

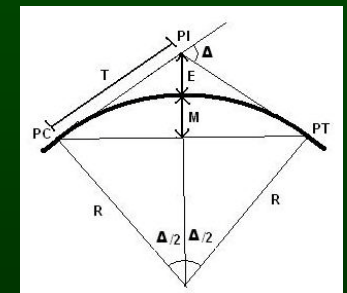
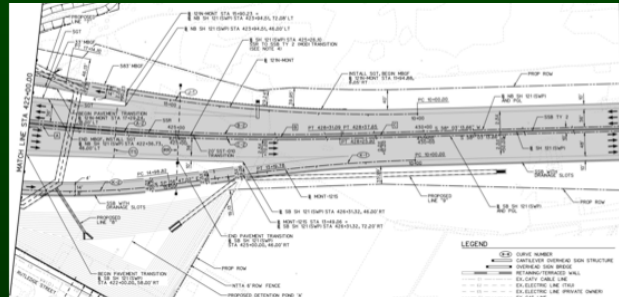
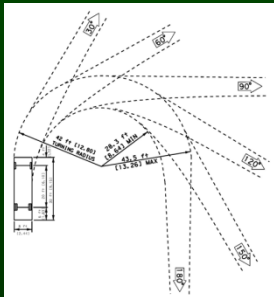


# 2011 AASHTO “Green Book”

2012 KYTC/FHWA/ACEC-KY Partnering Conference  
Louisville, Kentucky

September 11, 2012

Marshall Elizer, P.E., Gresham, Smith and Partners  
APWA Representative to AASHTO Technical Committee on Geometric  
Design



# Session Outline

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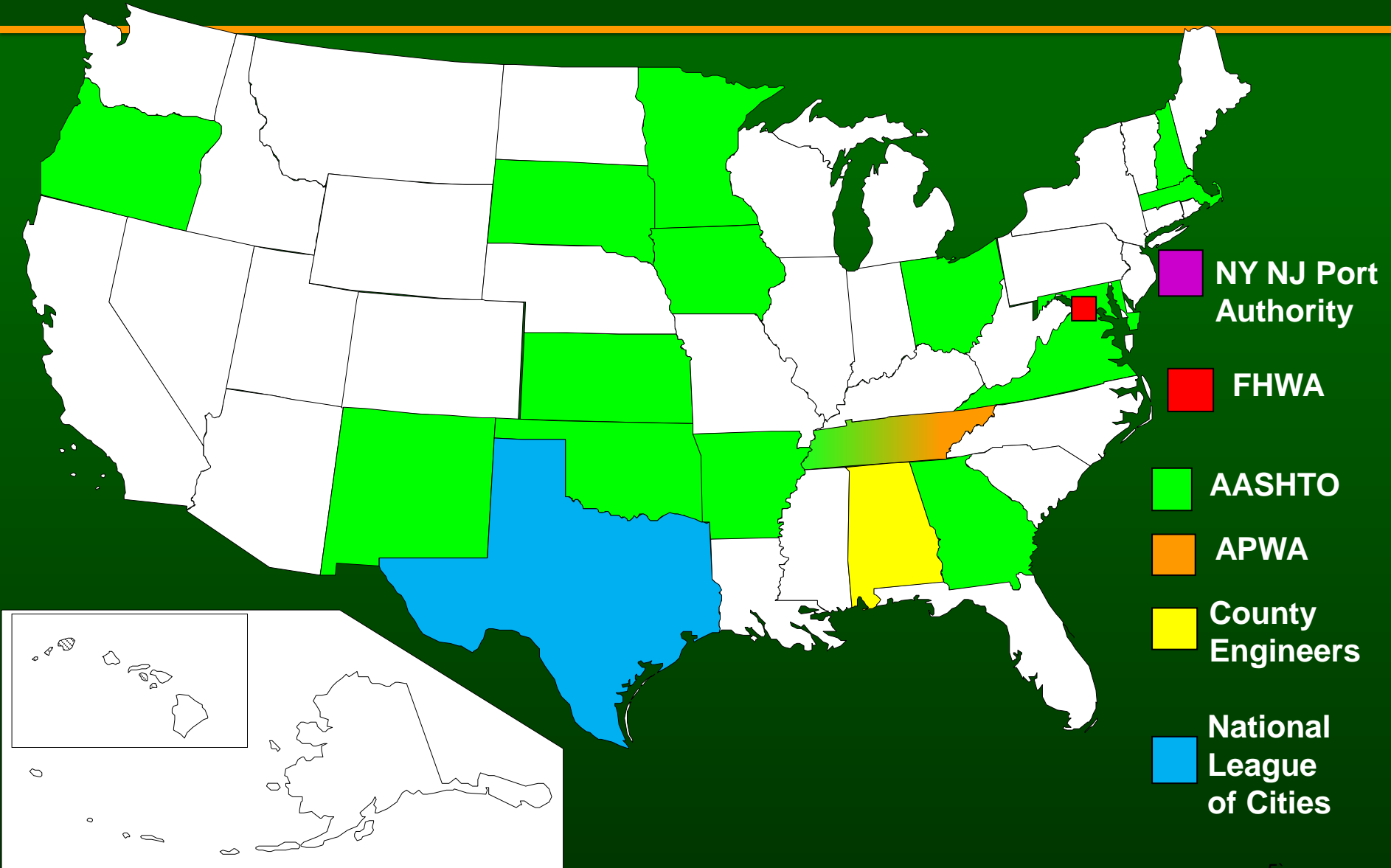
- AASHTO Technical Committee on Geometric Design
- Green Book History
- Policies for use, design exceptions, flexibility
- What's changed in the 2011 Green Book
- Questions & Answers

# AASHTO Technical Committee on Geometric Design Members

- 18 State Departments of Transportation
- National Association of County Engineers
- National League of Cities
- American Public Works Association
- Port Authority of NY, NJ
- Federal Highway Administration

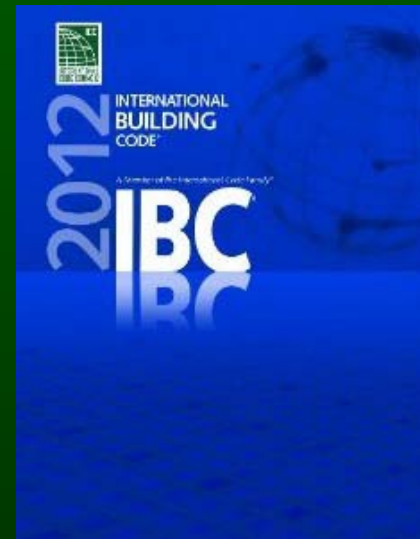


# Technical Committee on Geometric Design

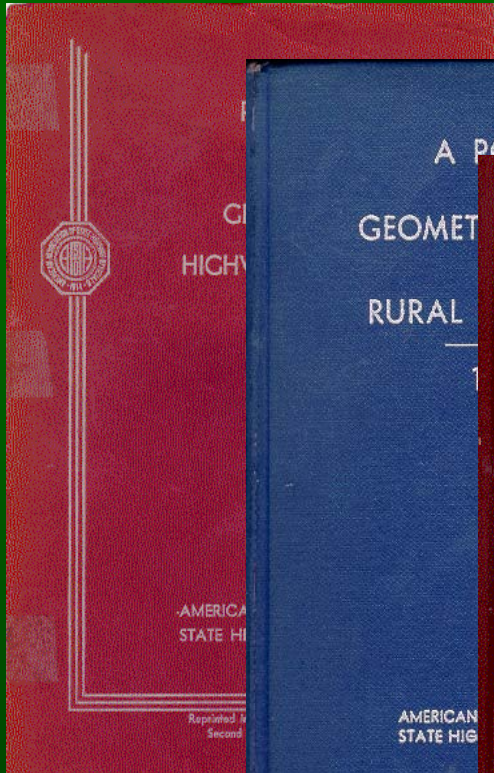


# Benefits of a National Design Policy

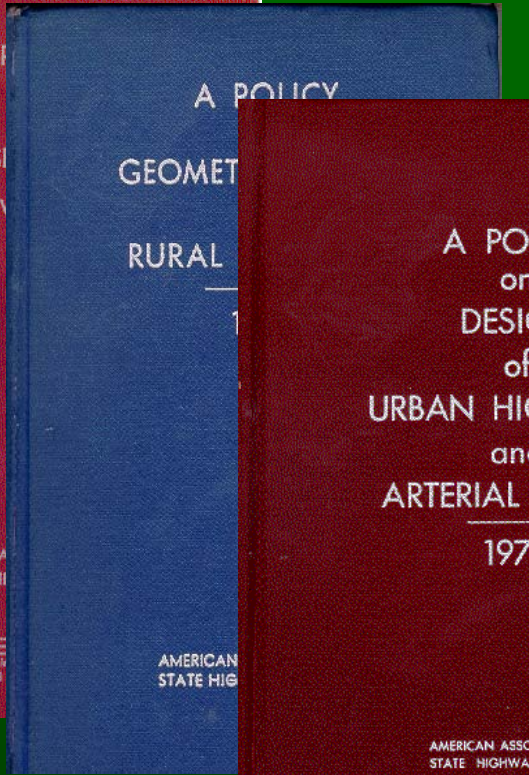
- Establishes the norm for professional practice
- Incorporates research and proven methods
- Supports public health and welfare (safety)
- Is adopted in whole or in part by many authorities
- Forms a level of quality and cost-effectiveness
- A “code” of sorts



