PEDESTRIAN & BICYCLIST
FOCUSED APPROACH TO SAFETY

Designing for Pedestrian Safety

Jacksonville, FL

August 2023

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

DESIGNING STREETS FOR PEDESTRIAN SAFETY [DAY 1]

Location: 980 North Jefferson Street, Jacksonville, FL

Date: Tuesday, August 29, 2023

Time: 8:00am-5:00pm

Facilitator: FHWA

Agenda Items

8:00am	Sign-in + Coffee and light breakfast items
8:30am	Welcome
	Opening Remarks *Mayor Deegan*
	Update from Jacksonville's Bicycle Pedestrian Advisory Committee
	Introductions
	Local Presentation Jeff Sheffield, North Florida TPO, Executive Director
Module 1	Marked Crosswalks & Enhancements
Module 2	Systemic Methods
12:00-12:45	Lunch
	Systemic Methods (continued) Group Exercise
Module 3	Curb Extensions/Bulb-outs
Module 4	Protected Intersections Individual Exercise
Module 5	Crossing Islands/Raised Medians
ADJOURN	

Additional information

- Day 2 instruction will begin at 8:30am, Wednesday, August 30.
- Light snacks and coffee will be provided between 8:00-8:30am.
- Please dress casually with comfortable shoes for walking if you plan on joining the optional site visit.

DESIGNING STREETS FOR PEDESTRIAN SAFETY [DAY 2]

Location: 980 North Jefferson Street, Jacksonville, FL

Date: August 30, 2023

Time: 8:00am-5:00pm

Facilitator: FHWA

Agenda Items

8:00am	Coffee and light breakfast items
8:30am	Welcome & Recap of Day 1
Module 6	Transit
Module 7	Road Diets
12:00-12:45	Lunch
Module 8	Multilane Arterials
	Site Visit
	Tabletop Exercise – Group Problem Solving
	Workshop Closeout - Final Thoughts Overview of discussed modules
ADJOURN	

1

Instructors

FHWA
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3

Objective of Workshop

- Saving Lives
- Provide in greater detail than the DPS 101 workshop the standards, guidance and best practices of the pedestrian safety countermeasures

4

Agenda

1. **Marked Xwalks and Enhancements** (1.5)
2. Systemic Methods
3. Curb Extensions/Bulb-outs
4. Protected Intersections
5. Crossing Islands/Raised Medians
6. Transit
7. Road Diets
8. Multilane Arterials

6

CMF/CRF Review

- Crash Modification Factor (CMF):
  - Factor to compute expected number of crashes after implementing countermeasure
- Crash Reduction Factor (CRF):
  - Percent fewer crashes expected given countermeasure than on similar road without countermeasure
- Relationship between CMF and CRF:
  - CMF = 1 - (CRF/100)
  - CRF = 100*(1 – CMF)
- CMF/CFR Clearinghouse:
  - www.cmfclearinghouse.org

7

CMF/CRF Important point

- May apply to all crashes, or crash specific subsets
  - (e.g., run-off-road, night, wet weather, multi-vehicle, etc.)
- Same treatment in different contexts or highway types may have different effects and different CMF values
  - Reference the research and studies on CMF clearinghouse website

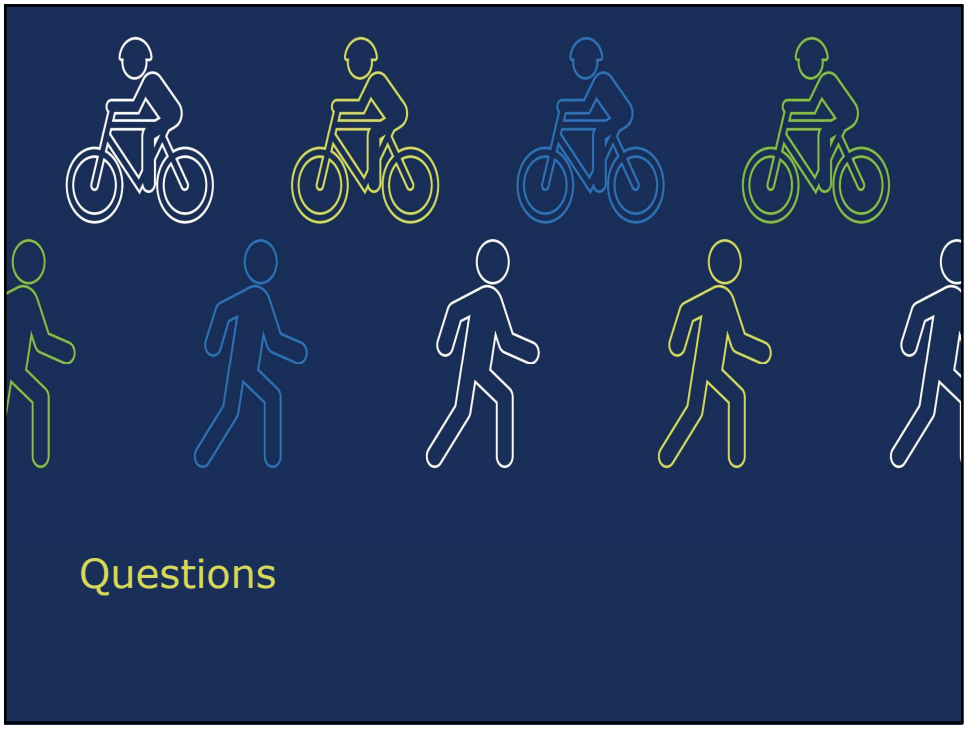
8

MUTCD

- National Standard
- Agencies may have supplements
- Experimental Process
  - Remember to copy Division office
- Interim Approvals
- Official Interpretations

- http://mutcd.fhwa.dot.gov/

9



10

Marked Crosswalks & Enhancements

PEDESTRIAN & BICYCLIST
FOCUSED APPROACH TO SAFETY

DPS 201

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

1

Case study: Crosswalks & Enhancements (Las Vegas, NV)

Las Vegas, NV

Problem and Background

- High pedestrian crash rate due to wide, fast roadways
- Six- to eight-lane roads
- 45 mph speed limits
- Among the highest ped fatalities in the nation
- Wanted to improve pedestrian infrastructure and provide a safer environment for vulnerable road users

Source: Pedro Venda, panoramio.com

2

Case study: Crosswalks & Enhancements (Las Vegas, NV)

Las Vegas, NV

Solution

- City worked with the FHWA to identify, install & evaluate various safety countermeasures
- 18 sites identified
  - 14 received countermeasures
  - 4 served as control locations
- Multiple countermeasures deployed at each site:
  - warning signs, advance yield markings, lighted pedestrian pushbuttons, high-visibility crosswalks, median refuges, automated pedestrian detection, speed trailers

3

Case study: Crosswalks & Enhancements (Las Vegas, NV)

Las Vegas, NV

Results

- Motorist yielding rates & pedestrian safety improved
- At one site, 11% of vehicles blocked the crosswalk before turning
  - After a "TURNING VEHICLES YIELD TO PEDESTRIANS" sign installed, no motorists blocked the crosswalk
- Number of pedestrians who looked for turning vehicles during the WALK increased with the sign

- Combining pedestrian safety countermeasures led to major increases in pedestrian safety
- City encouraged by results and hopes to further implement improvements

4

UVC – Crosswalk Definition

1-118 – Crosswalk

- (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.

5

How many crosswalks do you see?

Intersection 1

Intersection 2

6

Why are marked crosswalks provided?

- To indicate to pedestrians where to cross
- To indicate to drivers where to expect pedestrians
- At mid-block locations, crosswalk markings legally establish the crosswalk.

7

When are marked crosswalks provided?

MUTCD Section 3B.18 Crosswalk Markings

Guidance:

- *At locations controlled by traffic control signals or on approaches controlled by STOP or YIELD signs, crosswalk lines should be installed where engineering judgment indicates they are needed to direct pedestrians to the proper crossing path(s).*

8

MUTCD Section 3B.18 Crosswalk Markings

Guidance

- 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

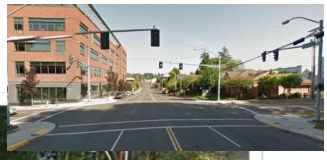
The engineering study should consider:

- Number of lanes
- Presence of a median
- Distance from adjacent signalized intersections
- Pedestrian volumes & delays
- Average daily traffic (ADT)
- Posted speed limit or 85th-percentile speed
- Geometry
- Possible consolidation of multiple crossing points
- Street lighting
- Other appropriate factors

9

Where should marked Crosswalks be provided?

- Uncontrolled locations?
- Stop controlled locations?
- Signalized locations?



10

Bruce Herms, 1972
Pedestrian Crosswalk Study

Herms, Bruce. 1972. Pedestrian Crosswalk Study: Accidents in Painted and Unpainted Crosswalks, Transportation Research Record No. 406, Transportation Research Board, Washington, DC.

- This oft-quoted, and usually misinterpreted study examined pedestrian crash rates of marked versus unmarked crosswalks in San Diego
- Herms' speculation that marked crosswalks confer a "false sense of security" and therefore causes higher pedestrian crash rates has been disproven
- Still, the paper serves as a warning not to paint a crosswalk without carefully considering whether the location will require additional safety features to make the crossing safe

11

Crosswalk installation recommendations

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

C = Compliant
P = Possibly compliant
N = Not compliant. Markings should not be installed without additional safety treatments

12

MUTCD Section 3B.18 Crosswalk Markings

Guidance

- New marked crosswalks 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 either:
  - The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an ADT of 12,000 vehicles per day or greater; or
  - The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.

13

District DOT's Uncontrolled crosswalk policy

Table 1 - Proposed DC Uncontrolled Crosswalk Engineering Treatments

For roadways posted 30mph or less

Roadway Configuration	1,500 - 9,000 vpd	9,000 - 12,000 vpd	12,000 - 15,000 vpd	> 15,000 vpd
2 Lanes[1]	A	A	A or B	B or C
2 Lanes with CTL[1]	A	A	B	B or C
2 Lanes One Way	B	B	C	C
4 Lanes w/Raised Median[2]	B	B	C	C
3 Lanes No Median[3]	B	B	C	C
5 Lanes w/Raised Median[3]	B	B	C	C
6 Lanes w/Raised Median[4]	B	B	C	D
4 Lanes No Median[4]	B	B or C	C	D
5 Lanes No Median[3]	B	B or C	D	D
6 Lanes No Median[4]	B	B or C	D	D

Volumes Below 1500 vpd	Parallel Crosswalk and/or W11-2 assembly
Treatment A	High Visibility Crosswalk and Side of Street Ped Law Sign
Treatment B	In-Street Stop For Peds Sign and/or Traffic Calming
Treatment C	Activated Pedestrian Device (RRFB, In-road LEDs, etc.)
Treatment D	Something with a red signal (Ped Hybrid, Full Signal)

Page 25 Appendix C DDOT Ped Master Plan

http://ddot.dc.gov/sites/default/files/dc/sites/ddot/publication/attachments/pedestrianmasterplan_2009.pdf

14

Best Practices

- Do a crosswalk Inventory based on set criteria
  - Improves defense during lawsuits
  - Consistency
  - Seattle, WA did evaluation of all crosswalks after Zegeer study published
- District of Columbia crosswalk reviews
  - Resurfacing projects
  - System wide evaluations
  - Corridor Analysis
  - Individual requests

15

Discussion: Local agency Process

- What factors are taken into consideration for installation of marked crosswalks in your agency/region?

16

17

Marked Crosswalks and Enhancements - Safety

- High-visibility crosswalks have been associated with a 40% decrease in pedestrian crashes (Signal and Non-signal in NYC).(1)
- In school zones, a decrease of 37% observed in San Francisco.(2)

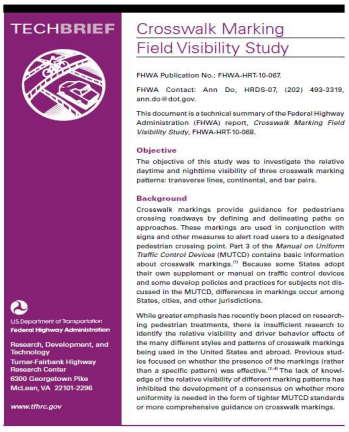
RESEARCH

- (1) Chen, L., Chen, C., Ewing, R., McKnight, C. E., Srinivasan, R., & Roe, M. (2013). Safety countermeasures and crash reduction in New York City—Experience and lessons learned. *Accident Analysis & Prevention*, *50*, 312-322.
- (2) Feldman, M., Manzi, J. G., & Mitman, M. F. (2010). Empirical Bayesian Evaluation of Safety Effects of High-Visibility School (Yellow) Crosswalks in San Francisco, California. *Transportation Research Record: Journal of the Transportation Research Board*, *2198*(1), 8-14.

18

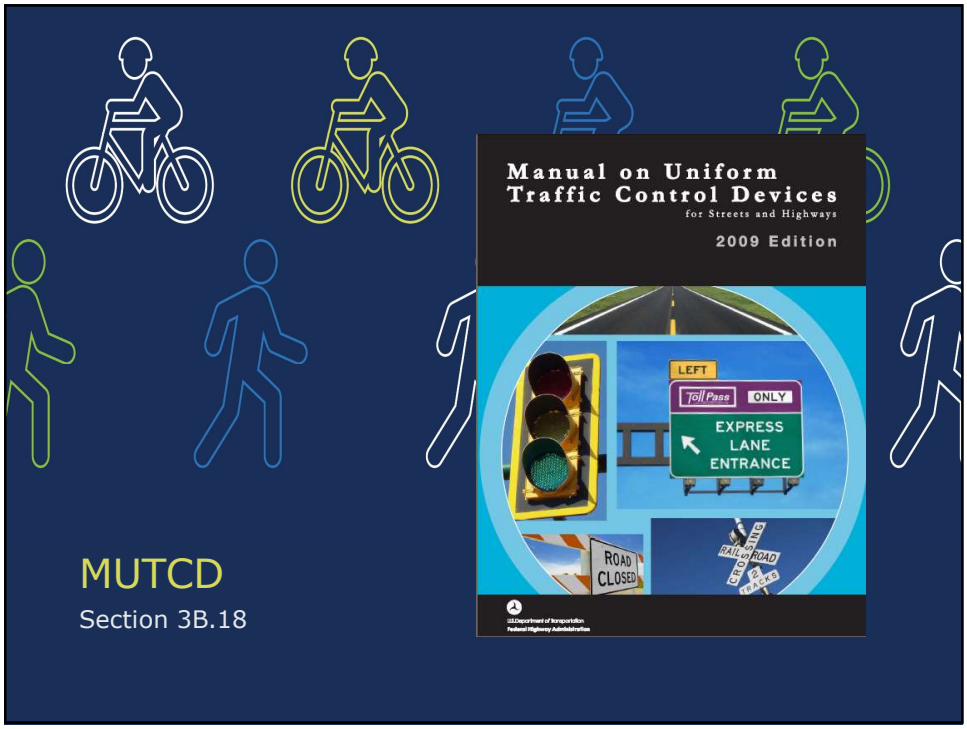
Safety research

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



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

19



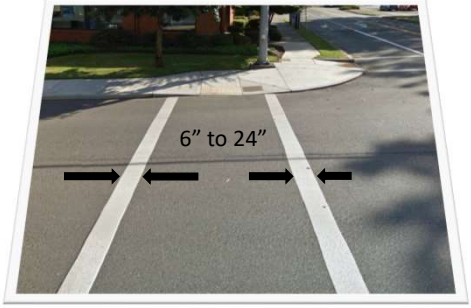
20

Any issues with these crosswalks?

21

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



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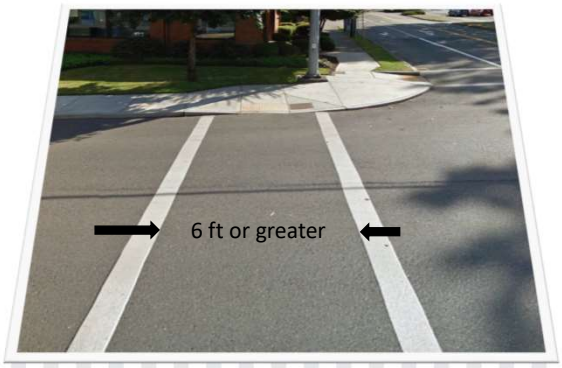
Section 3B.18 Crosswalk Markings

Guidance

- If transverse lines are used to mark a crosswalk, the gap between the lines should not be less than 6 feet.

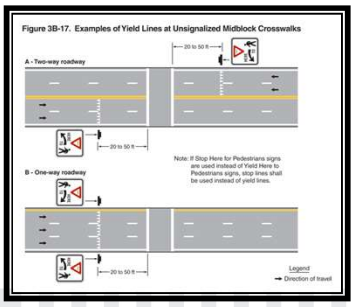


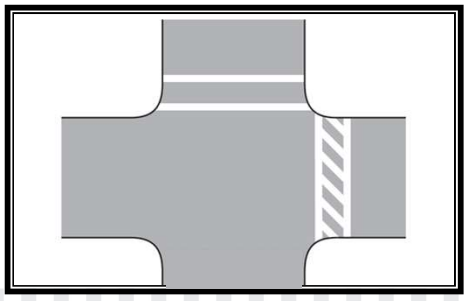
23

Section 3B.18 Crosswalk Markings

Guidance

- Transverse lines, if used on both sides of the crosswalk, should extend across the full width of pavement or to the edge of the intersecting crosswalk to discourage diagonal walking between crosswalks (see Figures 3B-17 and 3B-19).



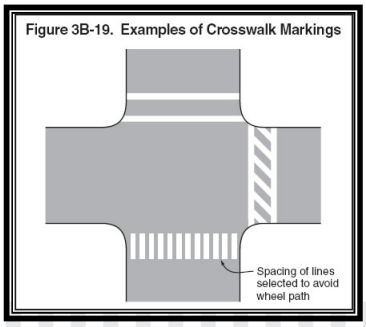


24

Section 3B.18 Crosswalk Markings

Option:

- For added visibility diagonal or longitudinal lines may be used to mark the crosswalk
- When diagonal or longitudinal lines are used, transverse lines may be omitted

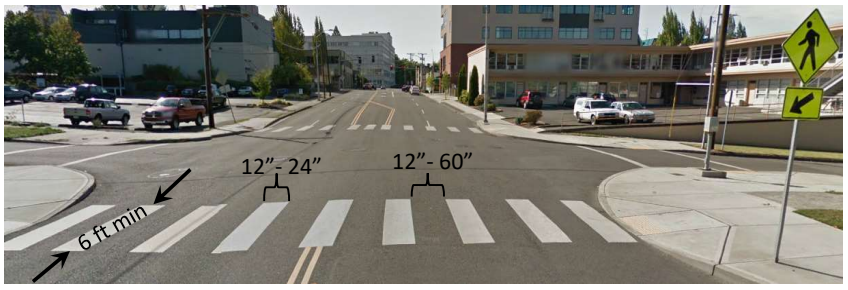


25

Section 3B.18 Crosswalk Markings

Guidance:

- *If used, the diagonal or longitudinal lines should be 12 to 24 inches wide and separated by gaps of 12 to 60 inches*



26

Staggered ladder
Aka piano keys

Guidance:

- *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*

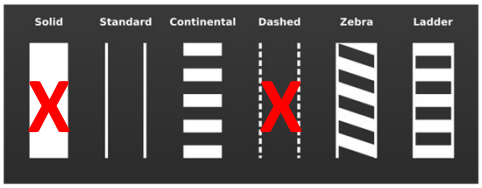
Benefits

- Less maintenance
- Longer service life
- Ultimately lower cost

27

Crosswalk Markings

- Although the MUTCD provides for design options, research and observation indicate that the continental and ladder designs are the most visible to drivers
- These "longitudinal" markings also improve guidance for pedestrians with low vision and cognitive impairments



28

National MUTCD Compliant?

- California
  - 4'x4'x4'
- Benefits
  - Higher friction than some markings materials
  - Wheelchairs, walkers don't have the slight bump

29

National MUTCD Compliant?

30

National MUTCD Compliant?

31

Inlaid Thermoplastic after a few years

32

National MUTCD Compliant?

33

National MUTCD Compliant?

34

Section 3B.18 Crosswalk Markings

Guidance:

- *Crosswalk markings should be located so that the curb ramps are within the extension of the crosswalk markings*

35

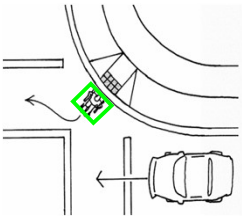
Section 3B.18 Crosswalk Markings

- Detectable warning surfaces are required by 49 CFR, Part 37 and by the Americans with Disabilities Act (ADA) where curb ramps are constructed at the junction of sidewalks and the roadway, for marked and unmarked crosswalks.
- Detectable warning surfaces contrast visually with adjacent walking surfaces, either light-on-dark, or dark-on-light.

36

ADA

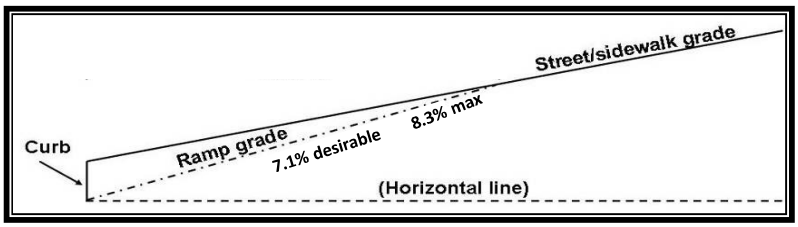
- Two Ramps in line with pedestrian zone ideal
  - PROWAG
    - 1 Ramp should be design exception
- Level landings:
  - Top - 4'x4'
  - Bottom - if single ramp making turn 4'x4'



37

Ramp Grade

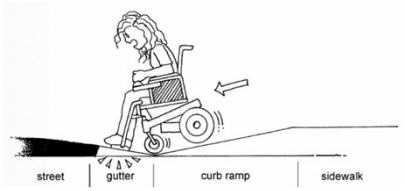
- Recommended maximum grade to allow for construction tolerance – 7.1%
- Maximum grade – 8.3%
- Least slope possible is preferred
- When "chasing grade," ramp length need not exceed 15', but slope must be uniform (PROWAG)

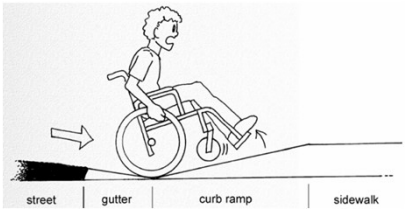


38

Change of Grade

- Abrupt changes of grade are difficult to use and can cause wheelchairs to flip over backward or forward

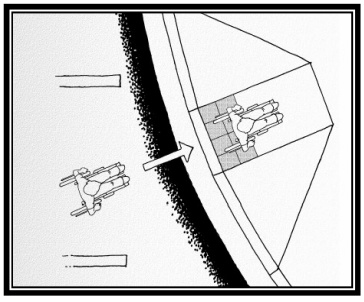


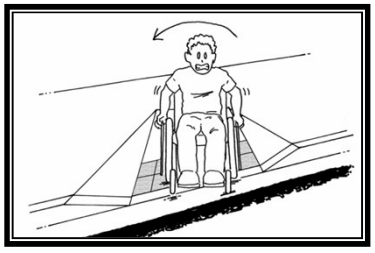


39

Ramp Alignment

- Ramp alignment is important to the stability of the wheelchair.
- Important grade changes take place at right angles
  - If not, a wheelchair becomes unstable and may tip

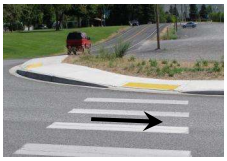




40

Prowag Cross Slope

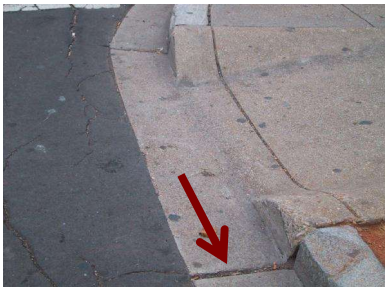
- **R302.6 Cross Slope.** Except as provided in R302.6.1 and R302.6.2, the cross slope of pedestrian access routes shall be 2 percent maximum.
  - **R302.6.1 Pedestrian Street Crossings Without Yield or Stop Control.** Where pedestrian access routes are contained within pedestrian street crossings without yield or stop control, the cross slope of the pedestrian access route shall be 5 percent maximum.
  - **R302.6.2 Midblock Pedestrian Street Crossings.** Where pedestrian access routes are contained within midblock pedestrian street crossings, the cross slope of the pedestrian access route shall be permitted to equal the street or highway grade.



