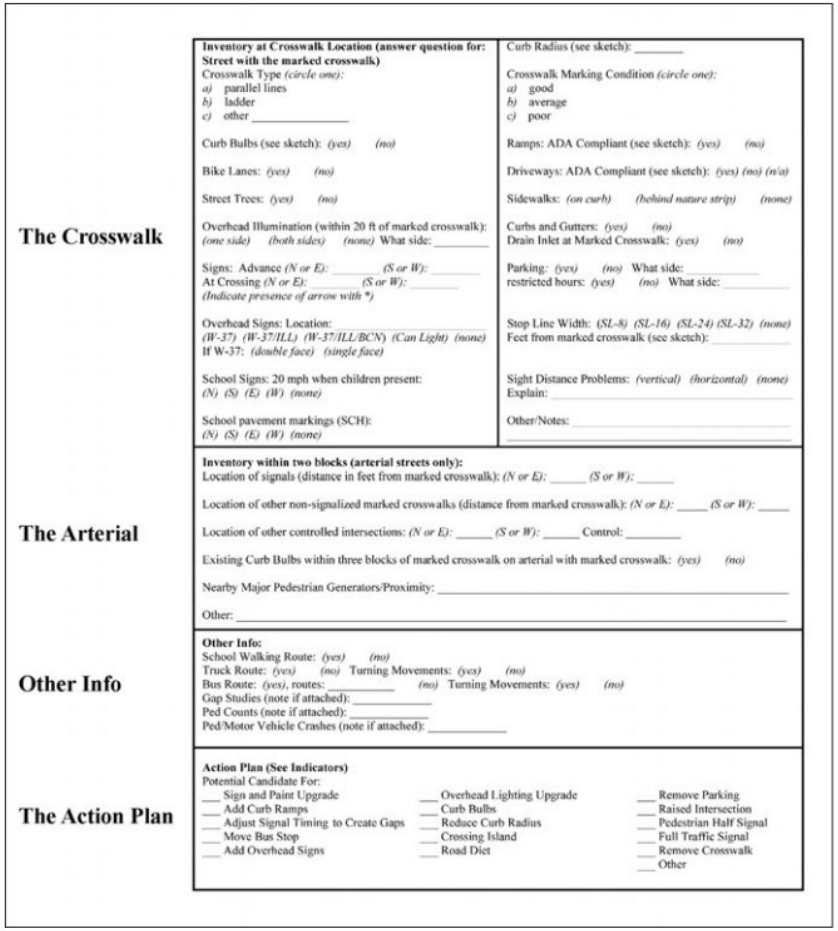
FIRST CUT:
Posted Speed Limit (if > 40 mph, choose N): _____
ADT: _____ Date: _____ Distance from marked crosswalk: _____
Number of Lanes/Direction (excluding center turn lane, and parking lanes without peak hour restrictions): _____
Center Turn Lane? *(yes)* *(no)*
Raised Median? *(yes)* *(no)*

Table: From Director's Rule # 01-02 on marked crosswalks *(circle one)*

Number of Travel Lanes (including Center Turn Lane) and Median Type	Vehicle ADT ≤ 9,000			Vehicle ADT >9,000 to 12,000			Vehicle ADT >12,000 to 15,000			Vehicle ADT >15,000		
	≤ 30 mph	35 mph	40 mph	≤ 30 mph	35 mph	40 mph	≤ 30 mph	35 mph	40 mph	≤ 30 mph	35 mph	40 mph
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
≤ 4 Lanes with Raised Median	C	C	P	C	P	N	P	P	N	N	N	N
≥ 4 Lanes with No Median	C	P	N	P	P	N	N	N	N	N	N	N

Circle one. **(These are general recommendations; good engineering judgement should be used in individual cases for deciding where to install marked crosswalks):**
C) Candidate for a marked crosswalk.
P) May or may not be a good candidate for a marked crosswalk. Might require mitigation, need more info.
N) Usually not a good candidate for a marked crosswalk unless mitigating measures are taken, need more info.

Figure 1. An inventory form was developed for the City of Seattle's inventory of marked crosswalks at uncontrolled locations. Page one is shown.



The Crosswalk

Inventory at Crosswalk Location (answer question for: Street with the marked crosswalk)
Crosswalk Type *(circle one)*:
a) parallel lines
b) ladder
c) other _____

Curb Bulbs (see sketch): *(yes)* *(no)*

Bike Lanes: *(yes)* *(no)*

Street Trees: *(yes)* *(no)*

Overhead Illumination (within 20 ft of marked crosswalk): *(one side)* *(both sides)* *(none)* What side: _____

Signs: Advance *(N or E)*: _____ *(S or W)*: _____
At Crossing *(N or E)*: _____ *(S or W)*: _____
*(Indicate presence of arrow with *)*

Overhead Signs: Location: _____
(W-37) *(W-37/ILL)* *(W-37/ILL/BCN)* *(Can Light)* *(none)*
If W-37: *(double face)* *(single face)*

School Signs: 20 mph when children present:
(N) *(S)* *(E)* *(W)* *(none)*

School pavement markings (SCH):
(N) *(S)* *(E)* *(W)* *(none)*

Curb Radius (see sketch): _____

Crosswalk Marking Condition *(circle one)*:
a) good
b) average
c) poor

Ramps: ADA Compliant (see sketch): *(yes)* *(no)*

Driveways: ADA Compliant (see sketch): *(yes)* *(no)* *(n/a)*

Sidewalks: *(on curb)* *(behind nature strip)* *(none)*

Curbs and Gutters: *(yes)* *(no)*
Drain Inlet at Marked Crosswalk: *(yes)* *(no)*

Parking: *(yes)* *(no)* What side: _____
restricted hours: *(yes)* *(no)* What side: _____

Stop Line Width: *(SL-8)* *(SL-16)* *(SL-24)* *(SL-32)* *(none)*
Feet from marked crosswalk (see sketch): _____

Sight Distance Problems: *(vertical)* *(horizontal)* *(none)*
Explain: _____

Other/Notes: _____

The Arterial

Inventory within two blocks (arterial streets only):
Location of signals (distance in feet from marked crosswalk): *(N or E)*: _____ *(S or W)*: _____

Location of other non-signalized marked crosswalks (distance from marked crosswalk): *(N or E)*: _____ *(S or W)*: _____

Location of other controlled intersections: *(N or E)*: _____ *(S or W)*: _____ Control: _____

Existing Curb Bulbs within three blocks of marked crosswalk on arterial with marked crosswalk: *(yes)* *(no)*

Nearby Major Pedestrian Generators/Proximity: _____

Other: _____

Other Info

Other Info:
School Walking Route: *(yes)* *(no)*
Truck Route: *(yes)* *(no)* Turning Movements: *(yes)* *(no)*
Bus Route: *(yes)*, routes: _____ *(no)* Turning Movements: *(yes)* *(no)*
Gap Studies (note if attached): _____
Ped Counts (note if attached): _____
Ped/Motor Vehicle Crashes (note if attached): _____

The Action Plan

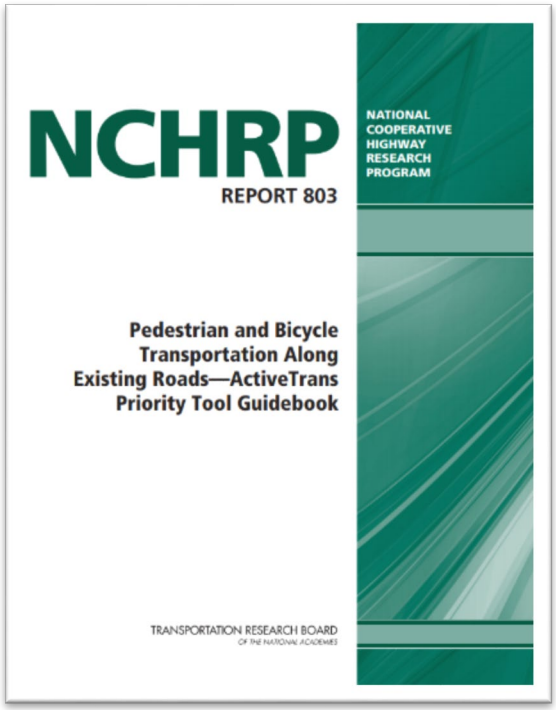
Action Plan (See Indicators)
Potential Candidate For:
___ Sign and Paint Upgrade
___ Add Curb Ramps
___ Adjust Signal Timing to Create Gaps
___ Move Bus Stop
___ Add Overhead Signs
___ Overhead Lighting Upgrade
___ Curb Bulbs
___ Reduce Curb Radius
___ Crossing Island
___ Road Diet
___ Remove Parking
___ Raised Intersection
___ Pedestrian Half Signal
___ Full Traffic Signal
___ Remove Crosswalk
___ Other

Figure 2. An inventory form was developed for the City of Seattle's inventory of marked crosswalks at uncontrolled locations. Page two is shown.

http://citeseerx.ist.psu.edu/viewdoc/download;jsessionid=1054591C88EF8267799D2D1037C556F1?doi=10.1.1.376.1348&rep=rep1&type=pdf

ActiveTrans Priority Tool Guidebook

- Step-by-Step methodology for prioritizing improvements to pedestrian & bicycle facilities
- Can prioritize separately or together as part of a "complete streets" evaluation
- Flexible: assign goals & values that reflect those of the agency & community
- Transparent: Broken down into series of discrete steps that can be easily documented & communicated to the public.



http://www.pedbikeinfo.org/pdf/PlanDesign_Tools_APT_Guidebook.pdf

ActiveTrans Priority Tool Guidebook

www.pedbikeinfo.org/apt

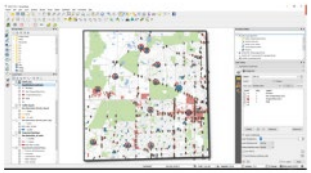
EXCEL Spreadsheet

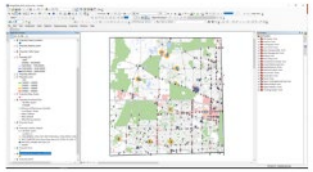
	A	B	C
1	**Step 1: Define Purpose**		
2			
3	**What type of prioritization is being done?**	**Selection**	
4	Mode	Pedestrian	
5	Location Type	Intersection or Crossing	
6			
7			