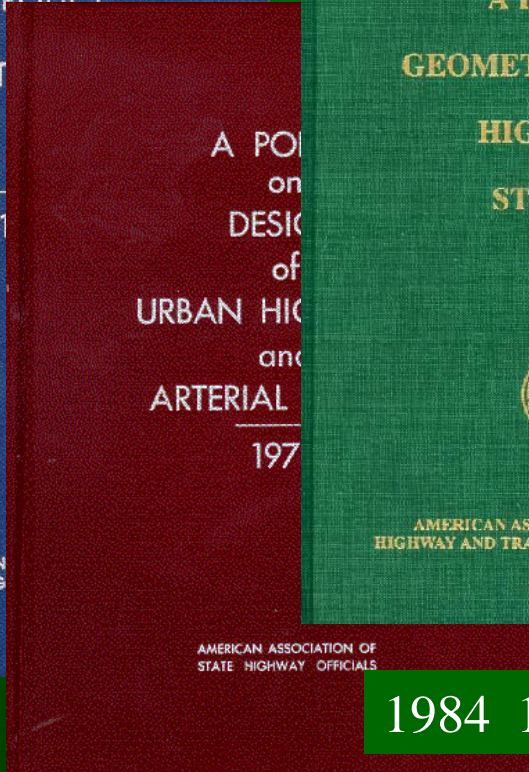
# Previous Editions



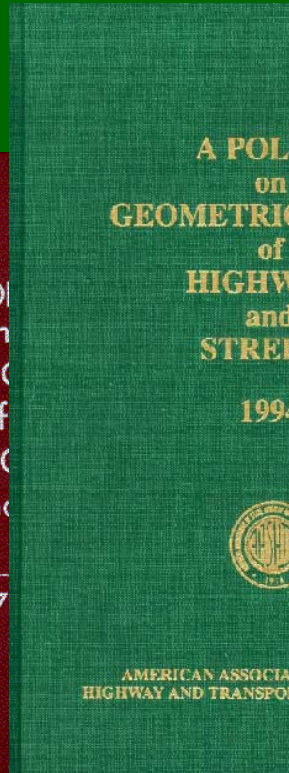
1950 1952



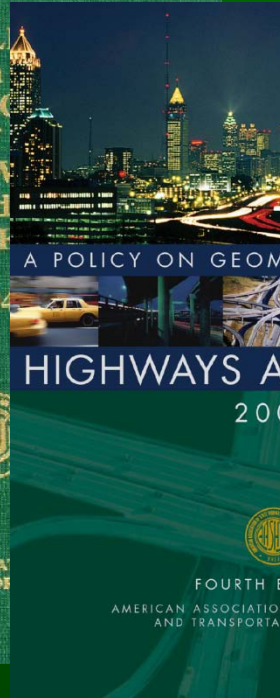
1954 1965



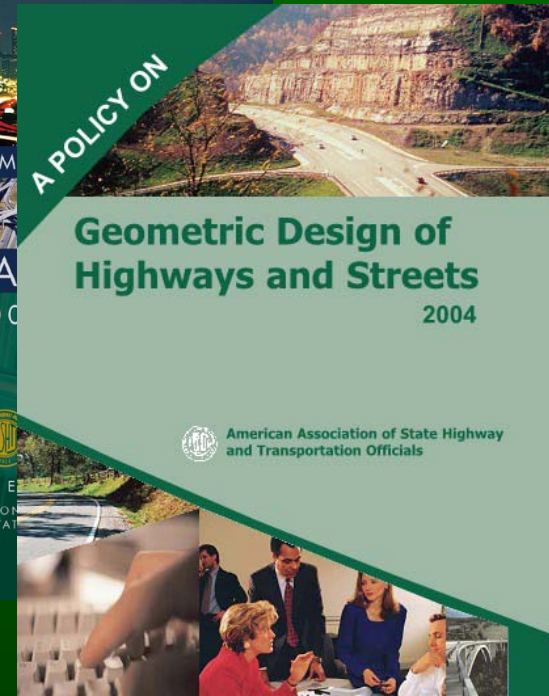
1957 1973



1984 1990 1994



2001



2004

# Continually Updated With Research

- Research proposed by State DOTs and FHWA
- AASHTO Standing Committee on Research (SCOR) prioritizes research needs statements
- Competitive, peer reviewed research process (NCHRP) administered by the Transportation Research Board (TRB) of the National Academies



**TRB** TRANSPORTATION  
RESEARCH BOARD  
OF THE NATIONAL ACADEMIES

**THE NATIONAL ACADEMIES**  
*Advisers to the Nation on Science, Engineering, and Medicine*



# Applications of the Green Book

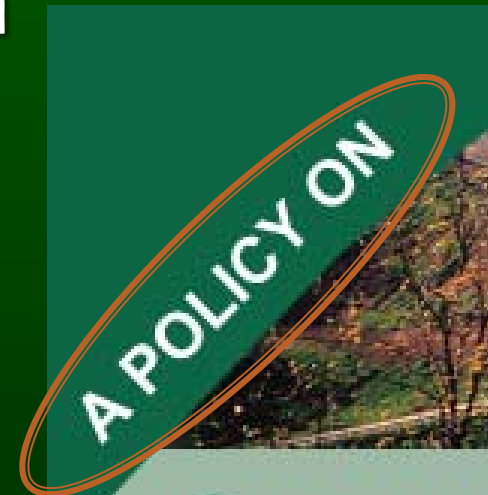
- Applies to new construction (projects on new alignment)
- Applies to reconstruction
- Does NOT apply to resurfacing, restoration or rehabilitation projects (“3R”)\*

\*FHWA has adopted the Green Book  
NHS freeway 3R projects



# The Green Book is a Policy on Geometric Design – not a standard

- Federal, state and local agencies establish “standards”
- Should not refer to the Green Book as “AASHTO standards”
- Should never refer to the Green Book as “safety standards”



# Individual State or local agency policies and manuals apply

- Federal, State and local agencies often have their own design manuals and policies
- Some States and local agencies have adopted the Green Book as their geometric design standards or design manual
- FHWA adopted the 2004 Green Book as the basis for minimum standards for the National Highway System (NHS) regardless of funding
- A new rulemaking is anticipated for adoption of the 2011 edition

# FHWA's Current Position on Green Book

- Until FHWA formally adopts the 2011 Green Book through formal rulemaking, the 2001 Green Book is the adopted standard (as specified in 23 CFR 625) for construction and reconstruction projects on the National Highway System.
- Until the 2011 Green Book is formally adopted, it should only be considered guidance. As we have done in the past, we encourage divisions to not require formal design exceptions for the thirteen controlling criteria on these projects if States choose to use values from the 2011 Green Book that are less conservative than in the 2001 edition.

# Standards for Federal Projects

- Programmatic
  - National (NHS, Interstate)
  - State (non-NHS and non-freeway RRR)
  - Local agency (off-system)
- Project-specific criteria
  - Based on applicable highway function and design controls



# Application of Standards

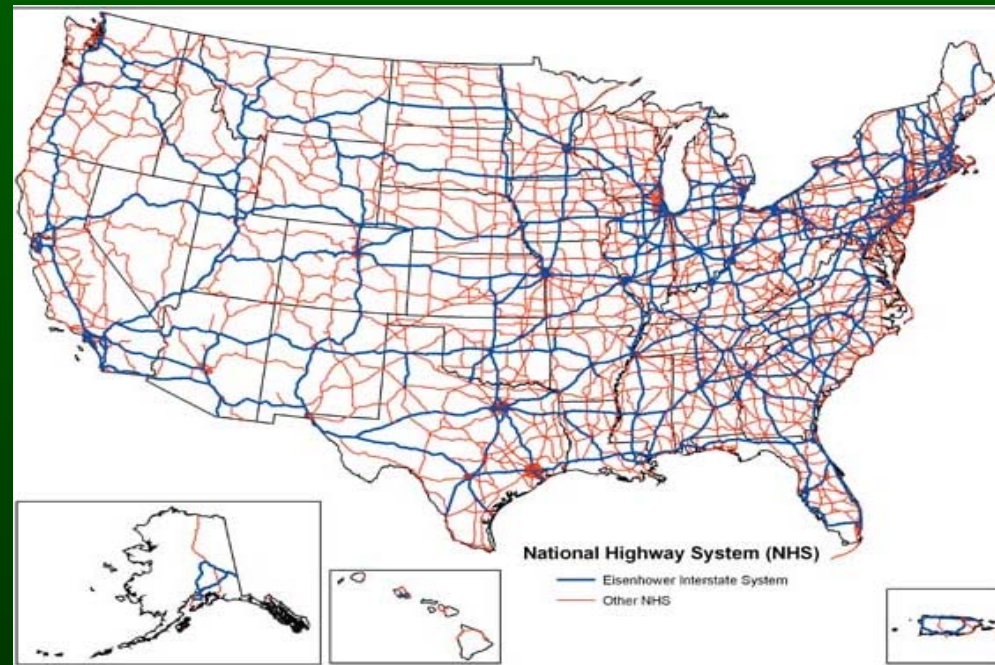
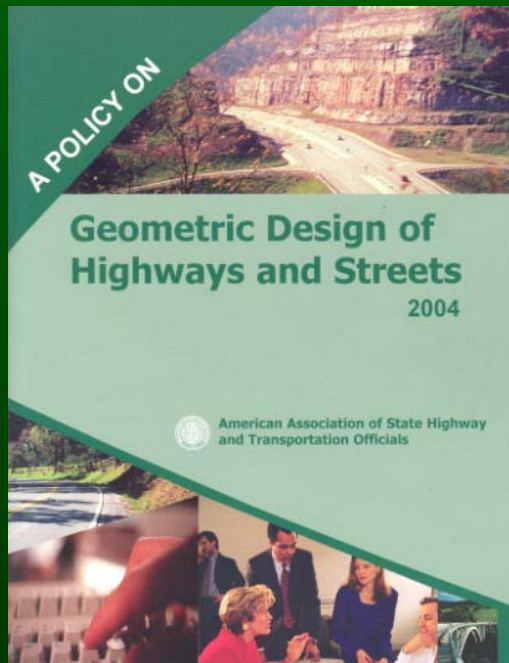
- Programmatic standards are applied to individual projects in establishing the:
  - Context and using it as a key design control
  - Geometric design controls (example: functional classification, design vehicle, LOS)
  - Design criteria values to choose for the project standards (example: design speed, maximum grade)

LOS E - Source: TRB Highway  
Capacity Manual 2000



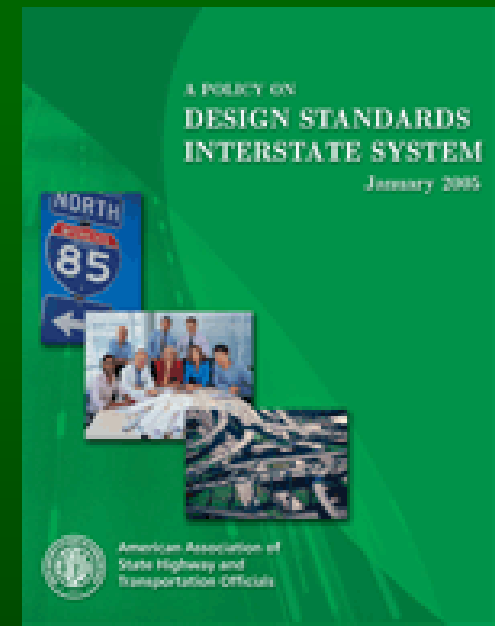
# FHWA Adopts AASHTO for the NHS

- AASHTO Policy is FHWA's standard for projects on the NHS (regardless of funding)
- For new construction or reconstruction
- For "3R" type of work on a NHS freeway



