COMPLETE STREETS DESIGN

R. Marshall Elizer, Jr., P.E., PTOE
Gresham, Smith and Partners

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Your Instructor: Marshall Elizer, P.E., PTOE

- Senior Principal, Gresham, Smith and Partners, Nashville, TN
- 40 years roadway design experience, 22 of those with local governments
- Technical Editor, ITE's *Urban Street Geometric Design Handbook*
- Policy Committee, ITE/CNU's *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*
- Member, AASHTO's Technical Committee on Geometric Design (*Green Book, Low Volume Roads Guide, etc*)
- Technical Advisory Committee, AARP's *Complete Streets for Older Adults*

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Learning Outcomes

- This 90-minute session will provide guidance on current and evolving design practice for Complete Streets. The material covered will define the typical goals of Complete Streets projects followed by review of the leading design guidance that can be used to achieve those project goals. Current federal and state guidance will be referenced as well. An example design project will be used to illustrate the design process for selecting key design controls and criteria.
- Specific objectives are:
  - Describe the benefits of adopting an effective complete streets design policy and deploying strategies necessary for its effective implementation
  - Identify and explain design research, best practices, standards, guides, and technical tools that design professionals can utilize to balance and meet the needs of all users
  - Explain technical design flexibility available within current design guidance and standards

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What is a Complete Street?

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A Complete Street is…

…designed to be safely traveled by ALL legal users…of all ages and abilities…no matter who they are or how they travel.

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Bottom Line?

A Complete Street is safe, comfortable & convenient for use by ALL legal modes….current and planned.

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What does a Complete Street look like?

There is no magic formula…each design is tailored to meet the needs of all users considering area context and overall transportation system needs.

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A Complete Street provides….

Minimum levels of:

- accessibility
- capacity of service
- quality of service
- safety
- convenience

….for all legal users.

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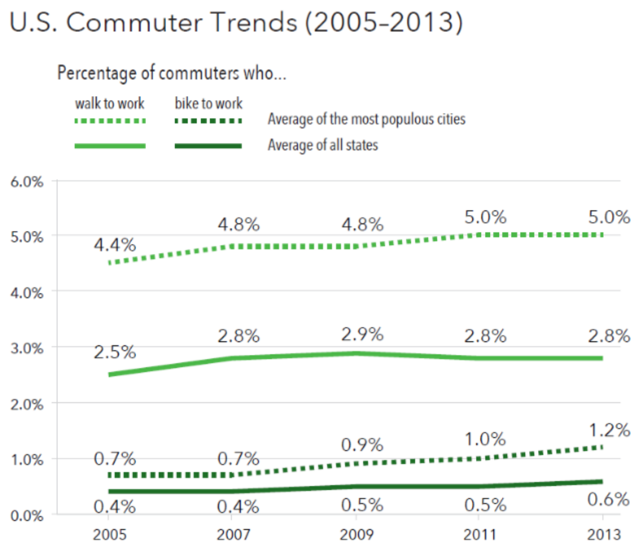
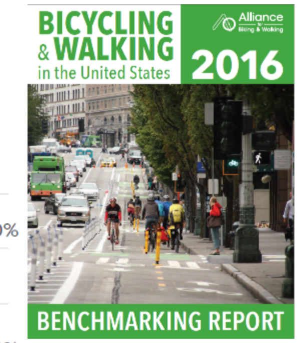
More Walking & Bicycling





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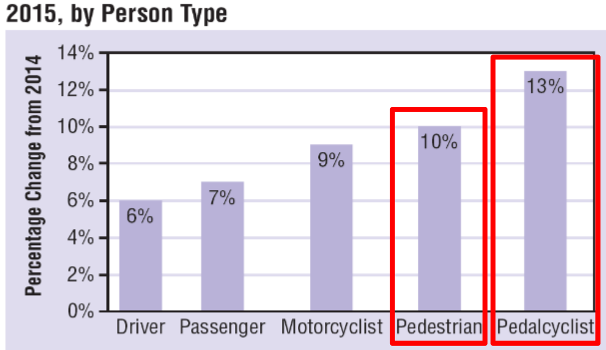
Safety, Safety, Safety

7.7 PERCENT INCREASE in U.S. traffic deaths from 2014 to 2015.
From 32,675 in 2014 to an estimated 35,200 fatalities in 2015 (+2,525)

Figure 3: Percentage Change in Fatalities From 2014 to 2015, by Person Type



All user types had significant increases, but **BICYCLE (13%) & PEDESTRIAN (10%)** fatalities increased the most.

Safety, Safety, Safety

Streets are highly dangerous for “vulnerable” users

Table 1. Probability of pedestrian death resulting from various vehicle impact speeds.

Vehicle speed (mph)	Probability of Pedestrian Fatality by Age Group			
	All Ages (%)	Age up to 14 (%)	Age 15 to 59 (%)	Age 60+ (%)
20	5	1	1	3
30	45	5	7	62
40	85	16	22	92

Source: Speed Concepts: Informational Guide, FHWA-SA-10-001, 2009

Complete Streets Design

Designing Streets and Roads

- Often complex but fairly standard process
- Street design has been traditionally driven by:
  - Functional classification (arterial, collector, etc)
  - Design-Year Vehicle ADT, % trucks/buses
  - Desired vehicular Level of Service (LOS)
  - Selected vehicle Design Speed
  - Pedestrian/bicycle minimums
  - Design Policy/Standards (Federal, State, local)
  - ADA requirements
  - Utilities, drainage, environmental, etc
  - Available budget and available right-of-way

But, there is a GROWING focus on serving ALL travel modes with more public involvement in the design process….so what does that involve?

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Complete Streets Design involves…

- The needs of all users/modes are fully understood and considered throughout the process….locally and system-wide.
- The process ensures the right of safe and convenient access and travel of all users and modes.
- The current and future land use and area *context* is a key consideration in determining design options.
- There is a robust process for evaluating and choosing design alternatives with consideration of all users/modes throughout the process.
- Local and system stakeholders are involved throughout the concept and detailed design process.

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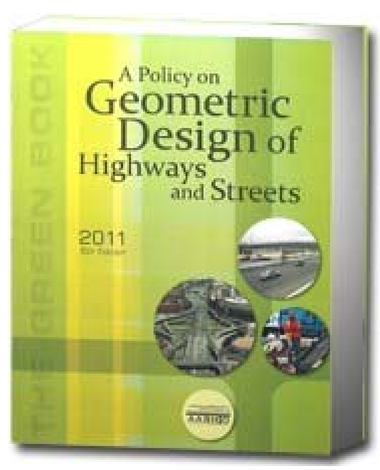
Existing Roadway Design Guidance

Federal Design Guidance

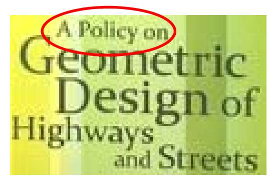
- 2011 “Green Book” is the latest edition
- Produced by the American Association of State and Highway Transportation Officials (AASHTO)
- Adopted by FHWA as the standard (specified in 23 CFR 625) for construction and reconstruction projects on the National Highway System (NHS)
- NOT the standard off of the NHS but many agencies adopt it.



Key Point

The AASHTO Green Book is written as a Policy on Geometric Design

- State and local agencies generally establish their own "standards"
- Should not refer to the Green Book as "AASHTO standards" other than for the NHS
- Should never refer to the Green Book as "safety standards"
- The Green Book provides support and guidance for Complete Streets design



Understand the Intent of the Green Book

"The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions. It is not intended to be a detailed design manual that could supersede the need for the application of sound principles by the knowledgeable design professional. Minimum values are either given or implied by the lower value in a given range of values. The larger values within the ranges will normally be used where the social, economic, and environmental (S.E.E.) impacts are not critical."

Green Book Foreword, 2011

AASHTO 2011 Green Book Multi-Modal Accommodation/Service

"Emphasis is placed on the joint use of transportation corridors by pedestrians, cyclists and public transit vehicles. Designers should recognize the implications of this sharing of the transportation corridors and are encouraged to consider not only vehicular movement, but also movement of people, distribution of goods, and provision of essential services. A more comprehensive transportation program is hereby emphasized."

Green Book Foreword, pg xlii

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AASHTO 2011 Green Book Chapter 1 – Highway Functions

- Emphasis on designer consideration of the "context" of the project area [sec 1.3.3 & 1.3.5]
- Highlights the flexibility available to encourage choosing design criteria [pgs 1-9 thru 1-13] that is:
  - consistent with the context of the project
  - needs and value of the community
  - with respect to economic limitations

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AASHTO 2011 Green Book
Functional Characteristics

- Rural: *"Minor arterials therefore constitute routes that should provide for relatively high travel speeds and minimum interference to through movement consistent with the context of the project area and considering the range or variety of users*" [pg 1-9]
- Urban: *"For facilities within the subclass of other principal arterials in urban areas, mobility is often balanced against the need to provide direct access as well as the need to accommodate pedestrians, bicyclists, and transit users*" [pg 1-11]

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AASHTO 2011 Green Book re "Context" Sensitivity

- *"The first step in the design process is to define the function that the facility is to serve and the context of the project area" [pg 1-13]*
- *"…the designer should keep in mind the overall purpose that the street or highway is intended to serve, as well as the context of the project area" [pg 1-13]*
- *"Arterials are expected to provide a high degree of mobility for the longer trip length. Therefore, they should provide as high an operating speed and level of service as practical within the context of the project area" [pg 1-12]*

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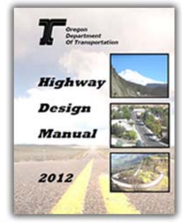
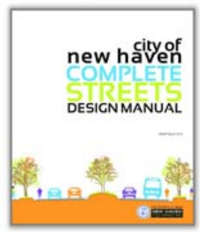
Individual State or local agency design policies & manuals typically apply

- Some States and local agencies have adopted the Green Book for their geometric design minimums or as their design guidance manual.
- Most State DOTs and local agencies have also developed their own geometric design policies, guidelines and standards.
- And many of those agencies (hundreds in fact) have also developed complimentary guidelines for the geometric design of "complete streets".





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Federal Policy supporting Complete Streets

United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March, 2010

The DOT policy is to incorporate safe and convenient walking and bicycling facilities into transportation projects. Every transportation agency, including DOT, has the responsibility to improve conditions and opportunities for walking and bicycling and to integrate walking and bicycling into their transportation systems. Because of the numerous individual and community benefits that walking and bicycling provide — including health, safety, environmental, transportation, and quality of life — transportation agencies are encouraged to go beyond minimum standards to provide safe and convenient facilities for these modes.

http://www.fhwa.dot.gov/environment/bicycle_pedestrian/overview/policy_accom.cfm

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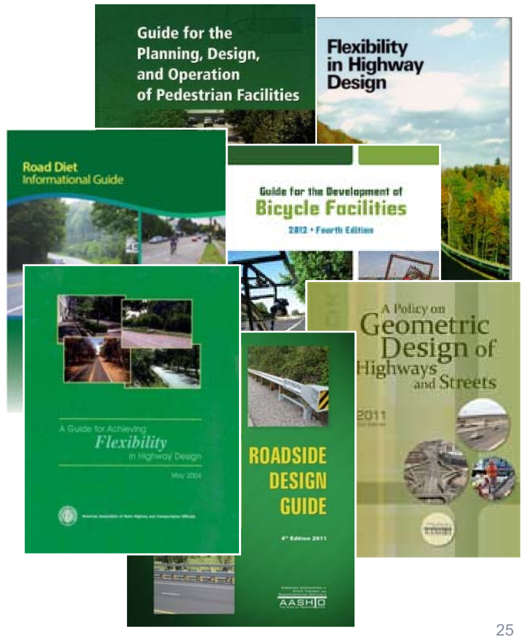
Broad Conventional Design Guidance

Traditional Guidance

- AASHTO: Green Book, ped/bike and other design references
- Other national guidelines & best practices
- State DOT Standards & Guidelines
- Local agency standards and guidelines



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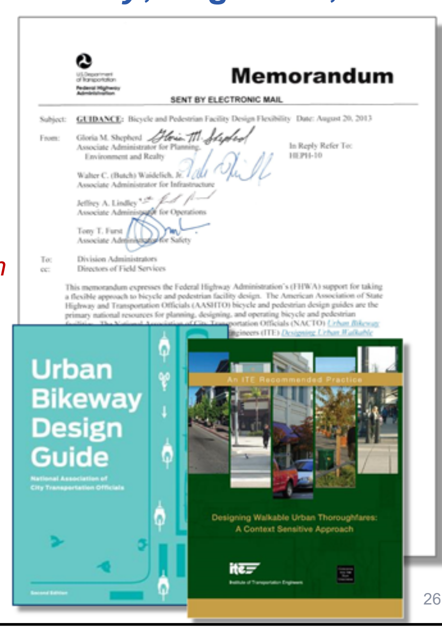
FHWA Design Guidance Memo: *Bicycle and Pedestrian Facility Design Flexibility*, August 20, 2013

- The AASHTO bicycle and pedestrian design guides are the primary national resources for planning, designing, and operating bicycle and pedestrian facilities.
- NACTO's *Urban Bikeway Design Guide* and the ITE's *Designing Urban Walkable Thoroughfares* guide build upon the flexibilities provided in the AASHTO guides.
- FHWA supports the use of these resources to further develop non-motorized transportation networks, particularly in urban areas.