Step 10A: Calculate Priority Score

ID	GAP LOCATION	Safety SCORE	Safety WEIGHTED SCORE	Existing Conditions SCORE	Existing Conditions WEIGHTED SCORE	Demand SCORE	Demand WEIGHTED SCORE	Prioritization Score	3	new rank	dif
1	Halsted St and Harrison St	10.0	100.0	4.7	47.3	10.0	60.0	207.1	30.0	1	0
2	Washington St and Lasalle St	10.0	100.0	2.5	24.9	2.8	16.7	141.5	8.3	2	0
3	21st St and Hoyne Ave	2.5	25.0	5.4	53.9	2.6	15.8	94.7	7.9	10	0
4	Honore St and Thomas Ave	1.3	12.5	7.7	77.7	3.7	22.2	186.9	11.1	8	1
5	Racine Ave and Flournoy Ave	6.3	62.5	2.3	23.4	4.4	26.4	112.3	13.2	6	1
6	Palatine Rd and Thornbark Dr	5.0	50.0	3.2	32.1	6.2	37.5	119.6	18.7	5	0
7	Taylor St and Loomis St	3.8	37.5	7.3	72.7	2.5	15.0	125.2	7.5	4	0
8	10th Ave and Jackson Blvd	0.0	0.0	7.7	77.0	5.4	32.2	109.2	16.1	9	1
9	Milwaukee Ave and Augusta Blvd	7.5	75.0	3.1	30.7	5.5	32.8	138.5	16.4	3	0
10	Damen Ave and Chicago Ave	0.0	0.0	2.2	21.2	2.6	15.7	38.0	7.9	11	0
11	1st Ave and Columbia St	1.3	12.5	6.4	63.6	7.1	42.5	118.6	21.2	7	-1

GIS





3 Analyze crash types and safety issues

- Diagram crash reports
- Identify crash factors
- Lead an informal site visit
- Conduct an Road Safety Audit

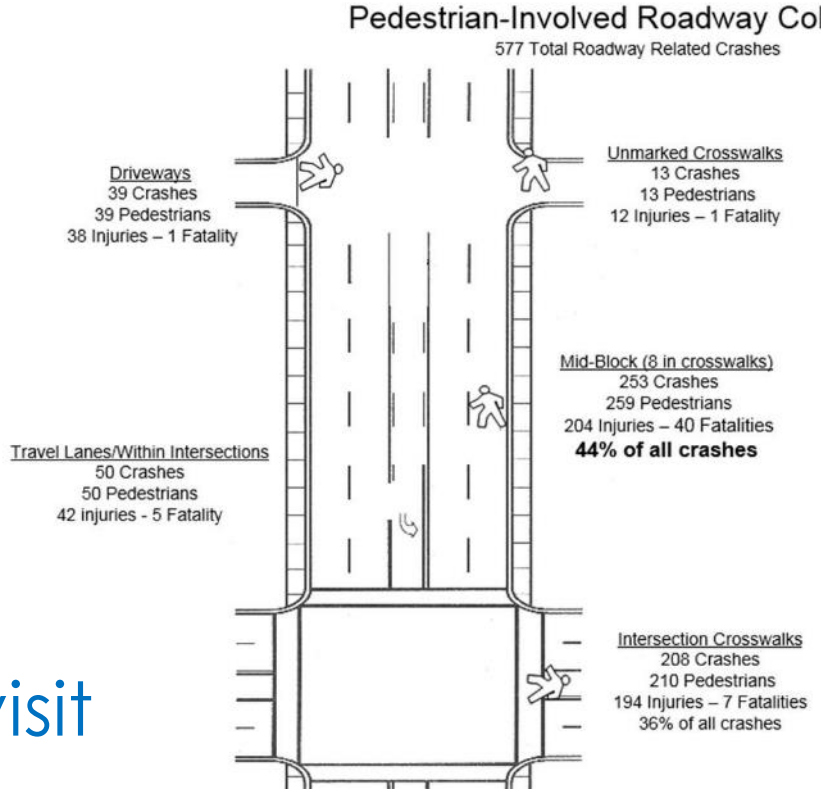


Image Source: City of Phoenix, Arizona

Implementation

- Crash Data
- High Crash Locations by
  - Location
  - Corridor
- Systematic Approach
  - Area wide
- Systemic Approach
  - Identifying roadway features
- Public Involvement

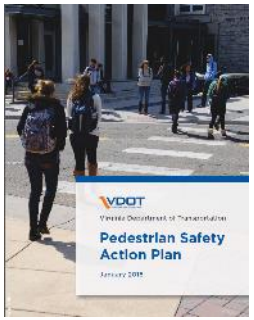
Systemic Approach

- A systemic approach to safety involves widely implemented improvements based on high-risk roadway features correlated with specific severe crash types
- Proactive
- Risk Based
- FHWA Safety Systemic Approach Training Webpage
  - https://safety.fhwa.dot.gov/systemic/training.cfm

Systemic Approach Common Risk Factors

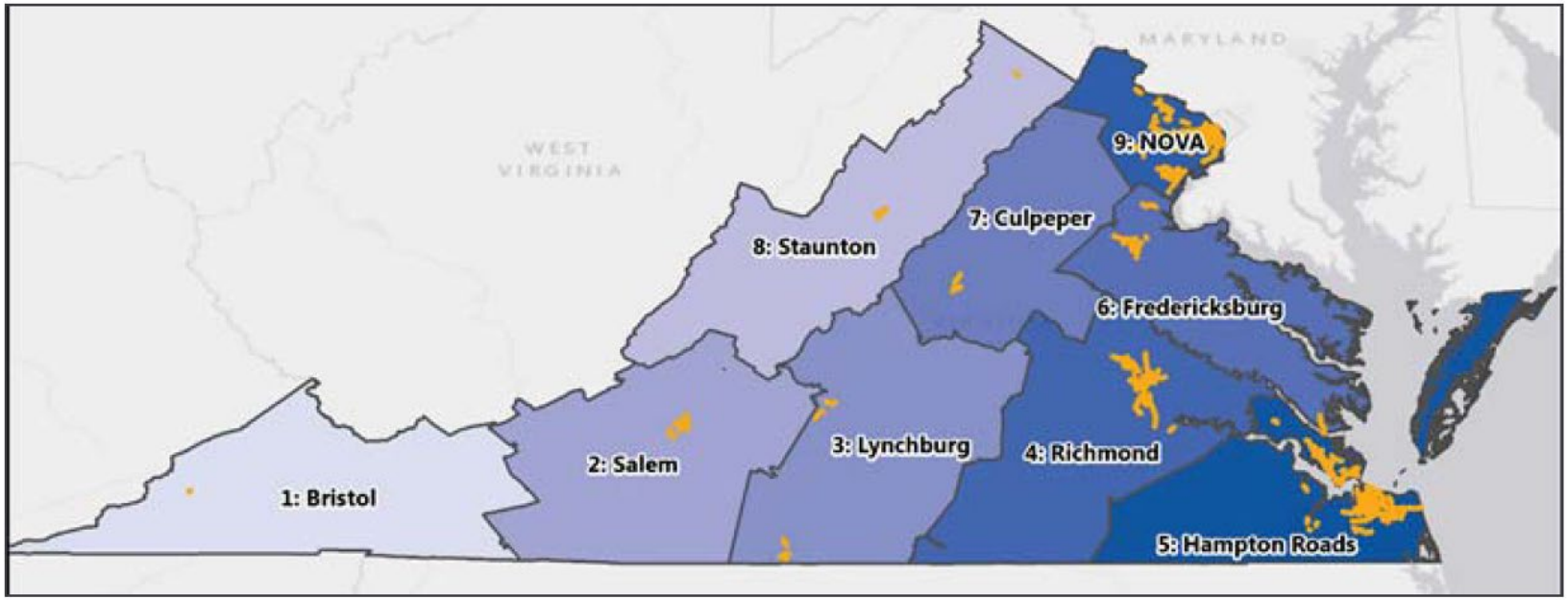
- Number of Crashes/Injuries/Fatalities
- Posted Speed limit
- AADT
- Undivided 4-lane Segment Characteristics
- Proximity to Signal
- Proximity to Transit Stop
- Pedestrian Activated Beacon or Flasher
- Near Senior Citizens, Schools, Bars, etc…

Virginia Systemic Analysis and Priority Corridors



181 Priority Corridors

Geographic Distribution of Priority PSAP Corridors



5 Consult design and installation resources

MUTCD

- Part 2: Signs
- Part 3: Markings
- Part 4: Highway Traffic Signals

AASHTO Guide for the Design of Pedestrian Facilities

Local design guidance and selection criteria

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

State Guidance Examples/Check MUTCD

- Virginia DOT Traffic Engineering Division
  - Guidelines for the installation of Marked Crosswalks
  - http://www.virginiadot.org/business/resources/IIM/TE-384_Ped_Xing_Accommodations_Unsignalized_Locs.pdf
  - Seattle Department of Transportation
  - Director's Rule 04-01
  - http://www.seattle.gov/transportation/docs/crosswalksDirectorsRule04-01FINAL.pdf
- City of Boulder
  - Pedestrian Crossing Treatment Installation Guidelines
  - https://www-static.bouldercolorado.gov/docs/pedestrian-crossing-treamtment-installation-guidelines-1-201307011719.pdf
- Pennsylvania DOT
  - Midblock Crosswalk Engineering and Traffic Study form
  - http://www.dot.state.pa.us/public/PubsForms/Forms/TE-113.pdf

6 Identify opportunities and monitor outcomes

Identify implementation opportunities

- Routine maintenance activities
- STIP

Consider funding options

- HSIP
- Other (TAP, CMAQ, STBG)

Construct improvements

- Review design considerations
- Conduct public outreach

Monitor results of implementation

- Track performance measures
- Obtain public feedback
- Analyze crash data

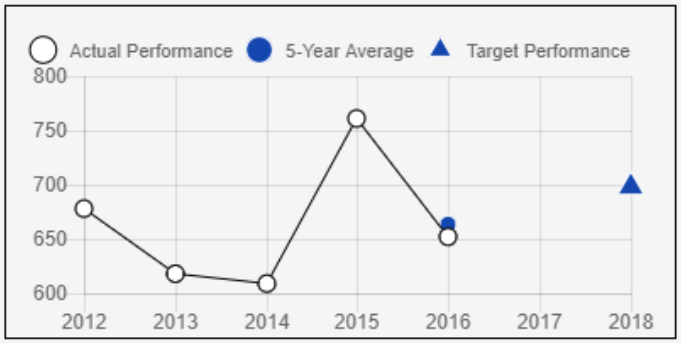
HSIP Non-Motorized Fatalities & Serious Injuries

Number of Non-Motorized Fatalities and Serious Injuries

Baseline
5-Year Average
2012-2016

663.6
Non-Motorized Fatalities and Serious Injuries
All Public Roads

Trend
2012-2016
Desired trend: ↓



Oklahoma Non-Motorized Fatalities and Serious Injuries 2012-2016

Target
5-Year Average
2014-2018

698.0
Non-Motorized Fatalities and Serious Injuries
All Public Roads

Learn More...