# Interstate Design Standards

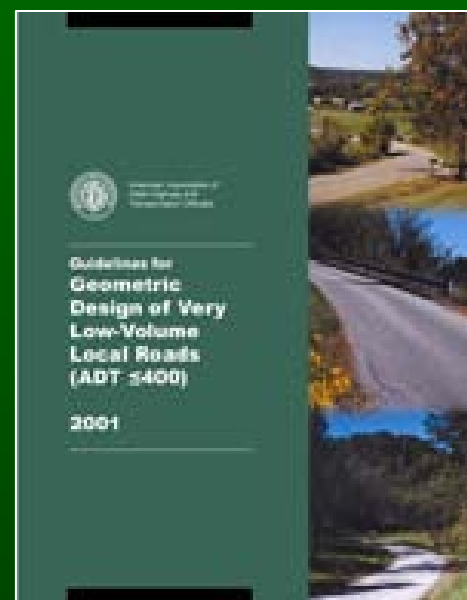
- Interstate System warrants a higher benchmark for design
- FHWA adopted the AASHTO “*Design Standards for the Interstate System*”
- Green Book guidance and criteria apply if not otherwise described in the Interstate Policy





# Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT $\leq$ 400)

- Addresses the unique design issues of determining appropriate cost-effective geometric design policies for very low-volume local roads
- Covers both new and existing construction projects.
- May be used in lieu of the Green Book for those facilities.

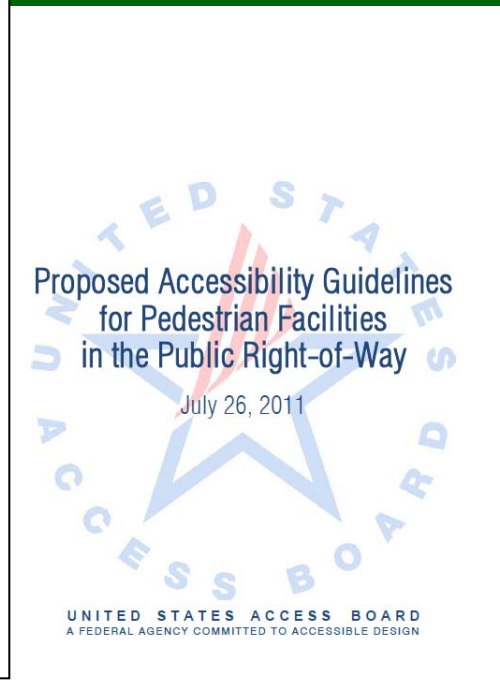
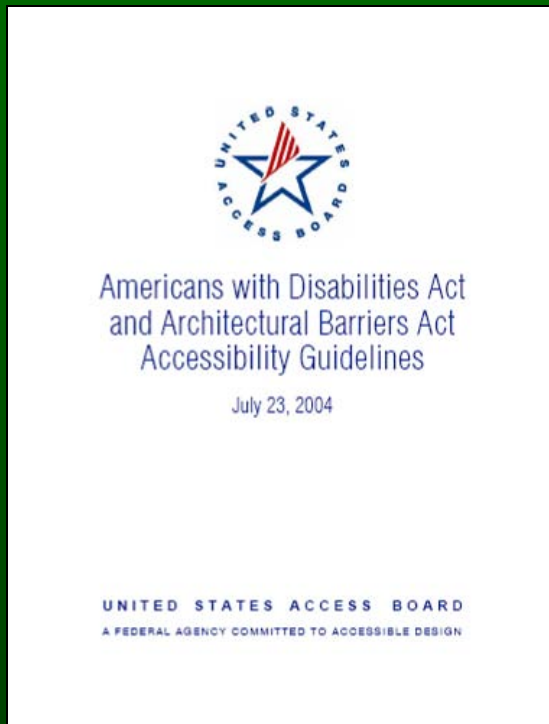


# Design Standards for non-NHS

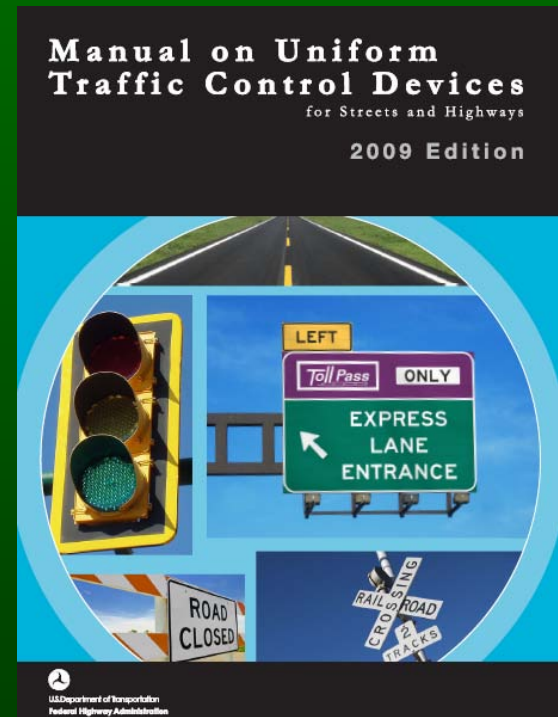
- States or local agencies are responsible for establishing their own design standards for non-NHS projects
- Federal projects must be designed and built in accordance with approved design standards
- Many states follow similar procedures for both Federal and non-Federal projects, to allow flexibility in funding options
- Most states offer technical guidance to local agencies for design of Federal projects

# Other Design Related Standards

## American with Disabilities Act Accessibility Guidelines\*



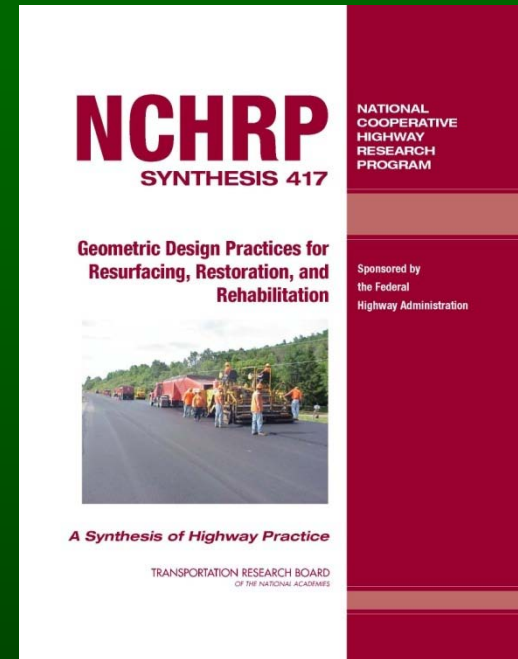
## Manual on Uniform Traffic Control Devices



\*Proposed to be superseded by Public Right-of-Way Accessibility Guidelines (PROWAG)

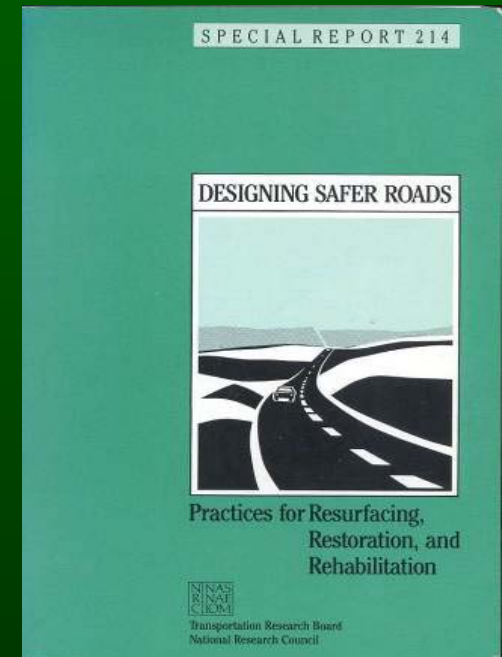
# 3R Design Standards

- For non-freeway 3R projects, States may develop separate design criteria with approval by FHWA in lieu of using the Green Book or other criteria applicable for reconstruction
- 42 States have opted to do so
- 8 States have similar design programs to achieve this purpose



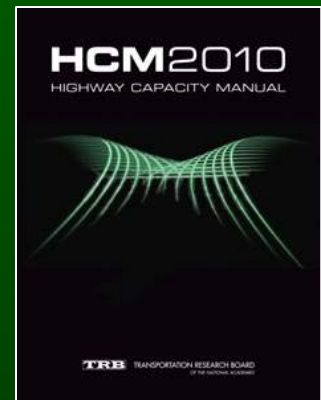
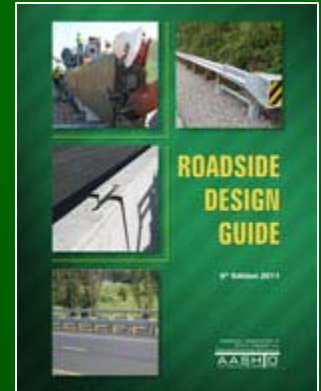
# 3R Design Guidance

- TRB Special Report 214 is a commonly used reference for 3R criteria
- A “safety conscious” approach for improvement of safety performance
- Evaluation of existing
  - Geometric design
  - Roadside conditions
  - Traffic operations
  - Pavement and drainage structures



# Other Guides and References

- Viewed as “best practices” but don’t rise to the same level of importance
- Listed in Federal Aid Policy Guide (FAPG) NS 23 CFR 25, para. 16
- Notable examples include:
  - AASHTO Roadside Design Guide 4<sup>th</sup> Edition
  - TRB Highway Capacity Manual



# Design Exceptions

- A documented decision to design a highway element or a segment of a highway to a criterion that does not meet the minimum value established for that highway or project
- Allowance for exceptions is a valid aspect of the design process
  - Not an admission of failure
  - Not flawed design
  - A necessary and legitimate exercise of professional evaluation and engineering judgment

# FHWA Policy – Title 23 Code of Federal Regulations

- PART 625—DESIGN STANDARDS FOR HIGHWAYS § 625.3 Application.