41

Gutter Slope
(Parallel to the curb and the roadway)

- Slope should not exceed 2% at the curb ramp*
  - But some slope is needed for drainage

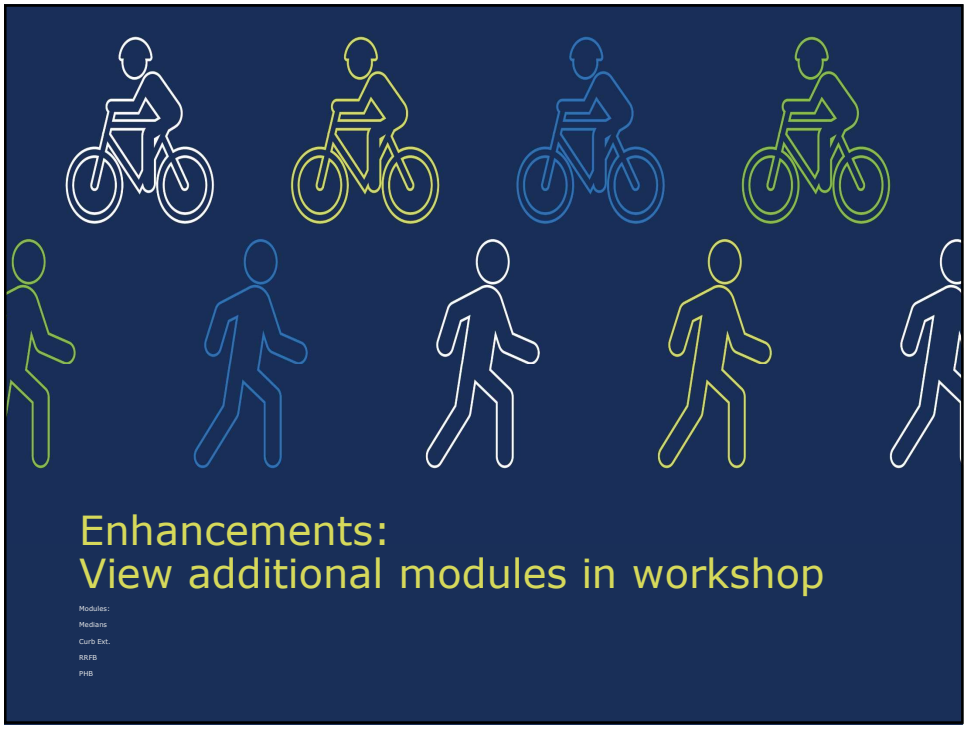
42

Marked Crosswalks and Enhancements - Cost

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	No. of Observations
Crosswalk	High Visibility Crosswalk	$3,070	$2,540	$600	$5,710	Each	4(4)
Crosswalk	Striped Crosswalk	$340	$770	$110	$2,090	Each	8 (8)
Crosswalk	Striped Crosswalk	$5.87	$8.51	$1.03	$26	Linear Ft	12 (48)
Crosswalk	Striped Crosswalk	$6.32	$7.38	$1.06	$31	Sq Ft	5 (15)

For other crosswalk types, costs tend to vary by a large amount. For instance, for crosswalks using other materials such as brick or pavement scoring, costs range from $7.25 to $15 per square foot, or approximately $2,500 to $5,000 each. Ladder crosswalks cost range from $350 to $1,000 each and patterned concrete crosswalks cost $3,470 each or $9.68 per square foot on average.

43



44

Advance Markings

- Advance PED XING or SCHOOL pavement stencils
- Advance solid lane lines

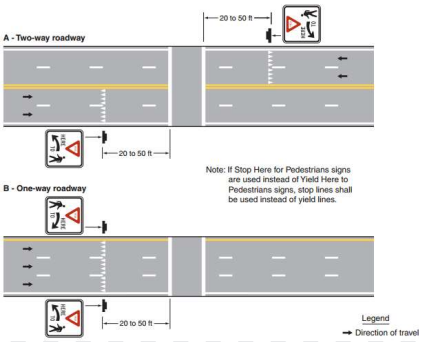
45

Advance, overhead & Crosswalk signs

46

Advance Stop and yield lines

- Optional for uncontrolled crosswalks
- 20 to 50 ft in advance of crosswalk
- YIELD vs. STOP – must match State law
- Stop line for “Stop Here For Pedestrians”, Yield line for “Yield Here for Pedestrians”



47

Two-stage Crossing Island

48

Raised Crosswalks

- FHWA Study "The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior" -2001
- Increase pedestrian visibility & more effective when combined with an overhead flashing light
- For low speed local streets
- Should not be used on emergency routes, bus routes, or high speed streets
- Storm water runoff and snow plowing considerations

Figure 6. Raised crosswalk and overhead flasher, Towerview Drive, Durham, North Carolina.

1-49

49

Raised Crosswalk

Table 8. Comparison of Vehicle Speeds at the Treatment and Control Sites.

CITY AND TREATMENT	50TH PERCENTILE SPEED TREATMENT SITE	50TH PERCENTILE SPEED CONTROL SITE	DIFFERENCE IN SPEEDS
Durham, NC – Research Drive Raised crosswalk	33.3 km/h (20.7 mi/h)	39.8 km/h (24.7 mi/h)	6.5 km/h (4.0 mi/h) *lower* at treatment site SIGNIFICANT[1]
Durham, NC – Towerview Drive Raised crosswalk & overhead flasher	18.5 km/h (11.5 mi/h)	38.4 km/h (23.9 mi/h)	19.3 km/h (12.4 mi/h) *lower* at treatment site SIGNIFICANT
Montgomery County, MD[2] Raised Crosswalk	34.6 km/h (21.5 mi/h)	38.6 km/h (24.0 mi/h)	4.0 km/h (2.5 mi/h) *lower* at treatment site NOT SIGNIFICANT

[1] Significant at the 0.05 level or better, using a two-tailed test.
[2] Vehicle speeds in Montgomery County were measured only when the staged pedestrian was present

Table 9. Pedestrians for Whom Motorists Stopped to Let Them Cross.

SITE AND TREATMENT	TREATMENT SITE	CONTROL SITE	SIGNIFICANCE
Durham, NC — Towerview Dr Raised crosswalk and overhead flasher	79.2% (159)*	31.4% (35)	• (0.000)
Montgomery County, MD Raised crosswalk	1.2% (169)	1.0% (198)	N

50

50

Raised Crosswalk Standard Drawings

- Place holder hidden slide
- Want to include standard drawings for raised crosswalks that are designed for specific speeds.
  - Dimensions for raised crosswalk for 25 mph vs. 35 mph

51

Lighting

- Coordinate streetlights with crosswalk markings
- Lights on both sides of street provide better uniformity
- Street lights should be installed on approaches to crosswalks for best results

52

Design and Operation Issues lighting both sides of crossing

Informational Report on Lighting Design for Midblock Crosswalks FHWA-HRT-08-053 April 2008

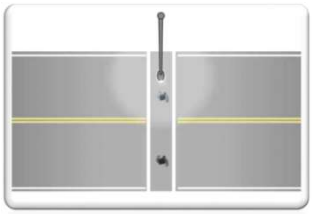


Fig 11. Traditional midblock crosswalk lighting layout

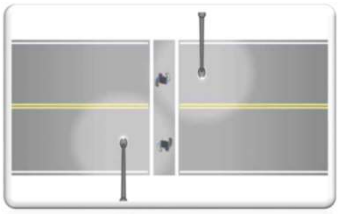


Fig 12. New design for midblock crosswalk lighting layout

Recommended lighting level: 20 lux at 5' above pavement

FHWA Report http://www.tfhrc.gov/safety/pubs/08053/08053.pdf

53

Pedestrian crossing flags

Interpretation Letter 2-563(I)
Pedestrian Flags for Crosswalks

April 27, 2005 Refer to: HOTO-1

Dear Ms. Varney:

Thank you for your February 15 request to experiment with the pedestrian flag education and awareness campaign to improve the safety of pedestrians at crosswalks. **We have reviewed your request and determined that the pedestrian flag is not a traffic control device. Therefore, you do not need to request approval from the Federal Highway Administration (FHWA) to experiment with the flag.** The flag concept described in your letter is similar to the concept of placing retroreflective material on clothing. Although it is not a traffic control device, it is a way to increase the visibility of pedestrians.

- http://mutcd.fhwa.dot.gov/resources/interpretations/2_563.htm

54

Pedestrian Crossing Flags

- NCHRP Report 562 Page 20
  - Moderately effective Salt Lake City UT and Kirkland WA
  - Yielding rates from 46% to 79%
  - Speed limits of 30 mph or less
  - http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf

Things to consider

- Flags get stolen
- Redistribution at corners
  - Neighborhood or business volunteers
- Some flag holder designs are used as garbage cans

55

Crosswalk Marking materials

How many are involved with material specs, inspecting or installing?

Continue Skip

56

Crosswalk Marking Materials

Less Durable

- Paint
  - Water borne
  - Oil-based

More Durable

- Epoxy
- Polyurea
- Thermoplastic
- Pre-formed marking tape

Guide for Maintaining Pedestrian Facilities for Enhanced Safety

57

Factors for choosing material

- Cost to install and maintain
- Durability
- Retroreflectivity (6 lbs. of glass beads per gallon of paint)
- Friction coefficient (avoiding slippery surface)
- Applied using existing agency labor and equipment or contractor
- Ability to remove markings if changes occur

58

Common practices

- Most communities use thermoplastic, which is recommended for its longevity.
- Many frequently use paint on existing roads or when there is an immediate need.
- Epoxy was also mentioned by a number of communities.
- Thermoplastic and epoxy markings are used most often on repaving projects.
- Those communities that paint markings typically use city crews and equipment
- Communities commonly use contractors to install thermoplastic markings.

59

Common issues with Non-Durable markings

- Maintenance
  - Re-striped several times a year based on the volume of traffic and the severity of weather
- To promote longer lifespan when using paint, a "high build grade" is recommended with glass beads for retroreflectivity.
- "High build" uses an acrylic cross-linking emulsion that allows for applications of up to 20 mils

60

common issues with Durable markings

- Less durable in cold weather climates
  - Where the roads are salted and sanded
  - Abrasiveness of these materials will cause more rapid deterioration of markings
  - Snow Plow Damage
- Some thermoplastic markings and some pre-formed marking tapes can become more slippery with wear
  - Manufacturers have significantly improved the friction factor of their materials
  - Slippery markings make it necessary to replace the markings sooner.

61

common issues with Durable markings: Nighttime

- Large percentage of pedestrian fatalities occur in the evening when conspicuity is reduced.
- Crosswalk markings must retain their retroreflectivity, usually accomplished by adding beads or other retroreflective material to marking material.
- When the markings wear, the retroreflective quality of the material is often lost first.
- Recommend methods established in the MUTCD and described on this website to check for the proper retroreflectivity of crosswalks:
  http://safety.fhwa.dot.gov/roadway_dept/night_visib/pavementreg.cfm

62

Epoxy

- Involves two-part system using a simple mixture of two bonding components
- Most significant downside is its application requires specialized equipment
  - Some states, only a handful of vendors have the specialized equipment
- Sandblasting of pavement is normally required to remove existing materials
- Some epoxies have a relatively long cure time (up to 45 minutes depending on ambient conditions)

63

Polyurea

- Durable and good color stability
  - 3 to 5 years service life
- Good abrasion resistance
- Cures in 2 minutes or less
- Requires special striping apparatus
- Experimental application by some agencies
  - Epoxy truck

64

Thermoplastic

- Durability
  - Snowplows often damage thermoplastic markings
  - Can recess markings to decrease the likelihood of snowplow damage, but this is very expensive
- Successful use of pre-formed thermoplastic relies on applying the material to a dry, clean surface nearly completely devoid of existing crosswalk material.
  - This can complicate applications on existing pavement.
- More cost-effective in the long run
- Better option on rougher pavement surfaces
- More visible and less slippery than paint when wet

65

Pre-Formed marking Tape

- Most durable
- Highly retroreflective
- Long-lasting
- Slip-resistant
- Little to no maintenance
- Although initially more costly than paint more cost-effective in the long run
- Recommended for new and resurfaced pavement
- More visible and less slippery than paint when wet

66

Brick or Pavers

- Not a crosswalk marking, but may be used for decorative purposes
- Must have reflectorized white lines on borders to qualify as marked crosswalk
- Expensive to replace if road or utility work cuts pavement
- Not comfortable for those in wheelchairs/strollers (bricks/pavers)
- Expensive to install and maintain
  - Pavers
  - Bowmanite materials
  - Stamped asphalt
  - Inlaid markings

67

Cost comparisons & Life-cycle cost

- A National Cooperative Highway Research Program (NCHRP) Synthesis 306: *Long-Term Pavement Marking Practices* provides cost comparisons and a life-cycle cost table
- In general, thermoplastics provide a life of two to three times that of paint for long lines,
  - Costs averaged almost five times that of paint
- Epoxy markings had a life of two to three times that of paint
  - Cost four times that of paint
- For life-cycle costs, paint was half the cost of thermoplastic
  - Costs and durability ranged significantly in this study.

68

New Pavement or Resurfacing

Include the cost of long-lasting pavement marking materials in the contract.

- Installed by contractors
- Provides longest service life
- Added cost will be minimal to project
- Benefits maintenance budgets

69

Relative comparison

Figure 31: Relative comparison of crosswalk marking materials

Material	Relative Cost $=Low $$$$=High	Lifespan (months)	Retroreflectivity *=Low ***=High
Paint	$	3 – 24	*
Epoxy Paint	$$	24-48	**
Thermoplastic (sprayed)	$$$	48-72*	**
Pre-formed Tape	$$$$	36 – 96*	***

Note: Estimates based on minimum standard crosswalk treatment and updated to reflect 2013 comparative costs.[16,17] Thermoplastic and tape have shortened lifespans in snowy areas where they are often damaged by snowplows. Inlaid thermoplastic or pre-formed tape may last significantly longer than standard surface applications.

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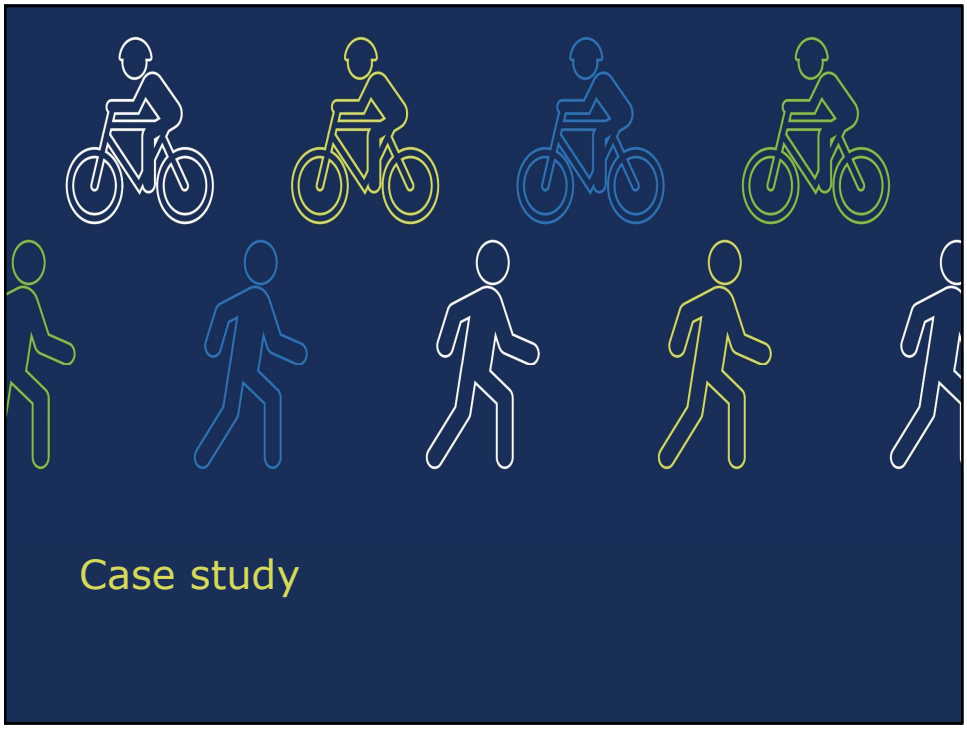

71

Case study: Crosswalks & Enhancements (Shoreline, WA)

Shoreline, WA

Problem and Background

- Aurora Ave lacked continuous sidewalks, signals & crosswalks
- Major north-south arterial
- 3 mile corridor
- High pedestrian traffic
- Crossing and travelling along roadway difficult and dangerous

72

Case study: Crosswalks & Enhancements (Shoreline, WA)

Shoreline, WA

Problem and Background

- Average ADT 45,000
- Major transit route
- Crash statistics among highest in the state
  - Percentage of fatal/disabling incidents twice the statewide average
  - Multiple spots along the corridor identified as high ped crash locations by state DOT

73

Case study: Crosswalks & enhancements (Shoreline, WA)

Shoreline, WA

Solution

- Corridor improved in segments
  - Continuous curbs, 7-foot sidewalks, & better lighting added
  - Two pedestrian bridges built
- Two-way left-turn lane replaced by a center median with left-turn and U-turn pockets
- Pedestrian crossing islands, crosswalks and signals installed
- Business access/transit lane added to improve transit times, reduce conflicts

74

Case study: Crosswalks & Enhancements (Shoreline, WA)

Shoreline, WA

Results

- Widely considered a success
- Businesses/citizens initially skeptical were satisfied with results
- In studies of first mile of improvements, officials found a more than 60 percent reduction in collisions for all roadway users

- Transit ridership increased dramatically

Source: FHWA, "Context Sensitive Solutions,"

75

Questions? Resources

- Marked vs. Unmarked Crosswalks at Uncontrolled locations
  - http://www.fhwa.dot.gov/publications/research/safety/04100/
- Crosswalk Marking Field Visibility Study
  - http://www.fhwa.dot.gov/publications/research/safety/pedbike/10067/10067.pdf
- MUTCD Section 3B.18
  - http://mutcd.fhwa.dot.gov/htm/2009/part3/part3b.htm#section3B18
- NCHRP Report 562 Page 20
  - Crossing flags
  - http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf
- The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior – 2001
  - Raised Crosswalks
  - http://www.fhwa.dot.gov/publications/research/safety/00104/
- Informational Report on Lighting Design for Midblock Crosswalks FHWA-HRT-08-053 April 2008
  - http://www.tfhrc.gov/safety/pubs/08053/08053.pdf
- PedSafe
  - Case Studies
  - http://www.pedbikesafe.org/PEDSAFE/casestudies.cfm

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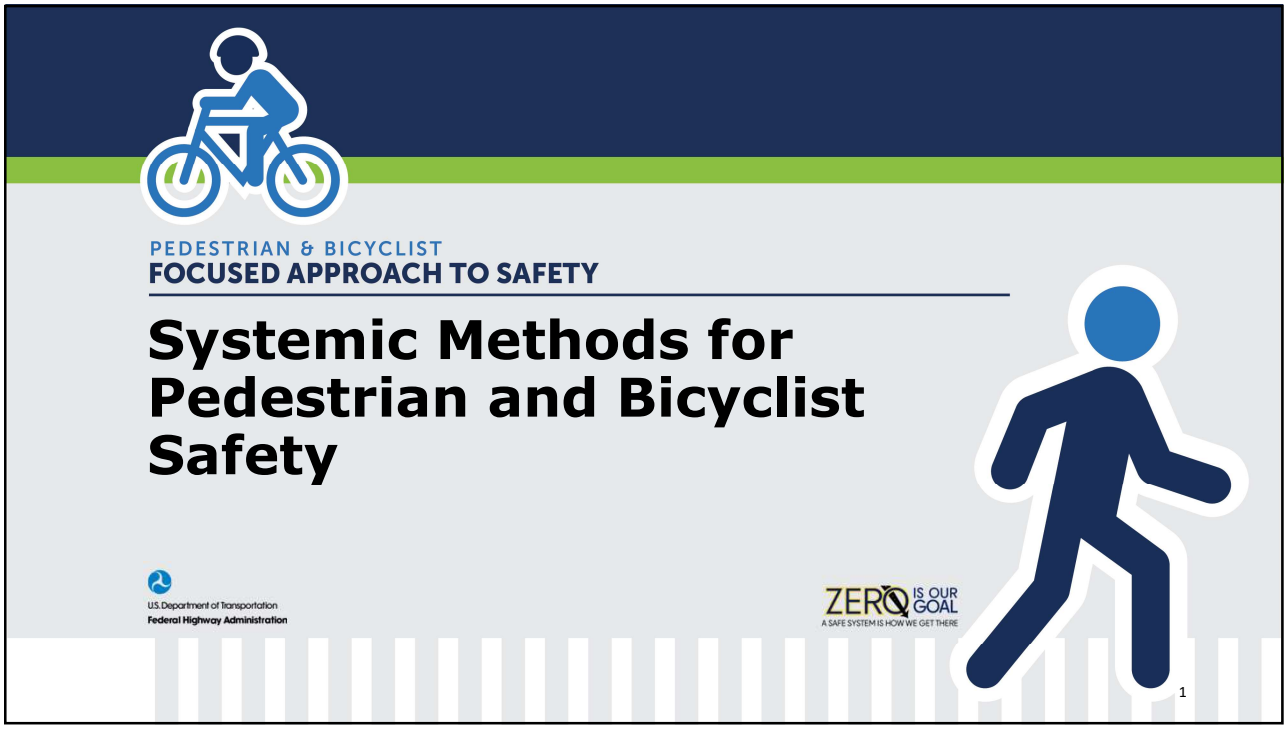

PEDESTRIAN & BICYCLIST
FOCUSED APPROACH TO SAFETY
Systemic Methods for Pedestrian and Bicyclist Safety
U.S. Department of Transportation
Federal Highway Administration
ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE
1

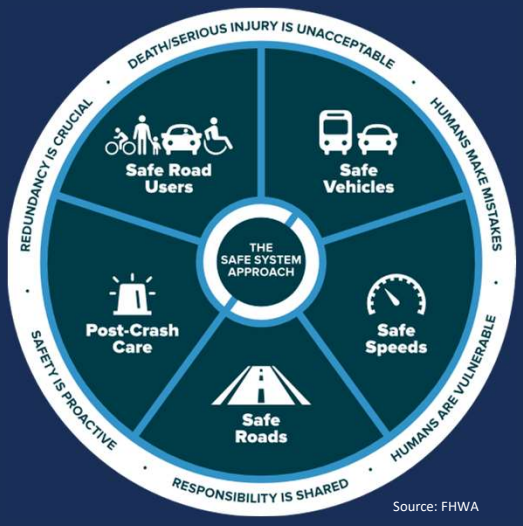
1


Do you think or know that all pedestrians and bicyclists report crashes?
Are all residents comfortable reporting crashes to the police?
2

2

A Paradigm Shift: Zero is Our Goal

The Safe System approach aims to **eliminate** fatal and serious injuries for all road users. It's the road map to get to zero.



Source: FHWA

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Six Key Principles

SAFE SYSTEM PRINCIPLES

Death/Serious Injury is Unacceptable

While no crashes are desirable, the Safe System approach prioritizes crashes that result in death and serious injuries, since no one should experience either when using the transportation system.

Humans Make Mistakes

People will inevitably make mistakes that can lead to crashes, but the transportation system can be designed and operated to accommodate human mistakes and injury tolerances and avoid death and serious injuries.

Humans Are Vulnerable

People have limits for tolerating crash forces before death and serious injury occurs; therefore, it is critical to design and operate a transportation system that is human-centric and accommodates human vulnerabilities.

Responsibility is Shared

All stakeholders (transportation system users and managers, vehicle manufacturers, etc.) must ensure that crashes don't lead to fatal or serious injuries.

Safety is Proactive

Proactive tools should be used to identify and mitigate latent risks in the transportation system, rather than waiting for crashes to occur and reacting afterwards.

Redundancy is Crucial

Reducing risks requires that all parts of the transportation system are strengthened, so that if one part fails, the other parts still protect people.

Source: FHWA. (2020). *The Safe System Approach* [FHWA-SA-20-015]. Federal Highway Administration, Washington, D.C.

4

The Five Safe System Elements: What do they mean for pedestrians and bicyclists?

Safe road users

Safe vehicles

Safe speeds

Safe roads

Post-crash care

5

Safe System Approach: Washington State Active Transportation Plan

Connectivity Goal	**Safety Goal:** Eliminate deaths and serious injuries of people walking and rolling.
Safety Goal	
Opportunity Goal	Adopt policies in support of the **Safe System Approach** including speed management for safety
Participation Goal	Identify and schedule any updates to manuals and guidance needed to support the **Safe System Approach**
Partnership Goal	Develop proactive safety plans for each WSDOT region grounded in the **Safe System Approach** and **Systemic Analysis**

6

6

Safe System Approach: Washington State Active Transportation Plan

- Systemic approach is used to select facilities where gaps are present in ped/bike infrastructure and level of traffic stress is high.
- Improvements may include:
  - Automated flashing warning signs that alert motorists to the presence of bicyclists where sightlines are limited.
  - Targeted shoulder improvements that provide extra space for riders where they are less visible to motorists.