Data: 2017 Oklahoma HSIP Report

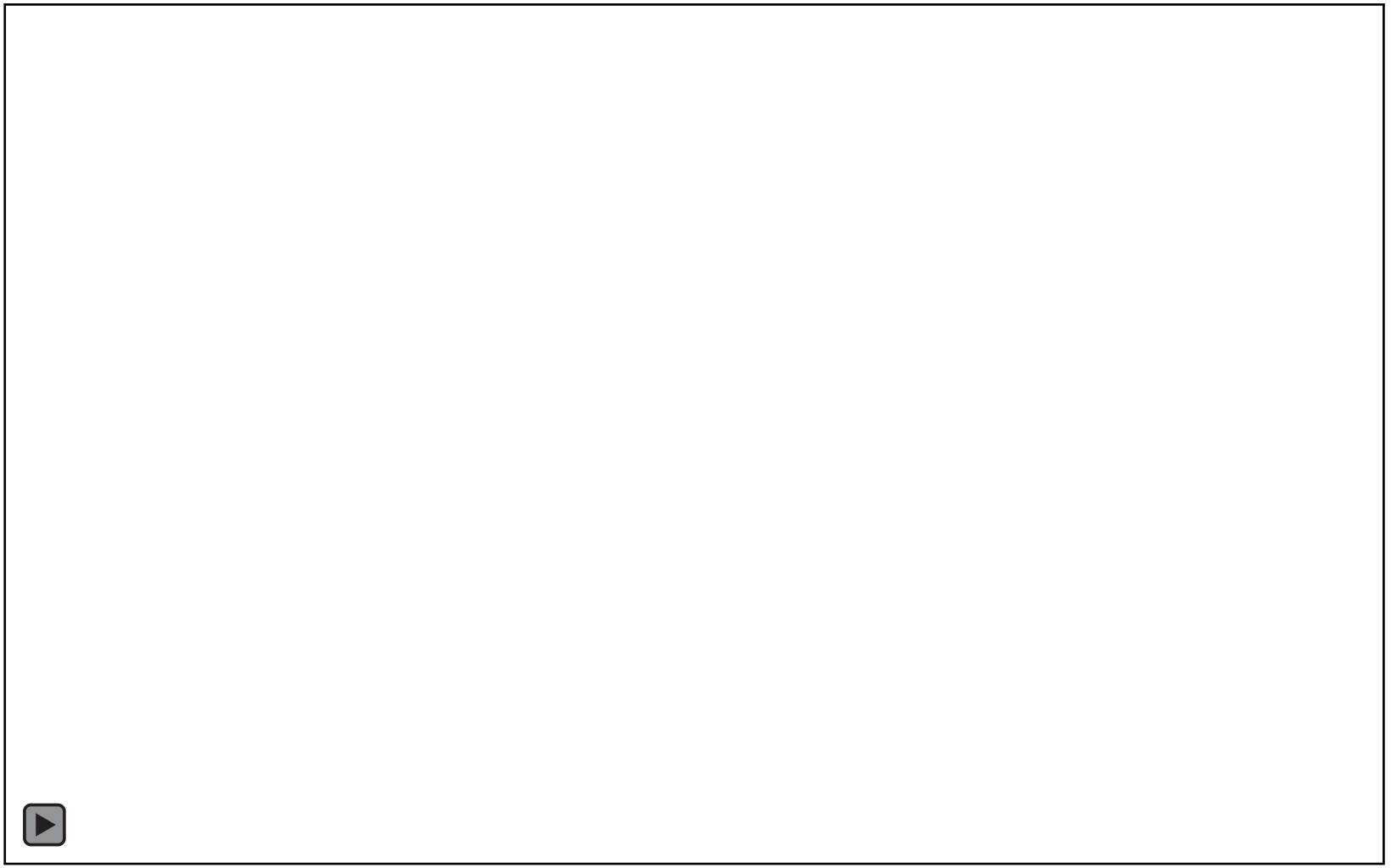
https://www.fhwa.dot.gov/tpm/reporting/state/safety.cfm?state=Oklahoma

Spectacular Seven

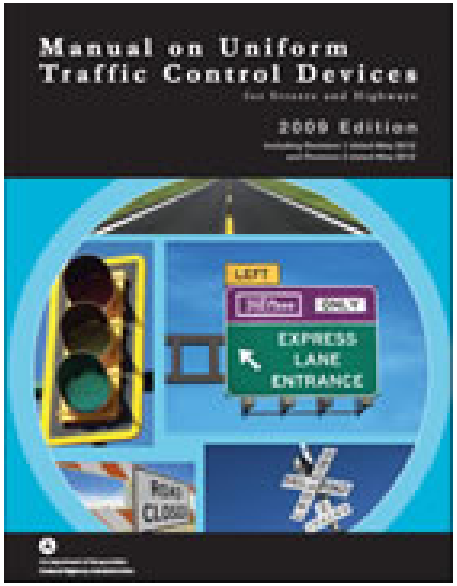
- Crosswalk Visibility Enhancements
- Raised Crosswalks
- Pedestrian Refuge Island
- RRFB
- PHB
- Road Diets
- **LPI**

Leading Pedestrian Interval

Leading Pedestrian Interval (LPI)