(f) *Exceptions.*

(1) Approval ...may be given on a project basis to designs which do not conform to the minimum criteria ...for:

(i) Experimental features on projects; and

(ii) Projects where conditions warrant that exceptions be made.



# Evaluation of “Controlling” Criteria

- FHWA policy recognizes it is impractical to require a formal design exception evaluation for every design element
- Attention is focused on elements of most substantial importance to the safety and operational performance of any highway: what are commonly referred to as the...

**“13 controlling criteria”**

# FHWA's 13 “Controlling” Criteria

- Design speed
- Lane width
- Shoulder width
- Bridge width
- Horizontal
- Superelevation
- Vertical curvature
- Grade
- Stopping sight distance
- Cross slope
- Vertical clearance
- Horizontal clearance (lateral offset to obstruction)
- Structural capacity

# Design Practice Involves Risk

- Balances risk tolerance with benefit/reward
- Relies on awareness and knowledge
- Identifies costs and impacts
- Evaluates alternatives and options
- Assesses risks (known and unknown)
- Evaluates mitigation measures
- Documentation and approval
- Monitor in-service performance



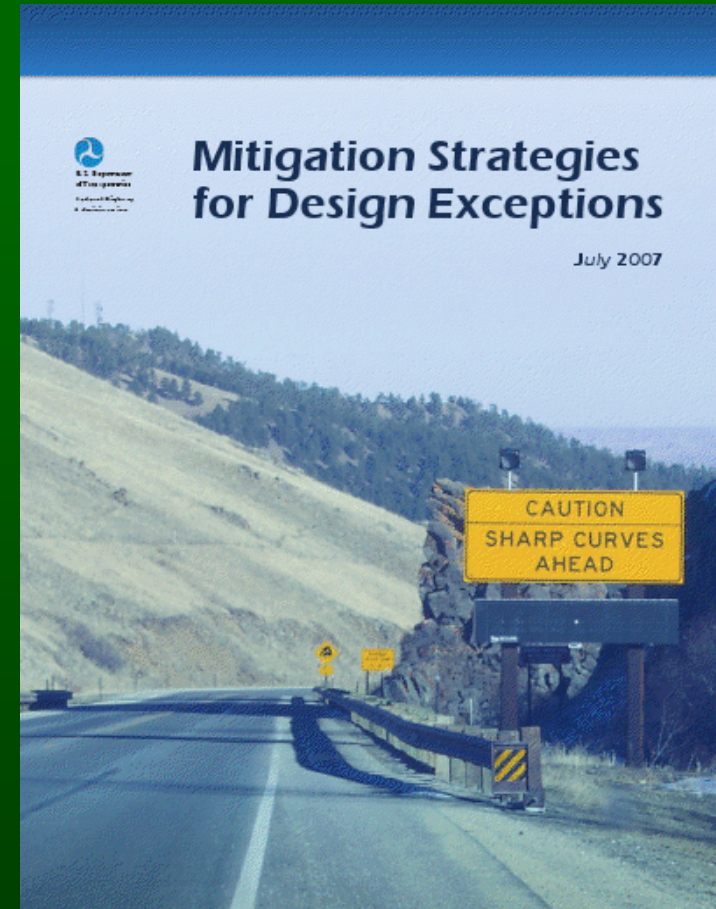
# Risk Considerations

- What is the degree to which a standard is being reduced?
- What is the “exposure” of the design exception
  - Length of exception segment
  - Traffic volumes of the facility
  - Duration of time the exception will be in place
- Where is the exception relative to other risk factors?



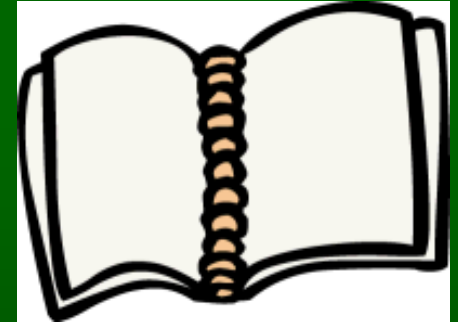
# Mitigation is a strategy to reduce risk

- Mitigate risks to the extent practical
- Countermeasures that are related to adverse effects can reduce their likelihood, extent, and severity
- Risks can also be mitigated by enhancing related elements

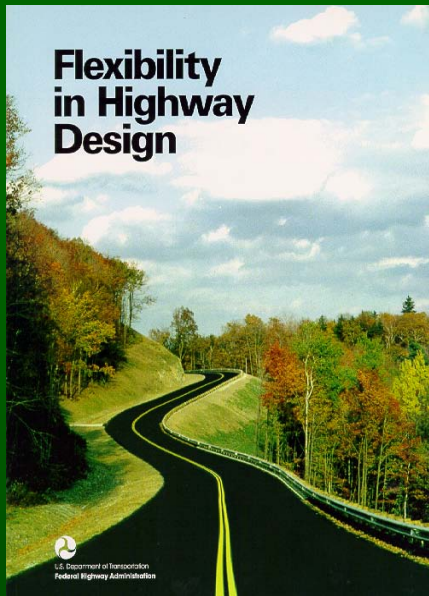


# Tort Risks

- Adherence to standard does not automatically demonstrate reasonable care
- Deviation from standard does not automatically demonstrate negligence
- A structured process for evaluating, approving and documenting the rationale for key design decisions is necessary to address professional responsibility and tort liability



# Flexibility in Highway Design

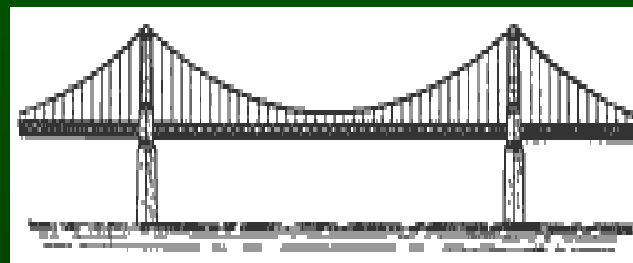
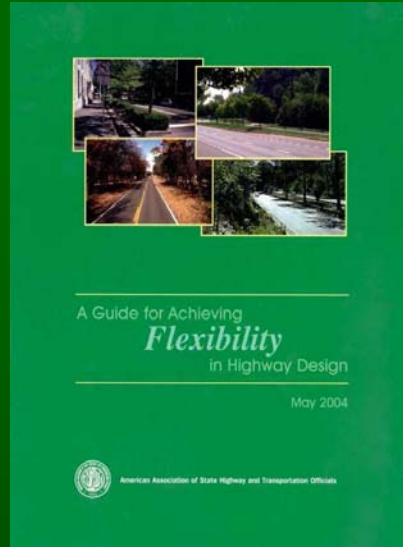
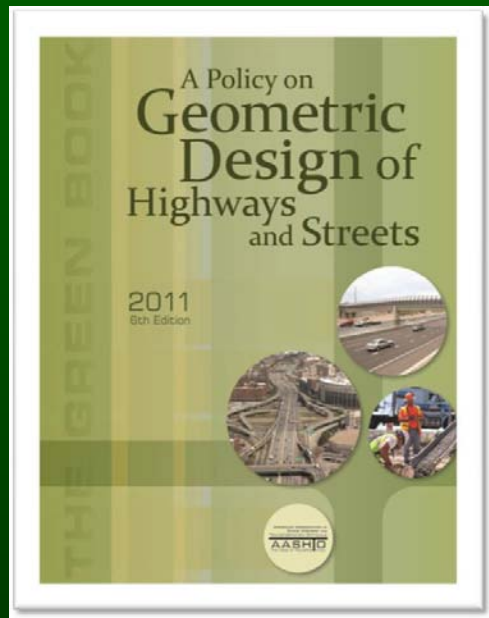


- Joint effort of:
  - FHWA
  - AASHTO
  - Non-traditional partners
- Central theme of Thinking Beyond the Pavement Conference in 1998

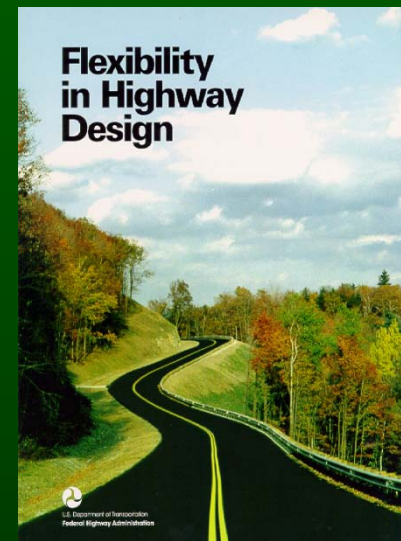
This guide does not attempt to create new standards. Rather, the guide builds on the flexibility in current laws and regulations to explore opportunities to use flexible design as a tool to help sustain important community interests without compromising safety. To do so, this guide stresses the need to identify and discuss those flexibilities and to continue breaking down barriers that sometimes make it difficult for highway designers to be aware of local concerns of interested organizations and citizens.