7

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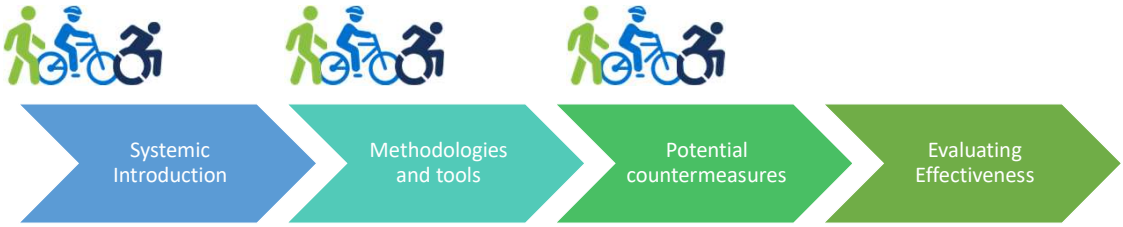
Topics



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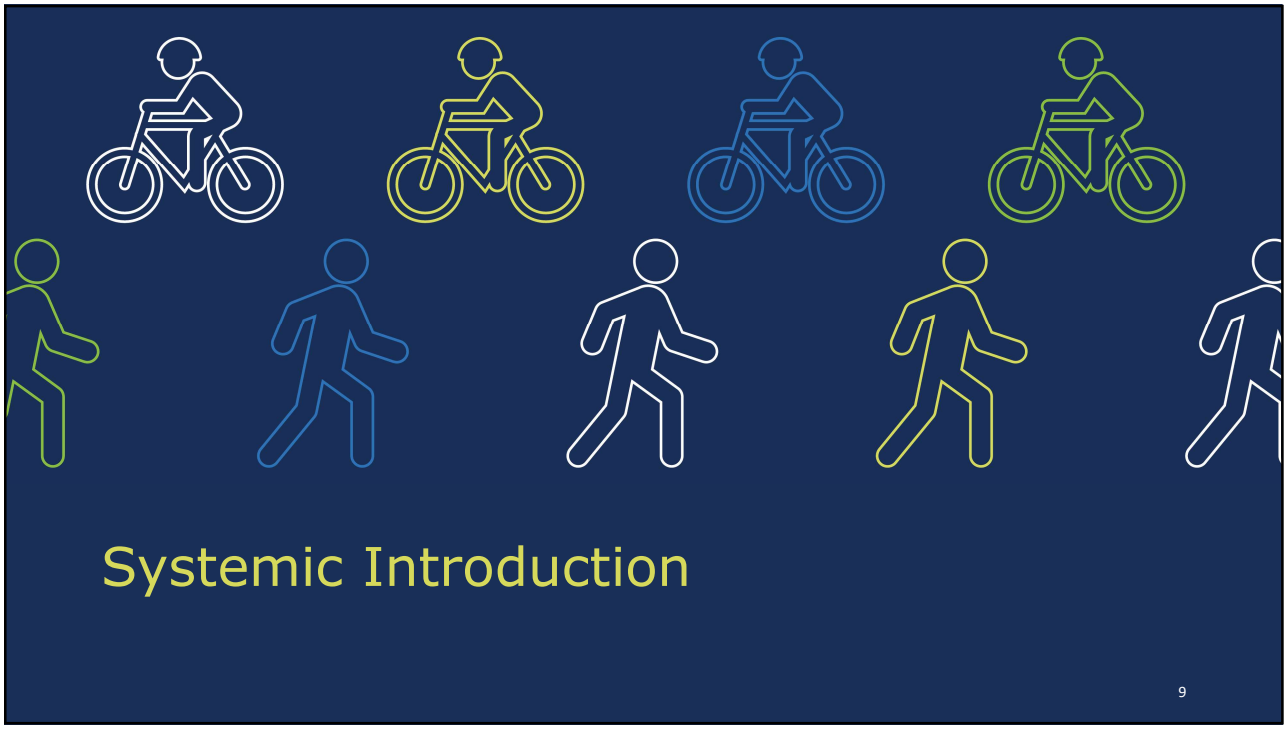

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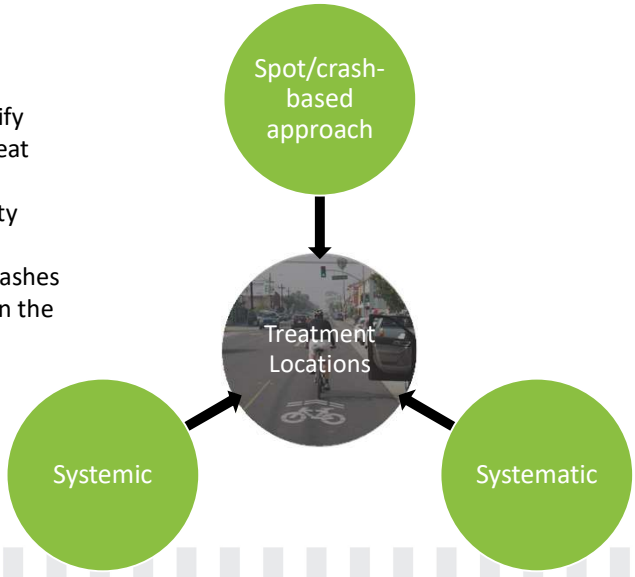
Choosing an approach to improve safety

OBJECTIVE: Identify and effectively treat sites with highest potential for safety improvement to prevent severe crashes from happening in the future



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10

Three Approaches to Address Severe Roadway Crashes

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Which approaches are you familiar with? Which ones have you used?

Hotspot/ Crash-Specific

Systematic

Systemic

https://pollev.com/safetyvhb

12

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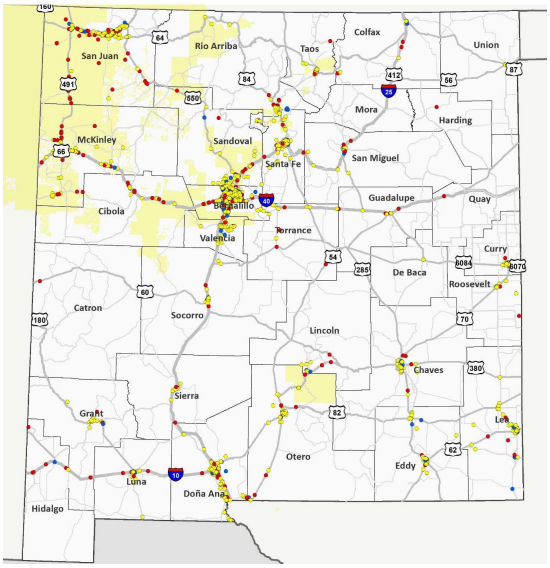

New Mexico DOT Pedestrian Safety Action Plan Pedestrian Crash Clusters

Traditional Crash-Based Approach

- Identify and treat locations that have experienced a high frequency of crashes in the past.
- The underlying safety issue typically varies at each site.
- Projects can range from relatively low-cost to larger capital improvement projects.

13

13

Limitations of a Traditional Crash-Based Approach

- The need for site-specific data.
- The inability to efficiently address highly-dispersed and/or infrequent crashes.
- The potential for high-cost improvements at spot locations.

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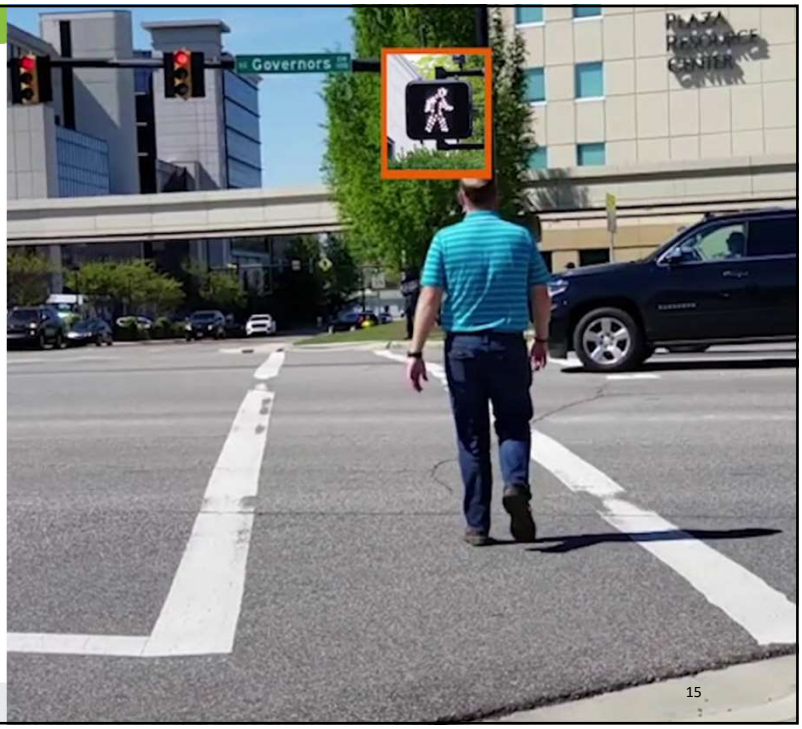
14

Systematic Approach

- Think "system-wide"
- Does not require additional analysis to prioritize locations
- Widespread deployment of safety improvements at all possible locations
- Standard policy for all roadways matching criteria



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Limitations of a Systematic Approach

- May require significant funding to address all locations
- Could result in increased project/program administration costs.
- Can have lengthy time period for full system implementation
- Does not prioritize based on risk of crashes

16

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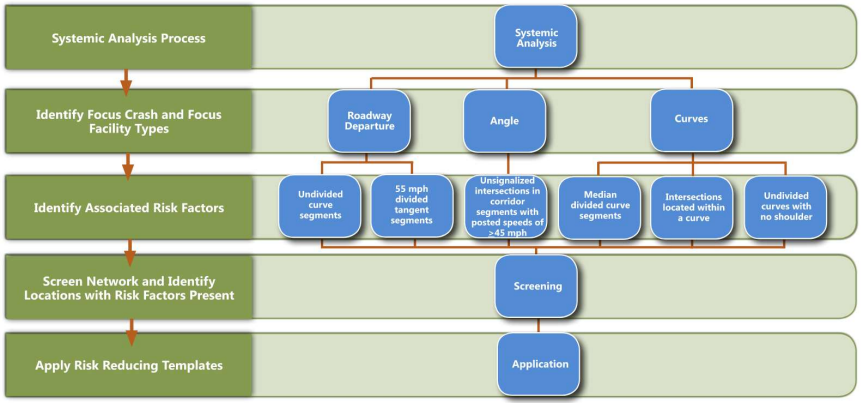

Systemic Approach

- Targets specific crash types or severity for formulation of system-wide methodology as identified by risk.
- Identify sites based on site-specific geometric and operational attributes.
- Site identification may include observed crashes, but that is not the sole determining factor.
- Addresses many sites throughout the network through lower cost improvements.

17

17

Limitations of the Systemic Approach

- Challenges evaluating benefit and cost-effectiveness at individual sites.
- Range of project and maintenance costs.
- Could result in increased project/program administration costs.

18

18

Systemic Approach and Equity

- Data analysis for network screening
  - Houston, TX Vision Zero Network
  - Differences in behavior in some communities
    - Risk factors may yet to be identified
- Prioritization of systemic safety improvements in underserved communities
  - Portland, OR lighting improvements

19

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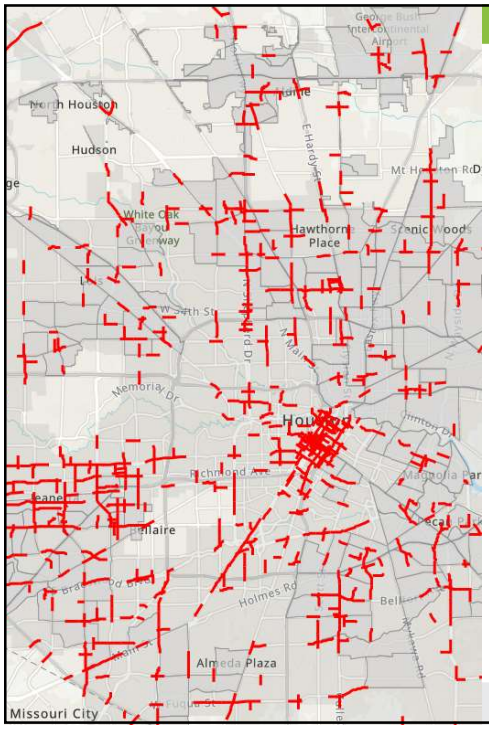


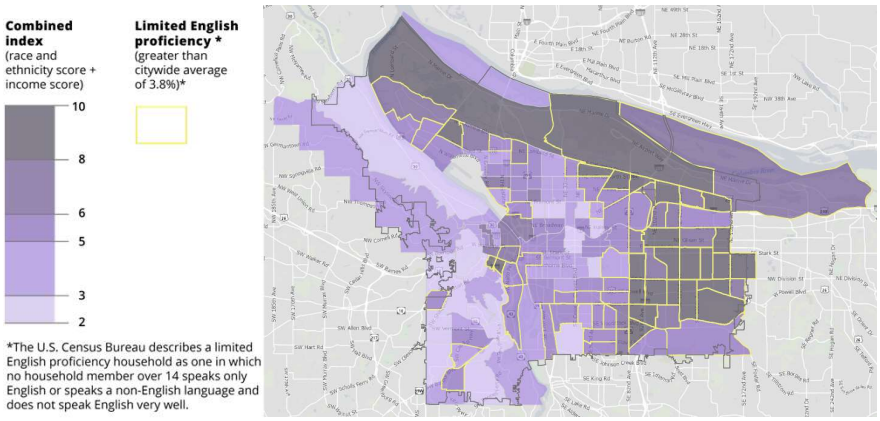
Houston Vision Zero High Injury Network

- Layers crash data with Social Determinants of Health (SDH) data from the Center for Disease Control's (CDC's) Social Vulnerability Index
- 60% of traffic deaths and serious injuries occur on 6% of Houston streets, most of which are located in vulnerable communities
- Identifies high risk roadways using SDH factors rather than a hotspot analysis
- Ultimately prioritizes systemic safety project selection in underserved communities

https://houstontx.gov/visionzero/index.html

20

Portland Equity Matrix



Develops scores for Census Tracts within City based on race, ethnicity, income and Limited English Proficiency (LEP). Used to help prioritize projects for funding.

21

Factors Influencing How Systemic Analysis is Performed

- Data availability
- Resources
- Established priorities
- State/local agency relationship

22

22

Compile Data

- Recommended data for systemic analysis include:
  - Pedestrian crash records, including injury severity, crash type, and spatial references
  - Detailed roadway data with key characteristics such as # of lanes
  - Vehicle traffic and pedestrian volumes or secondary data to estimate volumes (e.g., transit ridership, population/employment density, etc.)
  - Other measures of the built and social environment

23

23

Why Use Systemic to Address Bicyclist and Pedestrian Safety?

- Is not crash dependent
- Addresses many sites throughout the network through lower cost improvements

Charlotte Department of Transportation

24

24

Return on Investment Example

Option 1 (Traditional): Install roundabouts at 3 intersections	Option 2 (Systemic) Install LPIs at 2,000 signalized intersections across the State
Cost = $1M/site = $3M	**Cost** = $1,500/site x 2,000 = $3M
Crash history = 20 crashes/yr./site = 60 crashes	**Crash history** = 0.25 pedestrian crashes/yr./site x 2,000 = 500 ped crashes/year
Crash Modification Factor (CMF) = 0.6 (40% reduction in crashes)	**Crash Modification Factor (CMF)** = 0.81 (19% reduction in ped crashes)
Benefit = reduction of 24 crashes/yr.	**Benefit** = reduction of 95 ped crashes/yr.
Cost to reduce 1 crash = $125,000	**Cost to reduce 1 crash = $31,579**

25

25

Activity #1

$$\text{Improvement cost–effectiveness} = \frac{\text{Total Project Costs}}{(1 - \text{CMF}) \times 100}$$

	Cost		CMF for all Crashes
Signalized Intersection Pedestrian Crossings			
1. Minor signal modification: Retrofitting all 4 signalized crossings with APS and adding LPI	$25K	Per Intersection	0.90
2. Moderate signal modification: Adding 4 signalized crossings with APS, LPI, and curb ramp upgrades	$70K	Per Intersection	0.82
Mid-Block Pedestrian Crossings			
3. Mid-Block RRFB	$70K	Per Crossing	0.93
Unsignalized Intersection Pedestrian Crossing			
4. High visibility crosswalk and pedestrian crossing signs	$5K	Per Crossing	0.81
5. Two new ramps, pedestrian crossing signs, cut back median nose, and high visibility crosswalk	$25K	Per Crossing	0.81
6. Two new ramps, pedestrian crossing signs, installation of median refuge island, and high visibility crosswalk	$35K	Per Crossing	0.70

26

26

Activity #1

	Cost	CMF for all Crashes	Equation	Improvement Cost-Effectiveness
4. High visibility crosswalk and pedestrian crossing signs	**$5K**	**0.81**	$\frac{\$5,000}{(1-0.81)\times 100}$	**263**
6. Two new ramps, pedestrian crossing signs, installation of median refuge island, and high visibility crosswalk	$35K	0.70	$\frac{\$35,000}{(1-0.7)\times 100}$	1,167
5. Two new ramps, pedestrian crossing signs, cut back median nose, and high visibility crosswalk	$25K	0.81	$\frac{\$25,000}{(1-0.81)\times 100}$	1,316
1. Minor signal modification: Retrofitting all 4 signalized crossings with APS and adding LPI	$25K	0.90	$\frac{\$25,000}{(1-0.9)\times 100}$	2,500
2. Moderate signal modification: Adding 4 signalized crossings with APS, LPI, and curb ramp upgrades	$70K	0.82	$\frac{\$70,000}{(1-0.82)\times 100}$	3,889
3. Mid-Block RRFB	$70K	0.93	$\frac{\$70,000}{(1-0.93)\times 100}$	10,000

27

27

28

Systemic….the "Big Picture"

- An improvement that is widely implemented based on roadway characteristics correlated with particular severe crash types.
- **What is "risk"?** The potential for a specific type of severe crash to occur at a specific location because of the location's characteristics or features.

29

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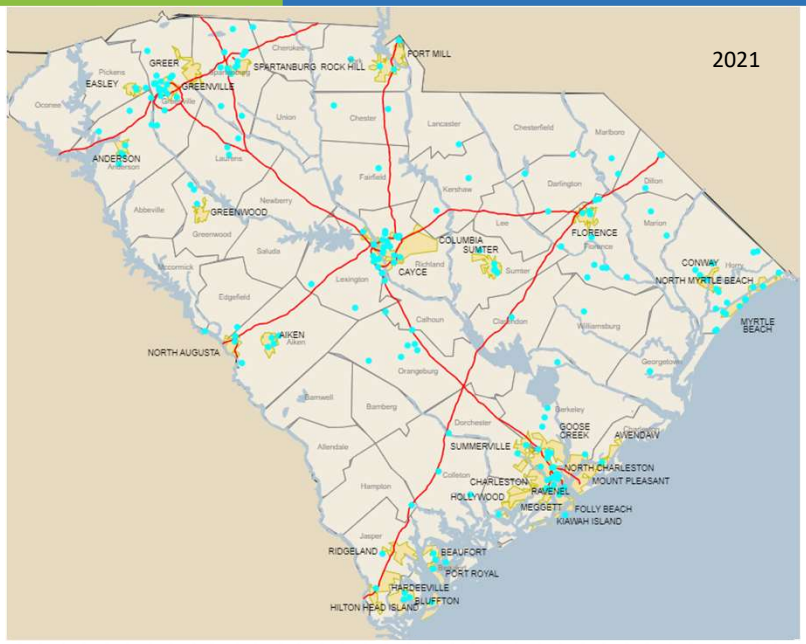

30

South Carolina Pedestrian Fatalities by Year

		2017		2018		2019		2020	
Total Crash		155		165		163		187	
Crash Location	Intersection	16	10.3%	18	10.9%	13	8.0%	24	12.8%
	Non-Intersection	139	89.7%	147	89.1%	150	92.0%	163	87.2%
Area Type	Rural	76	49.0%	80	48.5%	96	58.9%	109	58.3%
	Urban	79	51.0%	85	51.5%	67	41.1%	78	41.7%
Presence of Sidewalk	No	112	72.3%	127	77.0%	131	80.4%	150	80.2%
	Yes	43	27.7%	38	23.0%	32	19.6%	37	19.8%
Pedestrian Position	Intersection Area	9	5.8%	10	6.1%	7	4.3%	10	5.3%
	Crosswalk Area	7	4.5%	6	3.6%	3	1.8%	10	5.3%
	Travel Lane	131	84.5%	140	84.8%	141	86.5%	146	78.1%
	Paved Shoulder / Bicycle Lane / Parking Lane	1	0.6%	1	0.6%	2	1.2%	8	4.3%
	Sidewalk / Shared-Use Path / Driveway Access	2	1.3%	5	3.0%	3	1.8%	2	1.1%
	Other/Unknown	5	3.2%	3	1.8%	7	4.3%	11	5.9%

31

31

South Carolina Bike Fatalities by Year

		2017		2018		2019		2020	
Total Crash		17		23		26		14	
Crash Location	Intersection	2	11.8%	5	21.7%	6	23.1%	1	7.1%
	Non-Intersection	15	88.2%	18	78.3%	20	76.9%	13	92.9%
Area Type	Rural	13	76.5%	15	65.2%	10	38.5%	8	57.1%
	Urban	4	23.5%	8	34.8%	16	61.5%	6	42.9%
Helmet Use	No	15	88.2%	22	95.7%	18	69.2%	10	71.4%
	Yes	2	11.8%	1	4.3%	7	26.9%	0	0.0%
	Unknown/Not Reported	0	0.0%	0	0.0%	1	3.8%	4	28.6%
Bicyclist Position	Travel Lane	17	100.0%	22	95.7%	23	88.5%	13	92.9%
	Bicycle Lane / Paved Shoulder / Parking Lane/Sidewalk	0	0.0%	0	0.0%	2	7.7%	0	0.0%
	Other	0	0.0%	1	4.3%	1	3.8%	1	7.1%

32

32

Systemic….the "Big Picture"

Essential components of analysis include:

- Identifying **crash trends** and **common geometric features** common to those crashes.
- **Screening** the roadway network and **treating** those geometric features present on a subset of the of the network.

33

33

Where to begin?

- Focus Crash Type
- Focus Facility

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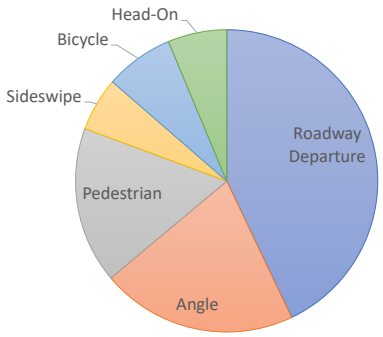
34

What we mean by "focus crash type"

- Greatest proportion of crashes
- Greatest number of severe crashes
- Overrepresentation based on exposure/volumes or severity



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What we mean by "focus facility"

- Greatest proportion of crashes
- Greatest number of severe crashes
- Overrepresentation based on exposure/volumes or severity

Rank	Crash Type	Total	Percent of NC Total
#1	Motorist Drive Out - Sign-Controlled Intersection	444	9.2%
#2	Motorist Overtaking - Other / Unknown	377	7.8%
#3	Bicyclist Ride Through - Sign-Controlled Intersection	296	6.1%
#4	Motorist Left Turn - Opposite Direction	277	5.7%
#5	Motorist Drive Out - Commercial Driveway / Alley	245	5.1%
#6	Bicyclist Left Turn - Same Direction	241	5.0%
#7	Non-Roadway	213	4.4%
#8	Motorist Right Turn - Same Direction	186	3.9%
#9	Motorist Overtaking - Undetected Bicyclist	166	3.4%
#10	Bicyclist Ride Out - Midblock - Unknown	157	3.3%
#11	Motorist Overtaking - Misjudged Space	154	3.2%
	Total for top 11 crash types	2756	57.1%

36

36

What we mean by "risk factor"

Crash risk factors are those common characteristics for the focus crash/facility type

- Volume
- Alignment
- Intersection Control
- Presence of Shoulders

37

37

Intersection Pedestrian & Bicyclist Risk Factors

General

- Proximity to transit and pedestrian generators (arenas, auditoriums, stadiums, restaurants, schools, and establishments that sell alcohol, etc.)
- Presence/condition of markings, signs, and signals

Signalized intersection

- Inadequate signal phasing
- Inadequate sight distance
- Turning movement conflicts
- Inadequate lighting
- Failure to stop/yield

Unsignalized intersection

- Inadequate sight distance
- Turning movement conflicts
- Failure to stop/yield
- Inadequate lighting

38

38

Segment Pedestrian & Bicyclist Risk Factors

- Inadequate warning of mid-block crossing
- High traffic volume
- High approach speed
- Failure to stop/yield
- Number of travel lanes
- Inadequate delineation/warning (signs, pavement markings, delineators)
- Poor nighttime visibility or lighting
- Distance between marked crosswalks
- Absence of a median refuge island

- Lack of dedicated space
- Narrow lanes
- Poor pavement quality
- Large speed differential
- High percentage of heavy vehicles
- Inadequate shoulder width
- Poor nighttime visibility or lighting
- Inadequate buffer/barrier from vehicles
- Inadequate pavement markings
- Proximity to transit

39

39

Equity Related Risk Factors

Factors	How it impacts Disadvantaged Communities
Time of day	May be likely to work on non-traditional hours, or commute during dark hours
Road type	Arterials and high-volume roadways are frequently present in the community
Ped/Bike Infrastructure	Often lack connecting or well-maintained ped/bike facilities
Land use	Frequently located near industrial areas, or may be a food desert
Multimodal	Lack connections to transit or ped/bike facilities, resulting in longer commutes
Mode choice	Households not have a vehicles - people may rely on walking, biking, or transit
Mistrust of Gov't Institutions	Lack of trust of law enforcement - crashes may go unreported
Funding	Transportation improvements are frequently under funded/not prioritized

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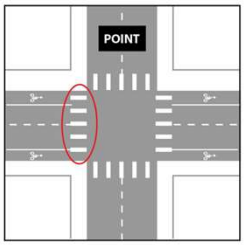
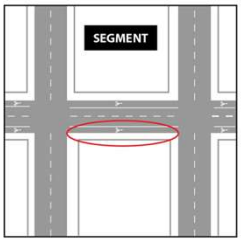
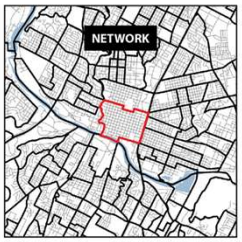
Geographic Scales Covered

Facility-Specific





Areawide



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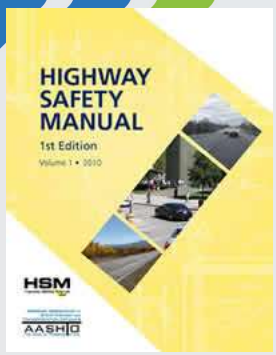

Tools for Risk-Based Safety Analysis

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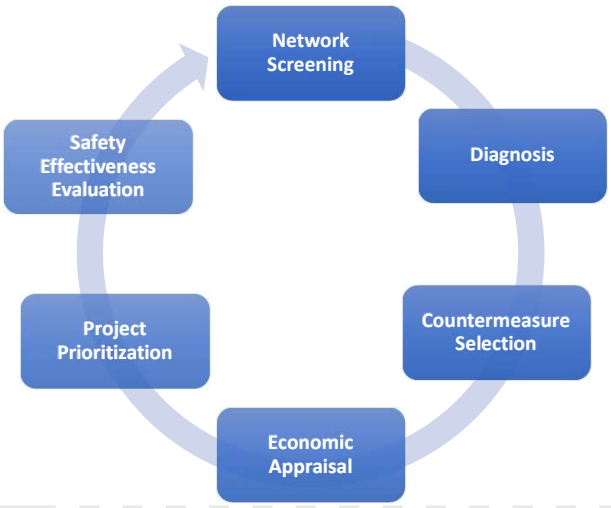
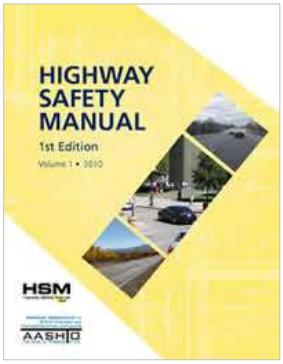
42

Highway Safety Manual (HSM)





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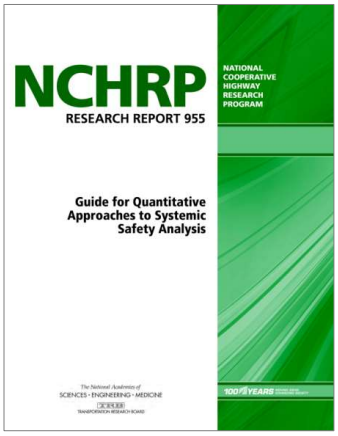
43

NCHRP Report 955 (2020)

This document:

- Provides detail on three systemic analysis tools:
  - FHWA Systemic Project Selection Tool
  - usRAP
  - Safety Analyst
- Determines appropriate applications for quantitative approaches to systemic safety analysis.
- Presents best practices for implementing quantitative approaches.
- Presents available resources for systemic safety analysis.