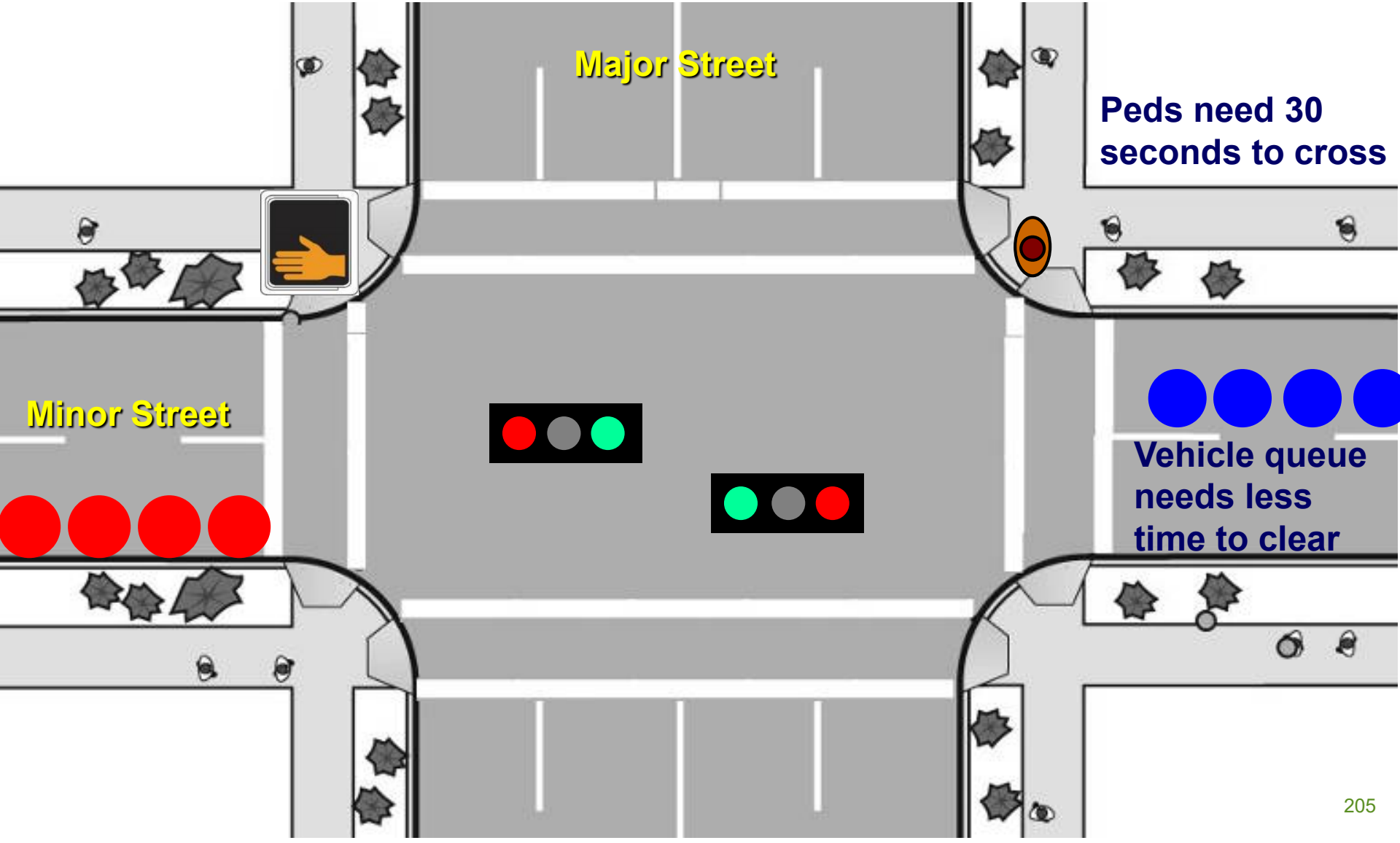
City of Charlotte, NC



MUTCD Sec. 4E.06, paragraphs 19-23

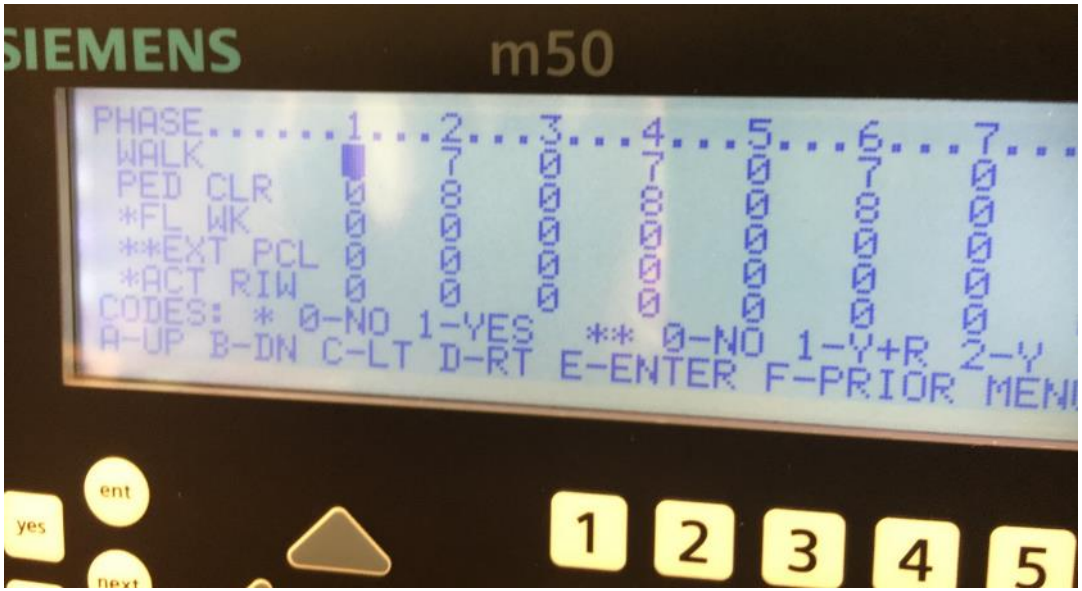
LPI : WALK comes on at least 3 seconds prior to the green vehicular signal; pedestrians enter crosswalk before turning vehicles start moving into their path.

Where do the extra 3-5 seconds come from?



Implementation Considerations

- Hardware Requirements
- Vision impairment
- Left Turn Phasing
- Mode of Operation



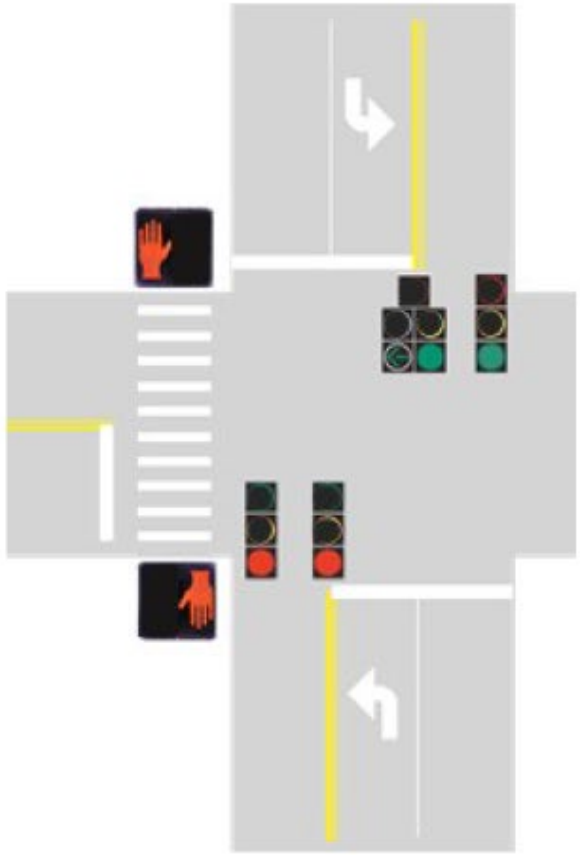
Controller Requirements

- NEMA TS2 Type 1 or 2
- 2070 or 270

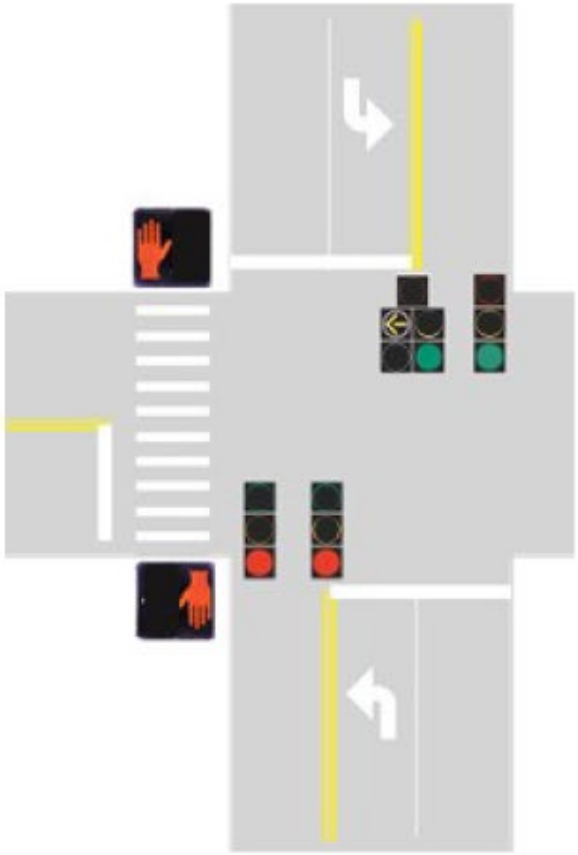
Vision Impairment and APS

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

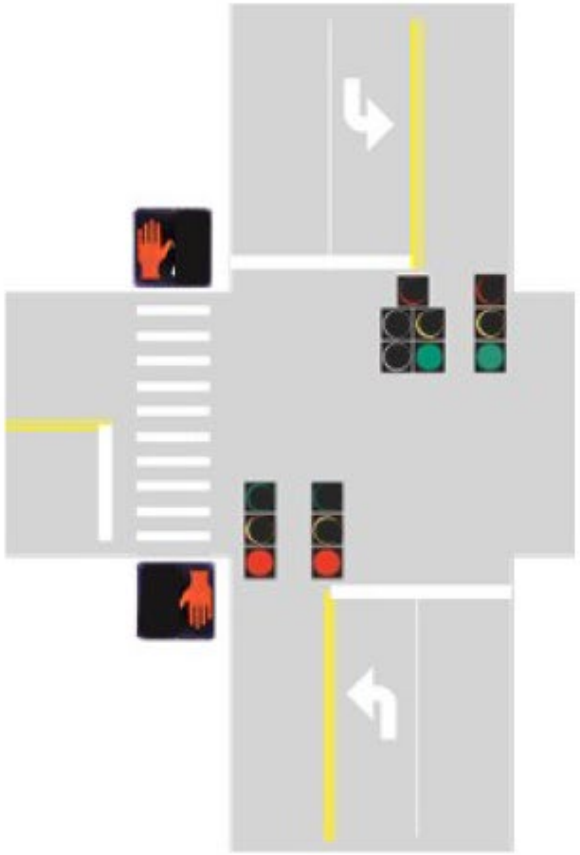
LPI & Protected / Permitted Left Turn Phasing 1/2