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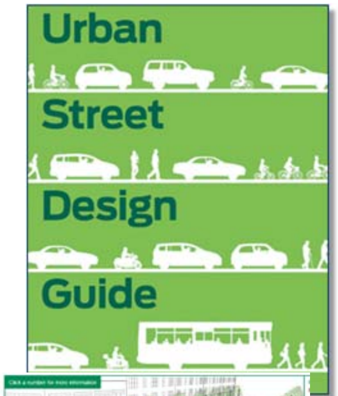
FHWA Perspectives on NACTO's Urban Street Design Guide - 2014

- The *Guide* provides sample scenarios that build on the flexibilities in the AASHTO *Policy on Geometric Design of Highways and Streets*, *Guide for the Planning, Design, and Operation of Pedestrian Facilities* and *Guide for the Development of Bicycle Facilities*.
- The *Urban Street Design Guide* can be used to inform the planning and design process in conjunction with these other resources.
- The *Urban Street Design Guide* can serve as one of many planning and design resources, but it does not supersede other existing national standards or guidelines.



Available at
http://nacto.org/usdg/

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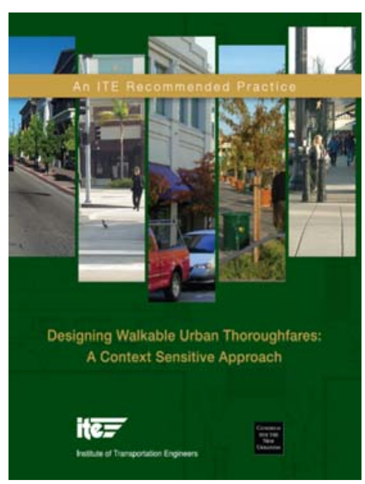
Other Design Guidance

Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, 2010

- Covers a wide range of issues and challenges in urban complete streets design.
- Relates guidance to AASHTO design policy.
- Provides specific guidance on many design features, techniques and tools.



Free download at www.ITE.org Bookstore

And much more national guidance…

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And even more…

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Numerous State DOT Complete Streets Design Guidance Documents

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And growing numbers of local CS design guides

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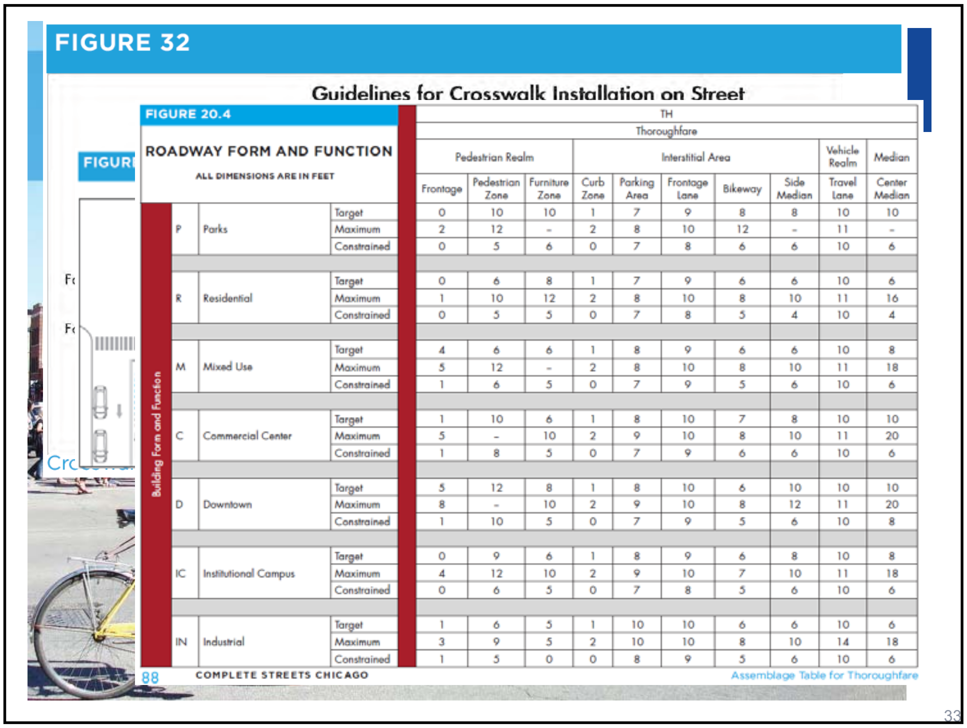

Building Form and Function				Frontage	Pedestrian Zone	Furniture Zone	Curb Zone	Parking Area	Frontage Lane	Bikeway	Side Median	Travel Lane	Center Median
				TH Thoroughfare									
				Pedestrian Realm			Interstitial Area					Vehicle Realm	Median
	P	Parks	Target	0	10	10	1	7	9	8	8	10	10
			Maximum	2	12	-	2	8	10	12	-	11	-
			Constrained	0	5	6	0	7	8	6	6	10	6
	R	Residential	Target	0	6	8	1	7	9	6	6	10	6
			Maximum	1	10	12	2	8	10	8	10	11	16
			Constrained	0	5	5	0	7	8	5	4	10	4
	M	Mixed Use	Target	4	6	6	1	8	9	6	6	10	8
			Maximum	5	12	-	2	8	10	8	10	11	18
			Constrained	1	6	5	0	7	9	5	6	10	6
	C	Commercial Center	Target	1	10	6	1	8	10	7	8	10	10
			Maximum	5	-	10	2	9	10	8	10	11	20
			Constrained	1	8	5	0	7	9	6	6	10	6
	D	Downtown	Target	5	12	8	1	8	10	6	10	10	10
			Maximum	8	-	10	2	9	10	8	12	11	20
			Constrained	1	10	5	0	7	9	5	6	10	8
	IC	Institutional Campus	Target	0	9	6	1	8	9	6	8	10	8
			Maximum	4	12	10	2	9	10	7	10	11	18
			Constrained	0	6	5	0	7	8	5	6	10	6
	IN	Industrial	Target	1	6	5	1	10	10	6	6	10	6
			Maximum	3	9	5	2	10	10	8	10	14	18
			Constrained	1	5	0	0	8	9	5	6	10	6

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Assemblage Table for Thoroughfare

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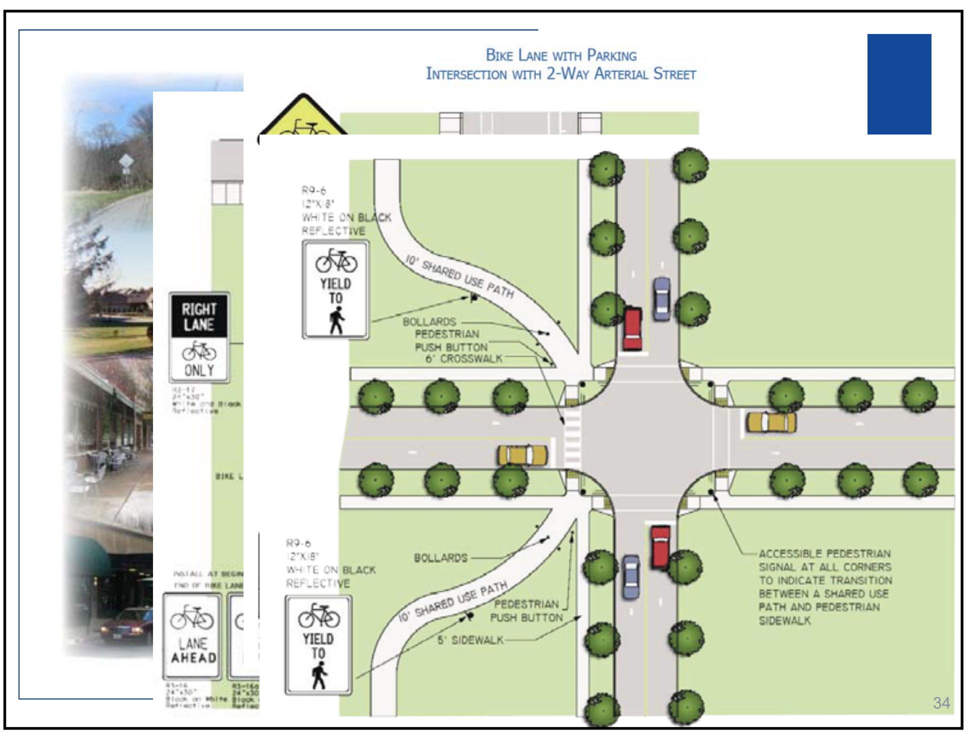

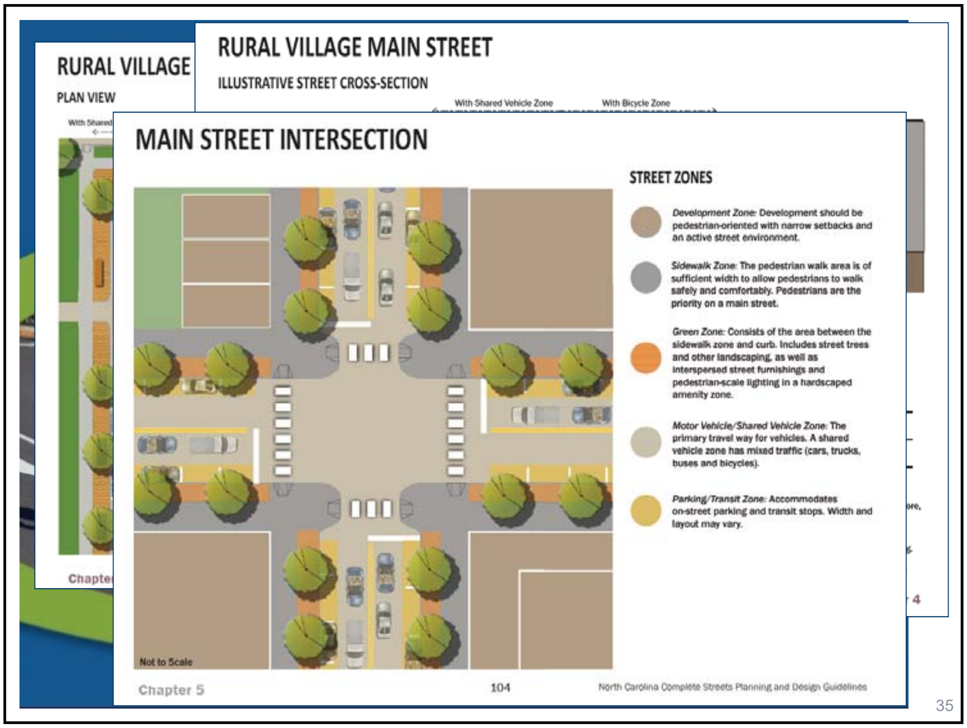

Complete Streets look different depending on the context of the environment. Rural areas must consider the needs for walking and biking, but the type and amount of infrastructure that accommodates this use will be drastically different than what's needed in an urban area.

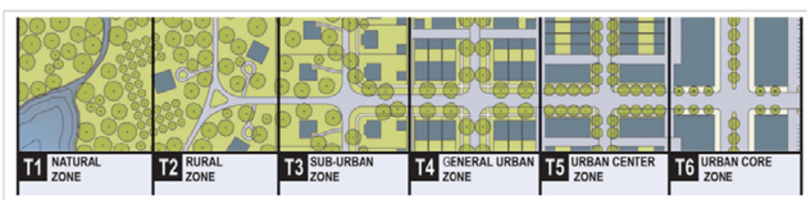

Table 4.3 Relationship Between Functional Classification and Thoroughfare Type

	Thoroughfare Types						
Functional Classification	FREEWAY/ EXPRESS-WAY/PARK-WAY	RURAL HIGHWAY	BOULEVARD	AVENUE	STREET	RURAL ROAD	ALLEY/REAR LANE
Principal Arterial	■	■	■	■	■		
Minor Arterial		■	■	■	■		
Collector				■	■	■	
Local					■	■	■

Shaded cells represent thoroughfare types that are not addressed in this report.