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FHWA Systemic Project Selection Tool

(2013)

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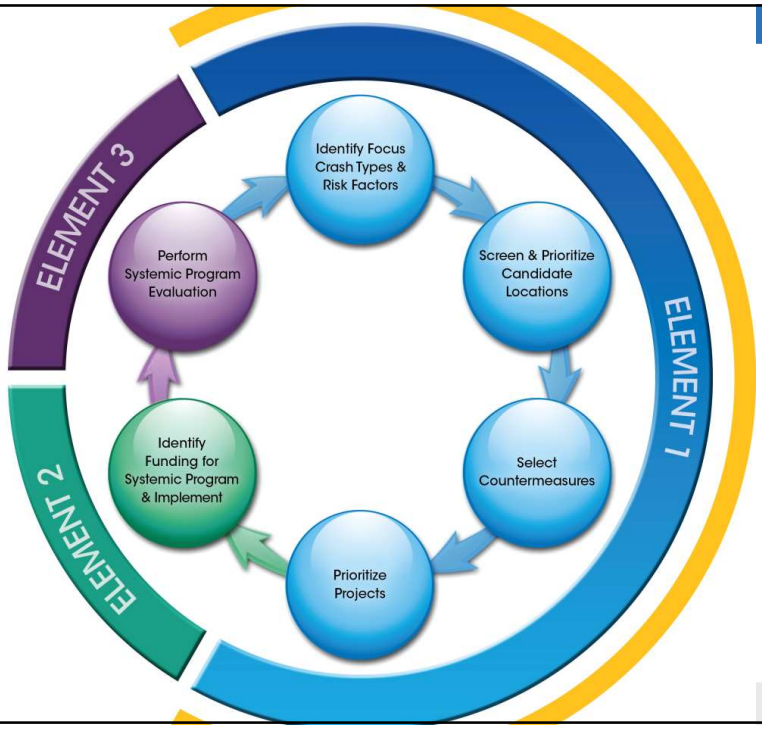


FHWA Systemic Project Selection Tool Element 1: Systemic Safety Planning Process

46

46

FHWA Systemic Project Selection Tool
Element 1: Systemic Safety Planning Process

47

47

Helpful Hints

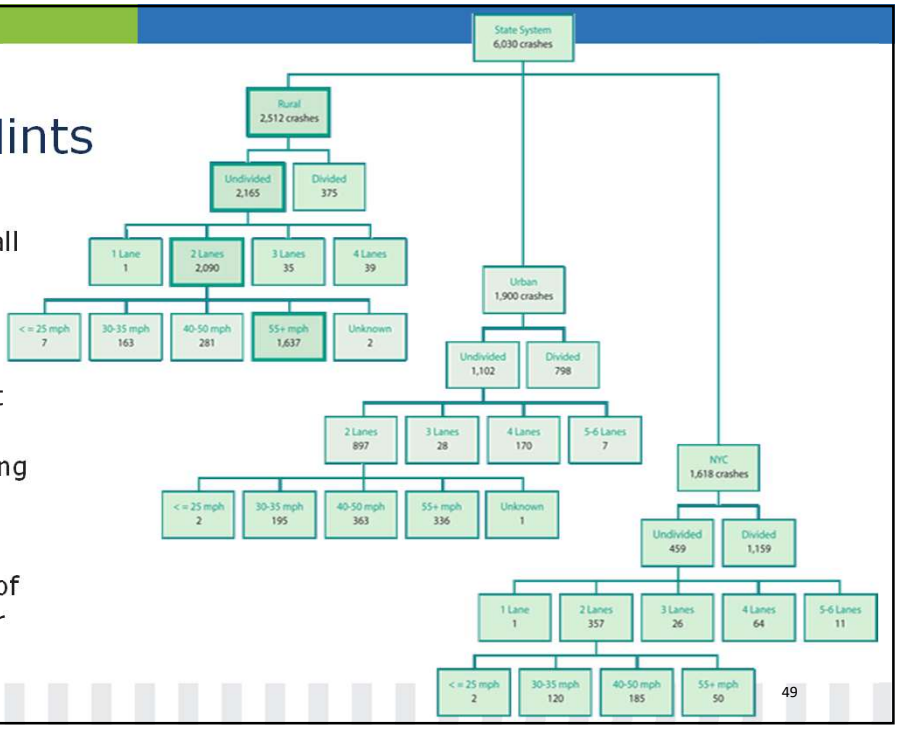
- Local focus crash types can differ from statewide focus crash types
- Focus crash types can include causal factors from the 4 E's

48

48

Helpful Hints

- Crash trees can include all severe crashes or just severe crashes for one focus crash type
- Experience suggests that 100 severe crashes or more is best for identifying patterns.
- Fewer facility types streamlines the process of identifying candidates for investment



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Helpful Hints

- A minimum of 2 to 3 risk factors are suggested to differentiate between sites
- Occasions may occur in which combining risk factors can indicate if a particular crash type is overrepresented

50

50

Helpful Hints

Many local agencies (particularly cities) are beginning to implement the systemic approach by completing a local road safety plan or a Vision Zero plan

51

51

NCHRP Report 893 - Systemic Pedestrian Safety Analysis

(2018)

52

52

Objectives of NCHRP Report 893

Develop a process (and Guidebook) that includes:

Analytical methods to identify risk factors associated with pedestrian crashes

Methods to identify appropriate and cost-effective systemic pedestrian safety improvements

Information to enable transportation agencies to prioritize candidate locations for selected safety improvements

53

53

Guidebook Elements

- Overview
  - Background on a Systemic Process and key features
  - How to use the Guidebook and intended audience
  - Relation to other agency processes
- Process steps
- Examples
- Glossary of key terms
- Appendices
- Companion: Final Report

54

54

Steps in the Guidebook

http://www.trb.org/Publications/Blurbs/17808

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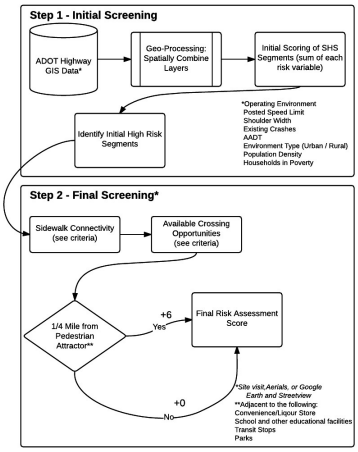
Examples with Key Takeaways

1. Seattle DOT
2. Oregon DOT
3. Arizona DOT
4. California DOT (Caltrans)



Preliminary Identification of High-Risk Segments (ADOT 2017).

56

56

Limitations and Considerations

- Recognition that limited data is a primary obstacle to implementing a robust systemic safety analysis process
- Limited data on behavior-based risk factors or examples in practice
- Limited research or evaluation of Steps 6-7 in practice
- CMFs for treatments applied systemically may differ from those applied based on crash history

57

57

Interagency Collaboration Opportunities

- Continued work to improve data: coverage, quality, standardization, timeliness, and spatial linkage
  - Pedestrian and motor vehicle traffic counts & volume estimation
- Build training/skills, tools, methodologies for developing SPFs for different contexts
- Conduct systemic countermeasure evaluations

58

58

AASHTOWare Safety by Numetric

- A suite of tools designed to improve highway safety by helping agencies plan and evaluate the implementation of safety countermeasures at locations with high potential for safety improvement
- Automates the analytical methods presented in Part B of the HSM
- Available through AASHTO

59

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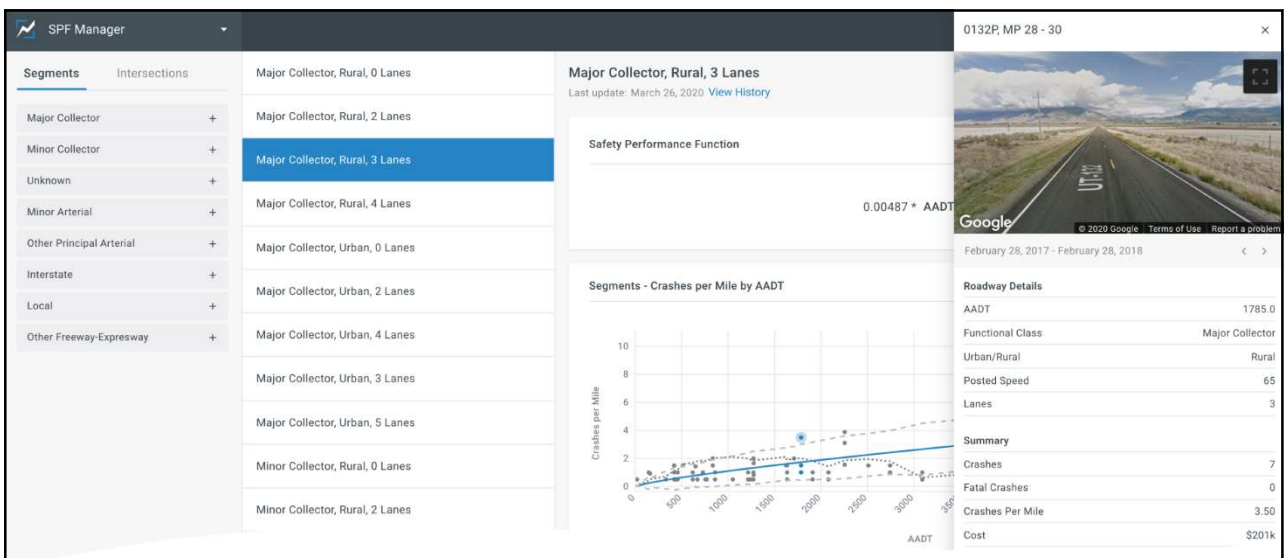


AASHTOWare Safety by Numetric

Crash-based screening module with four methods:

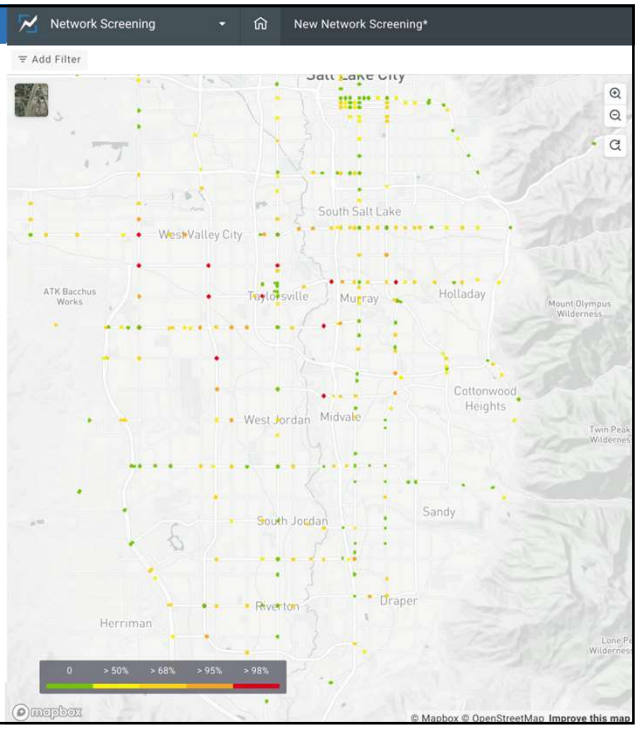
- Fixed segment
- Sliding window
- HSM method
- EB (Empirical Bayes) method

60

60

AASHTOWare Safety by Numetric

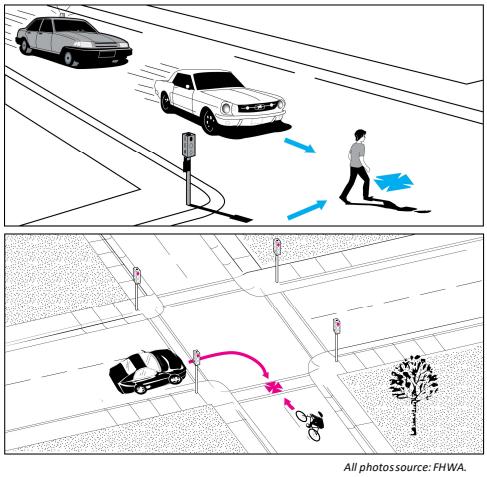
- Includes an overrepresentation module
- Can filter for sites that are compatible with a specific countermeasure
- Can produce "top countermeasures" based on crash history
- Can calculate a B/C ratio



61

What is PBCAT?

- Uses nonmotorized crash typing application*:
  - **Bicyclists**
  - **Pedestrians**
  - **Persons using personal conveyance devices**
- Assists State and local pedestrian/bicycle coordinators, planners, and engineers.
- Turns raw crash reports into data using consistent coding.



All photos source: FHWA.

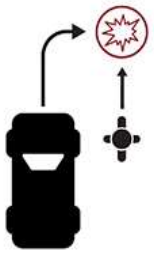
*https://www.pbcat3.org/

62

62

PBCAT Application Use Cases

- Stakeholder education on crash circumstances and scenarios.
- Road Safety Audit preparation and systemic analysis:
  - Richer data for detailed decisions.
  - Crash datasets tend to be streamlined.
  - Crash diagrams of movements, positions, etc.
- Conditions under which these events could occur.
- Areas where these crash types may occur.
- Corresponding systemic improvements:
  - Poor yielding (leading pedestrian interval – (LPI)).
  - Midblock (median refuge).
  - Transit-related (stop relocation).



Source: FHWA.

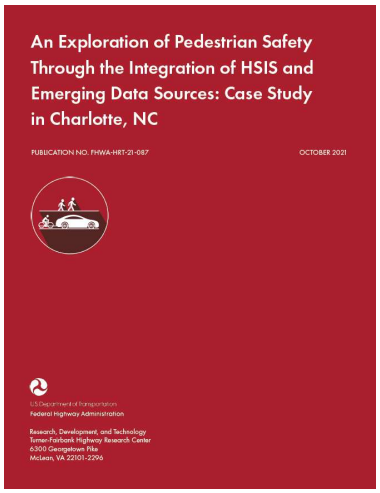
Thomas, L., D. Levitt, M. Vann, K. Blank, K. Nordback, and A. West. 2021. *Pedestrian and Bicycle Crash Analysis Tool (PBCAT): Version 3.0 User Guide.* Washington DC: Federal Highway Administration. https://pbcat3.org/PBCAT_UserGuide.pdf, last accessed July 11, 2022.

63

63

PBCAT in Practice

- City of Austin's Pedestrian Safety Action Plan.
- Wisconsin Department of Transportation statewide crash screening.
- North Carolina Department of Transportation statewide crash screening:
  - Part of the HSIS data system.
  - FHWA HSIS research: *An Exploration of Pedestrian Safety Through the Integration of HSIS and Emerging Data Sources: Case Study in Charlotte, NC.*



Source: FHWA.

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usRAP?

- The U.S. Road Assessment Program is a "tool for analyzing the safety of a roadway and generating data-driven solutions for correcting hazards"
- Data-driven planning tool
- Systemic analysis: focus on and correct hazardous locations
- Supports other initiatives (e.g. MIRE, data-driven initiatives/asset management)
- UDOT has taken significant steps to **collect data** using the usRAP methodology and **deploy it**

65

65

What is usRAP?

Model Inventory of Roadway Elements (MIRE) and usRAP

Status Key		Non-Local (Minor Collector and Above)		Local (Local Functional Class)	Unpaved (All Classifications)	HPMS Name
Complete / In Progress / Planned / Not Required		State-Owned Roads	Other Roads (Federal Aid)			
SEGMENT ELEMENTS	23. Surface Type	Asset Inventory	Collect: usRAP Maintain: ARNOLD	ARNOLD		Surface_Type (49)
	31. Number of Through Lanes					Through_Lanes (7)
	54. Median Type					Median_Type (35)
	79. AADT	Business Systems		ARNOLD		AADT (21)
	80. AADT Year					N/A
	91. One/Two-Way Operations	Collect: usRAP Maintain: ARNOLD				Facility Value 1 or 2 (3)
JUNCTION ELEMENTS	120. Junction Identifier	Asset Inventory	usRAP			
	122. Identifier for Road 1 Crossing Point					
	123. Identifier for Road 2 Crossing Point					
	126. Intersection Geometry					
	131. Intersection Traffic Control					

66

66

usRAP Objectives

Reduce death and serious injury on U.S. roads

Improve safety

Methodology for Risk Assessment

Major safety shortcomings that can be addressed by practical road improvement

Protocols

Star Ratings
Investment Plans

Strategic decisions on route improvements, crash protection, and standard route management

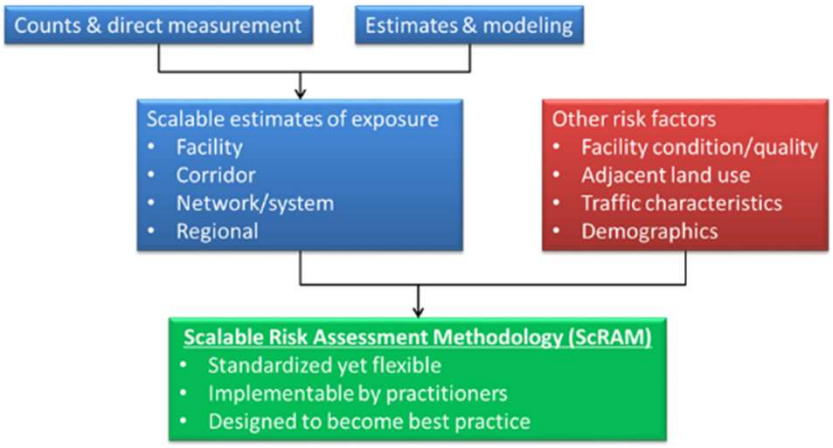
67

67

Scalable Risk Assessment Methodology

- Develop a standardized approach to estimate pedestrian and bicyclist exposure to risk.

Conceptual Framework for ScRAM



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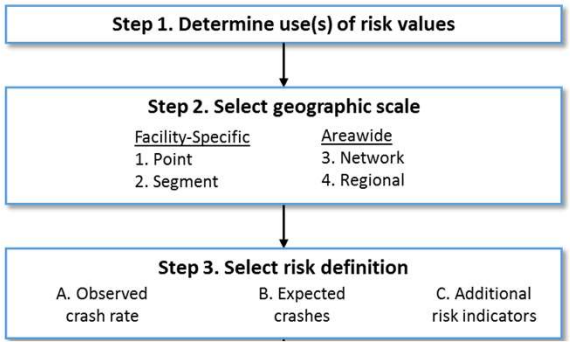
68

8 Steps of SCRAM

- Framework with flexibility
- Exposure is key ingredient, focus in project
- Scale matters (a lot)



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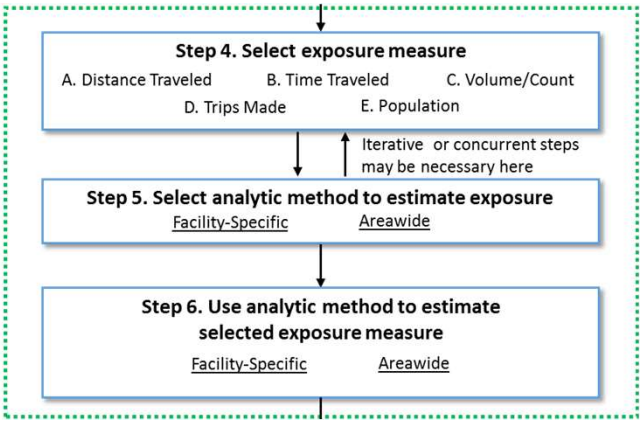
8 Steps of SCRAM

- Framework with flexibility
- Exposure is key ingredient, focus in project

Exposure Estimation Steps (inside dashed box)



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8 Steps of SCRAM

- Framework with flexibility
- Exposure is key ingredient, focus in project

Step 7. Compile other required data
(based on definition of risk selected in Step 3)

↓

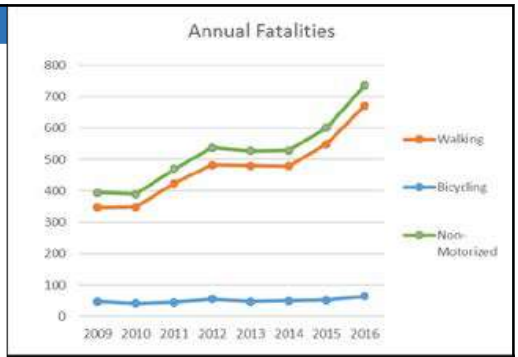
Step 8. Calculate risk values

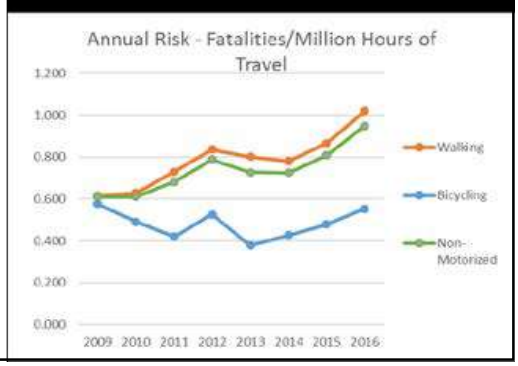
71

71

Areawide Non-Motorized Exposure Tool

- Combines the best of NHTS and ACS travel surveys
- Statewide and MPO area estimates of TOTAL pedestrian and bicyclist exposure





72

FHWA Contributing Factors for Focus Crash and Facility Types

- Main objectives of this project were to
  - select reliable and applicable data resources, statistical methodologies, analysis procedures, and tools;
  - conduct data analysis to identify and validate FCFTs and associated contributing factors;
  - and identify potential low-cost safety strategies that may effectively be used as systemic safety improvements

73

73

Seattle Department of Transportation's Bicycle and Pedestrian Safety Analysis (BPSA)

- Included an effort to estimate pedestrian and bicycle volumes using Census, economic, land use, infrastructure, and Strava data.
- Developed an exposure model that is used to estimate the number of events that might result in a crash.
- Initially used to propose standalone projects.
  - Has since incorporated BPSA into its Complete Streets Checklist process.