Northbound Left Turn
Green

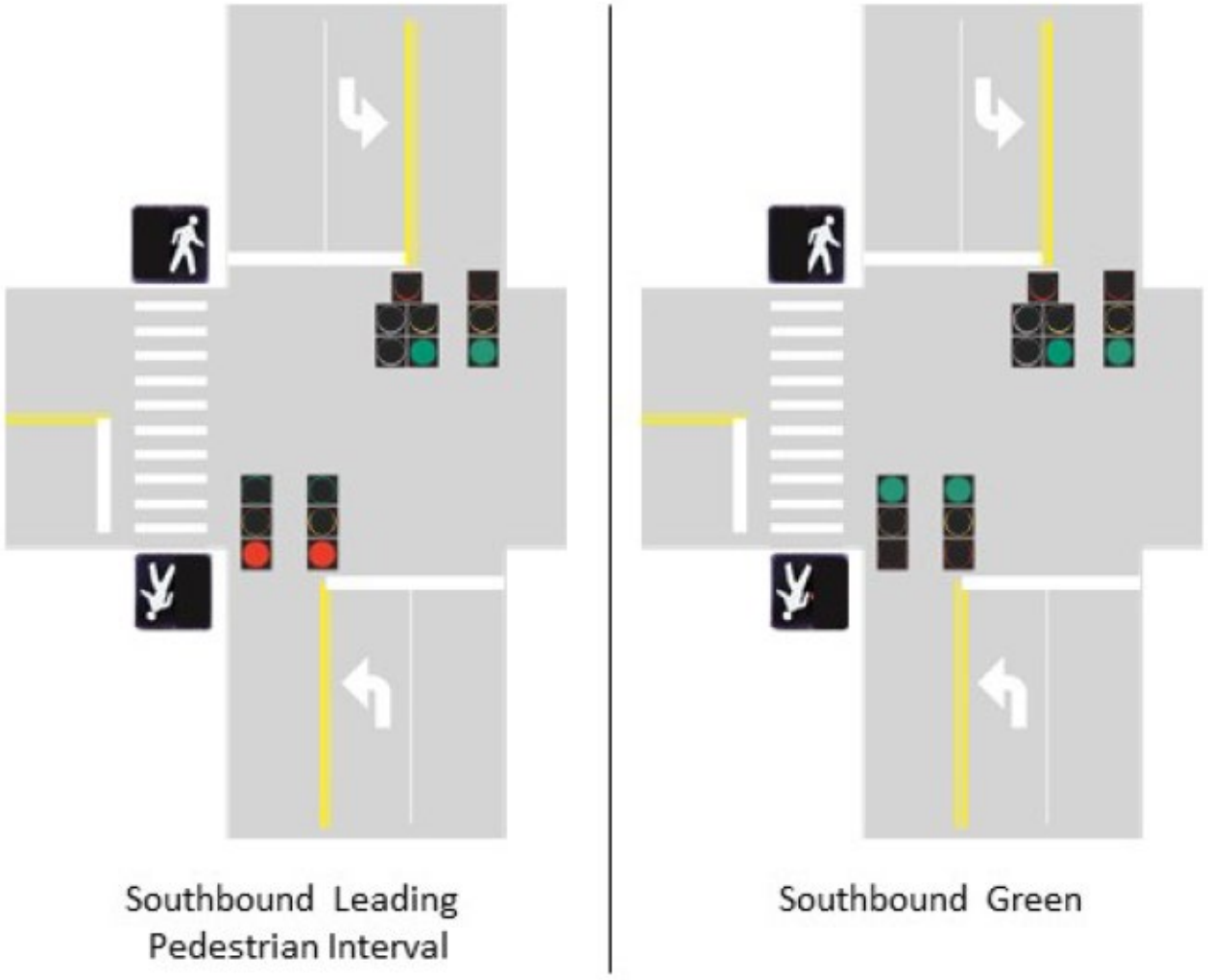


Northbound Left Turn
Yellow Change



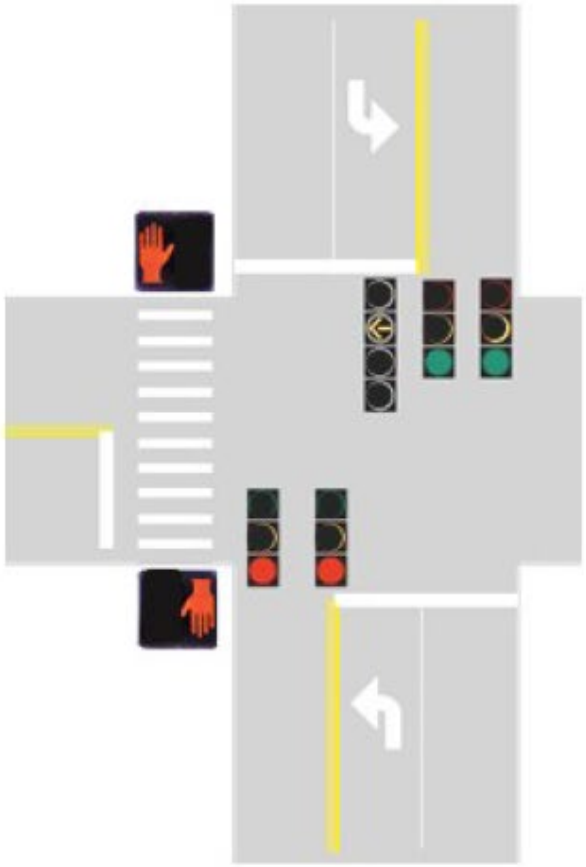
Northbound Left Turn
Red Clearance

LPI & Protected / Permitted Left Turn Phasing 2/2



LPI & Four Section Flashing Yellow Arrow 1/2

Northbound Left Turn
Green



Northbound Left Turn
Yellow Change

Northbound Left Turn
Red Clearance

LPI & Four Section Flashing Yellow Arrow 2/2

Southbound Leading Pedestrian Interval

Southbound Green

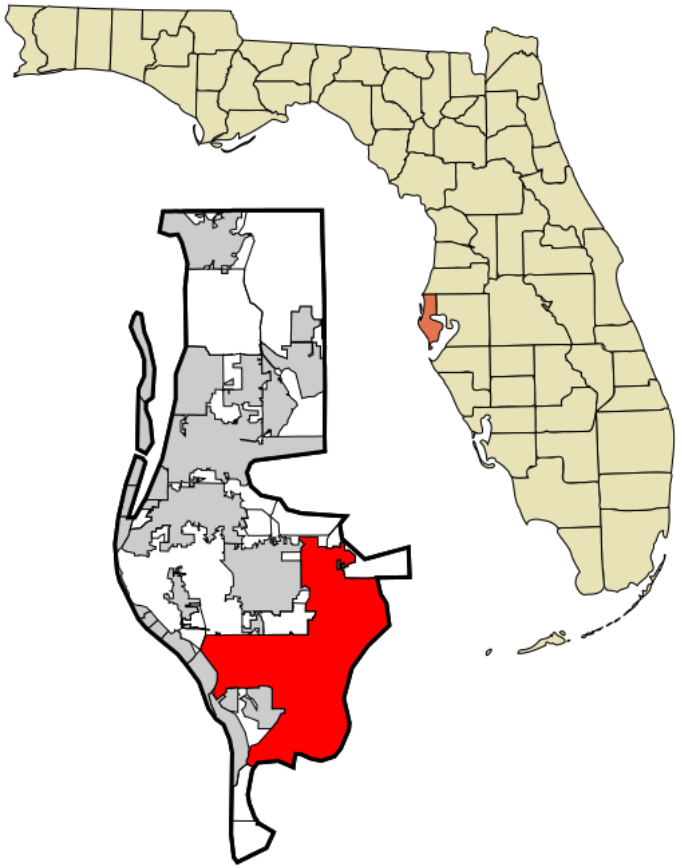
Flashing Yellow Arrow can be delayed after start of opposing green to allow opposing traffic to start.

Mode of Operation

- Free Operations – Added to overall cycle (which fluctuates per demand)
- TOD or Coordination – must be accounted for since vehicular time on coordinated phase (Main St.) will be shortened

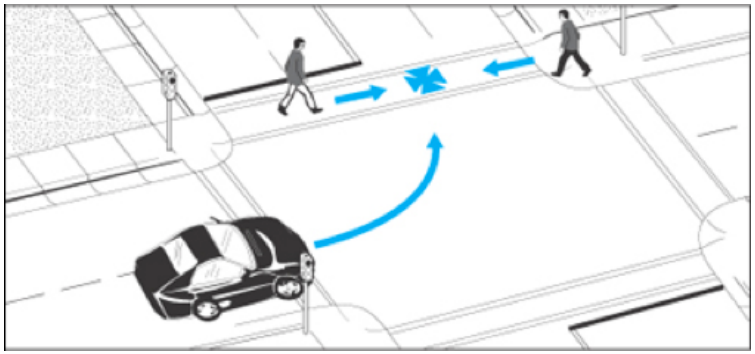
Case study
St. Petersburg, FL

- Problem/Background
- High rate of collisions between left-turning motorists and pedestrians during WALK interval
- LPI - 3 intersections
- Pedestrian crossings averaged 60 per hour
- No public outreach / awareness to ensure unbiased results



Case study
St. Petersburg, FL

- Installed 3-second LPI
- Studies pedestrian behavior and conflicts with turning vehicles
- Each street had four lanes & high traffic volume
- 30 mph posted speed
- Data collected for:
  - pedestrian/motor vehicle conflicts
  - pedestrians beginning to cross during the 5-second period at the start of the WALK interval
  - pedestrians starting to cross during the remainder of the WALK interval



Case study
St. Petersburg, FL

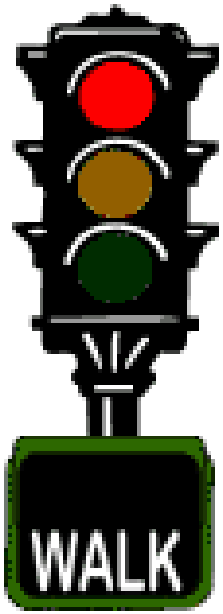
Results

Conflicts virtually eliminated for pedestrians departing during start of the WALK interval

- Before: average of 2-3 conflicts per 100 pedestrians
- After: no observation period had more than 2 conflicts per 100 pedestrians & 34 of the 41 periods had no conflicts

