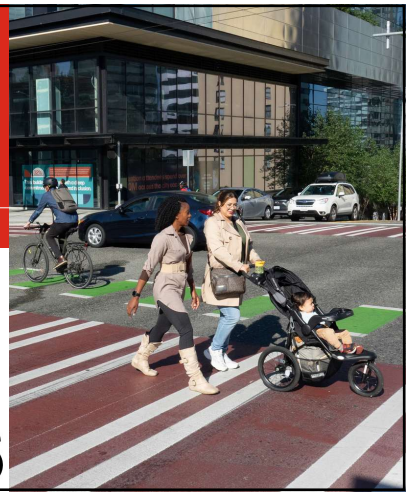
Designing Safe Streets



December 10, 2025

Jeremy Chrzan, PE, PTOE, LEED AP
Owner | Multimodal Design Practice Lead

TOOLE DESIGN

AMERICA WALKS

A Grim Reality

Traffic fatalities are a national crisis affecting *all road users*.

40,901
Lives lost on US roads in 2023

7,314
Number of pedestrians killed in 2023

1,166
Number of bicyclists killed in 2023

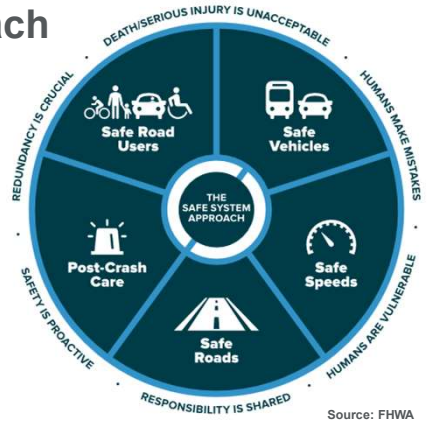
TOOLE DESIGN

Source: NHTSA CrashStats

Safe System Approach

Improve safety culture to increase **shared responsibility**

Implement road designs and operations that **prevent people from being killed or seriously injured** if a crash occurs



TOOLE DESIGN

Source: FHWA

What's the Problem?

Vehicles and Drivers

- Mindset / Distractions
- Size / Weight
- Blind spots

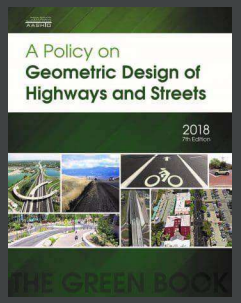
Roadway Design

- Systemic engineering modifications
- Aligning guidance and policies with the outcomes we want

Source: Axios

Sufficient flexibility is permitted to encourage independent designs tailored to particular situations.

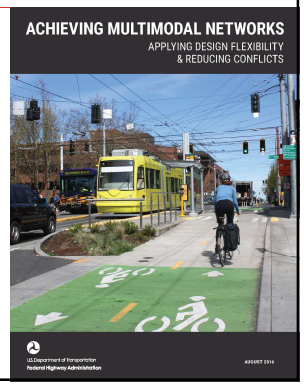
-AASHTO Green Book



TOOLE DESIGN

Wider Lanes are: Required, Right?

- 11' to 14' lanes historically favored to be more forgiving to drivers, especially on high-speed roads
  - Older AASHTO Bike Guides encouraged 14' for bicyclist safety
- AASHTO Green Book allows 9' to 12'
  - Allows 10' for "low-speed" roads (45mph or less)
- FHWA no longer requires design exceptions for lane width as a controlling criteria



TOOLE DESIGN

Wider Lanes are: Needed to Accommodate Vehicle Widths?

Design Vehicle Dimensions

Vehicle	Vehicle Length	Vehicle Width	Operating Width[1]
Passenger Cars and Light Trucks	19.0 feet	7.0 feet	9.0 ft
School Bus	36.0 feet	8.0 feet	10.0 ft
Transit Bus	40.0 feet	8.5 feet	10.5 ft
Single Unit Truck[2]	30.0 feet	8.0 feet	10.0 ft
Tractor-Trailer	55.0 feet	8.5 feet	10.5 ft

Source: *A Policy on the Geometric Design of Streets and Highways*, AASHTO, 2004. Chapter 2 Design Controls and Criteria
1 Assuming one-foot clearance on both sides of vehicle
2 The SU-30 design vehicle is commonly used to model emergency response vehicle operations

TOOLE DESIGN

Wider Lanes are: Less Safe?

Travel lanes of 10-feet as part of a thoughtful design of arterials and collectors do not negatively affect motorist safety.