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Table 6.4 Design Parameters for Walkable Urban Thoroughfares

Thoroughfare Design Parameters for Walkable Mixed–Use Areas									
	Suburban (C–3)						General Urban (C–4)		
	Residential			Commercial			Residential		
	Boulevard [1]	Avenue	Street	Boulevard [1]	Avenue	Street	Boulevard [1]	Avenue	Street
Context									
Building Orientation (entrance orientation)	front, side	front, side	front, side	front, side	front, side	front, side	front	front	front
Maximum Setback [2]	20 ft.	20 ft.	20 ft.	5 ft.	5 ft.	5 ft.	15 ft.	15 ft.	15 ft.
Off-Street Parking Access/Location	rear, side	rear, side	rear, side	rear, side	rear, side	rear, side	rear	rear, side	rear, side
Streetside									
Recommended Streetside Width [3]	14.5–16.5 ft.	14.5 ft.	11.5 ft.	16 ft.	16 ft.	15 ft.	16.5-18.5 ft.	14.5 ft.	11.5 ft.
Minimum sidewalk (throughway) width	6 ft.	6 ft.	6 ft.	6 ft.	6 ft.	6 ft.	8 ft.	6 ft.	6 ft.
Pedestrian Buffers (planting strip exclusive of travel way width) [3]	8 ft. planting strip	6–8 ft. planting strip	5 ft. planting strip	7 ft. tree well	6 ft. tree well	6 ft. tree well	8 ft. planting strip	8 ft. planting strip	6 ft. planting strip
Street Lighting	For all thoroughfares in all context zones, intersection safety lighting, basic street lighting, and pedestrian-scaled lighting is recommended. See Chapter 8 (Streetside Design Guidelines) and Chapter 10 (Intersection Design Guidelines).								
Traveled Way									
Target Speed (mph)	25–35	25–30	25	25–35	25–35	25	25–35	25–30	25
Number of Through Lanes [5]	4–6	2–4	2	4–6	2–4	2	4–6	2–4	2
Lane Width [6]	10–11 ft.	10–11 ft.	10–11 ft.	10–12 ft.	10–11 ft.	10–11 ft.	10–11 ft.	10–11 ft.	10–11 ft.
Parallel On-Street Parking Width [7]	7 ft.	7 ft.	7 ft.	8 ft.	7-8 ft.	7-8 ft.	7 ft.	7 ft.	7 ft.
Min. Combined Parking/Bike Lane Width	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.
Horizontal Radius (per AASHTO) [8]	200–510 ft.	200–330 ft.	200 ft.	200–510 ft.	200–510 ft.	200 ft.	200–510 ft.	200–330 ft.	200 ft.
Vertical Alignment	Use AASHTO minimums as a target, but consider combinations of horizontal and vertical per AASHTO Green Book.								
Medians [9]	4–18 ft.	Optional 4–16 ft.	None	4–18 ft.	Optional 4–18 ft.	None	4–18 ft.	Optional 4–16 ft.	None
Bike Lanes (min./preferred width)	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft. / 6 ft.	5 ft. / 6 ft.
Access Management [10]	Moderate	Low	Low	High	Moderate	Low	Moderate	Low	Low
Typical Traffic Volume Range (ADT) [11]	20,000–35,000	1,500–25,000	500–5,000	20,000–50,000	1,500–35,000	1,000–10,000	10,000–35,000	1,500–20,000	500–5,000
Intersections									
Roundabout [12]	Consider urban single–lane roundabouts at intersections on avenues with less than 20,000 entering vehicles per day, and urban double–lane roundabouts at intersections on boulevards and avenues with less than 40,000 entering vehicles per day.								
Curb Return Radii/Curb Extensions and Other Design Elements	Refer to Chapter 10 (Intersection Design Guidelines)								

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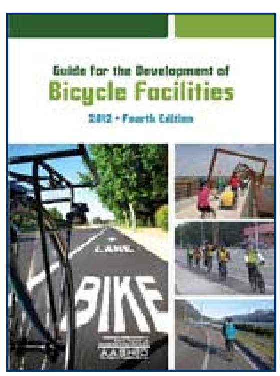
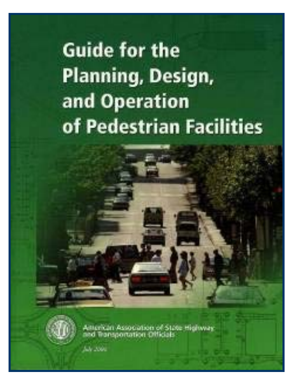
The New AASHTO Bicycle & Pedestrian Guides

- Pedestrian Facility design guide update scheduled for 2017 release
- Bicycle Facility design guide update scheduled for 2017/2018 release
- Expect new and more advanced guidance





Available thru the AASHTO Bookstore

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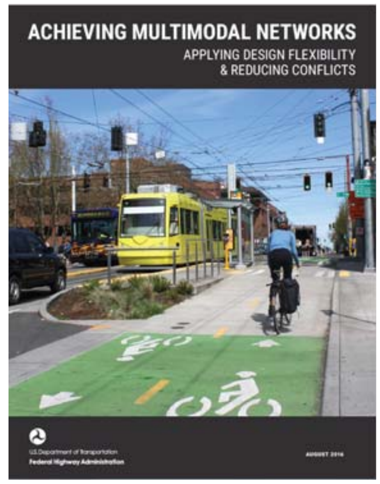
Achieving Multimodal Networks

- A resource for practitioners to build multimodal transportation networks
- Highlights ways to apply design flexibility found in national design guidance
- Focuses on reducing multimodal conflicts and achieving connected networks.
- Includes 24 design topics:
  - 12 design topics on design flexibility
  - 12 topics on measures to reduce conflicts between modes.
- Includes relevant case studies and references to appropriate design guidelines.



August 2016
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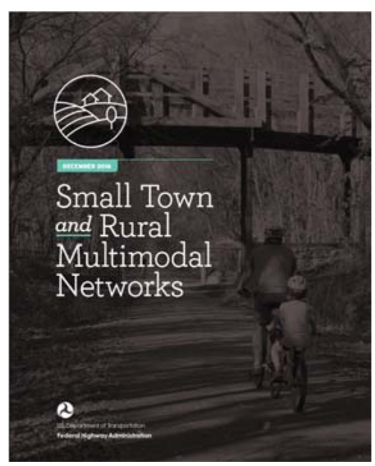
Small Town and Rural Multimodal Networks

- Resource & idea book intended to help small towns and rural communities support safe, accessible, comfortable, and active travel for people of all ages and abilities
- Provides a bridge between existing guidance on bicycle and pedestrian design and rural practice
- Encourages innovation in the development of safe and appealing networks for bicycling and walking in small towns and rural areas
- Shows examples of peer communities and project implementation that is appropriate for rural communities



December 2016
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Multimodal LOS/QOS Guidance

- *Guidebook for Developing Pedestrian and Bicycle Performance Measures,* Federal Highway Administration, US Department of Transportation, FHWA-HEP-16-037, March 2016.
- *Evaluating Complete Streets Projects: A Guide for Practitioners*, AARP/Smart Growth America, April 2015.

Both are free downloads

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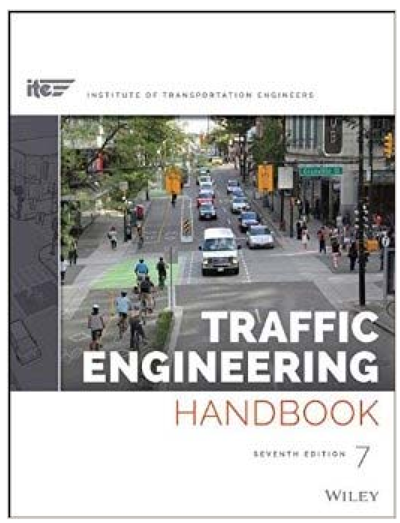
ITE Traffic Engineering Handbook

- CHAPTER 5: Level of Service Concepts in Multimodal Environments
- CHAPTER 9: Planning, Design, and Operations of Road Segments and Interchanges in Urban Areas
- CHAPTER 11: Design and Operation of Complete Streets and Intersections
- CHAPTER 14: Traffic Calming



2016
Available for purchase in hard or e-copy.

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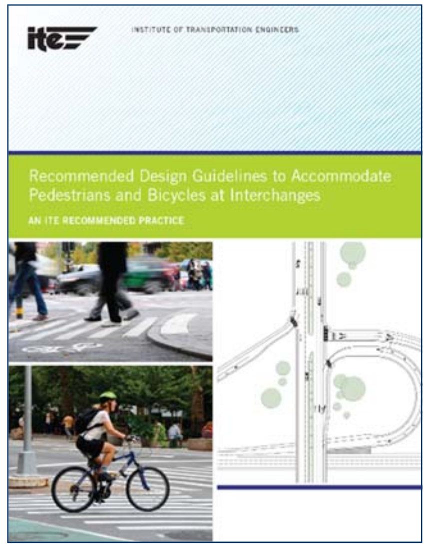
New ITE Bike/Ped Design Guidelines

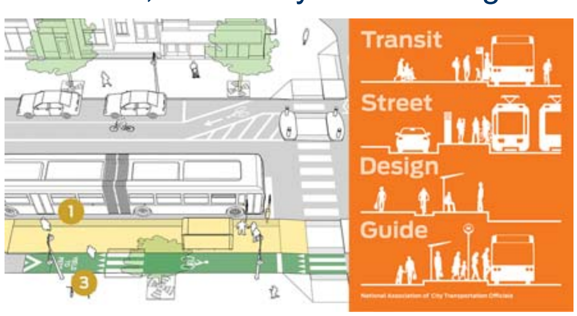
- Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges (2016)



Available for purchase in hard copy

Transit Street Design Guide NACTO

- Provides guidance for how cities can maximize transit potential on neighborhood and downtown streets
- Provides tools to actively prioritize transit on the street
- Chapters on Station Stops, Transit Lanes/Transitways, Intersections, Transit System Strategies



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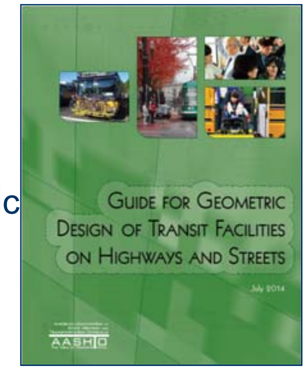
New guidance from ITE

Geometric Design of Transit Facilities on Highways and Streets, AASHTO

- AASHTO *Guide for Geometric Design of Transit Facilities on Highways and Streets* (2014)
- Significant guidance on integration of highway & transit modes and geometric design considerations
- Chapters on:
  - Design Parameters & Controls
  - Guidelines for Bus Facilities
  - Light Rail & Streetcar Facilities
  - Pedestrian & Bicycle Access
- Available in hard copy from AASHTO



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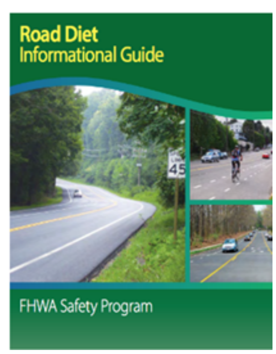
Road Diets (Lane Reductions)

- Encourage appropriate operating speeds
- Reclaims ROW for other features:
  - New/wider sidewalks
  - Bicycle lanes
  - Pedestrian buffers/landscaping
  - On-street parking
  - Wider medians/turn lane
- FHWA Case Studies: Evaluation of Lane Reduction "Road Diet" Measures and Their Effects on Crashes and Injuries, FHWA-HRT-04-082



FHWA Road Diet Informational Guide, 2014
Free download available

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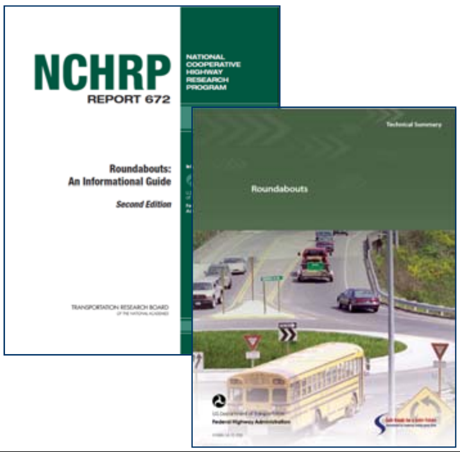
Roundabout Design Guidance

- FHWA Roundabout Technical Summary
- NCHRP Report 672 - Roundabouts



Parameter	Minimum "Mini-Roundabout"	Urban Compact Roundabout	Urban Single-Lane Roundabout	Urban Double-Lane Roundabout*
Maximum Entry Speed (mph)	15	15	20	25
Design Vehicle	Bus and single-unit truck drive over apron	Bus and single-unit truck	Bus and single-unit truck WB-50 with lane encroachment on truck apron	WB-67 with lane encroachment on truck apron
Inscribed circle diameter (feet)	45 to 80	80 to 100	100 to 130	150 to 180
Maximum number of entering lanes	1	1	1	2
Typical capacity (vehicles per day entering from all approaches)	10,000	15,000	20,000	40,000
Applicability by Thoroughfare Type:				
Boulevard	Not Applicable	Not Applicable	Not Applicable	Applicable
Arterial Avenue	Not Applicable	Not Applicable	Applicable	Applicable
Collector Avenue	Applicable	Applicable	Applicable	Not Applicable
Street	Applicable	Applicable	Applicable	Not Applicable

* Note the pedestrian and bicycle conflicts are inherent in multilane roundabouts unless they are signalized.