74

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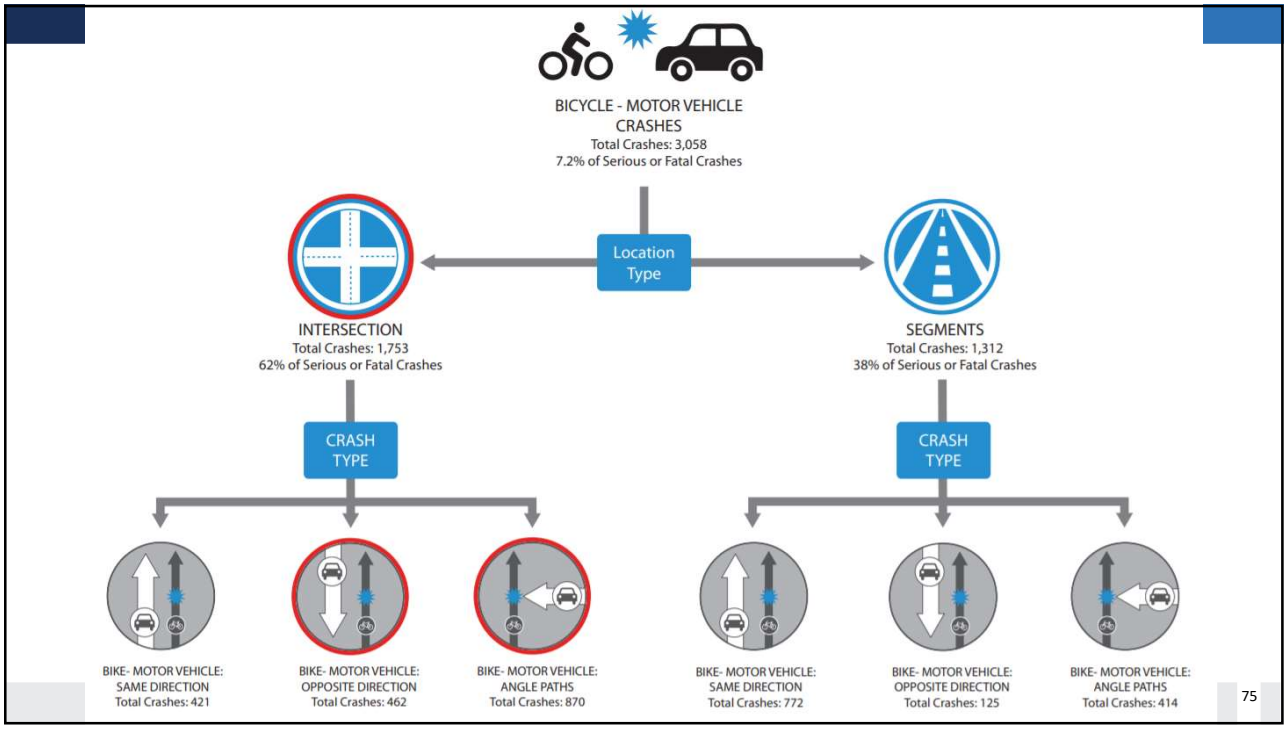
BICYCLE - MOTOR VEHICLE CRASHES
Total Crashes: 3,058
7.2% of Serious or Fatal Crashes
Location Type
INTERSECTION
Total Crashes: 1,753
62% of Serious or Fatal Crashes
SEGMENTS
Total Crashes: 1,312
38% of Serious or Fatal Crashes
CRASH TYPE
CRASH TYPE
BIKE- MOTOR VEHICLE: SAME DIRECTION
Total Crashes: 421
BIKE- MOTOR VEHICLE: OPPOSITE DIRECTION
Total Crashes: 462
BIKE- MOTOR VEHICLE: ANGLE PATHS
Total Crashes: 870
BIKE- MOTOR VEHICLE: SAME DIRECTION
Total Crashes: 772
BIKE- MOTOR VEHICLE: OPPOSITE DIRECTION
Total Crashes: 125
BIKE- MOTOR VEHICLE: ANGLE PATHS
Total Crashes: 414
75

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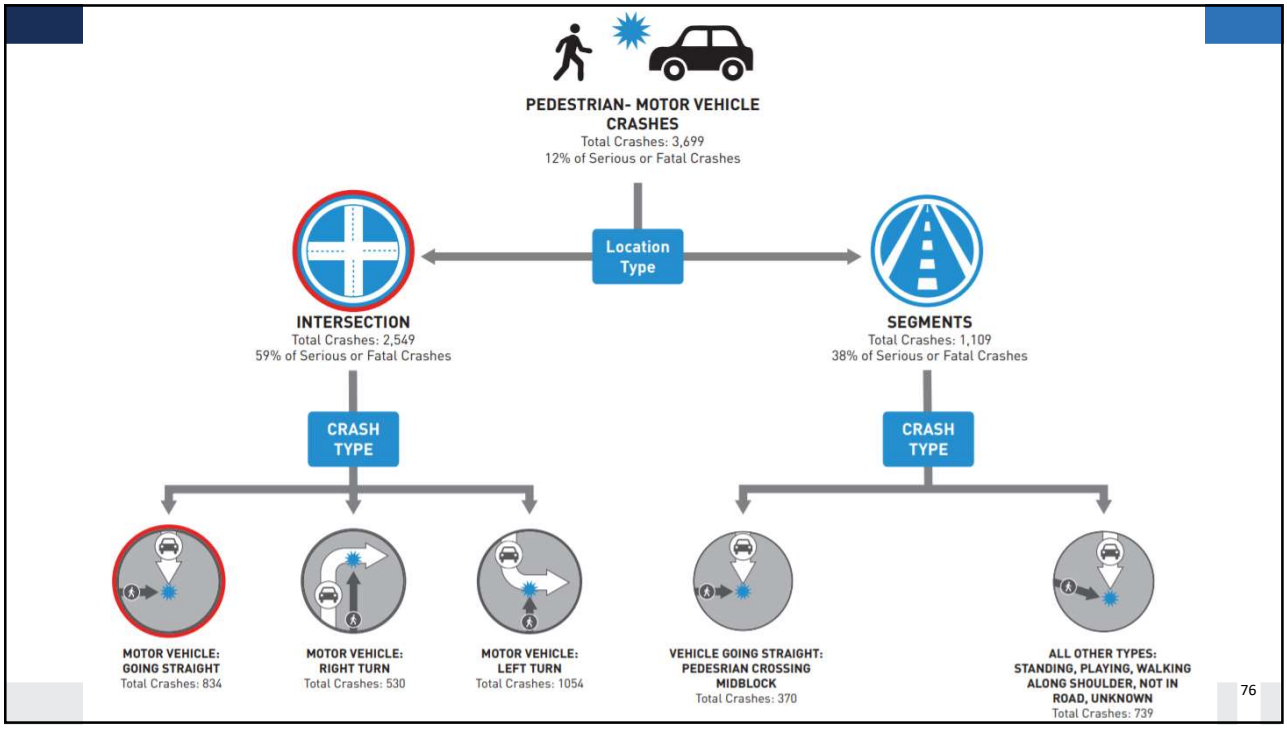
PEDESTRIAN- MOTOR VEHICLE CRASHES
Total Crashes: 3,699
12% of Serious or Fatal Crashes
Location Type
INTERSECTION
Total Crashes: 2,549
59% of Serious or Fatal Crashes
SEGMENTS
Total Crashes: 1,109
38% of Serious or Fatal Crashes
CRASH TYPE
CRASH TYPE
MOTOR VEHICLE: GOING STRAIGHT
Total Crashes: 834
MOTOR VEHICLE: RIGHT TURN
Total Crashes: 530
MOTOR VEHICLE: LEFT TURN
Total Crashes: 1054
VEHICLE GOING STRAIGHT: PEDESRIAN CROSSING MIDBLOCK
Total Crashes: 370
ALL OTHER TYPES: STANDING, PLAYING, WALKING ALONG SHOULDER, NOT IN ROAD, UNKNOWN
Total Crashes: 739
76

76


Potential Countermeasures
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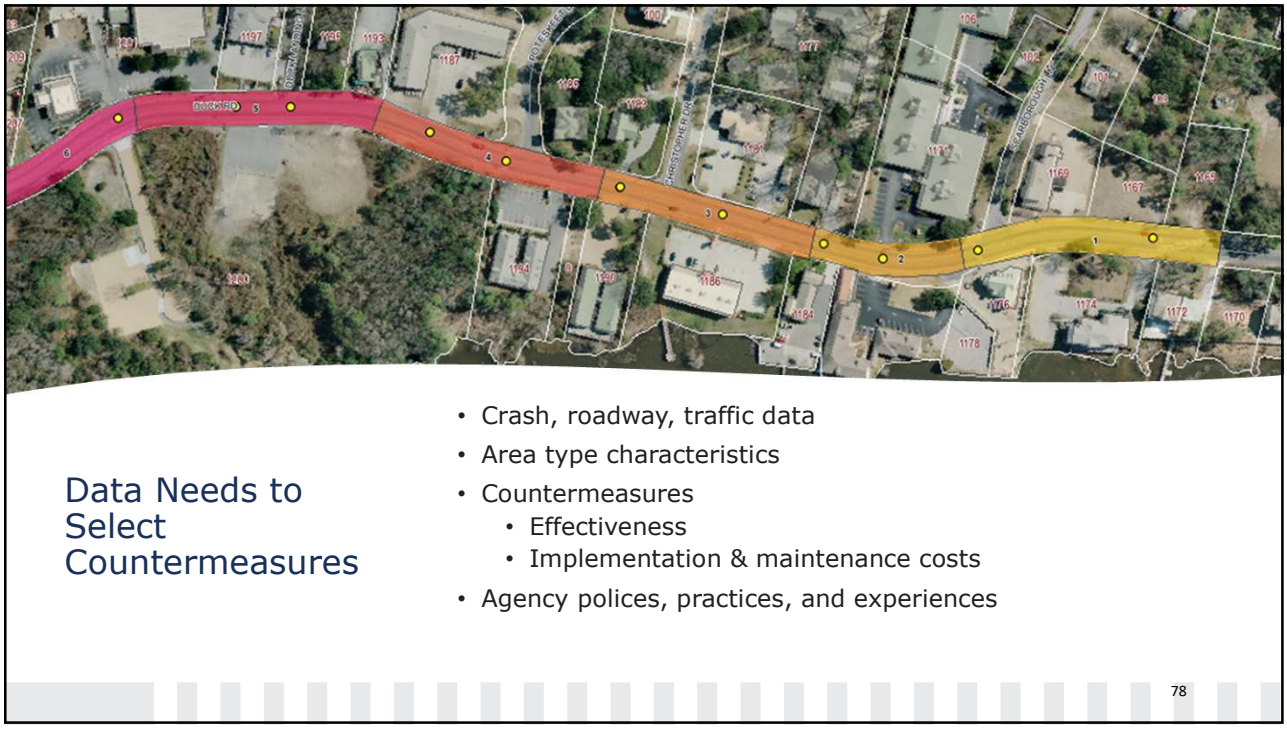
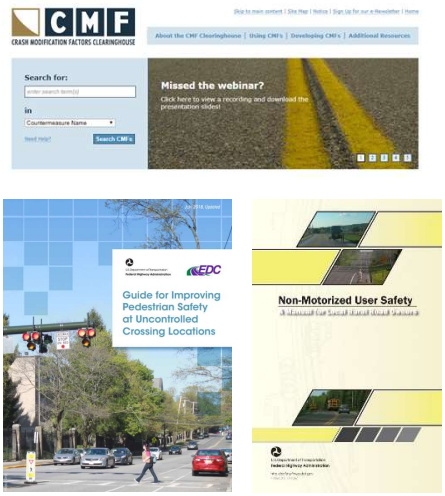
77


Data Needs to Select Countermeasures
• Crash, roadway, traffic data
• Area type characteristics
• Countermeasures
  • Effectiveness
  • Implementation & maintenance costs
• Agency polices, practices, and experiences
78

78

Systemic Countermeasure Resources

- FHWA PEDSAFE
- FHWA BIKESAFE
- FHWA Non-Motorized User Safety: A Manual for Local Rural Road Owners
- Crash Modification Factors Clearinghouse
- AASHTO Highway Safety Manual
- STEP Guide -- Selection process and Table 1
- AASHTO design guides
- NACTO Urban Street Design Guide
- Agency experience / engineering judgment
- And more…



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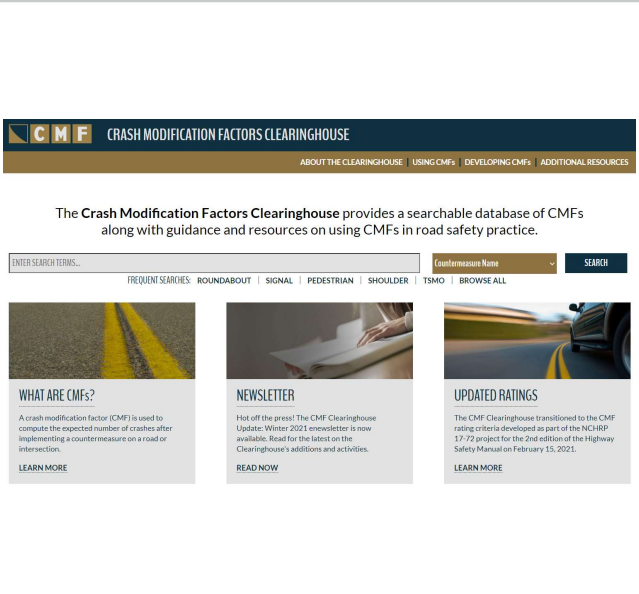
FHWA Crash Modification Factors (CMF) Clearinghouse

- Provides CMF Data through search function
- Has thousands of CMFs, with filter relating to:
  - Crash type
  - Crash severity
  - Roadway type
  - Area type
  - Intersection type
  - Intersection geometry
  - Traffic control



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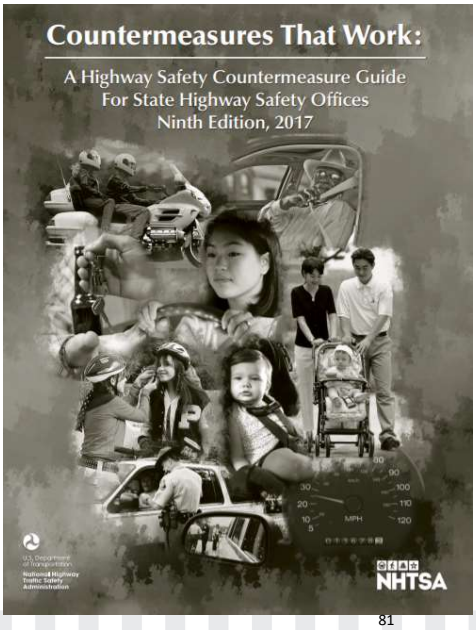
NHTSA Countermeasures That Work

- This guide is a basic reference to assist State Highway Safety Offices (SHSOs) in selecting effective, science-based traffic safety countermeasures for major highway safety problem areas. The guide
  - describes major strategies and countermeasures that are relevant to SHSOs;
  - summarizes their use, effectiveness, costs, and implementation time; and
  - provides references to the most important research summaries and individual studies.



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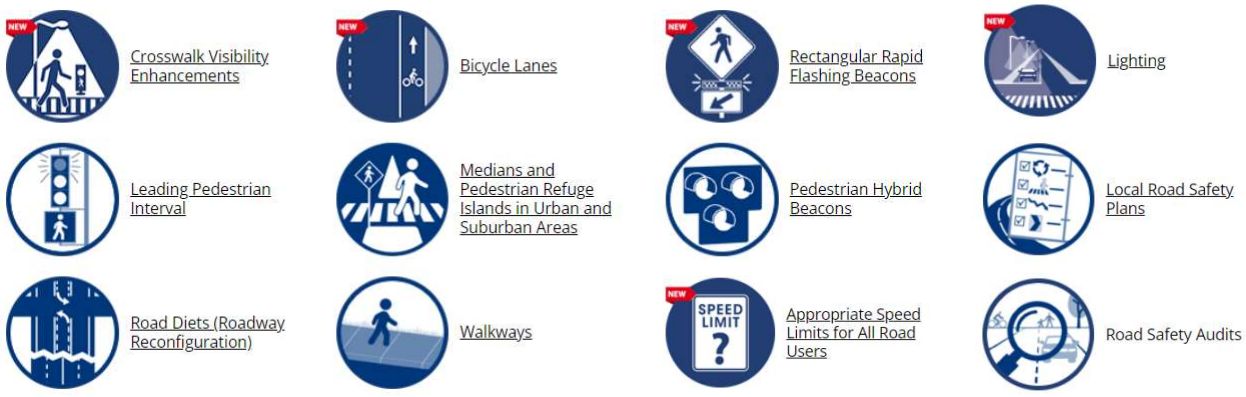
FHWA Proven Pedestrian and Bicyclist Countermeasures



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Discussion

Why are certain countermeasures better suited for systemic analysis/application?

What are some examples of systemic countermeasures?

83

83

Bicyclist Countermeasures

- Bike signal
- On-street bike facilities (bike lanes or separated bike lanes)
- Bicyclist pavement markings (shared lane markings)
- Advanced bicyclist warning signs
- Flashing beacons on advance warning signs
- Lighting

84

84

Pedestrian Countermeasures

- Enhanced crosswalks
- Remove parking near intersection (daylighting)
- Advanced pedestrian warning signs
- Flashing beacons on advance warning signs
- Median refuge
- Curb extensions
- Pedestrian countdown signals
- Lighting

85

85

Helpful Hints

- Remove initial countermeasures that are not feasible from consideration prior to workshops or meetings
- Seek input from stakeholders during screening process
- There is no optimum number of countermeasures

86

86

Activity #2

87

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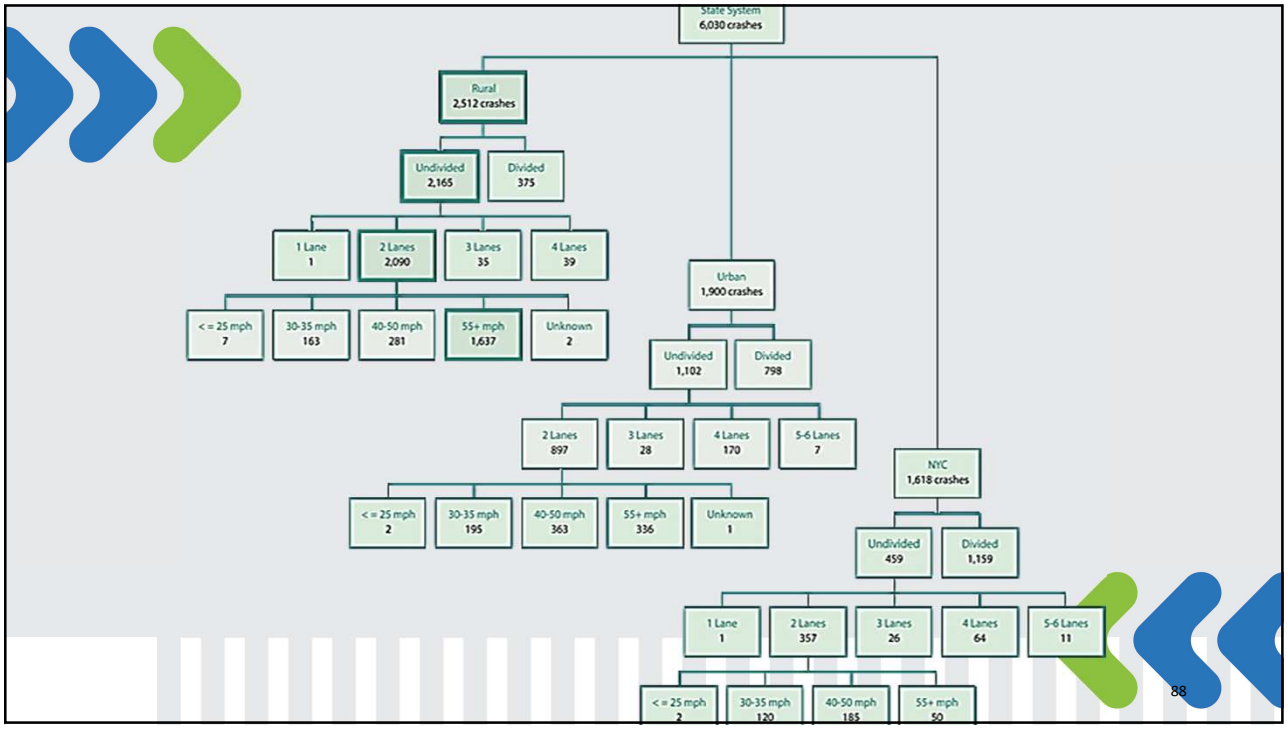

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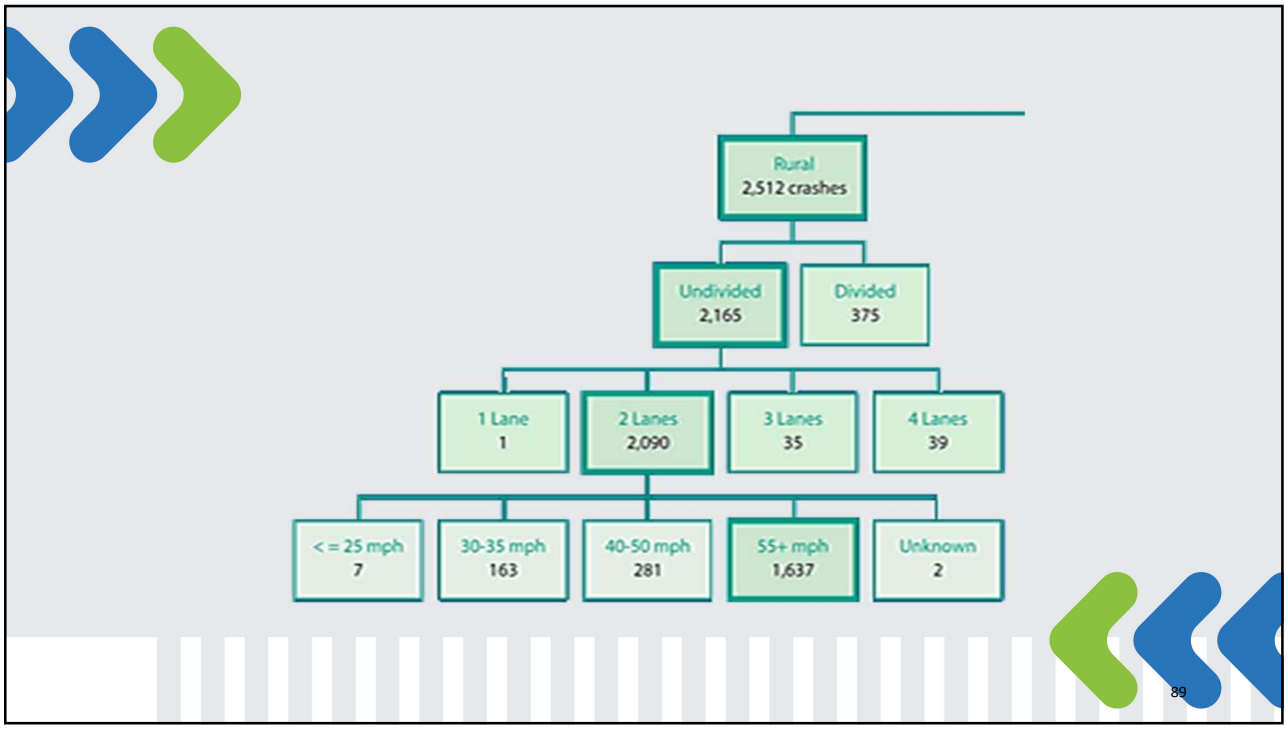
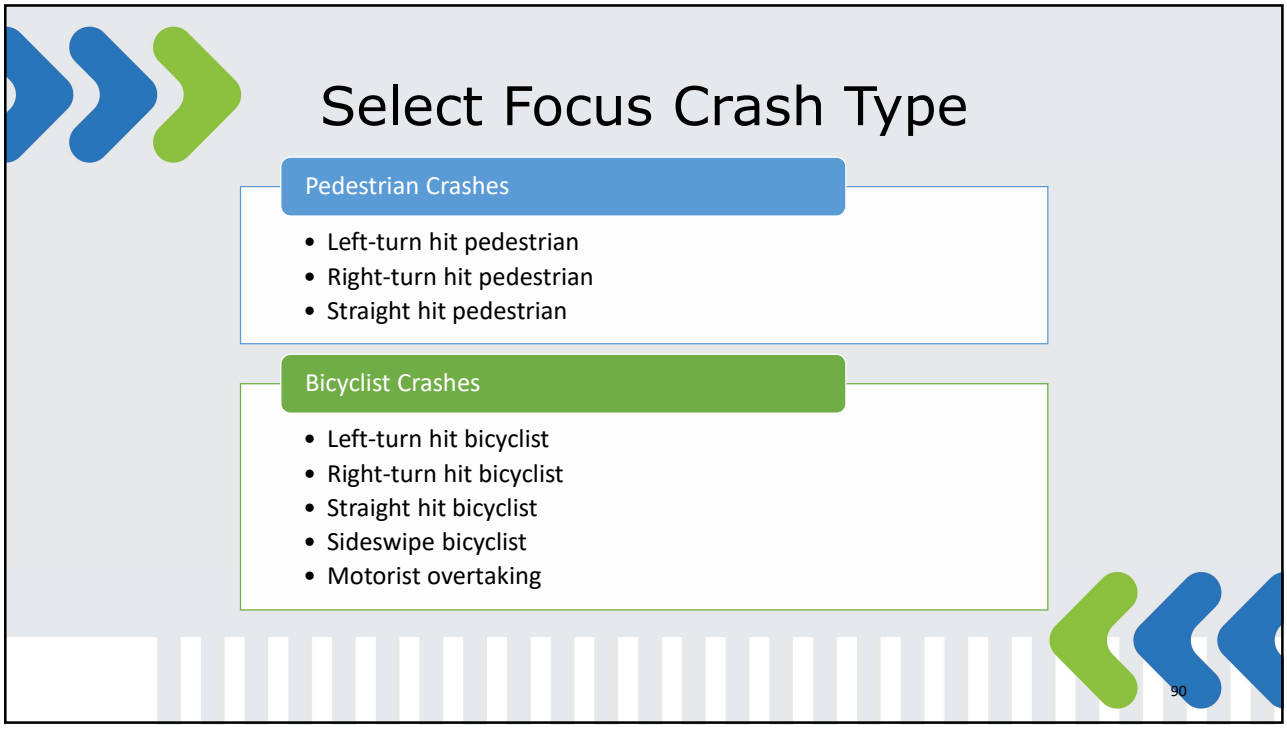

Rural
2,512 crashes
Undivided
2,165
Divided
375
1 Lane
1
2 Lanes
2,090
3 Lanes
35
4 Lanes
39
< = 25 mph
7
30-35 mph
163
40-50 mph
281
55+ mph
1,637
Unknown
2
89

89


Select Focus Crash Type
Pedestrian Crashes
• Left-turn hit pedestrian
• Right-turn hit pedestrian
• Straight hit pedestrian
Bicyclist Crashes
• Left-turn hit bicyclist
• Right-turn hit bicyclist
• Straight hit bicyclist
• Sideswipe bicyclist
• Motorist overtaking
90

90

Select Focus Facility Type

- Intersection
  - Signalized
  - Stop controlled
- Segment
- Functional class
- Number of lanes
- Horizontal/vertical curves
- Urban/suburban/rural

91

91

Identify Potential Risk Factors

- Select 2 or 3 risk factors
  - Presence of fatal/serious injury crashes can be a risk factor
- Risk factor may not appear to be overrepresented in crash data
  - Can perform descriptive statistics analysis for combinations of risk factors

92

92

Select Countermeasures

Pedestrians	Bicyclists
• Enhanced crosswalks • Remove parking near intersection (daylighting) • Advanced pedestrian warning signs • Flashing beacons on advance warning signs • Median refuge • Curb extensions • Pedestrian countdown signals • Lighting	• Bike signal • On-street bike facilities (bike lanes or separated bike lanes) • Bicyclist pavement markings (shared lane markings) • Advanced bicyclist warning signs • Flashing beacons on advance warning signs • Lighting

https://pollev.com/safetyvhb

93

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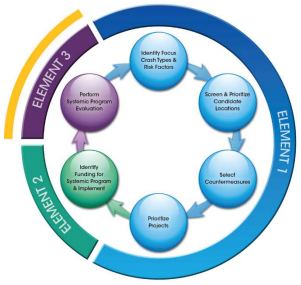
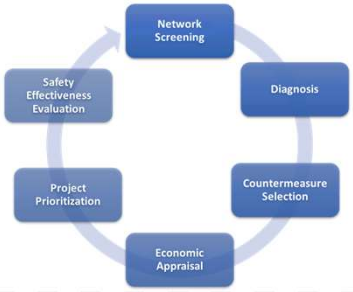
Why Evaluate Effectiveness

- Input into systemic planning process
- Proof of effectiveness generates support
- Addresses agency responsibility to invest resources effectively
- Focus on before vs. after crash statistics
- Guidance for interpreting results





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Evaluating Effectiveness

There are two primary levels for evaluating effectiveness:

- **Project-level:** impacts of each individual countermeasure or the average impact of combined countermeasures (new CMFs).
- **Program-level:** number and rate of crashes, injuries, and fatalities on the network; specific programs such as intersection, roadway departure, and pedestrian safety.