TOOLE DESIGN

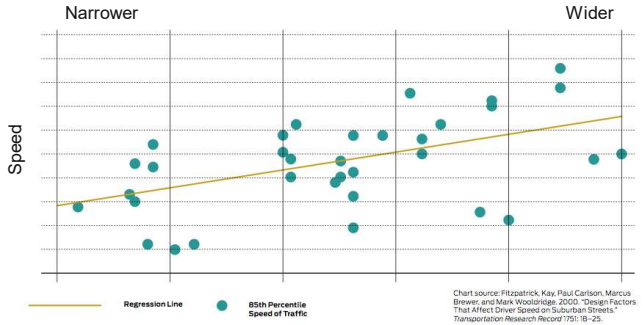
Wider Lanes are Needed for Capacity?

Travel lanes of 10-feet as part of a thoughtful design of arterials and collectors have no measurable effect on capacity.

TOOLE DESIGN

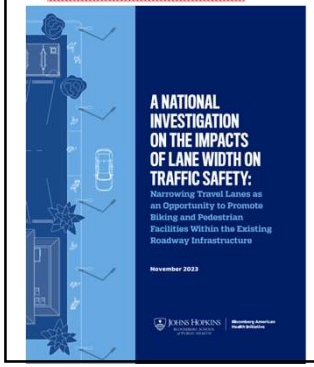
Narrow Lanes Can Reduce Speeds

"Narrow lanes can contribute to lower speeds when integrated as part of an urban street design."
- FHWA



TOOLE DESIGN

Narrow Lanes Are Allowed and Are Safer

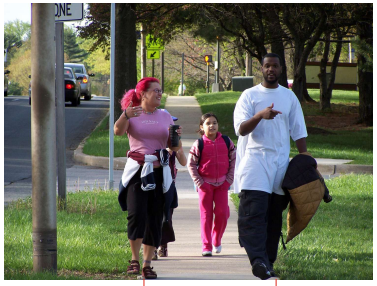


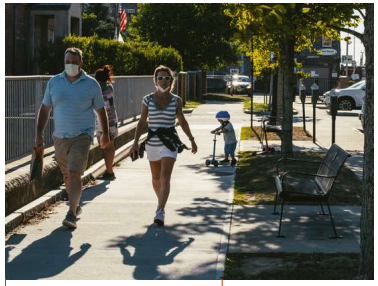
- Our survey of AASHTO member state DOTs indicate that the majority of state DOTs prefer to follow the conventional design standards adopted by their DOT, and the context-sensitive design approach has not been widely used within their jurisdiction.
- In practice we are far from implementation of the context-sensitive design solutions by most state DOTs. The design exception for lane width reduction projects seems to be a rare event in most state DOTs that participated in our survey.
- In the speed class of 20—25 mph, the driving speed is slow enough that drivers do not notice changes in lane widths. This hypothesis was confirmed by our findings that there is no significant difference in terms of the number of non-intersection crashes between 9-foot, 10-foot, 11-foot, 12-foot, or even 13-foot lanes.
- On the other hand, street sections with 10-foot, 11-foot, and 12-foot lanes have significantly higher numbers of non-intersection crashes than their counterparts with 9-foot lanes in the speed class of 30—35 mph.
- In other words, in the speed class of 30—35 mph, wider lanes not only are not safer, but exhibit significantly higher numbers of crashes than 9-foot lanes, after controlling for geometric and cross-sectional street design characteristics of street sections.

Narrow Lanes

Narrow Lanes

Sidewalk Widths

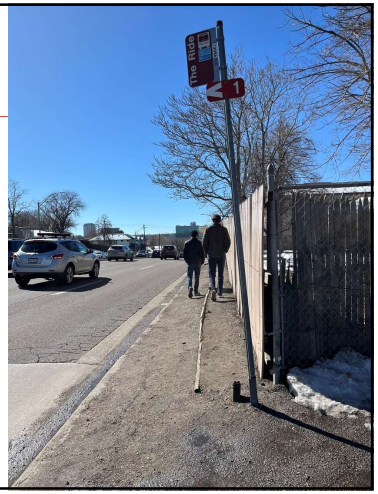




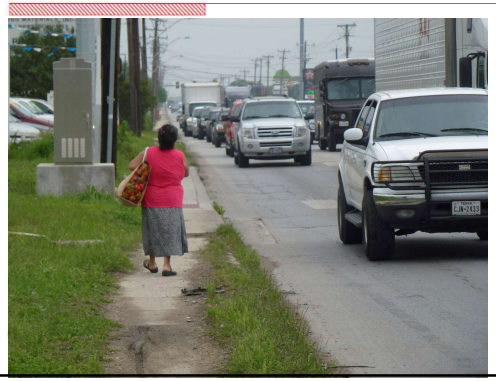
TOOLE DESIGN

Sidewalk Widths

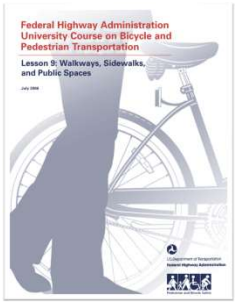
TOOLE DESIGN



Sidewalk Widths (Design and Maintenance)