Source: Jane Garvey, Acting Administrator, FHWA 1997

# “Bridging” Flexibility in Highway Design



**AASHTO “A Guide for  
Achieving Flexibility in  
Highway Design”**





# Why Flexible Design?

- Facilitates program/project delivery and achieving performance goals
- Allows consideration of a wider range of design options and alternatives to fit conditions
- Enables more cost-effective designs that improve safety and efficiency
- Promotes CSS principles (an FHWA and 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
- Apply performance criteria to evaluate flexible design decisions, as well as condition criteria
- Understand the risks and consequences for design decisions



# Designers routinely balance many factors in design decisions

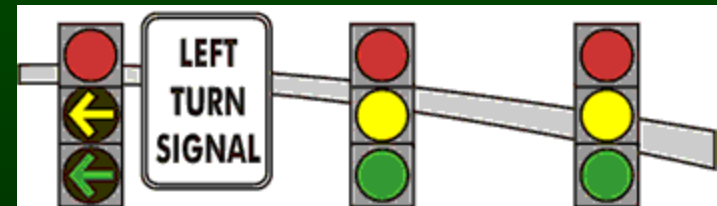
- Tradeoffs routinely considered:
  - Economics (agency or user costs/benefits)
  - Stakeholder or agency preferences
  - Environmental and social impacts or enhancements
  - Capacity, delay or speed
  - Ease of maintenance



Flush  
versus  
Raised



Permissive  
versus  
Protected

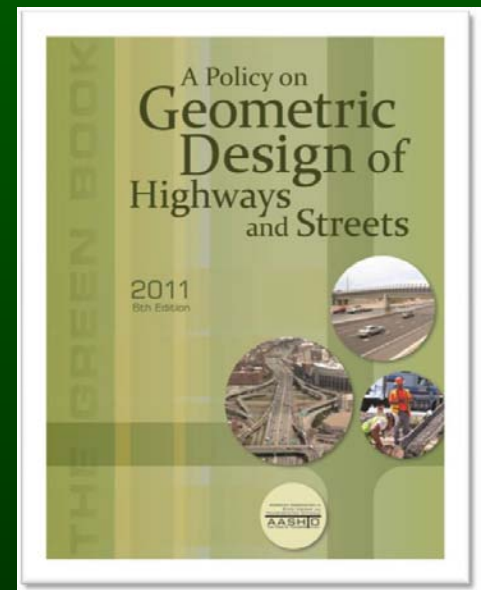


# AASHTO Flexible Design Policy

*“Highway engineers, as designers, strive to meet the needs of highway users while maintaining the integrity of the environment. Unique combinations of design controls and constraints call for unique design solutions...”*

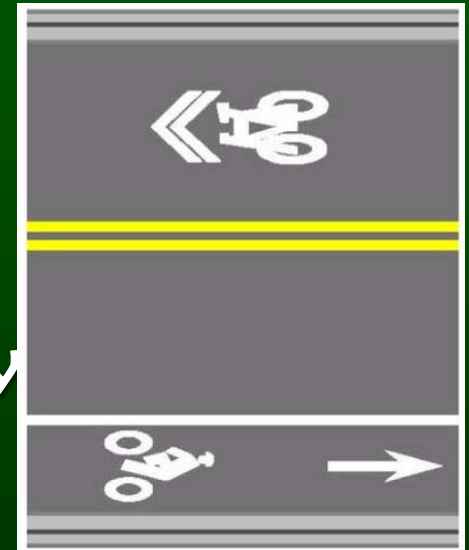
*“...Sufficient flexibility is permitted to encourage independent designs tailored to particular situations.”*

Source: Foreword, p. xli, 2011 Edition



# What Flexibility is in the Green Book?

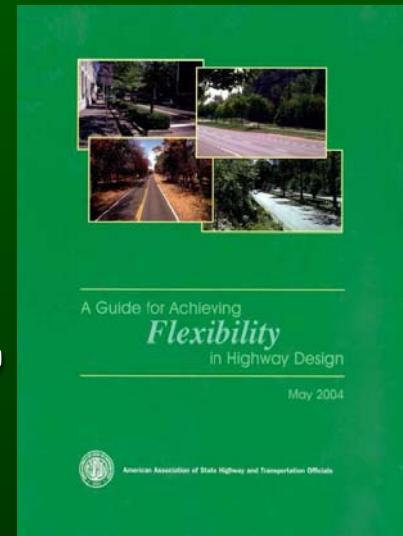
- Many dimensions and values are shown as ranges
- Many criteria described as “guidelines” or “typical”
- Many concepts are not dimensioned and discussed only in functional terms
- In many cases, choices are offered for how to complete a design
- Solutions or concepts not specifically included are not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



# Skilled Designers Minimize Risk

*“The ability to develop a context-sensitive solution by working within and sometimes outside design criteria, while maintaining the safety and operational integrity of the highway, requires a broad and deep understanding of the operational effects of highway geometry.”*

Source: A Guide to Achieving Flexibility in Highway Design, AASHTO 2004, p. 50



# Know how to use 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.”

2011 Green Book Foreword, pg xli

# Applying inherent flexibility involves:

- Establishing the project context and using it as a key design control
- Determining appropriate design controls (example: functional classification, design vehicle, LOS)
- Choosing appropriate design criteria for the project standard (example: design speed)
- Selecting optimum design values within a range of acceptable values (example: curve radii)



LOS E - Source: TRB Highway Capacity Manual 2000





# Example: Lane Widths Vary by Type

## Rural

- Freeways 12 ft
- Arterials 10 to 12 ft
- Collectors 10 to 12 ft; 9-ft lanes can be used for low volume, low speed reconstructed roads with acceptable performance
- Low volume 9 to 11 ft

## Urban

- Freeways 12 ft
- Arterials 10 to 12 ft
- Collectors 10 to 12 ft
- Local streets 10 to 12 ft; 9-ft lanes can be used in residential areas where the available or attainable width of right-of-way imposes severe limitations

**MYTH:** The Green Book does NOT require 12 ft lanes

# Other Lane Width Guidance

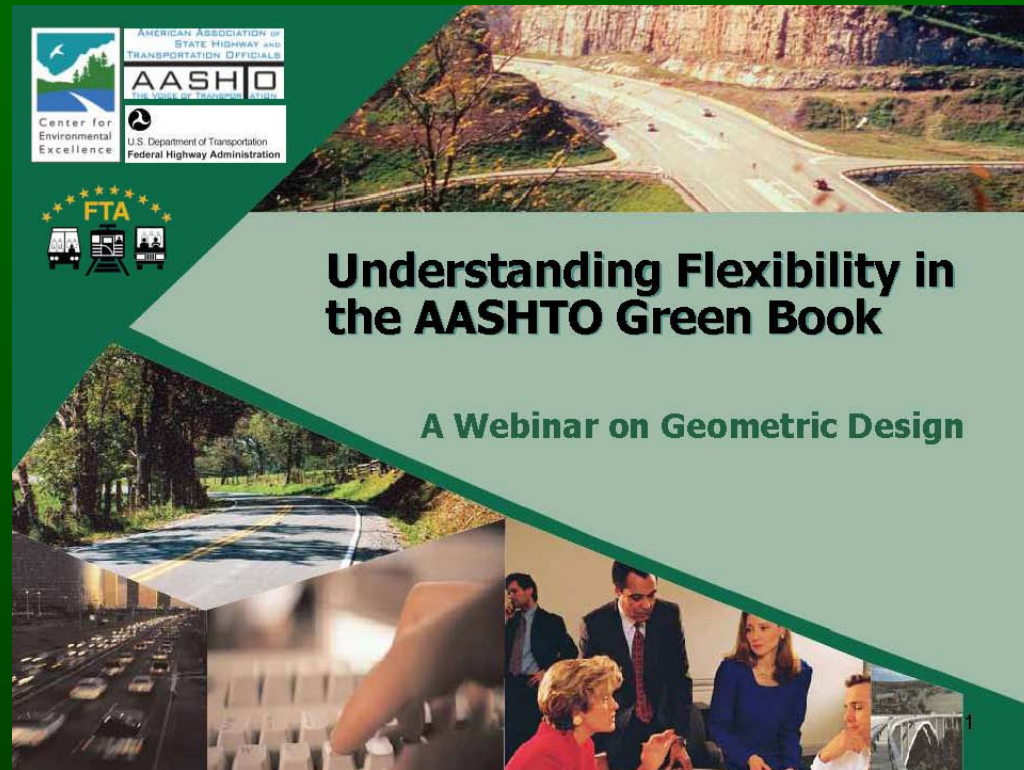
## Advantages of narrow lanes on urban arterials:

- Allow additional lane(s) in areas with constrained right-of-way
- Facilitate use of a wider outside lane or a designated bike lane
- Facilitate greater offset to parking lane
- Facilitate a flush or raised median
- Produce shorter pedestrian times
- More economical to construct
- Contribute to lower speeds



# More About Flexibility in Design

## AASHTO/FHWA Webinar on Geometric Design



The graphic features a central light green arrow pointing right, containing the text "Understanding Flexibility in the AASHTO Green Book" and "A Webinar on Geometric Design". To the left of the arrow are logos for AASHTO (American Association of State Highway and Transportation Officials), the Center for Environmental Excellence (U.S. Department of Transportation, Federal Highway Administration), and FTA (Federal Transit Administration). The background is a collage of images: a highway interchange, a winding road through a forest, a busy multi-lane highway, a close-up of a hand on a computer keyboard, and a group of people in a meeting.

[http://environment.transportation.org/center/products\\_programs/understanding\\_flexibility\\_green\\_book.aspx](http://environment.transportation.org/center/products_programs/understanding_flexibility_green_book.aspx)

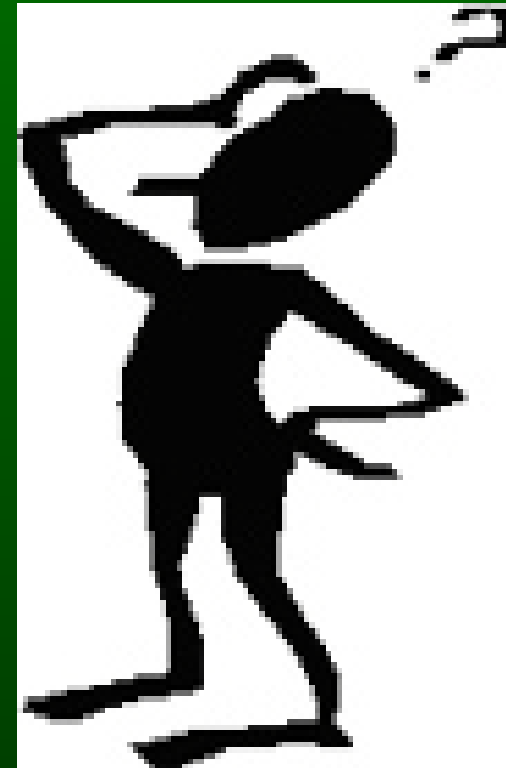
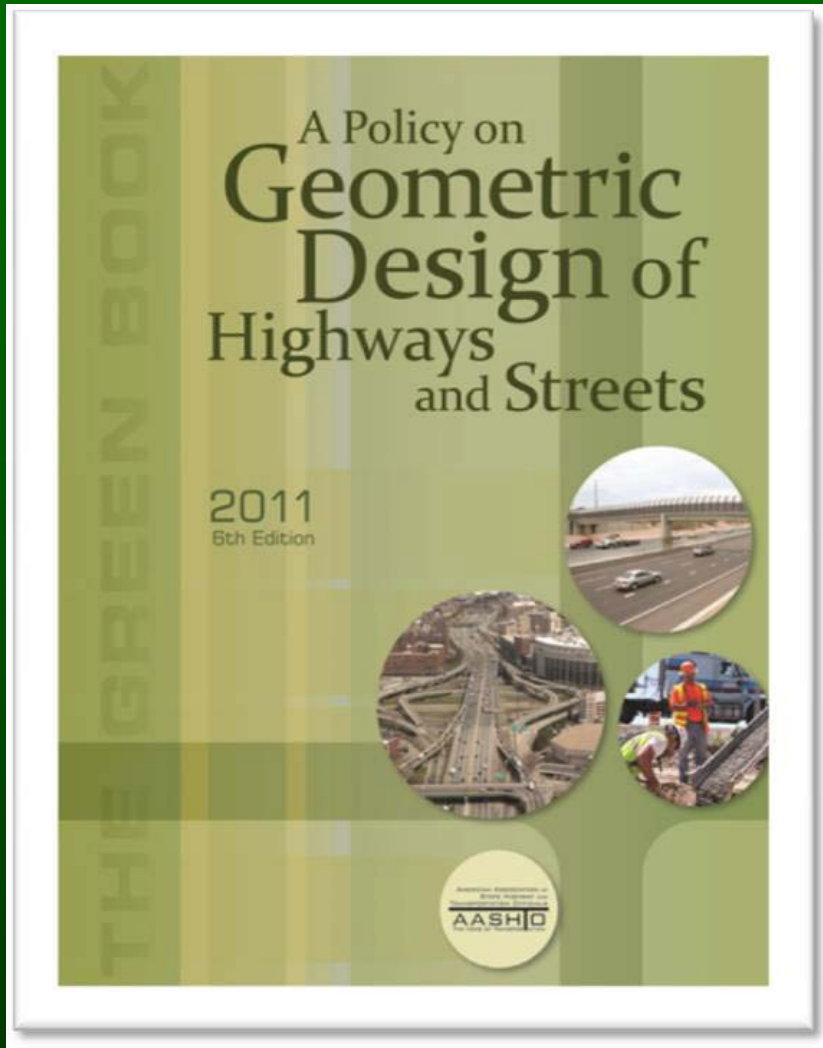
# The New Green Books Are Here!