96

96

Systemic Program Evaluation is System-wide

- May address locations with no crash history
- Maximizes data sample size
- Countermeasure-based

97

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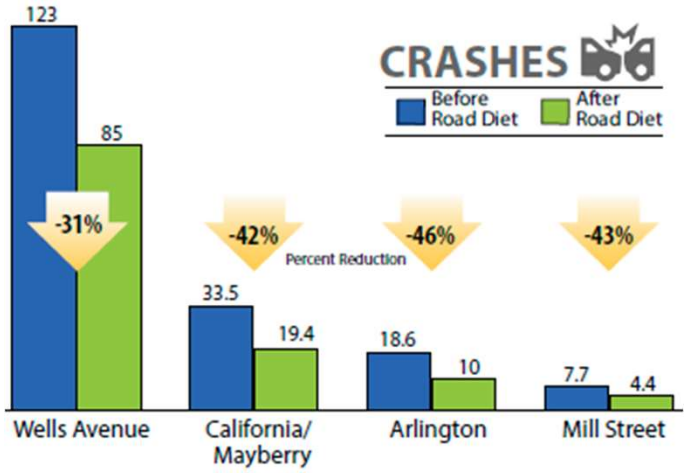
Data Needs for Systemic Program Evaluation

- Before and After Data
- Macro level = statewide, regionwide, and system-wide crash and roadway characteristics
- Micro level = project-specific data about type, location, implementation date



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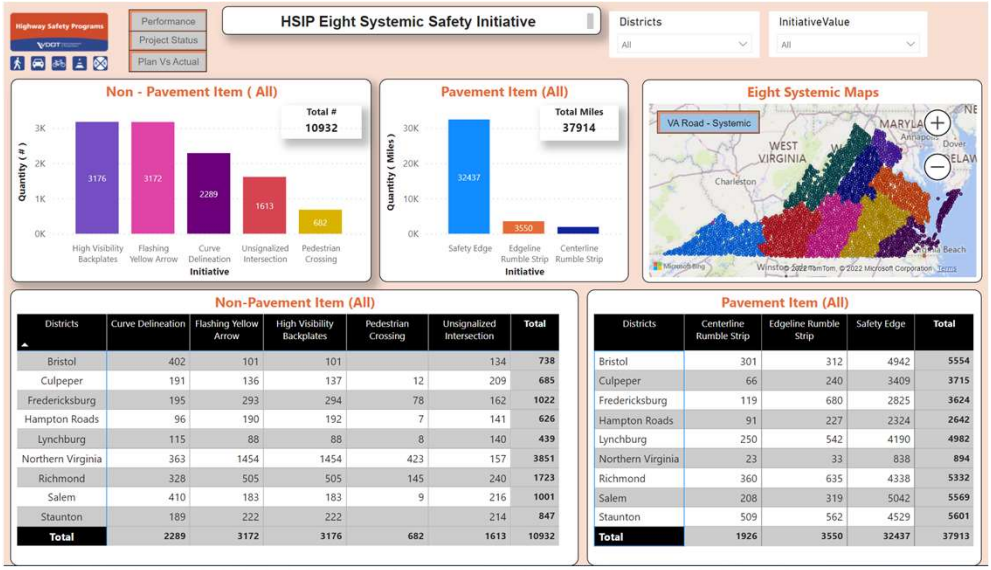
VDOT Installation Tracking



Non-Pavement Item (All)

Districts	Curve Delineation	Flashing Yellow Arrow	High Visibility Backplates	Pedestrian Crossing	Unsignalized Intersection	Total
Bristol	402	101	101		134	738
Culpeper	191	136	137	12	209	685
Fredericksburg	195	293	294	78	162	1022
Hampton Roads	96	190	192	7	141	626
Lynchburg	115	88	88	8	140	439
Northern Virginia	363	1454	1454	423	157	3851
Richmond	328	505	505	145	240	1723
Salem	410	183	183	9	216	1001
Staunton	189	222	222		214	847
Total	**2289**	**3172**	**3176**	**682**	**1613**	**10932**

Pavement Item (All)

Districts	Centerline Rumble Strip	Edgeline Rumble Strip	Safety Edge	Total
Bristol	301	312	4942	5554
Culpeper	66	240	3409	3715
Fredericksburg	119	680	2825	3624
Hampton Roads	91	227	2324	2642
Lynchburg	250	542	4190	4982
Northern Virginia	23	33	838	894
Richmond	360	635	4338	5332
Salem	208	319	5042	5569
Staunton	509	562	4529	5601
Total	**1926**	**3550**	**32437**	**37913**

99

99

VDOT Installation Tracking

Non Paving-related Safety Initiatives: **Pedestrian Crossing**

Curve Delineation | Flashing Yellow Arrow | High Visibility Backplates | **Pedestrian Crossing** | Unsignalized Intersection

Data as of 10/6/2021

Systemic Safety Criteria

Development CY 2021 **Delivery CY 2021** **Due by: 6/30/2025**

District	YTD # Q1-Q3 Comp	YTD Q1-Q3 Plan	YTD % Comp	CY 21 Plan	YTD # Q1-Q3 Comp	YTD Q1-Q3 Plan	YTD % Comp	CY 21 Plan	Life To Date # Comp	Life To Date Total #	Life To Date % Comp
Bristol			0%				0%				
Culpeper		4	0%	4			0%			12	
Fredericksburg	4	3	133%	3		2	0%	3	25	70	36%
Hampton Roads	3		0%				0%			3	
Lynchburg			0%				0%				
Northern Virginia	16		0%	30	1		0%	5	11	413	3%
Richmond	11	6	183%	15	2	2	100%	3	21	74	28%
Salem		2	0%	7			0%			9	
Staunton			0%				0%				
Total	**34**	**15**	**227%**	**59**	**3**	**4**	**75%**	**11**	**57**	**581**	**10%**

100

100

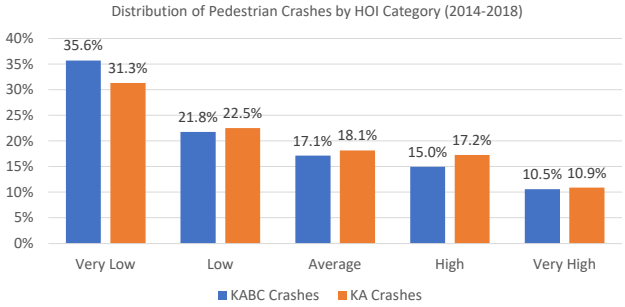
VDOT Health Equity Index (HOI) in PSAP

Composite index made up of factors such as:

- Income inequality
- Employment access
- Education
- Population density
- Food accessibility
- Walkability
- Access to care
- Environmental quality

Key Findings of Study

- HOI and zero vehicle households were the strongest indicators of pedestrian crashes – both all injury crashes and fatal/severe only crashes.
- Employment density was another strong indicator
- Population density and density of persons in poverty were poorer performers



Source: https://www.pedbikeinfo.org/pdf/Webinar_FHWA_041321.pdf

101

What tools does your agency have in place to track project installations?

102

102

Future Research Needs

- Research/guidance on how to better measure and account for individual- or behavior-based risk factors, such as motorist speed or pedestrian behaviors
- Further evaluation of the safety impacts of treatments in systemic applications
- Pooled sources of data or research to help quantify risk factors that are more generally applicable to many jurisdictions
- Studies evaluating the safety impacts of systemic vs. traditional (e.g., hotspot) approaches

103

103

Recap

The systemic method allows practitioners to proactively address safety risks throughout transportation network.

This method is not dependent on crash locations so it's appropriate for bicyclist/pedestrian analysis.

There are a number of low-cost countermeasures that can be widely deployed.

Tools are available, such as the FHWA Systemic Project Selection Tool and NCHRP 893.

104

104

Resources

- FHWA Systemic Project Selection Tool https://safety.fhwa.dot.gov/systemic/fhwasa13019/sspst.pdf
- NCHRP Report 955 https://www.trb.org/NCHRP/Blurbs/181589.aspx
- NCHRP Report 893 https://www.trb.org/Publications/Blurbs/178087.aspx
- FHWA Proven Pedestrian and Bicyclist Countermeasures http://safety.fhwa.dot.gov/provencountermeasures
- Synthesis of Methods (FHWA-SA-17-041) https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa17041/index.cfm
- Guide for Scalable Risk Assessment https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa18032/
- Scalable Non-Motorized Exposure Tool https://safety.fhwa.dot.gov/ped_bike/tools_solve/
- Seattle PBSA https://www.seattle.gov/Documents/Departments/beSuperSafe/BicyclePedestrianSafetyAnalysis.pdf
- VDOT Safety Investment Planning https://vdot.maps.arcgis.com/apps/MapSeries/index.html?appid=811732158c604926a4096664cbacf3c7

105

105

List of Countermeasure Resources

- NCHRP Report 500 series: https://www.trb.org/Main/Blurbs/152868.aspx.
- Highway Safety Manual, Part D.
- CMF Clearinghouse: http://www.cmfclearinghouse.org/.
- ITE Unsignalized Intersection Improvement Guide: https://toolkits.ite.org/uiig/.
- FHWA Proven Safety Countermeasures: https://safety.fhwa.dot.gov/provencountermeasures/.
- FHWA Rural Roadway Departure Countermeasure Pocket Guide: https://safety.fhwa.dot.gov/FoRRRwD/RwDPocketGuide.pdf.
- NHTSA Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices Tenth Edition, 2020: https://www.ghsa.org/sites/default/files/2021-09/Countermeasures%20That%20Work%2C%2010th%20Edition.pdf.
- FHWA Intersection Safety Strategies: https://safety.fhwa.dot.gov/intersection/stop/fhwasa15085.pdf.
- Pedestrian Safety Guide and Countermeasure Selection System: http://www.pedbikesafe.org/pedsafe/countermeasures.cfm.
- Bicycle Safety Guide and Countermeasure Selection System: http://www.pedbikesafe.org/bikesafe/countermeasures.cfm.
- FHWA LRSP Choose Proven Solutions Webpage: https://safety.fhwa.dot.gov/LRSPDIY/proven-solutions.cfm#.
- FHWA Low-Cost Safety Improvement Video Series: https://www.youtube.com/user/USDOTFHWA/videos.
- Manual on Uniform Traffic Control Devices: https://mutcd.fhwa.dot.gov/.
- FHWA STEP Resources: https://safety.fhwa.dot.gov/ped_bike/step/resources/.
- FHWA https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf
- FHWA Guide for Scalable Risk Assessment Methods for Pedestrians and Bicyclists https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa18032/fhwasa18032.pdf.

106

106

PEDESTRIAN & BICYCLIST
FOCUSED APPROACH TO SAFETY

Curb Extensions
Bulb Outs
Neckdowns

DPS 201

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

1

Why

STREETFILMS

2

When & Where

When

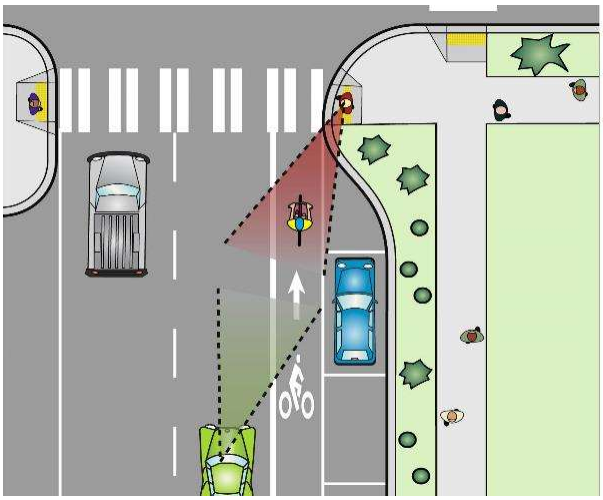
- Limited Sight Distance
  - Pedestrians & Vehicles
  - Vehicles and Signs
- Want to put two curb ramps in
- Discourage High speed turning
- High number of pedestrians waiting on corner

Where

- Wherever there is 24/7 on street parking
  - Intersections
  - Midblock

3

Better Visibility



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Better to see you with

Pedestrians wait where they can see - in front of parked cars

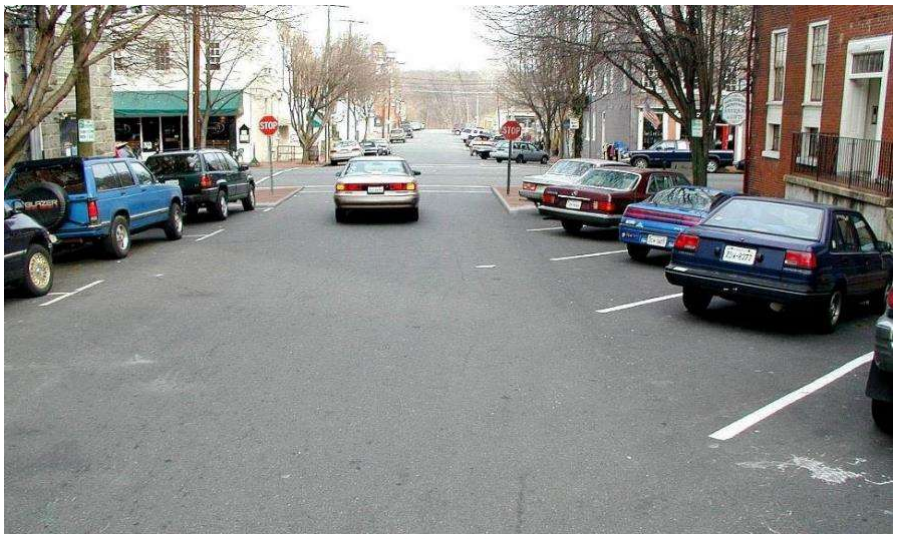
Curb extension places pedestrian where they can see and be seen

Salem OR

5-5

5

Win - Win



6

Case study: Curb Extensions (Cambridge, MA)

Cambridge, MA

Problem

- High motorist high speeds on Berkshire Street
- Failure to obey STOP signs
- Pedestrian activity (especially children)
- Popular motorist cut-through
- High number of pedestrian collisions

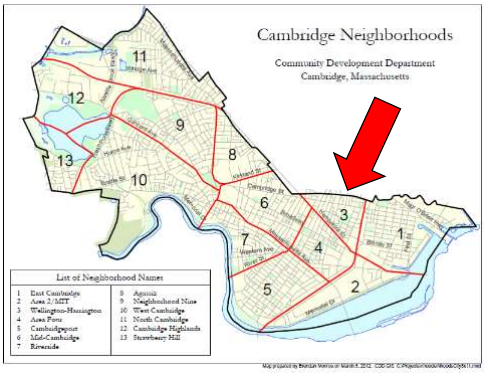
7

Case study: Curb Extensions (Cambridge, MA)

Cambridge, MA

Background

- Residential area with mix of businesses and retail shops
- Residents had long-complained about speeding and disregarding STOP signs
- Police data confirm the problem



8

Case study: Curb Extensions (Cambridge, MA)

Cambridge, MA

Solution

- Curb extensions installed as part of a traffic calming effort
  - 3 intersections
- Other improvements included:
  - Raised crosswalks/intersections
  - Chicanes
  - Restriping crosswalks
  - Altering pedestrian park access points
- Done in three phases - total cost $8,236,516
  - 20% local, 80% state/federal

Curb extension at Berkshire and Plymouth Streets

Motorist view of the curb extension at Berkshire and Plymouth Streets

9

Case study: Curb Extensions (Cambridge, MA)

Cambridge, MA

Results

- Curb extensions reduced the crossing distance, limited exposure time, improved visibility, & slowed turning vehicles
- Survey found 44% liked the changes, 28% did not
- 47% felt pedestrian safety improved
- 61% said it was more difficult to find parking (despite net loss of 1 on-street space)

Curb Extension at Berkshire St & York St

10

Curb Extensions/Bulb Outs - Safety

- NO CMF's/CRF's
- Curb extensions contribute to increased pedestrian safety by:
  - Increasing pedestrian visibility
  - Allows pedestrians to better observe approaching motorists
  - Decreasing crossing distance
  - Reducing pedestrian exposure to traffic
  - Can reduce speeds by visually narrowing the street
  - Slows turning vehicles
  - Can improve signal timing / may reduce cycle length

11

Safety Research

- PEDESTRIAN SAFETY IMPACTS OF CURB EXTENSIONS: A CASE STUDY Final Report SPR 304- 321
  - https://nacto.org/docs/usdg/pedestrian_safety_impacts_of_curb_extensions_randal.pdf
- Doesn't include CRF but covers yielding rates
- **Safety Performance**
  - By reducing the pedestrian crossing distance and exposure of pedestrians to traffic, this treatment should reduce the frequency of pedestrian collisions. A New York City study suggested that curb extensions appear to be associated with lower frequencies and severities of pedestrian collisions.(102) Curb extensions should also reduce speeds on approaches where they are applied.
- King, M. "Calming New York City Intersections" *Transportation Research Circular EC019:*
  - *Urban Street Symposium Conference Proceedings*, Dallas, TX, June 28-30, 1999.
  - Washington, DC: TRB, NRC, December 2000.

12

Benefits & liabilities

Signalized Intersections: Informational Guide

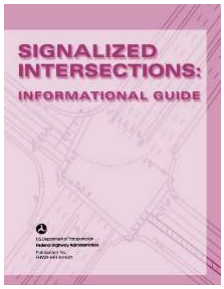


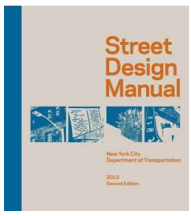
Table 45. Summary of issues for curb extensions.

Characteristic	Potential benefits	Potential Liabilities
Safety	Reduction in right-turning vehicle/pedestrian collisions. Fewer right-turn-on-red violations.	May increase right-turning/through vehicle rear- end collisions due to increased speed differential. Large vehicle offtracking.
Operations	Less overall delay due to reduction in time needed to serve pedestrian movement.	May adversely affect operation if curb extension replaces a travel lane. Right-turn movements delayed. Emergency vehicles may be significantly delayed.
Multimodal	Shorter crossing distance. Facilitates the use of two perpendicular ramps rather than a single diagonal ramp. Better visibility between pedestrians and drivers.	May be more difficult for large trucks and buses to turn right.
Physical	None identified.	Drainage may be adversely affected.
Socioeconomic	Low to moderate costs.	None identified.
Enforcement, Education, and maintenance	None identified.	None identified.

13

Design guidance

- NYC street design manual
  - Http://www.nyc.gov/html/dot/downloads/pdf/nycdot_streetdesignmanual_ch2.pdf
- WSDOT Design Manual Chapter 1510 Pedestrian Facilities
  - ***http://www.wsdot.wa.gov/publications/manuals/fulltext/m22-01/1510.pdf***



Chapter 2 - Geometry

Chapter 1510 – Pedestrian Facilities

14

Design guidance

Washington State DOT Design Manual

- Extend the curb no farther than the width of the parking lane.
- Design the approach nose to ensure adequate setback of vehicles to provide visibility of pedestrians.
- At traffic signals - curb extensions can be used to reduce pedestrian signal timing (less crossing distance).

15

When not to use

Washington State Department of Transportation

Washington State DOT Design Manual

- Do not use curb extensions on State highways when:
  - The design vehicle encroaches on curbs or opposing lanes
  - On-street parking is not provided/allowed.
  - The posted speed is above 35 mph.

16

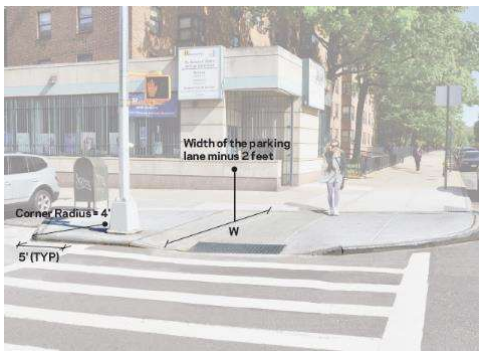
Curb extensions on one side of intersection

- Use Caution: Drivers that may run through the right turn lane on one side will hit the curb extension
- Bollards installed to help alleviate the situation

17

Dimensions
NYC Street Design Manual

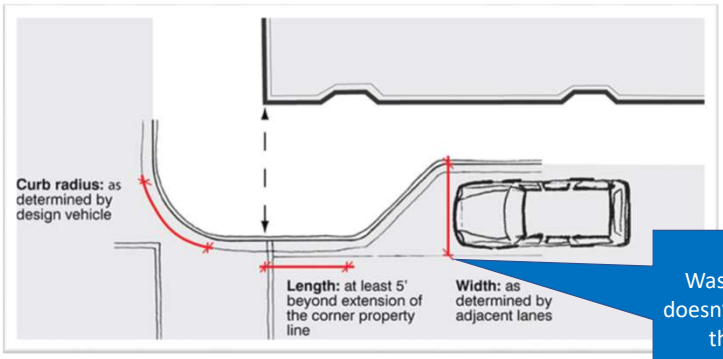
- Width is typically 2 feet less than width of parking lane
  - Curb extension can extend to (not into) the bicycle lane
- Minimum curb extension length typically equal to full width of the crosswalk



18

Dimensions
San Francisco better streets

Typical Bulb-Out Dimensions



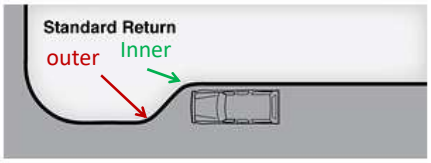
Washington D.C. doesn't allow farther than 6 feet. Potential for future bike lane

19

Radii
San Francisco better streets

Standard return:
inner/outer curb radius of 20ft & 10ft

- Enable street sweeping machines to sweep the entire curb line
- May be reduced to 15ft and 10ft to

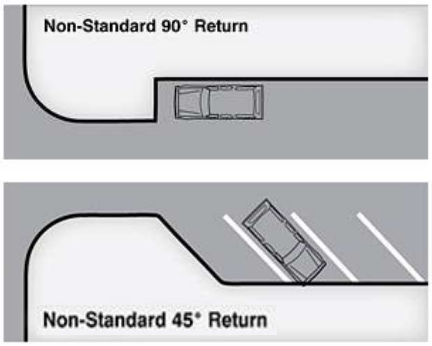


20

Radii
San Francisco better streets

Non-standard return:

- 90 degree return:
  - Used with parallel or perpendicular parking.
- 45 degree return:
  - used with either parallel parking (45 degree return) or angled parking.
- Increases pedestrian space & minimize parking loss
- More difficult & costly to maintain
- 90 degree - more difficult for vehicles to enter/leave the space



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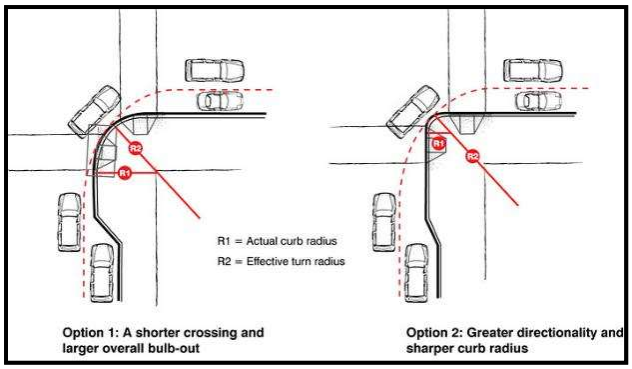
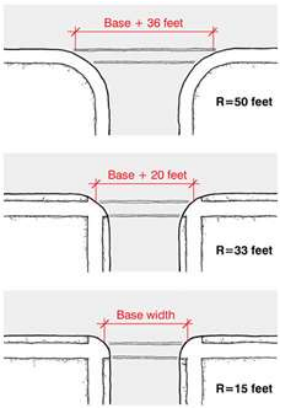
Radii
San Francisco better streets





22

Bus bulb out

23

Bus Bulb out examples

24

Drainage

- Must design to maintain storm water drainage & prevent ponding
- Options:
  - Relocate catch basins
  - Channel water through, around, or in-between
    - Bioswales

25

Drainage/Trench drains

- Trench Drain considered to reduce cost & implementation
- Proper proportion trench drain to sidewalk
  - Left picture, smaller drain, attractive and proportioned
  - Right picture, wide drain, visually too dominant

SFbetterstreets guide

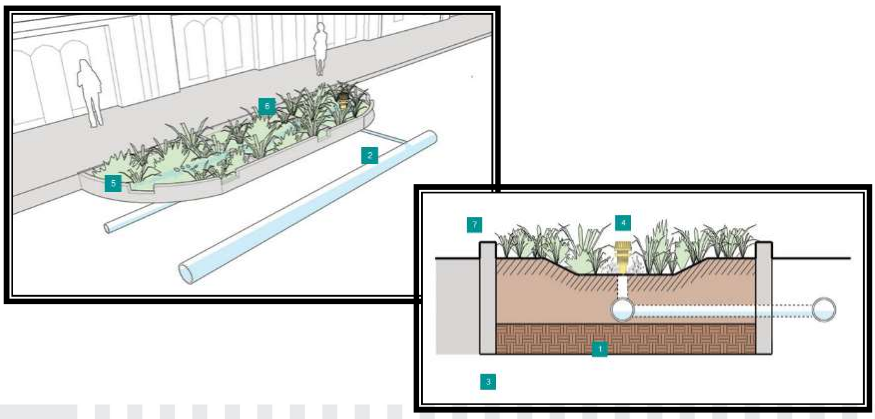
26

Drainage

27

Drainage/Landscaping

- NACTO Urban Streets Design Guide
- http://nacto.org/usdg/street-design-elements/stormwater-management/bioswales/



28

Bioswale design resources

- NYC Street Design Manual 6.6.1 – Stormwater-Capturing Installations

29

Mid-block considerations

- Include bollards, landscaping, or other buffers between pedestrians & vehicles
- Buffer treatment height, width, & design **must not** impede a driver's view of pedestrians
- Use special paving or edging treatment to distinguish the ped plaza from the travel lane
- Street lighting at choker

30

Mid-block considerations

- Street furnishings & other objects may be located on curb extensions to provide more ped space on sidewalk
- Should be used at designated mid-block crossings

31

ADA Treatments
What is Good & not compliant?

http://www.sauerburger.org/dona/crosscreditlist.html

32

ADA issues?

33

Site features

Site features such as landscaping, controller cabinets, poles, benches, planters, bollards, and newspaper stands should not obstruct the view of pedestrians or drivers.