Sidewalk Widths
Context Sensitivity



Land Use	Frontage Zone Minimum Width (FT) (A)	Minimum Pedestrian Through Zone Sidewalk Width (FT) (B) (E)	Minimum Buffer Zone Width (FT) (C) (D) (E) Posted Speed <= 35 MPH	Minimum Buffer Zone Width (FT) (C) (D) (E) Posted Speed >= 40 MPH (F)
Central Business District	2-6	8-14	4-8	6-10
Commercial	2-6	6-8	4-8	6-10
Residential	2	5-7	4-6	6-8

TOOLE DESIGN

Ohio Multimodal Design Guide

Public Spaces
Denison, TX

Inman Square, Cabridge, MA

Shared Use Path Widths

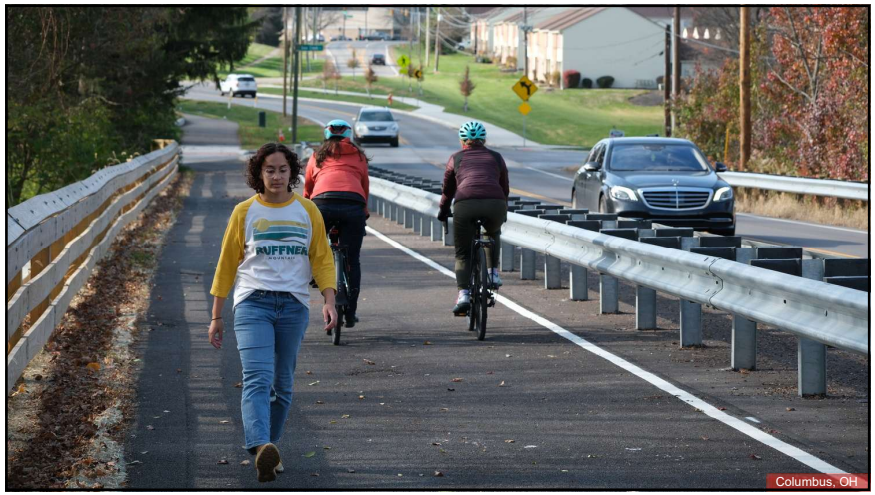
Recommended Shared Use Path Widths

Shared Use Path Operating Widths and Operational Lanes*					
SUPLOS "C" Peak Hour Volumes	Recommended Operational Lanes	Practical Minimum	Recommended Lower Limit	Recommended Upper Limit	Practical Maximum
150 to 300	2	8 ft	10 ft	12 ft	13 ft
300 to 500	3	11 ft	12 ft	15 ft	16 ft
500 to >600	4	15 ft	16 ft	20 ft	None

*Typical Mode Split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicyclists

11' wide is three operational lanes on a path

TOOLE DESIGN **AASHTO Bike Guide**



Intersection Design Objectives

Minimize Exposure to Conflicts
Reduce Speeds at Conflict Points
Communicate Right-of-Way
Providing Sight Distances
Transitions between Other Facilities
Needs of Persons with Disabilities

TOOLE DESIGN

Inman Square - Cambridge, MA (before)

Inman Square - Cambridge, MA (after)

Minimize Vehicle Turning Speeds

Design Controls & Evaluation:
Intersection Design and Check Vehicles
Turning Vehicle Design Speed
Actual and Effective Curb Radius

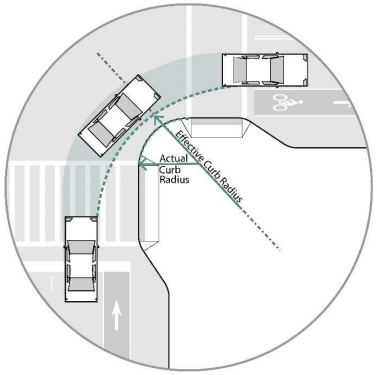
Treatments for Minimizing Turning Speeds
Truck Aprons
Turning Lanes and Channelized Islands
Median Islands and Hardened Centerlines

Designing Intersection and Driveway Corner Radii (to Minimize Turning Speeds)

TOOLE DESIGN

Intersection Corner Evaluation

- Choose most appropriate motorized design and check vehicle for the location
- Smallest feasible curb radius should be selected for corner designs based upon the design vehicle's effective turning radius