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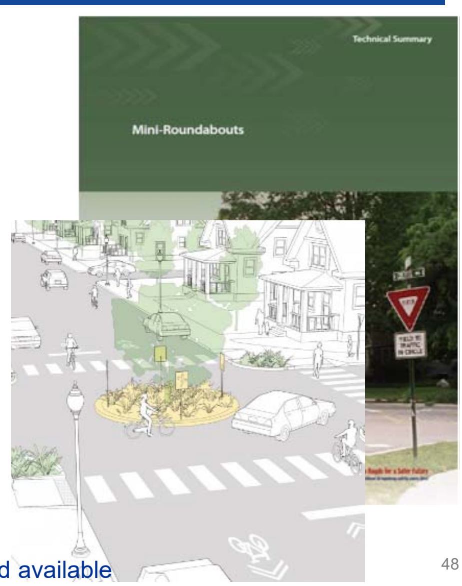
Mini-Roundabouts

- Mini roundabouts and neighborhood traffic circles lower speeds at minor intersection crossings and are an ideal treatment for uncontrolled intersections.
- Careful attention should be paid to the available lane width and turning radius used with traffic circles.



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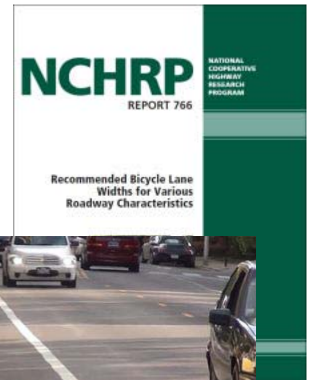
Recommended Bicycle Lane Widths NCHRP 766

- Presents recommendations for bicycle lane widths for various roadway and traffic characteristics, including traffic volume, vehicle mix (i.e., % trucks), lane width and/or total roadway width, and presence/absence of on-street parking.
- Conclusions most applicable to urban and suburban roadways with level grade and a posted speed limit of 30 mph
- Should be used cautiously for the design of roadways with vehicle speeds outside of the 25 to 35 mph range.



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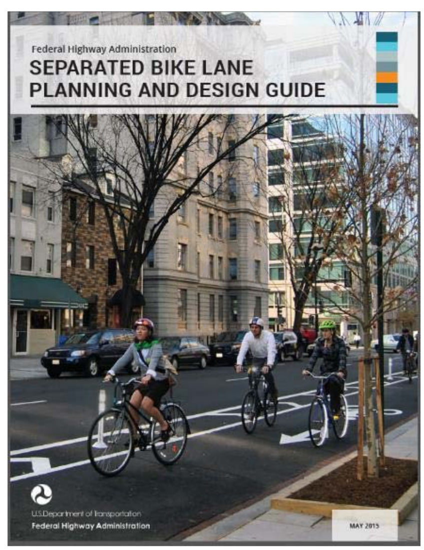
Separated Bike Lane Planning & Design Guide, FHWA, 2015

- A separated bike lane is an exclusive facility for bicyclists that is located within or directly adjacent to the roadway and that is physically separated from motor vehicle traffic with a vertical element.
- Also sometimes called "cycle tracks" or "protected bike lanes.“



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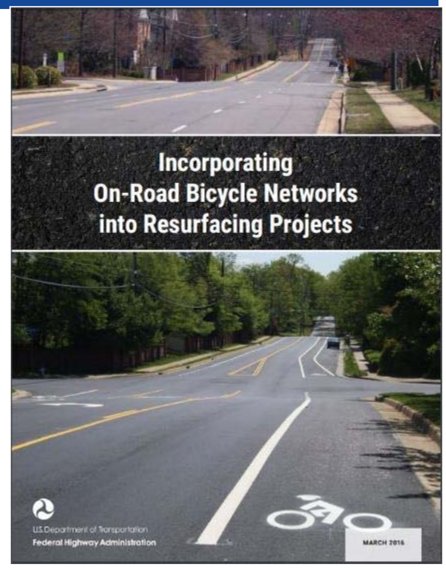
Incorporating On-Road Bicycle Networks into Resurfacing Projects

- Recommendations for how roadway agencies can integrate bicycle facilities into their resurfacing program.
- Methods for fitting bicycle facilities onto existing roadways, cost considerations, and case studies.
- Does not present detailed design guidance, but highlights existing guidance, justifications, and best practices for providing bikeways during resurfacing projects.



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Design Guidance - High-Speed to Low-Speed Transition Zones

- Presents guidance for designing the transition from a high-speed rural highway to a lower-speed section, typically approaching a small town.
- Includes methodology for assessing these highway sections and a catalog of potential treatments for addressing problems.
- Includes a Design Guidance document that a transportation agency can adapt to meet its own purposes and needs.

Design Guidance for High-Speed to Low-Speed Transition Zones for Rural Highways (NCHRP 2012)

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FHWA Speed Reduction Reference

Engineering Countermeasures for Reducing Speeds

A Desktop Reference of Potential Effectiveness, May 2014

Countermeasure	Area	Road Environment	Reference # (Year)	Sample Size (# of Sites)	After Measurement	Average Daily Volumes		85th Percentile Speeds			
						Before (veh)	After (veh)	Before (mph)	After (mph)	Change (mph)	%Change
GEOMETRIC FEATURES											
Speed Hump -rounded raised area across the road, typically 12 to 14 feet in length and 3 to 4 inches high	Urban	Local Street	1 (1999)	178		48 to 11544	46 to 11043	35 (4)	27 (4)	-8 (3)	-22% (9%)
		Local Street	2 (2005)	7		400 to 4362	401 to 3384	32 (3)	26 (2)	-6 (2)	-20% (6%)
		Local Street	4 (2000)	4		475 to 1506	433 to 1343	36 (2)	31 (2)	-5 (1)	-15% (3%)
Speed Cushion -speed hump typically 6 to 7 feet wide that allows most emergency vehicles to straddle the hump.	Urban		1 (1999)	1		3323	2321	35 (-)	28 (-)	-7 (-)	-20% (-)
			2 (2005)	2		1042 to 1556	693 to 1563	31 to 37	26 to 30	-5 to -7	-16% to 19%
Speed Table -a long speed hump typically 22 feet in length with a flat section in the middle and ramps on the ends	Urban		1 (1999)	72		198 to 14500	242 to 14400	37 (3)	31 (3)	-6 (3)	-16% (9%)
	Rural	Small town	3 (2008)	2	12 month	1480		33 (1)	29 (2)	-4 (1)	-14% (3%)
		Residential Streets	18 (2003)	19		198 to 2102	364 to 2061	38 (n/a)	29 (n/a)	-9 (n/a)	-24% (n/a)
Raised Intersection -a raised plateau, with ramps on all approaches, where roads intersect	Urban		1 (1999)	2				37 (1)	38 (4)	1 (4)	3% (11%)
	Urban	Local Street	5 (2004)	1				30 (-)	30 (-)	0 (-)	0% (-)

Geometric Features, Surface Treatments & Markings, Signs, Narrowing, Access Controls, and Combination Measures. Supported by 54 references.

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A Key Concept of Complete Streets Design:

Understanding Design Flexibility within Current Design Policy/Guidance

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Why Flexible Design?

- Allows consideration of a wider range of design options and alternatives to fit conditions
- Enables more cost-effective designs that improve safety and efficiency of all modes
- Promotes Context Sensitive Solutions (CSS) principles (an FHWA/AASHTO joint priority)

Flexible Design Philosophy

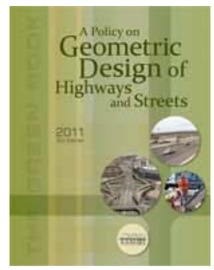
- Recognizes that flexibility is a necessary and desired aspect of the design process
- Uses a risk assessment and risk management approach for all aspects of the design
- Applies performance criteria to evaluate flexible design decisions, as well as condition criteria
- Understands the risks and consequences for design decisions – this often requires more information and higher level analysis than simply applying criteria "by the book"…and use of engineering judgment

The AASHTO Green Book is Flexible Design Policy

"As highway designers, highway engineers strive to provide for the needs of highway users while maintaining the integrity of the environment. Unique combinations of design requirements that are often conflicting result in unique solutions to the design problems"

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

Source: 2011 Green Book, Foreword



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What Flexibility is in the Green Book?

- Many dimensions and values are shown as ranges
- Many criteria described as "guidelines" or "typical"
- Many concepts are not dimensioned and discussed only in functional terms
- In many cases, choices are offered for how to complete a design
- Solutions or concepts not specifically included are not precluded
- Specific solutions are not mandated
- Designer judgment is implied or explicitly suggested

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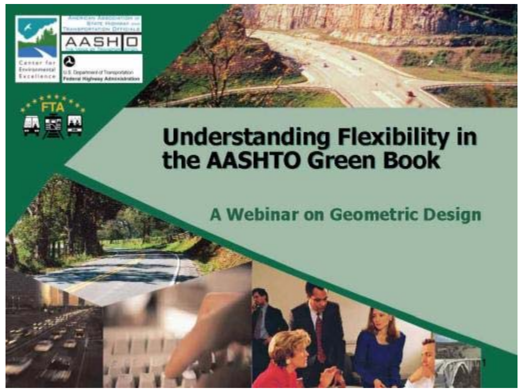
For More About Flexibility in Design

AASHTO/FHWA Online Webinar on Geometric Design



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Complete Streets Design Process Framework

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CS Design Process Framework


Fregonese Associates

1. Understand current conditions
2. Identify deficiencies
3. Set project goals
4. Develop cross-section and design feature options
5. Evaluate trade-offs and impacts, select final cross-section & features
6. Quality control check – have deficiencies and goals been addressed?

NOTE: Stakeholders are engaged throughout

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Step 1: Current Conditions

- Street character and its relationship to adjacent land uses (existing and future)
- How the street functions:
  - Vehicular traffic volumes/speeds, other users
  - Service level for pedestrians, cyclists, motorists
  - Special needs groups (older/younger/ADA/etc)
- Current design features
  - Number of lanes, medians, parking, sidewalks, bike provisions, traffic controls, trees/landscaping, etc
- Transit stops/stations
- Street's relationship to surrounding street/ped/bike/transit networks
- Transportation policies, plans, or planned projects that would influence future street needs

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Step 2: Identify Deficiencies

- Poor traffic service/safety within project limits (think ALL modes/conditions - cars, trucks, buses, peds, bikes, ADA, emergency access, etc)
- Inadequate pedestrian or bicycle facilities (condition, safety, convenience, system gaps)
- Gaps in the street network (congestion, circulation)
- Transit operations (stops, shelters, efficiency)
- Inconsistencies between the existing/future land use and the existing/planned street
- Other voiced stakeholder concerns and desires

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Step 3: Set Project Goals

- What conditions are expected to stay the same?
- What conditions do you WANT to stay the same, or change?
- Would the users and adjacent community like the street to change? Or not?
- If change is desired, what are the desired outcomes?
- What conditions are likely to change <u>because of</u> the street design?
- In the end will it meet stakeholders expectations?

	Cars	Trucks	Buses	Peds	Bikes	Others
What conditions exist today?						
What needs to change? And why?						
How is that change best achieved thru design?						

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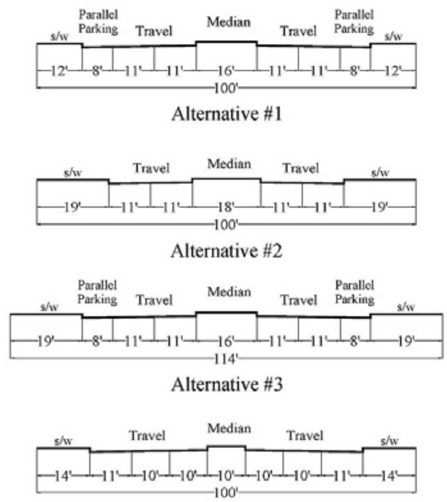
Step 4: Develop Cross Section & Design Feature Options

- Depending on the length of project, current/future land use & multimodal traffic demand, cross-section(s) and street features/criteria, cross sections can change within a project!
- If a feature is not needed now, but may be in the future, preserve that option!