The Green Book will help you design the perfect environmentally-sensitive highway!

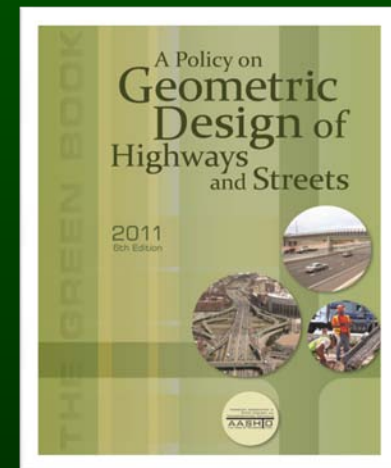
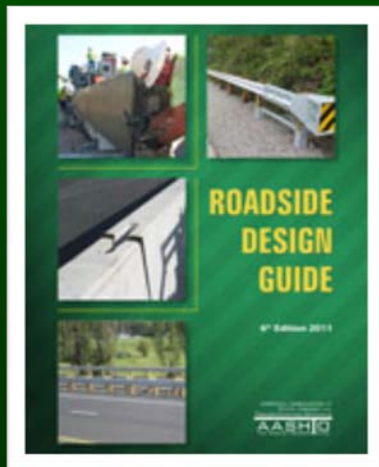


# What's New in the 2011 Green Book?



# 2011 Green Book - General Changes

- **NCHRP 20-07, Task 171:** *Identification of Conflicts with AASHTO Publications Related to Clear Zone*
  - Inconsistencies between Green Book and the Roadside Design Guide, etc.
  - Definitions, terminology, policy
    - ‘Horizontal Clearance to Obstruction’ renamed to ‘Lateral Offset to Obstruction’
    - ‘Recovery area’ replaced by ‘clear zone’



# 2011 Green Book – General Changes

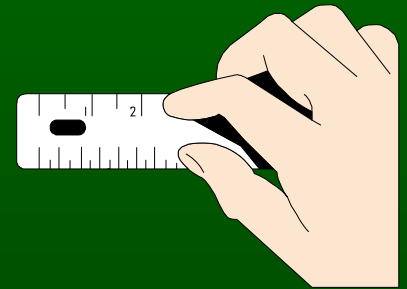
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- ‘Must’ or ‘shall’ only used in the case of a legal requirement
- ‘Where possible’ replaced by ‘**where practical**’ in most cases  
( *Almost anything is possible* )
- ‘improves safety’ or ‘safe’ replaced by ‘**reduces the frequency and severity of crashes**’ replaces
- Updated Photos



# 2011 Green Book - Format Changes

- Numbered sections and subsections
- Chapter-specific page #'s
  - e.g. Page 3-141
- Chapter #'s in the headers
- Chapters 5-8 organized consistently



# Chapter 1 – Highway Functions

- Emphasis on designer consideration of the “context” of the project area [1.3.3 & 1.3.5]
- Highlights the flexibility available to encourage choosing design criteria: [pgs 1-9 thru 1-13]
  - Consistent with the context of the project
  - Needs and value of the community
  - With respect to economic limitations



# Revised 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]*

# More on “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]*

# 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

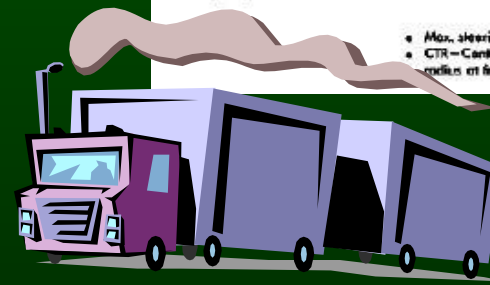
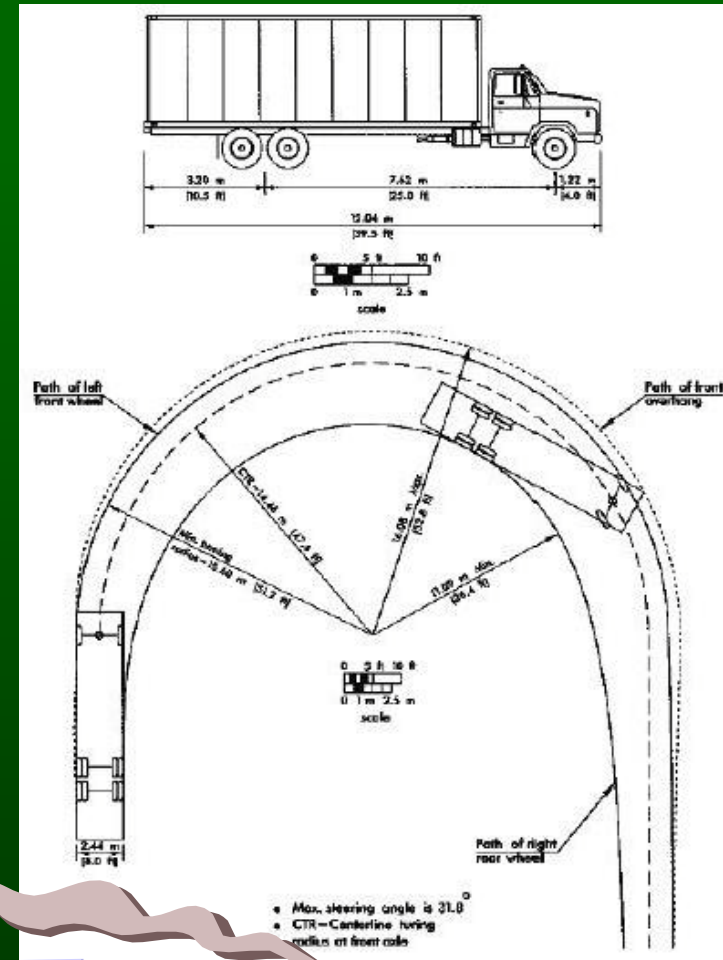


# Chapter 2 – Design Controls and Criteria

## Design Vehicles\*

- Added SU-40 single unit truck (3-axle) [pg 2-12]
- Removed WB-50 semitrailer truck and replaced with WB-62 [pg 2-23]
- Added WB-92B – Rocky Mountain Double [pg 2-26]

\* NCHRP Report 505: *Review of Truck Characteristics as Factors In Roadway Design*



# Design Speed

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## Selection of Design Speed:

- *“Above-minimum design values criteria for specific design elements should be used, where practical, particularly on high-speed facilities. [pg 2-54]*
- *On lower speed facilities, use of above-minimum design criteria may encourage travel at speeds higher than the design speed.” [pg 2-55]*

# The Pedestrian

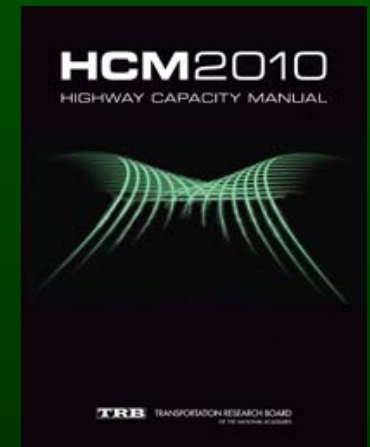
- Pedestrian walking speeds changed to be consistent with the MUTCD [pgs 2-79,80]
  - 3.5 ft/sec for pedestrian clearance (don't walk)
  - Total pedestrian crossing time based on 3.0 ft/sec
- References added to the PROWAG [pgs 2-78, 2-81]





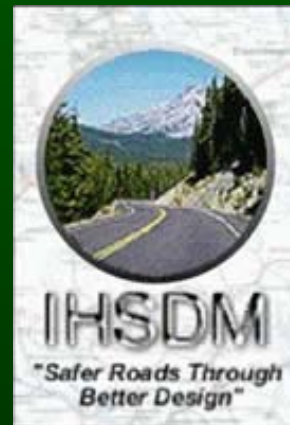
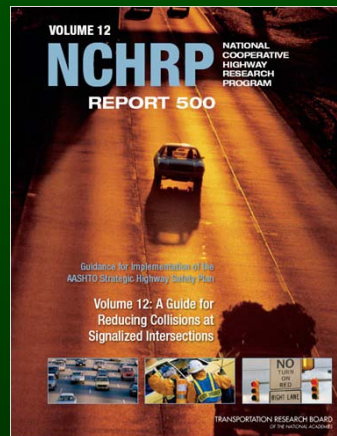
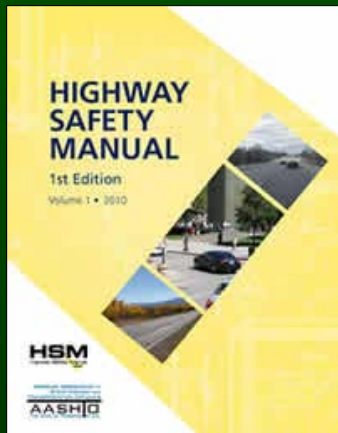
# Traffic Operations