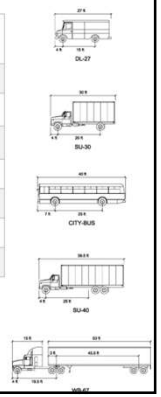


TOOLE DESIGN

Design Vehicles

Street A	Street B	Design Vehicle	Corresponding Turning (Effective) Radius
Local Streets and Streets on NEN	Local Streets and Streets on NEN	DL-27	16 feet
All Non-Local Streets, including enhanced streets	Local Streets and Streets on NEN	DL-27	16 feet
Local Streets and Streets on NEN	All Non-Local Streets, including enhanced streets	DL-27	16 feet
Streets on TEN	Streets on TEN	CITY-BUS	25 feet
Industrial Collector	Industrial Local or Collector	SU-40*	38 feet*
Truck Route	Truck Route	WB-67*	50 with oversteering*
Streets with mini-roundabouts	Streets with mini-roundabouts	SU-30**	30 feet

NEN = Neighborhood Enhanced Network; TEN = Transit Enhanced Network
**Designers should provide detailed AutoTURN or equivalent turning analysis, to support evaluation for specific corner design*
***The DL-27 may be an acceptable design vehicle for some residential intersections if the frequency of the SU-30 will be minimal.*



TOOLE DESIGN

Los Angeles Supplemental Street Design Guide

Does Corner Radius Matter?

Small Corner Radius

Curb Extensions

Curb Extensions

Philadelphia, PA

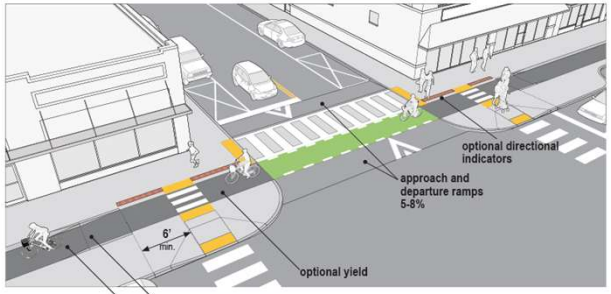

Pittsburgh, PA

Curb Extensions & Corner Radii

Falls Church, VA
Berman Park Trail

Curb Extensions

Raised Crossings

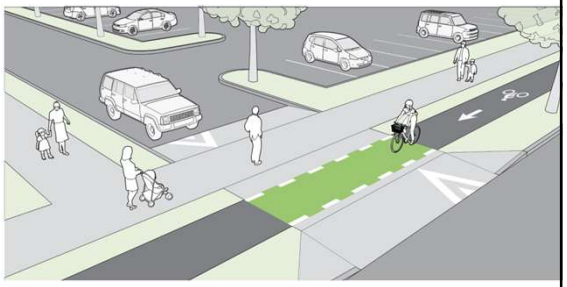


TOOLE DESIGN

AASHTO Bike Guide

Raised Driveway Crossings

Low Volume Driveways
Higher Volume Driveways
Driveway Frequency

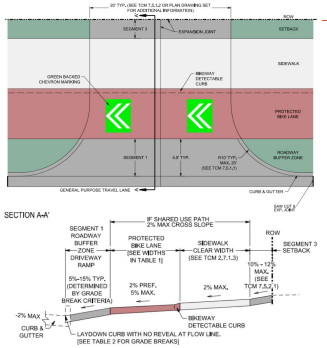


TOOLE DESIGN

AASHTO Bike Guide

Driveways

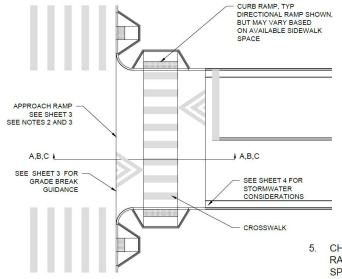
Driveways

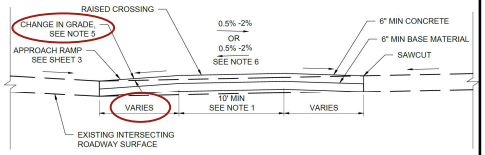


TOOLE DESIGN

City of Austin
Interim Standard Details

Raised Crosswalk / Speed Table Guidance





SECTION A-A. CONCRETE RAISED CROSSING
N.T.S

5. CHANGE IN GRADE WILL VARY BASED ON THE TARGET SPEED FOR THE RAISED CROSSING. FOR RAISED CROSSINGS AT STOP CONTROLLED INTERSECTIONS OR MIDBLOCK WITH A TARGET SPEED <10 MPH, AN 8% CHANGE IN GRADE IS APPROPRIATE. FOR RAISED CROSSINGS WITH A TARGET SPEED ≥ 10 MPH, A 5% CHANGE IN GRADE SHOULD BE USED.