Step 5: Balancing "Trade-Offs"

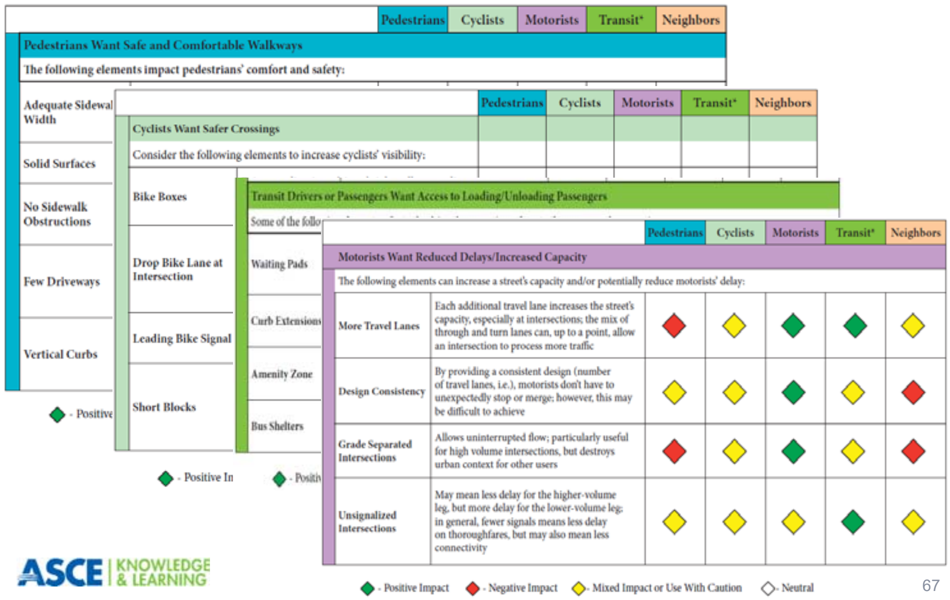
- No prescribed method to evaluate trade-offs in complete street design.
- Needs and priorities change from project to project, and often within projects.
- Use a method that identifies and weighs all user needs and solutions against each other.
- Selection of a final design may not meet all objectives but addresses those considered most important to the design team and community.


MARKET STREET TO HARRISON STREET


HARRISON STREET TO TOWNSEND STREET


TYPICAL SECTION AT BUS BOARDING ISLANDS

Step 5: Evaluate trade-offs and impacts, select final cross-section & features



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Step 6: Quality Control Check

- Will the final design concept address the deficiencies identified in Step 2?
- Will it address the goals identified in Step 3?
- Are the pros and cons of each design element understood?

User perspectives on design elements for safe pedestrian crossings

	Pedestrians	Cyclists	Motorists	Transit	Adjacent Uses
Mid-Block Crossings	●	●	✗	●	✓
Refuge Islands	✓	●	●	●	●
Medians	●	●	✓	✓	●
Curb Extensions	✓	●	●	●	✓
Pedestrian Countdowns	✓	—	●	—	—
Small Curb Radii	✓	—	●	✗	●

✓ Positive Impact ✗ Negative Impact ● Use with Caution — Neutral

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A Good Complete Streets Project Design Process Provides:

- A focused approach to providing the most complete street design for a given context and set of conditions.
- A commitment to include all stakeholders.
- A defined thought process for evaluating and balancing design trade-offs.
- A framework for assessing and applying new tools and techniques when appropriate.
- Accountability and transparency in the design process.

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Design Criteria and Controls

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Design Speed

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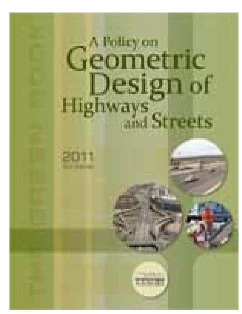
Speed & the AASHTO Green Book

- Design speed is a selected speed used to determine the various geometric features of the roadway.
- The assumed design speed should be a logical one with respect to topography, anticipated operating speed, adjacent land use (context), and roadway functional classification.
- Speed is a fundamental input to design.
- Low speed design is 45mph or less



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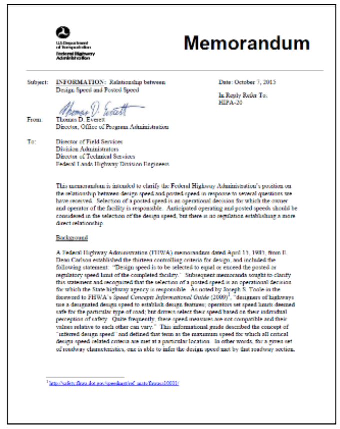
Recent FHWA Guidance Memo on Speed

Relationship between Design Speed and Posted Speed, October 7, 2015

- *“In urban areas, the design of the street should generally be such that it limits the maximum speed at which drivers can operate comfortably, as needed to balance the needs of all users. “*



Memorandum

Subject: INFORMATION: Relationship between Design Speed and Posted Speed

Date: October 7, 2015

In Reply Refer To: HIPA-20

From: Thomas D. Everett, Director, Office of Program Administration

To: Director of Field Services; Division Administrators; Director of Technical Services; Federal Lands Highway Division Engineers

This memorandum is intended to clarify the Federal Highway Administration's position on the relationship between design speed and posted speed in response to several questions we have received. Selection of a posted speed is an operational decision for which the owner and operator of the facility is responsible. Anticipated operating and posted speeds should be considered in the selection of the design speed, but there is no regulation establishing a more direct relationship.

Background

A Federal Highway Administration (FHWA) memorandum dated April 13, 1983, from R. Dean Carlson established the thirteen controlling criteria for design, and included the following statement: “Design speed is to be selected to equal or exceed the posted or regulatory speed limit of the completed facility.” Subsequent memoranda sought to clarify this statement and recognized that the selection of a posted speed is an operational decision for which the State highway agency is responsible. As noted by Joseph S. Toole in the foreword to FHWA's *Speed Concepts Informational Guide* (2009)[1], “designers of highways use a designated design speed to establish design features; operators set speed limits deemed safe for the particular type of road; but drivers select their speed based on their individual perception of safety. Quite frequently, these speed measures are not compatible and their values relative to each other can vary.” This informational guide described the concept of “inferred design speed” and defined that term as the maximum speed for which all critical design speed related criteria are met at a particular location. In other words, for a given set of roadway characteristics, one is able to infer the design speed met by that roadway section.

October 2015

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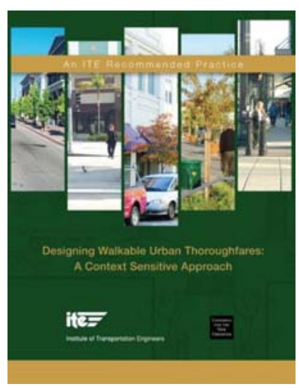
Speed - Designing Walkable Urban Thoroughfares

- Target Speed is the speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses to provide both mobility for motor vehicles and a safe/convenient environment for pedestrians and bicyclists.
- The target speed is usually the posted speed limit.



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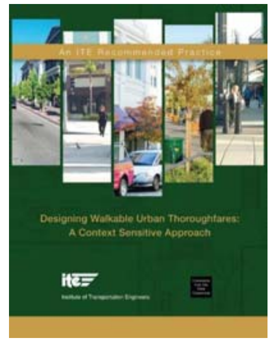
Speed - Designing Walkable Urban Thoroughfares

- Design speed – safety buffer for design parameters (max 5 mph over target speed)
- Walkable arterial standard: 25-30-35 mph target
- *Design speed should be determined by target speed; not operating speed (operating speed may be higher than desirable in an urban area with high levels of pedestrian activity)*



Speed - Designing Walkable Urban Thoroughfares

Determine target speed, then use design tools and features to achieve design speed

- Lane width
- Curb radii
- Curb extensions
- Marking & signing
- Paving materials
- On-street parking
- Landscaping
- Etc.

Speed- Designing Walkable Urban Thoroughfares

Table 6.2 General Parameters for Arterial Thoroughfares

	Suburban (C-3)				General Urban (C-4)				Urban Center/Core (C-5/6)			
	Residential		Commercial		Residential		Commercial		Residential		Commercial	
Context	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue
Target Speed (mph)	35	25-30	35	35	35	25-30	35	25-30 [3]	35	25-30	30	25-30 [3]
Design Speed	Design speed should be a maximum of 5 mph over the operating speed. Design speed is used as a control for certain geometric design elements including sight distance and horizontal and vertical curvature.											

Table 6.3 General Parameters for Collector Thoroughfares

	Suburban (C-3)				General Urban (C-4)				Urban Center/Core (C-5/6)			
	Residential		Commercial		Residential		Commercial		Residential		Commercial	
Context	Avenue	Street	Avenue	Street	Avenue	Street	Avenue	Street	Avenue	Street	Avenue	Street
Desired Operating Speed (mph)	30	25	30	25	30	25	25-30 [3]	25	25-30	25	25-30 [3]	25
Design Speed	Design speed should be a maximum of 5 mph over the operating speed. Design speed is used as a control for certain geometric design elements including sight distance, and horizontal and vertical curvature.											

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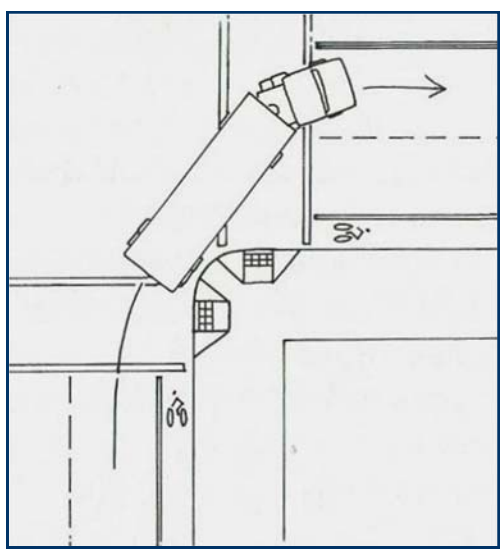
Design Vehicle

Design Vehicle

- Typically assume P (passenger car) and SU (Single Unit Truck)
- Special provisions for areas with routine transit vehicles (CITY-BUS) and/or larger trucks (WB-50) (WB-62FL)

Design Vehicle

- It is usually acceptable to design for large vehicles to turn using multiple lanes
- And it may be acceptable for occasional large vehicles to cross into oncoming lanes



Select the most appropriate design vehicle

Most facilities don't need to be designed for the worst case or exception vehicle.

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Lane Widths

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AASHTO Green Book

Although lane widths of 12’ are deemed “desirable” on both rural and urban facilities, there are circumstances that encourage the use of lanes less than 12’ wide:

- 11’ lanes - urban areas where right-of-way and existing development become stringent controls
- 10’ lanes - low-speed facilities
- 9’ lanes - low-volume roads in rural and residential areas

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Designing Walkable Urban Thoroughfares (ITE/CNU)

- 10’ to 11’ if design speed less than 35 mph
- Consider wider lanes along horizontal curves for off-tracking
- Consider wide curb lanes at intersections for large vehicles

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Lane width and safety

There is no indication that the use of 10- or 11-ft lanes, rather than 12-ft lanes, for arterial midblock segments leads to increases in accident frequency. There are situations in which use of narrower lanes may provide benefits in traffic operations, pedestrian safety, and/or reduced interference with surrounding development, and may provide space for geometric features that enhance safety such as medians or turn lanes. The analysis results indicate narrow lanes can generally be used to obtain these benefits without compromising safety.

Potts, Harwood & Richard - Relationship of Lane Width to Safety for Urban and Suburban Arterials, TRB 2007

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Designing for Pedestrians

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Sidewalk design criteria

Buffer pedestrians from roadway traffic with:

- **grass/landscape strips**
- **street trees/furniture**
- **parked cars**
- **bike lanes**

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Raised crosswalks, Refuge Islands

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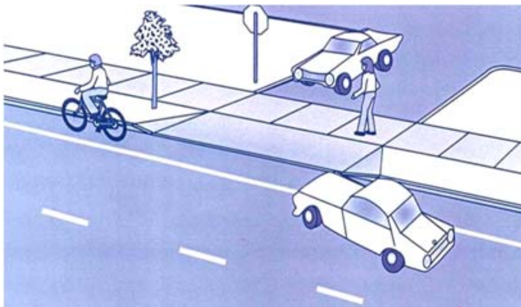
Prioritize pedestrians at driveway crossings



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Reduce crossing distances with curb extensions & refuge islands

- Shortens exposure time
- Improves visibility, especially for children
- Creates visual pinch points to slow traffic

Source: www.completestreets.org

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Avoid large turning radii which encourage fast turn speeds and limit sight distance

Source: www.completestreets.org

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Small Intersection Radii Slows Turns, Reduces Crossing Distances and Makes Pedestrians More Visible

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Pedestrians and Bridges

- A bridge may be the "make or break" link for pedestrian and bicycle networks.
- USDOT Policy: DOT encourages bicycle & pedestrian accommodation on bridge projects including facilities on limited-access bridges with connections to streets or paths.
  - This includes potential connections to facilities on parallel or intersecting streets or paths.

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Design Guidance for Bridges

- Think about "context"
- Design new and retrofit bridges for all potential users
- Consider that motorists can tolerate several-mile detours; non-motorized users cannot

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Designing for Bicycles

Bicycle Facilities

- Local street access
- Shoulders
- On-street bike lanes
- Separate cycle tracks
- Multi-use trails
- Bike racks

Bike lanes can make streets *safer*, by….