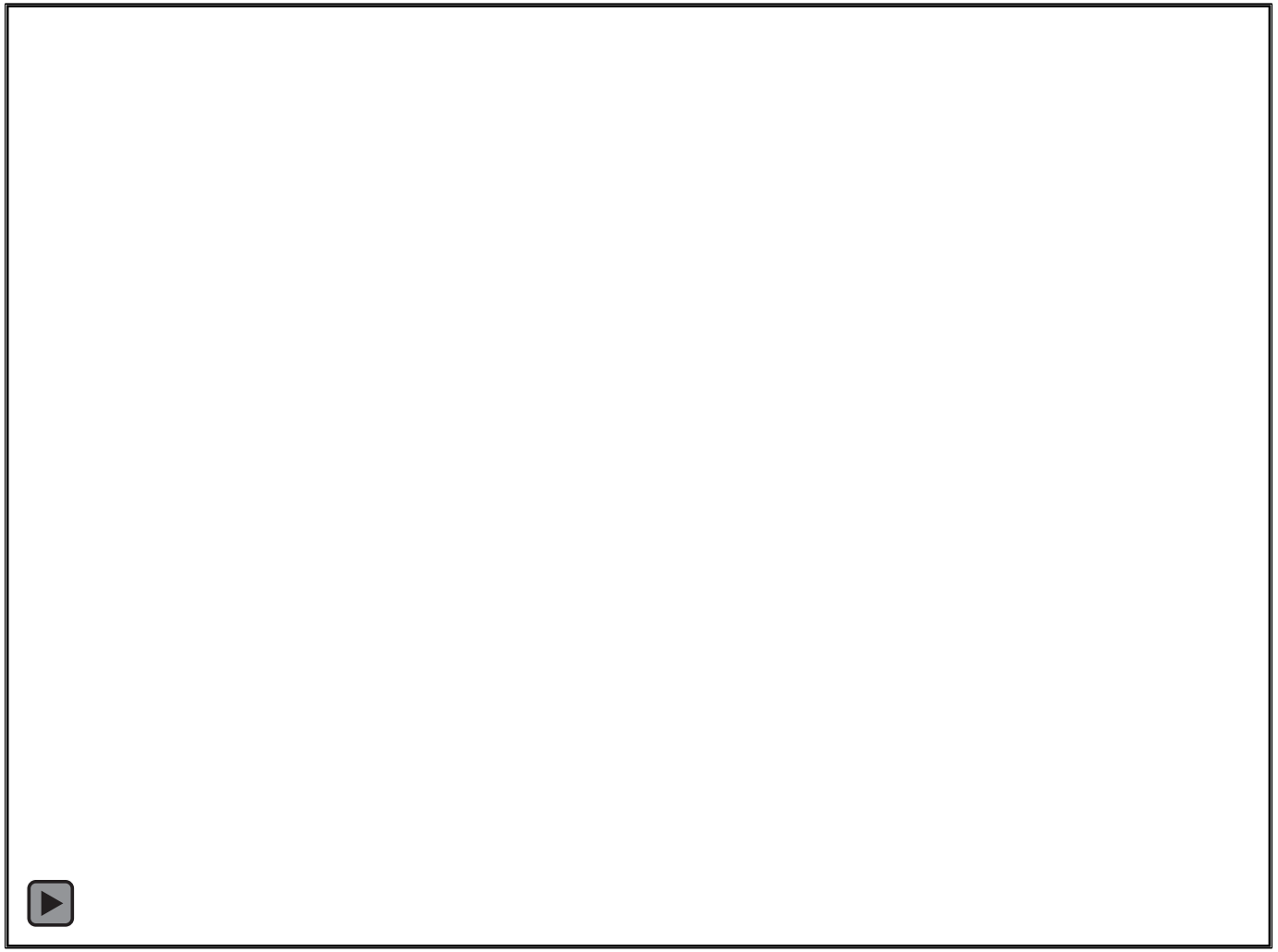
Smaller reduction in conflicts during the remainder of the WALK interval

Four months after installation, no reduction in effectiveness



Questions

Dreams of a Frogger







Group Field Exercise
Woodson Road

On-Ramp to Innovation
every day counts

Woodson Road (MO Route EE)

Speed limit: 40 mph
Roadway width: 57 feet
ADT: 10,000-14,000 (2010)

Field Visit Instructions

- MOST IMPORTANT – Don't get hit by a vehicle
- Break up into your groups
- Look for good pedestrian features
- Look for where crossings can be installed or improved
- Groups will report out when we return to class

Field Visit Instructions

Try to Observe:

- Driver yielding behavior
- Vehicle-pedestrian turning conflicts at crossing locations
- Vehicle operating speeds
- Lighting conditions at the crosswalk
- Visibility obstructions of the crosswalk due to roadway curvature or topography
- Obstructions such as on-street parking, vegetation and signage

Resources

- EDC4 STEP Website
  - https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/step.cfm
- EDC5 STEP Website
  - https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/step2.cfm
- FHWA Pedestrian Safety Website
  - https://safety.fhwa.dot.gov/ped_bike/
- PBIC Website
  - www.pedbikeinfo.org

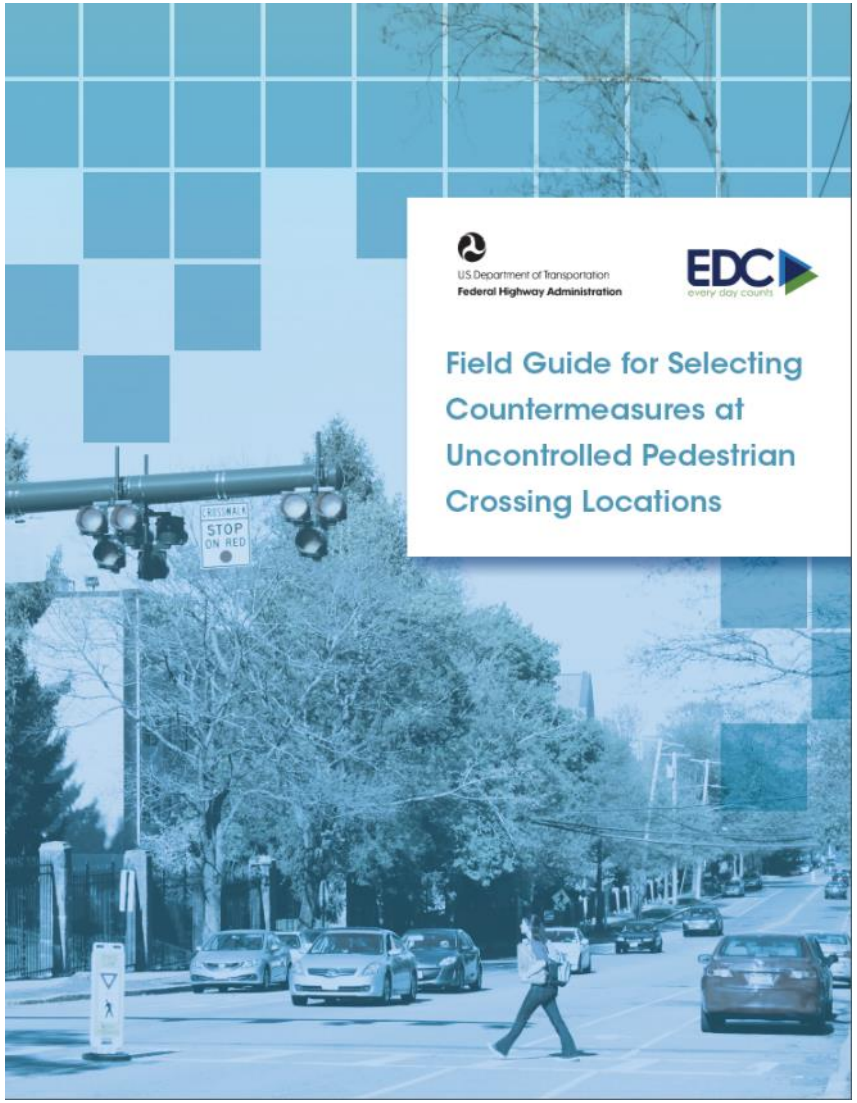
Resources

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

Costs of Treatments http://www.pedbikeinfo.org/cms/downloads/Countermeasure%20Costs_Report_Nov2013.pdf



Sample Inventory Form

On this example inventory form, the agency records information about roadway conditions and safety issues important to selecting countermeasures for uncontrolled crossing locations. The information added to this form is applied in Tables 1 and 2. Some information, such as pedestrian volume data, is used when reviewing MUTCD guidance for countermeasures such as the PHB.

Roadway Conditions Inventory

Speed Limit

☐ ≤ 30 mph ☐ 35 mph ☐ ≥ 40 mph

Total Vehicles per Day

Annual Average Daily Traffic (AADT): _____

Approximate Vehicles per Hour (VPH): _____

☐ AADT < 9,000
☐ AADT 9,000–15,000
☐ AADT > 15,000

Travel Lane Configuration

☐ 2 lanes without raised median
☐ 3 lanes without raised median
☐ 3 lanes with raised median
☐ 4+ lanes without raised median
☐ 4+ lanes with raised median

Crosswalk Length (feet): _____

Approximate Total Pedestrians per Hour (PPH) Crossing the Roadway: _____

Pedestrian Safety Issues Inventory

Noted conflicts at crossing locations ☐ Yes ☐ No

- History of turning movement crashes
- Observed conflicts at permitted crossings

Excessive vehicle speed ☐ Yes ☐ No

- 85th percentile speeds, per speed study
- History of speed-related crashes

Inadequate conspicuity/visibility ☐ Yes ☐ No

- Dim or dark conditions for pedestrians in the crosswalk
- Limited visibility of crosswalk due to roadway curvature or topography
- Obstructions, such as on-street parking, vegetation, and signage

Drivers not yielding to pedestrians in crosswalks ☐ Yes ☐ No

- Crash history in marked crosswalks

Insufficient separation between pedestrians and traffic ☐ Yes ☐ No

- Long crossing distance
- No buffer (e.g., landscape buffer, on-street parking, bike lanes)

EDC

Table 1: Application of Pedestrian Crash Countermeasures by Roadway Feature

Table 1 identifies suggested countermeasures for uncontrolled crossing locations according to roadway and traffic features. Review the corresponding worksheets for countermeasures considered for the site. The worksheets describe additional design and installation considerations for the countermeasures.

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

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

Given the set of conditions in a cell,

❶ Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.

\# Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.

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

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

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

Table 2: Safety Issues Addressed per Countermeasure

Table 2 identifies the safety issues that may be addressed by suggested countermeasures for uncontrolled crossing locations. Review the corresponding worksheets for countermeasures considered for the site. The worksheets describe additional design and installation considerations for the countermeasures.