TOOLE DESIGN

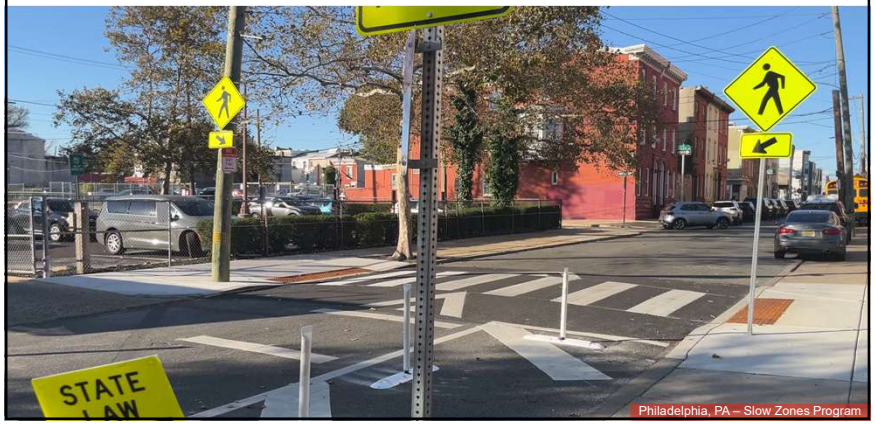
Ohio Multimodal Design Guide

Raised Crosswalks

"We don't have to wait for crashes to happen and people to die before we install these. We know they work, and they can prevent tragedies."
- Ed Sniffen, HDOT's Deputy Director

TOOLE DESIGN

Raised Crosswalks



Raised Crosswalks AND Driveways

Geometric Design Treatments to Improve Intersection Safety

Medians and Pedestrian Refuge Islands; Hardened Centerlines

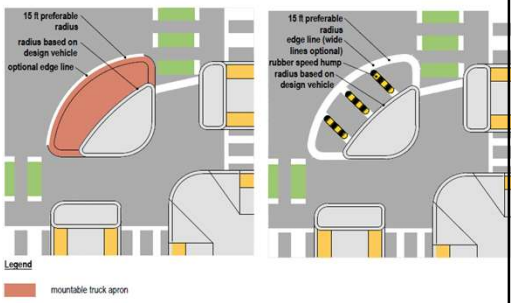
Curb Extensions

Curb Radius

Mountable Truck Aprons

Raised Crossings

Multiple Threat Crossing Treatments

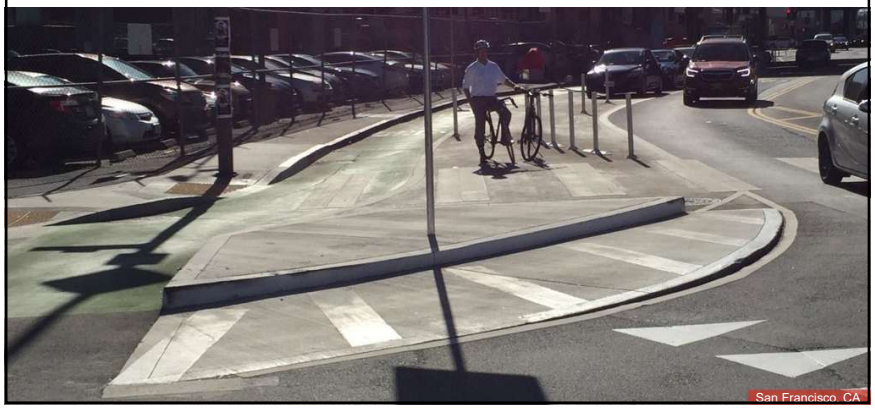


TOOLE DESIGN

AASHTO Bike Guide

Mountable Truck Aprons

Mountable Truck Aprons



Mountable Truck Aprons

Mountable Truck Aprons

Mountable Truck Aprons

Silver Spring, MD

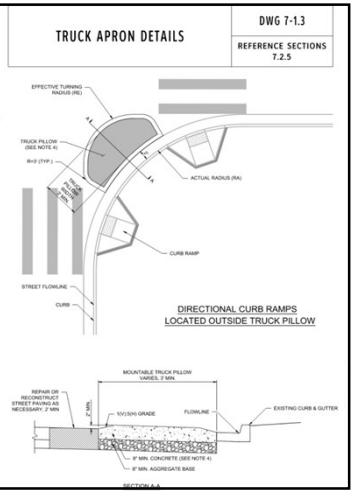
Mountable Truck Aprons

New York City, NY

Mountable Truck Aprons

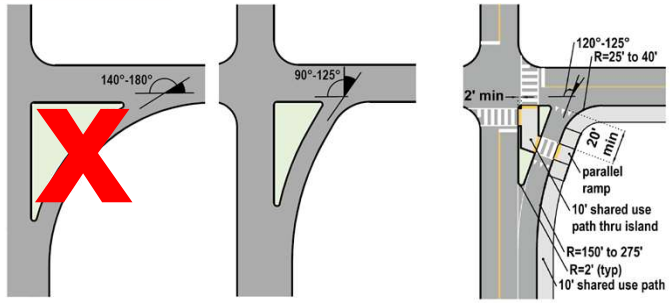
Quite a few example details provided in the OhioDOT Multimodal Design Guide, including some with drainage bypass to maintain drainage patterns.