34

Site features good or bad design?

35

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.

36

Sightlines
NYC Street Design Manual

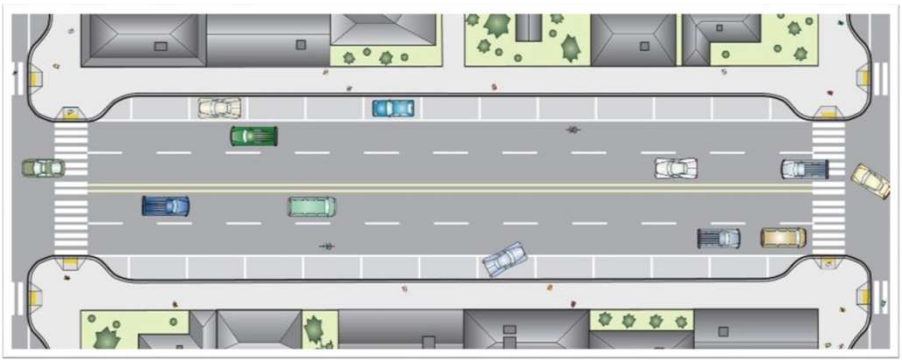
- Provide open sight–lines to the crossing for approaching motorists
- The design and placement of street furniture, trees, and plantings on a curb extension must not impede pedestrian flow, obstruct a clear path, interfere with "daylighting" the crossing, or emergency operations.

Curb extensions
(Credit: Michele Weisbart)

37

Parking Integrated with sidewalk

- Paving on curb extension should match the surrounding sidewalks



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Parking Integrated with Sidewalk

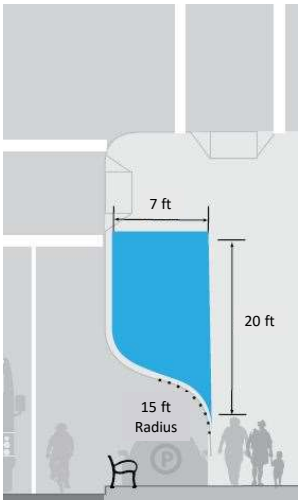
39

Parking Integrated with Sidewalk

40

Maintenance

- Street sweepers
- Snow plows



41

Maintenance

- Street sweepers – Planters and abrupt corners require hand-sweeping

42

Paint & delineator posts

43

Temporary to permanent

44

Curb Extensions/Bulb Outs - Cost

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	No. of Observations
Curb Extension	Curb Extension, Choker, or Bulb-Out	$10,150	$13,000	$1,070	$41,170	Each	19 (28)

Source: "Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public" October 2013

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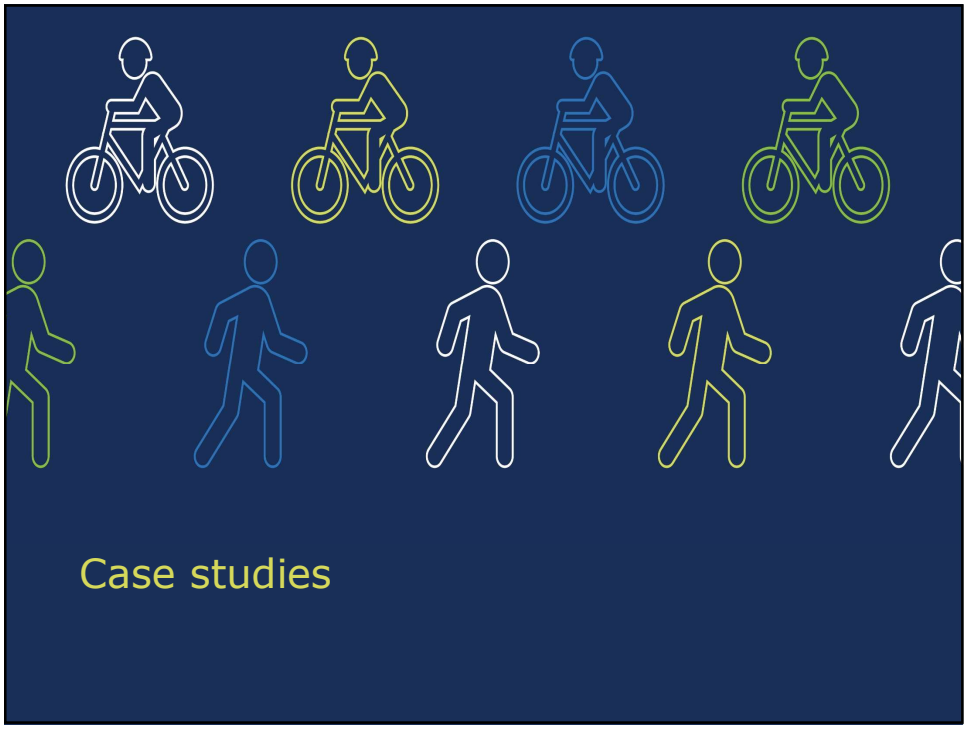


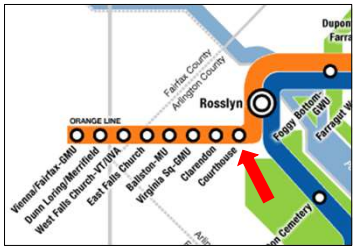
46

Case Study: Curb Extensions (Arlington County, VA)

Arlington County, VA

Problem/Background

- Wilson and Clarendon Boulevards near Court House Station on the Metrorail Orange line
- Heavy traffic/high vehicle speeds near a metro station
- Rosslyn-Ballston Corridor served by 5 underground metro stations and two main arterials
  - Difficult for pedestrians to cross roadways to stations
- 1999 'Pedestrian Initiative' launched to improve safety



47

Case Study: Curb Extensions (Arlington County, VA)

Arlington County, VA

Solution

- Reduced lanes from 3 to 2
- Seven curb extensions built to shorten crossing distances, calm traffic, & provide more visible crossing points
  - left space for busses to load and unload passengers
- Higher-visibility ladder crosswalks and signs installed
- Dangerous driveway removed

48

Case Study: Curb Extensions (Arlington County, VA)

Arlington County, VA

Details/Results

- Total project cost $50,000
- No before/after data gathered
- Staff & others report higher instances of drivers yielding to pedestrians
- Positive community reaction

49

Questions? / Resources

- NACTO Urban Street Design Guide
  - http://nacto.org/usdg/curb-extensions/
- NYC street design manual
  - Http://www.nyc.gov/html/dot/downloads/pdf/nycdot_streetdesignmanual_ch2.pdf
- WSDOT Design Manual Chapter 1510 Pedestrian Facilities
  - http://www.wsdot.wa.gov/publications/manuals/fulltext/m22-01/1510.pdf
- SF Better Streets Design Guide
- http://www.sfbetterstreets.org/find-project-types/pedestrian-safety-and-traffic-calming/traffic-calming-overview/curb-extensions/
- PEDESTRIAN SAFETY IMPACTS OF CURB EXTENSIONS: A CASE STUDY Final Report SPR 304- 321
  - http://www.oregon.gov/ODOT/td/tp_res/docs/reports/pedestrainsafetycurbext.pdf
- Signalized Intersections: Informational Guide
  - https://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/

50

PEDESTRIAN & BICYCLIST
FOCUSED APPROACH TO SAFETY

Crossing Islands/Raised Medians

Designing for
Pedestrian
Safety
201

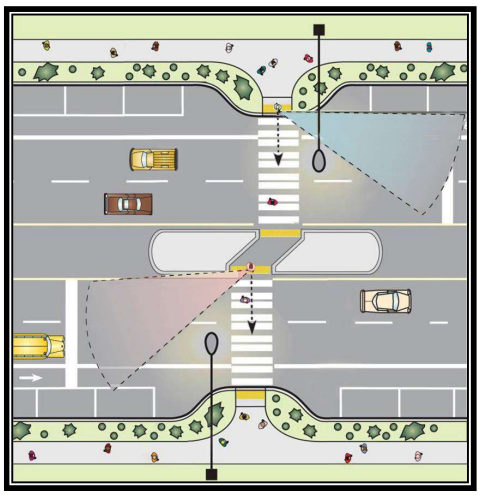
U.S.Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

1

List all features that improve pedestrian safety?

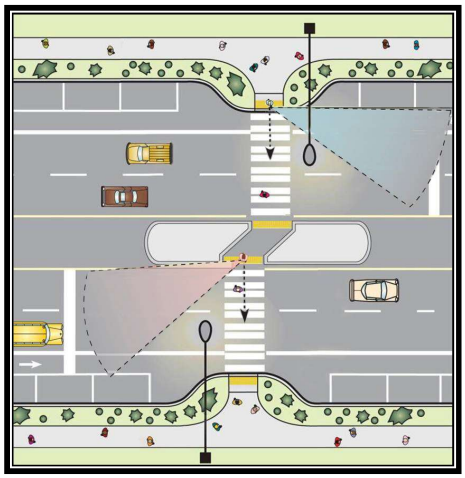
- Curb extension
- High visibility crosswalks
- Lighting
- Pulled back stop bar
- On street parking
- Bike lanes
- Zone system sidewalks
- ADA
- Raised crossing island



2

Why Raised Island are safer for pedestrians

- Breaks up complex crossing into two simpler ones
- Medians and Pedestrian Crossing Islands in Urban and Suburban Aras
  - One of FHWA's 9 proven safety countermeasures
  - http://safety.fhwa.dot.gov/provencountermeasures/



3

Crossing Islands/Raised Medians Safety

- Installing raised medians associated with a 25% reduction in pedestrian crashes in Florida (1)
- Installing raised medians associated with a 46% reduction in pedestrian crashes at sites with marked crosswalks, and a 39% reduction at sites with unmarked crosswalks in a sample from 30 U.S. cities (2)
- Installing refuge islands associated with a 56% reduction in pedestrian crashes (3)

RESEARCH

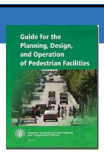
(1) Gan, A., Shen, J., and Rodriguez, A. (2005). Update of Florida Crash Reduction Factors and Countermeasures to improve the Development of District Safety Improvement Projects. Florida Department of Transportation.

(2) Zegeer, C., Stewart, R., Huang, H., and Lagerwey, P. (2002). Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations: Executive Summary and Recommended Guidelines, FHWA-RD-01-075.

(3) Institute of Transportation Engineers. (2004). Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer. Briefing Sheet 8, FHWA.

4

When to Install



Recommended:

- Midblock locations
  - Crossing exceeds 60 feet
  - Limited number of gaps in traffic
- Local roads with low speeds & volume
  - Aesthetic reasons
  - Special pedestrian circumstances
- Collector with moderate-to-high speeds & volume
  - Strongly recommended
- Midblock multilane arterials
  - Desirable and consideration for supplementary traffic control devices

Source: AASHTO Guide for the Planning Design, and Operation of Pedestrian Facilities, July 2004

5

When to install

Guidance

- Curbed sections of multi-lane roadways in urban and suburban areas, particularly in areas where there are mixtures of significant pedestrian and vehicle traffic (more than 12,000 ADT) and intermediate or high travel speeds. [1]

1. FHWA-SA-12-011
Proven Safety Countermeasures Medians and Pedestrian Crossing Islands in Urban and Suburban Areas

6

Suggested pedestrian Crossing island Installation criteria

Factors	OK	Should Consider	Install
Speed (mph)	30 or less	35	40 or more
ADT	< 9,000	9,000 - 15,000	> 15,000
Number of lanes	3	4-6	7 or more
Pedestrian volume	< 20/hour	< 20/hour	20/hour or more
Crashes	0	1-3	4 or more

- Table developed based on Marked vs. Unmarked Crosswalks at Uncontrolled locations Research (Speed, ADT, Number of Lanes)
- Warrant criteria for the PHB (Pedestrian volume)
- Number of crashes selected subjectively

7

Case study: Islands/Raised Medians (Eureka, CA)

Eureka, CA

Problem/Background

- Wide 3 lane road
  - No marked crosswalks
- Intersection near curve
- Avoided by pedestrians, bicyclists, & motorists
- Increased traffic led to more collisions
- Highest crash intersection in the city

8

Case study: Islands/Raised Medians (Eureka, CA)

Eureka, CA

Solution

- Worked with CALTRANS and community
- Temporary traffic controls used to test measures
- Median island and crosswalk installed for pedestrian & bicyclist refuge
- Other islands channel vehicles and provide more refuge
- Street lighting and LED signs offer visibility

Signs, cones, and barricades were used to test the improvements before becoming permanent

9

Case study: Islands/Raised Medians (Eureka, CA)

Eureka, CA

Results

- Reduced conflicts and enhanced safety
- No collisions reported since project completed in 2009
- New school, business, and housing increased foot traffic and activity

Intersection with the permanent improvements

10

11

Where to Place

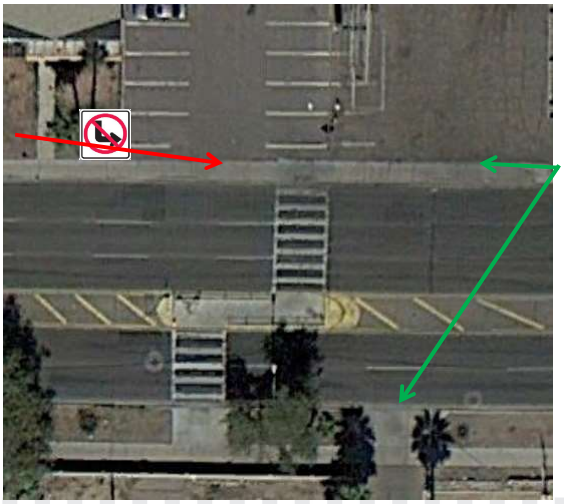
- Where there is room
- Where people are crossing
- Intersections
- Midblock

12

Can use for access management

13

Left turns prohibited at driveway



14

Potential driveway/island conflict

15

Driver prepares to make left turn

16

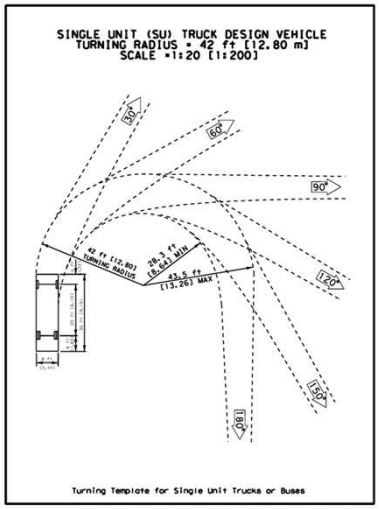
Driver clears island

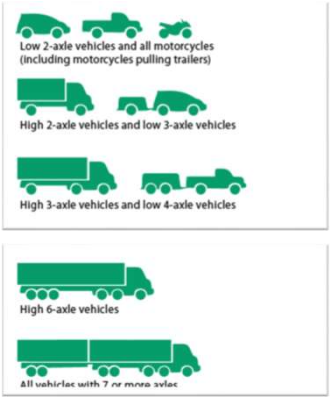
17

Driver pulls into median

18

Length of opening next to Median





6’–22’

20’- 34’

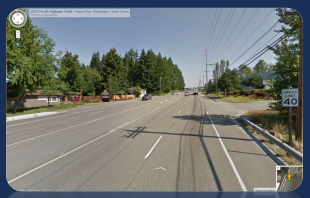
32’-72’

65’-71’

68’-111’

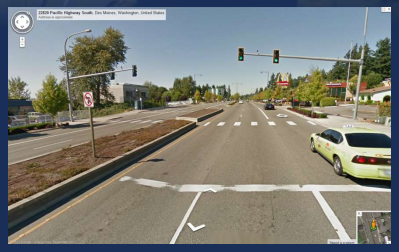
19

What type of median or Island



Flush

6” Raised Curb



Low Profile Barrier

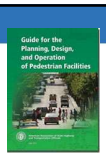
20

Flush (Two way center turn lane)

- A TWLTL is not a crossing island
- It's an opportunity for pedestrians to use what's already out there
- TWLTL provides space for island
- But better than yellow centerline

21

6-inch raised

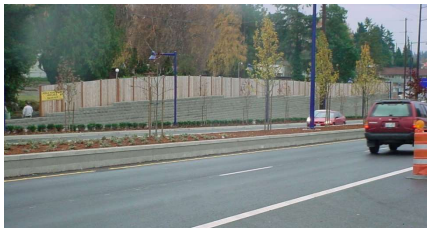


- Minimum 6 feet wide
- 8 feet to accommodate bicycles, wheelchairs, scooters, and groups of pedestrians
- Length parallel to street 20 feet minimum

22

WSDOT Low profile Barrier



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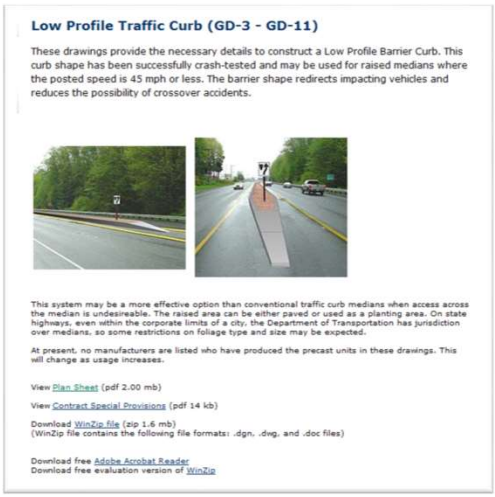
WSDOT Low profile Barrier

24

WSDOT standard drawings



Low Profile Traffic Curb (GD-3 - GD-11)

These drawings provide the necessary details to construct a Low Profile Barrier Curb. This curb shape has been successfully crash-tested and may be used for raised medians where the posted speed is 45 mph or less. The barrier shape redirects impacting vehicles and reduces the possibility of crossover accidents.

This system may be a more effective option than conventional traffic curb medians when access across the median is undesireable. The raised area can be either paved or used as a planting area. On state highways, even within the corporate limits of a city, the Department of Transportation has jurisdiction over medians, so some restrictions on foliage type and size may be expected.

At present, no manufacturers are listed who have produced the precast units in these drawings. This will change as usage increases.

View Plan Sheet (pdf 2.00 mb)

View Contract Special Provisions (pdf 14 kb)

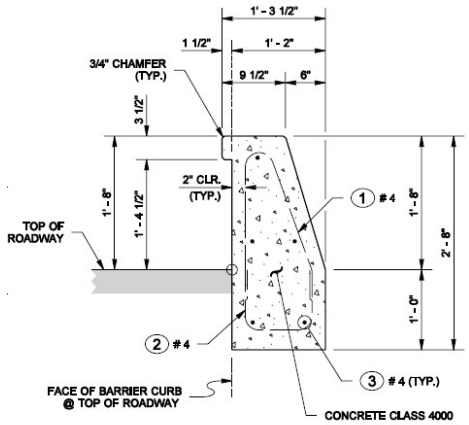
Download WinZip file (zip 1.6 mb)
(WinZip file contains the following file formats: .dgn, .dwg, and .doc files)

Download free Adobe Acrobat Reader
Download free evaluation version of WinZip

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

25

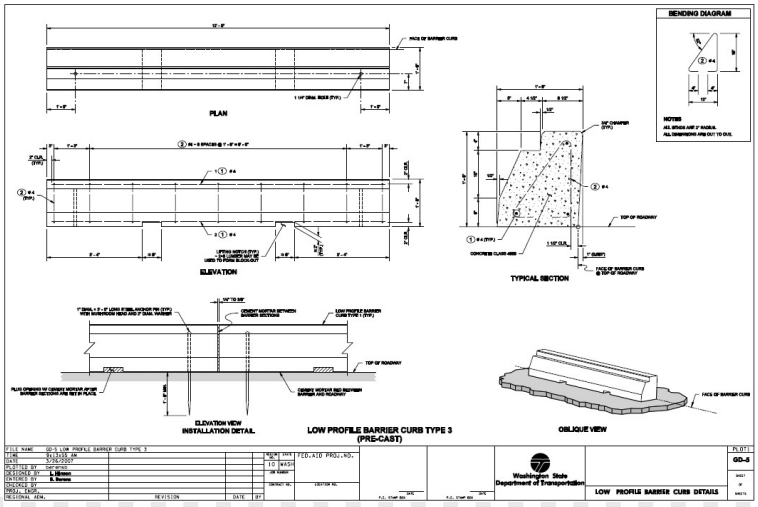
WSDOT Low Profile barrier with Chamfer



TYPICAL SECTION

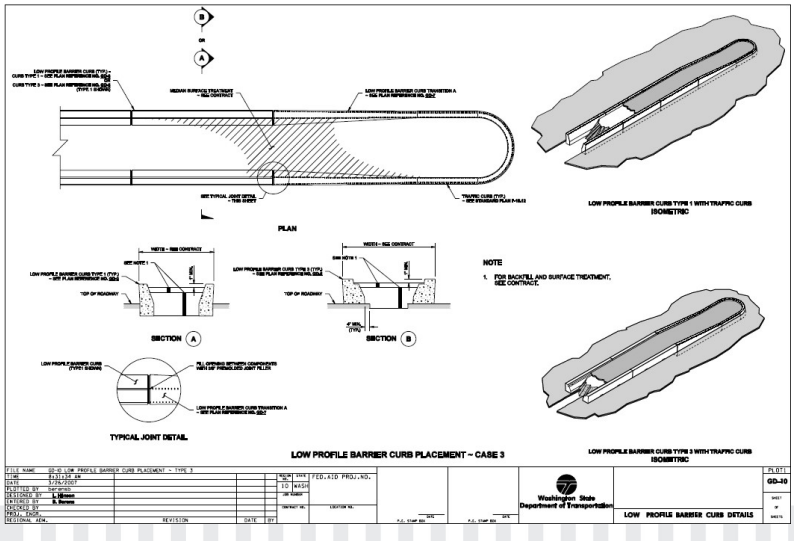
26

WSDOT Low profile barrier curb detail



27

Wsdot low profile barrier curb detail



28

"Model Design guide for living streets" Los Angeles County

Median Type	Minimum Width	Recommended Width
Median for access control	4 feet	6 feet
Median for pedestrian refuge	6 feet	8 feet
Median for trees and lighting	6 feet [1]	10 feet [2]
Median for single left-turn lane	10 feet [3]	10 feet [2]
Median for single left-turn lane and pedestrian refuge	16 feet [4]	16 feet

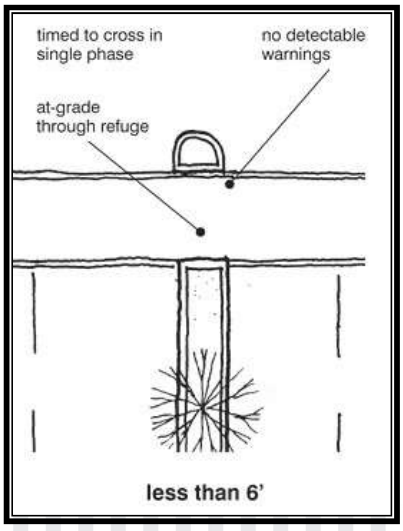
Table Notes

- [1] Six feet measured curb face to curb face is generally considered the minimum width for proper growth of small caliper trees (less than 4 inches).
- [2] Wider medians provide room for larger caliper trees and more extensive landscaping.
- [3] A 10-foot lane provides for a turn lane without a concrete traffic separator.
- [4] Includes a 10-foot turn lane and a 6-foot pedestrian refuge.

29

Medians less than 6 feet wide

- Signals should be timed so that pedestrians can cross entire street in one phase
- No detectable warning strips in median



Graphic: San Francisco Better Streets Guide

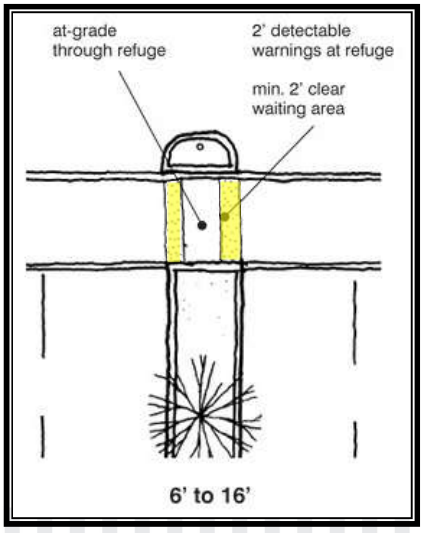
30

Less than 6 feet median no truncated domes

31

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

32

OK?

33

OK?

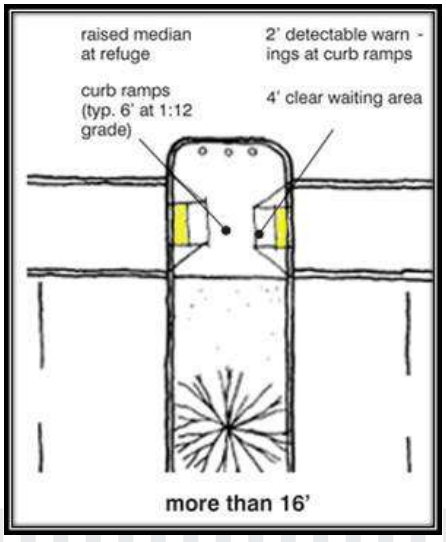
34

OK?