- “Principles for Acceptable Degrees of Congestion” content removed [pg 2-60]
- Now referenced to the TRB *Highway Capacity Manual*
- Multi-modal levels of service in HCM 2010
- Consideration for higher truck power-to-weight ratios and speed profile calculation [pg 3-114]



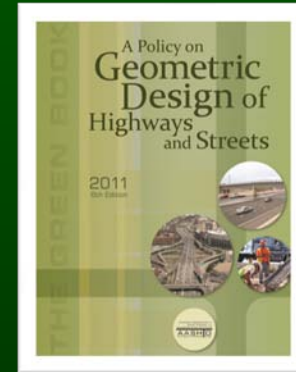
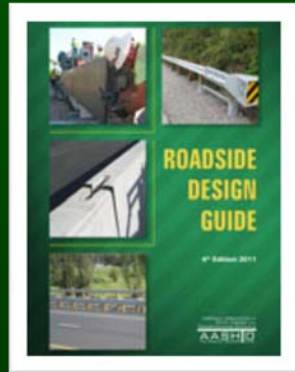
# Safety

- References to “Safety” are commonly changed to “crash frequency and severity”
- Updated safety resources added references to the AASHTO Highway Safety Manual, the NCHRP Report 500 series, and the IHSDM [pg 2-85]



# Clear Zone

- NCHRP 20-07, Task 171: *Identification of Conflicts with AASHTO Publications Related to Clear Zone*
  - Inconsistencies between Green Book, RDG, etc.



# Level of Service

Functional Class	2004 Green Book Urban & Suburban LOS	2011 Green Book Urban & Suburban LOS
Freeway	C	C or D
Arterial	C	C or D
Collector	D	D
Local	D	D

# Travel Lane Width (urban arterial)

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- “Lane widths may vary from 10 to 12 ft..... Lane widths of 10 ft..... may be used in highly restricted **more constrained** areas **where truck and bus volumes are relatively low and speeds are less than 35 mph** having little or no truck traffic.
- Lane widths of 11 ft..... are used quite extensively for urban arterial street designs.
- The 12-ft lane widths are most desirable and should be used, where practical, on higher speed, free-flowing, principal arterials.”

# Parking Lane Width (Urban Arterial)

---

2004 Green Book:

“Passenger vehicles parked adjacent to a curb will occupy, on the average, approximately 7 ft..... of street width. Therefore, the **total parking lane width for passenger cars should be 10 to 12 ft.....**”

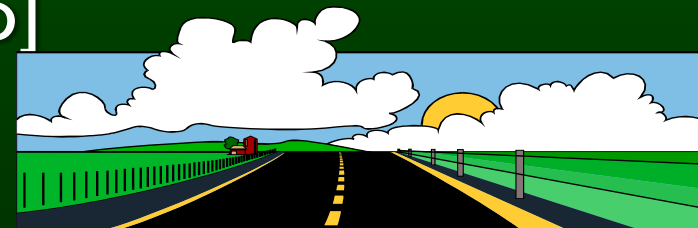
2011 Green Book:

“Passenger vehicles parked adjacent to a curb will occupy, on the average, approximately 7 ft..... of street width. Therefore, the **total parking lane width for passenger cars should be 7 to 10 ft.....**”

# Chapter 3 – Elements of Design

- Stopping Sight Distance tables clarified whether on level, wet weather, or grades [pgs 3-4, 3-5]
- Passing Sight Distance for Two-Lane Highways revised based on NCHRP Report 605\* (now consistent with MUTCD) [pgs 3-8, 3-9]
- Enhanced height of object discussion in the criteria for measuring sight distance rather than in discussion of its need [pg 3-15]
- Optimal passing lane flow rates and design length values added [pg 3-135]

\* NCHRP Report 605: *Passing Sight Distance for Two-Lane Highways*



# Chapter 3 – Elements of Design

- 2+1 Roadways design guidance added based on NCHRP Research Digest 275 [pgs 3-132,135]
- Revised method for “Lane Drop Taper Length” for passing lane sections is consistent with MUTCD [pg 3-134]
- Design controls for crest vertical curves updated based on passing sight distance [3-157]
- Lighting – updated to conform to the AASHTO Roadway Lighting Guide and IESNA publications [3-172]
- Discussions of drainage, fencing and noise barriers moved to Chapter 4



# Minimum Radii for Design Superelevation Rates, Design Speeds, and $e_{\max} = 8\%$

e (%)	$V_d = 15$ mph	$V_d = 20$ mph	$V_d = 25$ mph	$V_d = 30$ mph	$V_d = 35$ mph
	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)
1.5	932	1640	2370	3240	4260
2.0	676	1190	1720	2370	3120
2.2	605	1070	1550	2130	2800
2.4	546	959	1400	1930	2540
2.6	496	872	1280	1760	2320
2.8	453	796	1170	1610	2130

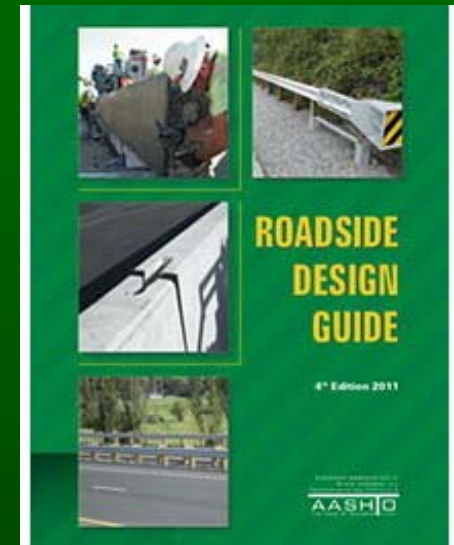
2004

e (%)	$V_d = 15$ mph	$V_d = 20$ mph	$V_d = 25$ mph	$V_d = 30$ mph	$V_d = 35$ mph
	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)
NC	932	1640	2370	3240	4260
RC	676	1190	1720	2370	3120
2.2	605	1070	1550	2130	2800
2.4	546	959	1400	1930	2540
2.6	496	872	1280	1760	2320
2.8	453	796	1170	1610	2130

2011

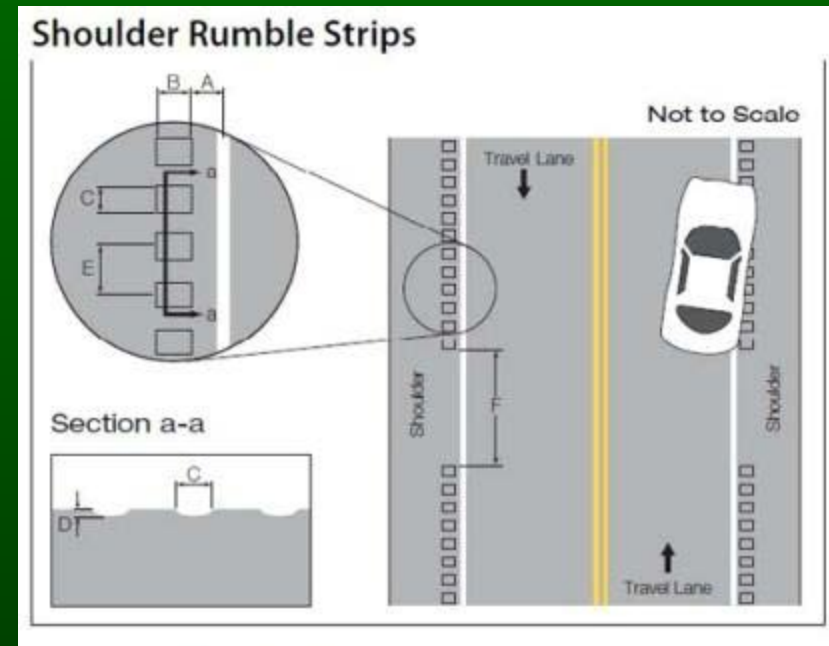
# Chapter 4 – Cross Section Elements

- Traveled Way definition revised to be consistent with **Roadside Design Guide**, i.e., exclude shoulders/bicycle lanes [pg 4-1]
- Lane widths: “In urban areas where pedestrian crossings, right-of-way, or existing development become stringent controls on lane widths, the use of 3.3-m [11-ft] lanes may be appropriate.” [pg 4-7]



# Chapter 4 Cross Section Elements

- Rumble Strip section added based on State experience and TRB/FHWA research (Section 4.5, pg. 4-14)



FHWA Technical Advisory T5040.35 Roadway Rumble Strips  
NCHRP Report 641 - *Guidance for the Design and Application of Shoulder and Centerline Rumble Strips*

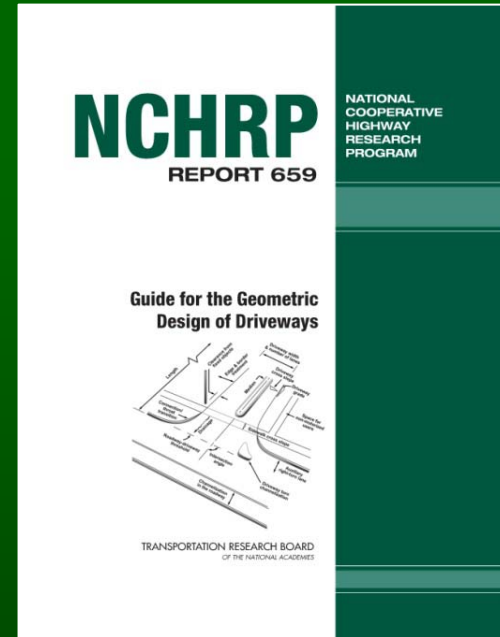
# Chapter 4 – Cross Section Elements

- Clear zone and lateral offset discussion provided in a more consistent format with the **Roadside Design Guide** [pg 4-15]
- Curbs: for high-speed ( $\geq 50$  mph) use sloping curbs; 4-in in rural or in urban/suburban areas with infrequent access points or streets, 6-in in urban/suburban areas with frequent access [pg 4-16]
- Sidewalks and Curb Ramps – updated discussion consistent with the AASHTO Pedestrian Guide and the PROWAG [pgs 4-57, 4-61]