Recommend no less than 3' wide



TOOLE DESIGN

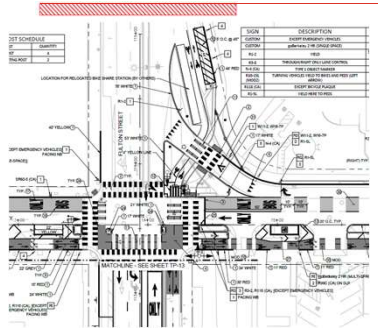
Slip Lanes / Channelized Right Turn Lanes



TOOLE DESIGN

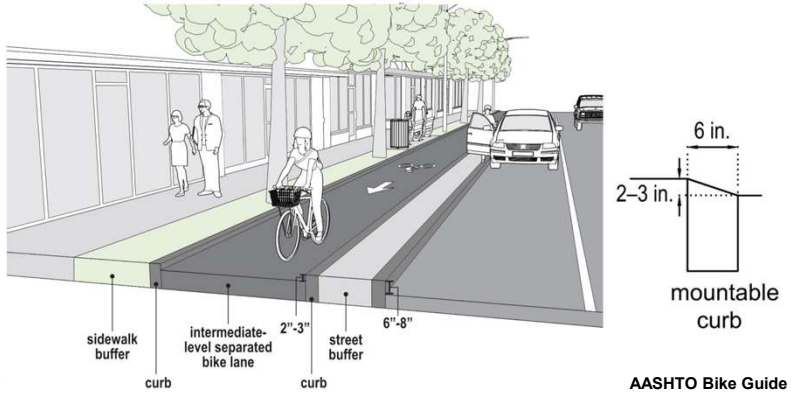
AASHTO Bike Guide

Slip Lanes / Channelized Right Turn Lanes



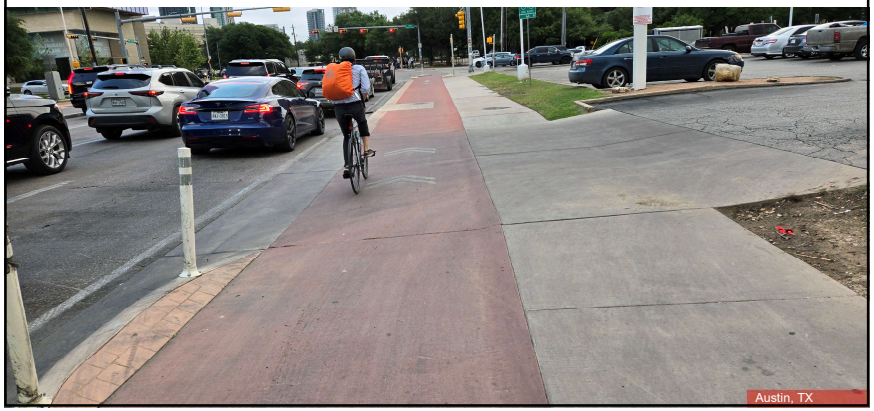
TOOLE DESIGN

Separated Bike Lanes (Intermediate-Level Elevation)



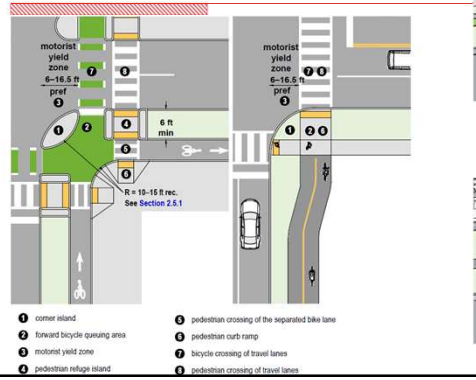
AASHTO Bike Guide

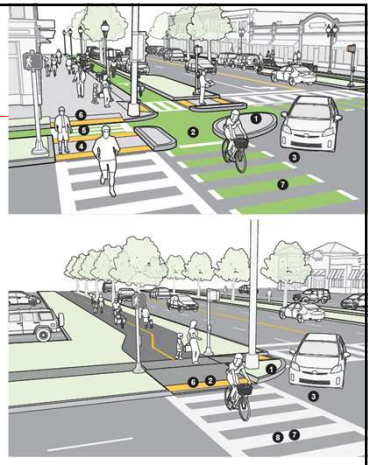
Separated Bike Lanes (Intermediate-Level Elevation)