35

Medians 16 feet wide or greater

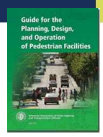
- Refuge islands should be raised
  - more visibility for waiting pedestrians.
- Raised islands should include two ramps
  - 8.3% (1 inch per foot)
- Ramp ~6 feet long for 4 & 5 inch height curb
  - 2 foot wide detectable warning strips on each end & minimum 4 foot wide waiting area



36

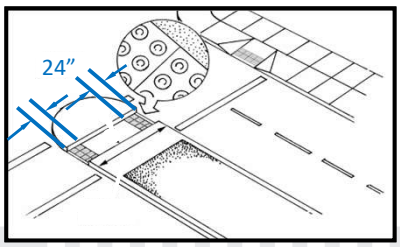
Medians 16 feet wide or greater

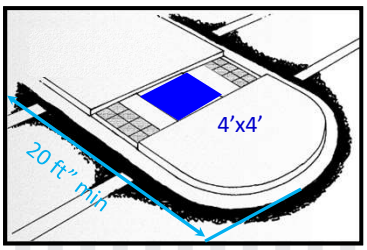
37



ADA – AASHTO Ped Green book 2004

- Islands with ramps – level landing min. 4x4ft
- Ramp slope of 1V:12H (8.33%)
  - Island width ~16 feet needed if 6" curb height
- Detectable warnings bottom of all ramps
- Island length parallel to street min. 20ft



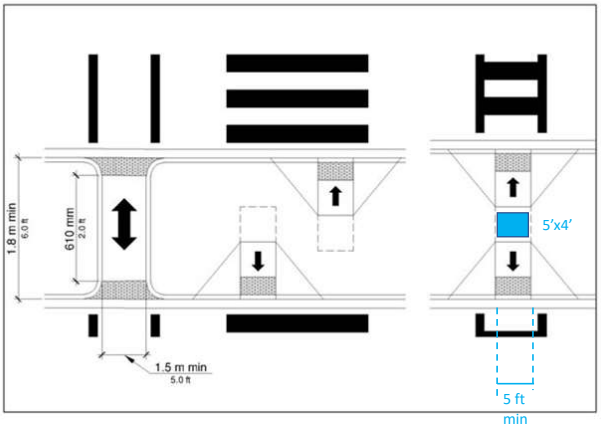


38

ADA PROWAG

- **R302.3.1 Medians and Pedestrian Refuge Islands.** The clear width of pedestrian access routes within medians and pedestrian refuge islands shall be 5.0 ft minimum.

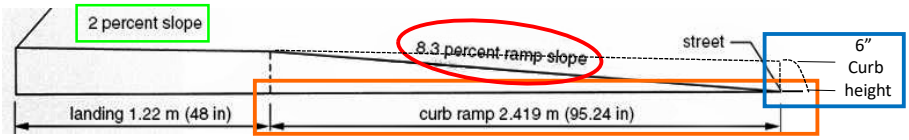
Figure R 305.2.4 Pedestrian Refuge Island



39

$$\text{Ramp Length} = \frac{\text{curb height } 6''}{(\text{ramp slope})_{8.3\%} - (\text{sidewalk cross slope})_{2\%}}$$

- Sample ramp length calculation
  - 6”/(8.3%-2%) = 7’ 11”
- Higher curb or flatter ramp grade = longer ramp



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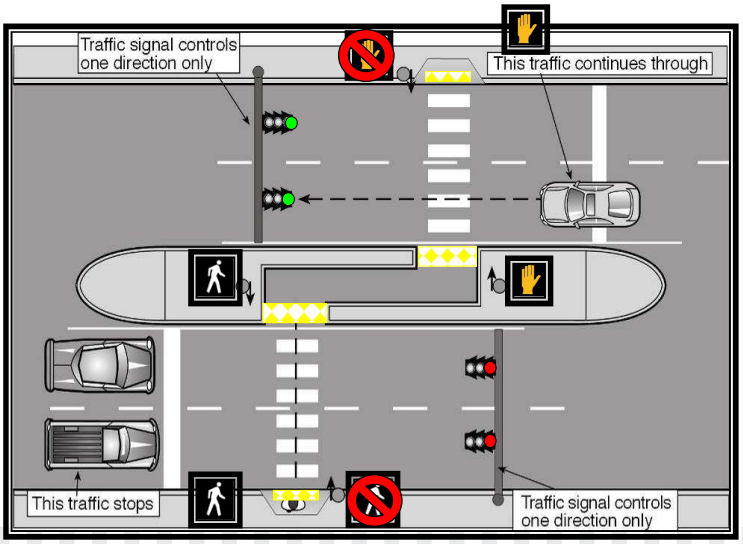
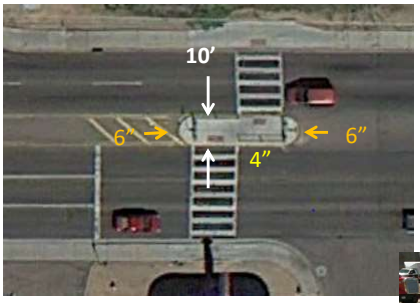
Two-Stage crossing



41

Two-stage crossing at 10 ft wide island



Compromise:

- Reduce island height in pedestrian area (4”)
- Keep 6” height at each end of island

Railing in island must be crash worthy

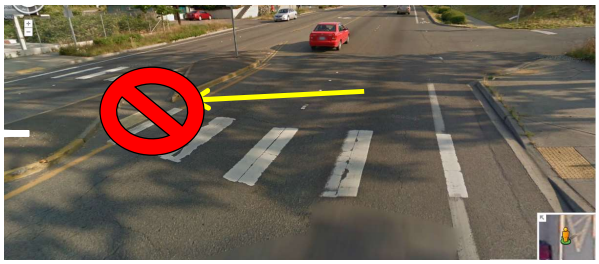
42

Two-stage island

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

43

Angled cut through right or wrong?



44

Angled cut through

- Blind use curb to find direction
- Finish curb to line up with crosswalk

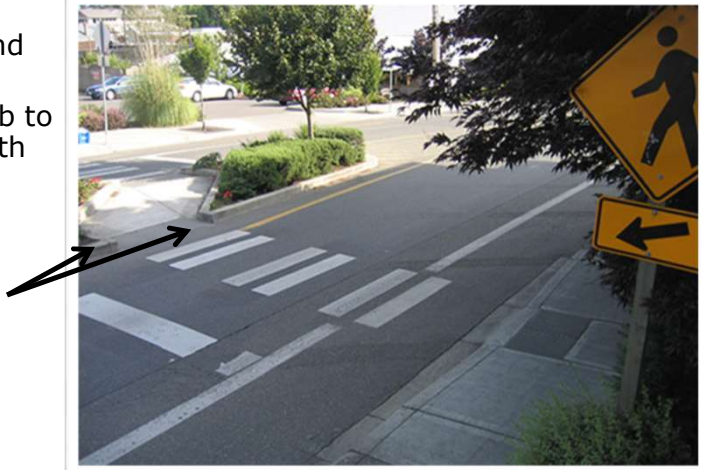


Photo credit: Carl Sundstrom

45

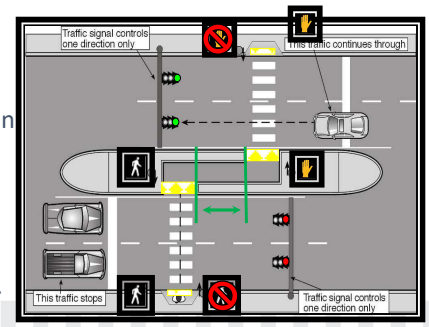
Informal Research on offset crosswalks

- Most UNSIGNALIZED 2-stage crossings are only staggered the width of the crosswalk.
  - Some are staggered the width of the crosswalk plus about 10 feet
- Amount of stagger need not be great
  - Especially with wider medians (16 feet or wider)
  - With medians of 20 feet or more the staggering may not be as important, even with signal or PHB-controlled
  - Every site is unique.
- The greater the stagger, the less likely someone will use it

46

Informal Research on offset crosswalks

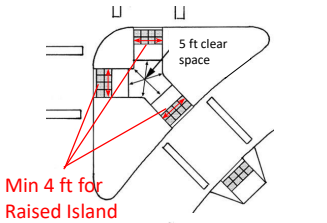
- For signal controlled crossings the width of the crosswalk plus 10 to 20 feet would typically be fine for narrower medians (in some cases to hold the pedestrians and to prevent pedestrians from viewing the wrong pedestrians signal head)
- Wider medians, greater than 16 feet, the width of the crosswalk should be sufficient
  - Most of the pedestrian signals should be equipped with "egg crate" visors so that they are seen by pedestrians in the crosswalk area and not outside the crosswalk.
  - This will also encourage more pedestrians to use the crosswalk.

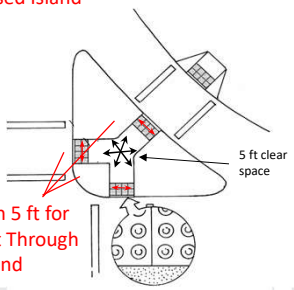


47

Cut-Through or Raised Corner Islands

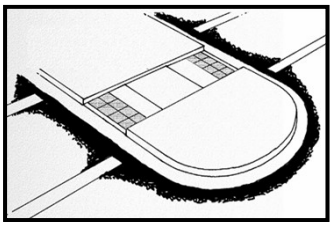
- With slip lanes, always use raised islands (not painted)
- Ramps must be at least 4 ft. wide
- For cut-through: must be 5 ft. wide
- Provide at least 5 feet of clear (turning) space or level landing
- Provide a 2-foot strip of detectable warnings at end of cut-through or at bottom of ramp
- Align cut-through or ramps with crosswalks





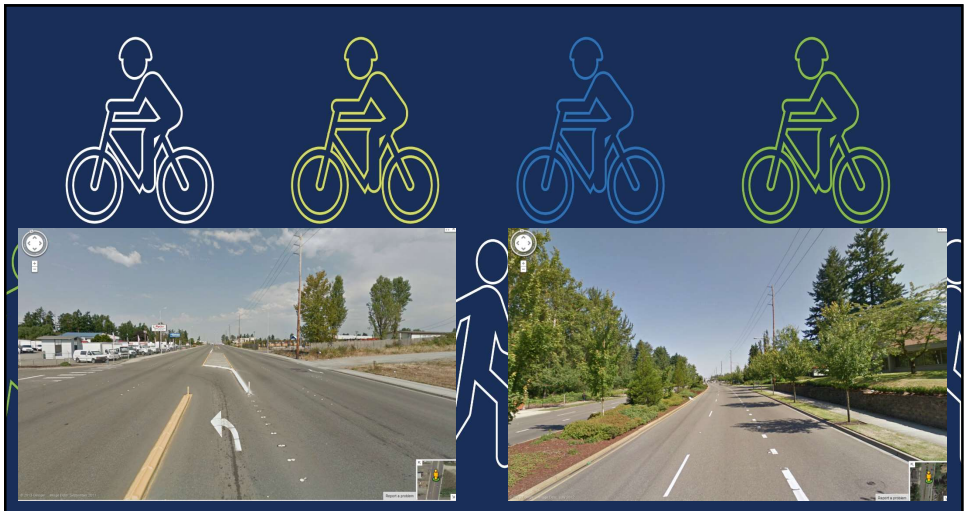
48

Drainage



- Cut-through needs some slope
- Remember drainage at bottom of ramp

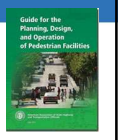
49



Landscaping

50

Landscaping



- Trees in median & sides of streets can help narrow long range field of vision for drivers, encouraging slower speeds
- Trees placed in median should comply with AASHTO Roadside Design Guide
- Trees should not block visibility of pedestrians crossing the street
  - Small caliper trees
  - Trim up branches
  - Bushes in median should be trimmed low

51

Placement of trees with respect to median openings

- Careful consideration should be given to the location & type of landscaping
- Plantings in narrow medians may create problems for maintenance activities
- Plantings may cause visual obstructions for turning motorists
- Plantings and objects in medians may constitute roadside obstacles

Source: AASHTO Green Book

52

Placement of trees & Shrubs with respect to median openings

Guidance to consider when planting trees/bushes in medians:

- Non-signal median openings
  - No shrubs with ultimate height over 30" within 50-ft of opening
  - No trees within 50 ft of opening
  - Second tree should be no closer than 100 ft from the first tree
  - No foliage between 2 ft and 6 ft above median
- Median opening at traffic signals
  - No shrubs with ultimate height over 30" within 50-ft of opening
  - No trees within 100 ft of opening
  - Second tree should be no closer than 100 ft from the first tree
  - No foliage between 2 ft and 6 ft above median
- Same dimensions apply to median pedestrian crossings

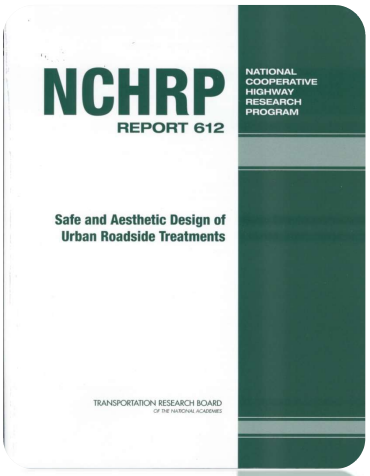
Source: Phoenix Traffic Operations Handbook, 2010

53

NCHRP Report 612

Objectives:

- Develop design guidelines for safe & aesthetic roadside treatments in urban areas
- Revised Chapter 10 of the Roadside Design Guide



54

Corridor Study Analysis Overview

- Identify 140+ miles of urban arterial roads
- Analyzed approximately 5 years of crash data
- Video tape corridor in both directions of travel and identify characteristics where crashes occurred (also compare to locations where the crashes did not occur)

California	7 corridors (47.3 miles)
Georgia	9 corridors (23.8 miles)
Illinois	7 corridors (48.5 miles)
Oregon	8 corridors (23.7 miles)

55

Evaluation of fixed Object Crashes Urban Corridors – Raised Curb

Lat. Dist.	Crashes	%	Cumul.%
0-1’	129	28.3%	28.3%
1-2’	157	34.4%	62.7%
2-4’	90	19.7%	82.5%
4-6’	50	11.0%	93.4%
6-8’	23	5.0%	98.5%
8-10’	6	1.3%	99.8%
10-15’	1	0.2%	100%
Total:	456	100%	

Over 80% of crashes with fixed objects 4’ or less from curb

Over 90% of crashes with fixed objects 6’ or less from curb

Source: NCHRP Report 612

56

NCHRP Report 612

Table 20. Lateral distance to objects that were hit for corridors with curb only.

Lateral Distance m (ft)	Speed Limit km/h (mph) 40 (25)	48 (30)	56 (35)	64 (40)	72 (45)	80 (50)	89 (55)	Total	Percent	Cumulative Percent
0–3 (0–1)	0	35	71	2	19	1	1	129	28.3	28.3
3–7 (1–2)	2	29	44	16	50	13	3	157	34.4	62.7
7–13 (2–4)	0	26	27	2	30	2	3	90	19.7	82.5
13–20 (4–6)	1	6	23	2	18	0	0	50	11.0	93.4
20–26 (6–8)	0	3	10	1	9	0	0	23	5.0	98.5
26–33 (8–10)	0	3	1	2	0	0	0	6	1.3	99.8
33–49 (10–15)	0	0	0	0	0	0	1	1	0.2	100
49–66 (15–20)	0	0	0	0	0	0	0	0	0.0	100
Total:	3	102	176	25	126	16	8	456	100	

57

Landscape Buffer (Planting Strip) Configuration Recommendation

- Avoid putting rigid objects in "landscape buffers" 3' wide or less.
- Place poles, light standards, or other large objects immediately adjacent to sidewalks or on opposite side of sidewalk -- not in center of planting strip.

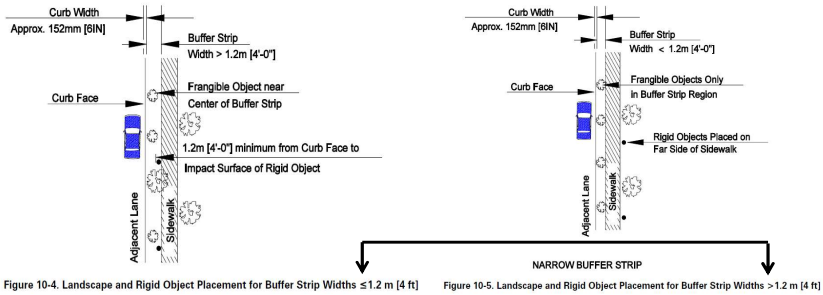


Figure 10-4. Landscape and Rigid Object Placement for Buffer Strip Widths ≤1.2 m [4 ft]

Figure 10-5. Landscape and Rigid Object Placement for Buffer Strip Widths >1.2 m [4 ft]

Source: NCHRP Report 612

58

Raised Islands non-compliant Designs

59

TL-2 WASHDOT Median\Wall

60

TL-2, 18 Inch Median Barrier

61

Landscaping

Landscaping can be a positive feature

- Must not block sight lines of pedestrians and motorists at the crossing area
- Use of small trees, low shrubs, colorful native plants

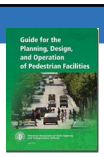
62

Maintenance

- Most likely swept by hand
- If swept by machine
  - Know width of sweepers
  - Know turning radius of sweepers
- Landscaping maintenance is essential

63

LANDSCAPING AS BARRIER



- May be used to prohibit midblock crossings at times
  - Traffic volumes and or speeds make intersection crossing preferred option
- Midrise shrubs and other types of planting alternatives for fencing
  - Used to divert the adjacent intersections
- Requires a commitment to maintain/water/repair

64

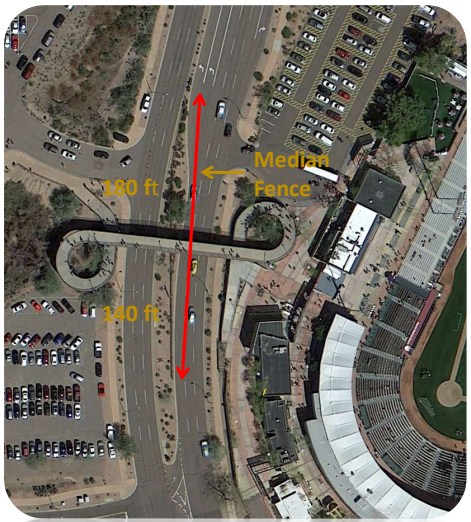
Pedestrian fences in medians

- Should be attractive
- Appropriate length to prevent crossings
- Treatments to prevent crossing as end points & median openings
- Visibility limitations for left turning motorists
- Must be crash worthy

65

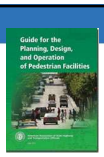
Median Fence for Pedestrian Overpass

Median fence was added when it was found that police could not force pedestrians to use overpass



66

Signalized midblock crossings



- Signals should be timed so that pedestrians can cross the entire street
- If the street is "too wide", and there is a sufficient median width, a 2-stage crossing may be considered
  - Median width min 6 feet – preferably 8 to 10 feet wide
  - What crossing distance is "too long" to warrant median installation?
    - Crossing distance may be based on cycle length & distance to nearest signal
- For 2-stage crossings, a pedestrian pushbutton must be installed in median
  - Consider APS pushbuttons

67

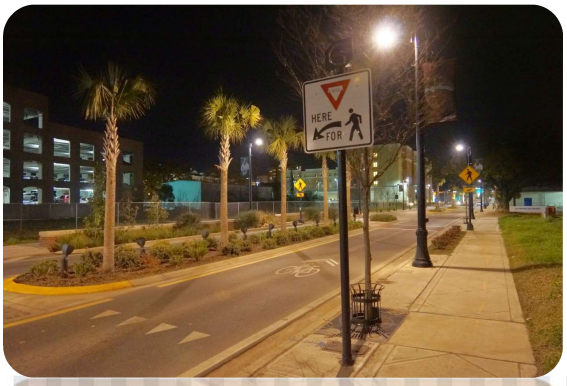
Median with parking sidewalk

NYC Street Design Manual

68

Lighting

- Lighting is encouraged to illuminate medians/crossing islands and crosswalk
- Continuous, double-sided lighting is preferred



69

Informational Report on Lighting Design for Midblock Crosswalks

- FHWA-HRT-08-053
  - April 2008
  - Available at http://www.tfhrc.gov/safety/pubs/08053/08053.pdf

70

Sample Illustrations from FHWA Report

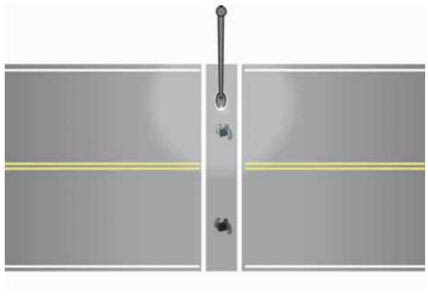


Fig 11. Traditional midblock crosswalk lighting layout

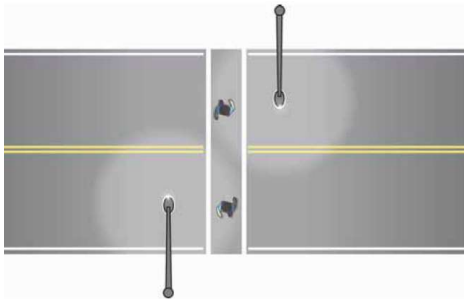


Fig 12. New design for midblock crosswalk lighting layout

Recommended lighting level: 20 lux at 5' above pavement

71

Cost

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	No. of Observations
Island	Median Island	$10,460	$13,520	$2,140	$41,170	Each	17 (19)
Island	Median Island	$9.80	$10	$2.28	$26	Sq Ft	6 (15)

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Median	Median	$6.00	$7.26	$1.86	$44	Square Foot	9 (30)

Source: "Costs for Pedestrian and Bicyclist Infrastructure Improvements: A Resource for Researchers, Engineers, Planners, and the General Public", October 2013

72

Possible Issues with Raised Medians

- Construction detours when half street is closed
- *Installing medians on existing streets with lots of driveways*
- Need room to make U-turns (narrow cross-sections)
  - Check turning templates
- Street width consideration (medians result in wider streets)
  - ROW cost/Maintenance/Traffic signal timing
- Prohibiting crossing may require median fencing
  - Aesthetics (wrought iron)
  - Make sure fencing does not block driver visibility
  - Fencing should be crash worthy
  - Provide about 200 feet fencing on either side of main crossing point (Rule of Thumb)
  - Issues at the end points of fencing

73

U-turn points for continuous medians

- U-Turn points were designed into continuous median
- Delineator posts discourage U-Turns for average drivers
- Emergency Vehicles run over delineators then replace
- Crossover point when roadwork is being done on one side of the roadway

74

75

Case study: Islands/Raised Medians (University Place, WA)

University Place, WA

Problem/Background

- City incorporated in 1995, wanted 'Main Street'
- Current main road was busy arterial with little ped/bike infrastructure
- Not safe for all users

Bridgeport Way, prior to improvements

76

Case study: Islands/Raised Medians (University Place, WA)

University Place, WA

Solution

- Held design charrette for road improvements
- Residents & city wanted road to accommodate all users:
  - Sidewalks, bicycle lanes, medians, streetlights, mid-block crossings, etc.
- Had to deal with critics and doubters

Is council moving too fast on Bridgeport?

By LINDA TARR
Editor

A discussion on where to ... after Public Works Director Ben Yazici informed the council that it would be near impos... should rely on research and the videos to answer questions, he said. ... or a three-land thoroughfare with roundabouts. The council is scheduled to make that deci... Council decides which fix for Bridgeport it wants to pursue. "It would be nice to have a ...

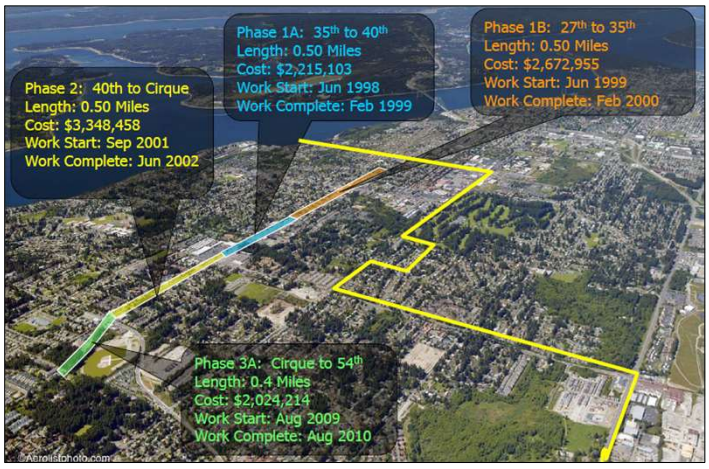
77

Case study: Islands/Raised Medians (University Place, WA)

University Place, WA

Details

- Roadwork began 2 years after charrette
- 4 phases
- 1.9 miles
- ~$10.2 million



78

Case study: Islands/Raised Medians (University Place, WA)

University Place, WA

Details

Roadway added elements that residents desired:

- Went from 5 lanes to 4 lanes with bicycle lanes and sidewalks
- Two-way turn lane replaced by landscaped median
- Mid-block crossings installed
- Utility lines buried
- lighting added

Mid-block pedestrian crossing

79

Case study: Islands/Raised Medians (University Place, WA)

University Place, WA

Results

- 20% reduction in accidents along corridor
- 40% reduction in injuries along corridor
- Sales volume along corridor increased
- Mobility improved

Before

After

80

National Guidance documents

- AASHTO Policy on Geometric Design of Highways and Streets
- AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities July 2004
- Public Right-of-Way Accessibility Guidelines

81

Questions? Resources

- AASHTO Guide for the Planning Design, and Operation of Pedestrian Facilities, July 2004
  - https://bookstore.transportation.org/Item_details.aspx?id=119
- AASHTO Policy on Geometric Design of Highways and Streets
  - https://bookstore.transportation.org/collection_detail.aspx?ID=110
- Public Right-of-Way Accessibility Guidelines
  - https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way
- Model Design Guide for Living Streets Los Angeles County 2011
  - http://www.modelstreetdesignmanual.com/download.html
- Update of Florida Crash Reduction Factors and Countermeasures to improve the Development of District Safety Improvement Projects
  - http://www.fdot.gov/research/Completed_Proj/Summary_SF/FDOT_BD015_04_rpt.pdf

82

Questions? Resources

- Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations FHWA-RD-01-075.
  - http://metroped.org/bpi/fhwa-rd-01-075_crosswalk.pdf
- Toolbox of Countermeasures and Their Potential Effectiveness to Make Intersections Safer
  - http://library.ite.org/pub/e26c7e9c-2354-d714-5181-4cc79fba5459
- Informational Report on Lighting Design for Midblock Crosswalks FHWA-HRT-08-053
  - https://www.fhwa.dot.gov/publications/research/safety/08053/08053.pdf
- NCHRP Report 612
  - http://www.trb.org/Publications/Blurbs/160176.aspx
- Washington State DOT Low Profile Barrier
  - http://www.wsdot.wa.gov/Design/Standards/PlanSheet/GD-3.htm

83