- Creating more appropriate vehicle lane widths
- Encouraging appropriate operating speeds
- Creating a "soft buffer" between travel lanes and roadside objects

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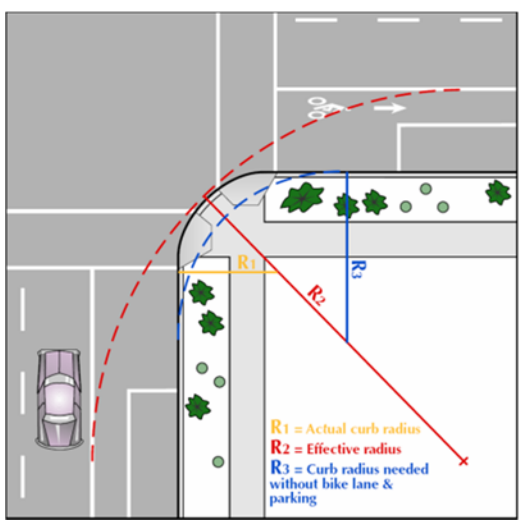
Bicycle lanes create a larger effective turn radius for larger vehicles



Oregon DOT

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Bicycle Facilities – Shared Lanes

- Generally on lower volume roads.
- Wide outside curb lanes.
- Often enhanced with "Bike Route" signs.
- Bicyclists may need to "take the lane" to avoid debris, potholes, bumps, etc.
- Need to maintain smooth pavement.
- Need bicycle-safe grates.

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Bicycle Facilities – Road Shoulders

- Allow motor vehicles and bicycles to coexist.
- Shoulders wider than 6 feet usually can handle bicyclists: prefer 8 or 10 feet on busier highways.
- Need to maintain smooth pavement (rumble strips?).
- Need bicycle-safe grates.
- Need to remove debris.
- Conflict with some State laws that prohibit using as travel lanes.

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Bicycle Facilities – Rumble Strips

- Can be hazardous to bicyclists.
- Need “escape” spaces

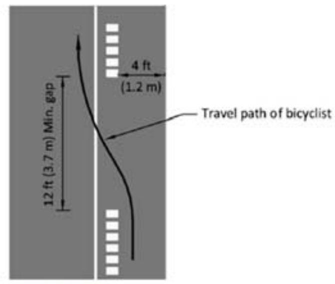

Exhibit 4.8. Rumble Strips

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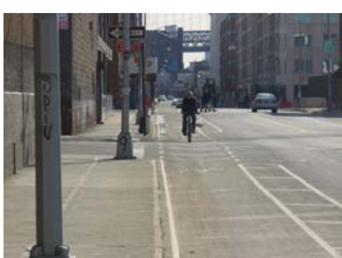
Bicycle Facilities – On-Street Lanes

- *Usually* same direction
- Can be left side
- Can be contraflow



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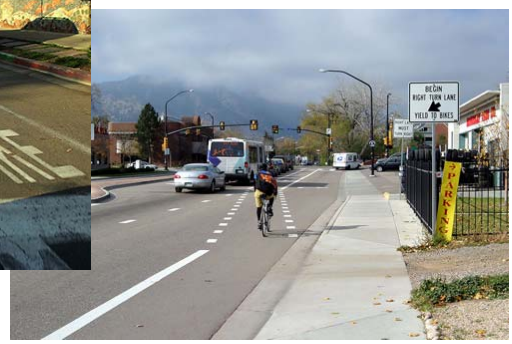
Bicycle Facilities

- Intersections need special considerations and treatments
- Caution with door zones



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Bicycle Facilities – Cycle Tracks

- A bicycle facility next to roadway (1 or 2 way).
- More popular in Europe (Netherlands, Denmark).
- Addressed in new AASHTO *Guide* and ITE’s Separated Bikeways report.
- May be grade separated from motor and pedestrian traffic.
- Can requires special intersection controls.

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Bicycle Facilities - Roundabouts

- Ongoing discussion about bicyclists traveling through roundabouts.
- See the AASHTO Guide and Bicycle Countermeasure Selection System (BIKESAFE)

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Bicycle Amenities

- Bike parking for transit
- Public bike parking
- Bike racks on buses
- Bike racks on trains

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Designing for Transit

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Adequate Bus Stop Access is Needed

- Designs should provide room for stops and amenities
- Designs should provide safe and convenient access to stops

Not accessible to those in wheelchairs

Message: Bus riders don't matter

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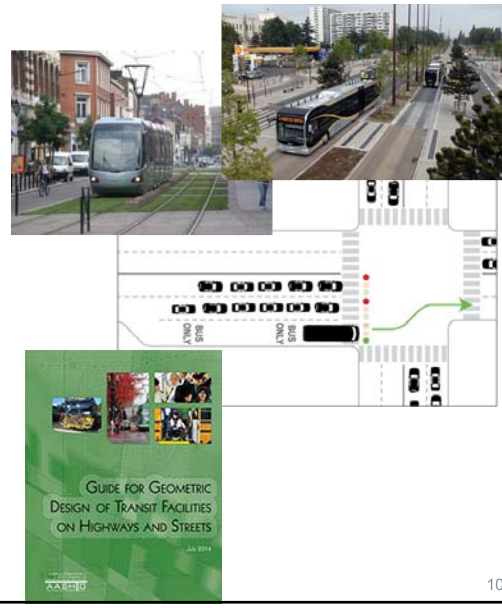
Designs should account for and facilitate transit operation balanced with other modes

- Multiple transit modes (bus, BRT, LRT, streetcar) in ROW
- May generate significant new pedestrian access demands
- May have special geometric design requirements
- May have special traffic control requirements (bus priority/preemption)
- New AASHTO guidance



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Road Diet Design

Road Diet Relationship to Complete Streets

- Encourage appropriate operating speeds (consistent with design speed)
- Reclaims ROW for other features
  - Bicycle lanes
  - Wider sidewalks
  - Street trees
  - On-street parking
  - Wider medians/turn lane
  - Etc.

- FHWA Evaluation: Evaluation of Lane Reduction "Road Diet" Measures and Their Effects on Crashes and Injuries, FHWA-HRT-04-082
- Examples from FHWA Bicycle Design Course: www.tfhrc.gov/safety/pedbike/pubs/05085/chapt15.htm

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Median Design

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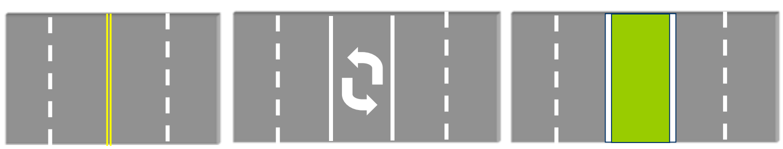
Medians Relationship to Complete Streets

- Safety
  - Reduced vehicular crashes
  - Crossing refuge for pedestrians
- Roadway character
  - Can encourage lower operating speeds
  - Terminates long vistas
  - Opportunities for landscaping enhancement but must consider sight distance impacts

Median Benefits



Vehicular Safety	30% potential increase in crashes Safety issue becomes more pronounced at 24,800 to 28,000 AADT threshold	12% potential increase in crashes Safety issue becomes more pronounced at 24,800 to 28,000 AADT threshold	Lowest crash rate
Mobility	Highest delay Minimize turn movements (driveway consolidation)	Least signal delay (storage)	Must provide adequate storage
Access	Unrestricted access	Unrestricted access	Most restrictive
Pedestrian safety	Pedestrian must cross four lanes of traffic	Widest crossing distance Center turn lane not a safe refuge	Pedestrians cross two lanes at a time Raised median provides refuge

Medians help reduce crash risk for random mid-block crossings.

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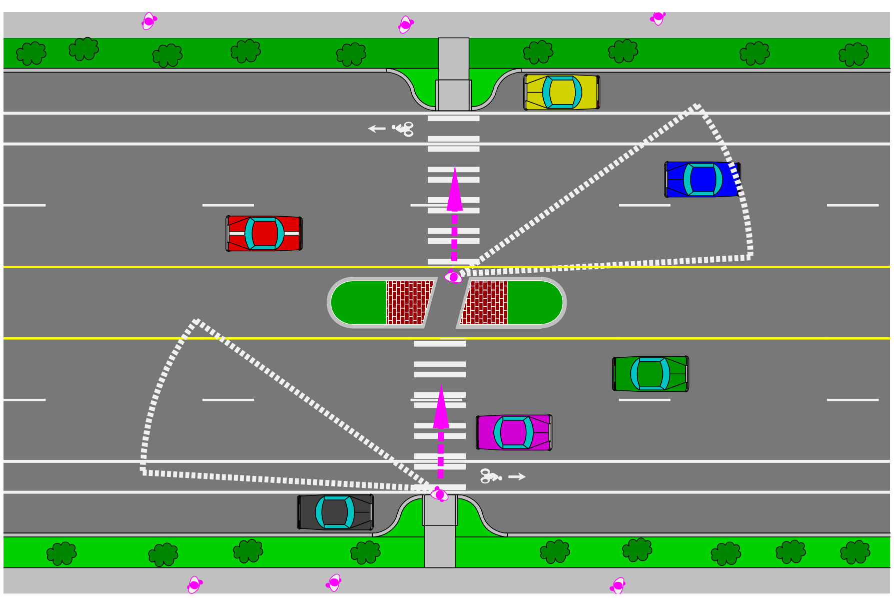

Medians & Refuge Islands break long complex crossing into two simpler crossings

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Designing Walkable Urban Thoroughfares

Table 9.1 Recommended Median Widths on Low Speed Thoroughfares (35 mph or less)

Thoroughfare Type	Minimum Width	Recommended Width
Median for access control		
Arterial boulevards and avenues Collector avenues and streets	4 ft.	6 ft. [1]
Median for pedestrian refuge		
Arterial boulevards and avenues Collector avenues and streets	6 ft.	8 ft.
Median for street trees and lighting		
Arterial boulevards and avenues Collector avenues and streets	6 ft. [2]	10 ft. [3]
Median for single left-turn lane		
Collector avenues and streets Arterial boulevards and avenues	10 ft. [4] 12 ft.	14 ft. 16-18 ft.
Median for dual left turn lane		
Arterial boulevards and avenues	20 ft.	22 ft.

Table notes:
[1] A 6-foot wide median is the minimum width for provision of a pedestrian refuge.
[2] Six ft. (measured between curb faces) is generally considered a minimum width for proper growth of small caliper trees (less than 4 in.). A wider 10-foot median is recommended for larger trees.
[3] Wider medians to provide generous landscaping are acceptable, if desired by the community. However, avoid designing medians wider than necessary to support its desired function at intersections. This can reduce the operational efficiency of the intersections and invite undesirable behavior of crossing traffic such as side-by-side queues, angle stopping, etc.
[4] A 10-foot wide median allows for a striped left-turn lane (9 to 10 ft. wide) without a median nose.

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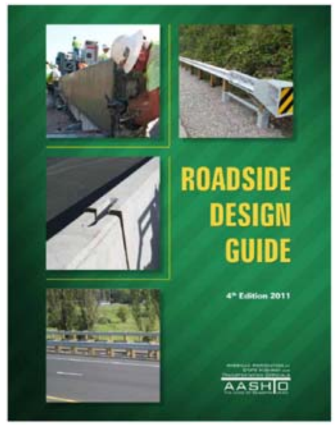
Horizontal Clearance

AASHTO Roadside Design Guide

Chapter 10 – Roadside Safety in Urban or Restricted Environments

- Extensive section on roadside features for urban and restricted areas and their safe placement
- Describes “enhanced lateral offset” for use in urban areas where conventional clear zone widths are impractical.
- Urban control zone concept: keep obstacles away from intersections, driveways, speed change lanes.
- Emphasizes that 1.5 foot min lateral offset to obstructions is NOT a clear zone.



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AASHTO Green Book and Horizontal Clearance

- Designers should understand that, once a vehicle leaves the road, a crash or potentially serious encounter with the roadside may occur, regardless of the clear-zone width.
- The selected clear-zone width is a compromise, based on engineering judgment, between what can practically be built and the degree of protection afforded the motorist [also consider safety of other ROW users].
- Limitations in available right-of-way, the location, frequency, and nature of roadside objects, or the presence of valued resources such as wetlands, or the need to provide for pedestrian or other activities may practically limit the clear-zone width.