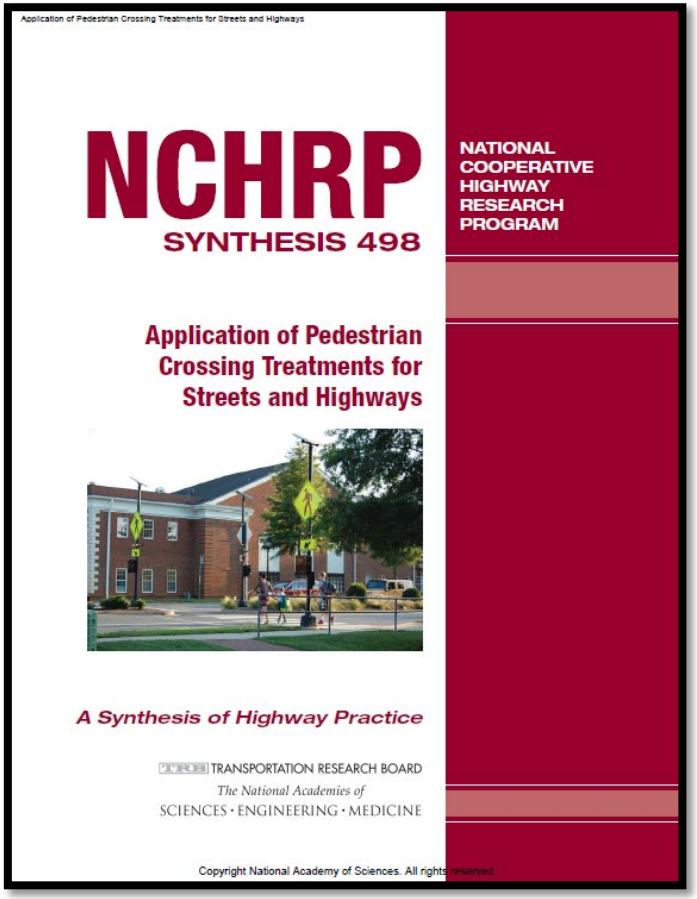
Pedestrian Crash Countermeasure for Uncontrolled Crossings	Safety Issue Addressed				
	Conflicts at crossing locations	Excessive vehicle speed	Inadequate conspicuity/ visibility	Drivers not yielding to pedestrians in crosswalks	Insufficient separation from traffic
Crosswalk visibility enhancement	✓	✓	✓	✓	✓
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	✓	✓	✓		✓

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

NCHRP Synthesis 498 (December 2016)

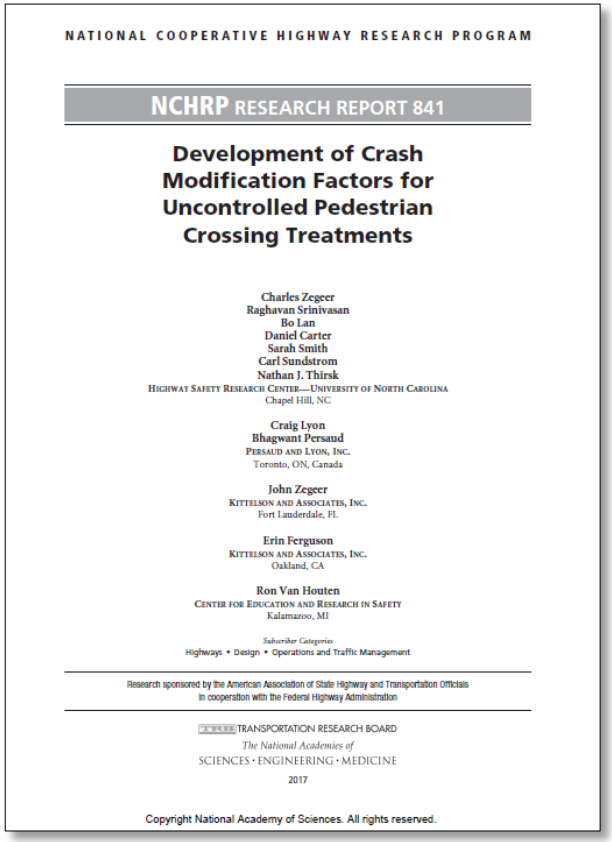
Developed by

1. Surveying State DOT's, Local Transportation Agencies
2. Identifying & synthesizing effective practices and policies
3. Comprehensive literature review of safety evidence for more than 25 pedestrian crossing treatments



http://www.trb.org/Publications/Blurbs/175419.aspx

NCHRP 841 Development of CMF for Uncontrolled Pedestrian Crossing Treatments



NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP RESEARCH REPORT 841

Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments

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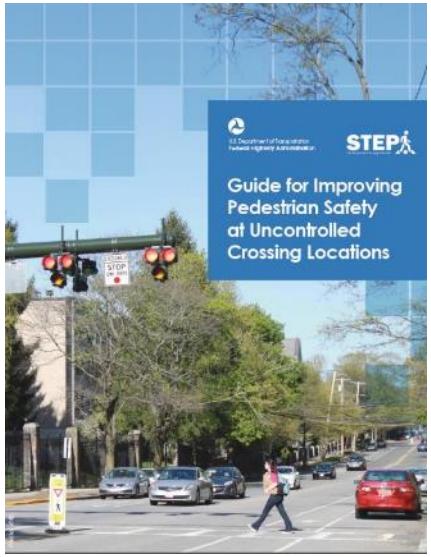
2017

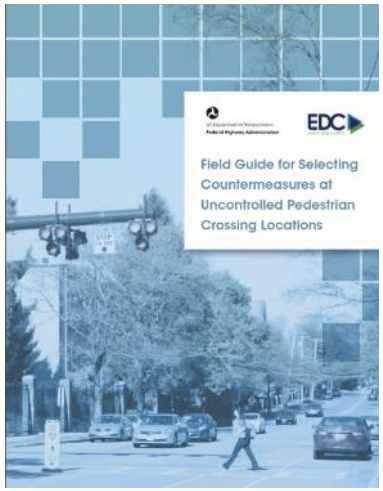
Table S-1. Recommended CMFs.

Treatment	Crash Type	Recommended CMF		Study Basis
		Estimate	Standard Error	
Refuge Island	Pedestrian	0.685	0.183	Median from two studies
	Total	0.742	0.071	Cross-section
	All Injury	0.714	0.082	Cross-section
	Rear-End/Sideswipe Total	0.741	0.093	Cross-section
	Rear-End/Sideswipe Injury	0.722	0.106	Cross-section
Advanced YIELD or STOP Markings and Signs	Pedestrian	0.750	0.230	Median from two studies
	Total	0.886	0.065	Before-after
	Rear-End/Sideswipe Total	0.800	0.076	Before-after
PHB	Pedestrian	0.453	0.167	Median from two studies
PHB + Advanced YIELD or STOP Markings and Signs	Pedestrian	0.432	0.134	Median from two studies
	Total	0.820	0.078	Before-after
	Rear-End/Sideswipe Total	0.876	0.111	Before-after
RRFB	Pedestrian	0.526	0.377	Cross-section

http://www.trb.org/Main/Blurbs/175381.aspx

STEP Guides and Tech Sheets



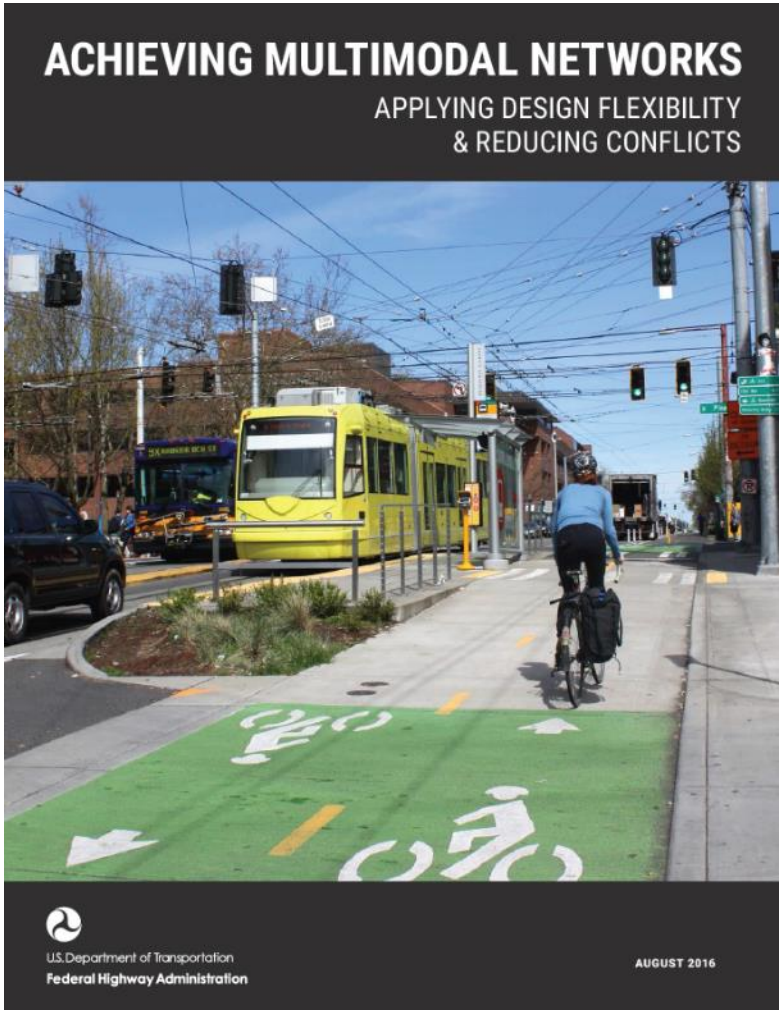


https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/step_tech_sheet.pdf

Achieving Multimodal Networks

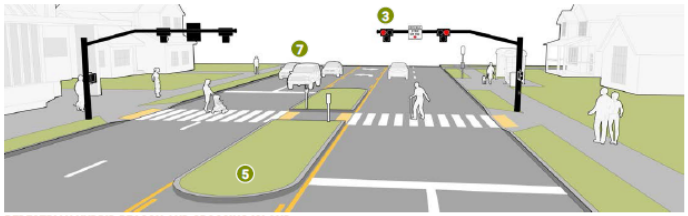
24 design topics: 2 Parts

1. 12 design topics on design flexibility
2. 12 topics on measures to reduce conflicts between modes

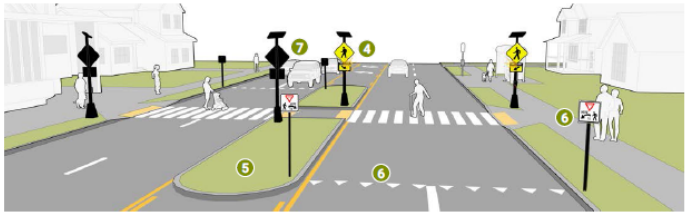


https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/

Design Flexibility



PEDESTRIAN HYBRID BEACON AND CROSSING ISLAND



RECTANGULAR RAPID FLASHING BEACON AND CROSSING ISLAND

RECTANGULAR RAPID FLASHING BEACONS

At uncontrolled crossings where a signal or pedestrian hybrid beacon is not warranted, cost prohibitive, or deemed unnecessary designers should consider supplementing pedestrian, bicycle/pedestrian, or school crossing warning signs with Rectangular Rapid Flashing Beacons (RRFBs). 4 Generally, this treatment should be used with caution at crossings with more than two lanes without a refuge. **FWHA Effects of Yellow Rectangular Rapid-Flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks** found an 88-percent average compliance rate for motorists yielding to pedestrians at crossings with RRFBs; this rate was sustained after 2 years **(2010, p. 9)**.