Intermediate-Level @ Floating Bus Stop

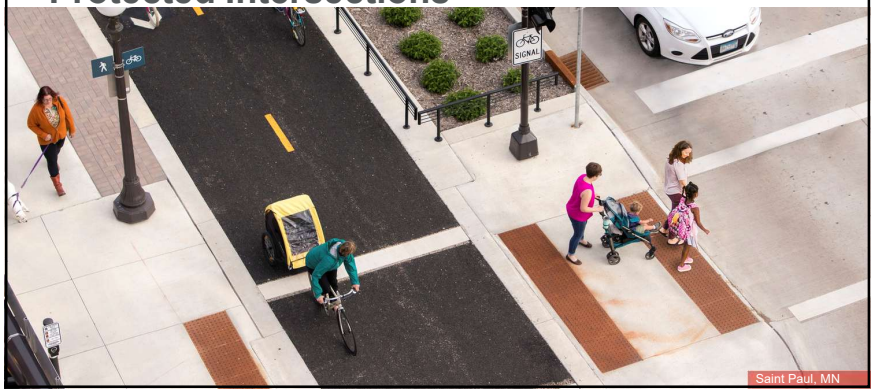
Protected Intersections





AASHTO Bike Guide

Protected Intersections



Saint Paul, MN

Protected Intersections

Austin, TX

Protected Intersections

Berkeley, CA

Protected Intersections

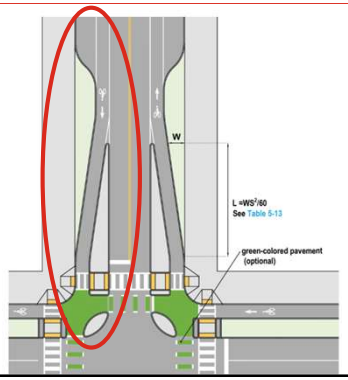
Protected Intersections

You can always transition a bike lane to a separated bike lane at intersections

NCHRP 1125 recommends this above all other options for safety and comfort

Provides opportunities for shorter pedestrian crossing distances and improved sight lines

TOOLE DESIGN



Selecting Pedestrian Crossing Treatments

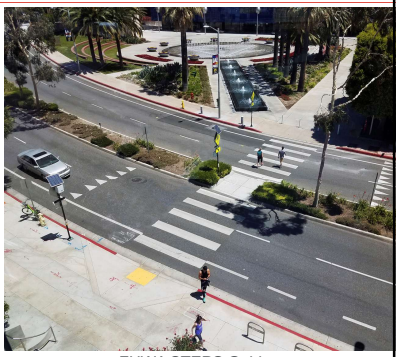
Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	1 2 4 5 6	1 5 6 7 9	1 5 6 7 9	1 4 5 6	1 5 6 7 9	1 5 6 7 9	1 4 5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

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

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

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



FHWA STEPS Guide

Selecting Bicycle Crossing Treatments

Tier 1: Signing & Markings

Tier 2: RRFB & Geometric Improvements

Tier 3: PHB, Signal, or Grade Separation

TOOLE DESIGN

AASHTO Bike Guide

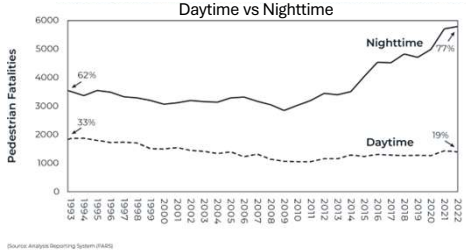
Uncontrolled Crossing Countermeasure Evaluation Table

Roadway Type	Vehicle ADT < 9,000			Vehicle ADT 9,000 - 12,000			Vehicle ADT 12,000 - 15,000			Vehicle ADT > 15,000		
Number of Travel Lanes and Median Type	Speed Limit (mph)											
	≤30	35	40≥[a]	≤30	35	40≥[a]	≤30	35	40≥	≤30	35	40≥
2 Lanes[b]	1	1	2	1	1	2	1	1	3	1	2	3
3 Lanes with Raised Median[c]	1	1	2	1	1	2	1	2	3	2	2	3
3 Lanes without Raised Median[c,d]	1	1	2	1	2	2	2	3	3	2	3	3
4 Lanes with Raised Median[c,d]	1	1	2	1	2	2	2	3	3	3	3	3
4+ Lanes without Raised Median	1	2	3	2	2	2	3	3	3	3	3	3

Notes:
[a] Where the speed limit exceeds 40 mph, Tier 3 should be considered.
[b] 1 lane in each direction.
[c] Raised medians must be at least 6 ft wide to serve pedestrians. See Figure 2-4 for different bicycle lengths to serve bicyclists. Where median width is less than these values, review category of 4+ lanes without raised median.
[d] 2 lanes in each direction.