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Fixed Objects and Street Trees

Relationship to Complete Streets

- Important buffer between pedestrian and travel lanes
- Contributes to roadway character
- Contributes to driver perception of speed

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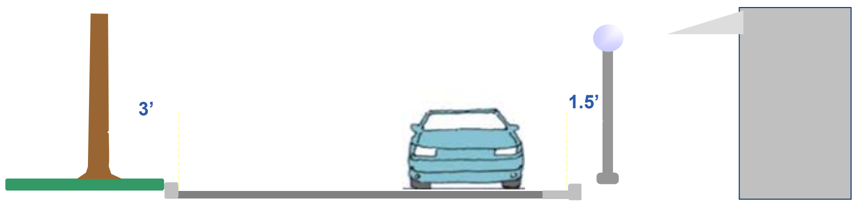
Horizontal Clearance = Lateral Offset Distance

- 1.5 from face of curb (roadside)
- 3 ft. from edge of inside travel lane (median)



Source: AASHTO Green Book minimums

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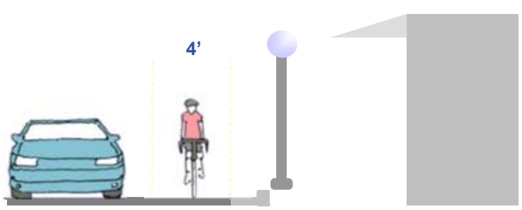
Horizontal Clearance

- Clearance mitigated when bike lanes and/or on-street parking are present



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Intersections

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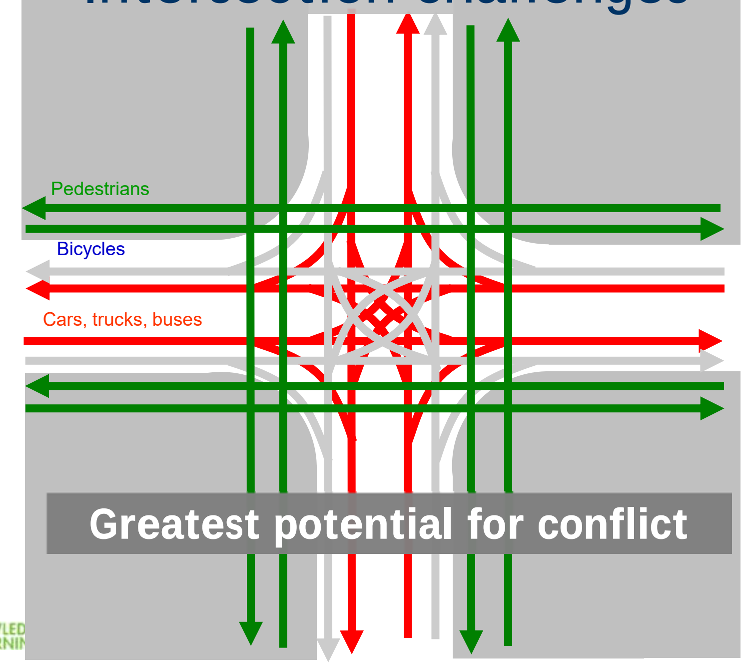
Intersection challenges



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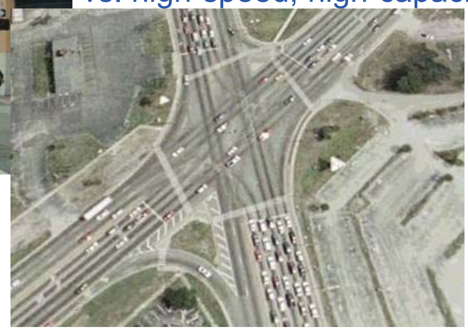
Intersection challenges

Compact, low-speed, human scale

vs. high-speed, high-capacity



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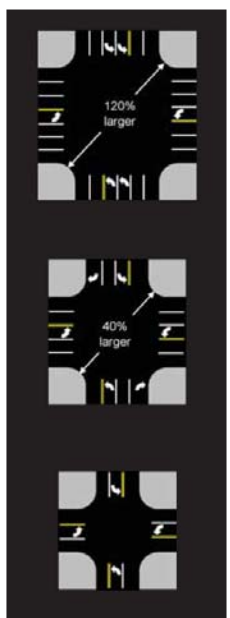
Consider the impacts of intersection scale when contemplating:

- Lane additions
- Lane widths
- Median type/width
- Turn lanes
- Corner radii



Turn lanes, through lanes, and lane widths all have an impact on intersection size.

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Intersection Components

- Corner radii
- Crosswalks
- Curb extensions
- Right turn lanes/channelization
- Roundabouts

Corner Radii Relationship to Complete Streets

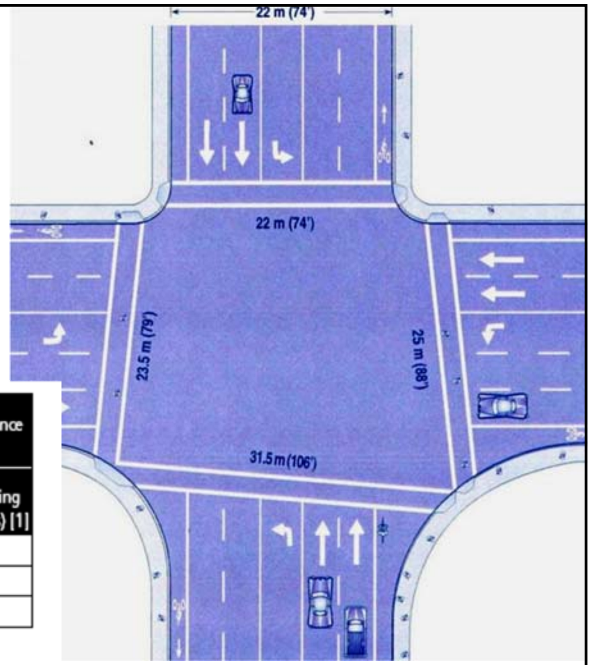
- Shorter radii create smaller intersections, more pedestrian scale
- Reduce pedestrian cross times
- Encourage more appropriate vehicular speeds in walkable/bicycle areas
- Allow for more compact crosswalk placement

Large radii

- Increase crossing distance and
- Make crosswalk & ramp placement more difficult

Effect of Curb Radii on Pedestrian Crossing Distance (Compared to 15 ft. Radius)		
Curb Return Radius (Feet)	Added Crossing Distance (Feet)	Added Crossing Time (Seconds) [1]
15	0	0
25	8	2
50	38	10

[1] Crossing time at 4 ft. per second.



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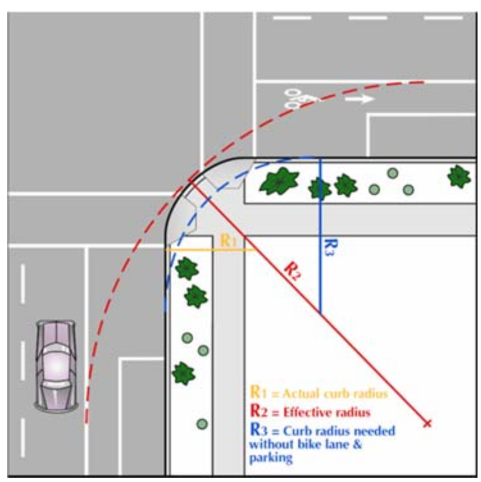
Effective Curb Radius

- Effective radius is larger than built radius if travel lanes are offset from curb w/ parking and/or bike lane



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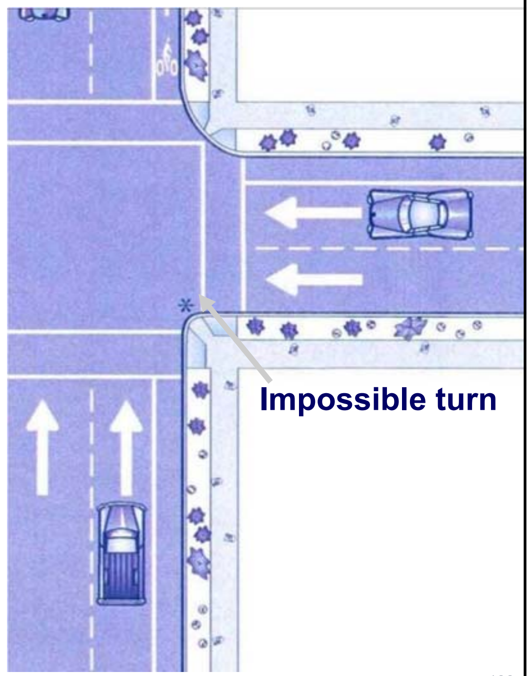
Keeping it tight: Curb radius

- On one-way streets, corners with prohibited turns can have a very small radius



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ITE/CNU – Walkable Streets Recommended Practice

Corner radii	Criteria
5 feet	Urban core/center where no turning vehicles are present (i.e. one–way street).
10 to 15 feet	High pedestrian volume (existing or anticipated). Low turning volume, speed. Passenger vehicle is design vehicle. Few trucks, buses.
> 15 feet	Encroachment of larger vehicles is unacceptable. Receiving lane is < 12 ft and lacks bike lanes or parking.

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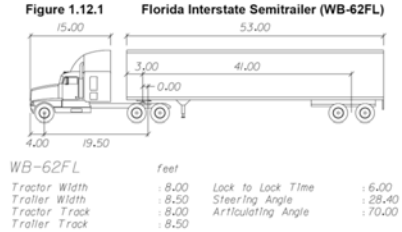
What about large vehicles?

Figure 1.12.1 Florida Interstate Semitrailer (WB-62FL)



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Must consider the range of likely vehicles, but don't have to design all elements for them.

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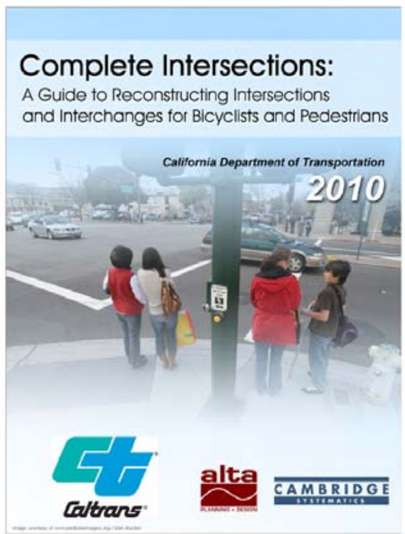
Complete Intersections….for bicyclists and pedestrians



A comprehensive guide for how to design or redesign intersections to optimize safety for pedestrians and bicyclists

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Engineering Countermeasures for Speed Management

Countermeasure	Reduction in 85th percentile speed
Roundabout *In urban and suburban environments where posted speed is 45 mph or less*	**25% to 42%**
Lateral Shift *Travel Lane shift*	**8% to 25%**
Center Island *Narrows travel lanes*	**12%**
Converging Chevron Marking Pattern[a] *Transverse pavement marking*	**11% to 24%**
In-Roadway Warning Lights *At pedestrian crossings*	**5% to 7%**
Speed Activated Feedback Signs *Dynamic display speed warnings*	**7% to 19%**
Gateway Treatment *Combined use of signs, landscaping, etc.*	**5% to 7%**

[a] Experimental treatment.

Source: FHWA, *Engineering Countermeasures for Reducing Speeds: A Desktop Reference of Potential Effectiveness,* May 2009. A full list along with studies cited can be found at http://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/.

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Midblock Crosswalk Guidance

Marked Versus Unmarked Crosswalks at Uncontrolled Locations

Crosswalk lines should not be used indiscriminately. An engineering study should be performed before they are installed at uncontrolled locations. A comprehensive study on the safety effects of marked crosswalks at uncontrolled locations was published by FHWA in 2001. The study compares the number of vehicle pedestrian crashes at matched pairs of marked and unmarked crosswalks at the same intersection.

Several key points from the study are important to the design of crosswalks:

1. Volumes of pedestrian crossings were three to four times higher at marked crosswalks than at equivalent unmarked crosswalks.
2. When adjusted for pedestrian volumes, there were no statistically significant differences in number of pedestrian-vehicle crashes at marked and unmarked crosswalks on the following types of roadways:
   - Two-lane roadways
   - Multilane roadways with Average Daily Traffic (ADT) less than 12,000
   - Multilane roadways with a raised median (pedestrian refuge) and ADT less than 15,000
3. Conversely, providing a marked crosswalk with no additional treatment (e.g. medians, flashing beacons, curb extensions, signage) at the following types of roadways was shown to increase the rate of pedestrian-vehicle crashes:
   - Roadways with speed limits of 40 mph or greater
   - Roadways with four or more lanes, no raised median, and an ADT of greater than 12,000
   - Roadways with four or more lanes, with a raised median, and an ADT greater than 15,000

Source: Zegeer et al. *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations.* Highway Safety Research Center, University of North Carolina, Chapel Hill, North Carolina, 2001. (FHWA-RD-01-075). The complete study and a table of recommended treatments by location type can be accessed from http://www.walkinginfo.org/library/details.cfm?id=54.