PEDESTRIAN CROSSING ISLANDS

Raised medians or pedestrian crossing islands are a Proven Safety Countermeasure and have demonstrated a 46-percent reduction in pedestrian crashes. Pedestrian refuge areas or islands 5 allow pedestrians to cross the street in two stages and significantly reduce the distance a pedestrian must cross at one time. The **AASHTO Pedestrian Guide** states that a crossing island should be considered "where the crossing exceeds 60 ft" **(2004, p. 90)**. **FHWA Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations** found that providing raised medians on multilane roads "can significantly reduce the pedestrian crash rate and also facilitate street crossing" **(2005, p. 55)**. However, on roadways with a raised median and volumes exceeding 15,000 ADT, a marked crosswalk is appropriate only with additional crossing treatments. Crossing islands should be a minimum of 6 feet wide **(ITE Designing Walkable Urban Thoroughfares 2010, p. 141)**. At locations where bicycles may be crossing, such as where a shared use path crosses a roadway, "10 ft is preferred in order to accommodate a bicycle with a trailer" **(AASHTO Bike Guide 2012, p. 5-48)**.

ADVANCE YIELD/STOP LINES AND SIGNING

Advance yield/stop lines and signing 6 can be installed at locations where there are concerns about multiple threat crashes. 7 They indicate to drivers the appropriate location to yield or stop so that they do not "place pedestrians at risk by blocking other drivers' views of pedestrians and by blocking pedestrians' views of vehicles approaching in the other lanes" **(MUTCD 2009, Sec. 3B.16)**. Additionally, parking should be prohibited in between the yield or stop line and the crosswalk to increase visibility.

CASE STUDIES

I STREET AT MAKEMIE PLACE, SW
WASHINGTON, DC

A Safe Routes to School action plan for Amidon-Bowen Elementary School evaluated the intersection of Makemie Place and I Street SW for a potential crosswalk. Prior to the study, schoolchildren had to cross I Street SW at one of two signalized intersections approximately 600 feet apart to access the main school entrance. The City installed a marked crosswalk halfway between these intersections at the T-intersection of Makemie Place SW along with warning signs, a crossing island, and curb extensions to increase driver awareness of the crossing, reduce vehicle speeds, and increase the pedestrian queuing area. This crossing also connected bus stops on both sides of I Street SW. Crosswalk signs were installed as part of an experiment and are non-compliant.

IMPROVEMENT PLAN FOR UNCONTROLLED MARKED CROSSWALKS
SEATTLE, WA

In 2001, the City of Seattle completed a detailed inventory analysis of 622 marked crosswalks at uncontrolled locations. Crosswalks were rated based on traffic volume, number of lanes, and speed. In 2002, the City released a multi-year Improvement Plan for Uncontrolled Marked Crosswalks that addressed identified deficiencies. Rather than just decide "yes" or "no" on whether to mark a crosswalk, the improvement plan asks "what are the most effective measures that can be used to help pedestrians safely cross the street?" The plan was implemented over a period of six years. Deficiencies were addressed with signing, markings, crossing islands, road and lane diets, rectangular rapid flash beacons, pedestrian signals, and other ADA improvements.

SE BUSH STREET AND 122ND AVENUE PEDESTRIAN HYBRID BEACON
PORTLAND, OR

As part of the SE Bush neighborhood greenway project, the Portland Bureau of Transportation installed a pedestrian hybrid beacon at the SE Bush Street crossing of 122nd Avenue in July 2012. Counts at this location did not meet the pedestrian hybrid beacon warrant prior to installation. However, engineers designed the intersection to accommodate 50–100 bicycle and pedestrian crossings during the peak hour based on previous experience where bicycle and pedestrian volumes increased following installation of other neighborhood greenways in the City. December 2013 counts indicated that pedestrian hybrid beacon warrants are satisfied at this location.

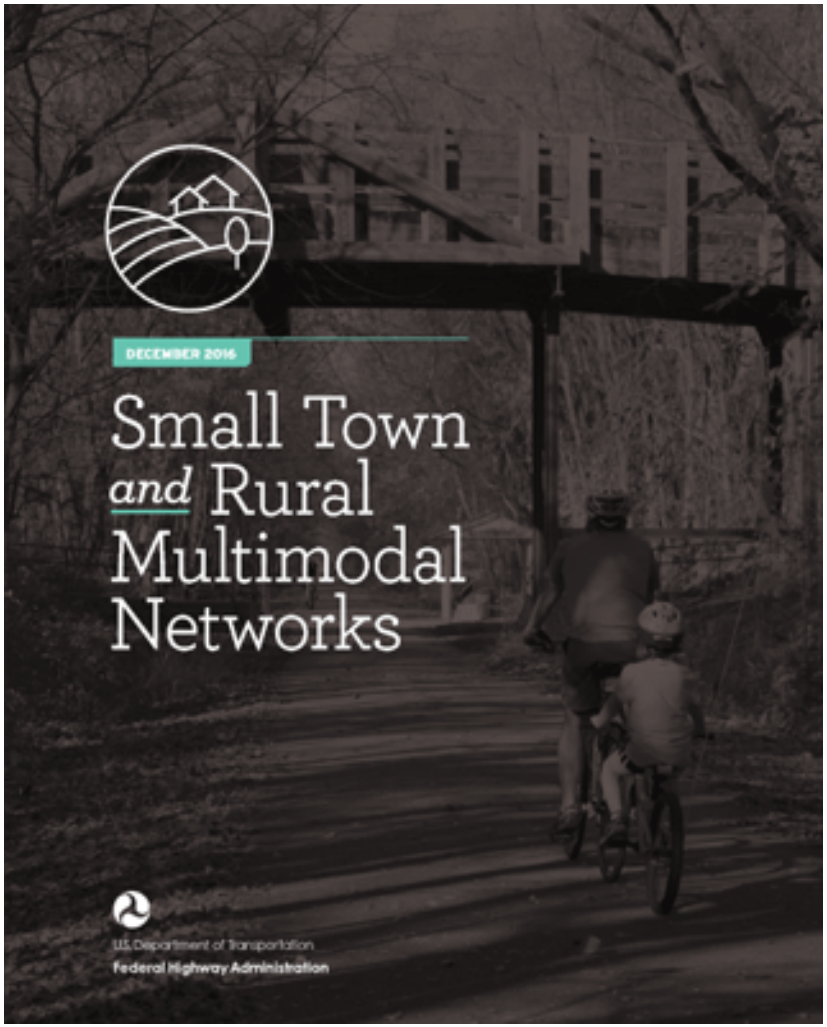
Source: Scott Batson, City of Portland Bureau of Transportation

Small Town and Rural Multimodal Networks

FHWA-HEP-17-024

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/

- Resource and Idea book to support safe, accessible, comfortable, and active travel
- Bridges design and practice
- Examples & project implementation



Multimodal Main Streets

The ITE Walkable Urban Thoroughfares Guide 2010 recommends the following design details for walkable and bikeable commercial main streets:

- **Minimum sidewalk width:** 6 ft (1.8 m)
- **Furnishing zone:** 6 ft (1.8 m)
- **Target travel speed:** 25 mi/h (40 km/h)
- **Number of through lanes:** 2
- **Lane Width:** 10–11 ft (3.0–3.3 m)
- **Parallel On-Street Parking Width:** 7–8 ft (2.1–2.4 m)
- **Bike facility:** 5–6 ft (1.5–1.8 m) min

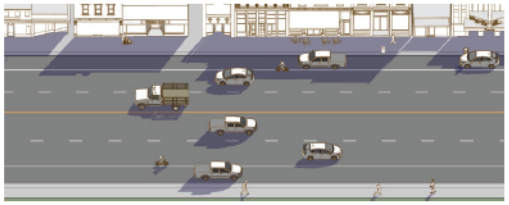
Multimodal Main Streets

FOUR-LANE STREET SCENARIOS

Figure 5-8. The following concepts illustrate potential design options for main streets with multiple travel lanes in each direction.

EXISTING CONDITIONS FOUR-LANE

Rural highways are often widened through town centers, providing multiple travel lanes to reduce impediments to through traffic. These configurations may encourage inappropriately high-speed travel and erratic behavior in the vicinity of pedestrian and bicycle activity.



ROAD DIET

A four-lane to three-lane road diet can balance the needs of through travel and local community access, while increasing safety.

Road diets are an FHWA Proven Safety Countermeasure. For more information on road diets, refer to the FHWA Resurfacing Guide 2016 and the FHWA Road Diet Guide 2014.

STREETSCAPE EXPANSION WITH BIKE LANES

Narrowing and consolidating excess space dedicated to motor vehicles can provide room to expand sidewalk areas.

Road diets are an FHWA Proven Safety Countermeasure. For more information on roadway reconfigurations, refer to the FHWA Road Diet Guide 2014. Refer to the ITE Walkable Urban Thoroughfares Guide 2010 for more information on sidewalk configuration.

EDC4 Other Initiatives of Interest

https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/connections.cfm

https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/ddsa.cfm

https://safety.fhwa.dot.gov/provencountermeasures/local_road/

Traffic Calming ePrimer

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

LPI Additional Resources

- FHWA
  - Proven Safety Countermeasures
  - https://safety.fhwa.dot.gov/provencountermeasures/lead_ped_int/
- Safety Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals on Pedestrian Safety
  - Publication No. FHWA-HRT-18-044
  - October 2018
  - https://www.fhwa.dot.gov/publications/research/safety/18044/18044.pdf
- NACTO Urban Street Design Guide
  - https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/leading-pedestrian-interval/





Thank You
Walk Safely and Cross Safer

On-Ramp to Innovation
every day counts