Safety at Night

30 Years of Pedestrian Fatalities (1993-2022)
Daytime vs Nighttime



TOOLE DESIGN

NCHRP
Research Report 1157

National Cooperative Highway Research Program

Strategies to Improve Pedestrian Safety at Night
A GUIDE

NATIONAL ACADEMIES Sciences Engineering Medicine
TRB TRANSPORTATION RESEARCH BOARD

Safety at Night

Reduce potential for a severe outcome through managing vehicle speeds

Decrease likelihood of a crash through increasing driver awareness of pedestrians (enhancing visibility)

Reduce pedestrian exposure (i.e., time pedestrians spend in the roadway)

TOOLE DESIGN

Safety at Night

Countermeasure	Pedestrian Risk Category		
	Manage Vehicular Speeds	Enhance Visibility	Reduce Pedestrian Exposure
Road Reallocations	X		O
Speed Feedback Signs	X		
Automatic Speed Enforcement	X		
Lower Speed Limits	X		
Lighting		X	
Marked Crosswalks		X	
Traffic Signals		X	
Pedestrian Hybrid Beacons		X	
Rectangular Rapid Flashing Beacons		X	
Daylighting/Curb Extensions	O	O	O
Crossing Islands	O		O
Sidewalks/Walkways/Shared Use Paths	O	O	O

TOOLE DESIGN

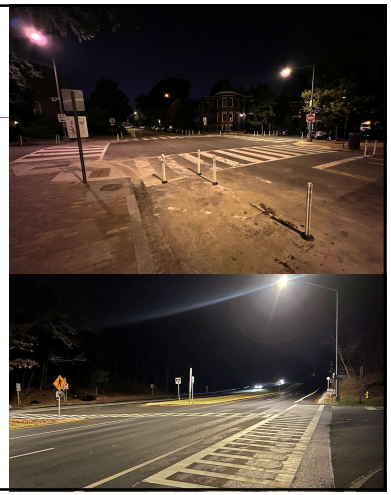
X indicates the primary pedestrian risk category for that countermeasure
O indicates a secondary pedestrian risk category or categories.

Safety at Night

Design considerations for spot lighting:

- Illuminate key aspects of the roadway such as user conflict areas, intersections, and complex roadway conditions.
- Install lighting **in advance** of mid-block crossings and intersections **to illuminate the front of a pedestrian**.
- Illuminate locations with known pedestrian safety and/or security issues such as bridges, underpasses, and tunnels.
- Ensure that street features such as trees, signs, or other obstructions do not block the light from reaching the roadway/pedestrian facilities.

TOOLE DESIGN



> **Lighting alone will not substantially increase pedestrian safety in high-risk environments. Additional nighttime pedestrian countermeasures – especially to slow driver speeds – are needed to substantially mitigate pedestrian risk at night.**

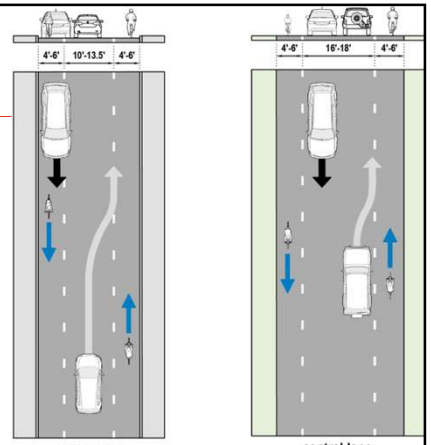
TOOLE DESIGN

Advisory Shoulders (Experimental)

Two Variations:

- 10'-13.5' central travel lane
- 16'-18' central travel lane

Crash Modification Factor (CMF) as "Edge Lane Roads"



central lane suitable for one vehicle

central lane suitable for two vehicles

TOOLE DESIGN

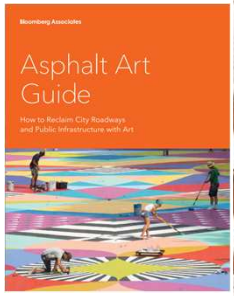
Advisory Shoulders (Experimental)

Yarmouth, ME
Population: 9K

Hanover, NH
Population: 11K
Photo Credit: FHWA

TOOLE DESIGN

Asphalt Art

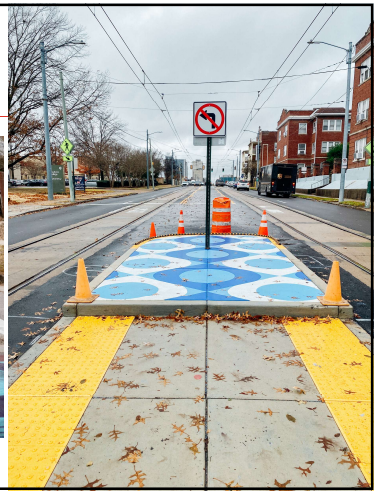


https://asphaltart.bloomberg.org/

Source: Bloomberg

TOOLE DESIGN

Asphalt Art



Denver (above)
Memphis (right) – Source Khara Woods

Thank you!

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