Figure 11.3 Pedestrian Crash Types at Intersections

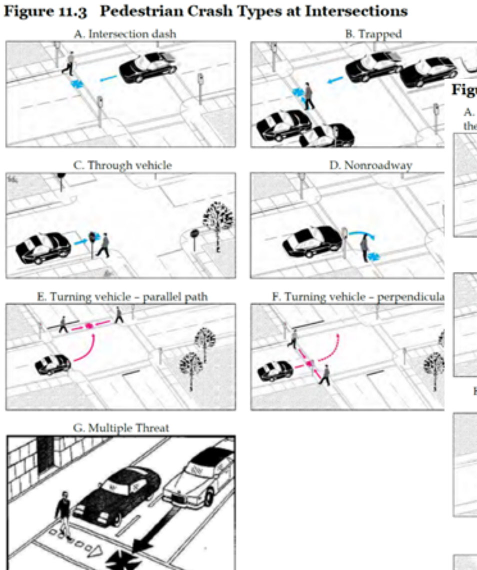
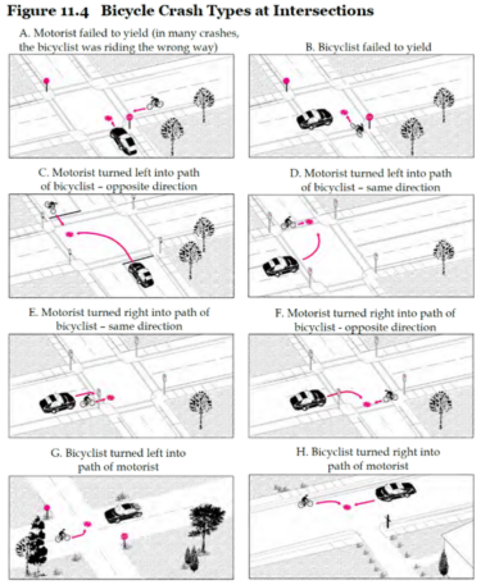
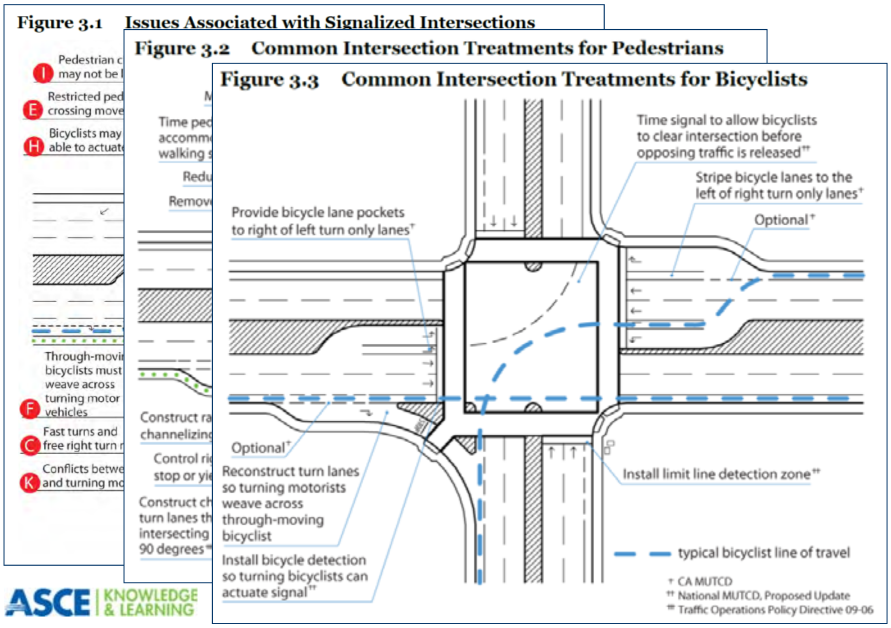


Figure 11.4 Bicycle Crash Types at Intersections



Signalized Intersection Issues



What About Liability?

Design and Liability

Even though design flexibility has been available and encouraged in key design guidance, many designers have been reluctant to use it.

Today's design practices continue to become more "context" sensitive and less focused on "generally accepted" standards and policy.

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How to Minimize Individual & Agency Risks

- The most solid legal defenses are based on immunity such as statutory design, statutory discretion or compliance with internal or external policy.
- Significant guidance exists for defense strategies in cases where generally-accepted standards of design are not strictly followed but the design is considered reasonably safe.

Step 1:Ensure a clear design policy exists for your agency that addresses flexibility in design and use of engineering judgment…. ….coordinated with your attorney.

Step 2: During design, solidly document the reasons for variances from "generally accepted" design guidance and do so in conformance with your agency's design policy.

i.e., NCHRP Legal Research Digest 57, Design Liability Defense Practices for Design Flexibility, March 2012

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Thoughts on Liability

- Don't let liability concerns get in the way of innovative and creative design
- Thoroughness and understanding of design guidance is required, but unique approaches are allowed and encouraged
- Being too conservative belittles our skills as engineers and limits growth in the profession
- Designers should remember that their skills, experience and judgment are valuable tools that should be used

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Design Example

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Jones Avenue Corridor Existing Conditions

- One mile long; two 11-ft thru lanes each direction
- 65 to 70 ft. ROW with above-ground utilities
- 5 to 8 ft. sidewalks w/ numerous obstacles
- No bicycle facilities or on-street parking
- 30 MPH posted speed limit
- ADT ranges from 22,000 to 36,000vpd
- Ten (10) street intersections, five (5) signalized
- Thirty-six (36) private drives
- Major east-west transit route with several stops
- Significant pedestrian activity, particularly in evenings/special events
- Limited bicycle activity along street but substantial in adjacent neighborhoods
- Several intersecting streets are one-way
- Frontage is mix of retail and small office uses
- Adjacent to major university

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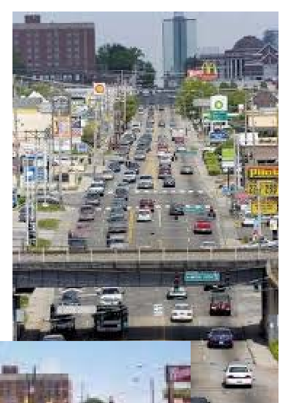
Jones Avenue Corridor, Midtown, USA

Community's Project Vision

The goal of the Jones Avenue Corridor Project is to convert a mid-town, auto-oriented state highway corridor that is frequently used as a pass through on the way to somewhere else and make it into an urban, multi-modal corridor providing safe and attractive transportation for pedestrians, bicyclists, transit, and cars, while creating a unique urban district with a variety of opportunities for people to stay and discover a great place.



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Key Issues/Challenges from Studies &Stakeholders

Traffic Operations:
- Difficult to make left turns
- Restricted left turns at some locations
- High volumes serving local and thru traffic

Transit:
- Unpredictable schedule during heavy traffic
- Lack of bus stop facilities

Safety:
- Left turn difficulty creates unpredictable patterns
- Pedestrians interfere with traffic at peaks
- Emergency vehicles often impeded
- Sidewalks not wide enough for peaks
- No provisions for bicycles

Service/Deliveries:
- Alleys too narrow
- Delivery trucks park in streets, alleys and on sidewalks

Adjacent Hospitals/University:
- Continued growth plans
- Cut thru traffic both campuses
- Hospitals desire more street closures
- Events/congestion obstruct hospital access
- Jones corridor is first impression

Parking:
- Not enough…assigned business or public uses
- No on-street parking on Jones
- Lack of street parking enforcement
- Predatory towing

Context/Land Use:
- Jones corridor seen as “back door”
- Protect and enhance “landmarks”
- Inconsistent development standards
- Businesses adapted to thru traffic rather than area neighborhoods
- Higher density/land use mix needed

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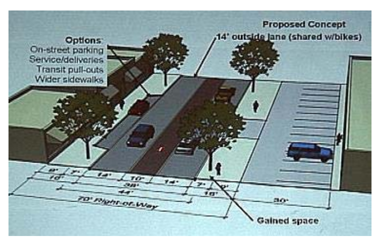
Alternative Design Options Evaluated

- Number of thru lanes, traffic LOS, diversion
- Intersection corner radii
- Sidewalk widths/amenities, pedestrian LOS
- Median location/type/design
- Median opening locations/turn prohibitions
- Driveway number/location/design
- Midblock pedestrian crossings
- Traffic signals/traffic controls
- Bicycle accommodation/amenities
- Landscaping/streetscape amenities
- Parking – location, type
- Transit stops/amenities/pullouts
- Underground/relocate utilities



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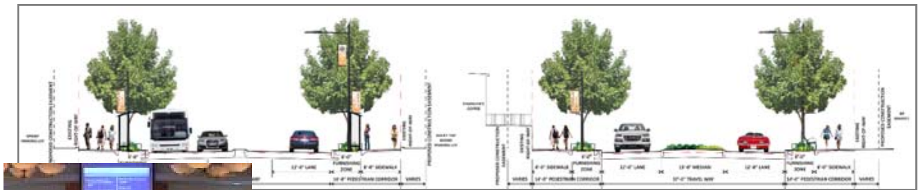
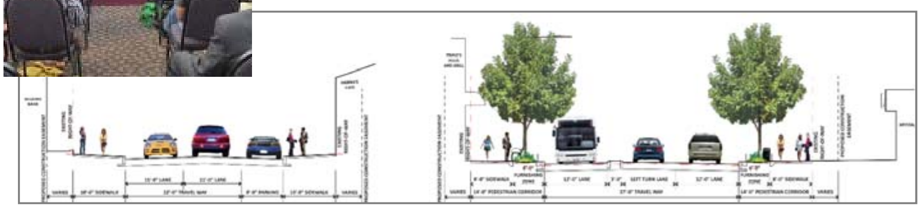
Alternative Cross-Section Designs Developed through Stakeholder Involvement



Pros, cons, impacts of various options on all modes identified and trade-offs discussed relative to project goals.



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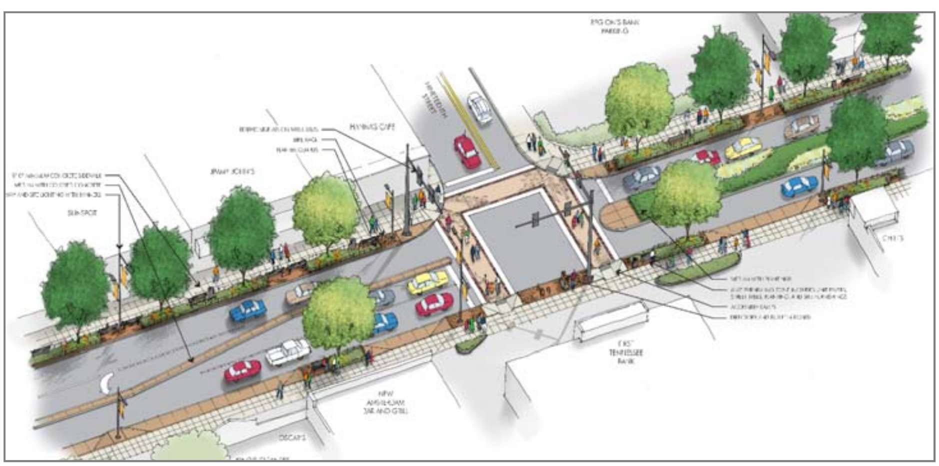
Final Alternatives Selected and Visualized



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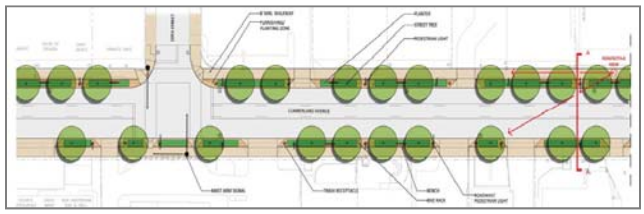
Jones Corridor Final Design Choices

- Two thru lanes 13 ft. w/ bike allowance
- 12 to 15 ft. sidewalks w/ amenities
- Selected 11 ft. turn lane locations
- 15 to 25 ft. corner radii
- Parallel on-street parking space pockets added
- Transit stops/amenities added
- One mid-block crosswalk added
- Extensive streetscape/landscaping
- Textured pavement used at intersections
- Utilities relocated to back alleys
- Left turns prohibited except at signals and major drives



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Final Thoughts

- Complete streets design is a process…every outcome is usually different in some way.
- It requires understanding of service to all modes, in an integrated and balanced manner, compatible with the surrounding land use and coordinated with community interests.
- Stakeholder engagement is critical.
- Geometric design flexibility is usually necessary.
- Engineering judgment is always necessary.

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Acknowledgments

Smart Growth America
Making Neighborhoods Great Together

National Complete Streets Coalition

ite

apbp
Association of Pedestrian and Bicycle Professionals

NACTO

NCHRP NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

TRB

U.S. Department of Transportation

AASHTO
THE VOICE OF TRANSPORTATION

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- *United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation*, Regulations and Recommendations Signed by Secretary of Transportation on March 11, 2010 and announced March 15, 2010. Free download.
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- *Urban Street Design Guide*, NACTO. Free web version.

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Thank You !!

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