# Chapter 4 Cross Section Elements

- Discussion of driveway profiles to accommodate vehicle under-clearance, pedestrians, and drainage. References NCHRP Report 659 *Guide for Geometric Design of Driveways* [pg 4-48]
- Use of diagonal curb ramps discouraged [pg 4-62]
- Added discussion of on-street back-in, head-out diagonal parking [pg 4-72]



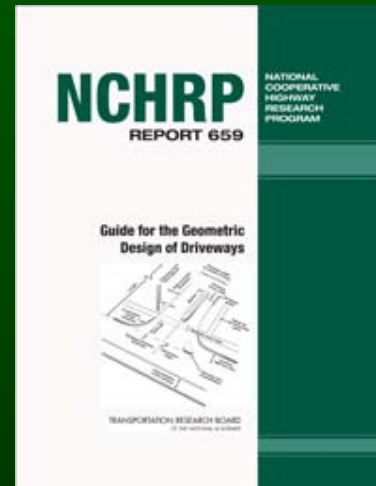
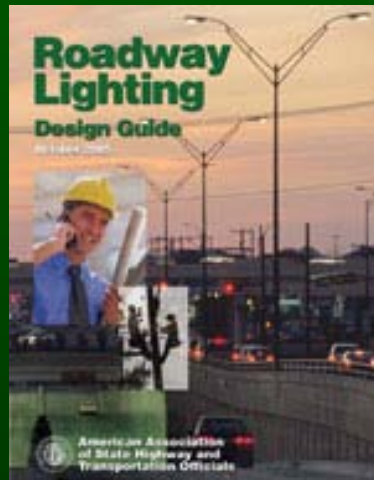
# Chapter 5 – Local Roads and Streets

- Updated reference to AASHTO LRFD Bridge Design Specifications [pgs 5-7, 5-19]
- Clear zone and lateral offset discussion to be consistent with Roadside Design Guide [pgs 5-8, 5-20]
- Added discussion of Level of Service in Rural and Urban areas [pgs 5-3, 5-12]



# Chapter 5 Local Roads and Streets

- Updated references to AASHTO *Roadway Lighting Design Guide* and ANSI/EISNA publications [pg 5-22]
- Added reference to NCHRP Report 659: *Guide for the Geometric Design of Driveways* [5-19]



# Chapter 6 – Collector Roads and Streets

- Added discussion about selection of LOS for collectors [pg 6-12]
- Added roadside design discussion to clarify clear zone and lateral offset [pg 6-17]
- Pedestrian, bicycle and sign structures should provide 15 ft..... minimum vertical clearance [pg 6-17]





# Chapter 7 – Arterials

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## Rural section additions:

- Added discussion about use of minimum radii and lengths of horizontal curves [pg 7-3]
- Medians: “...multilane undivided facilities should be discouraged except where provision of a median or turn lane is not practical” [pg 7-12]

## Urban section additions:

- Characteristics: “The type of arterial selected is closely related to the level of service desired for all users and urban context in which it is located.” [pg 7-26]
- LOS selections [pg 7-28]

# Chapter 7 Arterials

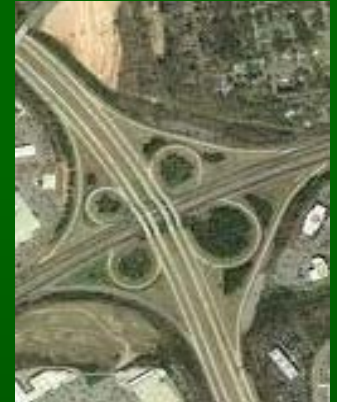
Added discussion about:

- Relationship between Design Speed and lane widths [10 ft..... < 35 mph] [7-29]
- Benefits of parking lanes [7-34]
- Benefits of medians to pedestrians in urban areas [7-31]
- Offset left turn lanes when selecting median widths [7-31]



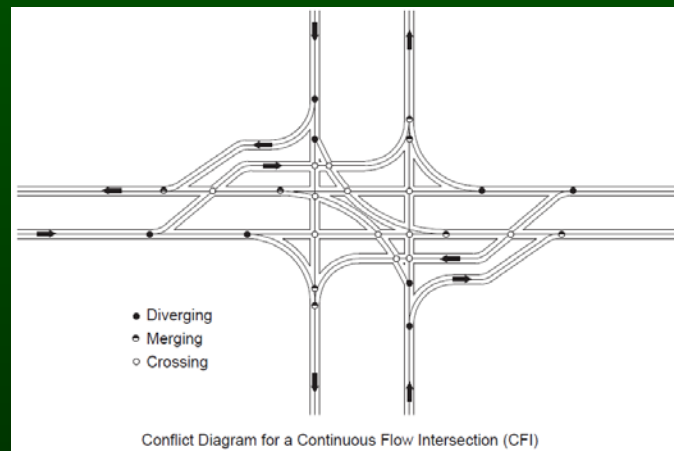
# Chapter 8 – Freeways

- Added discussion on superelevation rates considering snow/ice, viaducts, and section consistency [pg 8-3]
- Roadside Design: reorganized Clear Zone and Lateral Offset [pg 8-5]
- Shoulder width: where DDHV for truck traffic exceeds 250 veh/h, a paved shoulder width of 12 ft..... “should be considered” [previous “should be 12 ft.....’] [pg 8-3]



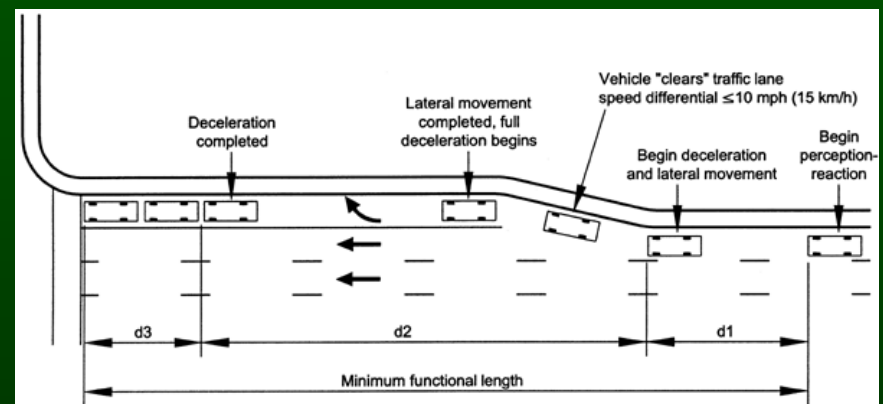
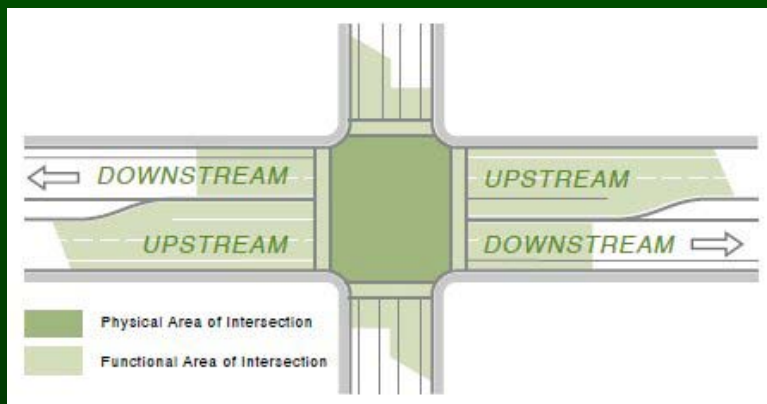
# Chapter 9 – Intersections

- Added or updated discussions of:
  - Intersection capacity based on HCM [pg 9-7]
  - Roundabouts [pgs 9-21, 9-167]
  - Continuous Flow Intersections [pg 9-160]
- Expanded discussion of Indirect Left Turns and U-turns [pg 9-162]



# Chapter 9 Intersections

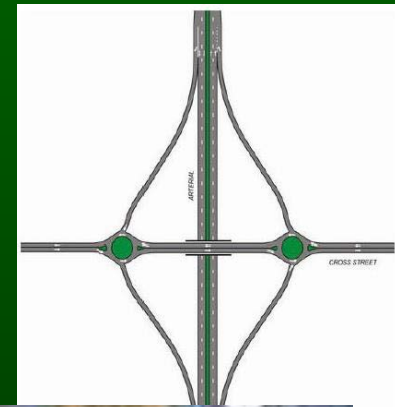
- Based on TRB Access Management Manual:
  - Definition of Functional Area [pg 9-2]
  - Components of Auxiliary Lanes [pg 9-124]
  - Deceleration Length Discussion [pg 9-126]
- Added design criteria for double/triple left turn lanes based on NCHRP 505 [pg 9-139]



# Chapter 10 –

## Grade Separations and Interchanges

- Updated Exhibits and discussion for Directional/Semi-directional Interchanges
- Included an Exhibit for Diamond Interchange with Roundabout Intersection Control [10-42]
- Added discussion about:
  - Roundabout ramp terminals
  - Ramp metering [10-128]
  - Two-lane loop ramps [10-90]
  - Left-side ramp terminals [1-103]
  - Vertical clearance above RR's [10-22]



# Chapter 10

## Grade Separations and Interchanges

- Terminology for Single-Point Diamond Interchange (SPDI) [previously SPUI] [10-42]
- Ramp shoulders and lateral offset: “The left and right shoulder widths may be reversed if needed to provide additional sight distance.” [10-102]
- Procedure for measuring the distances between ramp terminals is given in the HCM 2010 new weaving methodology (measured between the painted noses) [10-106]



# 2011 Green Book Availability & Cost

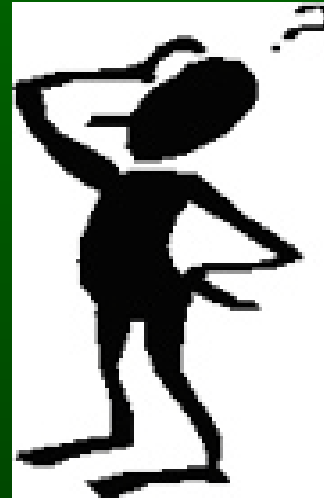
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# Questions?



# Thank You

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